Soil Particle Size Analysis and Clay Size Fraction Extraction

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Agenda

- Soil particle size analysis
  - Importance
  - Challenges
  - Methods
- Clay Particle Size Extraction
  - Challenges of isolating clays
  - Usefulness of clay analysis
  - Methods
- Particle Size and Research Projects at Undergraduate Institutes
  - Project length, research time and funding constraints
  - Training future scientists

Particle size in soils

- Influences
  - Carbon and nitrogen content
  - Water flow
  - Nutrient availability
  - Acidity
  - Aeration

Measurement

- Historically, a tedious measurement
  - Sieving and rototap
    - Not useful for clay size fractions
  - Gravimetric analysis
    - Better for clays, a little more tenuous for sands, but measurements are 18 to 24 hours in length
  - Pipette method
    - Requires more diligent preparation (removal of organics) and a long analysis time.
    - Large sample sets require a large amount of lab space

Soil Particle Size at an Undergraduate Research Institute

- Time is of the essence!
  - Gravimetric analysis
    - Stokes Law
    - Very cheap and easy
    - 18-24 hours per sample
  - Pipette method
    - Better for clay
    - Takes a lot of counter space and a huge block of uninterrupted time
    - Total process takes several days

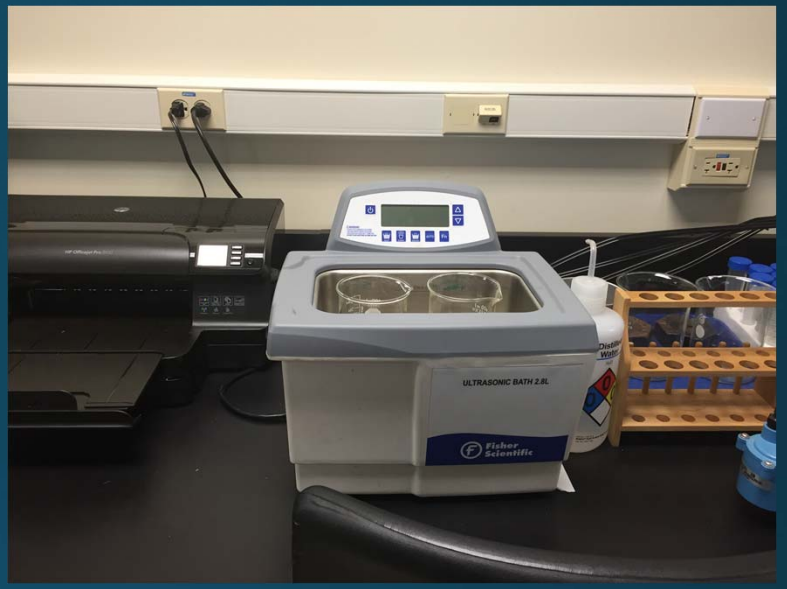
Bulk Soil Analysis

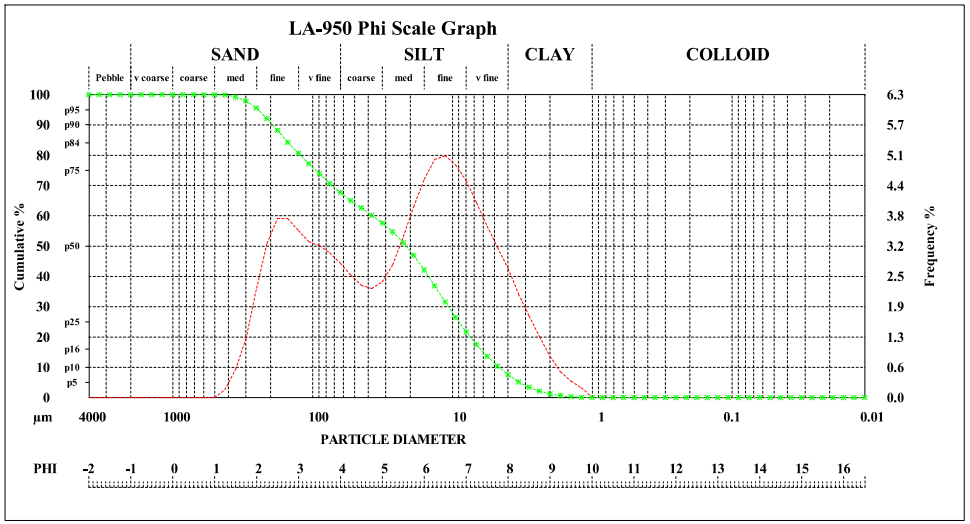
- Based on calibration with USDA particle size standards
- Soil air dried and gently crushed with mortar and pestle to break aggregates
- Sieved to 2mm size
- Soil in stock solution
  - 50 g of sodium hexametaphosphate per 1 L of deionized water
  - 5ml of soil in about 50 ml of water

Bulk Soil Analysis

- 10 minutes in ultrasonic bath prior to introduction to Camsizer
  - Treat multiple samples at the same time in bath
- 2 minutes of ultrasonic on Camsizer

- Possible to do have too much ultrasonic!

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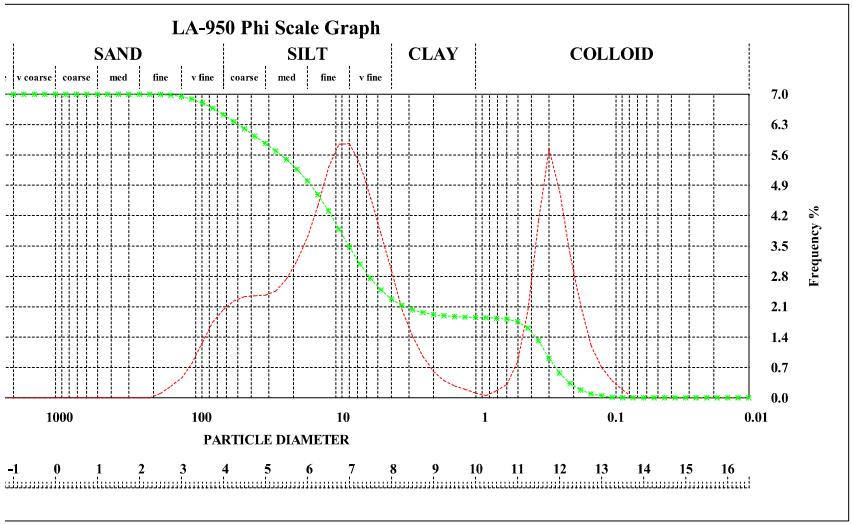
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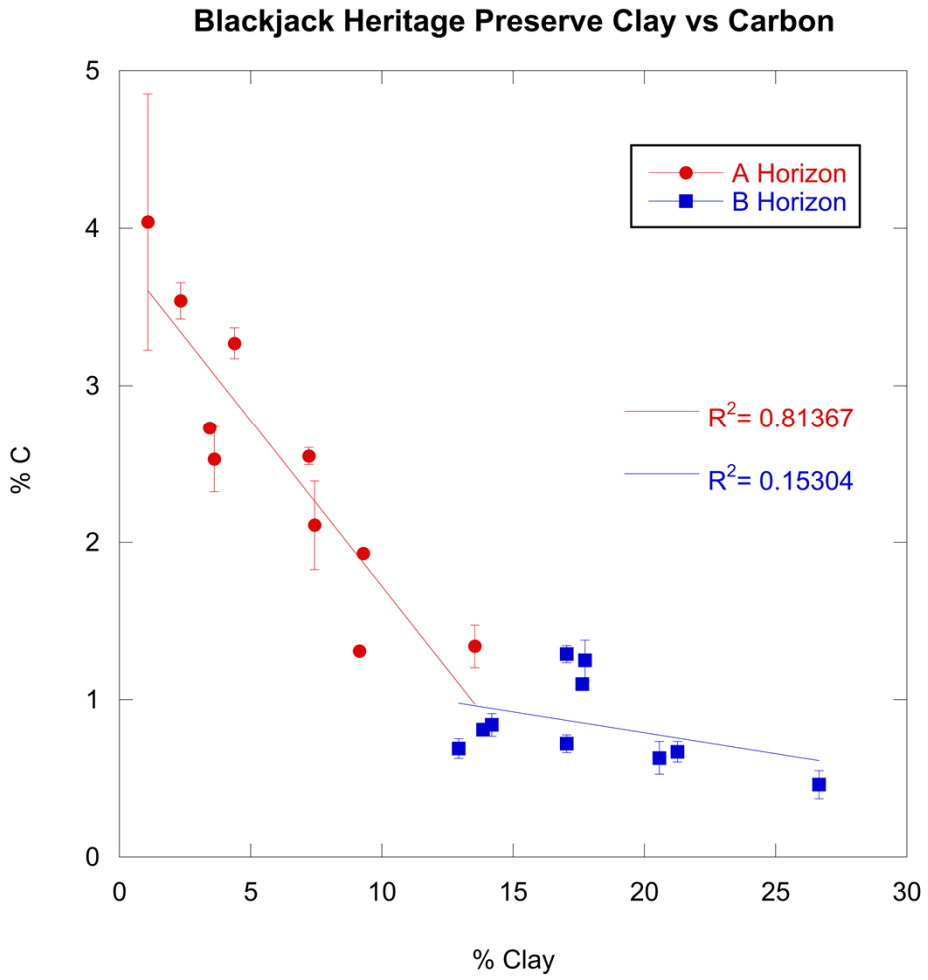
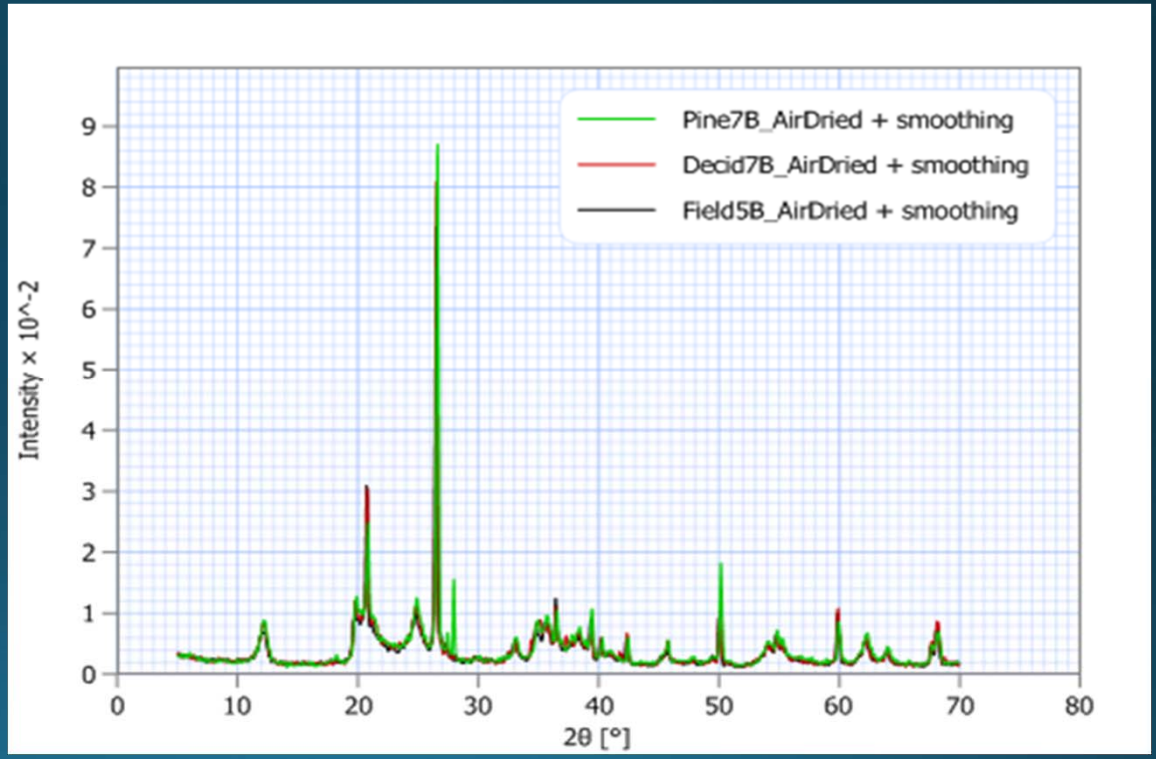
Bulk Soil Analysis

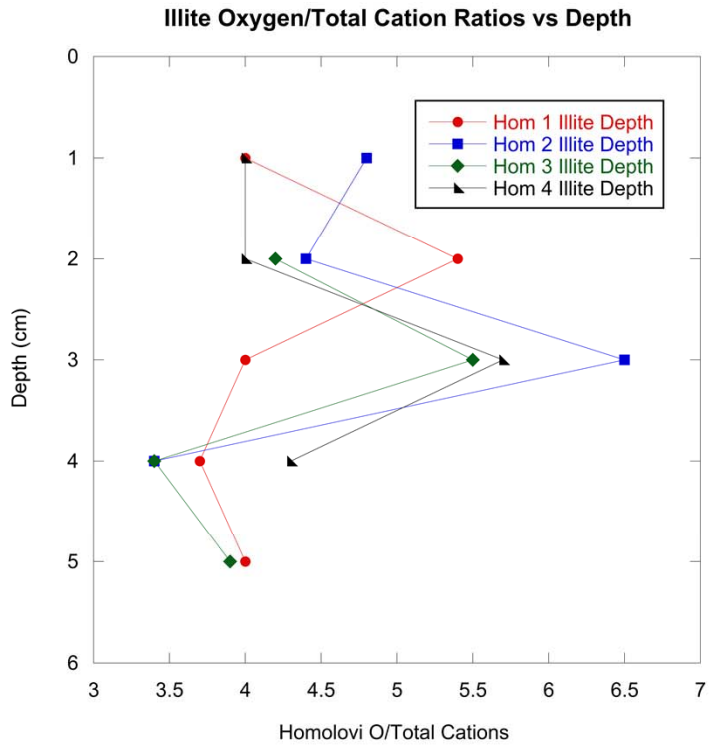


Interest in clay fraction

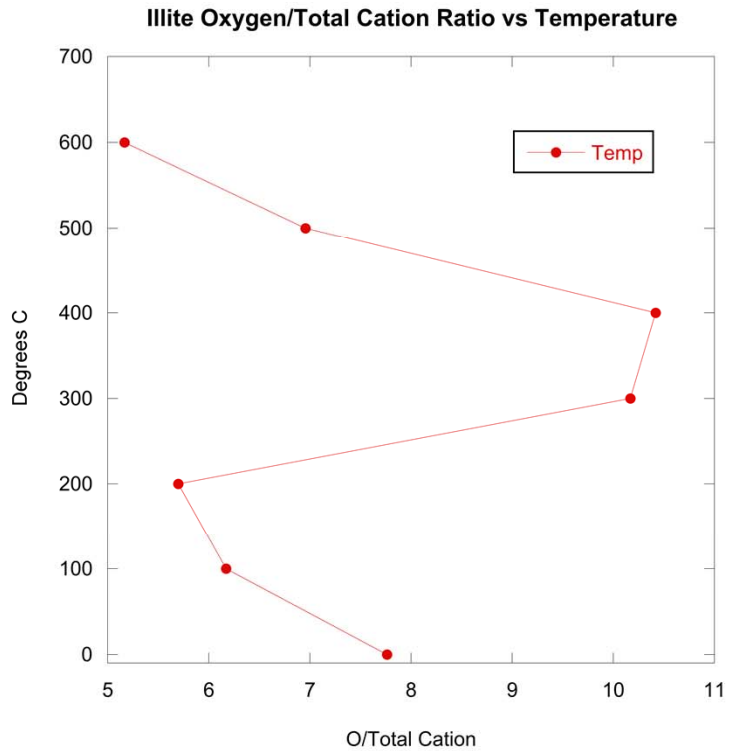
- Clay chemistry
  - Affects on carbon and nitrogen storage in soils
  - Shrink swell properties in Carolina Piedmont
  - Changes in clay chemistry due to heating
- Issue in isolating clay---and proving it.



Samples



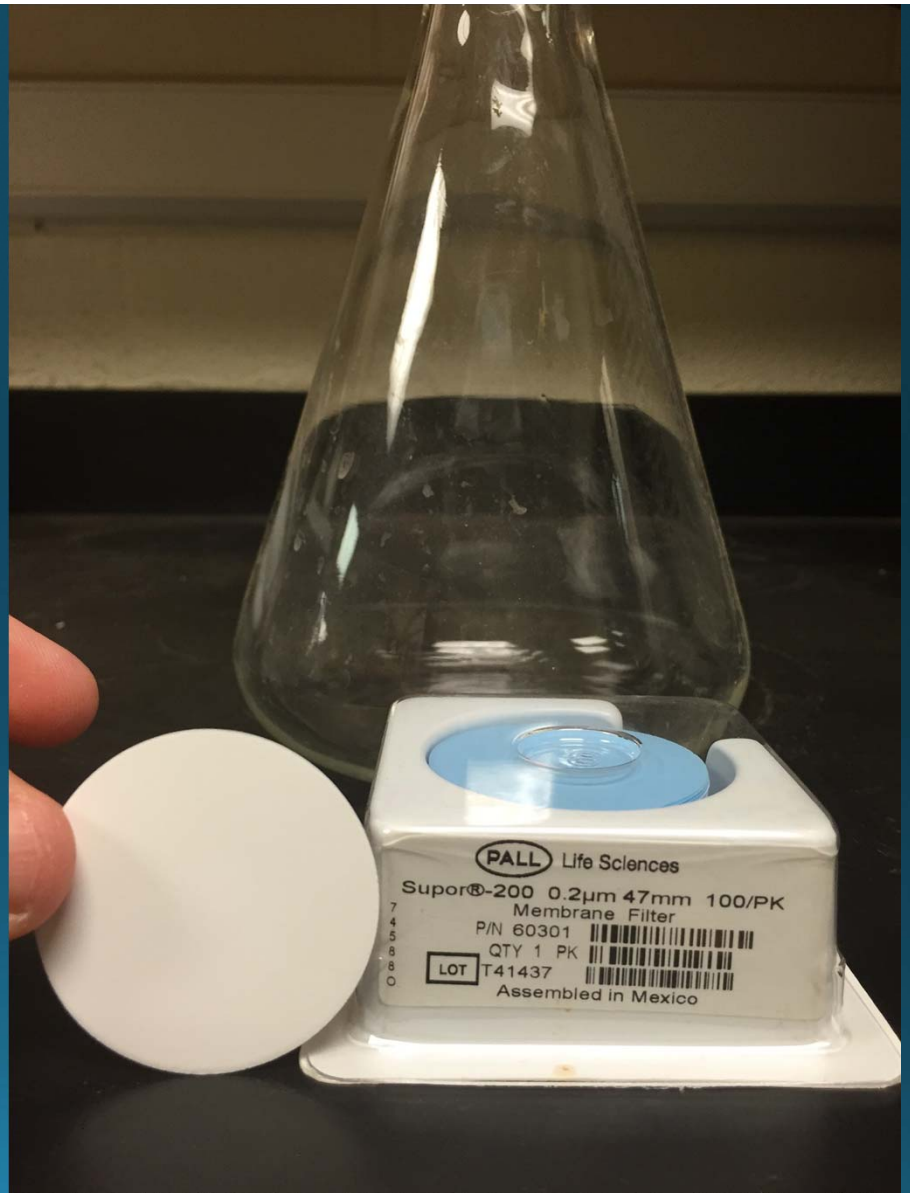
Standard



Isolating Clays

- Using fine mesh filter paper
  - Soil sieved to 53 microns and added to 100 ml of water
  - Open ended cylinder attached to Erlenmeyer flask with vacuum attachment
  - Fine mesh filter paper placed between with glassware clamped together.
  - Vacuum pump attached to bottom flask and soil water added to cylinder.

  - Gradually filter out finer particles until size you wish to analyze is on paper.
  - We captured everything between 2 and 0.5 microns



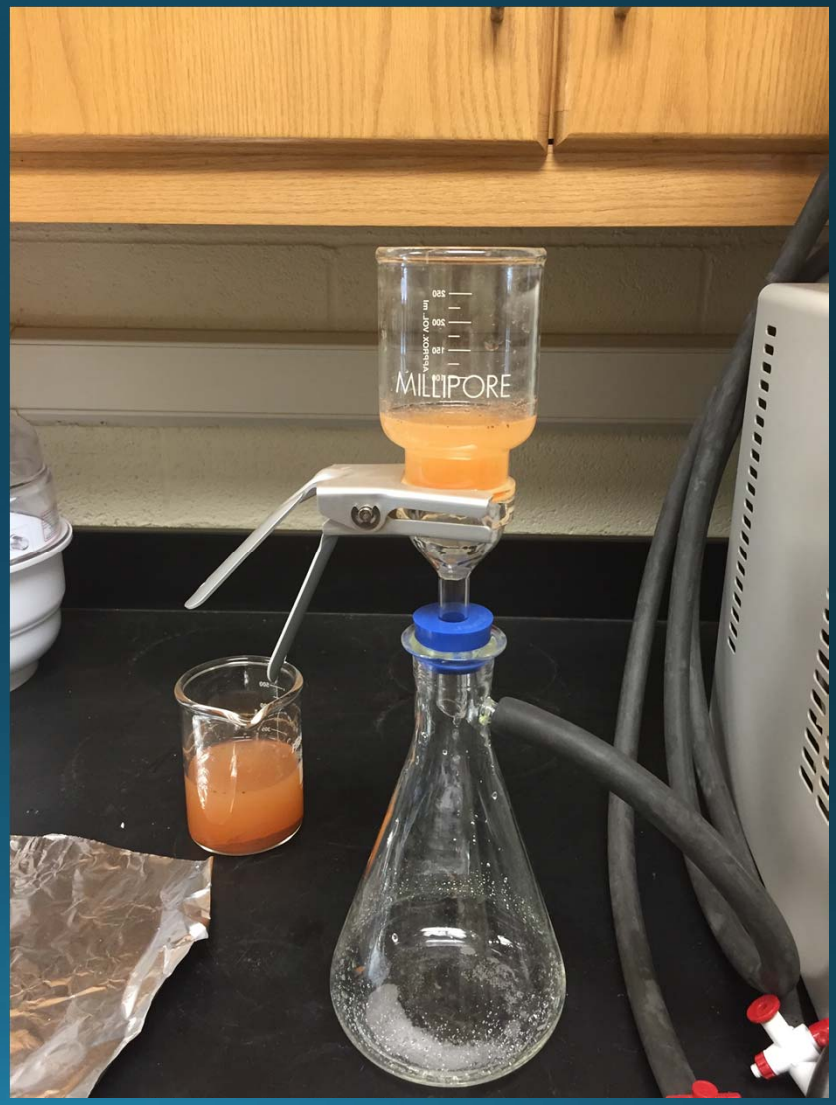
Isolating Clays

Volumetric Glassware with open bottom

Filter paper

Funnel with built in ceramic filter

Flask with vacuum attachment



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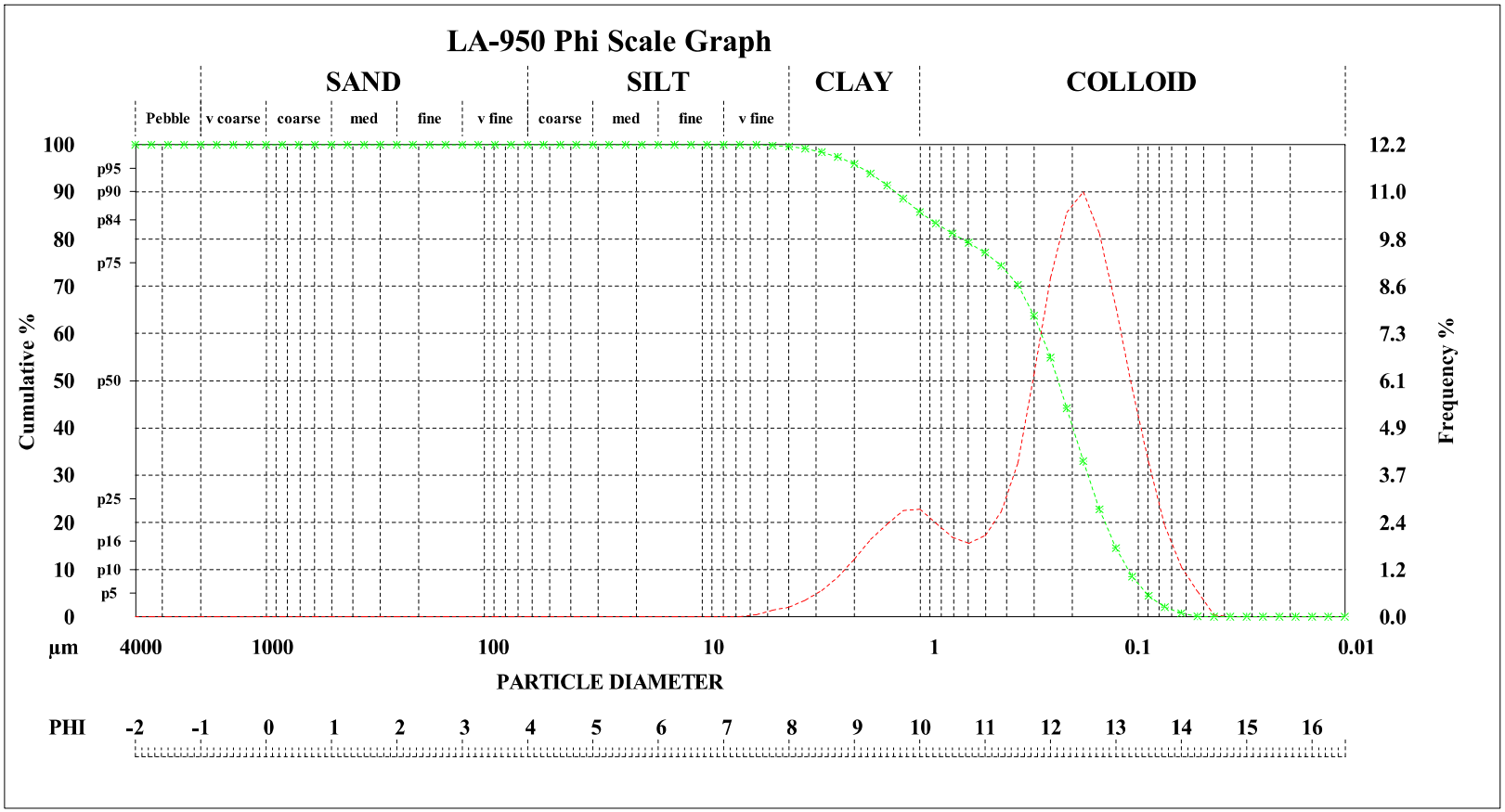
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Isolating Clays

- Positives
  - Can have complete control over the size range you are interested in.
  - Inexpensive
  - Little lab space required
- Negatives
  - Can be time consuming for clay rich soils
    - Lots of filter changes
  - Soil sometimes not easily released from filter paper
  - Sometimes need several runs to have enough sample for geochemical analysis

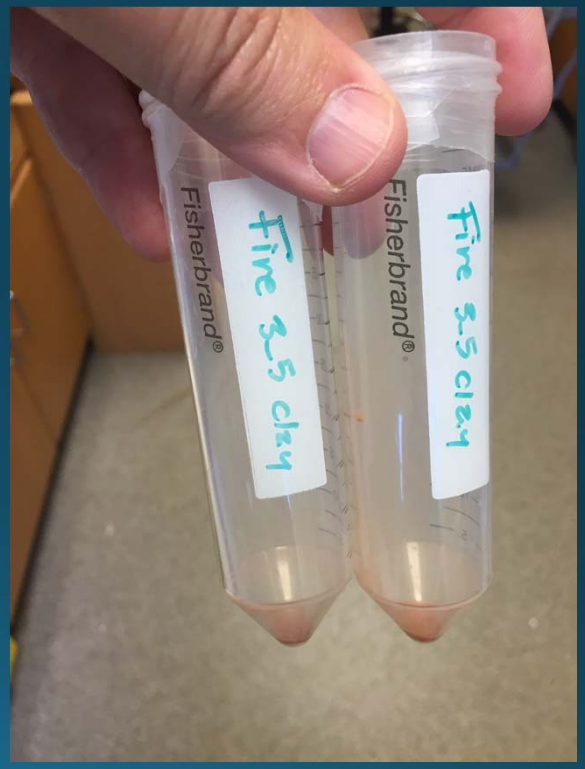
Isolating Clays

- Centrifuge system
  - Use variable speeds to separate out particle sizes.
  - Sieve soils to 53 microns
  - Add 5 ml of soil to 35 ml of deionized water.
  - Centrifuge for 5 minutes at 140 G.
    - Causes silt to settle while clay stays in suspension
  - Pour suspension into new centrifuge tube
  - Centrifuge for 10 minutes at 2500G.
    - Causes clay to settle into pill at bottom.
  - Allow to dry for 24 hours

Isolating Clays

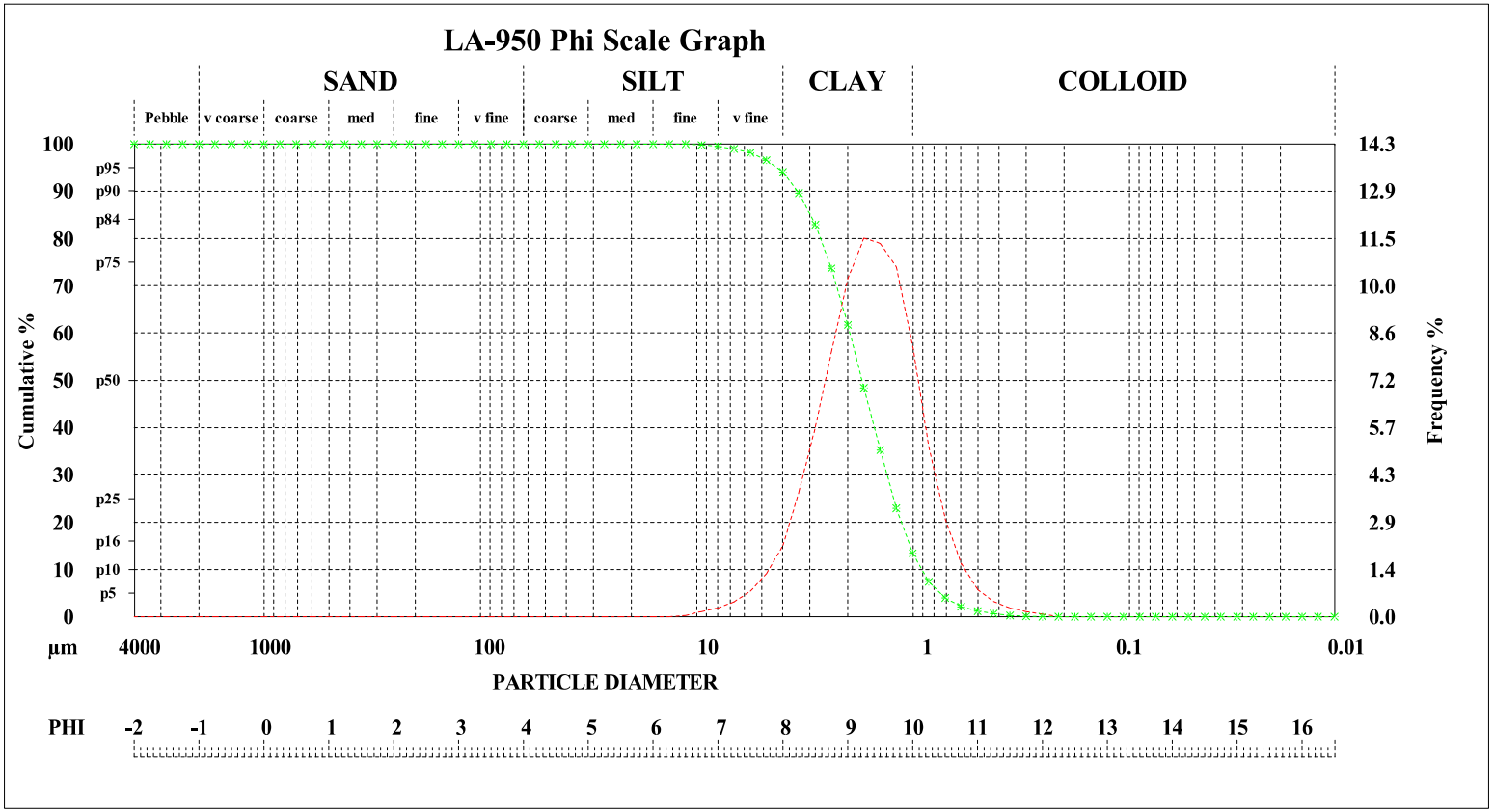
Silt Removal

Clay Transfer



Clay After Drying

Isolating Clays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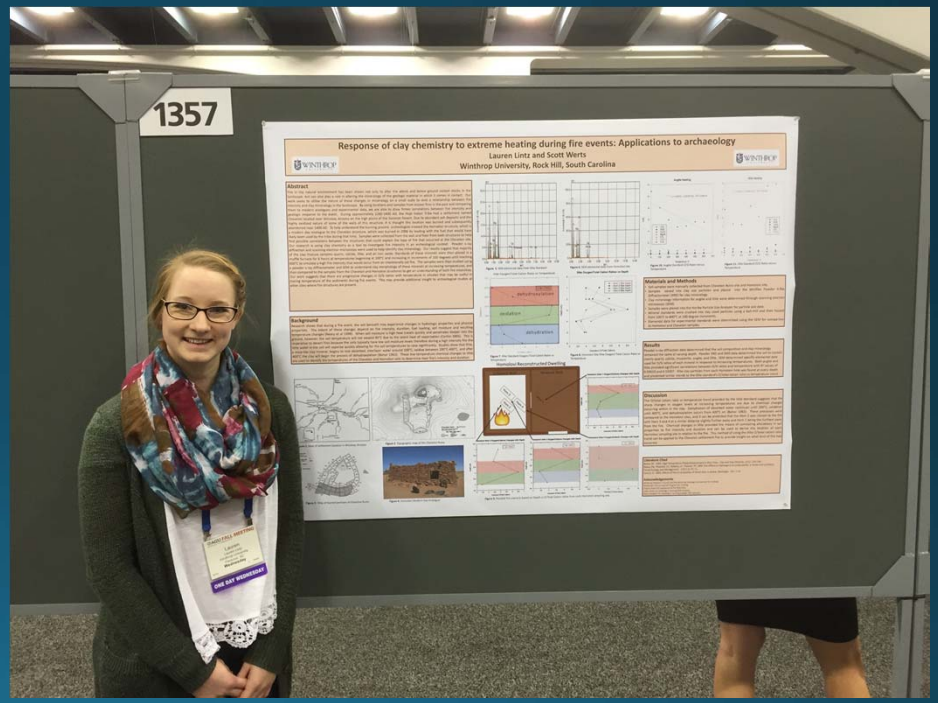
Undergraduate Research Institute

- Winthrop University
  - 6500 undergraduates
  - More than 360 presentations of research and local, state and national levels last year
    - University supplements student travel to present
  - Students publish with faculty
  - Summer research programs

  - Use of research equipment is free for student researchers and faculty



Undergraduate Research Institute

- Undergraduate Students
  - Take between 12 and 21 credits per semester
  - Work/Study
  - Very limited amount of time
  - Also require uncomplicated pieces of equipment
  - Option for research courses on campus
    - 9 hours per week in lab

Undergraduate Research Institute

- Particle size system
  - Cuts down on sample time from hours at minimum to minutes
  - Significantly reduces space needs during sampling
    - Samples not spread across lab to settle or dry
    - With undergraduates coming in and out at different times during the day, it's a bigger deal than you might think
  - Students can easily stop and start sample processing
    - An hour in between classes can make headway on samples

Undergraduate Research Institute

- Particle size system
  - Need for multiple researchers to utilize instruments to justify the cost.
  - Used for soils research
  - Also used for:
    - Ecology (sand size differences for mesofauna habitat)
    - Biochem (particle size of tablets and dissolve rates)
    - Inorganic Chemistry (creation of zinc oxide particles
  - Collaborative environment in undergraduate institutes

Questions?