















"Physical" Evidence	"Alteration" Evidence
 Looking for and investigating the cause of contamination events as the revealing trace Examples: Documented release/spill Storage of chemicals Contaminants (type & amount) characteristics Pattern & correlations of contaminants in mixtures Spatial and temporal concentration distribution 	 Looking for and investigating the <i>effect</i> of contamination as the revealing trace The effect could be on microorganisms, plants, or contaminated media itself Examples: Trace atmospheric contaminants present in groundwater



Contaminants where Environmental Forensics can be used

- Chlorinated solvents (PERC)
- PCBs / "Dioxins&Furans"
- Pesticides (persistent/non-persistent)
- Pharmaceuticals and personal care products
- Metals (mercury, lead, chromium, arsenic etc.)
- VOCs
- PAHs
- Methane (coal bed methane)
- Hydrocarbons (refined/unrefined)









































Biomarkers • Organic compounds in petroleum whose chemical structure can be unequivocally linked to a naturally occurring biochemical interest- Historical knowledge of containation • Solid knowledge of stabile environment of concerrent • Indicator compounds – unique chemicals identifying the mixture or source e.g. lead for gasoline



Indicator Compounds

- Simple analysis usually requiring GC or LC coupled with mass spectrometry
 - Retention time and mass spectral match
- Testing for presence or absence
 - $-\,$ YES or NO $\,$

Chemical Environmental Forensic Investigations

Biomarkers

- Isotope analysis
- Biomarkers
- Pattern Assessment
 - chemical mixtures
 - weathering products
 - Pattern matching for identification
 - Weathering pattern to determine age







Matrix









Investigation	Main Findings	
Line of Evidence 1: Historical Document Review	• The general Barnison nervine revealed higher natural background values of Perfamilies 110 ray lag proposed for site charmy, such higher PF values is such over reported and accurate dress work on accurate site and movements. For example, PF values is such over a 200 ray Ray to U.S. movements which Theorem and Callwei (Darway Ray and Arabier 2001). The foreign set of the second set of	
Line of Evidence 2: Chemical Fingerprinting/Statistics	Link 1.2 Image: A data in the link Image: A data in the link<	
Line of Evidence 2: Mineralogical Fingerprinting		







Envines Monit Assess (2015) 187-4099 DOI 10.1007/s10661-404-4099-5	Contents Hill (2017) 575-681 Contents Hill (2017) 575-681 Contents Hill available at ScienceDirect Chemosphere FLSEVIER journal homepage: www.elsevier.com/locate/chemosphere Ecological risk estimation of organophosphorus pesticides in riverine
Mercury contamination in the estuaries and coastal sediments of the Strait of Malacca	ecosystems Sze Yee Wee, Ahmad Zaharin Aris [®] Departmer of drawnamic Strence, Inculty of Internamental Studies, Universit Pairs Malaysia, 43400 UM Sording, Sdaugur, Malaysia
Ley Juen Looi - Ahmad Zaharin Aris - Fatimah Md. Yusoff - Zailina Hashim	HIGHLIGHTS GRAPHICALABSTRACT Preliming strength of risk is vital for suscitability of mericine
Reserver: 3 April 2014/Accepted: 28 October 2014 © Springer International Publishing Switzerland 2014	 ecosystem. Rot sagerst a potential risk of chor- pyroties and durizon in inversience or comparison of the humans can be exposed to high OPP concerning due to the unregulated pollution risk.



