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Evaluating potential for ground and surface water contamination from new and traditional munitions

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INTRODUCTION

- Contamination of military training grounds due to energetic compounds can be an issue both in France and in the United States.
- With the development of new insensitive munitions, a new set of compounds is being introduced to the environment. These new compounds are more soluble and therefore can have greater mobility in the environment and higher potential for contaminating ground and surface waters.
- This study is evaluating fate and transport of one traditional explosive compound (1,3,5-hexahydro-1,3,5-trinitro-1,3,5-triazine: RDX) and two new ones (3-nitro-1,2,4-triazol-5-one: NTO and 2,4-dinitroanisole: DNAN) in two environments with contrasting climatic conditions:
 - in military camp of Bitche (Moselle, France-Human-Environment-Observatory (OHM) Bitche County), with a temperate humid climate and presence of peat bogs, and
 - in Fort Huachuca (Arizona, USA - in close vicinity of the OHM Pima County), an arid environment with sandy loam soils.

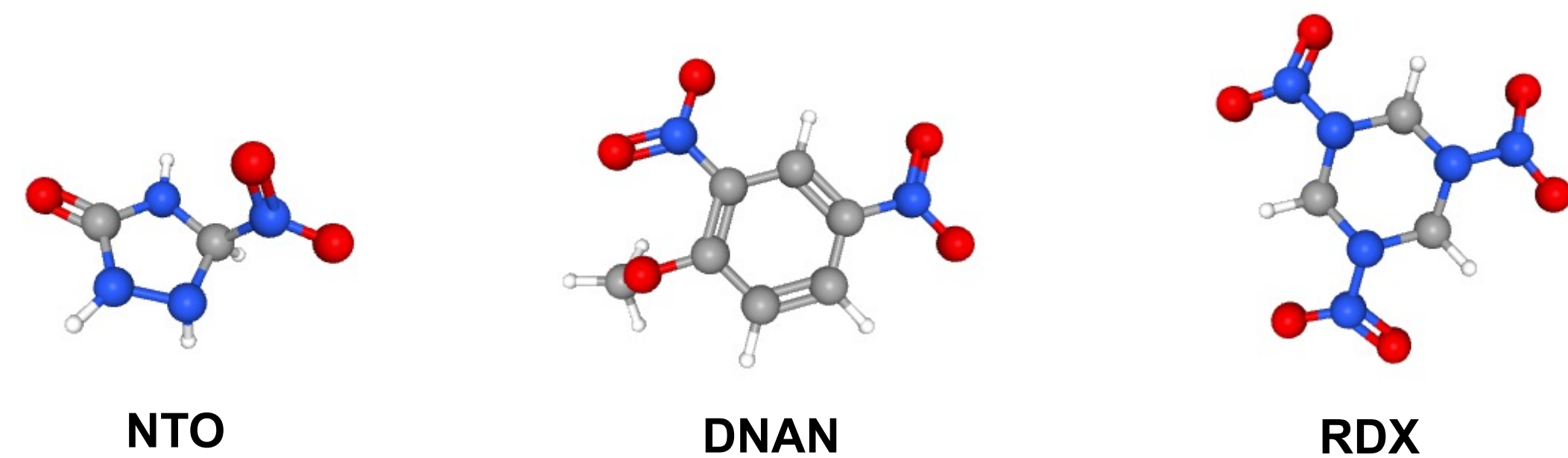


Figure 3. Studied energetic compounds.



Figure 2. Maps of study locations, Pays de Bitche (left) and Fort Huachuca (right).

MATERIALS AND METHODS

- Soils have been collected at both locations at or in proximity of military installations.
- Fort Huachuca soil is Lanque sandy loam, coarse-loamy, mixed, superactive, thermic Pachic Haplustolls. Organic carbon content (OC): 0.8% at 0-20 cm; pH 6.6 at 0-20 cm, 6.2 at 50-100 cm, electrical conductivity (EC) 0.37 mS/cm at 0-20 cm, and 0.16 mS/cm at 50-100 cm. Soil characterization is ongoing. Pays de Bitche soil is a wetland soil with two distinct horizons, top organic horizon (0-50 cm) and bottom mineral horizon (50-100 cm).
- Soils were ground and passed through 2 mm sieve.
- We are conducting adsorption experiments to determine fate and transport parameters for studied compounds for the surface soil horizons (0-20 cm in Fort Huachuca and 0-50 cm in Pays de Bitche) as well as subsoil horizons (50-100 cm in both Fort Huachuca and Pays de Bitche).
- Soils were equilibrated with solutions of RDX and DNAN prepared in 0.005M CaCl₂ in range of concentrations (2, 8, 16, 32, 64, 128 mg/L for DNAN and 2, 8, 16, 20, 24, 28 mg/L for RDX) for 24h. After that they were centrifuged, and supernatant filtered and analyzed by high-performance liquid chromatography (HPLC).



Figure 3. Soil profile at Fort Huachuca (left) and surface organic horizon (0-50 cm) (top right) and subsoil mineral horizon (50-100 cm) (bottom right) of the Pays de Bitche soil.



Figure 4. Location of soil collection at Fort Huachuca.

RESULTS

- Adsorption coefficients were determined for the two horizons of the Fort Huachuca soil for DNAN and RDX. Surface soil horizons for both locations as well as subsoil horizons were used.
- Adsorption of contaminants by subsoils is rarely examined and fate and transport parameters for them are usually estimated. We would like to verify if assumptions made during estimation are accurate.
- Adsorption coefficients were higher for DNAN than RDX for both surface soil and subsoil horizon.
- There was greater difference between adsorption coefficients obtained for surface soil and subsoil for RDX than DNAN. This is consistent with adsorption of RDX being dominated by partitioning to organic matter, while DNAN adsorbing to both organic matter and clays. Fort Huachuca soil has high activity clays, which would promote DNAN adsorption.

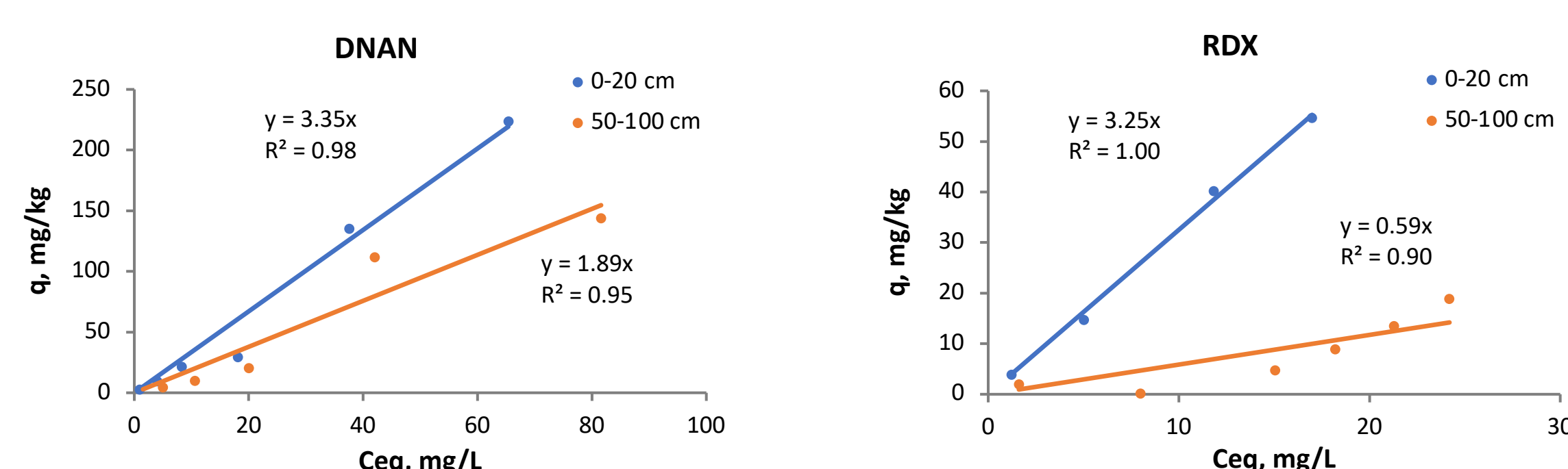


Figure 5. Adsorption isotherms for DNAN and RDX for 0-20 and 50-100 cm horizons in Fort Huachuca soil.

FUTURE WORK

- We plan to perform transformation experiments for both soils under aerobic and anaerobic conditions to reflect the effect of prolonged water saturation on fate of studied compounds.
- Bacterial diversity and community structure will be compared in both sites, at different depth, and exposed to selected IM molecules.
- Bacterial communities associated with microbial transformation or impacted by munitions compounds toxicity will be characterized.
- For each field location we will apply FRESCO model developed by the U.S. Army Engineer Research and Development Center (ERDC).
- We will predict fate and transport of energetic compounds using site specific transport parameters determined in the lab experiments.
- Will make predictions for current climate and for scenario with predicted changes in climate for the next 20 years.

EXPECTED OUTCOMES

- Improved knowledge of the risks of environmental contamination in connection with military activities, a theme of concern for both observatories.
- Better understanding and prediction of the role played by soils and soil micro-organisms in limiting the transport of molecules used in new and traditional types of munitions.
- Modelling will allow us to predict the fate of these molecules in the context of climate change and the differing climate and hydrologic regimes of the two observatories.

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