PERFORMANCE OF ENGINEERED COVERS TO ISOLATE WASTE:

CHANGES IN PROPERTIES OF MAIN COVER BARRIER MATERIAL, LOW PERMEABILITY CLAY

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Objective

Cracking of clay barrier materials and its impacts to dose (via radon emission and transport to ground water) needs to be assessed for waste facilities:

- Decommissioning
- Low level waste
- Uranium tailings
- Waste incidental to reprocessing

Background

- Clay engineered barriers can be constructed in the field to a hydraulic conductivity as low as 10E-8 cm/sec but cracking may compromise its performance

- Cracks will form in clay engineered barriers due to drying, root penetration, changes in soil structure, within a few years of construction

- Crack networks can increase the hydraulic conductivity of the clay barrier materials by up to three to four orders of magnitude

Nature of Crack Effects

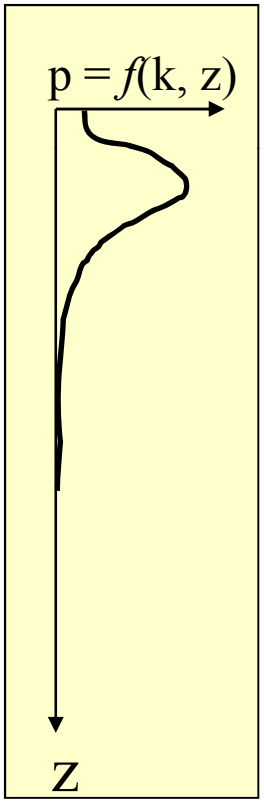
- **Cracks will form on surface exposed to atmosphere, creating (and exposing) more surfaces.**

Nature of Crack Effects

- **Horizontal cracking begins on surface**
  - *suction-strain interaction causes shrinkage*
  - *differential drying causes bending, which causes upheaval of surface*

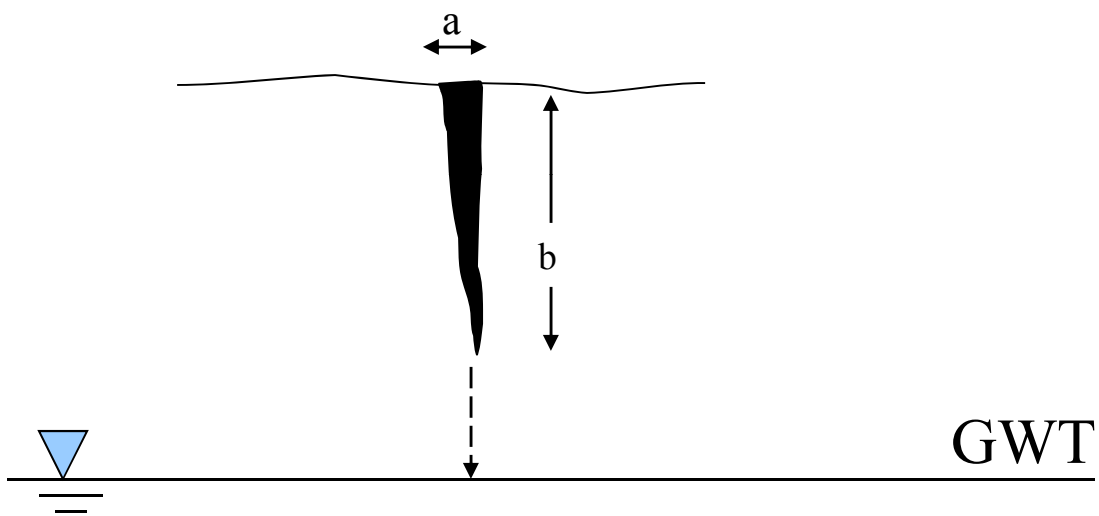
- **Vertical crack propagation**
  - *relative humidity in crack space*
  - *plasticity characteristics of the soil*
  - *suction profile function of permeability*

    p = f(k, z), which is created by cracking



Nature of Crack Effects

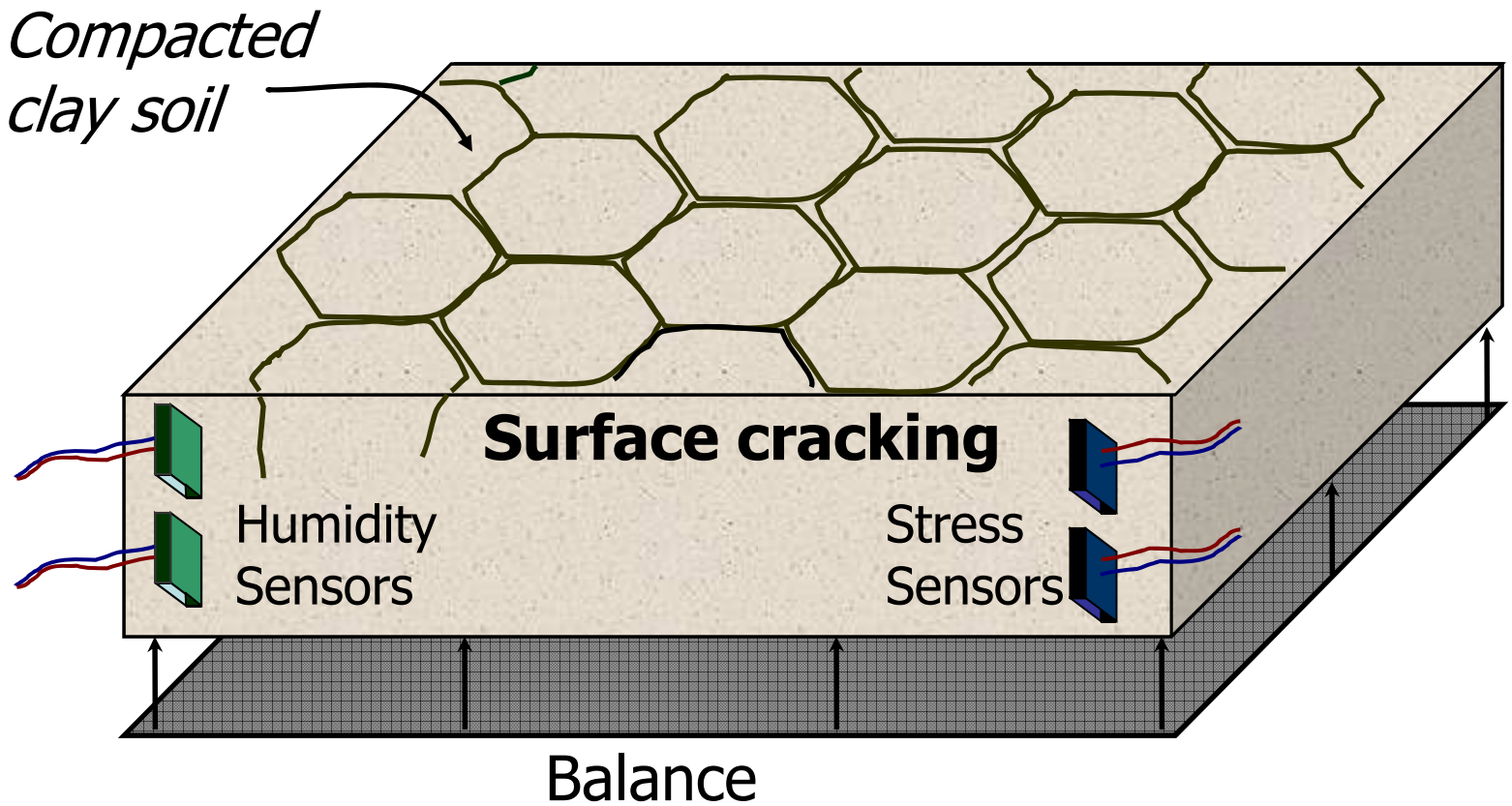
- **Crack initiation is purely mechanical**
  - *cracks penetrate as a function of opening width, which is independent of saturation line*



- **Crack opening width depends on shrinkage potential (plasticity) of clay**

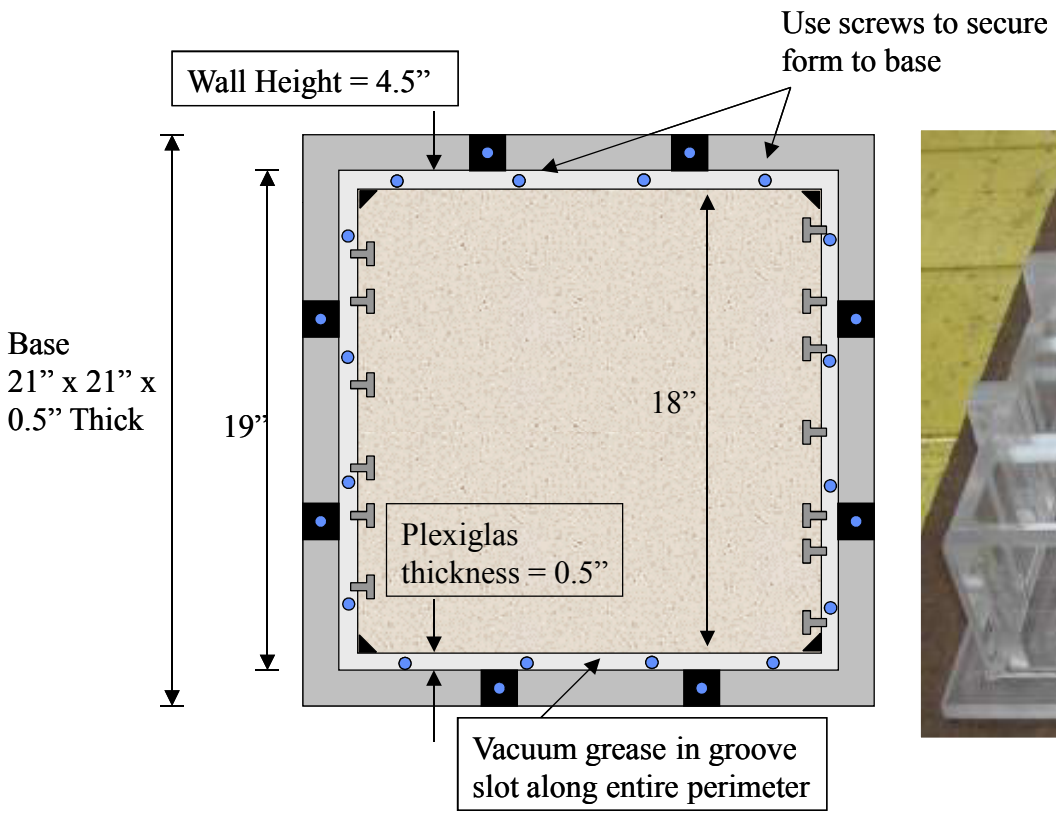
Model Experiment

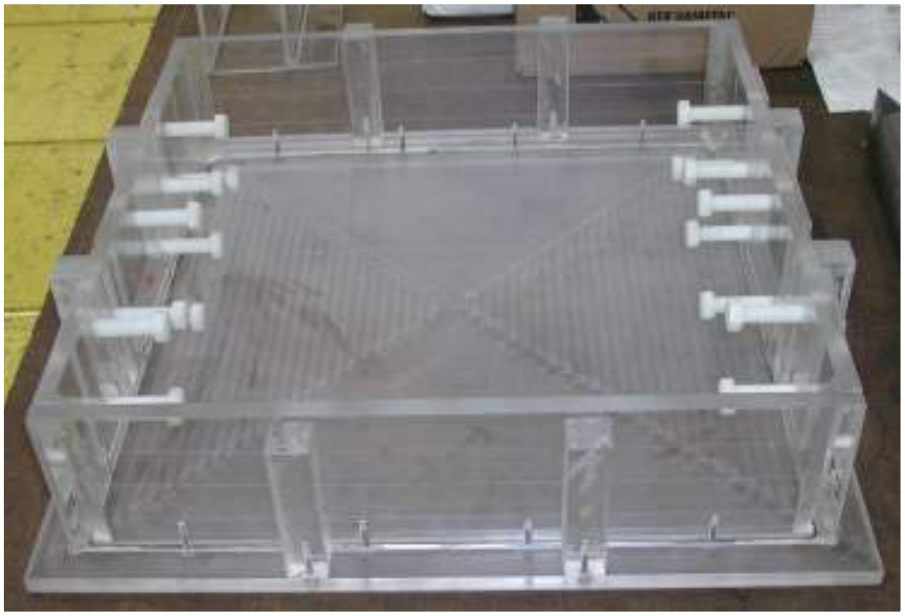
- Wide Plexiglas section to observe **horizontal cracking**
- Test beds placed within ***low relative humidity*** chamber



Test Bed Construction

- ✓ Sufficient volume for multiple sensor array
- ✓ Soil nails to reduce side wall effects
- ✓ Scoring of soil to ensure crack isolation
- ✓ Soil exposed to controlled low humidity environment



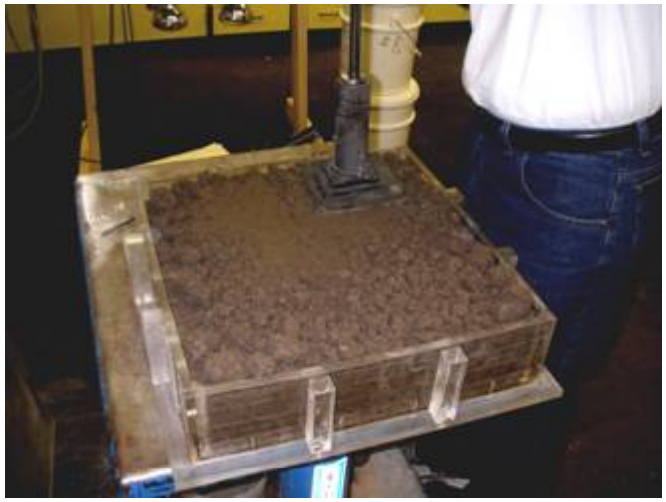


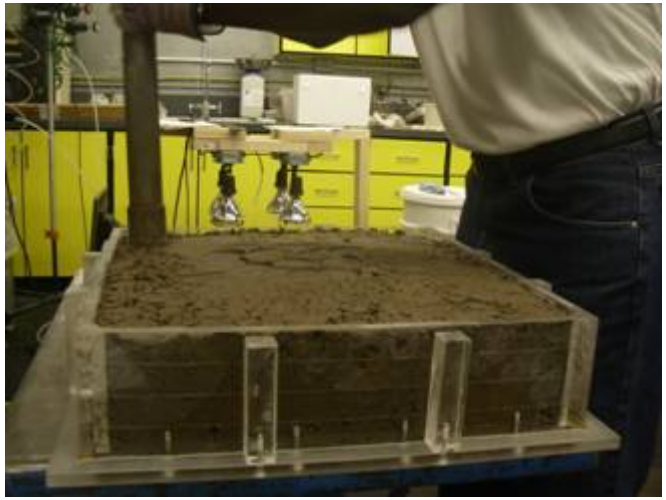
Soil Preparation

- **CH Soil Selected:**
  - PI = 52
  - MC = 32% (7% > OMC)
  - Dry Density = 84 pcf

- **Compacted using open ended proctor hammer**
  - Large plate for gross compaction
  - Small diameter for smoothing
  - Five 1” lifts = 4.5” thickness

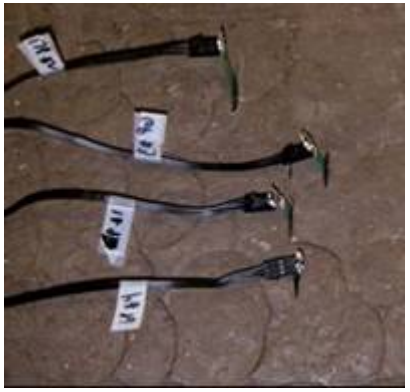
- **Density verified using volume sampling tool**



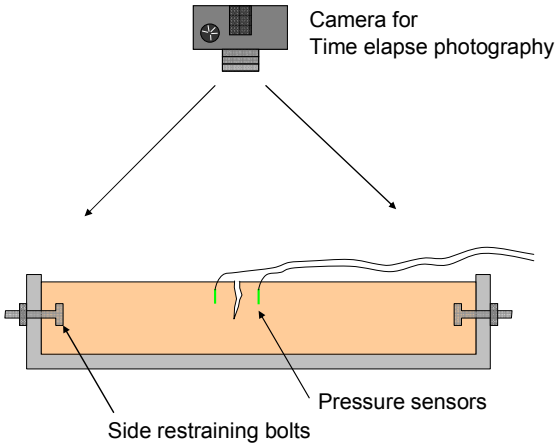


Instrumentation

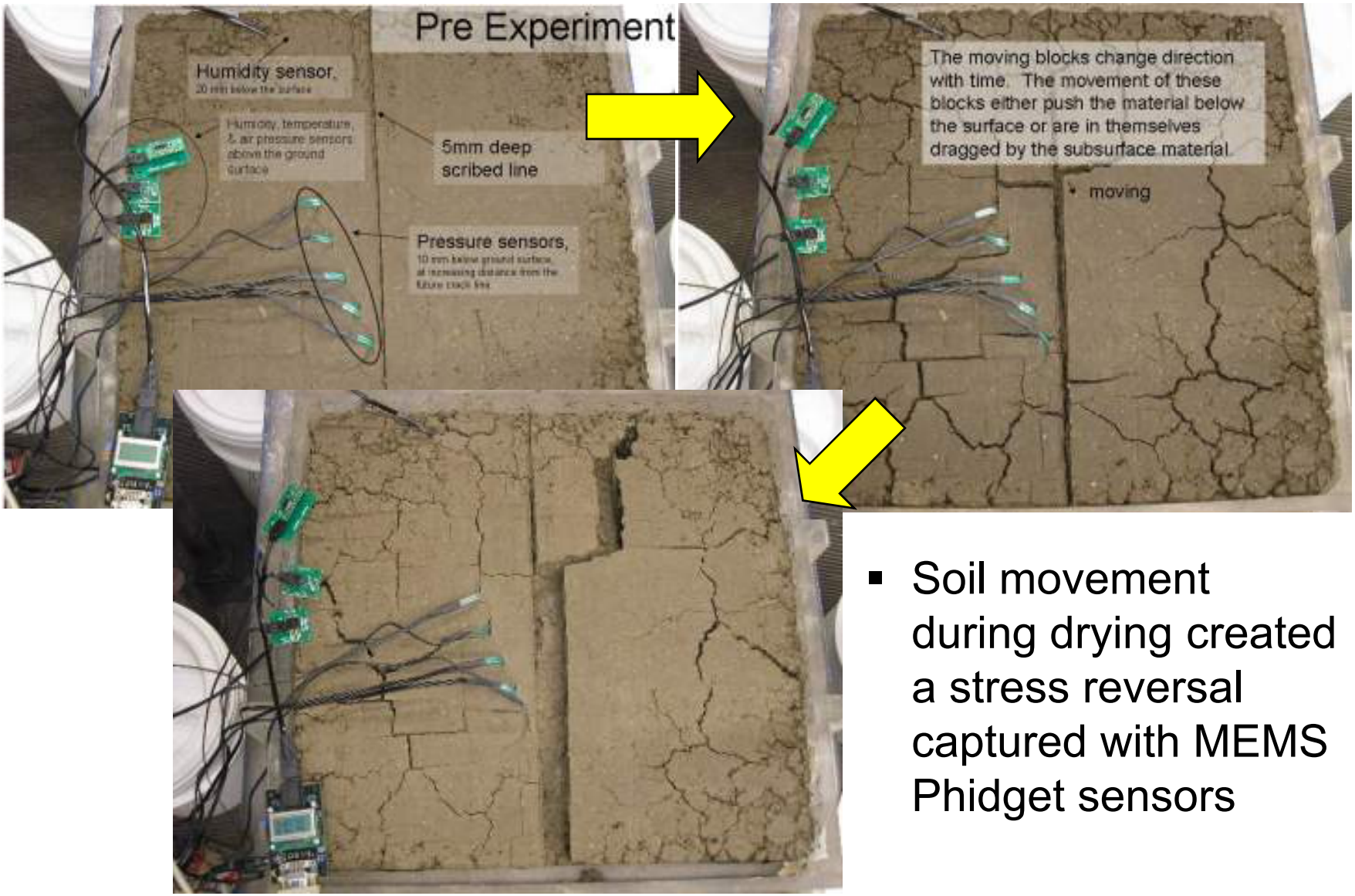
- ✓ Instrumented with lateral stress sensors



- ✓ Time lapse still photography and videography

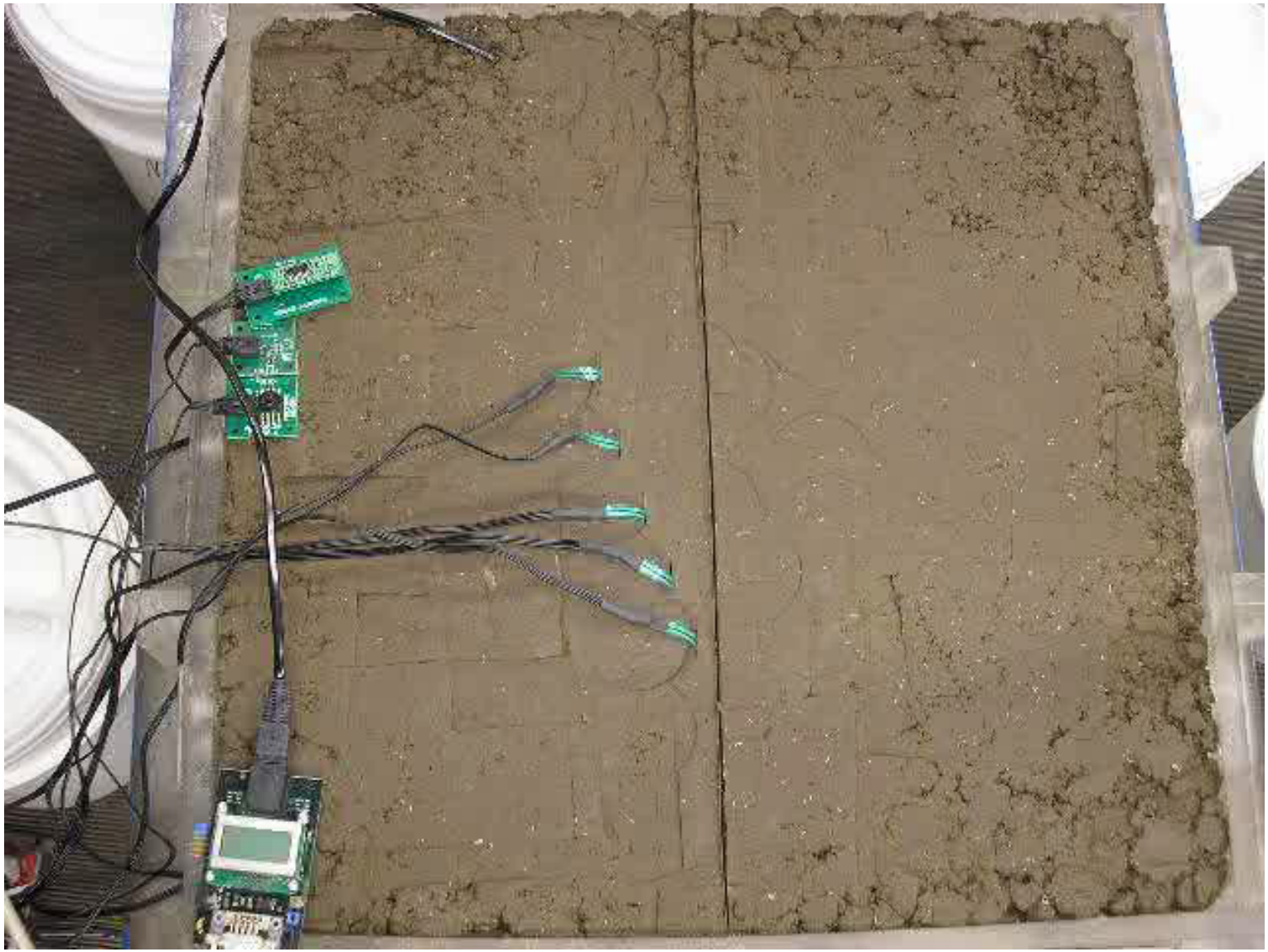
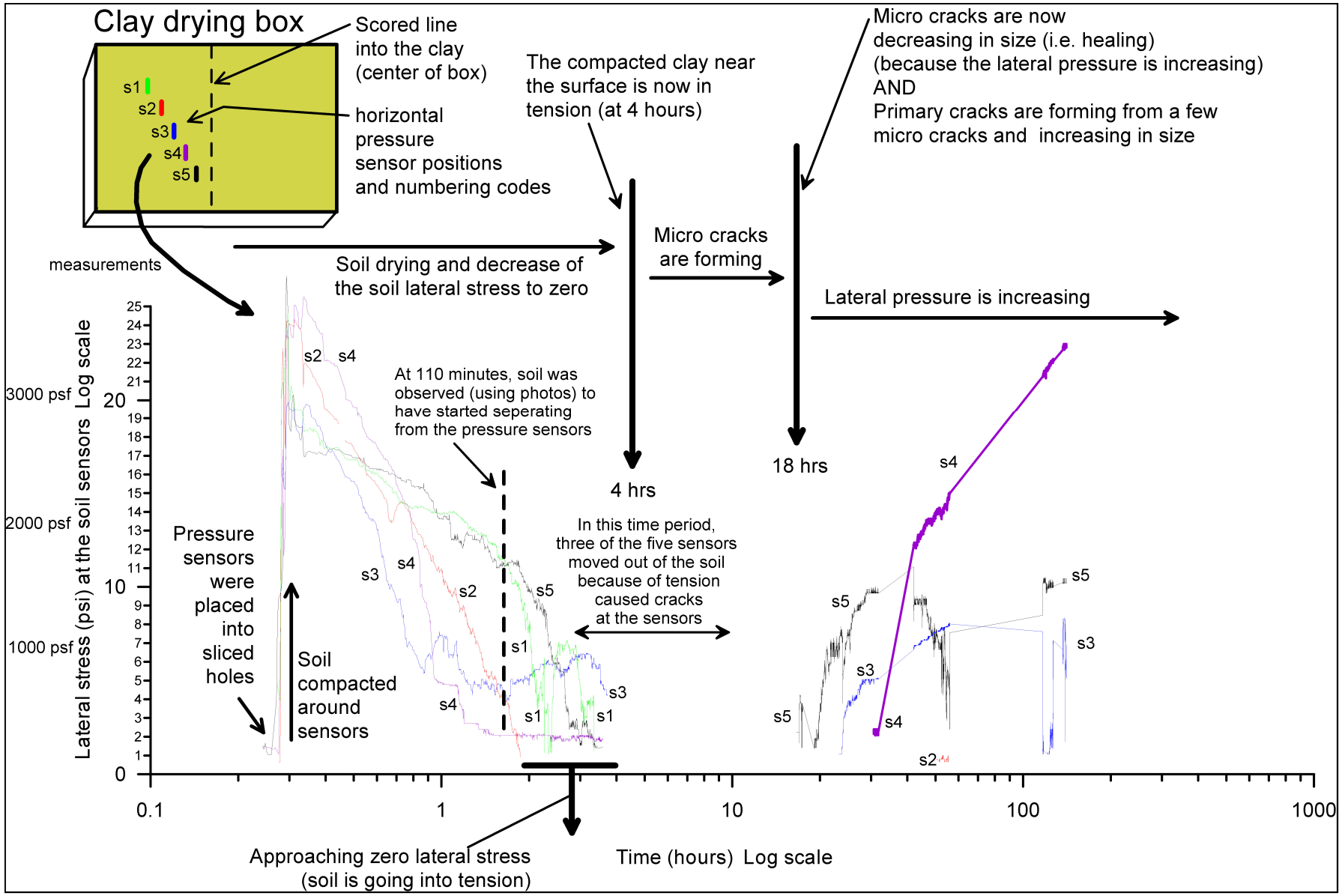


Key Cracking Responses



- Soil movement during drying created a stress reversal captured with MEMS Phidget sensors

Time lapse crack response



Sensor Response