



LABORATORY DIRECTED RESEARCH &amp; DEVELOPMENT

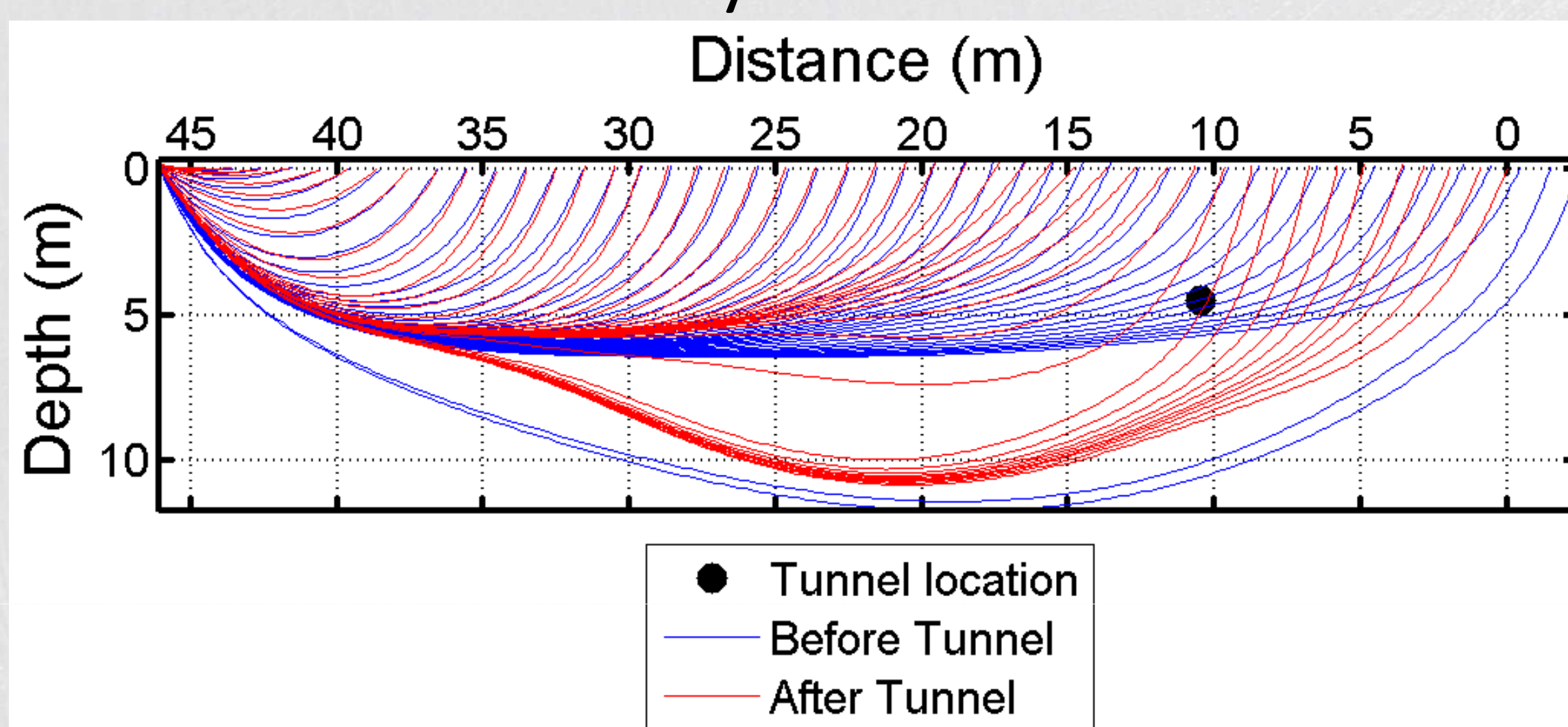
## Early Career R&D Program

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### Problem

- Clandestine tunnels are used to smuggle drugs, weapons, and people but detecting them has been problematic
- Traditional seismic reflections/refractions from tunnels are not always seen in the data
- Understanding of tunnel interface phenomena to improve detection of small and large tunnels
- Border security, force protection, & HDBT defeat

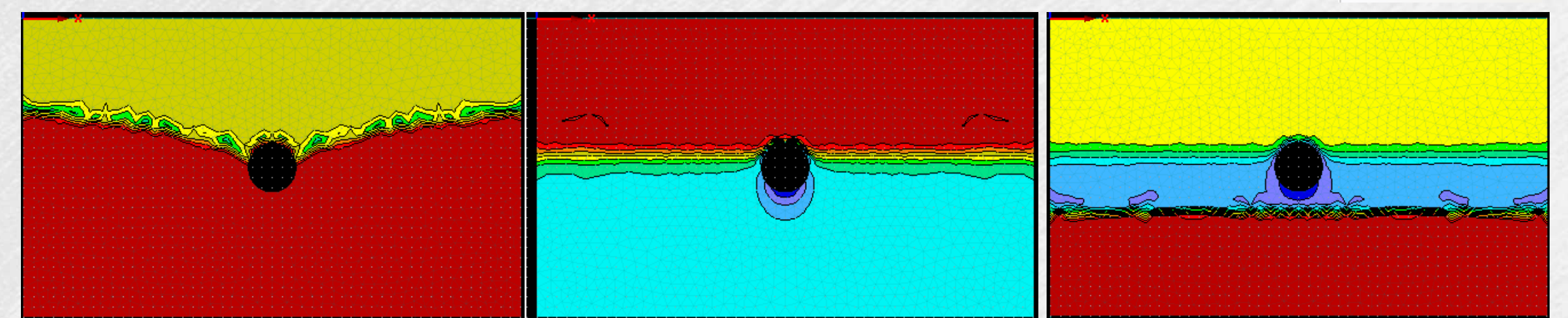


### Approach

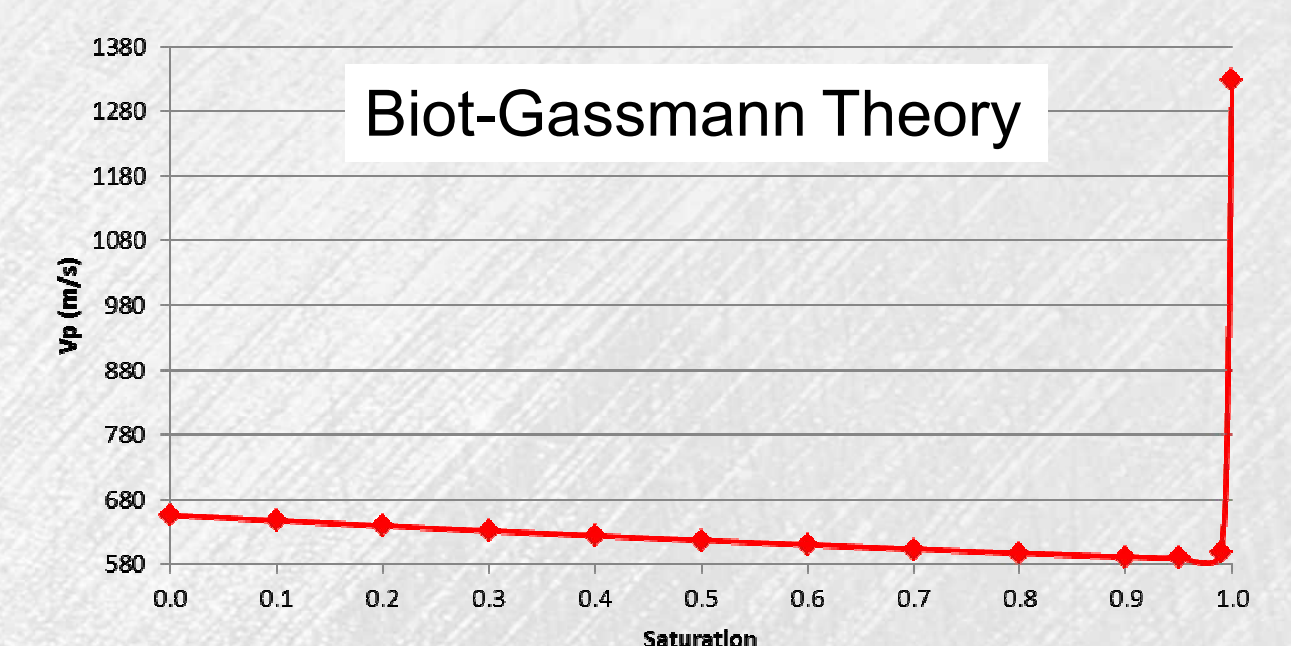
- Investigate the effects of tunnel construction on seismic waves by:
  1. Modeling fracturing and dewatering of pores around the tunnel
  2. Converting pore saturation to seismic velocities
  3. Modeling seismic wave propagation through effective media
- Improve data processing techniques for tunnel detection
  - Surface and body wave diffractions
  - Reverse time migration (RTM)
  - Others
- Goals
  - Answer why seismic data detects tunnels in some cases but not others
  - Develop more robust techniques for tunnel detection, which is an issue of national security

### Results

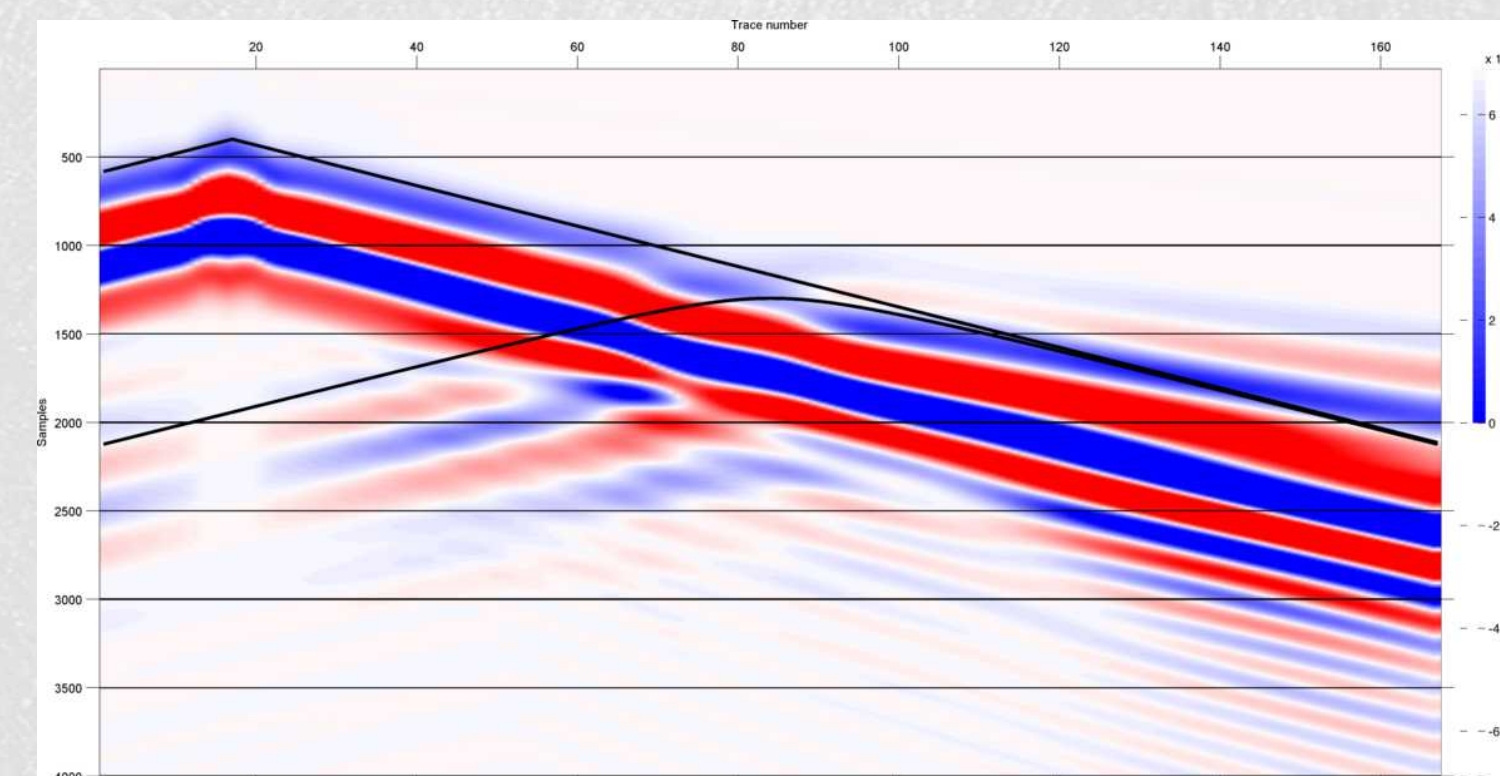
- Fluid flow models to show the influence of:
  - Different subsurface materials
  - Various tunnel shapes
  - Water table depth relative to the tunnel



- Pore saturation versus seismic velocity
  - Theoretical relationships perform poorly in shallow (>200m) materials
  - Lab results show velocities decrease more rapidly than theory predicts



- Seismic data processing
  - Reverse time migration code improvements
  - Developed wavefield transformation algorithms



### Significance

- This work can provide the basis for new tunnel detection capabilities, which can be applied to HDBT defeat, domestic and foreign border security, and force protection
- Subsurface saturation results will be useful for UXO and mine detection
- Potential customers for follow-on work include: DoD, DHS, DOE Nonproliferation, DARPA, DTRA, and OFA customers