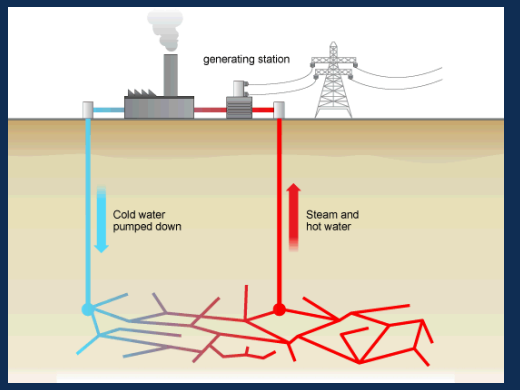

SAND2015-6390PE

Waste Not Want Not

Research Experience for Teachers

Laura B. White, Bernadette A. Hernandez-Sanchez

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Geothermal Energy:

Using energy from Earth's core to produce electricity

- Pros:
  - Sustainable, renewable
  - Low emissions
  - Wells capable of providing heat for decades
- Cons:
  - Individual wells may cool down or collapse
  - High capital costs (drilling!)

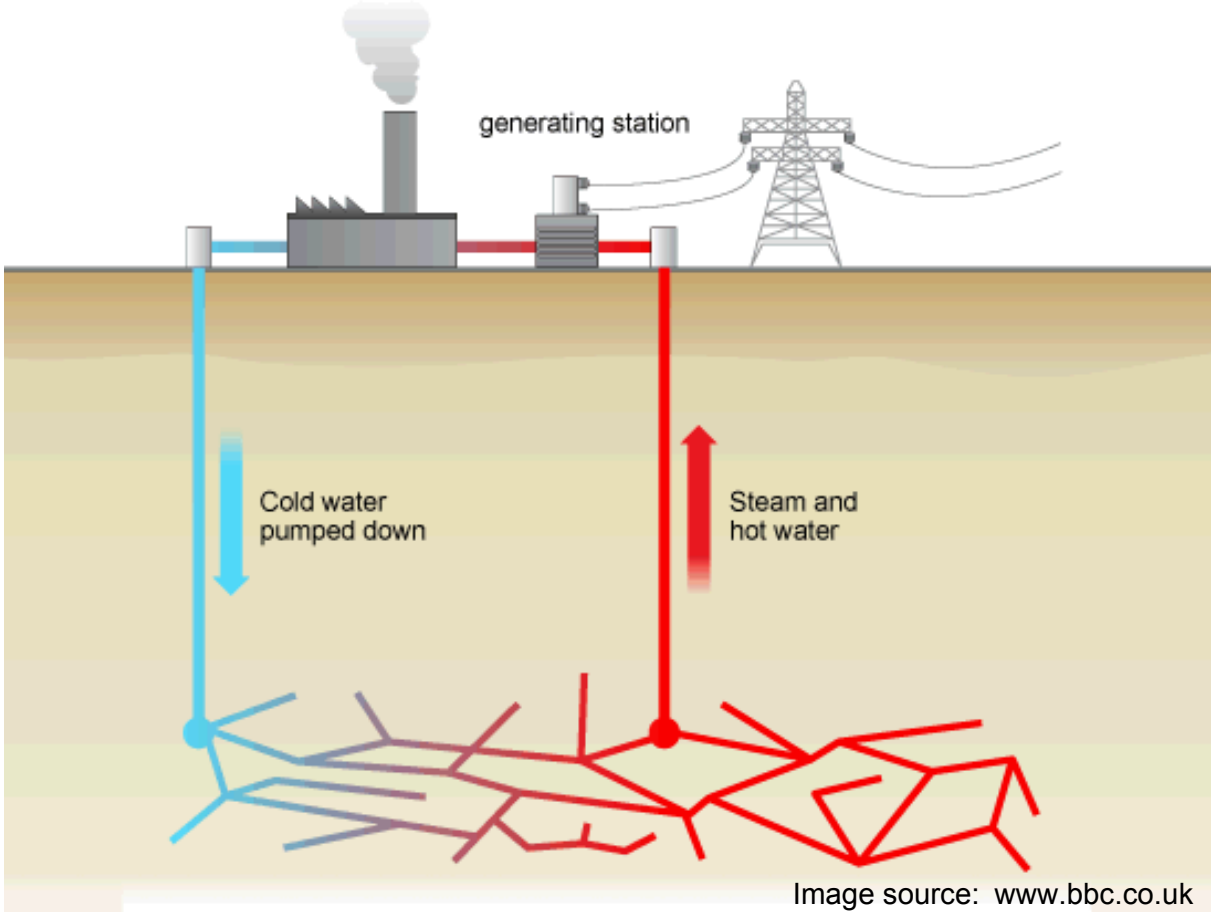

Image source: www.bbc.co.uk

→ So how we can improve the efficiency of this type of alternative energy?

Monitoring Productivity of Wells

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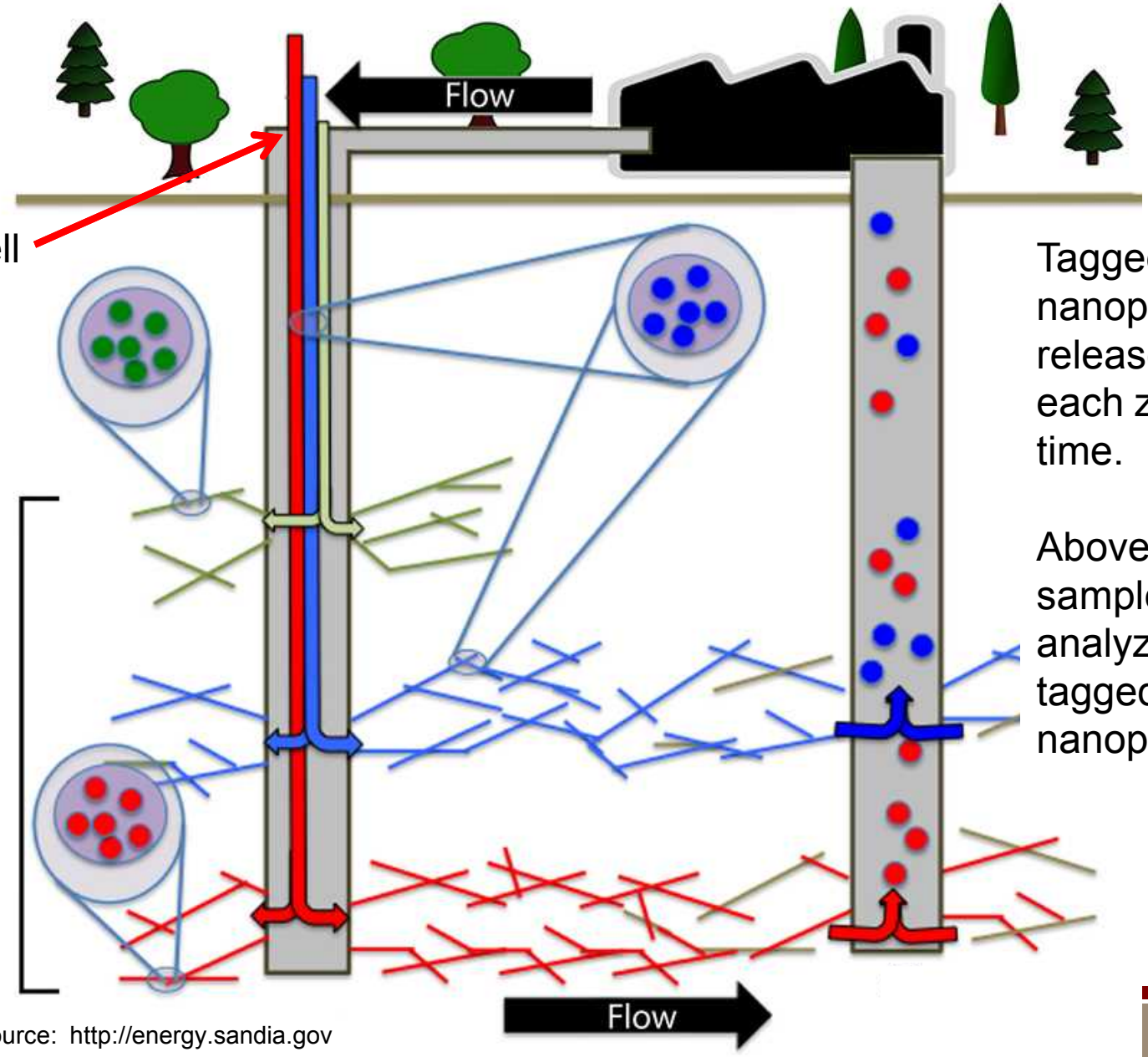

Fractured zones loaded with unique tagged nanoparticles inside the proppant.

Tagged nanoparticles released from each zone over time.

Above-ground samples will be analyzed for the tagged nanoparticles.

Source: http://energy.sandia.gov

Concept of “tagging” proppant

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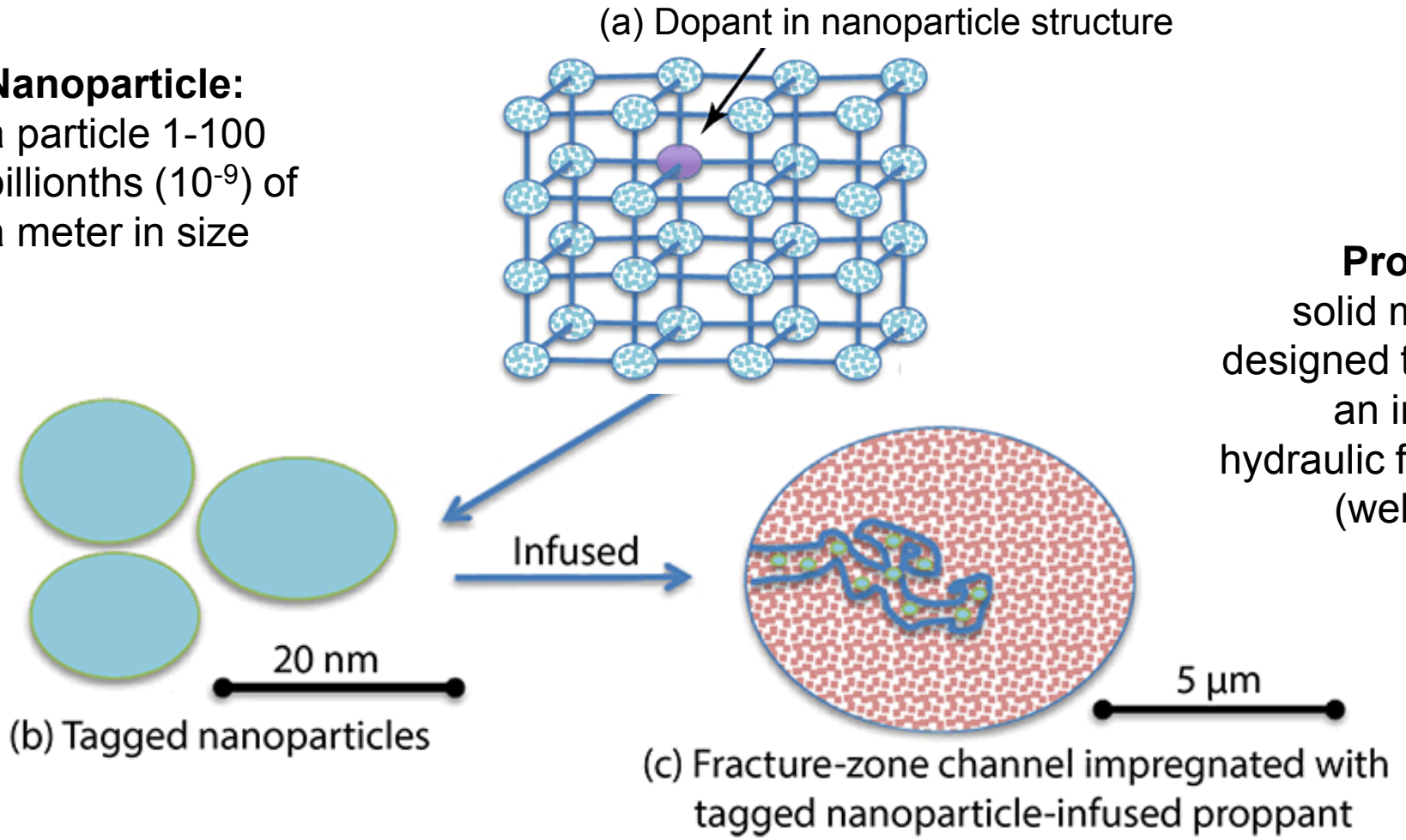
Nanoparticle:
a particle 1-100 billionths (10^{-9}) of a meter in size



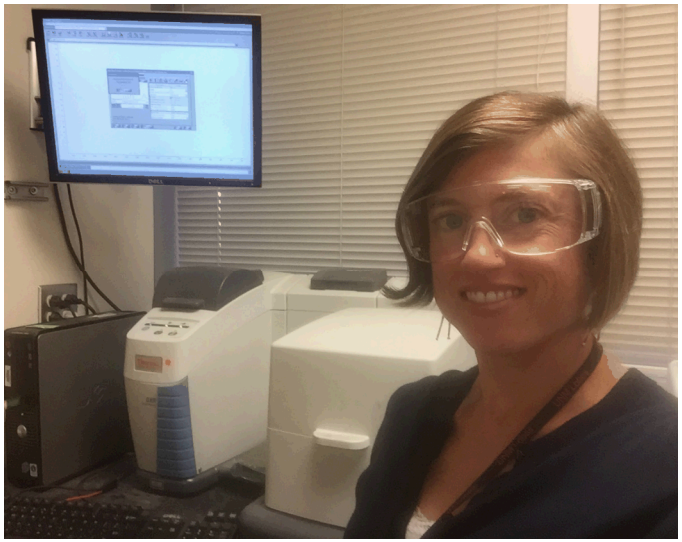
Proppant:
solid material designed to keep an induced hydraulic fracture (well) open

Image source: http://energy.sandia.gov

My Objectives

1. Characterize proppant and tags using

   Raman

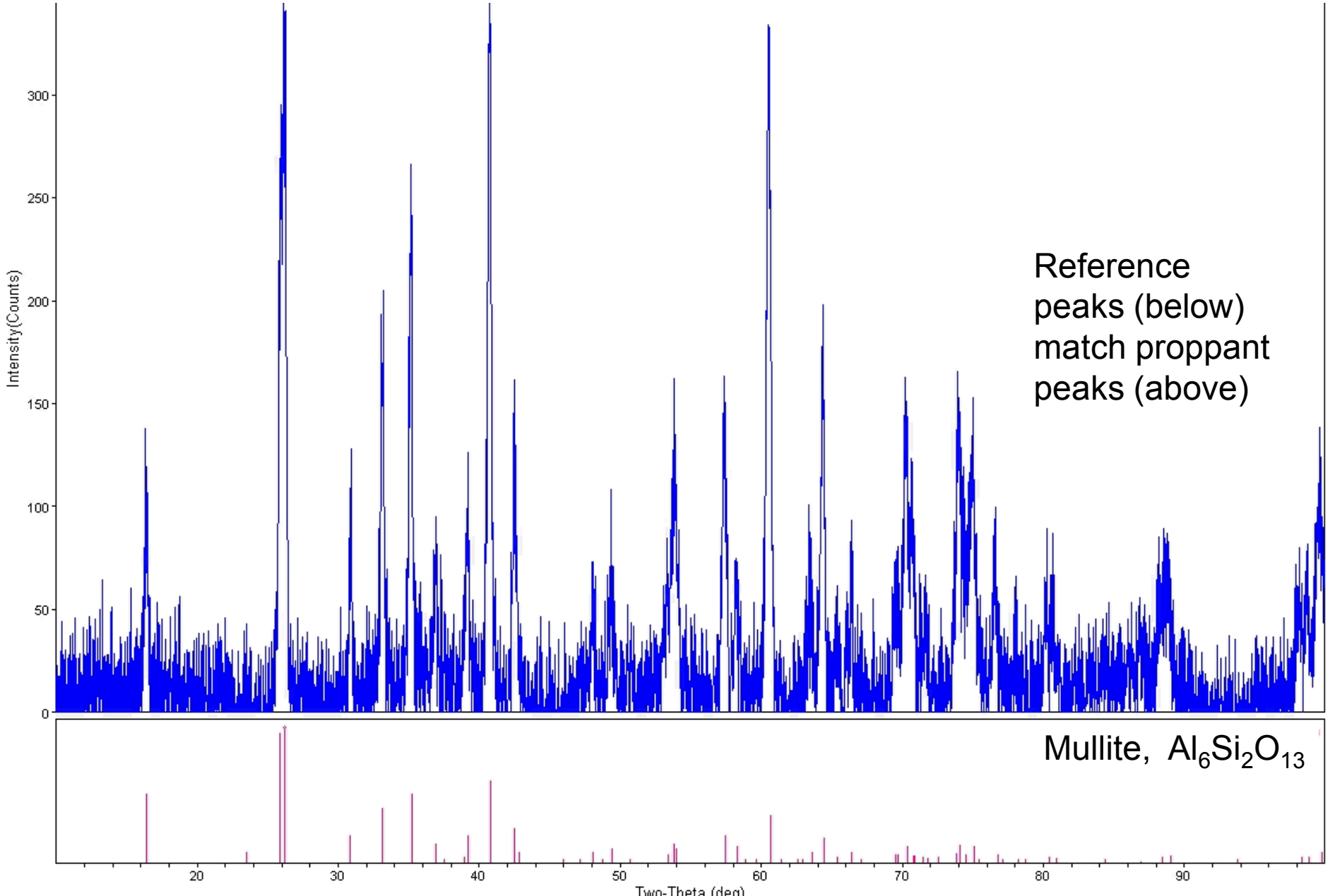


   Powder X-ray Diffraction

2. Load proppant with tagged nanoparticle (t-NP)

   & set up release studies

Characterization of Carbo Ceramic Proppant



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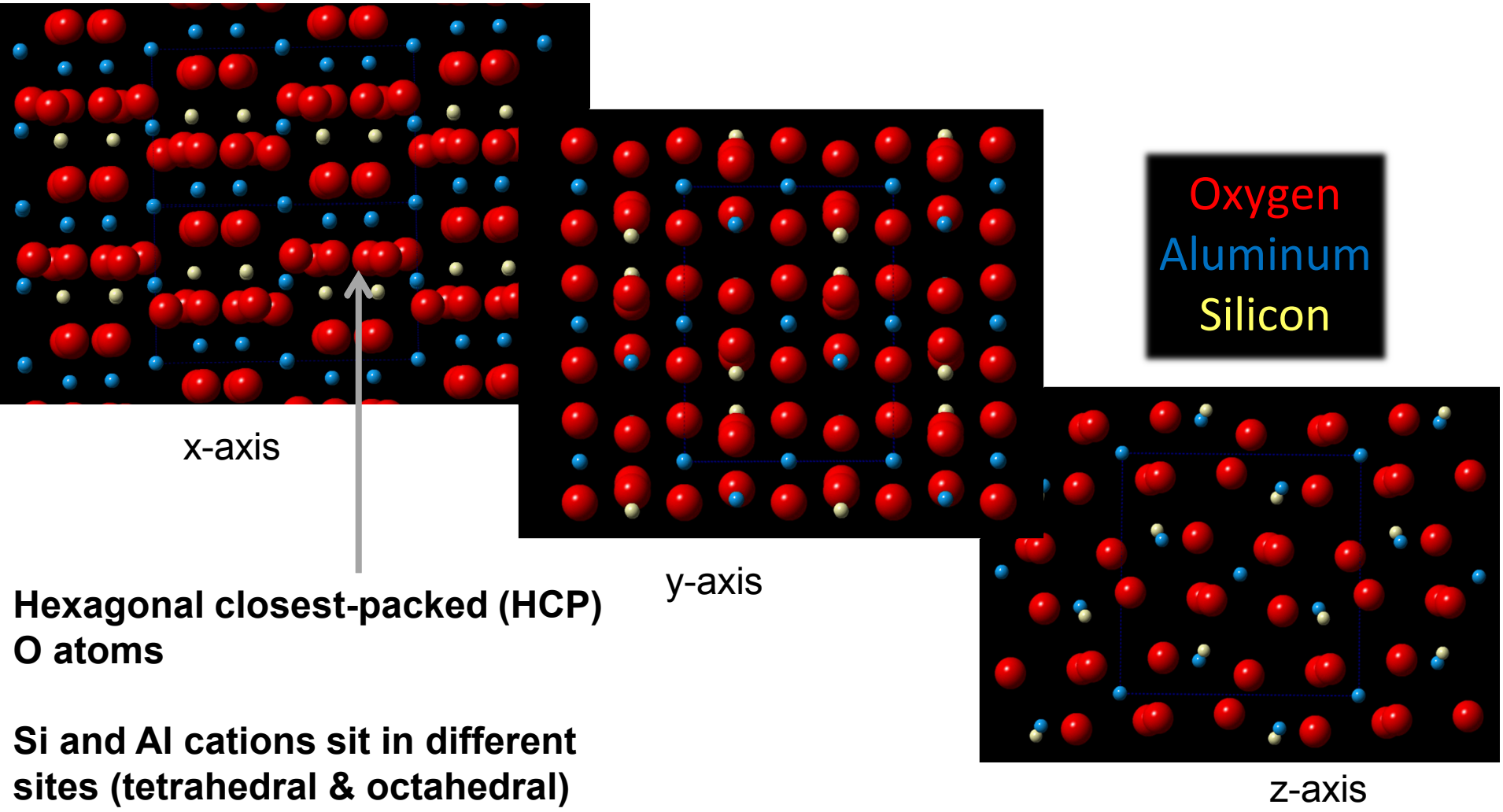
Crystal Structure of Mullite



Hexagonal closest-packed (HCP) O atoms

Si and Al cations sit in different sites (tetrahedral & octahedral)

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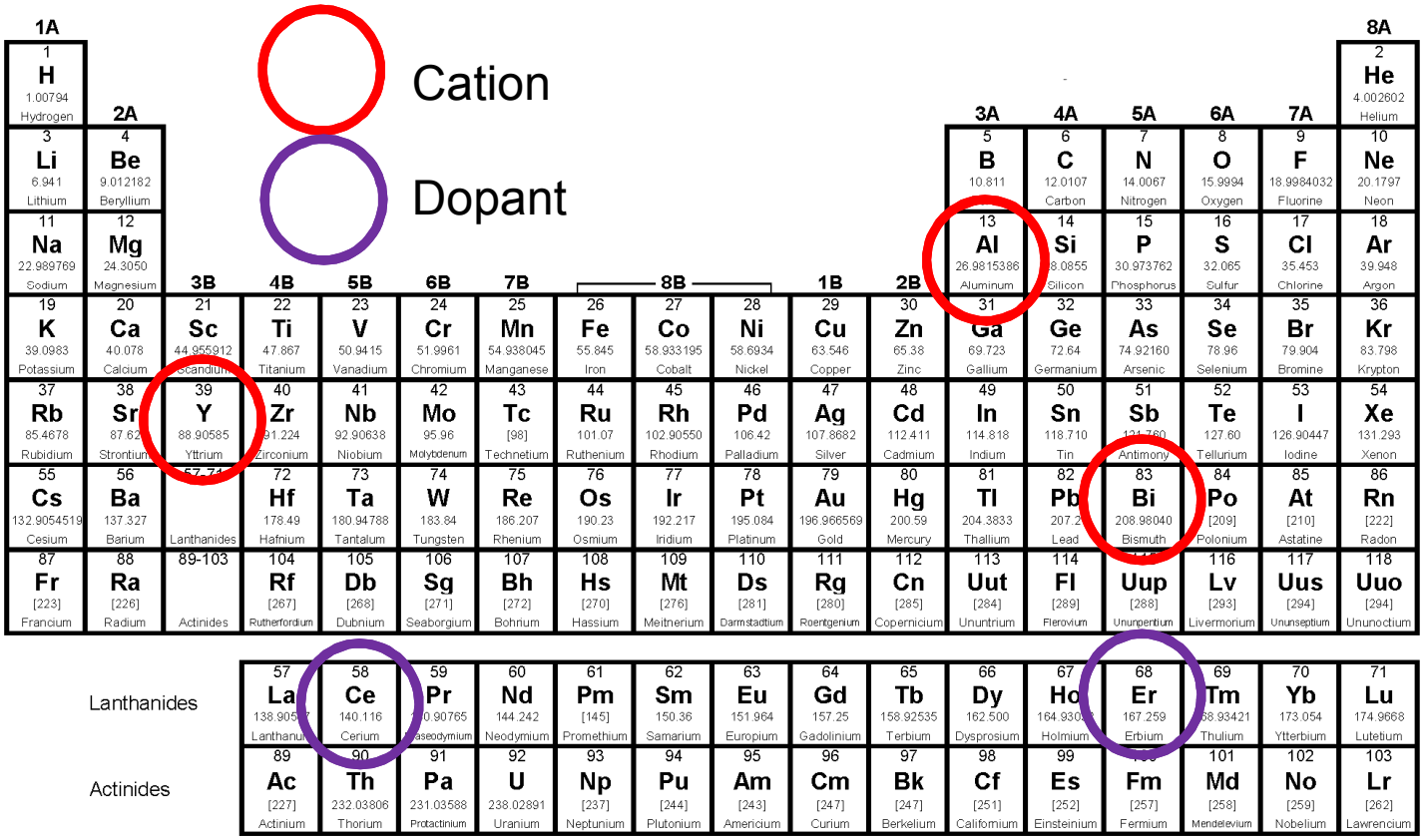
Tagged Nanoparticles

- Yttrium oxide, Y_2O_3:Er 10%
- Boehmite, AlO(OH):Ce 10%
- Bismuth oxide, Bi_2O_3:Ln 10%



We need baseline characterization data on these materials →

Raman on bulk vs nanoscale

Comparison of Raman Spectra of Y_2O_3 nanoparticles with Y_2O_3 bulk

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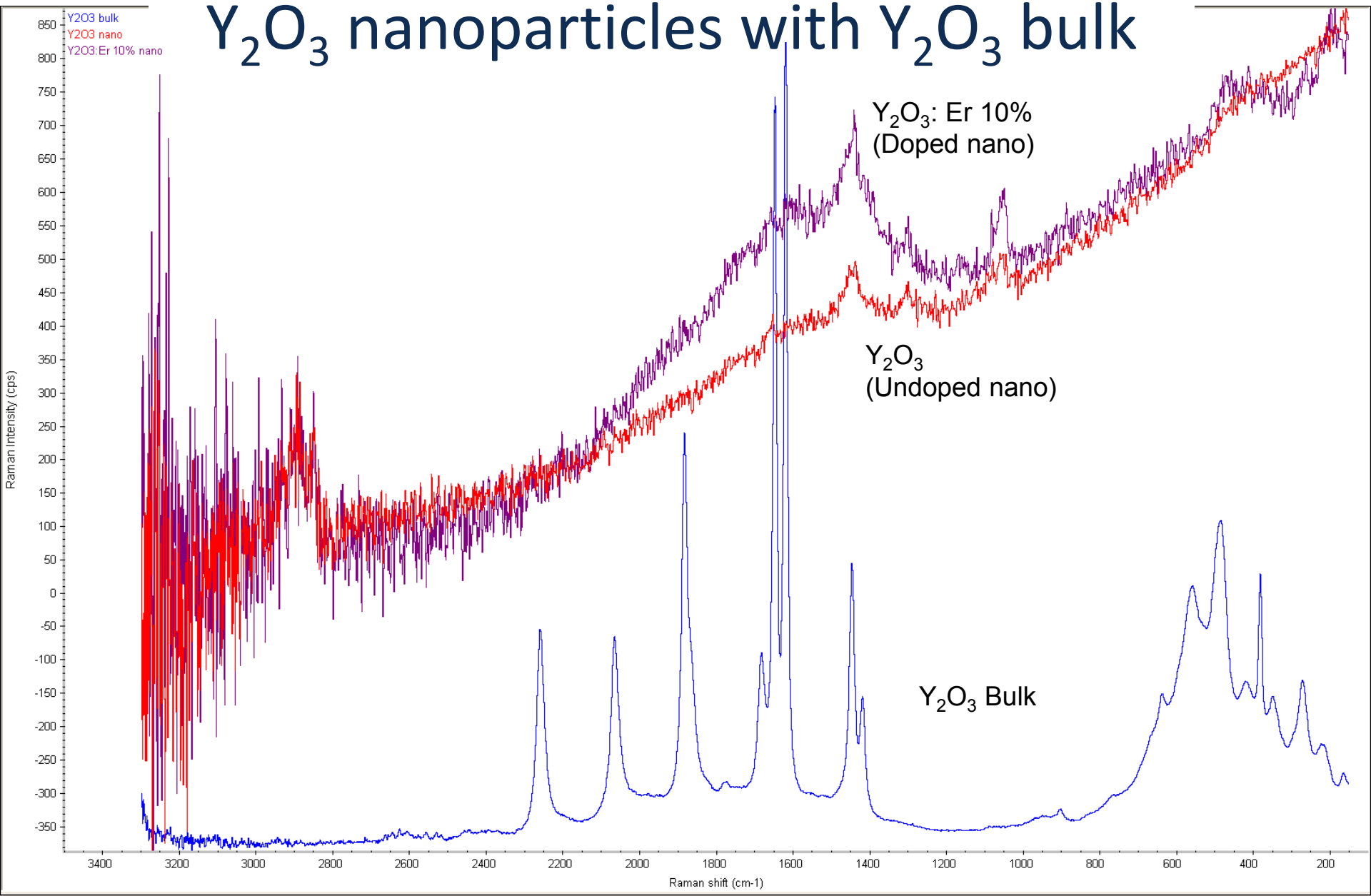

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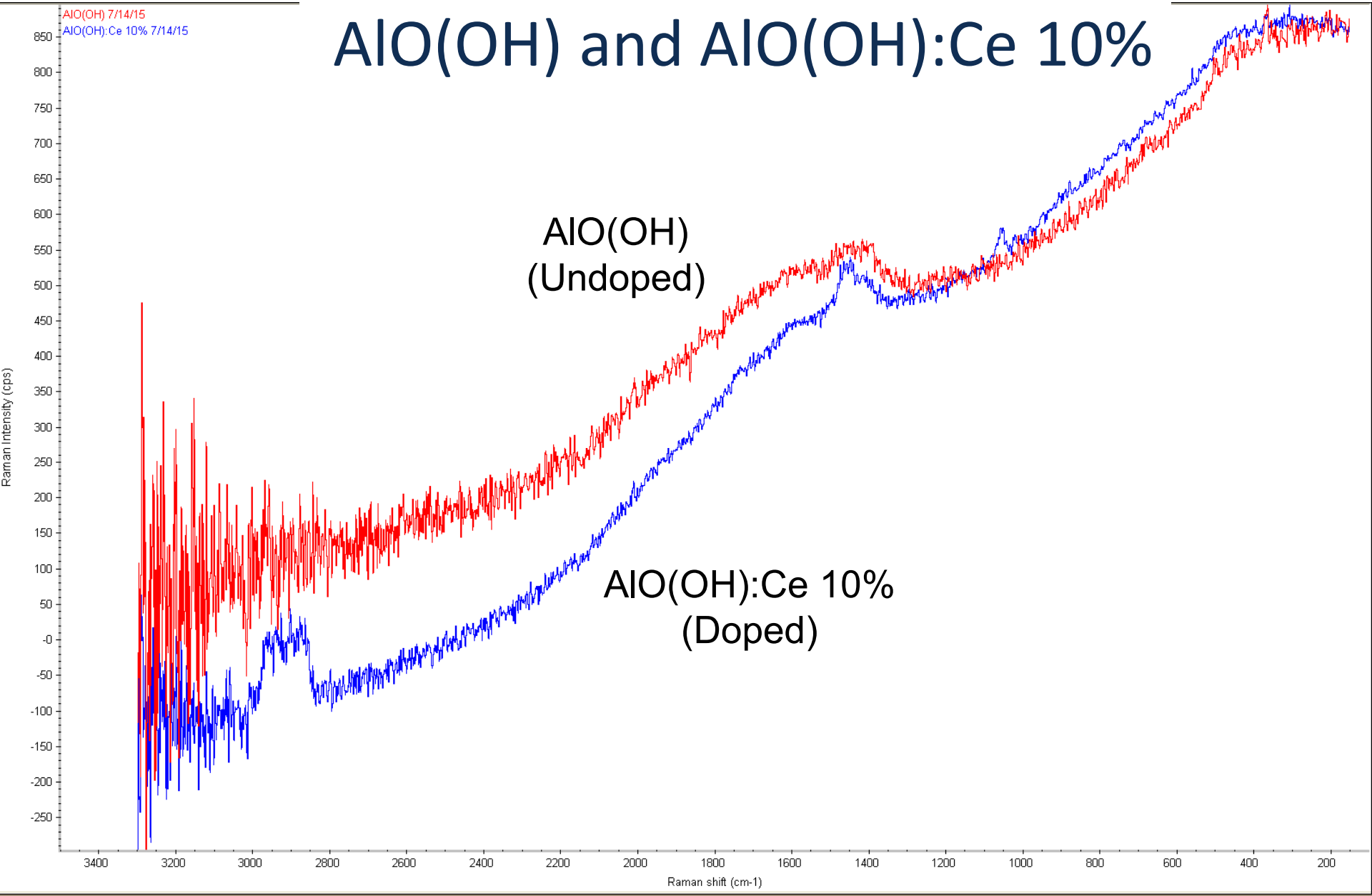
Raman spectra of AlO(OH) and AlO(OH):Ce 10%



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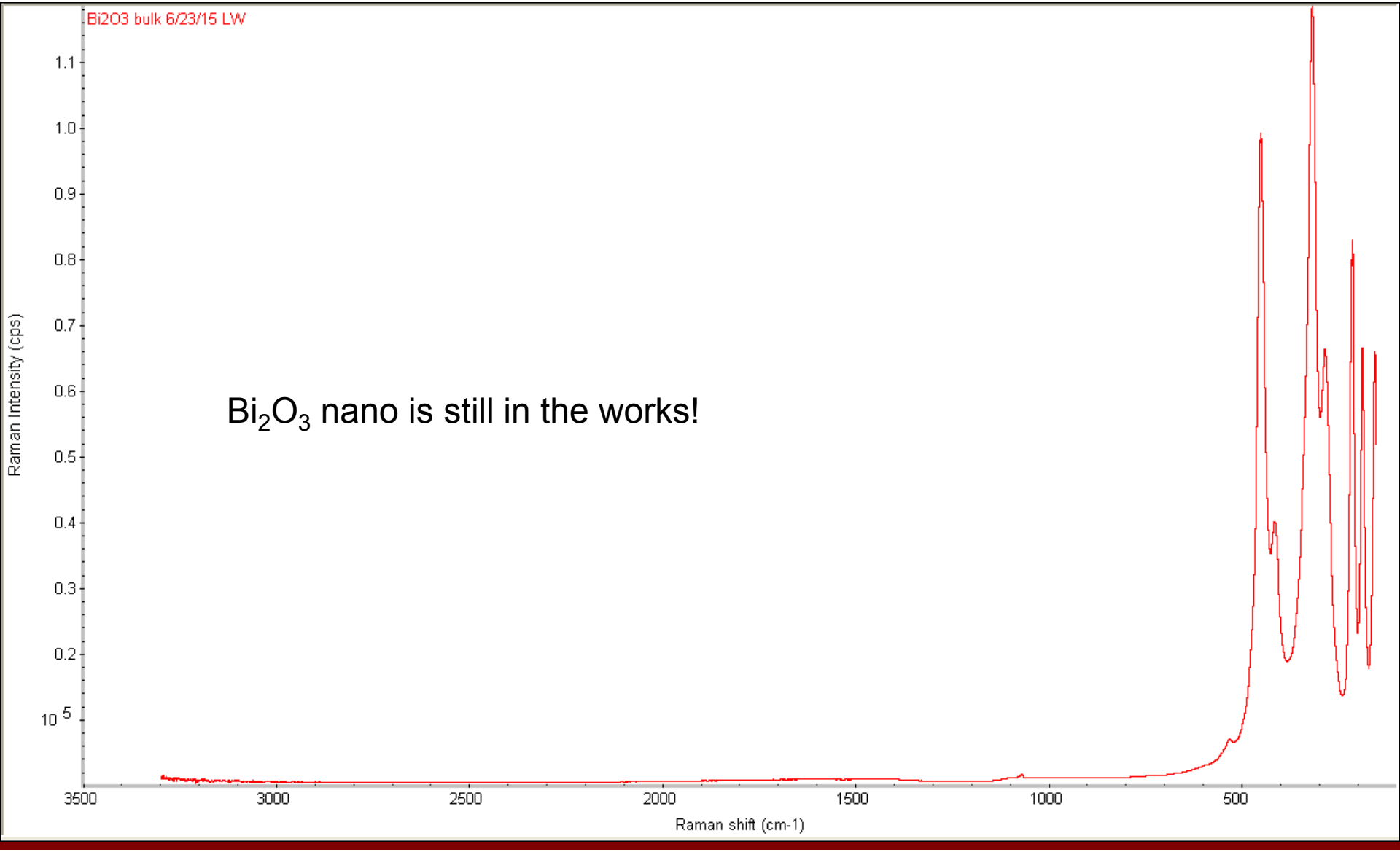
Raman spectrum of Bi_2O_3 bulk



Bi_2O_3 nano is still in the works!

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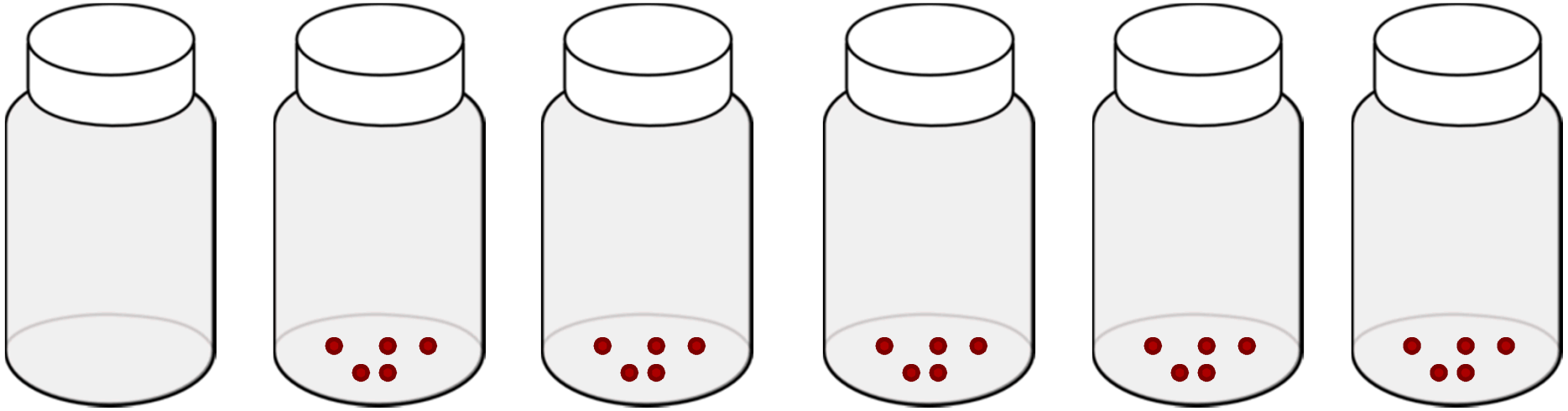
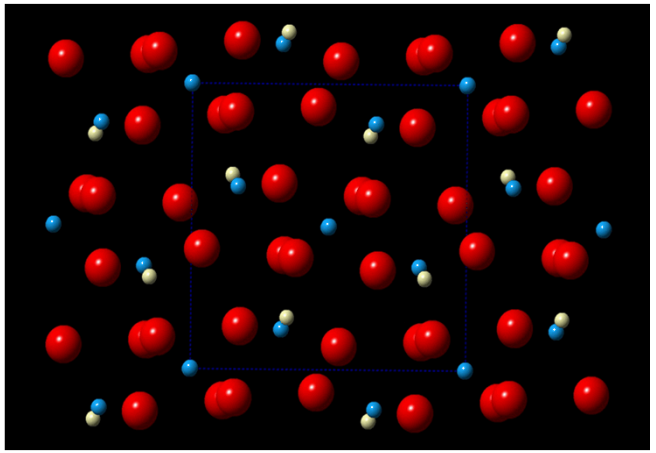
Loading Proppant with Tagged Nanoparticles

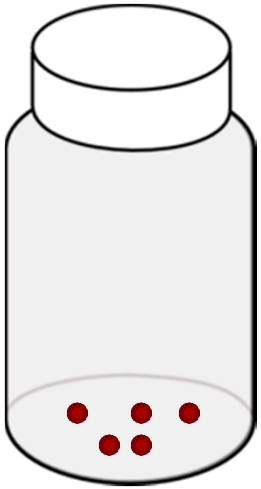


1. Each vial contains:
   - 0.5 g proppant beads
   - 10 mL DI H_2O
   - 0.05 g t-NP
2. Stir or swirl for 0 - 1800 minutes
3. Measure concentration of t-NP with ICP
4. Calculate amount of t-NP attached to proppant = ($[t\text{-}NP_{exp}] - [t\text{-}NP_{cntrl}]$)

Summary

- I successfully characterized the proppant beads as mullite, $Al_6Si_2O_{13}$ a ceramic aluminum silicate
- I characterized 2 of the 3 nanomaterials which will be used to tag the proppant





- Once the Bi_2O_3 nanoparticles are synthesized, those will need to characterized
- Proppant loading and release studies will be continued

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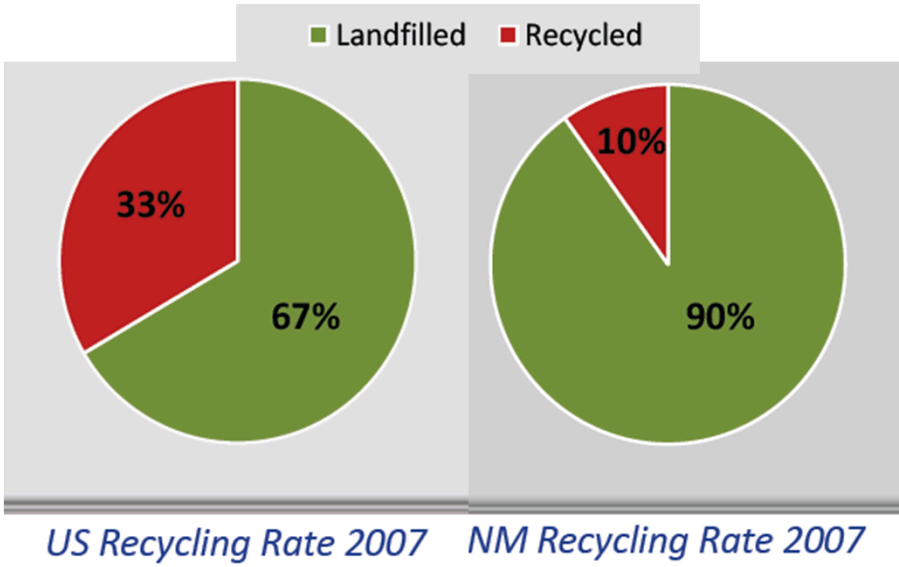
Project:

WASTE NOT WANT NOT

Introduction/Motivation

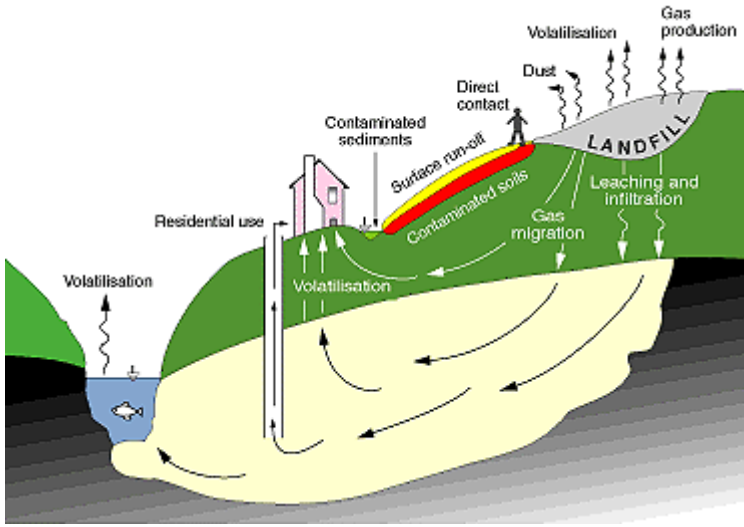
- What is the problem?
  - Americans produce a LOT of trash (>5 lbs/person/day)
  - New Mexico's recycling statistics are abysmal (10% compared to 33%)



➢ New Mexico Environment Department needs our help improving these statistics (goal: 50% diversion rate!)

Essential Questions

1. Should we as Americans continue to produce waste in the same way as we do now?
2. Why do we produce as much waste as we do?
3. What are the effects of this waste production?
4. Where does our waste go?



Project Task

- Students will design a solution to our waste problem: **increase diversion rate, reducing waste sent to landfill**
- **Present a proposal** to the NMED
- Goal: to increase diversion rate to 50% (currently 21%)
- Solutions may take a variety of forms and could include social, political, educational, infrastructural, or economy (incentive-) based programs or changes.
- Top proposal(s) could then be implemented at the school-, community-, city-, and/or state-level.

Content standards covered:

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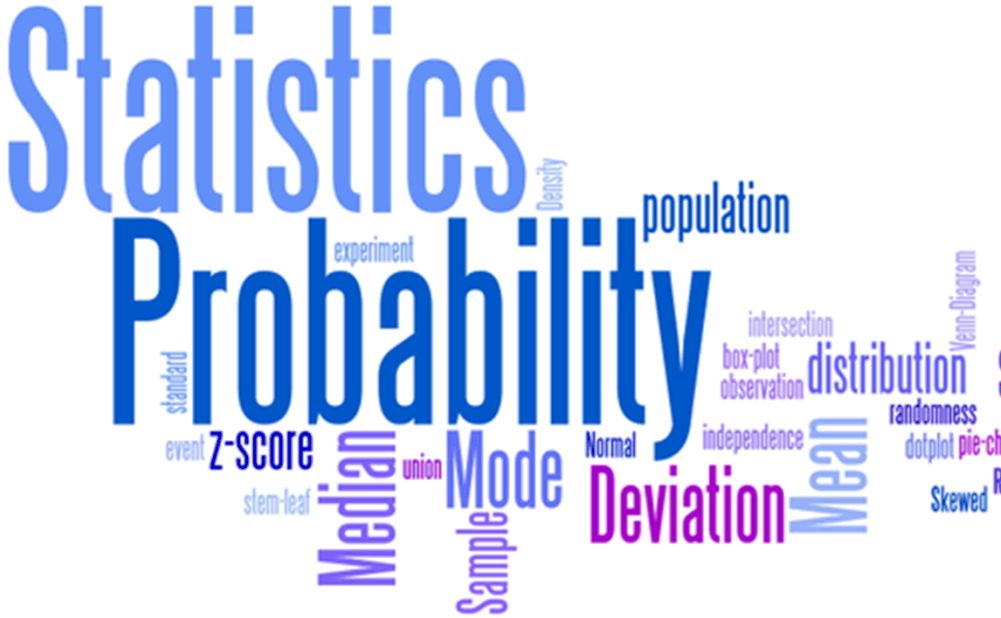
Environmental Science

- Types of pollution, disposal, reduction
- Impacts on human health and the environment
- Economic impacts
- NM Geology, Soil and Soil Dynamics

Probability and Statistics

- Simple probability
- Basic statistics (mean, standard deviation)
- Hypothesis testing



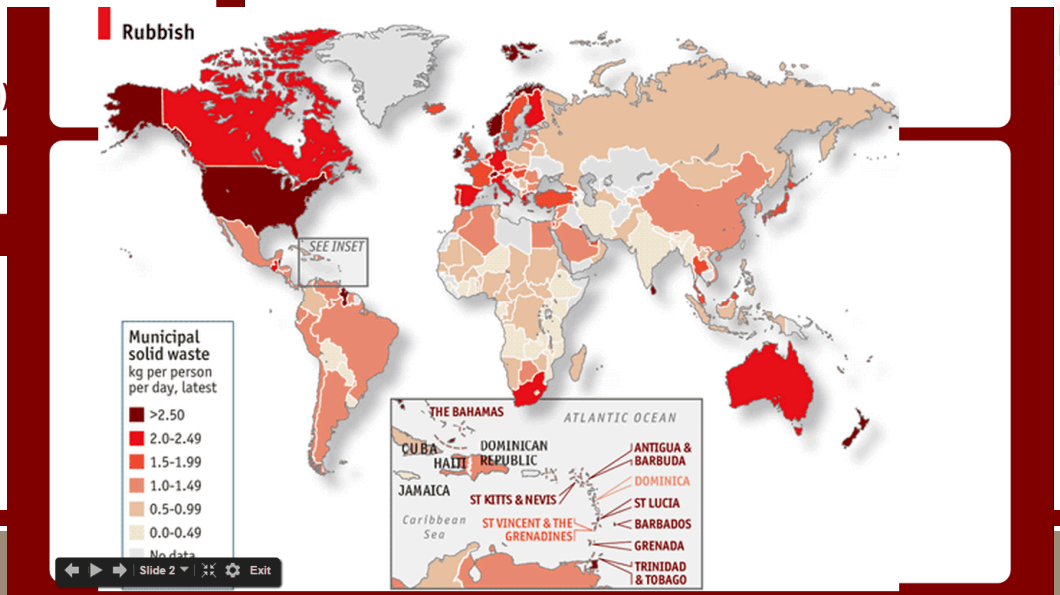
Lessons & Activities

Knows	Need-to-Knows	Next Steps

- Activity 1: Project Launch
  - Students are presented with
    - Waste production statistics
    - Memo from NMED requesting their help

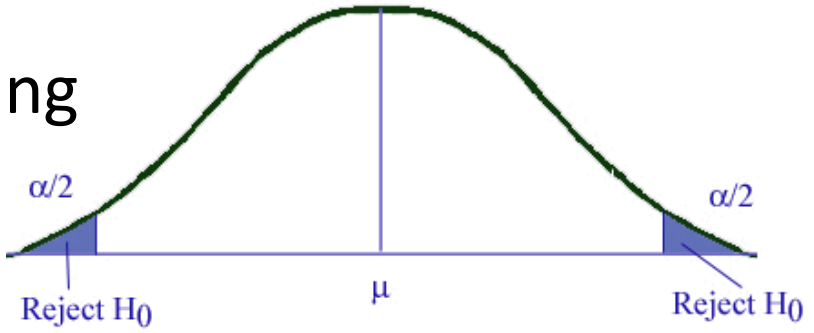
Municipal Solid Waste

(aka Garbage, trash, rubbish)

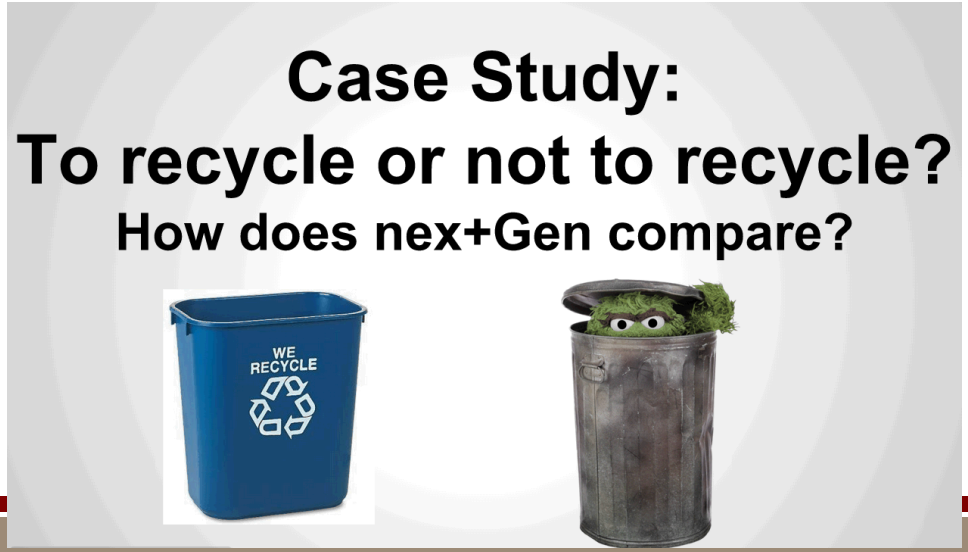


Lessons & Activities

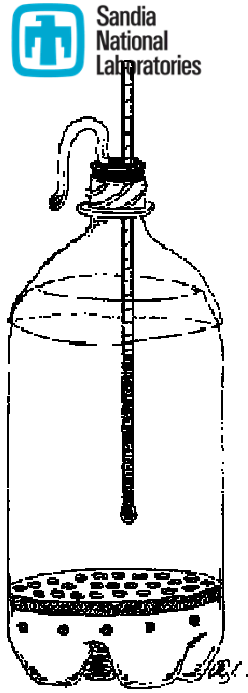
- Lesson: Intro to hypothesis testing
  - Stating hypotheses: H_0 and H_a
  - Type I and type II errors
  - Make and interpret a decision based on the results of a statistical test



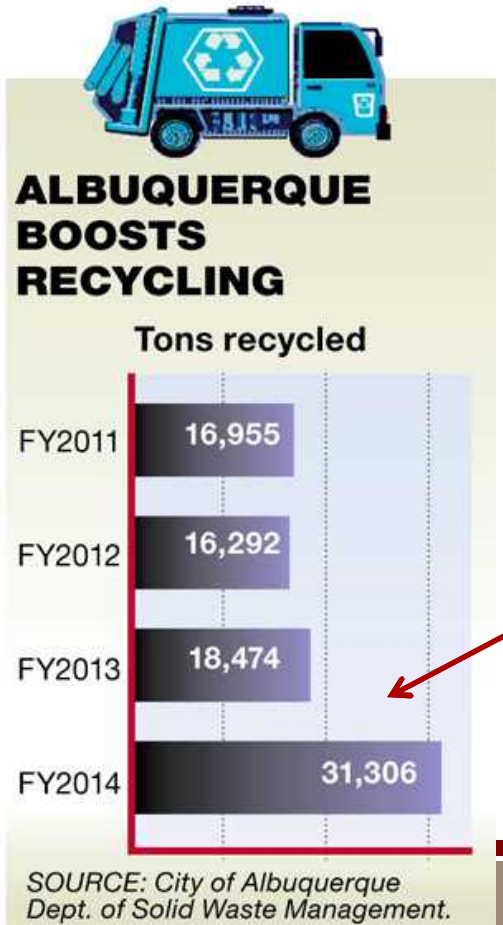
- Activity: Case study: To recycle or not to recycle?
  - Designing an experiment
  - Analyzing data
  - Accept or rejecting H_0



Lessons & Activities



- Composting Lesson & Lab Activity
  - Aerobic respiration
  - Anaerobic fermentation
  - Factors that affect composting rates
- Field Trips to Friedman Recycling Facility, Soilutions Composting, and local landfill



Blue Bins deployed city-wide