

The CACNews

News of the California Association of Criminalists • Third Quarter 2009



The President's Desk

Carry on the Tradition

The 113th Seminar was held May 11-15, 2009 in beautiful Lake Arrowhead. The staff of the San Bernardino County Sheriff's Laboratory should be commended for putting together such a diverse program in a wonderful setting. The workshops and technical program topics were excellent examples of what an important benefit this association is to its members: providing training across all aspects of criminalistics. During these times of budget constraints, there are few training opportunities that provide such wide breadth of criminalistics training at such a low cost.

Workshops included Alcohol Interpretation, Leadership, Crime Scene Processing, Quality Assurance and DNA Statistics. Represented during the technical sessions were Controlled Substances, Ethics, Trace Evidence, Firearms, Crime scenes, Toxicology, and DNA. Through participation in seminars, study groups, regional lunch/dinner meetings, and Endowment sponsored training courses, members have numerous opportunities to be exposed to all of the disciplines within this field. The membership is upholding the vision of our founders, who started this association to foster an exchange of ideas and information, to establish friendship and cooperation, and to encourage a high level of ethics and competence.

Our profession has witnessed many changes over the years since the founding of the CAC. The expansion of laboratories due to increased caseloads and the high level of technical expertise needed to analyze a variety of physical evidence have led to more specialization. Accreditation requirements, including proficiency testing, have made it nearly impossible to remain proficient and perform casework in multiple disciplines. It is still of utmost importance that a criminalist in any discipline have a basic knowledge of the capabilities of other sections so that each piece of evidence that is submitted can be critically analyzed to ensure that proper case questions are addressed.

Utilizing the resources the CAC has to offer can enhance your career. You may be newly hired, fresh out of college, eager to learn about the different disciplines within the field and contemplating the sections in which you may wish to work during your career. Maybe you are well into your career and recognize the need to keep up with the technological changes that may affect your daily casework. Or, perhaps you have developed a level of expertise and recognize that you have something to offer to the members and choose to present a paper or put on a specialized training course. In the future you may consider moving into supervision and wish to learn about different operational practices of other laboratory systems. Whatever your situation you owe it to yourself to take advantage of this great resource.

I would like to thank Jennifer Mihalovich for her outstanding service as president this past year. Jennifer represented our association during a year when the National Academy of Sciences presented their report regarding the use of forensic science in this country. She also represented the CAC as a member of the AB 1079 Crime Laboratory Task Force. This involved a commitment of attending monthly meetings and participating in task force projects. We look forward to the report by this committee which should be ready during the late fall of 2009. The recommendations of this committee, along with the National Academy of Sciences report, will present challenges to our profession in the near future.

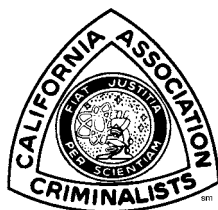
Typical of the leadership and initiative of our members, several have already begun to address one of the recommendations of the NAS report, that of a National Code of Ethics. This committee, led by Pete Barnett, should be commended for taking the initiative to tackle this project. They welcome input and plan to have a work product to present at the AAFS meeting in February 2010. Our Association has a reputation of initiating and participating in issues at a national level, such as certification and development of standards. We need to carry on this tradition by voicing our concerns and offering solutions as our profession is being scrutinized.

Mary

The membership is upholding the vision of our founders, who started this association to foster an exchange of ideas and information, to establish friendship and cooperation, and to encourage a high level of ethics and competence.



Mary Hong
CAC President



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The CAC is a private foundation dedicated to the furtherance of forensic science in both the public and private sectors.

Please direct editorial correspondence and requests for reprints to the editorial secretary.

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Notice to Contributors: We publish material of interest to our readers and are pleased to receive manuscripts from potential authors. Meetings and course announcements, employment opportunities, etc. are also solicited. Advertisements are also accepted, although a fee is charged for their inclusion in *The CACNews*. Please contact the advertising editor for further information.

Submissions should be made in the form of Windows compatible files on CD or by e-mail. MS Word files should be saved as version 2000 compatible. Alternatively, text files may be saved as plain ASCII files without formatting codes, e.g. bold, italic, etc. Graphics, sketches, photographs, etc. may also be placed into articles. Please contact the editorial secretary for details.

The deadlines for submissions are: December 1, March 1, June 1 and August 15.



On the cover...

San Bernardino Sheriff crime scene specialists Jessica Cundieff (l) and Heather Harlacker (r). Together with Justin Lyndes they demonstrated chemical methods of searching for blood patterns at the recent CAC Spring Seminar.

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CACBits



CAC member Greg Laskowski uses a Mikrosil cast of a suspected homicide weapon to do a comparison. The *Forensic Files* episode, "Over a Barrel," originally aired in 2004.

Extreme Forensics Looking for Stories

We are seeking cases clear of appeals and forensically intriguing stories...as well as intellectually stimulating crime scene investigations.

The television show *Extreme Forensics on Investigation* Discovery is currently researching forensic criminal cases to use in the second season of the popular show. *Extreme Forensics* focuses on how interesting and innovative forensic science and technology was responsible for solving crimes.

If you have any cases in mind, please contact Jen Ciraldo at: jen@straydogentertainment.com or call 917-270-7382.

Visit investigation.discovery.com/tv/extreme-forensics/extreme-forensics.html

CAC Awards Presented at the Spring Seminar

Ed Rhodes Award to **Heidi Hunsicker, OCSO**

ABC Award to **Samantha Frost, UCD**

Most Outstanding Paper (Fall 2008) to **John Murdoch** for his paper: "Firearm and Toolmark Identification—Meeting the *Daubert* Reliability Challenge."

Award for Service to the CAC:

Mark Traugbber, Eric Halsing, Julie Leon, Ron Nichols, Adam Dutra, Keith Inman, Norah Rudin, Mey Tann, Alicia Lomas-Gross, Cindy Fung.

Criminalist Openings Expected

It is highly likely the Los Angeles Police Department will be hiring 20 new criminalists in fiscal year 09/10. Ten early in the fiscal year and ten six months later. All will be as-

signed to biology and must qualify for assignment to perform forensic DNA analysis. Applications for Criminalist are always accepted. When sufficient applications are received the group is closed and a test for that group is scheduled. Go the following link for particulars about the job and the application process.

http://personline.lacity.org/job_list/index.cfm?FuseAction=Showspec&CC=2234

Next Meeting is Santa Clara

The next CAC semiannual seminar will be hosted by the Santa Clara Crime Lab from October 26-30, 2009 at the Doubletree Hotel. Tentative workshops include DNA, Courtroom testimony, Firearms and CSI graves.

The following spring meeting will be a bit earlier than usual: April 25-30, 2010 at the Tenaya Lodge in Yosemite, hosted by DOJ Fresno. After that, the fall 2010 meeting will be hosted by the Alameda county crime lab and then LA Sheriff will host the spring 2011 meeting.

FSS meeting canceled

Even though the CAC offered up to ten \$1,000 stipends to members who presented papers at the Lausanne meeting of the Forensic Science Society, the overall number of delegates was simply too few to make the meeting practical, and it was canceled late in May.

New Forensic Publication

A new periodical aimed at crime lab personnel interested in management is now available. From the press release: "*Forensic Science Policy and Management* is the only journal dedicated to improving the effectiveness, efficiency, quality, and operations of forensic science laboratories as well as to the education and training of forensic scientists. The journal provides a vital forum for exploring both current practice in forensic science and methods for improving and advancing the field so that it can meet rapidly increasing public needs and expectations.

The editors, Jay Siegel, of Purdue University and Max Houck of West Virginia

University are well known in the field of forensic science. The contact information is:

Julie Sikora, Taylor & Francis, 325 Chestnut Street, Suite 800, Philadelphia, PA 19106, Tel: 800-354-1420, ext. 267

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The Editor's Desk

A Pocketful of Change

Change can be difficult, but it is important and integral for life.

The Miriam-Webster on-line dictionary definitions for “change” include:

1. *To give a different position, course, or direction.*
2. *To make a shift from one to another.*
3. *To become different.*
4. *Coins especially of low denominations <a pocketful of change>.*

Change, or the promise of change, is so important it was the focal point and rallying word of our last presidential election. Change can be thrust upon us or we can seek it out. Change can cause improvement or it can confound and confuse us. As we go through our lives we constantly deal with change—big, small, important, and insignificant. The only definition of change, on the above list, that doesn't come with a certain level of stress or concern is “a pocketful of change.” But, the reality for me of a “pocket full of change” has also changed. With the greater use of credit and debit cards, I have much less change in my pocket. I don't know if this is a good or bad change, but I do know my change jar (actually a side-arm vacuum bottle) takes considerably longer to fill. However, my change jar was used to collect coins to play slot machines on the rare occasion I went to Las Vegas, but, as I learned on my most recent trip to Sin City—most slot machines no longer take coins. Therefore, one change is offset by another change, resulting in one less reason to keep change.

The focus of this editorial will be one of the minor changes in your life, hopefully not completely insignificant, but definitely minor. Every spring, the CAC goes through change. Elections occur for half of the positions on the Board of Directors. This last spring I was elected to the position of editorial secretary, beating my imaginary opponent by a landslide. With this election, I replaced Ron Nichols who served the CAC as editorial secretary for the last six years.

The primary responsibilities of the CAC editorial secretary are the production of the *CACNews* and the maintenance of the CAC website. If I really had to produce the newsletter or maintain the website myself, I never would have chosen to pursue this position. Luckily, the CAC has an exceptional Publications Committee composed of talented volunteers dedicated to providing you with exceptionally produced and maintained CAC information sources. Because of the Publications Committee, the change of editorial secretary will have a minimal impact on the overall look and feel of our association's communication tools. However, I do plan to have an impact by bringing my experiences to the job and continue to build and improve on the good work of those before me.

As individuals, our own interests, experiences, and beliefs influence every endeavor we choose to pursue. For six years Ron did an excellent job as editorial secretary, providing the CAC with what was needed while subtly influencing things with his view on life and our profession, which were based on personal and professional experiences. I intend to bring to my new position ideas born from my own personal and professional experiences. This change, like many others, is good because it allows the presentation of new ideas and experiences. I hope that when I am replaced, the next editorial secretary brings change with a whole new set of ideas and experiences to share.

I love being a part of the criminalistics profession. The work we do is important and helps society in ways most people never have the chance to experience. I have had the opportunity to work in several specialties and at many different levels. I have participated in several professional organizations and feel that the California Association of Criminalists is the best. The CAC has historically taken the lead on issues at the core of a profession such as ethics and certification. All of this is why I have chosen to once again serve such a worthy organization. In addition, I feel that at this point in my career I can bring a unique set of skills and experiences to the CAC.

In a previous issue [*CACNews*, 4thQ 2008] I wrote a guest editorial about an area I feel the CAC has been lacking. Preparing casework criminalists to be the profession's future leaders and to help bridge the gap between the needs of bench analysts, supervisors and managers. Future editorials will focus on these complex but important issues.

For the next two years, I will be sitting on the board of directors of two forensic science professional organizations,

*Starting with
this issue of
the CACNews
you will see
comments from
some of our
new members.*



Greg Matheson
CAC Editorial Secretary

the CAC and ASCLD. I will use this opportunity to share with both boards, and with you, the wants and needs of analysts and managers. For the next issue of the *CACNews* I have asked Dean Gialamas, the Laboratory Director of the Orange County Crime Laboratory and ASCLD President to write an article for the *CACNews*. It will be from his perspective and focus on the relationship between ASCLD and the CAC, what CAC members mean to ASCLD, and what ASCLD should mean to the CAC. It is advantageous to all of us to improve our lines of communication.

Starting with this issue of the *CACNews* (see page 33) you will see comments from some of our new members. I challenged our newest members with several questions. Their responses should be read and digested by decision makers

within the CAC. I found their input both interesting and informative. Thanks to those who responded with their thoughts and suggestions.

Finally, I want to challenge all of you, who had the persistence to get this far, to drop me an e-mail with your thoughts and ideas about creating change in the *CACNews* and the CAC website. Or, if you don't have any suggestions at this time, just send me an e-mail so I know someone read this to the end.

Thank you for your time and involvement in a wonderful organization. I am looking forward to this change.



SJSU Expresses Gratitude

On behalf of San Jose State University, I am please to acknowledge California Association of Criminalists' generous donation of \$5,000 to support the CAC Forensic Science Scholarship Fund.

San Jose State University is committed to providing an outstanding education and to improving lives in the many communities it touches. Your financial support helps us sustain this commitment to excellence.

Thank you for your generosity. Please know it is deeply appreciated and will be carefully stewarded.

Fred Najjar
Vice Pres., University Advancement

A Thank You from CSULA

The Criminalistics faculty of the School of Criminal Justice and Criminalistics at the California State University, Los Angeles wish to thank the California Association of Criminalists for its support of our academic and research programs. Specifically, we would like express our appreciation for the \$3,500 award given in support of our research on the development of biochemical assays to correlate bloodstains with bodily injuries. We are also indebted to the CAC for its continued support of our graduate students. The \$5,000 gift for scholarships will further the success of our students in their scholastic and professional pursuits.

Professors Donald Johnson & Katherine Roberts
California State University, Los Angeles

James Blanco: A Cautionary Tale

An ethics case against James Blanco was resolved at the business meeting of the American Academy of Forensic Sciences on Feb. 18, 2009. The AAFS membership overwhelmingly rejected his bid for reinstatement after his expulsion by the Board of Directors in September 2008. Among his few

supporters, I noted some Criminalists and I understand there was much discussion of the matter in their section business meeting. I am writing this in hopes of clarifying the issues.

The AAFS Ethics committee, after extensive investigation and testimony, found that Mr. Blanco had purposely used an inapplicable technique on a particular type of problem in order to mislead a legal proceeding to the benefit of his client.

I was not a party to the complaint or the proceeding so I was not privy to any confidential information. I am familiar with the type of problem, the technique he applied, and with Mr. Blanco himself. I have known him for most of his career, though we have never worked together. The content of this article is based solely on that knowledge and a review of the information posted on the AAFS Members' page of the website so that voting members could familiarize themselves with the issues before considering Mr. Blanco's appeal.

First let us consider the problem—a line intersection. Mr. Blanco was asked by his client to determine which came first, text in inkjet printing or a signature in ballpoint ink. His client alleged that the inkjet text entry had been placed on the document after he had signed it.

In November of 2005, James Blanco, a Forensic Document Examiner in private practice with offices in Los Angeles and San Francisco, issued a report on a line intersection matter. His report indicated that he based his findings on IRLum and visual examination of the back of the paper. He appended a dramatic IRLum photograph which appeared to show a dark line on top of a glowing line, knowing that his report would be used immediately in a settlement hearing. Later in the course of an ethics investigation, he claimed that he had actually based his findings on other techniques, but had not had time to list them in his report. He was unable to recall what they were, and his meager bench notes did not refer to any other types of examinations. There is a strong implication that Mr. Blanco based findings he knew were about to be used in a legal proceeding on one technique of marginal usefulness and another that had 50% chance of actually being misleading.

Opinions expressed in Feedback are solely those of the author. Letters may be edited for clarity and brevity.

The next question is: Did James Blanco knowingly prepare a misleading report to the benefit of his client?

In order to believe that Mr. Blanco made an innocent mistake, one must accept the following propositions:

Mr. Blanco managed to remain ignorant of a well-established and long-known principle of document examination while working under the supervision of another FDE in an Accredited laboratory. Mr. Blanco maintained that ignorance while studying for the rigorous testing he underwent to obtain ABFDE Certification and the continuing education necessary to retain it. Mr. Blanco did not read the 16 articles he cited in his defense against the ethics charges. None of them recommended IRLum for line intersections problems and some warned against doing so. Mr. Blanco slept through, or immediately forgot the content of, a workshop he paid hundreds of dollars to attend. The ABFDE workshop on line intersection problems was held Nov.8-10, 2005; the date of the report in question was Nov. 11, 2005. Despite his firm belief in the validity of IRLum for line intersection problems, Mr. Blanco felt it necessary to defend himself by claiming to have actually relied upon other techniques, the particulars of which he was unable to recall or document.

The conclusion that Mr. Blanco knowingly issued a false report is simply inescapable. He tried to use the excuse that it was only a "preliminary" report, yet he knew full-well that it was to be used in a court matter that very day. He appended to that report a dramatic photograph that appeared to support his client's position, fully cognizant that that photograph might well be misleading. What he did was tantamount to Photoshopping in a smoking gun.

During his impassioned plea to the membership during the AAFS business meeting, Mr. Blanco did say something of note. He looked out into the audience and said, "If they can do this to me, they can do it to you!" Well, yes, one would certainly hope so.

Susan Morton, D-ABFDE

Contact the author of this letter for expanded information regarding the technical aspects of the techniques Mr. Blanco used in his examination and his professional background. The expanded information was deleted from the original submission for brevity. —Ed.

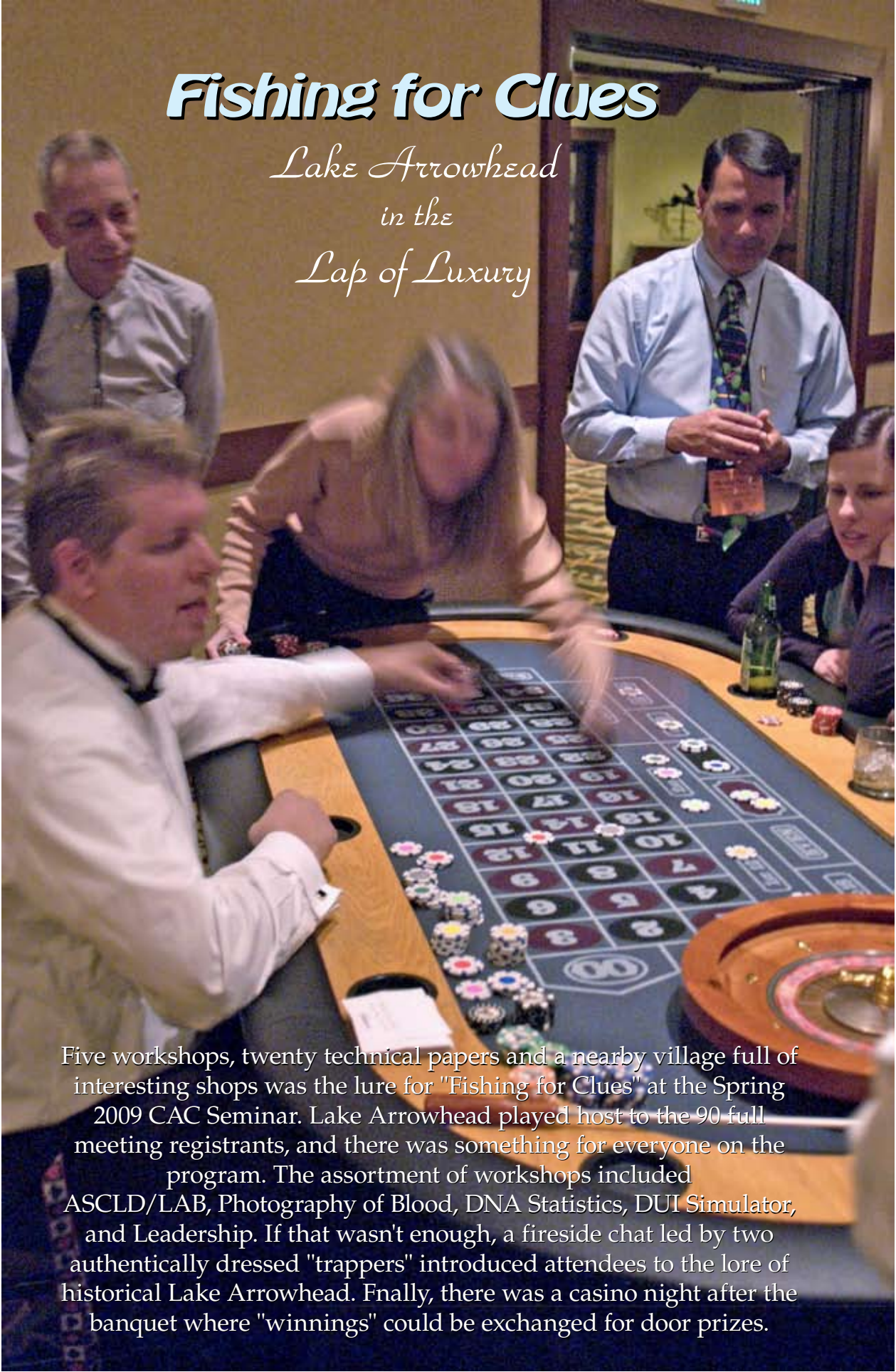
A Deliberative Body



Your newly installed CAC Board of Directors includes (at left) President Mary Hong, President Elect Adam Dutra, Regional Director South, Janet Anderson-Seaquist, Membership Secretary Patricia Huck, Recording Secretary Jamie Miller, Treasurer Michael Parigian, Editorial Secretary Greg Matheson, Immediate Past President Jennifer Mihalovich. Regional Director North Jeanette Wallin is shown at left in the top photo.

Fishing for Clues

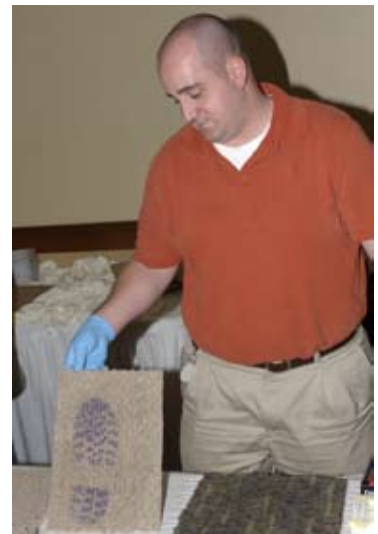
*Lake Arrowhead
in the
Lap of Luxury*

A photograph of a roulette table in a casino. A female croupier in a black dress is leaning over the table, which is covered with a blue felt featuring a grid of numbers and betting areas. Several people are seated around the table, including a man in a white shirt and a woman in a dark top. A man in a light blue shirt and patterned tie stands behind the table, holding a small object. The table is cluttered with colorful roulette chips and a green bottle. The background shows a dimly lit casino interior with a mirror reflecting part of the scene.

Five workshops, twenty technical papers and a nearby village full of interesting shops was the lure for "Fishing for Clues" at the Spring 2009 CAC Seminar. Lake Arrowhead played host to the 90 full meeting registrants, and there was something for everyone on the program. The assortment of workshops included ASCLD/LAB, Photography of Blood, DNA Statistics, DUI Simulator, and Leadership. If that wasn't enough, a fireside chat led by two authentically dressed "trappers" introduced attendees to the lore of historical Lake Arrowhead. Finally, there was a casino night after the banquet where "winnings" could be exchanged for door prizes.



Workshops: (clockwise from upper left) "Drinking and Driving Correlation Study"; "ASCLD/LAB International", Anja Einsele, Instr.; "The Art of Leadership", Keren Stashower, Instr.; "Lights, Camera, Latent Blood" (bottom 3), J. Cundieff, J. Lyndes and Heather Harlacker, Instr.; "Presenting DNA Statistics in Court", George Carmody, Instr.



Between bites of fresh s'mores, the group is entertained with some early lake folklore.



The technical session begins.



Vendor breaks provide an opportunity to catch up with old friends and new technologies.



Pete Barnett leads the panel discussion on developing a national code of ethics. (middle) Well-deserved service awards are presented by President Mihalovich.



Hiram Evans (r) preserves the oral tradition of the passing of the coconut while Jennifer and Dave welcome Mary with the trappings of her new office. (Bottom, middle) Past, present and future CAC presidents. (l-r) Jennifer Mihalovich, Mary Hong and Adam Dutra.



Prizes, prizes!





Daniel Gregonis: 2009 Anthony Longhetti Distinguished Member Award

When I was first told that I had been nominated for the Anthony Longhetti Distinguished Member Award I was surprised and flattered. When I went to the CAC web site and looked at the previous recipients, I was immediately humbled since many of the individuals on that list have been my teachers and mentors over the years.

As I thought further about this award I thought about the criminalist that it is named after. Anthony Longhetti left a legacy throughout the forensic science community in the form of students, coworkers, employees as well as association and academy members. I am proud to be a small part of that legacy.

Mr. Longhetti was a generalist in life as he was in the field of criminalistics. As a generalist in criminalistics Tony believed that an analyst should be able to recognize, properly document and collect any type of physical evidence and have a working knowledge of the various specialties in the lab. He supported the idea that each criminalist should be trained in sequentially more difficult and complex analyses and acquire expertise in a specialty after establishing a solid foundation in more general fields with shorter training loops. Through the frequent and free sharing of information and expertise, the California Association of Criminalists has played an integral part in establishing this foundation for its members.

One of the true strengths of the CAC is the significant representation of private examiners. These members offer different perspectives that everyone can learn from; in fact some of the most valuable experience I have gained is through working with private examiners, usually while I am called by the prosecution and the private examiner is called by the defense. Value the different perspective they bring, listen to what they have to say.

Looking at our membership, I know Tony would be pleased with the significant increase in numbers over the years, particularly in the younger members who bring enthusiasm and new ideas to the field. I learned early on that, if you open your mind, you can learn more from new criminalists than you teach. Dave Stockwell taught me that lesson well and I thank him for it.

It is not only learning but also the relationships and friendships of the members that make this an exceptional organization to belong to and participate in. The networking that the CAC facilitates is invaluable. The friendships I've made are lifelong and priceless.

Finally, and most importantly for tonight, I would like to thank the association for this award. I am very honored and I will cherish it as I hope to continue to serve the California Association of Criminalists in the future.

—Daniel Gregonis



After banquet, it was time to try one's luck!



ABSTRACTS

FROM THE SPRING 2009 SEMIANNUAL SEMINAR

Gun Powder Visualization by Digital Infrared Photography

Bill Matty

State of California – DOJ-CCI

Several different fabrics of differing colors and patterns were photographed under varying light conditions in order to determine optimum photographic conditions to enhance gunpowder pattern visualization. Depending on the type of dye used, the use of infrared photography can enhance the ability to see the gunpowder pattern (or other stain) to a remarkable degree. Infrared photography is a very useful tool for the detection and recording of gunpowder patterns on cloth which has a dark color or a multi-colored pattern.

Was That a Gunshot I Heard?

Lucien Haag

Forensic Science Services

The idea of sound as form of physical evidence may seem questionable to many yet sound is an integral and daily aspect of the physical world. Witnesses may claim to have heard what they characterize as one or more gunshots. Gunshots or similar high amplitude impulse sounds may, on occasion, be inadvertently recorded. This presentation provides some insight into the nature of such sounds, the limited instrumentation available to accurately measure them and the behavior of these sounds as they propagate over distance.

Uncertainty Of Measurement as Required by ISO Standards

Jack Wallace

Ventura County Crime Laboratory

Current ISO standards require that laboratories report the uncertainty of measurement in a manner useful to their clients, and the recent NAS report on Strengthening Forensic Science makes a similar recommendation. However, there has been little discussion of this topic in the forensic literature, and consequently many forensic scientists are concerned regarding how these requirements might be satisfied. Fortunately, procedures for estimating uncertainties have long been of interest to the larger testing community, and this paper summarizes several such methods that can be helpful to forensic laboratories. These approaches are based on (1) within-laboratory precision control samples, with and without estimates of extramural sources or error; (2) proficiency test results; (3) readability limits; (4) propagation of error considerations; (5) external standard reference materials; (6) standardized methods with known uncertainties; (7) expert judgment; (8) comparison to similar methods and analytes; (9) operational limits; (10) ruggedness testing. For each of these approaches

we identify the principal underlying assumptions and limitations, and provide limited examples from the forensic arena. The goal of this presentation is to enable forensic scientists to recognize those approaches that apply to their discipline, and to avoid those that do not.

Assessment Of Smokeability of 80mg Oxycodone HCl Controlled Release Tablets

Helene Jensen

Drug Enforcement Administration

Oxycodone is a powerful synthetic opiate that is legally used in the long term treatment of pain. Oxycodone is classified as a Schedule II drug by the United States Code of Federal Regulations and the California Health and Safety Code 11055 due to its highly addictive properties and its high abuse potential. In recent years the 80 mg controlled release tablets, have become a popular drug of abuse. In particular, many abusers crush the tablets and ingest, inhale or inject the dissolved powder, or more recently, have started to smoke these oxycodone tablets. The smokeability of the tablets was tested by utilizing Purdue manufactured 80 mg controlled release, oxycodone HCl tablets (OC80). The tablets are commonly smoked by cutting them into quarters and heating a quarter tablet at a time on a piece of aluminum foil. As the tablet starts to melt, it slides down the foil leaving a "skid mark" and the smoke that is produced is inhaled through a straw by the user. This process was repeated in the lab wherein the emitted smoke was collected into methanol and the presence of oxycodone was confirmed by gas chromatography coupled with a mass spectrometer (GC-MS). Further testing of the "skid marks" on the foil by GC-MS also indicated the presence of oxycodone residue. In addition, a vacuum pump, utilizing a Buchner funnel with a moist piece of filter paper was used to collect the smoke as a quarter of an OC80 tablet was heated on foil. The smoke on the filter paper was then quantitated by gas chromatography with a flame ionization detector (GC-FID) and found to contain approximately 35-40% of the available oxycodone HCl. Thus, based on the experiment, a quarter of an OC80 tablet is equivalent to the user getting approximately 7-8 mg of oxycodone HCl for one "hit."

XRD Applications for Forensic Drug Analysis

Todd Davis

Drug Enforcement Administration

X-ray techniques have been used in forensic sciences for several decades. Powder data has been used for the identification of unknown materials or mixture of phases since the 1930's. X-ray Diffraction (XRD) techniques can be used as a nondestructive method of analysis and is especially suited for the determination of evidentiary materials that must not be destroyed. Previous forensic approaches for XRD included the analysis of paint, glass, fiber, metals, and soils. Now, with the development of ultra-fast X-ray detectors, it has allowed the technique to become a useful tool for the efficient screening of drug analysis. Identification of powder data is achieved by comparison of experimental data with standard data in crystallographic databases. The ICDD currently has one of the largest PDF libraries containing over 199,000 substances. However, current adulterants and illicit preparations were not available in PDF which prompted the DEA to create

a working library that would fill in the necessary gaps. Most powder diffraction applications include phase identification, quantification, and determination of crystallite and particle size. Qualitative phase identification of polycrystalline organic, inorganic, and metallic substances has been studied with numerous controlled and non-controlled substances. New techniques have allowed the identification of the components present in pharmaceutical tablets directly through the blister packaging. These techniques have also been explored for the identification of illicit pharmaceutical preparations received from clandestine laboratories in addition to ecstasy whole tablet analysis. An evaluation of samples encountered at the DEA ranging from milligram residues to kilogram seizures has been studied. Relatively simple modifications of the diffractometer will increase its sensitivity to small amounts of sample to improve the lower limits of quantitation. X-ray diffraction in combination with the Rietveld method will also yield a reliable and accurate method to quantify the relative phase abundances in drug samples.

Development of a Mandatory National Code of Ethics for Criminalists

Moderator: Peter Barnett, Panel: Carolyn Gannett, John Murdock, Jim White, Peter Deforest, Jasmine Jefferson, Jeff Thompson

The National Academy of Sciences' recent report, *Strengthening Forensic Science in the United States: A Path Forward*, calls for the development of a national code of ethics for forensic scientists. Recommendation 9 is to establish "a national code of ethics for all forensic science disciplines. . . . Such a code of ethics could be enforced through a certification process." (Another recommendation in the report calls for mandatory certification of all forensic scientists.) An initial draft of a code of ethics, developed by a CAC committee, will be presented to the CAC membership for review and comment. Comments offered by criminalists during the panel presentation, and solicited from all CAC members over the next several months, will be used to develop a final draft of the document which will be presented for approval of the membership at the Fall seminar. Exactly how, when, or if the report's recommendation will be implemented is not known at the present time. But as the process evolves it is hoped that a document developed by working criminalists represented by members of the California Association of Criminalists will play a substantial role in the development of the national ethics code called for by the National Academy's report.

Rapid Set-Up and Validation of a New DNA Laboratory

Natasha Poe

Coroner Forensic Science Center DNA Laboratory—St. Tammany Parish

In 2004, St. Tammany Louisiana parish residents identified the need for forensic DNA services and voted for a property tax to support a state-of-the art forensic science center in the coroner's office. The tax specified that the center provide DNA profiling, toxicology and pathology for the residents of the parish for twenty years. After delays due to hurricane Katrina, the tax collection finally began in October 2006 and funds became available for laboratory implementation.

In order to provide law enforcement agencies and the district attorney's office of St. Tammany Parish with results

as soon as possible, the coroner implemented the DNA laboratory in an expedited fashion. The coroner hired seasoned forensic analysts and additionally contracted with outside subject matter experts to assist the DNA analysts in validating the procedures and equipment. This novel implementation approach allowed the laboratory to begin receiving and testing evidence in August of 2007, less than one year after the tax was implemented and four months after laboratory building renovations began. The DNA laboratory received ASCLD/LAB accreditation in June 2008 and is currently waiting for their CODIS hardware to be installed.

The rapid implementation of the St Tammany Parish Coroner Forensic Science Center DNA laboratory comes at a time when many DNA laboratories in the United States are struggling to reduce DNA backlogs, while concurrently dealing with increased numbers of case submissions due to the increased importance of DNA evidence in solving crimes. The novel approach taken by the coroner to rapidly implement and expand laboratory operations will be discussed.

The Harper Family Murder Trial: Kern County's First Quintuple Homicide

Gregory Laskowski

Kern County District Attorney

In July of 2003, five people were found murdered in their home in Bakersfield, California. The husband of the deceased was developed as a suspect, but claimed he had an ironclad alibi; he was over 2,000 miles away in Columbus, Ohio at the time of the murders. This presentation will discuss the crime scene, the physical evidence collected and analyzed including novel geographical forensic entomological evidence, and some of the expert testimony given at the sensational murder trial.

Analyzing *Salvia Divinorum* and its Active Ingredient Salvinorin Utilizing TLC and GC-MS

John Jermain

Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF)

Due to the powerful psychoactive chemical ingredients found in *Salvia divinorum*, Federal and state legislatures, including California, have been considering prohibition of the sale of the herb and making it a Schedule I Controlled Substance. Because of this legislation and the current legal status of the plant throughout the remainder of the country, the San Bernardino County Sheriff's Department's Scientific Investigations Division has taken steps to insure proper testing procedures are available to analyze *Salvia divinorum* and its active chemical ingredient salvinorin A. The studies described herein were performed due to the interest in developing procedures to identify the presence of salvinorin A. The two techniques that were utilized for this study were TLC and GC/MS. Raw dried leaves of *Salvia divinorum*, commercial *Salvia divinorum* extracts ("5x", "10x", and "20x"), *Cannabis sativa* L., and thirteen other species of *Salvia* were examined by TLC in order to determine if salvinorin A could be distinguished from the chemical components in the other plant species. While GC/MS is the preferred method used by surveyed crime laboratories to identify salvinorin A, there are a wide variety of extraction techniques utilized. Several of these extraction procedures were studied in order to determine which technique is best suited in analyzing salvinorin A.

Prevalence of Drugs in Addition to Alcohol at BAC Levels Above the Legal Limit

Melissa Kramer

Los Angeles Police Department

California Vehicle Code (V.C.) 23152(a) states, "It is unlawful for any person who is under the influence of any alcoholic beverage or drug, or under the combined influence of any alcoholic beverage and drug, to drive a vehicle." At the Los Angeles Police Department Scientific Investigation Division, blood samples from individuals arrested in violation of a variety of laws, including V.C. 23152, and measuring at or below 0.08% BAC are subjected to a routine ELISA blood screen using Immunalysis kits for PCP, cocaine, opiates, amphetamine, methamphetamines, THC, barbiturates, and benzodiazepines. We have chosen to conduct a study to expand the window to include 0.15% BAC and below in order to ascertain what drugs, if any, are found in addition to higher alcohol levels.

The data collected included 431 cases over a 7-month period from October 2007 to April 2008. This information comprised a majority of all samples analyzed in the Blood Alcohol Section of the Toxicology Unit that met the above criteria. Of the 431 samples, 40% of cases with an alcohol level of 0.09-0.15% BAC screened positive for at least one of the eight drugs included in the screen. The most prevalent drugs detected at these levels were THC, cocaine, and benzodiazepines with percentages of 62%, 24.5%, and 17.5%, respectively.

Information regarding drug-positive cases can be useful not only in a court of law as an addition to driving under the influence of alcohol, but also as an explanation of symptoms inconsistent with ethanol impairment at the time of arrest. From these results, the number drivers under the influence of drugs is significantly underestimated in the city of Los Angeles due to the policy of drug testing only those samples that lie at or below the statutory alcohol limit. These data are important as law-makers consider the necessity of expanding legislation with respect to the drug impaired driver. The data presented here may also be an underestimation of drug impairment because of the limitations of the ELISA panel. Toxicology laboratories commonly restrict the cases that undergo drug analysis because of limited resources; however, in this era of increased prescription drug abuse this topic deserves greater attention.

In Search of a Replacement for the Centricon 100 Centrifugal Filter: A Comparison With Eight Post DNA Digest Purification and Concentration Devices

Dan Gregonis

Los Angeles County Sheriff's Department

The Centricon 100 centrifugal filtration device has been used in forensic science to help purify and concentrate DNA for over 20 years. With the discontinuation of these devices new methods/apparatuses must be verified to meet the needs of the concentration and clean-up steps following phenol/chloroform/isoamyl alcohol (PCI) "organic" extraction. Pall Life Sciences corporation produces a product called "Microceps™" and Sartorius Stedim biotech produces a product called Vivacon 2 (in 30, 50 and 100K molecular weight cutoffs) that are very similar in design and function to the Centricon®

100 which were manufactured by Millipore. Furthermore, Millipore is now manufacturing a product called "Amicon® Ultra-4" as a replacement for their Centricon series and also has the Microcon 30 and Microcon 100 filtration devices for use in a micro centrifuge. Robotic post digest cleanup is also available through the use of the Qiagen Biorobot EZ1 using the Investigator Kit. This study is designed to define analysis parameters for the Microceps™, Vivacon 2 (30k, 50k and 100k), Ultra-4, Microcon 30 and Microcon 100 as a potential replacement for the Centricon® 100s and to determine if any of these devices are as good as or superior to the Centricon® 100 for recovery of DNA. The Qiagen EZ1 using the Investigator kit was also compared. The centrifuges available for this study included the IEC Centra MP 4R and IEC CL31R at Los Angeles Sheriff's Department, the IEC Centra CL2 at Los Angeles Police Department and the Beckman Allegra 6R, Beckman TJ-6 and the Thermo Scientific Megafuge 11R at the San Bernardino County Sheriff's Department. All of these centrifuges had fixed angle rotors. The study itself consisted of several smaller studies. The first was to determine the optimal RCF and times required to obtain a usable volume after concentration.

The second study involved the recovery of DNA from extracted samples. The third study estimated the efficacy of recovering

different sized DNA fragments and the final part of the verification measured the various devices in cleaning up known inhibitors. The Vivacon 100 by Sartorius is a suitable replacement for the Centricon 100. This device performs at an equal or better level in the recovery of DNA after a Phenol-Chloroform extraction and takes less time (three 15 minute spins compared with three 20 minute spins). For challenged samples (either low level or degraded samples) the Microcon 30s are recommended since they are superior to either the Centricon 100s or the Vivacon 100's in the recovery of total DNA and the recovery of smaller fragments of DNA. The Vivacon 30 and 50, the Microcon 100 and the EZ1 using the Investigator kit are also suitable replacements for the Centricon 100's although the EZ1 is not recommended for very low level and/or potentially degraded samples. Neither the Microcep 30 nor the Amicon Ultra-4 performed as well as the Centricon 100. Advantages and disadvantages of each device will be discussed.

Isomer Determination of Cathine in Khat

Rochelle Hranac, Arizona Department Of Public Safety (Part 1)

Lon Anderson, Drug Enforcement Administration (Part 2)

In January 2009, the khat plant (Schedule II) and its active components, cathinone (Schedule II) and cathine (Schedule IV), were added to California Health and Safety Code as controlled Substances. Cathine (d Norpseudoephedrine) is an isomer of a non-controlled substance, l-norpseudoephedrine, thereby requiring the forensic analyst to perform testing to identify the isomer present. This presentation presents both sample preparation and instrumental techniques to identify cathine as well as the isomer. Sample preparation using acid-base extraction and/or dry-solvent extraction techniques are discussed. Four instrumental techniques to determine the isomer are presented: Gas chromatography with derivation, chiral gas chromatography, liquid chromatography with circular dichroism detection, and capillary electrophoresis.

The Recovery of Mitochondrial DNA from the Attached Side of Self-Adhesive Stamps

Meiling Cabral

Los Angeles Police Department

The ability to recover a genetic profile from the backs of self-adhesive stamps holds significant implications to the field of forensic science. This knowledge is pertinent in cases in which stamp evidence is commonly encountered; examples include extortion, threats, and kidnapping, where identifying the individual source of DNA may prove pivotal in criminal investigations. In 1994, the U.S. Postal Service discontinued the sale of water-activated stamps and replaced them with a pressure sensitive self-adhesive stamp. The self-adhesive stamp provides an alternative evidentiary source of DNA—DNA from fingerprint residues or “touch” DNA. Thus, there is a need to develop a method to successfully obtain a DNA profile from this alternate source of evidence. To determine the feasibility of recovering “touch” DNA from self-adhesive stamps, ten research subjects were instructed to affix self-adhesive stamps to a total of twenty envelopes. Prior to extraction, the image-side of the self-adhesive stamps was exposed to UV light for 10 minutes to decontaminate the external surface of the stamp. The stamps were extracted with phenol: chloroform: isoamyl alcohol and the extracts were purified and concentrated using Centricon® 100 microconcentrators. The extracted products were amplified and a haplotype was obtained using the LINEAR ARRAY™ Mitochondrial DNA HVI/HVII Region-Sequence Typing Kit. Three hypotheses were tested to examine the factors that may influence the recovery of mtDNA profiles. The recovery success for each research subject was calculated to determine whether the recovery of mtDNA profiles varies among subjects. Chi square analysis was performed to test the null hypothesis that there is no difference in recovery between self-adhesive stamps affixed to envelopes in the morning as opposed to the afternoon/evening. Chi square analysis was also used to evaluate the null hypothesis that there is no difference in recovery between freezer-stored and mailed samples. When considering full and partial profiles, the overall recovery success was found to be 54%. The results were inconclusive in determining whether recovery of mtDNA profiles varied among subjects. The ability to successfully recover mtDNA profiles from self-adhesive stamps was found to be independent of the time of day the stamp was affixed to the envelope. Recovery success was also found to be independent of the stamp's exposure conditions, whether freezer stored or transported via the U.S. Postal Service. The results of this study demonstrate that it is feasible to recover mtDNA from the attached side of self-adhesive stamps.

An Evaluation of the Mode of Transmission of Mutations in the Mitochondrial DNA Control Region

Lisa Anderson

California State University, Los Angeles, School of Criminal Justice and Criminalistics

Mitochondrial DNA (mtDNA) has played an increasing role in the analysis of biological evidence. Its application in identifying decomposed remains and victims of mass disasters has been extensively documented and investigated. MtDNA can also be used in general forensic casework when nuclear DNA is not available or may be too degraded to in-

terpret. While it is not possible to individualize evidence to the exclusion of all other individuals, mtDNA profiles may provide identifying criteria relating to the family origin of the individual who deposited the evidence. However, since mtDNA is inherited from an individual's mother, relatives generally cannot be distinguished among family pedigrees in the maternal lineage. Studies have demonstrated that mtDNA is susceptible to genetic mutation. In particular, a high degree of polymorphism is observed within hypervariable region I (HVI) and II (HVII) of the control region. The mutations may be somatic (mitotic) or may originate in the female germ-line (meiotic). Generally, only a single mtDNA type is detected within an individual, a condition referred to as homoplasmy. However, when a mutation arises, but is only reflected in some copies of an individual's mtDNA, the result is a combination of normal (wild) and mutant types. This mixture of haplotypes on mtDNA sequences is referred to as heteroplasmy. The presence of heteroplasmic mutations can present advantages and disadvantages in a forensic context. The present study examines mtDNA polymorphisms in human head hair, saliva and bloodstains with respect to their potential for forensic application. MtDNA was isolated and polymorphisms were detected by applying sequence-specific oligonucleotide probe analysis. The particular focus was to characterize heteroplasmic mutations as germ-line or somatic in origin. This distinction is important in a forensic context because if transmission of a mutation occurs along the germ-line, this would support the collection of samples from maternal relatives or any tissue source associated with the decedent. However, if transmission is somatic in origin, intra- and inter tissue variation may exist and reference samples must correspond to the tissue analyzed in the case sample. Failure to do so would potentially result in a false exclusion. Bloodstains, head hairs, and buccal swabs representing the U.S. Caucasian population group were typed using the LINEAR ARRAY™ mtDNA HVI/HVII Region-Sequence Typing Kit. For the purposes of this study a sample was scored as heteroplasmic if two probe signals were visible within a single probe region (either with equal or uneven intensity). The results of this study demonstrate heteroplasmic expression in hair, tissue, blood and saliva within transmission of a particular mutation.

Use of Sample Matrix® to Capture and Stabilize Crime Scene Biological Samples

Katherine Roberts

California State University, Los Angeles

The successful resolution of crime scene investigations often depends on the ability to identify and individualize biological evidence. Fundamental to this analysis is the stabilization of biological evidence, because testing generally does not proceed immediately after collection. Crime scene samples and liquid extract derivatives are routinely stored frozen in forensic laboratories, to be thawed at the time of analysis. However, numerous lines of evidence indicate that the process of freezing and thawing has detrimental effects on biological samples. Many crime scene samples are sub-optimal for analysis—the further degradation of the samples by current storage systems only exasperates the difficulty of identifying and individualizing biological evidence. Biomatrica, Inc. has developed a proprietary platform technology for the dry storage of biological materials at ambient temperatures. The key component of this technology is SampleMatrix™, which

was derived from studies on extremophile organisms. These organisms can survive extreme environmental conditions. SampleMatrix™ consists of protective agents developed from combining small molecule chemistry with advanced polymer chemistry. This product has multiple components: 1) the dissolvable polymer in a stabilization buffer adjusted for the different biological samples; 2) a stabilizing solution containing small synthetic molecules. We have conducted research on the effectiveness of SampleMatrix™ to stabilize biological evidence as compared to conventional storage methods. The study tests the hypothesis that the storage of biological samples, swabs and liquid DNA extracts, in the SampleMatrix™ polymer at room temperature reduces the exogenous degradation of DNA by minimizing the adverse effects of hydrolysis and freeze-thawing. Blood, semen, and saliva stains of different concentrations were initially deposited on five different substrates. Each stain was sampled by swabbing with water or Sample Matrix™ as the wetting agent and then exposed to room temperature v. freezer storage for longitudinal study. In addition, we have conducted parallel studies whereby blood, semen, and saliva were directly applied to swabs and subsequently stored for longitudinal study. This presentation will discuss the results of the experimental conditions that were evaluated by Real-Time and STR analysis following standard forensic protocols.

Development of the Powerplex® 16 HS System

Lotte Downey

Promega Corporation

Short tandem repeat (STR) analysis remains the primary method for human identification. Forensic Typing, criminal databasing and relationship testing laboratories in the US and many other regions of the world use a standard set of 13 STR markers selected by the US Federal Bureau of Investigation for the Combined DNA Indexing System (CODIS). The PowerPlex® 16 HS System co-amplifies these 13 loci (D18S51, D21S11, TH01, D3S1358, FGA, TPOX, D8S1179, vWA, CSF1PO, D16S539, D7S820, D13S317, and D5S818) plus the low-stutter Penta E and Penta D markers and the gender-determining Amelogenin locus. One primer for each of these loci is labeled with fluorescein, carboxy-tetramethylrhodamine (TMR) or 6-carboxy-4', 5'-dichloro-2',7'-dimethoxy-fluorescein (JOE). Amplicon size is determined by comparison with the Internal Lane Standard 600 (ILS) labeled with carboxy-X-rhodamine (CXR). This four-color chemistry can be analyzed on the ABI Prism® 310, 3100 and 3100-Avant genetic Analyzers and Applied Biosystems 3130 and 3130xl Genetic Analyzers using existing dye matrix standards. The PowerPlex® 16 HS System provides a hot-start Taq DNA polymerase in a modified master mix to provide increased ease-of-use and performance over previous PowerPlex® systems. This assay has increased

tolerance to common forensic sample inhibitors known to reduce genotyping success rates. The presentation will share results from sensitivity and inhibitor studies along with developmental validation results.

GC-C-IRMS: It's Use/Misuse in the Floyd Landis Sports Doping Case

Bob Blackledge

Forensic Chemist Consultant

Gas chromatography combustion stable isotope ratio mass spectrometry, GC-C-IRMS, is the analytical method used as a confirmatory test for the presence of exogenous anabolic steroids in urine. This analytical technique should especially be of interest to CAC members because it has many potential applications to questions addressed in forensic science. This presentation will explain the scientific basis for GC-C-IRMS and use the data from the Floyd Landis sports doping case to illustrate possible pitfalls.

An Investigation Into PCR Inhibition Issues Encountered Using Microcon® for DNA Extraction, and Subsequent Validation of the Vivacon 2 for Casework DNA Extraction

Mehul B. Anjaria, Kellie A. Fenesan, Chantel M. Giamanco

Human Identification Technologies, Inc.

In November 2007 Human Identification Technologies, Inc. (HIT) was forced to abandon use of CENTRICON(r) Centrifugal Filter Devices for organic DNA extraction clean up due to their unavailability in the marketplace. The MICROCON(r) Centrifugal Filter Device was assessed and found to be a suitable replacement, and in fact produced slightly better DNA yields than did the Centricon. Initially, the Microcon appeared to perform well with casework samples. However, over time an increase in apparent PCR inhibition was observed. This was generally overcome by amplifying a reduced amount of DNA extract. The practice of exposing Microcons to ultraviolet light prior to use in casework was investigated as a possible aggravating factor, but experiments showed that the ultraviolet treatment did not have a detrimental effect. As the inhibition reached unacceptable levels, HIT began validating the VIVACON 2 as a replacement for the Microcon. The Vivacon performed well during the validation for both extraction and the concentration of extracts, and therefore HIT has abandoned the Microcon device in favor of the Vivacon. The troubleshooting approach used to deal with the inhibition encountered will be described and data from the Vivacon validation will be presented. Results of a literature search on ultraviolet treatment of consumables prior to PCR will also be described.

Challenging the Canon

"I wonder if other dogs think poodles are members of a weird religious cult."

—Rita Rudner

For the first time in some while, we are actually at our normal office writing this *Proceedings*. We notice the menu has changed, and whether it was just for the sake of change, or to lure customers in these lean economic times, the sexual innuendo of the names of some dishes would require sexual harassment training if spoken to a government co-worker. We manage to order without necessitating sensitivity training.

In our various movements around the state and the country, we hear from many of you that you actually read this column, and that it is not just a mental soliloquy. Further, we hear that you read it in spite of the fact that you sometimes, or even frequently, disagree with us, and that it stimulates discussions in your laboratory about the issue of the day. If so, then these POLs have greatly exceeded our modest expectations, and we thank you for it. On that note, we offer up yet another platter of slightly jumbled thoughts, hopefully seasoned sufficiently to be palatable, yet not so over-spiced as to burn.

Today we talk about what will surely be the center of the forensic science universe for the foreseeable, if not foreseeable, future; the National Academy of Sciences report entitled STRENGTHENING FORENSIC SCIENCE IN THE UNITED STATES: A PATH FORWARD. The fact that the title appears in all caps is an indication that someone believes it is an important piece of work.

Much has already been written and said about the report; conferences have already occurred discussing the points of the report in detail; Congress has already held hearings and heard testimony on the report; organizations have issued statements on its contents; and grant solicitations have been promulgated with the findings of the report in mind. And it has been out, as of this writing, for exactly one day shy of 90 DAYS. This is astounding activity for our field. Neither DNA nor fingerprints inspired this frenzied level of activity when first introduced.

Given all of this activity, what could your humble writers possibly contribute to the discussion? While we may have much to share of a technical nature with the various folk responsible for the "PATH FORWARD," this doesn't seem like quite the right venue for such discussions. Rather, we will use this edition's bully pulpit to reflect on the transformation

of a profession as viewed from within it, with more than 50 combined years of practice providing the wind for our sails. We are definitely not social scientists or psychologists, so we cannot provide expert analysis on the effect of the coming paradigm shift on those influenced by the pending changes, whatever they turn out to be. We will simply reflect on what we, as practicing criminalists, observe.

Fundamentally, *the canon of forensic science is being challenged* (some might say through the use of a war cannon aimed at its very core). The challenges made are to its technical, cultural, and administrative functions.

What is a canon? A commingling of definitions produces this understanding of the word:

A canon is an authoritative set of principles, rules, standards, and criterion within a field.

Its root can be traced to the Latin *canōnicus*, and the Greek *kanōnikós*, meaning of or under rule¹. One important but not exhaustive listing of the canons of forensic science that are challenged by the NAS report include:

1) Technical

Individualization—the belief (or rule) that one can attribute an evidence item to one and only one source, to the exclusion of all others. Currently five common disciplines claim the ability to perform absolute source attributions: dermal ridge prints, firearms and toolmarks, bite marks, handwriting, and DNA²

Competence—the belief (or rule) that practitioners are properly educated and trained to analyze physical evidence, and to communicate the meaning of their results within the limits of scientific knowledge and within proper legal bounds.

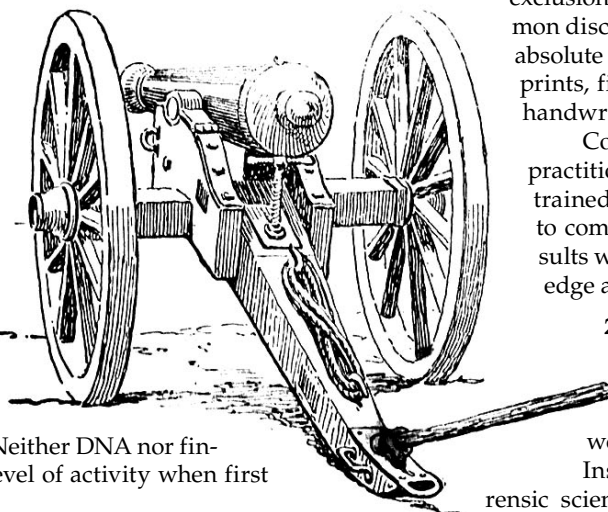
2) Cultural

Infallibility—the belief that forensic science (not a forensic scientist) is infallible, trustworthy, and objective.

Insularity—the belief that only forensic scientists are capable of defining the problems of the field and suggesting solutions to those problems. If measured by an in-breeding coefficient similar to that used in DNA statistical analysis, such a percentage value would likely be placed in the high 90's. According to

1 Dictionary.com

2 Yes, DNA. The FBI published a paper outlining their criteria for establishing when a source attribution can be made.



this rubric, anyone who has not gone to a crime scene, opened a bag of evidence, looked at the muck of the world, analyzed forensic data, or testified in front of a jury does not have the *bona fides* to comment on the state of the practice, the meaning of physical evidence, or how to practice the discipline.

3) Administrative

Comprehensiveness—The belief that all relevant evidence is being examined and is offered to the criminal justice community.

Organization—the belief that the current institutions of forensic science within the US are the ones most likely to produce useful and correct results to the trier of fact.

Objectivity—the belief that one can learn to avoid subconscious bias and that no administrative assistance is required to achieve it.

Some have responded to this canonical remonstrance by declaring, *ipse dixit*, that it is apocryphal³. Simply, the report is declared to be of questionable authority, and therefore its recommendations can safely be ignored, with no peril accruing to the process of criminal justice. This is pretty much like spitting into the wind, or tugging on Superman's cape;⁴ trouble predictably will ensue. Most responses begin with some variation of "... we welcome the recommendations of the report..." and then detail either why it won't apply to the author's field of expertise, or how 'some other discipline may have to change, but not us, cuz we're solid.'

Part of what drives this fear of change is the fear of admitting to failure or mistakes; the toll for analyst error in forensic science is perceived as grave, unforgiving, consequential, and permanent. An analyst does not want to admit that she has inadvertently contributed to a miscarriage of justice, either letting a guilty person go free, or sending an innocent person to jail. This personal responsibility can weigh heavily on an individual. Second, any error, whether verified or just perceived, will take on a life of its own, memorialized in reports and testimony that become part of a searchable database (you knew that both prosecutors and defense attorneys have access to extensive databases of your public work, and sometimes even internal documents, didn't you?) Third, in accredited labs at least, your analytical acumen is called into question, resulting in re-training, further training, and more proficiency tests (although this doesn't seem to occur nearly as often as one would predict, based on reports and audit documents that we have seen). Finally, no one likes to make a mistake, or at least admit to one. To err is human, but to err is also to have one's ego, self-respect, job satisfaction, and a host of other personal habits and traits called into question. Scapegoating occurs, along with internal ostracism, leading to a decline in morale and productivity. A laboratory section

³ of doubtful authorship or authenticity.

⁴ Our apologies to Jim Croce

is rapidly or slowly destroyed by early retirement, sideways movement to another discipline that is perceived to be "safer," flight to another lab, or defection from forensic science entirely.

Another fear, if admitted by practitioners, is that there really is not much science in forensic science. A substantial difference exists between the type of research reported in major scientific journals and that reported in forensic literature. This has resulted in part because of the vast disparity in resources available for basic research and that provided to forensic science, but primarily because of the genesis of forensic work in the context of law enforcement. Historically, requests for forensic analysis arose specifically to answer questions generated in the context of criminal or civil cases. This is a substantially different environment than that in which most science is practiced. Not infrequently, the answer was known—detectives usually "knew" who had committed a crime, or what happened, and needed help proving it. The stories of Paul Kirk and E.O. Heinrich describing the perpetrator from items of evidence are delightful precisely because they constitute the unusual, not the norm. When is the last time you wrote a report describing the perpetrator as a farmer who drove a tractor or pushed a wheelbarrow (and telling detectives the drive-by shooter wore a hoodie doesn't count)? It has been a struggle attempting to escape from these origins, trying to invent the scientific prequel to forensic science. We wonder whether, like Rita Rudner, other scientists think criminalists are part of some weird religious cult. To the extent that we believe in those canonical precepts outlined above, we are, and, in fact, they do.

When called to defend the profession, we must all decide, individually and collectively, which stance advances the cause of justice, and which obstructs, obfuscates, or inhibits it. It is one thing to courageously defend a strong position, and another to blindly defend all that we have inherited as gospel. In the parlance of the military, is this the hill we want to die on⁵?

As practitioners, we must admit that improving forensic science requires more than just us. The proper analysis of physical evidence requires a broad category of experts and stakeholders to produce reliable, valid analytical results that can be appropriately communicated to the triers of fact. Our efforts should always be tuned to understanding our work in the context of the criminal justice system, and how our proper interpretation of the evidence is affected by a wide variety of factors, with ingredients that include both scientific and human variables. Identifying and controlling for them should be the start of re-writing the canon. □

⁵ with apologies to the grammarians for the dropped participle





REGIONAL REPORTS NORTH / SOUTH

From Jeanette Wallin, Regional Director, North:

The U.C. Davis Forensic Science Program and Department of Justice Sacramento Laboratory hosted a luncheon and study group meetings on April 22, 2009. The guest speaker was Renee Romero, director of the Washoe County Sheriff's Office Criminalistics Laboratory in Reno, Nevada. She presented "An Interesting Case with a Super Bowl Ending"—a homicide case involving different forensic disciplines. Aspects of the recent NAS report were addressed throughout the presentation. There were approximately 60 luncheon attendees.

The QA study group met before the luncheon for a presentation and discussion on the NAS report. There were 19 attendees.

After lunch, the Drug and DNA study groups met. The drug study group discussed recent methods for manufacturing PCP and MDMA. There were 10 attendees to this meeting.

A variety of topics were presented at the DNA study group: batch processing of cases, forensic animal testing, domestic dog population genetics, forensic applications in cats, thoughtful reporting of evidence, and troubleshooting on the EZ1 robot. There were approximately 47 attendees to this meeting.

The firearms, alcohol, arson, and trace study groups did not meet during this period of time.

I am currently seeking a laboratory to host a northern luncheon and study group meetings during the summer.

From Janet L. Anderson-Seaquist, Regional Director, South:

The Long Beach Police Department Crime Laboratory cancelled the Study Group meeting tentatively scheduled for March 2009. I was unable to find a different agency to host with such short notice. The Los Angeles Police Department Crime Laboratory has committed to host the next Study Group meetings the last week of July or first week in August later this year. There have been some changes to the Study Group Chairs and the current Southern Region Study Groups and contact information is as follows:

Fire Debris Analysis: Eric Wahoske (323) 260-8510

Trace Evidence: Mel Kong (619) 531-2613

Blood Alcohol: Eileen Boyd (805) 477-7256; Robert Kane (661) 868-5650; Janet Anderson-Seaquist (805) 662-6804

Controlled Substances: Denise Lyons (805) 477-1938; Janet Anderson-Seaquist (805) 662-6804

DNA: Annette McCall (714) 834-4510; Juli Buckenburger (714) 834-4510

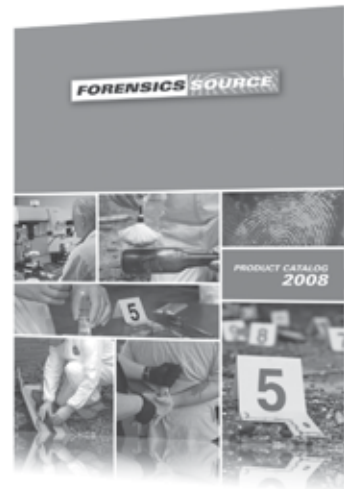
Toxicology: Ines Collison (714) 834-4510; Eucen Fu (323) 343-0530

Quality Assurance: Nathan Cross (323) 415-8123

CSI: Steve Cordes (619) 531-2656

I am currently soliciting individuals who will Co-chair Study Groups.

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Evaluating Antimony and Barium Ratios Found in Elemental Data from Gunshot Residue

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Introduction

Over the years, there have been many attempts to evaluate the potential of gunshot residue (GSR) as physical evidence. Articles dating from 1935 have attempted to analyze firearms residue in order to provide information valuable to the investigation of crimes committed with firearms [1]. Residues from the discharge of firearms consist of particles of metal from cartridge casings and the barrel of the weapon, lubricant within the barrel and burned and unburned primer and propellant. These particles are expelled from the weapon upon discharge and become lodged on persons or objects near the discharge point. The typical GSR primer particle is an aggregate of barium, antimony and lead. The analysis of GSR primer residue evidence depends on the unique existence of these three elements and the morphology of the particle itself.

There is not universal agreement among GSR analysts about what constitutes a true GSR particle or the interpretation of results. Differences in opinion have focused on the number of elements within a particle, particle morphology, and even the numbers of particles present [2]. Additionally, studies have been published that suggest the possibility of similar such tri-element particles from sources other than the discharge of firearms. Samples of environmental origin have been linked to brake linings, electrical wiring, cartridge operated tools and fireworks [3] [4].

Given the existence of barium, antimony, and lead particles in the environment, a mechanism needs to be developed to distinguish true shooters from environmental contaminants. This project attempts to aid in this differentiation by proposing the existence of a unique elemental signature to gunshot residue. Previous reviews of the data available in the literature suggest a consistency in the ratio of barium to antimony from the hand swipes of individuals that have fired a weapon that is not present in those of auto mechanics, telephone workers, carpenters and others, generally what is classified as environmental contaminant sources [5] [6] [7].

Over a three year period, four sets of test fire data were collected. Different weapons and ammunitions were used. Barium and antimony concentrations were recorded from residue on the hands of the shooters. One set of environmental samples from a number of individuals who had not recently handled or discharged a firearm were also collected. Occu-

pational groups represented included electricians, gas station attendants, plumbers, x-ray technicians, office and construction workers, firearms examiners, brake mechanics, painters and police officers [8] [9]. This project attempts to determine whether there is constancy in the antimony to barium ratios from the test fire data that can uniquely identify gunshot residue and differentiate it from any barium and antimony found on occupational workers. Additionally, it will explore the effect, if any, of increasing the number of shots fired during test fires on the barium and antimony ratio.

Review of the literature

Forensic investigation of gunshot residue is based on the analysis of chemical residues from the discharge of a firearm. These residues occur in trace amounts and can come from parts of the weapon (barrel) and cartridge (primer, propellant, bullet, cartridge casing, and jacketing material). When a weapon's firing pin strikes the primer cap igniting the primer within, the components of the primer are vaporized. Primer vapors can condense as droplets only to be heated and subjected to the extreme pressures within the gun barrel as the propellant burns and expands [10]. Elements from the cartridge casing and bullet mix in with primer residue to produce a collection of organic and inorganic particles in various sizes.

Gunshot residue is deposited on anything within the vicinity of the discharge of the weapon including the clothing and body of the person firing the weapon and the target depending on the distance between the gun and target. Vapors from the combustion of the primer and propellant can be ejected from gaps in the firing mechanism of the gun, from the ejection of spent cartridges and from the muzzle of the weapon itself and are known as blowback [10]. If the target is inanimate or has been immobilized, then the residue will persist at its location of deposition until disturbed. GSR residue on the hands or body of the shooter however begins to fall away with movement and activities like eating or washing the hands. One study showed that normal use of the hands following test fires resulted in significant drops in the levels of barium and antimony found on hand swipes after only two hours and that washing of the hands resulted in the obliteration of GSR residue to below hand blank values [6]. Detection of organic GSR residue has been reported possible up to seven hours on the person of the shooter and up to five days on unwashed clothing [11].

Gunshot residue analysts have concerned themselves mainly with lead, barium and antimony from the primer, the inorganic components of GSR, and nitrates and nitrites from the propellant or gunpowder, the organic components of GSR. Early detection of organic components involved creating a cast of the suspected shooter's hand and was invented in 1933 in the Mexico City Police lab. The dermal nitrate test, also called the paraffin test used diphenylamine in sulfuric acid to detect nitrates and gave a blue color with these compounds. However, it was later discovered that oxidizers also led to a positive reaction and false positives could be generated by fertilizer, matches, urine, fingernail polish as well as other substances [12].

Later chemical tests based on color change were the Griess test, which is specific for nitrites and uses naphthylamine, and sulfanilic acid in acetic acid, the Walker test and its replacement the modified Griess test which uses desensitized photographic paper, sulfanilic acid and alpha-naphthol in methanol [13].

Thin layer chromatography (TLC) has been used to ana-

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lyze organic components of gunshot residue since the 1970's with some success [14]. The benefits of TLC are its ease of use and cheapness as a method of analysis. However, as a quantitative technique it is relatively poor and large amounts of sample are needed for analysis.

Gas chromatography (GC), widely used in analytical chemistry for complex chemical separations has also been used to analyze gunshot residue. GC is fast, highly sensitive and available in most forensic labs. Problems with its use in organic GSR analysis arise from the non-volatility of nitrocellulose (rendering it impossible to analyze) and instability of some nitrate compounds on GC columns [10]. Other methods for organic gunshot residue analysis are myriad and include high performance liquid chromatography (HPLC) with electrochemical, mass spectrometric and fluorometric detection, supercritical fluid chromatography (SFC) and micellar electrokinetic capillary electrophoresis (MECE).

Inorganic analysis of gunshot residue generally falls into two categories: bulk analysis, the investigation of the overall composition of the GSR residue sample and particle analysis, which probes the inside of each individual particle to find out if it contains the three elements considered to be consistent with GSR: barium, lead and antimony.

Early bulk analysis methods included color tests like those performed by Harrison and Gilroy in the 1950's which could detect lead, barium and antimony using triphenylmethylarsonium iodide and sodium rhodizonate [15]. Later, neutron activation analysis (NAA) was used to identify bullets and determine shooting distances by bombarding samples with neutrons [12]. In the 1970's, Atomic absorption spectroscopy (AAS) proved to be a more readily available method of analysis. It was used to identify lead in hand swabs and later barium and antimony by first vaporizing, then volatilizing samples and measuring changes in energy transitions of electrons in the sample [16] [17].

Inductively coupled plasma-atomic emission spectroscopy (ICP-AES) was shown to be more accurate than AAS with greater sensitivity for barium as well as other elements in a study by Koons et al. from 1988 [18]. ICP-AES uses plasma rather than a flame to excite elements which then emit a characteristic radiation pattern. A similar method, inductively coupled plasma-mass spectrometry (ICP-MS) uses inductively coupled plasma to produce ions with a different detector, the mass spectrometer. Ions are separated based on their mass to charge ratio within the mass spectrometer and the detector receives a signal that is proportional to the concentration of the ion. Another study by Koons from 1998 reports that benefits of ICP-MS are: "a lack of interferences by swab extract constituents, low detection limits, wide linear dynamic ranges, short analysis times, and good precision and accuracy", and ICP-MS is suitable for both GSR sample ranges as well as hand blank ranges [19].

Finally, XRF provides an exciting combination of quick analysis times, the potential for portability, a wide dynamic range and broad applicability across the elemental spectra [20]. XRF works by bombarding samples with high energy x-rays. This energy excites atoms within the sample, ejecting inner electrons. Electrons from higher energy shells drop in to fill the newly created spaces in inner shells. When an electron moves from a higher energy shell to a lower energy shell the energy difference is given off as radiation or fluorescence. The fluorescent radiation of each element has a characteristic signature making elemental identification possible and the

intensity of the radiation given off allows for quantitation. XRF has some significant advantages. The analysis is quick and non-destructive.

Newer field portable XRF instruments are also now available. Since GSR is susceptible to disruption when disturbed or improperly handled, a field portable unit may prove useful. On site collection and analysis of GSR samples eliminates the potential for the loss of evidence or possible sample contamination by untrained collectors and the non-destructive nature of XRF preserves important evidence even if in trace amounts.

Particle analysis by scanning electron microscopy/energy dispersive x-ray (SEM/EDX) is currently the most widely used method for examining gunshot residue in forensic labs [21] [3]. Work by Wolten et al. and Nesbitt in the 1970's established a method of analysis for gunshot residue by SEM/EDX for forensic labs [22]. A later series of papers on the topic detailed extensively the process for identifying GSR in handwipes, the contribution of environmental contaminants to samples and detailed case analyses from law enforcement agencies [23] [24] [25]. While SEM is the most widely used method of GSR analysis, it occupies a large amount of laboratory space, is not portable, and the analysis is very time consuming.

SEM/EDX classifies a particle as GSR based on the elemental composition and the morphological features of the particle. The American Society for Testing and Materials (ASTM) has written the, "Standard Guide for Gunshot Residue Analysis by Scanning Electron Microscopy/ Energy Dispersive X-ray Spectrometry", a publication that has been updated several times since 1995 [26]. The ASTM standard follows work by Wallace and McQuillan from the 1980s that attempted to develop a common classification system for the analysis of GSR via SEM that would bring firearms experts to a consensus on what is GSR [27]. Particles containing lead, barium and antimony, and particles containing only barium and antimony are considered "unique" to GSR. Other particles lacking the tri-element combination but containing at least one of the primary elements at a high level may be considered "indicative" of GSR. Major, minor and trace contributors to each particle are identified and the resulting elemental profile is interpreted by the GSR analyst as either characteristic of true gunshot residue or not [4]. A secondary identifying feature of gunshot residue is the morphology of the particle.

Some studies have compared gunshot residue particles to those of environmental origin and found that some particles previously thought to be "unique" to gunshot residue are found in non-firearms related samples. A study by Garafano et al. in 1999 determined that "unique" particles of barium and antimony were also found in samples from auto mechanics, gas station workers and brake mechanics. Additionally, cartridge-operated industrial tools such as nail guns generated particles with barium, antimony and lead [3].

A more recent study by Torre et al. found that even the classic "unique" three element barium, antimony and lead particle was not truly unique to gunshot residue. Swabs from new brake linings produced particles similar in composition and size to gunshot residue. The only feature claimed by the authors to allow the two particles to be distinguished was their morphology. They considered ideal GSR morphology to be "spherical or globular, with surface either perfectly smooth, pitted with craters, coated with roundish and smooth nodules but never – even in part – rough or dusty" [4]. It was further suggested that the term gunshot residue is too specific. The

more inclusive term “primer discharge residue” could encompass correctly fireworks, gunshot residue, cartridge-operated industrial tools and blanks.

Clearly elements in gunshot residue also occur in nature and in man made products. In addition to the environmental sources discussed earlier, Romolo et al. report that environmental lead arises from leaded gasoline, paint, plumbing, glass, solder and battery plates and antimony oxide is used as a fire retardant in clothing [12]. Barium, which is used as a filler in paper production, is found in paint and pigments and is used as a contrast for medical x-rays [28].

Elemental ratios have been used in other disciplines to identify or classify unknown samples. There is even a history of its use in forensic science. In 1978, Blanchard et al. attempted to identify unknown paper samples based on the elemental profiles and ratios in the clays used as fillers in paper [29]. Using samarium and scandium in ratio with various other elements the authors were able to successfully match samples from four papers to their known counterparts. A fifth paper was unable to be identified due to its low level of clay. From these results and the analysis of other clays the authors determined that clays vary in elemental profiles and could be used as a fingerprint of sorts for forensically identifying paper.

Elemental ratios are also used by paleoceanographers to examine the shells of sea creatures to help understand environmental conditions in ancient oceans. Elements in ratio with calcium are used to extrapolate backward to estimate the chemical composition of past sedimentary deposits, and temperatures of ocean water through history [30].

Another interesting use of elemental ratios can be found in a paper by Fulton et al. in which the authors attempted to discover if human skeletons could be reassembled by trace elemental ratios found in bone [31]. The authors were testing the hypothesis that a human's dietary intake over a lifetime, as well as country of origin is reflected in the elemental makeup of the skeleton. Many bones from the same skeleton were tested to determine if ratios were consistent throughout an individual's skeleton. These levels were also compared to bones from other skeletons to determine if elemental ratios were an individualizing characteristic. Elemental ratios combined with current anthropological techniques were found to be of use in assigning bones to particular skeletons.

Materials & Methods

In a journal article by Trombka et al. [5] the authors plotted data pulled from two literature sources- articles by Kilty [6] and Havekost, [7] and compared the barium and antimony concentrations as well as the antimony to barium ratios for data taken from environmental hand samples (non-shooters) and test fires (shooters). The results from this analysis suggested the need for further study to determine if the observed relationship between the barium and antimony levels held for larger samples.

Four test fire protocols were developed and carried out by the New York State Police in Albany from 2001 – 2003. Environmental or non-shooter samples were taken and analyzed via ICP/MS in New Haven by members of the physics department at the Univ. of Connecticut. Samples from each test fire protocol were sent to NMS labs in Pennsylvania for analysis via ICP/MS. This new test fire and environmental data was compared with literature data from Kilty and Havekost for this project to look at the analytical value of GSR antimony to barium ratios.

The first test fire protocol used 25 randomly selected firearms with ammunition supplied by the manufacturer. Each weapon was fired once and after each test fire sample swabs were taken. In protocol two, a single firearm – Smith and Wesson .38 caliber and Winchester ammunition was used for 12 sets of test fires. Each set consisted of five fired shots followed by sample swab collection for a total of 60 shots fired and 12 swabs. Protocol three used the same .38 caliber revolver and single ammunition as in protocol two. Swab or scraping samples were taken after each test fire and two sets of 12 test fires were done. The fourth and last test fire protocol used the same weapon and ammunition as in protocols 2 and 3 but varied the amount of shots fired. Six sets of test fires were done with six swabs collected per set. In each set swabs were collected after 2, 3, 4, 5, 6 and 10 shots fired.

Environmental swabs were taken from 215 individuals from the palm and or back of the hand. Study subjects included volunteers multiple occupational groups including construction workers, firearms examiners, brake mechanics, police officers, and electricians as well as others. Protocol design stipulated that subjects must not have handled a firearm within 24 hours or washed their hands within one hour. The subject's right or left hand, chosen randomly, was then swabbed with 5% nitric acid and the swabs analyzed by ICP-AES/MS.

Data from the four test fire protocols was converted from parts per billion (ppb) to micrograms (mcg) in order to compare it to environmental study swabs taken and data from the Kilty and Havekost articles. All values that were recorded as 'ND' (not detected) or '< a value' were not used in graphical or statistical analysis for this project. Each set of study data was first analyzed separately via linear regression. When the data from each protocol was examined, it was found that contamination of the substrate material from protocol two rendered the data unusable. Only test fire data from protocols one, three and four was used for analysis. Next, test fire study data was plotted with environmental study data and examined. Since test fire protocol four was also concerned with differences in elemental values depending on the number of shots fired a separate graph was made differentiating each data set by number of shots fired.

After analysis of the study data separately, graphs were made of study data combined with literature data from Kilty (test fires) and Havekost (non-shooters). All study data was then plotted with the Havekost data grouped by occupation to explore if occupation played any role in antimony and barium concentrations. Data was analyzed statistically using SPSS for windows, version 15 [32].

Results and Discussion

Study data including each test fire protocol and the environmental study data were examined separately to determine if there was a correlation between barium and antimony concentrations and to compare the antimony to barium ratios across protocols. Linear regression analysis shows that there is some tendency toward linearity in the test fire protocols that is not seen in the environmental study data. The plots of the antimony to barium ratio vs. barium concentration show that regardless of differences in barium concentration detected, the antimony to barium ratio stays within a range of roughly 0.3 to 1 for each test fire protocol. The environmental study data shows that there is little correlation between the

barium and antimony concentrations. Additionally, the antimony to barium ratio vs. barium concentration data for the environmental samples appears scattered and not clustered around a mean.

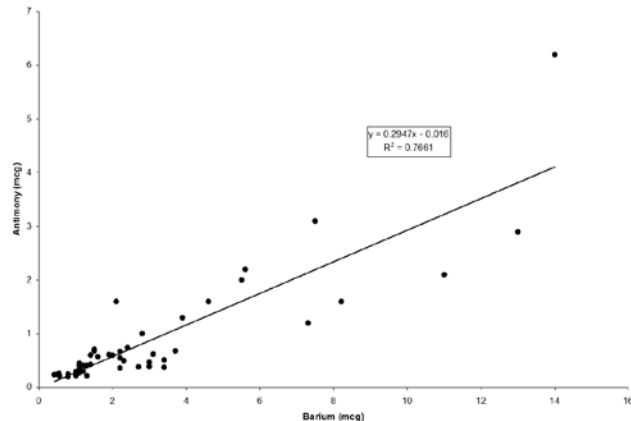


Figure 1 – Test fire protocol one, relationship between antimony and barium

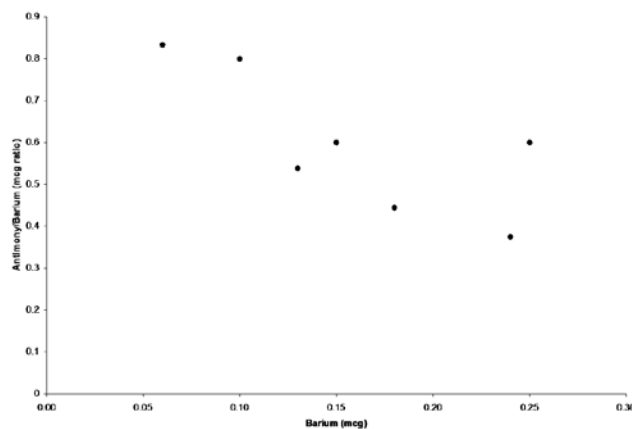


Figure 4 – Test fire protocol three, relationship between barium and antimony/barium ratio

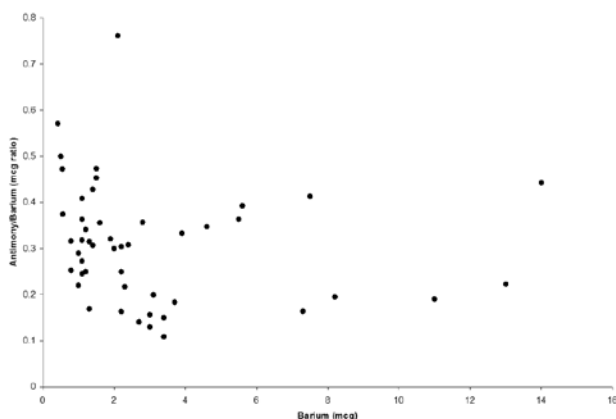


Figure 2 – Test fire protocol one, relationship between barium and antimony/barium ratio

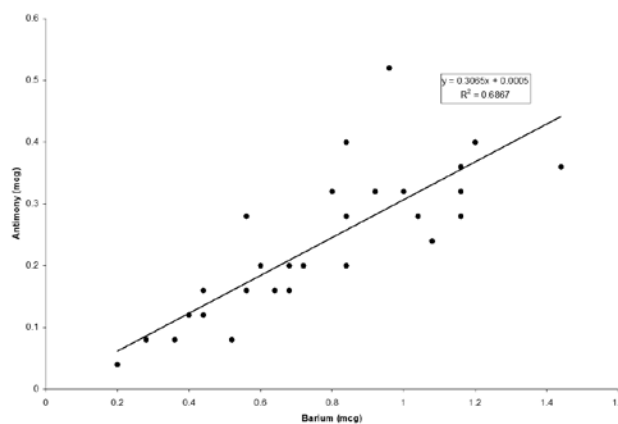


Figure 5 – Test fire protocol four, relationship between antimony and barium

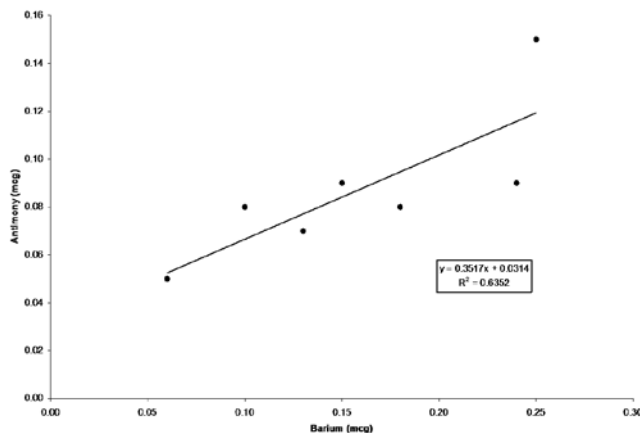


Figure 3 – Test fire protocol three, relationship between antimony and barium

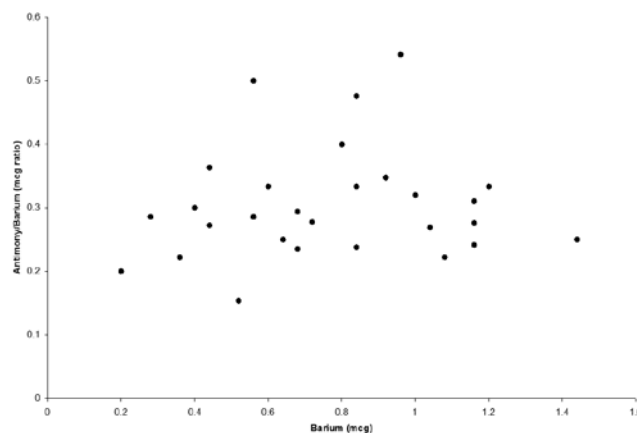


Figure 6 – Test fire protocol four, relationship between barium and antimony/barium ratio

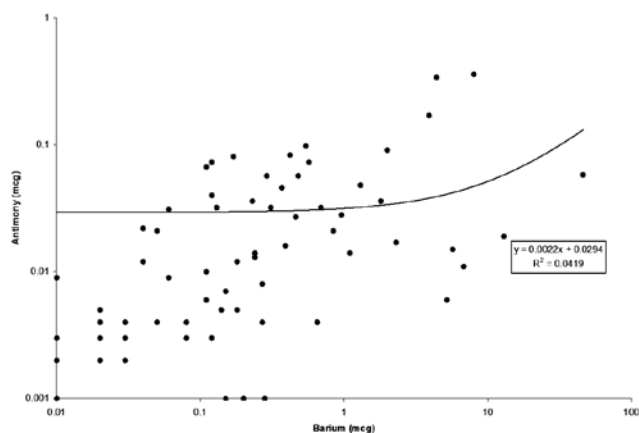


Figure 7 – Environmental study data, relationship between barium and antimony

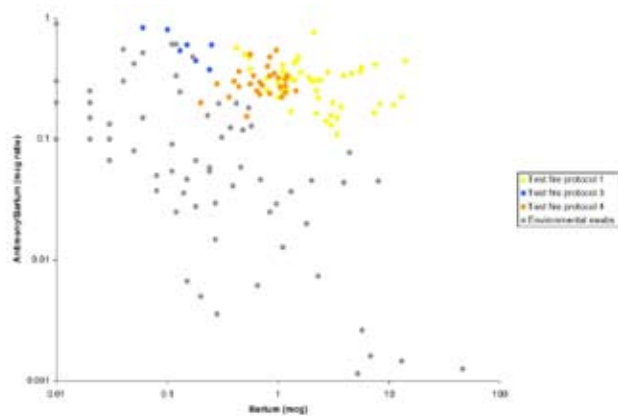


Figure 9 - Antimony to barium ratio vs. barium concentrations, all study data

Study group		Barium (mcg)	Antimony (mcg)	Antimony/Barium ratio (mcg ratio)
Test fire protocol 1	mean	2.13	0.58	0.23
	std. deviation	2.81	0.94	0.17
Test fire protocol 3	mean	0.16	0.09	0.60
	std. deviation	0.07	0.03	0.17
Test fire protocol 4	mean	0.73	0.23	0.30
	std. deviation	0.30	0.11	0.80
Environmental swabs	mean	1.59	0.03	0.14
	std. deviation	5.77	0.62	0.18

Table 1 - Means for each study protocol

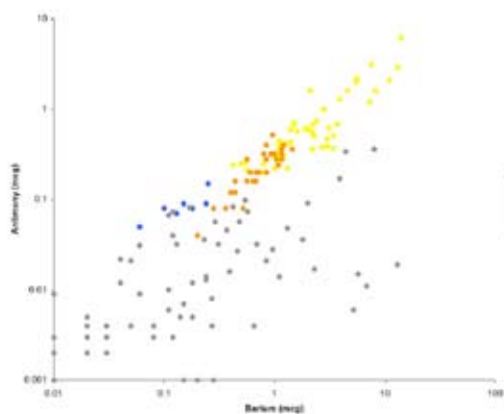


Figure 8 - Antimony vs. barium concentrations, all study data

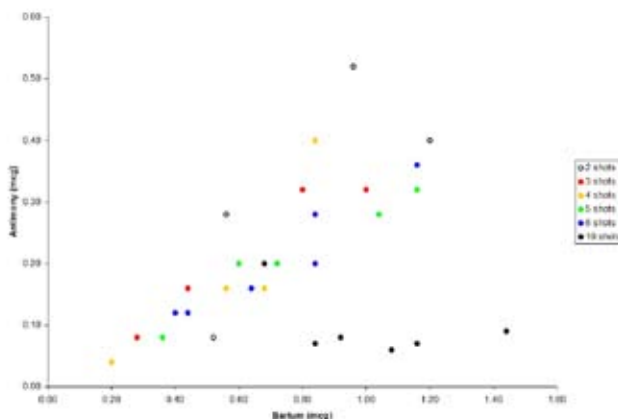


Figure 10 - Test fire protocol 4, antimony vs. barium concentrations by # of shots

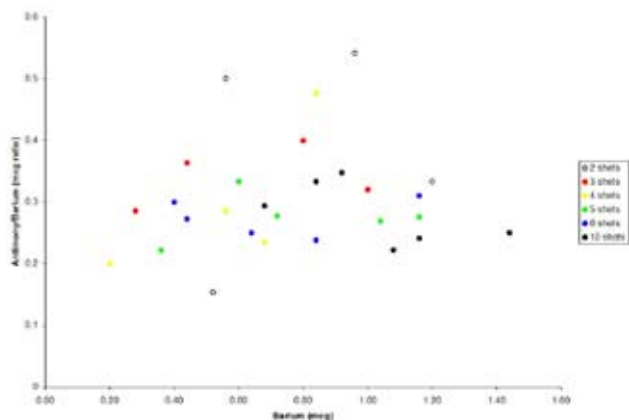


Figure 11 - Test fire Protocol 4, antimony/barium ratio by number of shots

Figures 10 and 11 show the relationship between the number of shots fired per collection swab to the elemental concentrations and ratio from protocol number four. Based on these preliminary results, it doesn't appear that the number of shots affects the ratio value significantly. This data however was analyzed statistically to determine if any hidden correlation could be found. The mean antimony/barium ratio between number of shots fired varies within less than 0.1 - a variation not found to be statistically significant.

After analyzing the study data gathered for this project, data from two previous studies - Havekost [7] and Kilty [6] were included for analysis and comparison. Nearly 230 non-shooter samples from Havekost and 12 shooter samples from Kilty were added to graphs of study data and included in further statistical analysis. The graphical comparison of study data to literature data can be seen in figures 12 and 13. It is interesting to note the clustering of all shooter data, both study and literature, and the scattered nature of both the non-shooter study samples and the Havekost non-shooter samples. As seen in table two however, the mean antimony/barium ratio in the Kilty shooter data is lower than that of the test fire protocols and is the same as the Havekost non-shooter data.

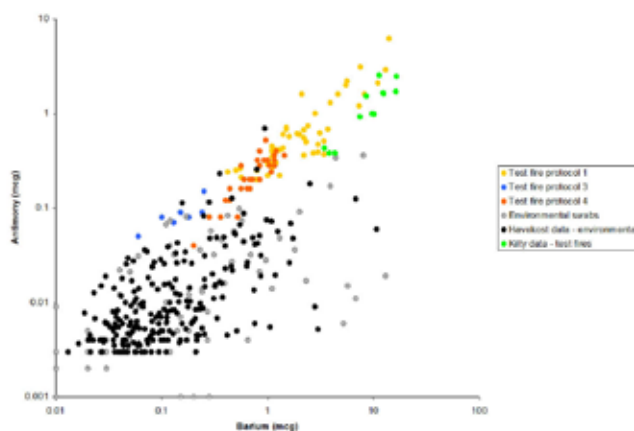


Figure 12 – Comparing barium to antimony concentrations in study data by protocol with literature data (Havekost, Kilty)

Study Group		Barium (mcg)	Antimony (mcg)	Antimony/Barium ratio (mcg ratio)
Test fire protocol 1	mean	2.13	0.58	0.23
	std. deviation	2.81	0.94	0.17
Test fire protocol 3	mean	0.16	0.09	0.60
	std. deviation	0.07	0.03	0.17
Test fire protocol 4	mean	0.73	0.23	0.30
	std. deviation	0.30	0.11	0.80
Environmental swabs	mean	1.59	0.03	0.14
	std. deviation	5.77	0.62	0.18
Havekost non-shooter data	mean	0.32	0.02	0.13
	std. deviation	0.92	0.06	0.14
Kilty shooter data	mean	9.68	1.30	0.13
	std. deviation	4.24	0.72	0.04

Table 2 - Means for study and literature data

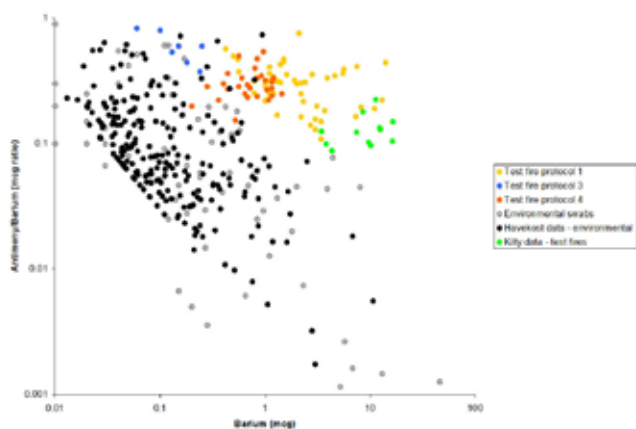


Figure 13 - Antimony vs. barium concentrations in study data

Since some overlap can be observed in figures 12 and 13 between the antimony/barium ratios of shooters and non-shooters, a graph was constructed identifying the non-shooters by occupation to determine if some occupations tended to have elemental ratios that more closely resembled that of gunshot residue. Singled out for comparison were some occupations that might be expected to yield higher levels of barium and antimony in hand swabs such as auto mechanics, electricians, and law enforcement. Figure 14 below shows this breakdown by occupation. While the occupations of individuals from the environmental samples that overlapped with test fire data were largely in the class of 'other' (teacher, student, office worker etc), samples from telephone workers and auto mechanics tended to overlap to a greater degree. There were not enough individuals from each occupational group to analyze the significance of occupation statistically.

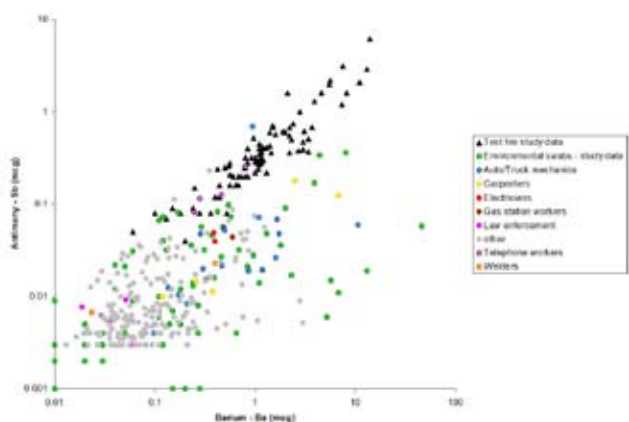


Figure 14- Comparing barium and antimony concentrations of Havekost study data by occupation with test fire and environmental study data

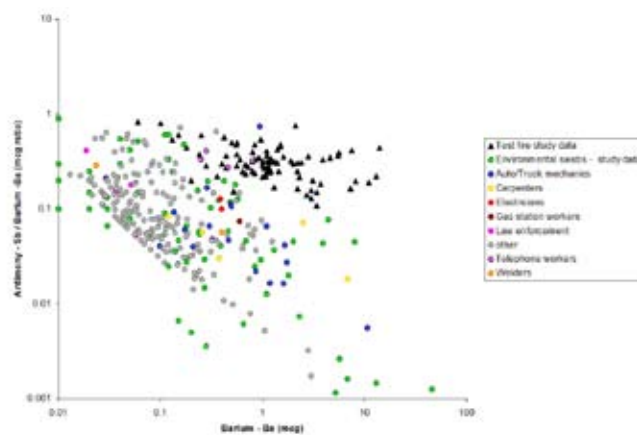


Figure 15 - Comparing antimony/barium ratios and barium concentrations of Havekost study data by occupation with test fire and environmental study data

Conclusion

This project found obvious trends in the test fire data. The designation of shooter or non-shooter was found to be a very important predictor of antimony to barium ratio when analyzed statistically and the graphical analysis of the test fire data shows clear clustering of data around a mean. Experimental test fire swabs showed that while the barium concentration changed the antimony/barium ratio varied only minimally even from swabs fired by different weapons and using different ammunition. However some gaps in the knowledge of occupational data for non-shooters made it difficult to assess differences seen in the overall scale of elemental values. Elemental concentrations alone were not useful in distinguishing shooter from non-shooter as they varied within test fire protocols.

Further work is needed to examine if the relationship between the antimony and barium levels in gunshot residue suggested by this project is indeed valid. Also important is the further exploration of hand swab data from individuals in occupations that may tend to overlap with the GSR ratio data such as electricians and auto mechanics. A larger study of environmental samples would allow for the statistical analysis of the importance of occupation on antimony to barium ratio. Perhaps an interesting addition would be individuals who work specifically with fireworks and cartridge powered industrial tools as some evidence has shown elemental similarity between them and gunshot residue.

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New Members Speak Out!

Responses to a recent questionnaire. . .

STEPHANIE CALLIAN

Orange Co. Sheriff-Coroner Dept. (Two years as a forensic scientist)

Why did you choose to become a forensic scientist? I heard about forensic science for the first time in a math class (go figure!) in high school. At that point I was starting to really think about what I wanted to study in college and what I wanted to do as far as a career was concerned. The teacher had described the job as one in which you would have some flexibility in daily routines. Basically he made it sound like a forensic scientist was given a few cases to work and it was up to them how they approached each case. He said the job would be different everyday and always exciting. The job sounded appealing because I liked the independence that it offered, as well as not being tied to a desk everyday, which I couldn't picture myself doing. In addition, I have always enjoyed being in a lab environment. So it sounded like the perfect job for me.

Why did you join the CAC? I joined the CAC because it seemed like the best way for someone new to the field to be introduced to the many techniques that the field employs; what works what doesn't, the differences between various labs, etc. It also seemed like a great way to network with people from other labs, and to just get involved in some small way.

Where do you see yourself in the next 5 years? 10 years? Or? I would like to stay with the Orange County Crime Lab, complete my training, and work my way up to being a Forensic Scientist III. I would like to be involved in some validation of new instrumentation, and at some point possibly be a member of the CSI team.

Do you have any suggestions for the CAC to help attract more professionals like yourself to the association? Nothing that I can think of.

As a new member of the CAC, is there anything else you would like to share with the membership? Thank you for allowing me to be a part of the organization. I just recently went to my first DNA workshop and had a great time!

DR. ERIC C. PERSON

Asst. Prof, Dept of Chemistry, CSU, Fresno (Eight years in the forensic sciences.)

Why did you choose to become a forensic scientist? General interest in applied chemistry and a professor who did a sabbatical at Scotland Yard.

Why did you join the CAC? To keep professionally connected and involved. In part a credibility / job requirement.

If you have been employed as a forensic scientist for greater than 5 years, why did you choose now to join the CAC? I moved from Washington to California. I canceled membership with NWAFS and joined CAC.

Where do you see yourself in the next 5 years? 10 years? Or? More or less the same position.

VINCENT VILLENA

Kern Co. Reg. Criminalistics Lab. (Two years as a forensic scientist.)

Why did you choose to become a forensic scientist? Love chemistry and used to be in law enforcement (prison guard); put two fields together.

Why did you join the CAC? Most renowned forensics organization in California or the west coast, for that matter.

Where do you see yourself in the next 5 years? 10 years? Or? 5 years a II, 10 years a III/Supervising and CAC President.

Do you have any suggestions for the CAC to help attract more professionals like yourself to the association? There are more and more universities offering Forensic Science degrees. If advisors, who are often CAC members, could stress more the importance of belonging to a professional organization for the advancement of their careers, it may increase the number of our affiliate members. Also, increase the number of CAC-sponsored CCI courses that could give CAC members advantage in registration.

As a new member of the CAC, is there anything else you would like to share with the membership? One major objective of the organization is dissemination of information related to our fields. Although there is success in participation in seminars, study groups however are getting a little passive.

DARYL CHAN

Los Angeles Police Dept. (Fourteen months as a forensic scientist.)

Why did you choose to become a forensic scientist? I wanted to do something different with my biology degree besides medical school or get a PhD. Also I personally think that the type of thinking required for criminalist has been my approach to science since I was in high school. The profession and the type of critical thinking are a perfect fit for my personality.

Why did you join the CAC? I joined when I was a grad student and I thought it was a good way to network for a job by joining and going to the meetings.

Where do you see yourself in the next 5 years? 10 years? Or? In the next 5 to 10 years I see myself as a III or Supervising Crim. As enough time passes, I eventually would pursue the lab director position and hope that the current lab director would be promoted to commanding officer.

Do you have any suggestions for the CAC to help attract more professionals like yourself to the association? I would suggest more events. More meetings, study groups, and other gatherings. I would also encourage more disclosure of knowledge and friendly through CAC sponsored events outside of the regular biannual meetings.

As a new member of the CAC, is there anything else you would like to share with the membership? I think that the point system for becoming a lifetime member is difficult to obtain for some people and not by choice. I have been denied attending a CAC meeting twice now and can probably no longer apply the meetings I attended as a grad student toward lifetime membership.

VANESSA GOULD

Los Angeles Police Dept. (Eighteen years as a forensic scientist.)

Why did you choose to become a forensic scientist? Watching 'Quincy' in college launched my interest and led me to pursue an internship with the local medical examiners office. I had the interest in science and forensics just made it all the more fascinating.

Why did you join the CAC? If you have been employed as a forensic scientist for greater than 5 years, why did you choose now to join the CAC? Assigned to the firearms unit for the last 15 years at an otherwise isolated (separated from the main laboratory) location, I wanted to make sure to keep abreast of current circumstances in other units. As my interest in leadership grows, the knowledge gained at CAC seminars develops my technical competence and skills to think of the future of my laboratory and create an vision.

Where do you see yourself in the next 5 years? 10 years? Or? I see myself in a leadership position as an honest, forward thinking, communicating and competent leader.

Do you have any suggestions for the CAC to help attract more professionals like yourself to the association? Consider a "planned" change by using a positive approach. Focus on what the association is doing right, discovering the "best of what is" in the association. My belief is that the CAC has innovative members—just listen to their research papers! Maybe one could collect stories by interviewing members and create a pool of information describing the association as an innovative system.

As a new member of the CAC, is there anything else you would like to share with the membership? My new motto: "Good things happen when you go for it"

CORAL LUCE

San Diego Police Dept. (Five months as a forensic scientist.)

Why did you choose to become a forensic scientist? I chose forensic science because it is a challenging yet rewarding career. My career interest has always been in biology, so I thought that a position in a forensic biology lab would be the right fit for me.

Why did you join the CAC? It is important for me to be a part of the CAC in order to keep current on new technological advances in the field and also to associate with fellow criminalists.

Where do you see yourself in the next 5 years? 10 years? Or? In five years I see myself as a criminalist II at the San Diego Police Dept. continuing to gain knowledge and experience in the field. In ten years I see myself as possibly pursuing a technical lead position. I cannot think much further ahead than ten years at this time.

Do you have any suggestions for the CAC to help attract more professionals like yourself to the association? I have a couple colleagues from graduate school that would be interested in being a member. Being a new member, I am unaware if you attract many out of state people or hold many out of state conferences.

As a new member of the CAC, is there anything else you would like to share with the membership? I am excited

to be a part of the forensic science community and also to have been accepted as a member of the CAC.

LISA MERZWSKI

San Diego Police Department (Three 1/2 years as a forensic scientist)

Why did you choose to become a forensic scientist? Prior to all the CSI shows, I loved crime novels and I knew that I wanted to work in a job that mattered every day. I wanted to make a difference and be challenged. Once I read my first Patricia Cornwell novel, I knew forensics was for me. It took me awhile, but I finally made it.

Why did you join the CAC? I have been participating in CAC group meetings and seminars since I was a graduate student and I always wanted to join. It is a prestigious group that has given me so much knowledge, without asking for anything in return.

Where do you see yourself in the next 5 years? 10 years? Or? I want to work in several different areas of forensics, and become an expert in those fields. Additionally, I want to gain valuable crime scene experience, not only from doing crime scene reconstruction but attending training classes.

Do you have any suggestions for the CAC to help attract more professionals like yourself to the association? I would like to see local networking meetings, brain storm sessions, or perhaps professional social meetings. Everyone is busy, but meeting with like minds opens people to new ideas and lets them know who is seeing what.

As a new member of the CAC, is there anything else you would like to share with the membership? Just to thank the CAC for their support so far in my career.

AMANDA DAVIS


Los Angeles Sheriff's Dept. (Four 1/2 years as a forensic scientist.)

Why did you choose to become a forensic scientist? I knew by the end of high school that I wanted to go into this field. I saw it as a means of combining my interests of problem solving and chemistry. I have both Nancy Drew and Mr. Wizard to thank.

Why did you join the CAC? I originally joined the CAC as a student member. Attending CAC meetings is an excellent way for students to enhance their qualifications and to build upon their knowledge of the field. I continue to benefit from the learning aspect of CAC membership, but I also find the organization to be a means of developing professional contacts.

Where do you see yourself in the next 5 years? 10 years? Or? Given my current assignment to quality assurance, I cannot think beyond ISO accreditation at this point!

Do you have any suggestions for the CAC to help attract more professionals like yourself to the association? Judging by the list of applicants being considered at each meeting, I believe the CAC is doing a good job of attracting students and young professionals. I believe the CAC attracts such interest through both its existing members (word of mouth) and its reputation. □

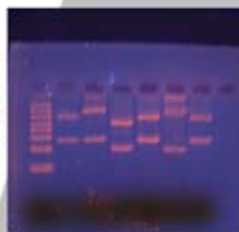


If you see
this ad in
color,
you've found
the ONLINE
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CACNews

This poster, by Nikki Batey and Kim Worst, was displayed at the POBS (Penn Ohio Border Section) Annual Awards Banquet at Westminster College on April 24th, 2009. It was also displayed at the Best of Westminster Drinko Center Poster Symposium at Westminster College on April 24th, 2009. The POBS meeting is an annual meeting for ACS (American Chemical Society) where students from the area present research to the board members and other associates. The Best of Westminster was a poster session to display how funds from the Drinko Center were used; students, professors, and community members attended.

The Science Scene

The picture to the right is a digital photograph of the Agarose gel used for DNA electrophoresis after a PCR reaction. This picture shows that Suspects C and E were present at the crime scene.



The picture to the left shows the students in the biology lab learning about PCR reactions and gel electrophoresis from Dr. Corrette-Bennett.



Who

On the morning of Saturday March 28th, 2009 Johnny's mother was on her way back from work at the restaurant when she noticed him lying in the front yard. When she approached Johnny she noticed there was a big gash on his forehead. In panic, she yelled, which actually helped to wake Johnny up. She called the police and said that Johnny was hurt and is unconscious; but, by the time the police and ambulance arrived, Johnny was coherent. The paramedics checked Johnny to make sure he was not seriously injured. As they were searching and

Acknowledgements

Drinko Center for Excellence in Teaching and Learning
Biology Department
Tri Beta Biology Honors Society
Chemistry Department
Chem Club



Workshop

March 28, 2009

Hoyt Science and Resource Center

The picture to the right shows the results of a chromatography analysis. Pens collected from the suspects were compared to a note found at the crime scene. Suspect B was guilty of writing the note.



The picture to the right shows the final results of soil testing. The students tested for the presence of various compounds in different soil samples. It was determined that Suspect C matched the crime scene.



The picture to the left shows two students working in the chemistry lab, watching the solvent line proceed up the column, intently waiting for the results.



The picture to the left shows students working in the chemistry lab performing tests on different soil samples.

Done It?

analyzing him, they found a note in his pocket. Johnny's mother was able to calm him down so that he could recall what happened to him the night before. Johnny told his mother that he was on his way home after walking Stella to her house, when all of a sudden he felt a sharp pain on his head and he could not recall anything else from that point. The note was sent to the lab for analysis. The police wanted to get as more evidence as they could, so they collected soil samples from the bottom of all the suspects' shoes, and they swabbed Johnny's cheek and collected some DNA. Your job is to narrow down or even figure out who is responsible for hurting Johnny and why!



Nikki Batey is a junior biochemistry major from Cecil, PA. After college, she hopes to attend graduate school and earn her masters and Ph.D. Afterwards, she wants to become a college professor.



Kim Worst is a junior chemistry major with a minor in secondary education from Butler, PA. After college she hopes to find a job teaching chemistry to high school students.

Selection of Immersion Media for Trace Evidence Examination

John Thornton
Napa Sheriff's Department

Meagan Gallagher
California Department of Justice – Central Valley Laboratory

The microscopic determination of refractive indices of various types of trace evidence requires immersion media. Although immersion media of known refractive index are commercially available in the range 1.30 to 2.31, the acquisition of *appropriate* media isn't as simple as placing an order to a supplier. The selection of media should be appropriate to the type of evidence being examined.

Cargille Laboratories is the preeminent supplier of known refractive index media. Cargille does a rather good job of marketing immersion media, but any supplier of immersion media must wrestle with difficult physical, toxicological, and economic considerations. We will discuss these considerations here, with regards to specific physical evidence types.

Ideal attributes

An ideal medium possesses the following attributes: Stable toward air and light, Colorless, Non-toxic, Miscible with other liquids for intermediate refractive indices, Odorless, Non-reactive with any solid, Low volatility, Low dispersion, Low viscosity, Inexpensive.

Unfortunately, we do not live in an ideal world, and media meeting all of these requirements, particularly those of high refractive index ($>1.700^1$), simply do not exist. Media of high refractive index pose a particular problem because they tend to be extremely toxic, colored to the point of obscuring the specimen being examined, difficult to stabilize, tend to shift in refractive index, may not exist as a liquid at room temperature, and, for very high refractive index values, may not even be commercially available.

The Cargille offerings represent a point of departure in this discussion. Cargille offers immersion liquids in the range 1.300 to 2.11, and refractive index melts, which are solids at room temperature, in the range 2.12 to 2.31. Altogether, they offer a total of 222 liquids and 20 melts, arranged in 9 series² covering this refractive index range.

Cargille media

Cargille Series AAA. Series AAA covers the range 1.300 to 1.395 in intervals of 0.005. The liquids are adjusted to ± 0.0002 when supplied, but as with all other liquids, the refractive index may shift with exposure to air and light, or with evaporation.³ This series is formulated from colorless

¹ In the discussion following, refractive index values will follow the normal convention. The value is for monochromatic light of 589 nm (D line) and a temperature of 20° C. Other conditions, (i.e., dispersion and other temperatures), will shift the value.

² The special Series E is not counted, as it is essential redundant with respect to refractive indices.

³ Evaporation ordinarily causes a liquid to increase in refractive index. In the Cargille Series M liquids there is an exception, as discussed in the text. Media with refractive indices above 1.778

fluorocarbons and chlorofluorocarbons⁴, which have low toxicity. Forensic practice has little use for these liquids of very low refractive index, with the possible exception of a liquid for the fiber fluorocarbon.

Cargille Series AA. Series AA covers the range 1.400 to 1.458 in intervals of 0.002, adjusted to ± 0.0002 . The liquids are colorless silicones and aliphatic hydrocarbons. A few minerals (e.g., opal 1.406 and fluorite 1.434) will have refractive indices in this range, making this series valuable for forensic practices.

Cargille Series A. Series A covers the range 1.460 to 1.640 in intervals of 0.002. The liquids are stable, relatively non-volatile hydrogenated terphenyls, adjusted to ± 0.0002 , and are of low toxicity. Although colorless at the low end of the series, they progress to a faint yellow at the high end of the series. This series is of great utility in forensic practice, since many minerals and all common glass will fall within this range of refractive indices.

Cargille Series B. Series B covers the range 1.642 to 1.700 in intervals of 0.002, adjusted to ± 0.0002 . These liquids are halogenated ring compounds, with the addition of sulfur at the high end of the series. As the refractive index increases, the stability of the liquid decreases, and the color deepens from faint yellow to yellow or yellow-brown. This series is essential any forensic laboratory attempting to identify minerals by refractive index.

Cargille Series E. This special series of high dispersion liquids covers the range 1.500 to 1.640 in intervals of 0.005, adjusted to ± 0.0005 . Intended for dispersion staining and for dispersion measurements at specific wavelengths, the series is supplied with optical constants for F (486 nm), D (589 nm), and C (656 nm) lines. The series closely parallels the A series, but is twice as costly.

Cargille Series M. Series M covers the range 1.705 to 1.800 in intervals of 0.005, adjusted to ± 0.0005 . This series, formulated from hydrogen terphenyl/methylene iodide/methylene iodide plus sulfur/methylene iodide plus sulfur plus SnI_4 , is slightly volatile and should be kept tightly stoppered. All members of this series are colored, from yellow on the low end to dark red on the high end. Upon evaporation, the liquids in the 1.705 to 1.735 range tend to decrease in refractive index. The liquids in the 1.740 to 1.800 range tend to increase in refractive index and may form crystals. Determination of the refractive indices of many minerals requires liquids that fall within this range. These liquids are quite toxic.

(methylene iodide saturated with sulphur) change rapidly with evaporation.

⁴ The precise formulation of the Cargille liquids is viewed proprietary information, however some general information regarding the composition is provided. In the past, Cargille liquids once contained Polychlorinated Biphenyls (PCB's), but due to their toxicity, Cargille no longer uses these compounds.

Cargille Series H. Series H covers the range 1.81 to 2.00 in intervals of 0.01, adjusted to ± 0.0015 . These liquids contain arsenic tribromide/arsenic disulfide/arsenic tribromide plus sulfur plus bromobenzene, making them both toxic and corrosive, although relatively stable. All of the liquids in this series possess a deep coloration ranging from yellow to brown as the refractive index increases. A number of minerals have refractive indices in this range.

Cargille Series EH. The last liquid in the Cargille series covers the range 2.01 to 2.11 in intervals of 0.01, adjusted to ± 0.0015 . These liquids, similar in composition to the H series but with the addition of selenium, are also toxic, corrosive, and deeply colored. A number of minerals will have refractive indices in this range.

Cargille Series FH and GH. These series include low melting point solids covering the range 2.12 to 2.21 (Series FH) and 2.22 to 2.31 (Series GH), in intervals of 0.01. These materials require heating to melt the solid, typically accomplished by placing the slide containing the media + sample on a hot plate (not a flame). Since these melts universally possess a deep coloration, the cover slip must be pressed to form a thin film which, if the specimen grains are suitably fine, results in a preparation that is sufficiently translucent to permit observation. When the medium cools to 25°C., it will have the stated index value.

Using the Series H and EH liquids and the Series FH and GH melts requires special precautions, such as the use of a properly vented fume hood, gloves and protective clothing, since they contain arsenic tribromide, which is truly nasty stuff. In addition to the possibility of direct ingestion or vapor inhalation, arsenic tribromide also absorbs through the skin. Arsenic tribromide also poses a hazard to equipment since it is corrosive to both metal and leaded optical glass and particularly damaging to the high refractive index (but soft and easily etched) glass used for refractometer prisms. Even with a short duration of time, arsenic tribromide will attack a refractometer prism.

Glass

The selection of immersion media for the characterization of glass is straightforward and easy.⁵ Glass evidence will fall in the range 1.5130 to 1.5300, with the majority of samples falling in the 1.514 to 1.527 range. The Cargille Series A will cover this entire range.

Fibers

With the exceptions noted below, most evidence fibers fall in the 1.53 to 1.56 range, covered by the Cargille Series A liquids. Terylene, with a refractive index of 1.630, will just squeeze into the Cargille A series. Fluorocarbon, however, with a refractive index of 1.371, requires a liquid from the Cargille AAA series. It is possible to purchase a single liquid of

⁵ While the refractive index of glass may be determined by a thermal technique rather than a succession of liquids of known refractive index, many analysts choose to verify a thermally derived refractive index value first with a commercial liquid of known value and then verify that value by means of an Abbe refractometer. Therefore, liquids of known refractive index still have a role to play, even if the analytical modality is based on the thermal approach. For the thermal approach to glass refractive index, the selection of media is easy: Either the Locke A, B, or C oils, or Dow Corning Silicone Oil 710 (for soda/lime/silica glass), Dow Corning Silicone Oil 550 (for borosilicate automobile headlamp glass), or Dow Corning Silicone Oil F/6/7024 (for glass above the normal range of soda/lime/silica glass).

1.370 for this orphan fiber, or to use absolute ethanol (1.390).⁶ For general mixtures made up in the laboratory, hexane (1.39) may be mixed with bromoform (1.56) if a refractometer is available to measure the resulting intermediate index⁷. Aramid, Novoloid,⁸ and certain polyesters comprise the problem fibers.⁹ Novoloid falls within the range of the Cargille Series M liquids. One, but not both refractive indices, may be determined for Aramid Kevlar® with the lower series of Cargille liquids, but determining the two indices and the birefringence requires the use of melts.

Minerals

With practically no exceptions, and with good reason, the forensic literature is silent concerning measurement of high refractive index of minerals. There are squillions of minerals with indices above 1.700, and a great many with indices above 1.800. A very high index forces the analyst to use media that possess undesirable characteristics with respect to toxicity. It is not an exaggeration to say that these materials can be *life threatening*. If the determination of refractive index of microscopic grains is necessary then the use of these liquids is unavoidable. Indices greater than 2.31, the upper end of the Cargille GH series, presents an essentially hopeless situation. For example, Rutile (Titanium dioxide, TiO₂), one of the most abundant minerals in the earth's crust, has refractive indices of 2.62 and 2.9. For the most part, very high refractive index determination for many minerals has not been accomplished by immersion techniques, but rather by Brewster's Angle measurements on large specimens.¹⁰ We must also recognize that if we cannot determine two refractive indices (i.e. ω , and ϵ in the case of uniaxial crystals and α , β , and γ in the case of biaxial crystals), neither can we obtain a specific value for the birefringence. The Cargille Series M is suitable for many minerals. However, if a laboratory plans to perform serious

⁶ If fluorocarbon really is an issue, the refractive index could be verified by comparison with isotropic Ammonium fluosilicate, (NH₄)₂SiF₆, with a refractive index of 1.370.

⁷ It's likely that bromoform will be at hand, since it is commonly used in the forensic laboratory for density gradients of both glass and soil.

⁸ Aramid will include Kevlar and Nomex. (Kevlar 29 2.114 1.633, Kevlar 49 2.107 1.638, Kevlar 149 2.151 1.647, Nomex 1.82 1.66). Novoloid will include Kynol 1.650 1.648).

⁹ Examples would include Polyester oxybenzoate (p-Ethylene oxybenzoate type) 1.662, Polyester 4 GT (1,4-Cyclohexanedimethanol type) 1.690, and Polyester 2 GT (1,4-Butanediol type) 1.710.

¹⁰ For those who wish to be reminded, Brewster's Angle is the unique angle at which light rays reflected from a material are all polarized into a single plane. On larger specimens, this angle may be measured with great accuracy, and is related to the refractive index of the material:

$$\text{Brewster's Angle } (^\circ) = \text{Arctan (Refractive Index)}$$

For example, if the reflected Brewster's Angle is 68.96°, the refractive index of the material would be 2.60. A further example would be Rutile (TiO₂), having one refractive index at 2.9, would have a Brewster's Angle of 70.97°. Even opaque materials, hematite being a good example, will typically reflect 5% of the incident light, which is sufficient to measure Brewster's Angle.

work in the area of mineral identification, they should consider making up liquids for use with specific ranges, such as the range 1.52 to 1.58 for the feldspars, with a desirable interval of 0.001, and 1.66 to 1.74 for pyroxenes and olivenes, with an interval of 0.005 at most. Mixed media in the 1.52 to 1.58 range must of course be checked with an Abbe refractometer.¹¹ With higher refractive index media, the Abbe refractometer would be in peril of attack from aggressive media.

Analysts may use solid compounds of known refractive index to check the index of a liquid, but the solid material must be insoluble in the liquid. Only isotropic material should be used, however, since anisotropic materials may, depending on their orientation show refractive indices anywhere between ω and ϵ in the case of uniaxial crystals and anywhere between, α , β , and γ in the case of biaxial crystals, which would introduce unnecessary complications. The following is a list of isotropic salts which may be used for liquid refractive verification.

1.326	Sodium fluoride	NaF
1.352	Potassium fluoride	KF
1.410	Potassium cyanide	KCN
1.459	Ammonium alum	$\text{NH}_4\text{Al}(\text{SO}_4)_2 \cdot 12 \text{H}_2\text{O}$
1.481	Potassium chromium alum	$\text{KAl}(\text{SO}_4)_2 \cdot 12 \text{H}_2\text{O}$
1.490	Potassium chloride	KCl
1.504	Sodium uranyl acetate	
	$\text{Na}(\text{C}_2\text{H}_3\text{O}_2) \cdot \text{UO}_2(\text{C}_2\text{H}_3\text{O}_2)_2$	
1.559	Potassium bromide	KBr
1.586	Strontium nitrate	$\text{Sr}(\text{NO}_3)_2$
1.617	Sodium bromate	NaBrO_3
1.640	Ammonium chloride	NH_4Cl
1.667	Potassium iodide	KI
1.698	Cesium bromide	CsCl
1.736	Magnesium oxide	MgO
1.755	Arsenic trioxide	As_2O_3
1.775	Sodium iodide	NaI
1.782	Lead nitrate	$\text{Pb}(\text{NO}_3)_2$
1.788	Cesium iodide	CsI
1.825	Potassium chloroplatinate	K_2PtCl_6
2.07	Silver chloride	AgCl
2.25	Thallous chloride	TlCl
2.42	Thallous bromide	TlBr

Due to the extreme toxicity of high refractive index mediums, we advise against making them. If it is unavoidable however, the analyst should take extreme care and consult a comprehensive Material Safety Data Sheet. α -Monobromonaphthalene has a refractive index of 1.658, Methylene iodide has a refractive index of 1.74, Methylene iodide saturated with sulfur will reach 1.778, Methylene iodide, sulfur, and arsenic will deliver 1.868, and Selenium and arsenic selenide will exceed 2.71. The effort required to deal with these materials is almost certainly less than the effort that would be expended in applying other approaches. Identification of a mineral requires only that we identify its mineral phase and determine

¹¹ Typical Abbe refractometers operate in the range 1.300 to 1.710, although other substitute prisms may allow for a 1.400 to 1.760 range. Pulfrich refractometers, which are much less common, are generally restricted to a lower range, and top out at about 1.73. A glass hemisphere adaptation of the Pulfrich refractometer has been claimed to reach out to 1.85, but we have no knowledge of it and don't know of anyone who does.

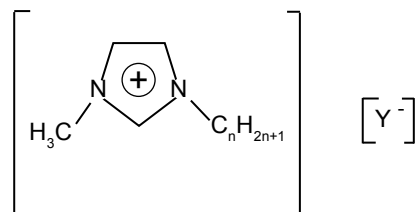
its elemental composition. We may achieve this alternatively with x-ray fluorescence, electron probe, x-ray diffraction, or other instrumental approaches. Density determination is also useful, particularly on a very small quantity of evidence material.

Paint

Considerations of refractive index of inorganic household, automotive, and artist's paint constituents parallel those applicable to minerals. The refractive index of some common paint components exceed even the Cargille GH melts. These include, but are certainly not limited to, Titanium white (TiO_2) 2.62 and 2.9, Red ochre ($\text{Fe}_2\text{O}_3 \cdot n\text{H}_2\text{O}$) 2.95 and 2.74, Hematite (Fe_2O_3) 2.94 and 3.22, Red lead (Pb_3O_4) 2.4 and 2.4, Lead (III) oxide (PbO_2) 1.94 and 2.09, Cadmium red ($\text{Cd}(\text{S},\text{Se})$) 2.506 and 2.509, Chrome yellow (PbCrO_4) 2.36 and 2.66, Cadmium yellow (CdS) 2.506 and 2.509, and Lead (II) oxide (PbO) 2.665 and 2.535. As we have discussed with respect to minerals, the analyst desirous of determining precise or even approximate refractive indices must, (or should, if prudence is to prevail), surrender at the Cargille GH melt at 2.31 and reach for another approach.

Neoteric Optical Media

The synthesis of aqueous based media of (fairly) high refractive index has recently been described. Although not yet commercially available, these liquids will likely be offered at some time in the near future. In the interim, they could be, given sufficient motivation, made up in the laboratory. They are described, and their synthesis provided, in: Maggei Deetieffs, Kenneth R. Seddon, and Michael Shara, "Neoteric optical media for refractive index determination of gems and minerals," *New J. of Chem.*, 2006, 30, 317-326. These neoteric ionic liquids are based on the 1-alkyl-3-methylimidazolium cation:



Deetieffs *et al.* describe the synthesis of a series of media in which the carbons number 2, 4, 6 and 8. The anions are halides of Bromine and Iodine. A liquid of refractive index 2.010 was achieved with the cation of carbon 2 and iodide as the anion. The minimum refractive index was 1.547 with 6 carbons and Iodine. Liquids in the higher range are intensively colored, however.¹²

¹² We have not tried these neoteric liquids. Alas, we do not have any particular reputation for aptitude in organic synthesis, and some of the syntheses described by Dietieffs *et al.* would seem to be a real bitch.

A Variation of the Oblique Illumination Method for Refractive Index Determination

John Thornton
Napa Sheriff's Department

Meagan Gallagher
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Using oblique illumination, we can determine whether an immersion medium has a higher or lower with respect to refractive index than the evidence material in which it is immersed. In this regard, it delivers the same information as the Becke Line technique.

If we adjust the microscope to partly intercept the illumination beam in such a manner that the evidence specimen is illuminated by ray approach from only one side, the specimen will appear shaded on one side. Which side is shaded depends on the refractive indices of the specimen and the surrounding medium.

Typically, we promote oblique illumination by inserting a stop, that is, an opaque mask or screen below the substage condenser. This blocks a portion of the light delivered to the specimen, rendering a section of the observed field darker. (As we will later discuss, we may block the light at one of several points, not just below the condenser, and we may actually dispensed with the stop altogether). The dark portion of the field, observed even in the absence of a specimen on the stage, is the side opposite the direction of approach of the stop. A portion of the actual specimen also appears darker, but not necessarily on the same side as the darker portion of the field. If the specimen has a higher refractive index than the medium, the portion of the specimen on the side of the approach of the stop appears darker. If the specimen has a lower refractive index, the dark portion of the specimen will be on the side opposite of the approach of the stop.

Optical mineralogy literature often refers to the oblique method in conjunction with the name Schroeder van der Kolk¹. This literature provides abundant descriptions of the technique, but the original articles are rarely cited, probably because they are so obscure. After considerable searching, we have found two citations², apparently textbooks, one of which we cannot locate (the German one), and one (the Dutch one) which we wouldn't be able to read even if we were able to locate it.

The technique depends on heterogeneity of the light

1 Some confusion exists within the optical mineralogy literature as to Schroeder van der Kolk's name. In some references his work is attributed to "van der Kolk," as if Schroeder was his first name. (We all know of course that Schroeder is Lucy van Pelt's piano-playing unrequited love in the Peanuts cartoons). The real Schroeder van der Kolk had a first name, although it is very rarely cited. It was Jacobus.

2 J.L.C. Schroeder van der Kolk, *Kurze Anleitung zur mikroskopischen Kristallbestimmung*. Weisbaden, 1898, cited in F.E. Wright, "Oblique illumination in petrographic microscope work". *Amer. J. Sci.* Ser. 4, 35:63-82

J.L.C. Schroeder van der Kolk, *Inleiding tot de bepaling van mineralen onder het mikroskoop*. Van Markens Drukkerij, Delft, 1898.

rays between the specimen and the retina of the eye. When the refractive index of the specimen is higher than that of the medium, a portion of the light is prevented from reaching the specimen, and light from the side of the specimen opposite the stop is refracted so that it does not enter the objective. Consequently that side of the specimen appears dark and the side away from the direction of the approach of the stop is illuminated and appears brighter. The same general principles that apply to the Becke Line phenomenon govern oblique illumination as well. However, general rules for oblique illumination cannot be stated as emphatically as for the Becke Line technique because of the position of focus of the substage condenser. The specimen is typically below the focus of the condenser; if the specimen is above the focus, however, as a result of the positioning of the substage condenser, the oblique phenomenon may be reversed. Good professional practice demands examination of a known specimen to verify that the oblique phenomenon is not reversed.

In his original work, Becke described a method of observing the halo or bright line effect which bears his name, but clearly he appreciated the oblique illumination approach as well³. For reasons that are not altogether recoverable, Becke has not received credit for the oblique illumination technique, which is typically associated with Schroeder van der Kolk.

Microscopy literature has adequately established that the stop may be inserted at various places. Becke's original article in which he describes *schiefe Beleuchtung* (oblique illumination) speaks of a simple stop, such as a card, placed below the condenser, or the use of an Abbe condenser, the complete form of which originally had a rotatable diaphragm capable of being decentered by means of a rack and pinion. Stoiber and Morse⁴ describe a stop immediately above the objective Chamot and Mason⁵ mention a small screen mounted above the eyepiece, or the partial insertion of an accessory plate, e.g., the frame or housing of a Bertrand lens or an analyzer.

To our knowledge, an English translation of Becke's original article did not exist until recently. In reading his article, it is beyond cavil that he appreciated oblique illumination some five years before the publication by Schroeder van der Kolk, who was nevertheless credited with the discovery. Becke's article provides a very succinct discussion of the physical principles behind oblique illumination.

Becke's original article also makes it very clear that the position of the stop is not a critical factor. A cardboard card (or even one's finger) inserted under the condenser is certainly the most popular method, likely due to convenience. Any means of interrupting a portion of the rays delivered to the retina of the eye will suffice. Although Becke suggests a diaphragm aperture, it need not be under the condenser. In actuality, generating oblique illumination does not require a stop to be introduced in the path at all. *The iris of the eye is an*

3 F[riedrich Johann Karl] Becke, "Über die Bestimmbarkeit der Gesteinsgemengtheile, besonders der Plagioklase auf Grund ihres Lichtbrechungsvermögens," (Regarding the Determination of Mineral Compositions, Especially of Plagioclase, on the Basis of its Refractive Ability), *Sitzungsberichte der Kaiserlich-Königlichen Akademie der Wissenschaften zu Wien* 102 (1893) 358-376.

4 Stoiber, R.E., and Morse, S.A. *Microscopic Identification of Crystals*, Ronald Press, New York, 1994.

5 Chamot, E.M., and Mason, C.W. *Handbook of Chemical Microscopy*, Vol. 1. Wiley, New York, 1958.

aperture diaphragm, and may serve as a suitable stop, that is, as a means of interrupting the rays from the specimen, without the necessity of the introduction of a stop. Since we typically consider the eye as something apart from the microscope, this fact seems to have been overlooked.

If the intensity of the illumination is increased slightly above the level of comfortable sustained viewing of the specimen, the iris of the eye will compensate by decreasing the aperture. Then by a lateral movement of the head toward the 9 o'clock or 3 o'clock direction, we may appreciate the heterogeneity of the rays. Depending on the difference in refractive index between the specimen and the medium, the eye iris intercepts either the high intensity portion of the rays or the low

intensity portion. When the high intensity rays are blocked, the portion of the specimen from which those rays emanate will appear darker than the overall field.

Moving the head back and forth in the 9 o'clock / 3 o'clock directions reveals the shading associated with the oblique illumination phenomenon without the necessity of the introduction of a stop. The effect is subtle, and is not as dramatic as the introduction of a stop, which results in a portion of the entire field darkening. Using this method, only a portion of the specimen shows the shading. But this easily mastered technique provides a simple and quick alternative to using a stop, and may be used to advantage in conjunction with the Schroeder van der Kolk and Becke approaches.

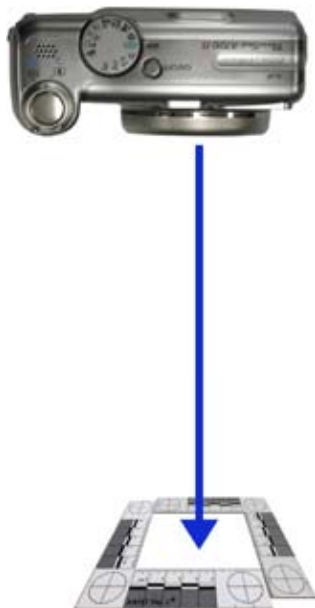
Part 2 of a Series by Carolyn Gannett

Forensic Photoshop Cheat-Sheet:

Rectifying Angled Images

Documenting impression evidence, and sometimes bloodstain pattern evidence, requires photographs to be taken from an angle perpendicular to the surface. But, not every scene cooperates—sometimes there's just no photographing through that toilet or boulder. In such cases, it may still be possible to obtain an image that appears to have been taken straight on. Here's one way to do it using Photoshop.

Don't forget to document your actions in your notes, or turn on the History File, or do both. To turn on the History File in Photoshop click Edit > Preferences > General; in the dialog box, click History Log and choose Metadata. This saves the History File as part of the Photoshop file. To view it, click on File > File Info... and click the History tab.



1 Tape two L-shaped scales together, and photograph them straight on at the about same distance from which the impression or pattern will be photographed.

2 Surround the impression or pattern evidence with the taped scales.



3 Set the camera to take TIFF or RAW images at the maximum depth of field possible and capture an image of the evidence (with scales) as close to straight on as possible.

If the maximum depth of field is too small for the entire pattern to be in focus, use a tripod and capture two or more images, each with different parts of the image in focus.

IN PHOTOSHOP:

ONE ANGLED IMAGE

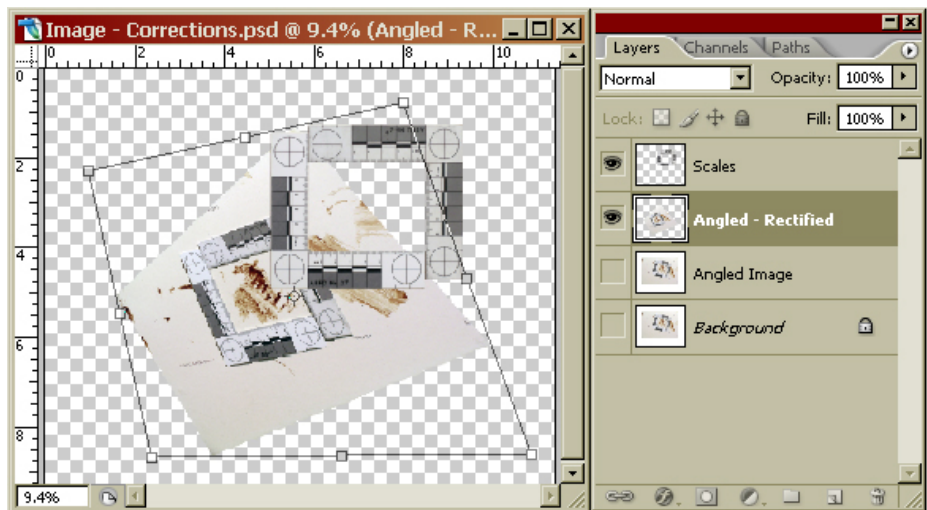
1 Load the angled image ("Angled Image") and the perpendicular image of the scales ("Scales") into separate layers. Copy the Angled Image to "Angled-Rectified." Place the Scales layer on top.

2 In the Scales layer, delete everything in the image except the scales.

3 Turn on only the Scales and the Angled-Rectified layers. Resize the Scales layer (cntrl-T; hold down the shift key as you resize in order to maintain the aspect ratio) so that its sides are no longer than the shortest length of any scale side in the Angled-Rectified layer.

4 Double the size of the canvas: Image > Canvas Size...

5 Reshape the Angled-Rectified layer until its scales are the same size as those in the Scales layer. Use: Edit > Transform > Distort or Skew or Perpendicular. It may help to first draw guides concurrent with the edges of the Scales image: click and drag from a ruler (View > Rulers) to create a guide.



IN PHOTOSHOP:

TWO ANGLED IMAGES

1 Load the angled images into separate layers. Highlight both layers (shift-click), and then click Edit > Auto-Align Layers.... Choose the "Auto" option and click OK.

2 With both layers still selected, choose Edit > Auto-Blend Layers. Select Stack Images and Seamless Tones And Colors. Click OK. The entire pattern should now appear in focus.

3 Highlight only the upper layer. Merge the two layers (cntrl-E); choose the Apply option when the dialog box appears.

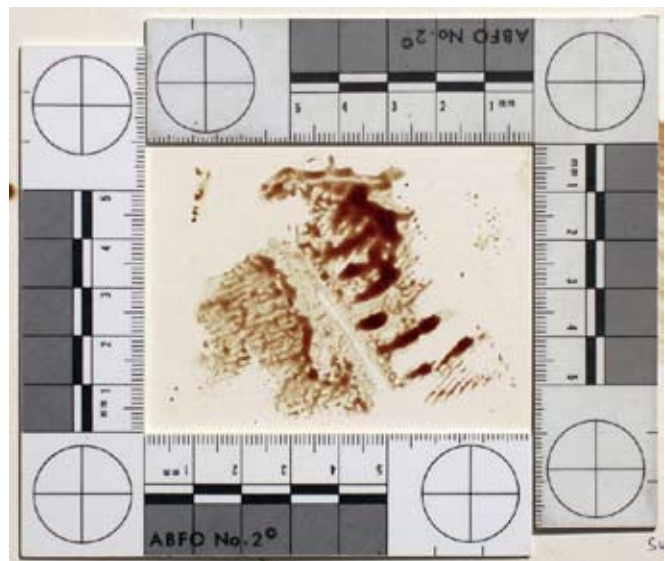
4 Using the merged layer as the angled image, follow the instructions above for one angled image.

The results for this example can be compared at right:

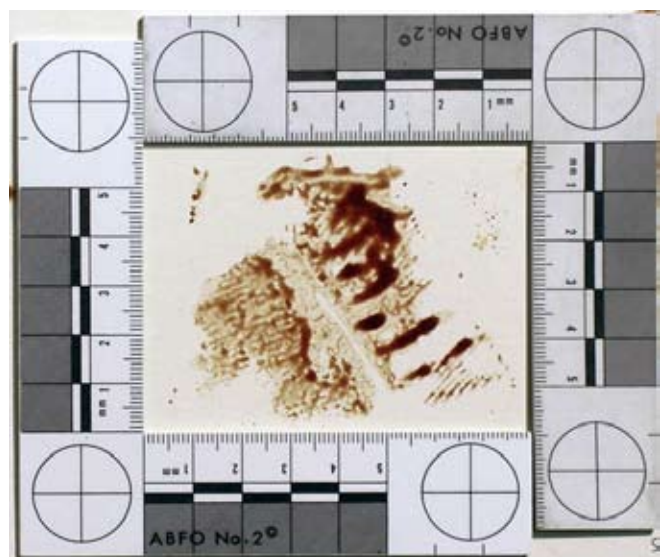


To learn the basics of Photoshop:

- Sign up for an on-line class through a local college, e.g., Grossmont College in San Diego.
- Check Foray Technology's on-line tutorials and training schedule for week-long classes (www.foray.com/training/index.php).
- Get a tutorial workbook, such as "Classroom in a Book" and teach yourself.



PHOTOGRAPHED STRAIGHT ON



RECTIFIED IN PHOTOSHOP

Identification and Characterization of Nanometer-Thick Fluorocarbon Surface Layers on Individual Textile Fibers via Synchrotron ATR FTIR Spectromicroscopy

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BACKGROUND: The Principal Researcher had previously obtained cloth samples from two separate sources. Groups A, B, and C were provided by Paul L. Johnson, Technical Service Specialist, 3M PMCS Division, St. Paul, Minnesota. Groups D and E were from Dr. Stephen Coulson, Technical Director, Porton Plasma Innovations (P2i) Ltd., Porton Down, U.K. In each group of swatches the cloth was identical except:

GROUP A: A1 100% cotton knit that has received the 3M Company proprietary protective finish (a fluorocarbon)

A2 100% cotton knit that has received *no* surface modification treatment

GROUP B: B1 100% cotton woven that has received the 3M Company proprietary protective finish (a fluorocarbon)

B2 100% cotton woven that has received *no* surface modification treatment

B3 100% cotton woven that has received some *other* manufacturer's (not specified) proprietary protective finish (a fluorocarbon)

GROUP C: C1 80/20 polyester/rayon that has received the 3M Company protective finish (a fluorocarbon)

C2 80/20 polyester/rayon that has received *no* surface modification treatment

C3 80/20 polyester/rayon that has received some *other* manufacturer's (not specified) proprietary protective finish (a fluorocarbon)

GROUP D: D1 Bleached only cotton with P2i protective plasma treatment (a fluorocarbon)

D2 Bleached only cotton with *no* protective treatment

GROUP E: E1 Finished cotton with P2i protective plasma treatment (a fluorocarbon)

E2 Finished cotton with *no* protective treatment

In previous examinations of these samples via SEM/EDS1 the treated fabrics as well as individual treated fibers could be distinguished from the untreated fabrics and individual fibers by a small fluorine peak present in the treated samples and absent in the untreated samples. However, it was not possible by SEM/EDS to distinguish between fabrics or fibers treated by different manufacturers.

In an additional limited previous examination of the B group fabrics by flash pyrolysis GC/MS¹ all three could be distinguished by differences in their pyrolysis mass spectra. However, this analysis required small swatches of material and was not sufficiently sensitive for single fiber samples.

The ability to not only distinguish fibers having some form of surface modification from otherwise identical fibers not having any surface modification, but to even be able to distinguish from otherwise identical fibers having different manufacturers' proprietary surface modifications would be a significant advance in the area of fiber trace evidence.

Fiber surface modification layers are extremely thin and previous attempts at their identification by either transmitted light FTIR microscopy of flattened fibers or attenuated total reflectance (ATR) FTIR microscopy have failed, only revealing the spectrum of the fiber core. For the following reasons it was hoped this thin surface layer might be characterized by using as the IR source a beam off of a synchrotron and coupled to an FTIR microscope having an ATR objective with a germanium objective:

1) *Brightness.* For a typical thermal IR source for a bench top IR system, as you go to smaller and smaller apertures the brightness of the beam greatly decreases. The beam from a synchrotron is diffraction limited, 3 to 20µm for mid-IR wavelengths. For FTIR spectromicroscopy based on synchrotron radiation the beam may be focused down to a spot with a diameter ≤10µm, and the beam is hundreds of times brighter than with a conventional IR source. For aperture sizes of 10 microns and smaller a synchrotron source has a signal to noise ratio more than a 1000 times better than a conventional thermal IR source for mid-IR spectromicroscopy.

2) *No Sample Damage.* Unlike laser UV probes and x-ray microprobes, mid-IR light is too low in energy to harm (degrade) most samples.

3) *Limited Surface Penetration.* With the attenuated total reflectance (ATR) technique there is limited penetration of the evanescent wave from the IR beam into the depths of the sample, hence the majority of the signal will be due to absorption of energy at or near the surface of the sample.

4) *Germanium crystal on microscope objective.* Because of the refractive index of germanium, evanescent waves through the crystal that is in intimate contact with a sample will have a more shallow penetration depth than other common ATR crystals such as diamond or zinc selenide. Since the fiber surface modification layer is very thin and on the fiber surface, the best chance for the detection and characterization of this surface modification layer via ATR would be by use of a germanium crystal using the beam from a synchrotron as the infrared light source. That no sample preparation is required is an added advantage.

All cloth and fiber samples were examined at the 1.4.4 beamline at the Advanced Light Source (ALS) at Lawrence Berkeley National Lab., [infrared.als.lbl.gov/content/beamline-1-4/144]. The 1.4.4 beamline is equipped with a Nicolet Nexus 870 FTIR bench coupled to a Continuum XL imaging microscope having a single element MCT A* detector (liquid nitrogen cooled). Although the MCT A* detector has great sensitivity, its spectral range is limited to 800 - 10,000 cm^{-1} .

Operators at the 1.4.4 beamline have a choice of using either the thermal infrared source normally used by the Nicolet Nexus 870 FTIR or instead using the beam from the synchrotron. In order to demonstrate and quantitate any advantages provided by the synchrotron source, we had hoped to be able to keep all other instrument conditions constant and for a given fiber sample obtain one spectrum using the synchrotron source and another spectrum using the instrument source. However, we found that this was not possible. If one visualizes the microscope objective with germanium crystal, the proximal end of the crystal (the end that will make contact with the sample) is roughly hemispherical. Ideally, both the beam from the synchrotron and the beam from the FTIR instrument bench should be focused at the same spot on the Ge crystal and that should be at the bottom center of the hemisphere. When we checked the beam alignments we found that they were not focused at the same location on the crystal and neither was focused at the bottom center of the hemisphere and each was focused at a different location some distance from the bottom center. For best quality spectra this focal point on the crystal needed to be in intimate contact with the fiber. This could only be found by trial and error. Because the focus point of the beam for either source was not at the bottom center of the hemisphere, direct contact of the fiber with the bottom center did not produce the best spectra, but contact with any area distant from bottom center caused the fiber to roll or be pushed away. When good contact near the focus point was finally achieved using the synchrotron source, after collecting a spectrum one could not just switch over to the FTIR bench source since that would not be a good location on the crystal for that beam. In the limited time available (we had four days assigned to us) it was not possible to correctly align the two beams and still have sufficient time to examine the fiber samples. Therefore, all of our spectra were collected using the beam off of the synchrotron.

RESULTS: All attempts at obtaining infrared spectra characteristic of any surface modification treatment were unsuccessful. Whether we examined a swatch of material or an individual fiber, the spectra obtained were all characteristic of the underlying fiber core rather than that of any surface modification layer.

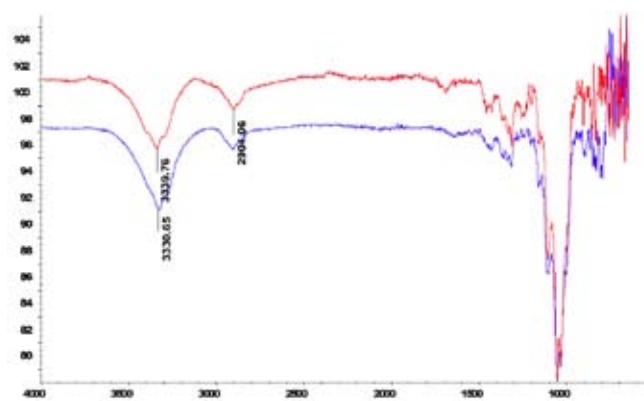


Fig. 1. Sample A1 (red, upper trace), 100% cotton knit with 3M protective finish (#20) and Sample A2 (blue, bottom trace) 100% cotton knit with no protective finish.

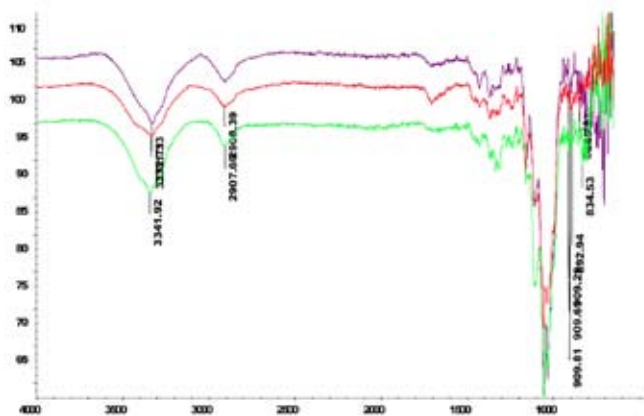


Fig. 2. Different fibers or locations on fibers, all from Sample B1, 100% cotton woven with 3M protective finish. Spectra #24, #25, #26.

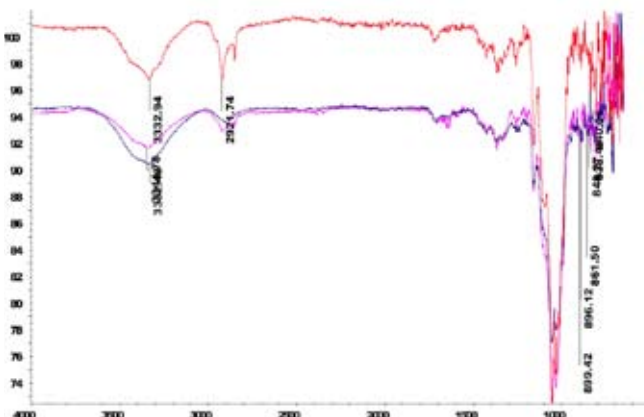


Fig. 3. Different fibers or locations on fibers, all from Sample B2, 100% cotton woven with no protective finish. Spectra #27, #28, #29.

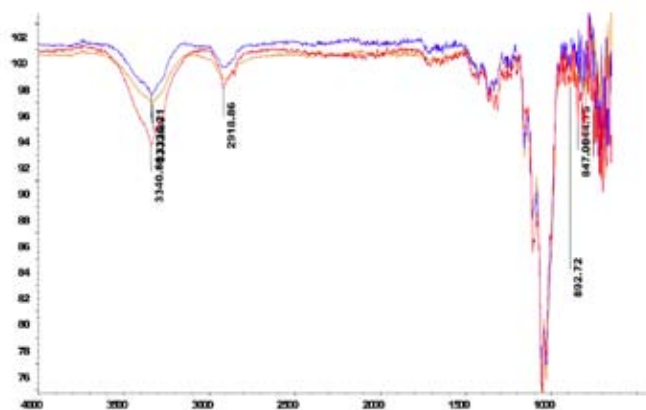


Fig. 4. Different fibers or locations on fibers all from Sample B3, 100% cotton woven with a different manufacturer's (not specified) protective finish. Spectra #30, #32, #33.

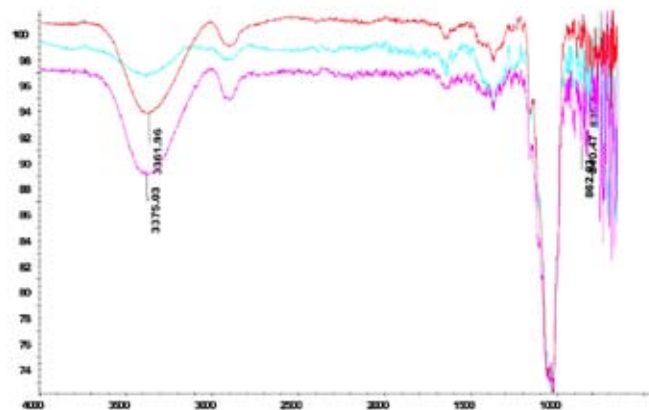


Fig. 7. Different fibers or locations on fibers all from Sample C2, 80/20% PET/rayon with no protective finish. Spectra #45, #46, #48. All rayon fibers.

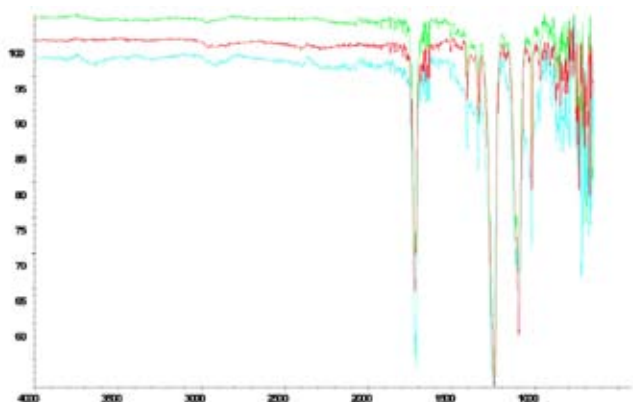


Fig. 5. Different fibers or locations on fibers all from Sample C1, 80/20% PET/rayon with 3M protective finish. Spectra #34, #37, #38. All PET fibers.

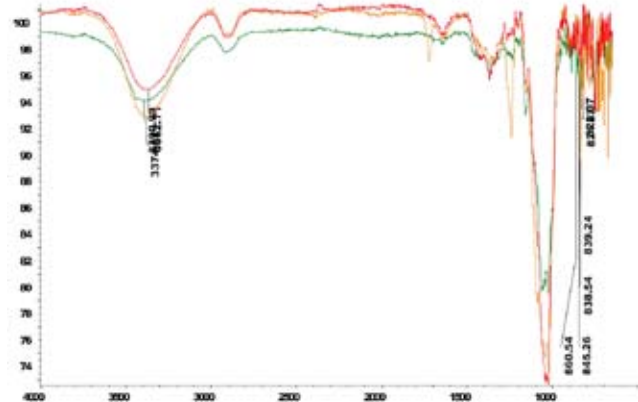


Fig. 8. Different fibers or locations on fibers all from C3, 80/20% PET/rayon with a different manufacturer's (not specified) protective finish. Spectra #49, #50, #51. All rayon fibers.

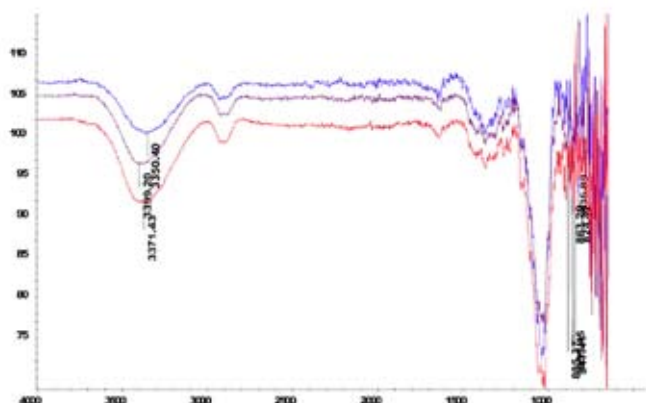


Fig. 6. Different fibers or locations on fibers all from Sample C1, 80/20% PET/rayon with no protective finish. Spectra #41, #42, #43. All rayon fibers.

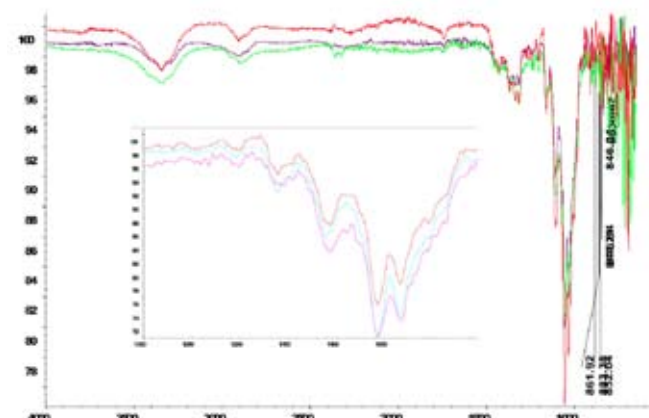


Fig. 9. Different fibers or locations on fibers from Sample D1, bleached only cotton with P2i treatment. Spectra #53, #54, #55.

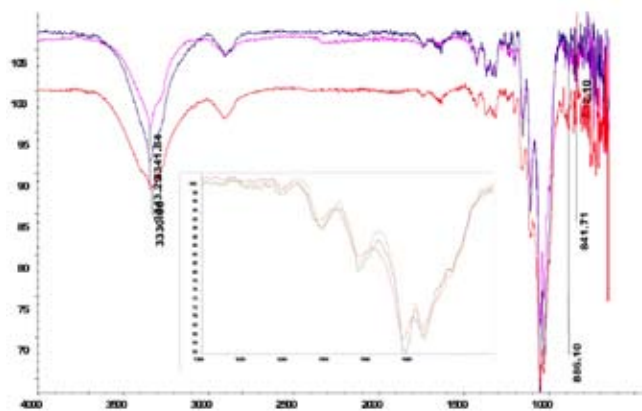


Fig. 10. Different fibers or locations on fibers from Sample D1, bleached only cotton with P2i treatment. Spectra #59, #60, #61.

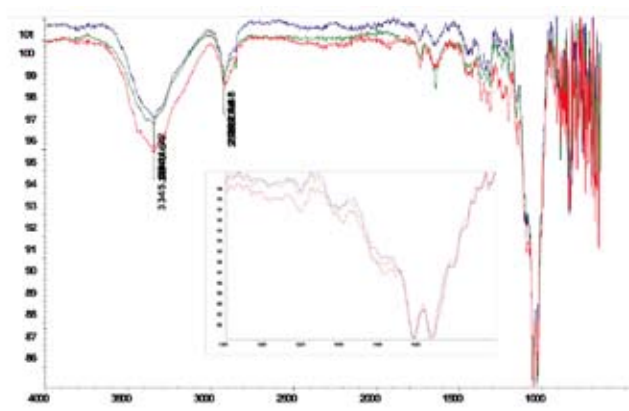


Fig. 13. Different fibers or locations on fibers from Sample E1, finished cotton with P2i treatment. Spectra #69, #70, #71.

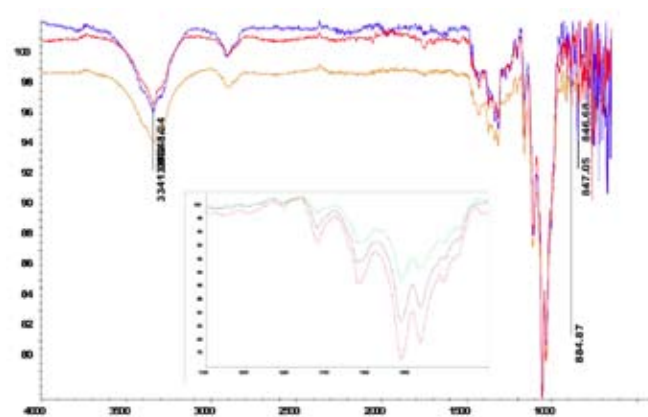


Fig. 11. Different fibers or locations on fibers from Sample D2, bleached only cotton with no treatment. Spectra #56, #57, #58.

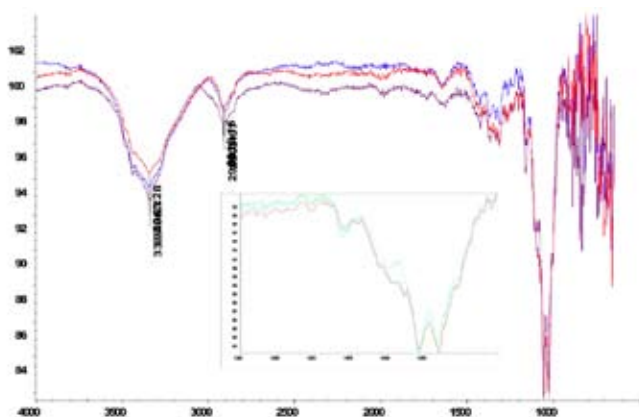


Fig. 14. Different fibers or locations on fibers from Sample E2, finished cotton with no treatment. Spectra #72, #73, #74.

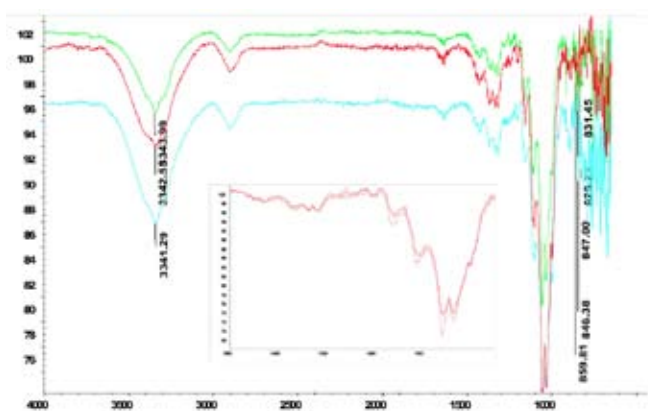


Fig. 12. Different fibers or locations on fibers from Sample D2, bleached only cotton with no treatment. Spectra #62, #64, #65.

Although some differences can be seen in some of the spectra, they are inconsistent and would not permit a definitive identification of treated or untreated or to distinguish between the proprietary methods of different manufacturers.

It would appear from these results that ATR FTIR microspectroscopy either with an infrared source from a beamline from a synchrotron or from the thermal source from the FTIR instrument bench is not capable of distinguishing between those similar fibers having and not having a surface modification treatment or for distinguishing between fibers having different manufacturers' proprietary surface modification treatments. All of the spectra are saved to a CD and will gladly be made available to other researchers.

¹Chapter 9, Characterization of Surface-Modified Fibers, Robert D. Blackledge and Kurt Gaenzle in *Forensic Analysis on the Cutting Edge - New Methods for Trace Evidence Analysis*, Robert D. Blackledge, Editor, 2007, Wiley Interscience, ISBN 978-0-471-71644-0.

SUMMARY OF GRANT EXPENDITURES:

- \$482.36 lodging at La Quinta Inn & Suites, Hayward, CA from 25 – 29 Aug. 2008 (Reffner and Blackledge shared a room)
- \$406.63 Orbitz [flight for Blackledge (round trip San Diego – San Jose) plus rental car]
- \$ 67.17 additional for Hertz car rental (mostly gas) from 25 – 30 Aug. 2008
- \$ 469.00 flight cost for Reffner [round trip on Jet Blue from JFK – OAK]
- \$1425.16 Total expenditures from an initial grant of \$1500.00

I thank the CAC and especially the members of the Endowment Committee for approving this grant and providing the funds that made this study possible.

Robert D. Blackledge

The Advanced Light Source at the Lawrence Berkeley National Laboratory

What Can National Laboratories Do For Criminalists?

*Bob Blackledge
Forensic Chemist Consultant*

In this issue of the *CACNews* is a Report to the CAC outlining the results of a research study conducted at one of the infrared beamlines coming off the synchrotron at the Advanced Light Source (ALS) at the Lawrence Berkeley National Laboratory. In terms of its stated objectives, the outcome of this research would have to be judged unsuccessful. However, I do not want readers to dismiss the many opportunities afforded by the various national laboratories.

First of all, even negative results have value. We were looking at fibers that had originated from fabrics that may or

may not have received some type of surface treatment (stain resistance, permanent press, etc.). If otherwise identical fibers could be distinguished (treated from untreated, or brand X treatment from brand Y treatment) it would have forensic value. To get an idea of the possible advantages of using the beamline off of a synchrotron as an IR source, read the article at: infrared.als.lbl.gov/IRNews/IRNews7.pdf.

That any surface treatments were so thin that they were virtually undetectable from the background of the fiber core tells us that other infrared methods are also likely to prove unsuccessful. At least I can't visualize an infrared method that would have greater sensitivity for thin surface traces than ATR (attenuated total reflectance) using an FTIR microscope with an objective with a germanium crystal that makes intimate contact with the fiber and uses a beamline coming off of the synchrotron as the infrared source. The results also tell us that Raman microspectroscopy is also unlikely to provide useful results since the Raman effect is much weaker (and also subject to interference from fluorescence). A previous study was able to distinguish tiny swatches of fabric by using flash pyrolysis capillary column gas chromatography mass spectrometry (Py GC/MS), but lacked the sensitivity to distinguish between individual fibers. Although not simple, there are several things that could be done to increase the sensitivity of that method and perhaps that is the approach to take.

Who can use the facilities at national laboratories? Anyone; you don't even necessarily have to be a U.S. citizen. However, there is a procedure one needs to follow in order to be granted access time for their experiments. Although there will be some variation between different national laboratories, the first step is to write up a research proposal. Each national laboratory and some subdivisions of national laboratories (example, ALS) has a webpage where you can find instructions for preparation of research proposals. All of the research proposals submitted for a certain time frame (at ALS it is six month periods) for a certain unit of the national laboratory (e.g., the 14.4 infrared beamline at ALS) are evaluated and rank-ordered by a committee comprised of scientists expert in that particular area. Those proposals ranked above the cut-off level will be assigned time for use of the facility (in your proposal you will have indicated how much time you need for your experiments). Whether or not your proposal makes the cut-off, you will also get feedback from the committee regarding the proposal's strengths and weaknesses. Well beforehand you will be able to request dates for your use of the facility, and the staff will take everyone's requests into consideration and come up with a published schedule. When you arrive at the facility you will not be strictly on your own; there will be experienced staff glad to help orient you and (if needed) help you set up your experiments.

Why would one want to use the facilities at a national laboratory? Fair question. If you have evidence in a criminal case and you want to conduct examinations on it using instrumentation not available in your forensic laboratory but available at a national laboratory, I'd say that your chances of success are not very



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good. Not impossible; just not good. National labs are not set up for “drive-in” examinations! If you had previously conducted experiments at this particular section of this national laboratory (i.e., already had good contacts with the staff in that section), and if you already had developed a validated protocol for the experiments you needed to run, it would help your odds. It would also help if when you looked at the schedule of facility time assigned you came across a university professor that you knew who might be willing to squeeze you in on his/her assigned time. And of course, it always helps if your case is very high-profile.

Your chances are far better if the experiments you want to run are for research. Because of the lead time required it would be difficult for a student working on an advanced degree to submit a research proposal and get it ranked and accepted and assigned time at the facility within the student's time constraints for graduation. However, frequently the experiments done by a student towards a graduate degree are an extension of their major professor's research. So forensic science professors (or working criminalists who also work part-time as adjunct professors) who lack an item of equipment or a specific type of attachment for an instrument at their university or forensic laboratory might locate a national laboratory having the desired equipment. They could write up and submit a research proposal and by the time it was evaluated, ranked, and approved they might have a promising student who would be perfectly positioned to take advantage of this opportunity.

My research was performed at the 1.4.4 infrared beamline of the ALS the last week in August of 2008. Even though at that time my proposal had not yet been evaluated, ranked, and approved, they were able to squeeze me in with the necessary beamline time. The time period for which my research application was submitted was the first half of 2009. When my application was eventually approved, I was allotted 80 hours of beamline time even though I had already completed the experiments outlined in my initial research proposal. I requested and received the period from 23-27 June 2009. Instead of examining surface-treated fibers, I will be working with John Reffner and the staff at the 1.4 beamline to look at adhesive traces that may be adhering to transferred glitter particles that were originally affixed to arts and crafts items or items of apparel. Stay tuned!

Following are some websites you might want to peruse if the possibility of running experiments at a national laboratory interests you:

National Lab websites listings:

dir.yahoo.com/Government/U_S__Government/Research_Labs/?b=0

en.wikipedia.org/wiki/United_States_Department_of_Energy_National_Laboratories

www.er.doe.gov/National_Laboratories/index.htm

Center for Accelerator Mass Spectrometry:

cams.llnl.gov/

For example, see “About Microprobe PIXE” at cams.llnl.gov/nuc-mic.php Also go to “Nose-only inhalation toxicology” at cams.llnl.gov/nose.php Could microbeam PIXE examination of nasal swabs show if a person was nearby when a firearm was discharged?

National Center for Electron Microscopy:

ncem.lbl.gov/index.html

Your lab has SEM/EDS, but does not have TEM? Take a look at what they have!

Berkeley Lab:

www.lbl.gov/

ALS at Berkeley Lab:

www.als.lbl.gov/

At this site you can go to all the individual beamline sites and also find out what energy ranges, types of instruments, and types of experiments can be performed at each.

ALS Infrared Beamlines Homepage:

infrared.als.lbl.gov/content/home

Beamline 1.4:

infrared.als.lbl.gov/content/beamline-1-4

Mike Martin's home page (he is in charge of the infrared beamline):

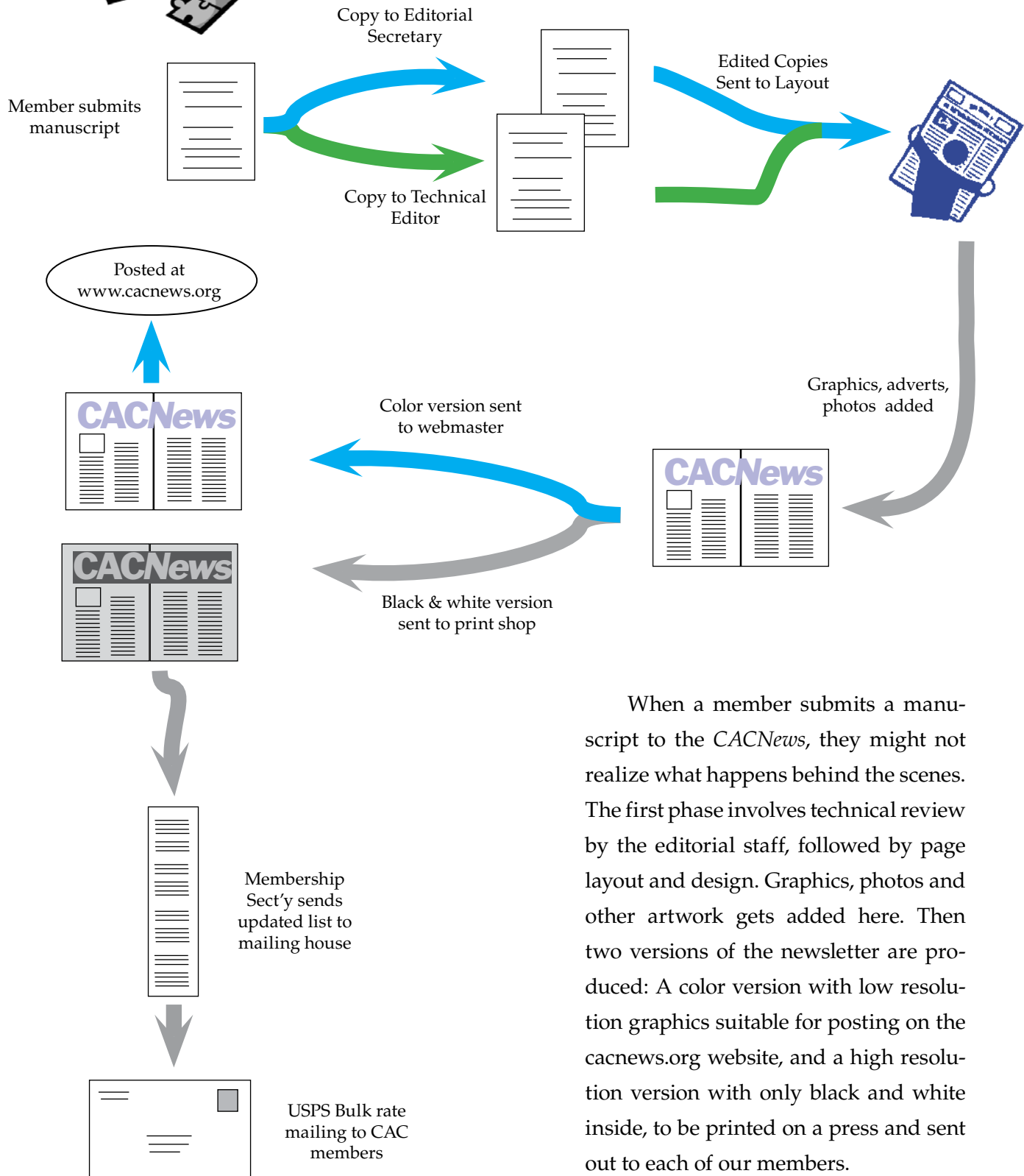
www.lbl.gov/mmartin/

A Practical Example:

It is not unusual for wallboard (aka: drywall, Sheetrock, gypsum) traces to be found as trace evidence. In a given case, recovered traces may help to associate a suspect with the crime scene. But to what extent can wallboard originating from different sources be distinguished? We would expect that at the very least there would be class differences. For example it's likely we would find differences where the gypsum (hydrated calcium sulfate) originated from mines compared to if it was a byproduct of a coal burning electrical power plant. Recently in the U.S. there have been odor and corrosion problems with drywall imported from China [www.cen-online.org May 4, 2009, page 50]. We should see differences there also. But can we also see differences depending on the gypsum mining site or the origin of the coal being burned in the electrical power plant? Could we have even greater discrimination if we perhaps looked at the stable isotope ratios of sulfur (S34 and S32), and/or oxygen (O18 and O16)? Few forensic science labs have the equipment to carry out such an analysis. Hmm. Using Google and general search terms I found the website for UCLA SIMS Home Page (<http://sims.ess.ucla.edu/index.php>). Putting my cursor on Applications and clicking I see a page headed Major Applications of the UCLA IMS-1270. I also see “sulphates” in the column under Stable Isotopes. Well, the UCLA SIMS lab might be great for those of us living in the southern part of the state, but are there similarly equipped facilities further north? Under Resources from the pull down menu slide your cursor down to “Other Links” and then click on “Worldwide Ion Probes.” There you will see that instrumentation is also available in Livermore and Menlo Park. So you've never operated an ion microprobe and don't feel qualified to do this on your own? Not necessarily a problem. If they feel it is an interesting experiment that will likely produce new and publishable information, the staff at these facilities may be very happy to collaborate with you. What does it cost you? Lots of time, but very little actual money. Use of the facilities is free; you just have to pay your expenses for transportation, housing, and meals.



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When a member submits a manuscript to the *CACNews*, they might not realize what happens behind the scenes. The first phase involves technical review by the editorial staff, followed by page layout and design. Graphics, photos and other artwork gets added here. Then two versions of the newsletter are produced: A color version with low resolution graphics suitable for posting on the cacnews.org website, and a high resolution version with only black and white inside, to be printed on a press and sent out to each of our members.

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