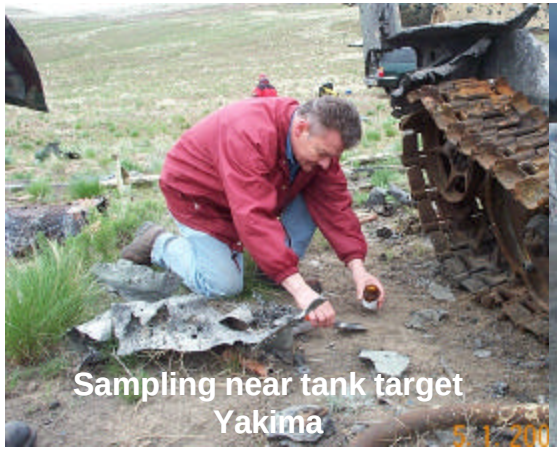
Distribution and Fate of Energetics on DoD Test and Training Ranges

CP-1155


Sampling near tank target
Yakima


Sampling snow,
Ethan Allen


Sampling hand grenade range
Ft. Lewis

Judith C. Pennington

U.S. Army Engineer Research and Development Center

Environmental Laboratory

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PERFORMERS

- **Drs. Judith C. Pennington, James M. Brannon**
  U.S. Army Engineer Research and Development Center
  Environmental Laboratory, Vicksburg, MS
- **Dr. Thomas F. Jenkins**
  U.S. Army Engineer Research and Development Center
  Cold Regions Research and Engineering Laboratory, Hanover, NH
- **Dr. Sonia Thiboutot**
  Defence Research Establishment Valcartier, Canada
- **Mr. John E. Delaney**
  Navy Explosives Ordnance Disposal Technology Division, Indian Head, MD
- **Mr. Jay Clausen**
  AMEC Earth & Environmental, Inc., Westford, MA

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TECHNICAL OBJECTIVE

Provide techniques to assess the potential for groundwater contamination from residues of energetic materials (TNT, PETN, NG, RDX, and HMX) at test and training ranges.

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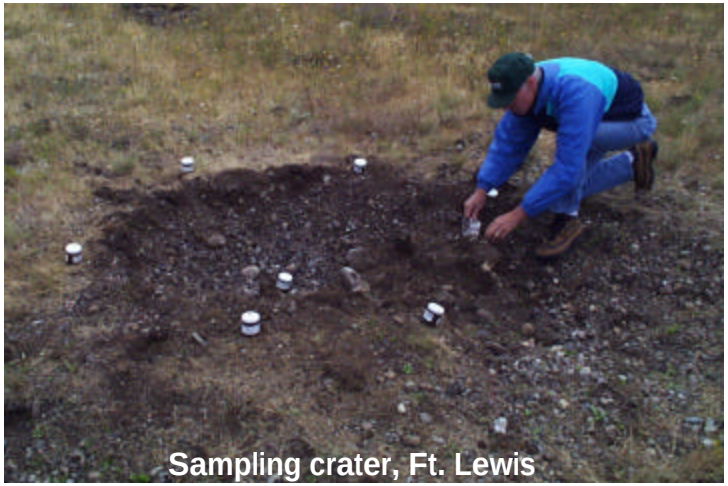
Evaluating Energetics Contamination

- Determine what energetics can be expected from specific range activities
- Determine what distribution and concentrations of energetics are associated with specific range activities
- Develop a scientifically appropriate sampling regime to overcome site heterogeneities
- Determine effects of climate/geology on transport potential


Composite sampling, Yakima


Sampling crater, Ft. Lewis


Sampling hand grenade range
Ft. Lewis

Fate and Transport

- **Review existing data and identify data gaps in process descriptors**
- **Determine appropriate descriptors in the laboratory**
  - **Dissolution kinetics**
  - **Partitioning coefficients**
  - **Transformation rates**
  - **Adsorption kinetics**
  - **Desorption kinetics**
  - **Degradation rates**

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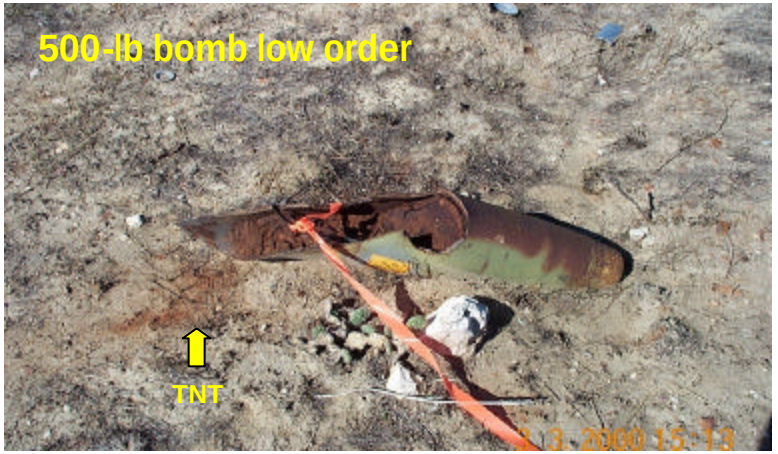
Controlled Detonations

- **High order detonations**
  - Confined and unconfined
  - Comparison of residues from detonations using C4 and shape charges
  - Residues on snow
- **Low order detonations**
  - Various degrees based on energy yield
  - Confined and unconfined
- **Unconfined charges**
  - Detonation of specific mass and shapes of 5 munitions
  - Fixed mass/shape with various initiations (C4, shape charges, direction of detonator)



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Firing Range Source Term

- Historical firing records
- Dud and low order rates
- Actual range data

Comparisons to Findings at Massachusetts Military Reservation

- Typical or unique?


40-mm UXO


Excavated mortars


UXO

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Field Sampling to Date

- Fort Lewis, WA
  - Heavy artillery range
  - Hand grenade range
  - Heavy artillery firing points
  - Groundwater monitoring wells
- Yakima Training Center, WA
  - Impact craters
    - Heavy artillery
    - Antitank
  - Firing points
    - Heavy artillery
    - Antitank range
    - 120-mm tanks
    - Mortars
  - Surface water
  - Water supply wells
  - Claymore mine
- Camp Guernsey, WY
  - Heavy artillery ranges
  - Heavy artillery firing points
  - Demolitions "blow-in-place"
  - Surface water
- Shilo Canadian Force Base
  - Unconfined charge
  - Range sampling
- Hand grenade ranges
  - Fort Leonard Wood, MO
  - Fort Wayne Wright, AK
  - Fort Richardson, AK
  - Camp Bonneville, WA

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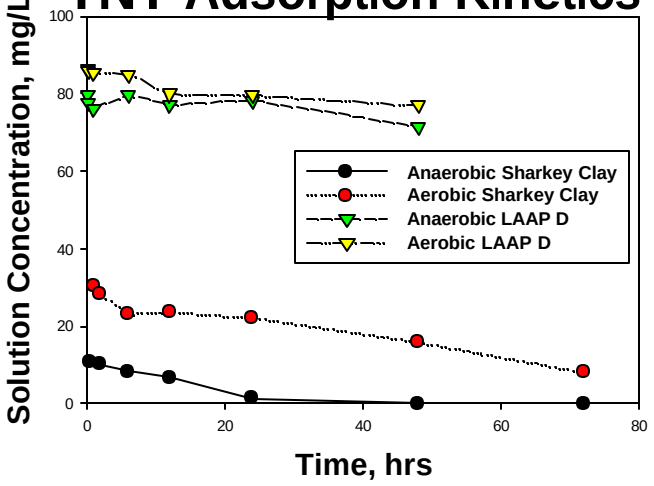
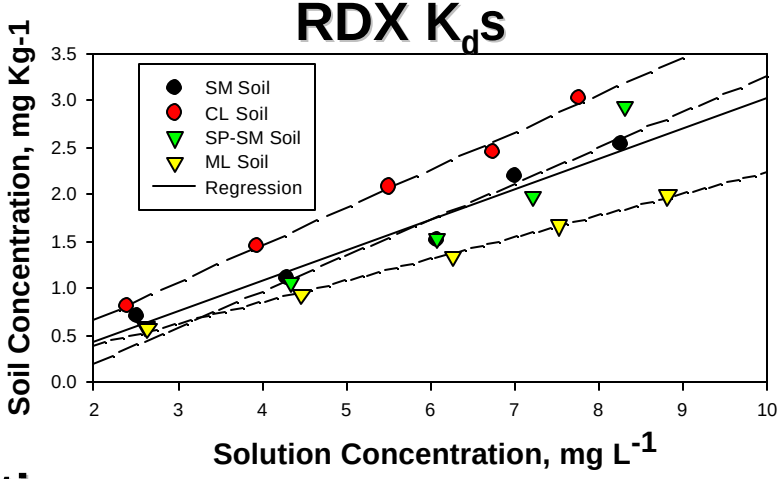
Fate and Transport

TNT Adsorption Kinetics

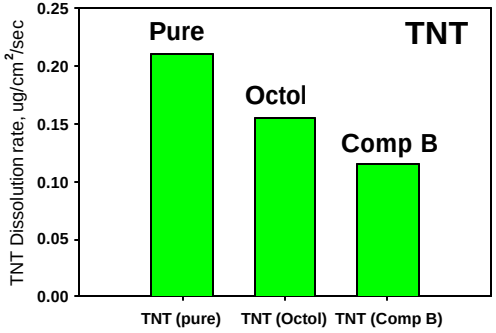


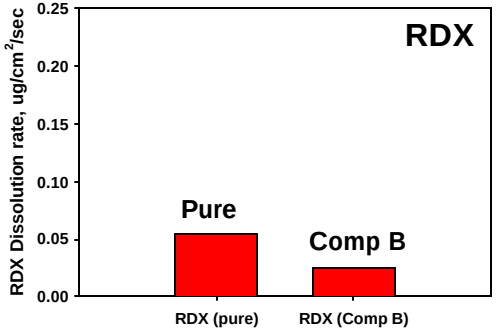
RDX K_ds

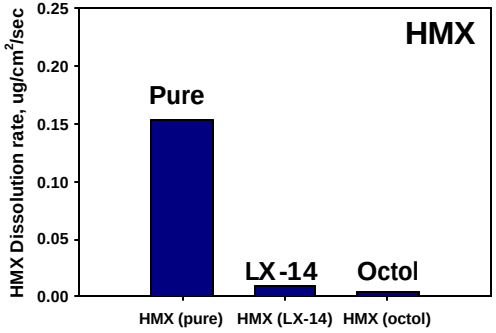


Dissolution

Octol: 70% HMX, 30% TNT Comp B: 59.5 % RDX, 39.5% TNT, 1% wax LX-14 95.5% HMX, 4.5% Estane







Mean of 3 replicates at 20 °C and 150 rpm stirring rate

Source: LTC Jason Lynch and Dr. James M. Brannon, Florida State University and U. S. Army Engineer R& D Center Environmental Laboratory, respectively

Conclusions To Date

- **Firing Points: Potential for propellant residues**
- **Impact Craters from High Order Detonations: Concentrations relatively low**
- **Low Order Detonations: Very high local concentrations; potential point source of contamination**
- **Grenade Ranges: Relatively high concentrations; relatively uniformly distributed (On a mass loading basis, may be the most significantly contaminated location.)**
- **Sampling: Compositing will be necessary to obtain representative samples**
- **Subsampling: Proper subsampling is essential for obtaining representative samples**
- **Analysis: Method 8330 is inadequate for artillery range characterization where concentrations are typically low ppb; Method 8095 more appropriate (dl=1ppb)**


105-mm muzzle


Hand grenade pit

Applications

Examples of range management practices that may be suggested for sustained range use

- Locate and remove low order detonations and duds
- Periodically remediate surface soils of hand grenade ranges
- Develop a groundwater monitoring plan and contingency plans