Moving Trace Evidence Forward through Research

JoAnn Buscaglia
FBI Laboratory

2011 Trace Evidence Symposium
Kansas City, MO

Counterterrorism and Forensic Science Research Unit

Mission:

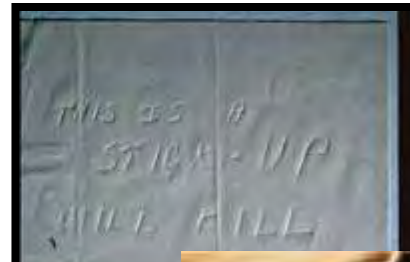
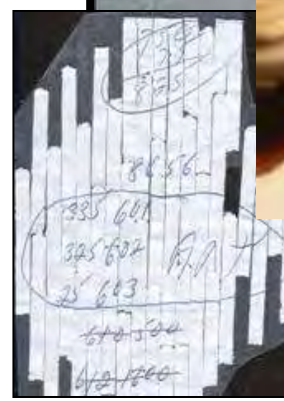
The Counterterrorism and Forensic Science Research Unit (CFSRU) formulates and executes R&D initiatives to benefit the FBI as well as our other federal, state, local, and international partners.

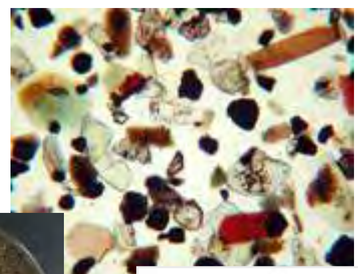
Program Areas:

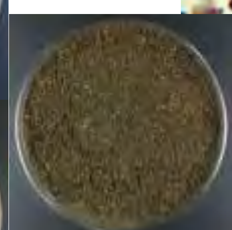
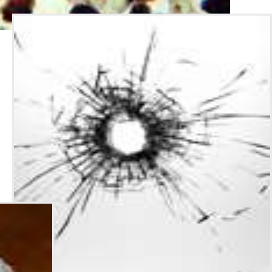
- C/T, Intelligence, and Forensic Science R&D
  - Internal R&D
  - Outsourced R&D
  - Visiting Scientist Program
- Interagency Collaborations

R&D Initiatives: Physical Sciences

- Materials Analysis
  - Microscopy and Microanalysis
- Latent Prints
- Questioned Documents



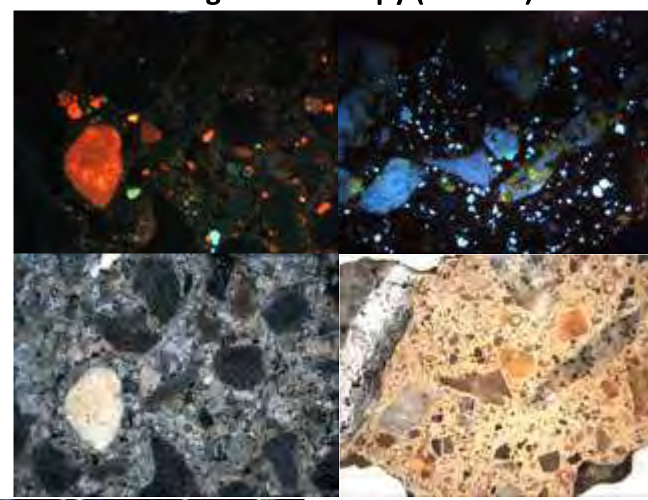




Cathodoluminescence (CL) of Materials

Evaluate use of cathodoluminescence (CL) for determining geographic origin of mineral grains, and as a point of comparison in forensic examinations involving soils, building materials, and manufactured products that contain geologic materials, such as paints, tapes, and glass.

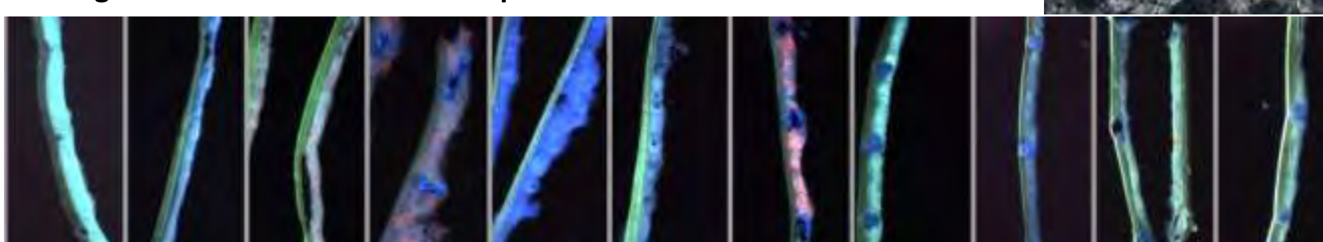
Contact: JoAnn Buscaglia

Concrete masonry unit under CL (top) & reflected light microscopy (bottom)



Reflected light (left) and CL (right) images of white architectural paint (multi-layer)

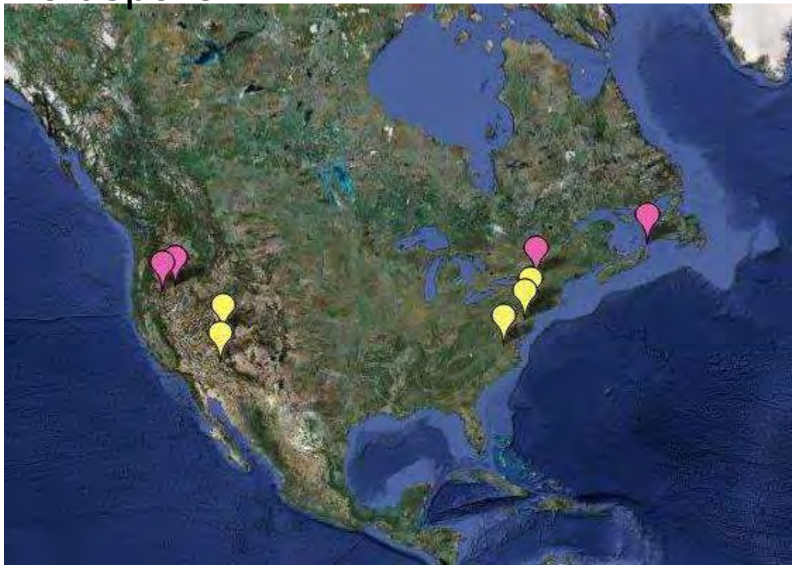
CL images of cross-sections of duct tapes form different manufacturers



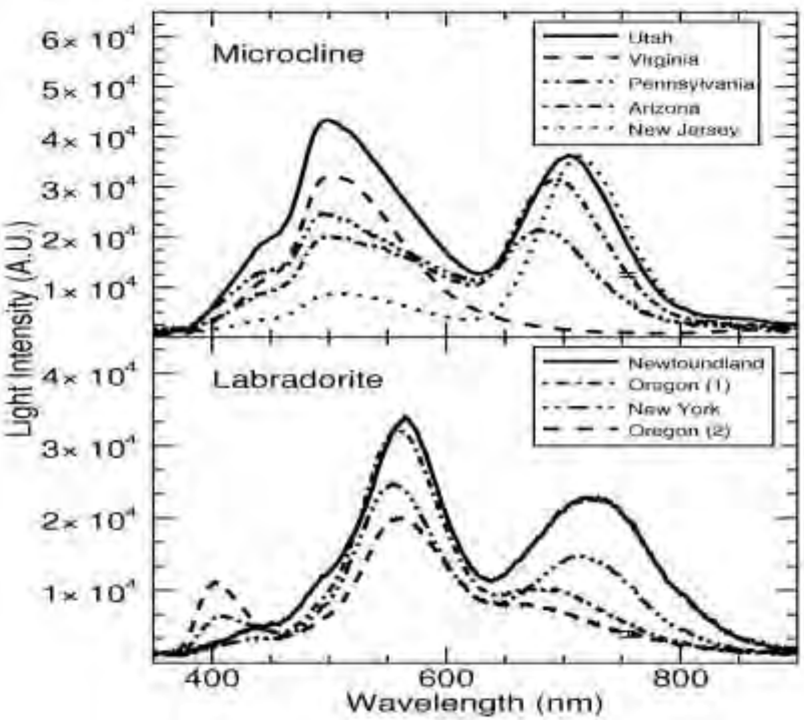
Cathodoluminescence (CL) of Minerals

Evaluate use of cathodoluminescence (CL) of minerals for provenance and forensic source discrimination; Correlate CL emission with geologic origin, mineral type, and elemental analysis.

Feldspars



North America including contiguous United States, portions of Canada, and Mexico. Markers locate general site of samples. Yellow designates microcline samples, magenta designates labradorite samples (Google Maps).



Representation of variability in feldspar type by provenance formation indicated on the map.

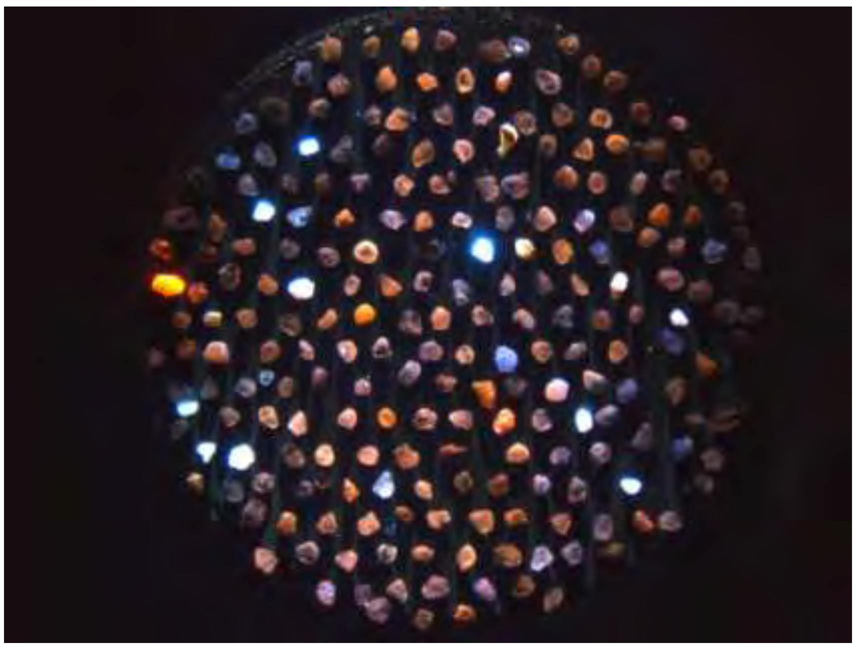
FEDERAL BUREAU OF INVESTIGATION LABORATORY DIVISION

Cathodoluminescence (CL) of Sediment Samples

"The future of forensics"

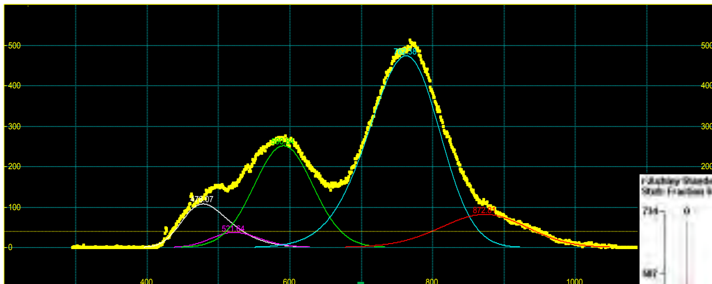
COUNTERTERRORISM AND FORENSIC SCIENCE RESEARCH UNIT

Evaluate CL use for forensic source discrimination and geolocation / constrain provenance

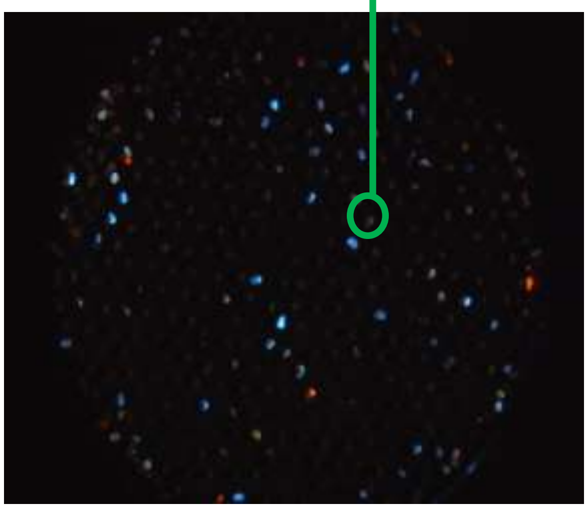


CL image of sieve fraction of sand from Grand Haven, MI on an SEM stub prepped with back-sieving

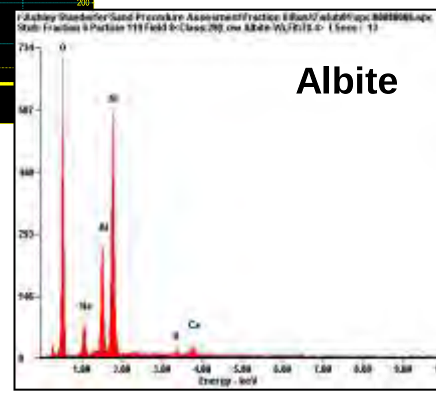
Cathodoluminescence (CL) of Sediment Samples



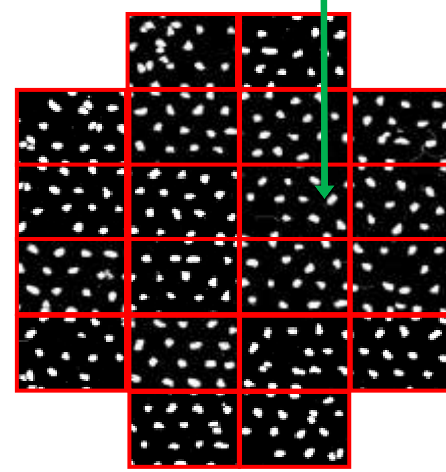
CL Particle 22
(Blue-Grey)



CL: 5 sec exposure



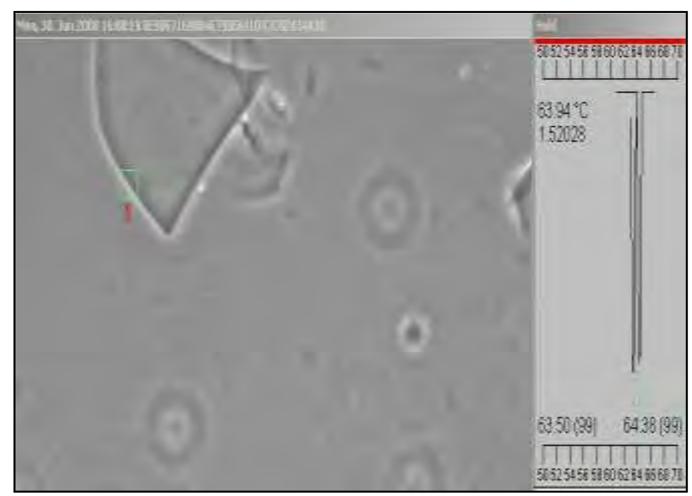
SEM-EDS
Particle 119



SEM-EDS Field Map

Glass

- SWGMAT Glass Subgroup
- ASTM Standard Methods development
- International collaboration (BKA)
  - RI and elemental compositional variations within new production glass products; match criteria assessment
    - Koons and Garvin, *J. Foren. Sci.*, 2011 (RI only).
- Elemental Analysis Working Group
  - Funded by NIJ Grant
  - Organized by FIU
  - Modeled after NITE-CRIME



Aims of the EA Working Group

- ***To improve the forensic analysis of glass through validation and standardization efforts*** for a variety of elemental composition analysis methods (µXRF, LIBS, ICP-MS and LA-ICP-MS). A standard method for solution ICP-MS analysis of glass already exists (ASTM E2330-04).
- ***Develop ASTM methods*** for µXRF, LA-ICP-MS and, possibly, LIBS for the elemental analysis of glass (then paint and soils).
- ***Design round robin exercises*** that 1) inform the participants on the performance of the methods they utilize through feedback and 2) provide insight on match criteria selection and significance of a "match" when a match is found.
- ***Collaborate with trace examiners*** (eg. SWGMAT) to develop a ***common language*** that can be used to communicate the findings of elemental analysis comparisons of glass evidence.

EAWG Members

Jose Almirall[1], Tatiana Trejos[1], Erica Cahoon[1], Emily Shenck[1], Sarah Jantzi[1], Stefan Becker[2] Marc Dücking[2], JoAnn Buscaglia[3], Robert Koons[4], Scott Ryland[5], Ted Berman[5], Kristine Olsson[6], Tiffany Eckert-Lumsdon[7], Melissa Valadez[8], Randall Nelson[9], Edward Chip Pollock[10], Christopher Hanlon[11], David Rudell[12], Alex Heydon[12], Adolfo Caballero[13], Vincent Zdanowicz[14], Shirly Montero[15], Andrew van Es[15], Jhanis Rodriguez[16], Troy Ernst[17], Theresa Hosick[18], Chris Palenik[19], Claude Dalpe[20], Igor Gornushkin[21], Steve Buckley[22], Ela Bakowska[23]

1. Department of Chemistry and Biochemistry and International Forensic Research Institute, FIU, Miami, FL
2. Forensic Science Institute, Bundeskriminalamt (BKA), Wiesbaden, Germany
3. Federal Bureau of Investigation (FBI Laboratory CFRSU), Quantico, VA
4. Consultant (Retired from FBI Laboratory CFRSU), VA
5. Florida Department of Law Enforcement, Orlando, FL
6. Johnson County Crime Lab, KS
7. US Army Criminal investigation Lab, Atlanta, GA
8. Texas Department of Public Safety, TX
9. Tennessee Bureau of Investigation, TN
10. Laboratory of Forensic Science, Sacramento, CA
11. Miami Dade Police Department, Miami, FL
12. Center of Forensic Sciences, Canada
13. Procuraduría General de Justicia, Nuevo León, México
14. Dept. of Homeland Security, CBP Research Laboratory, VA
15. Netherlands Forensic Institute, The Hague, Netherlands
16. Applied Spectra, CA
17. Michigan State Police - Grand Rapids Forensic Laboratory, MI
18. US EPA – NEIC Laboratory, CO
19. Microtrace LLC, Illinois
20. RCMP-GRC, Ottawa, Canada
21. BAM, Berlin, Germany
22. Photon Machines, Seattle, WA
23. Corning Incorporated, Corning, NY

August 2010 meeting, Breckenridge, CO, (Elevation 2927 m)

EAWG - 4 Round Robin Studies

1. December 2008 - Performance of analytical methods, comparison of 2 glass samples K1 vs Q1 (same source)
2. August 2009 - Analytical performance of methods using larger set of standard materials and comparison samples in order to evaluate different match criteria [K vs Q1(same source) and K vs Q2 (different source, same plant 2 years apart)]
3. December 2009 - comparison of larger set of samples in order to permit further evaluation of discrimination capabilities, samples were originated from same plant manufactured at different time intervals
   a) August 2010 - extended statistical analysis: extended evaluation of several match criteria and interpretation of results
4. December 2010 - comparison of set of samples originating from the same source and from different sources to evaluate type I and type II errors

Products from EAWG

- Two publications describing the RR results.
- Draft ASTM Standard methods of glass analysis by µXRF and LA-ICP-MS.
- Presentations at the Trace Evidence Symposium 2011
  - Characterization of Materials by Elemental Analysis; µXRF, LA-ICP-MS and LIBS Method Performance, Use of Match Criteria and Significance of Association
  - A Comparison of Solution Based and Laser Ablation ICP-MS Analysis of Forensic Glass Samples and A Proposed Standard Test Method for Determination of Trace Elements in Glass Samples Using Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS)
  - Precision of Elemental Analysis Measurements of Glass by µ-XRF and the Impact on Forensic Comparisons
  - A Proposed Standard Test Method for Forensic Analysis of Glass Using Capillary Micro-x Ray Fluorescence Spectrometry
  - When is a peak, a peak? Calculating detection and quantification limits for micro X-ray fluorescence spectrometry of glass samples
  - Improvements in Analytical Precision in the Forensic Analysis of Glass through the Use of Metal Filters in µ-XRF Analysis

Hair - Microscopy

Microscopic Effects on Hair Removed Antemortem and Stored Under Various Conditions

Compare decompositional changes in ante- and postmortem hairs to determine if characteristics consistent with postmortem root banding and/or putrid roots may occur in hairs removed antemortum.

Contact: Stephen Shaw (TEU)

Fabric and Fibers

Fabric Damage Alteration in a Burial Environment

Test the effect of decomposition processes (1yr) on the ability to identify fabric damage (using fabrics of different fiber types).

Contact: Sandy Koch (TEU)

Physical Matching of Fabrics

To further evaluate the reliability of physically matching fabrics as a means of positive source identification.

Contact: Stephen Shaw (TEU)

Evidential Value of Textile Fibers

To further investigate the evidential value of textile fibers commonly found in casework.

Contact: Stephen Shaw (TEU)

Paint

Characterization and Discrimination of Single White Layer Architectural Paints

Contact: Diana Wright (CU)

- Update will be presented at TES 2011 on Wednesday (Paint Session)

R&D Initiatives: Chemistry

"The future of forensics"
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- Field and Lab Instrumentation
- Explosives
- Stable Isotopes
- Spectroscopy
- Trace Volatiles

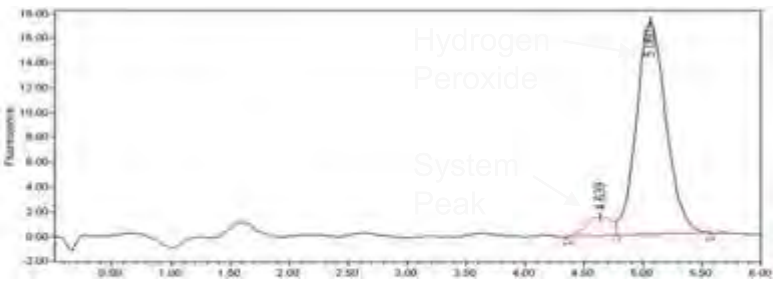
Evaluation and Analysis of Novel Explosives

Identify analytical methods and technologies to detect and identify current and new threat explosives.

Contact: Mark L Miller

Active Research:

- Method development.
- Explore separation parameters.
- Optimize method and instrument conditions.
- Study calibration data and field samples.



Detection of Explosives and their Metabolites in Human Hair

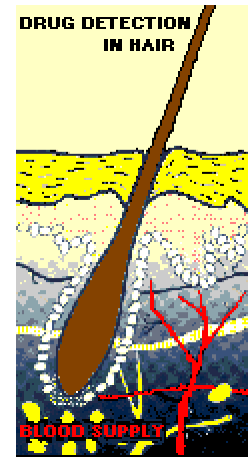
Explosives can be absorbed into the body which may subsequently be found along with their metabolites in biological matrices including hair.

Contact: Dr. Mark L Miller

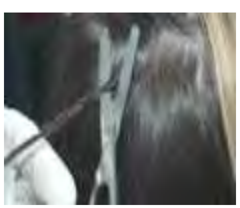
Goal: Identify individuals and their roles in handling explosives

Active Research:

- Method development.
- Optimize extraction & analysis.



Previously established



Hair Collection

Extraction

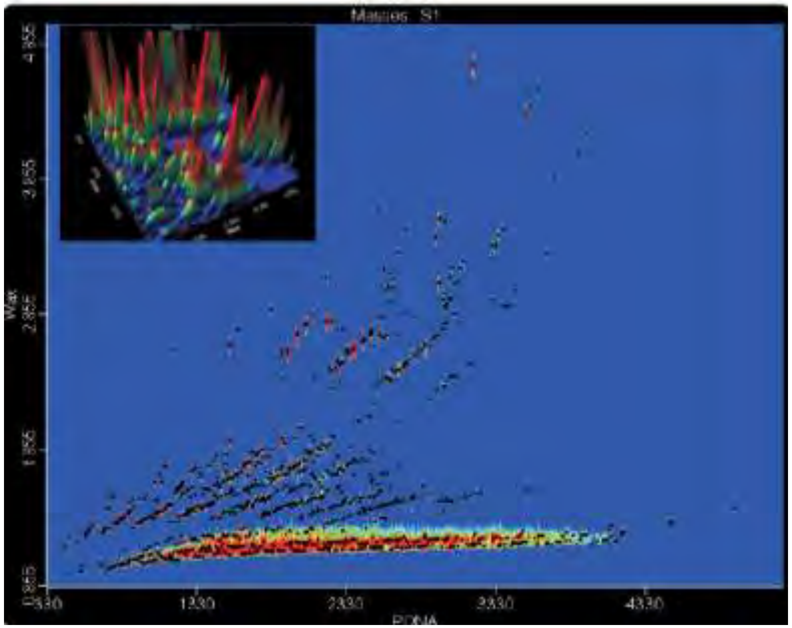
Matrix Removal

Analysis

Multidimensional GC/MS-FID Analysis of Explosives

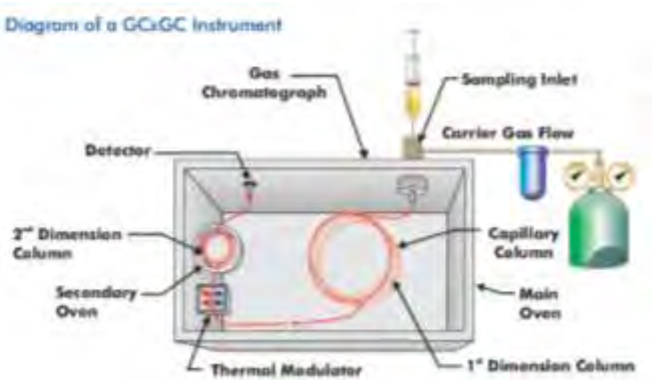
Identify new analytical methods to separate and identify complex mixtures of explosives containing samples using GC/MS-FID.

Contact: Chris Tipple



Active Research:

- Instrument acquisition and set-up.
- Two-dimensional method development.
- Optimize method and instrument conditions.



Factory-Caused Isotope Variations in Explosives

Identify the mechanistic causes of isotopic variations in nitro-organic explosives and document temporal variations from specific factories.

Contact: Libby Stern

Active Research:

- Method development and validation.
- Assessment of carbon, nitrogen and oxygen isotope variations.
- Assessment of utility of this approach.

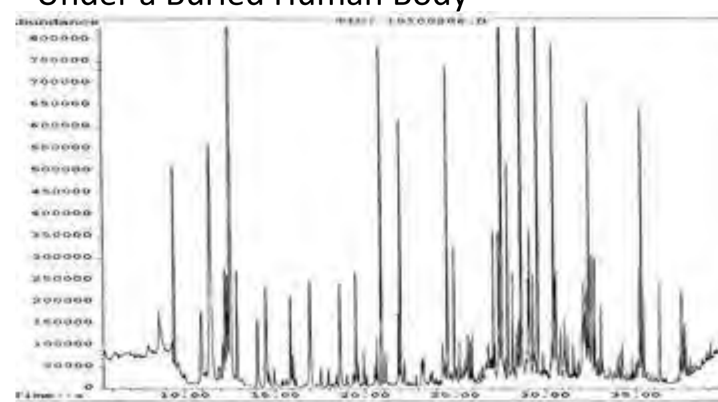
Trace Volatiles Analysis

Apply analytical instrumentation and methods to reproduce canine ability to extract and detect volatile organic compounds (VOCs) from human scent and decomposition of human remains

Contact: Brian Eckenrode

- Characterize human (living / deceased) chemical constituents released and thei persistence.
- Understand and detect human decomposition chemistry.
- Identify target compounds and respective concentrations.
- Optimize analytical methods for potential field use.
- Identify VOCs for use as canine training aids.
- Locate clandestine burial sites.

Complex Chromatogram of VOCs Collected Under a Buried Human Body

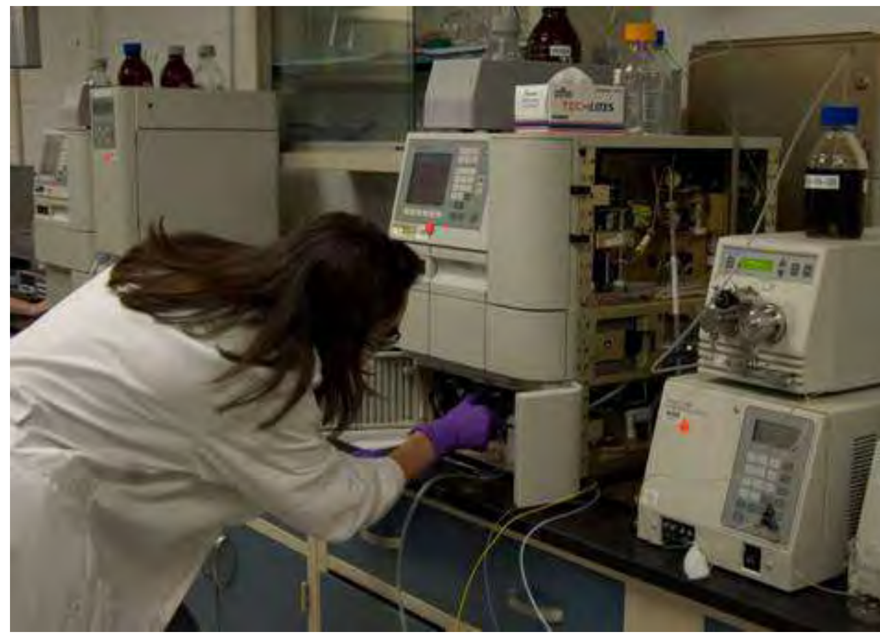


Visiting Scientist Program

Managed within CFSRU and administered in cooperation with DOE’s Oak Ridge Institute for Science and Education (ORISE).

- Builds relationships in the scientific community primarily through educational institutions.

- Participants are university faculty, post-graduates, and Ph.D., M.S., and B.S. - level students.



VSP Info: http://www.fbijobs.gov/242.asp; http://see.orau.org/ProgramDescription.aspx?Program=10063

Visiting Scientist Program

The VSP provides opportunities for participants to:

- Continue their education.
- Enhance their professional development in applied scientific research.
- Become well trained, highly skilled, experienced scientists for future employment in forensic fields.

- All assignments require an FBI security clearance
- Limited to US Citizens

VSP Info: http://www.fbijobs.gov/242.asp; http://see.orau.org/ProgramDescription.aspx?Program=10063

Visiting Scientist Program

Eligibility:

- College degree (doctoral, master's, bachelor's, or associate’s) in an appropriate science, engineering, or technology discipline within five years of appointment date, or
- Current affiliation with an educational institution either as faculty or as a student actively pursuing a degree.
- U.S. citizen

Appointments range from 3 -12 months and are renewable for up to 5 years.

VSP Info: http://www.fbijobs.gov/242.asp; http://see.orau.org/ProgramDescription.aspx?Program=10063

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Questions?

Contact: JoAnn.Buscaglia@ic.fbi.gov