

## **TOUGH Short Course**

Lawrence Berkeley National Laboratory  
Earth Sciences Division  
Berkeley, California

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### **Motivation for Problems 2 and 3**

- Goals
- Laboratory Experiments
- Model for Problems 2 and 3

### **Goals**

- Non-Aqueous Phase Liquid (NAPL) contaminants are pervasive in the environmental and difficult to locate.
- Geophysical methods may be useful for their detection.
- Laboratory experiments were performed to test various geophysical methods (e.g., seismic, radar, electrical resistivity).
- The model for Problems 2 and 3 was developed in part to help interpret geophysical measurements.
- These problems also serve to demonstrate basic T2VOC modeling concepts and complex multiphase flow phenomena.

## Past Experiments

- Small tank experiments with injection of LNAPL at bottom
- Dodecane (LNAPL) has 14% lower acoustic velocity than water
- Surrogate (inverted) for more toxic DNAPL experiment

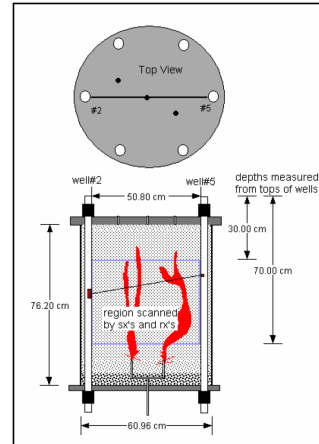


Figure 1. Small tank experiment

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## Past Experiments

- Tank filled with coarse sand; LNAPL slowly injected at bottom.
- Cross-borehole seismic measurements collected.
- Tank excavated and NAPL concentration measured.

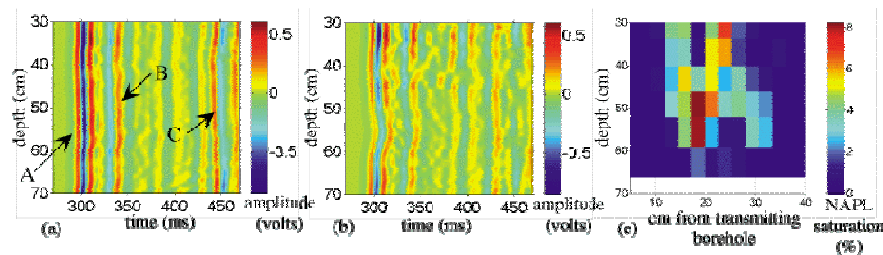


Figure 2. Seismic waveforms (a) before and (b) after LNAPL injection, and (c) measured NAPL saturation

- Reference: Kowalsky, M. B., J. T. Geller, P. K. Seifert, K. T. Nihei, R. Gritto, J. E. Peterson, Jr. and L. R. Myer (1998), Acoustic visibility of immiscible liquids in poorly consolidated sand, *Proc. Soc. Exploration Geophysics*, 1041-1044.

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## Past Experiments

- Similar experiment but with coarse sand underlying fine glass beads.
- Thick NAPL lens developed under glass bead layer.
- NAPL concentrations measured following experiment.

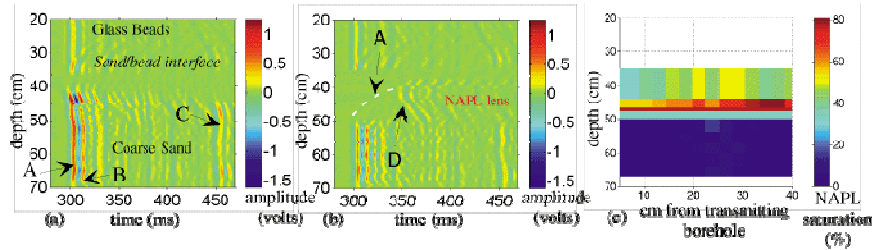


Figure 3. Seismic waveforms (a) before and (b) after LNAPL injection, and (c) measured NAPL saturation

- Reference: Geller, J. T., M. B. Kowalsky, P. K. Seifert and K. T. Nihei (2000), *Acoustic Detection of Immiscible Liquids in Sand*, *GRL*, 27(3), 417-420.

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## Past Experiments

- More recent experiments involve PCE (DNAPL) spills

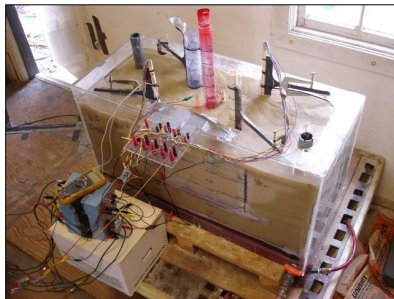


Figure 4. Tank experiment with increased number of geophysical measurements and more complex heterogeneity

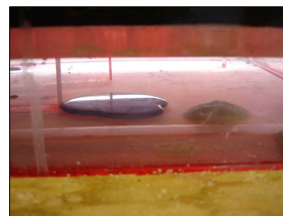


Figure 5. Pool of PCE that broke through to bottom of tank

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## Experiment Modeled in Problems 2 and 3

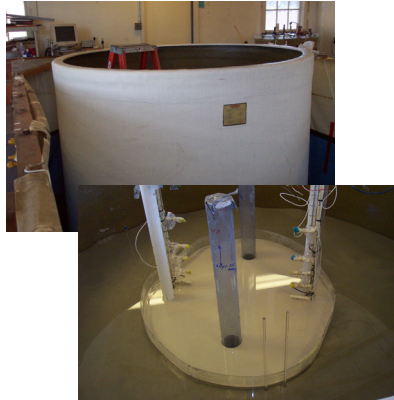


Figure 6. Large-scale tank experiment

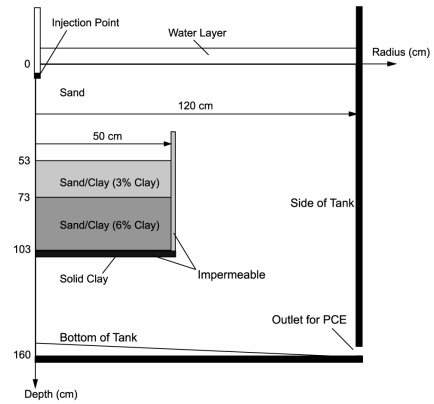


Figure 7. Radial model used to simulate experiment