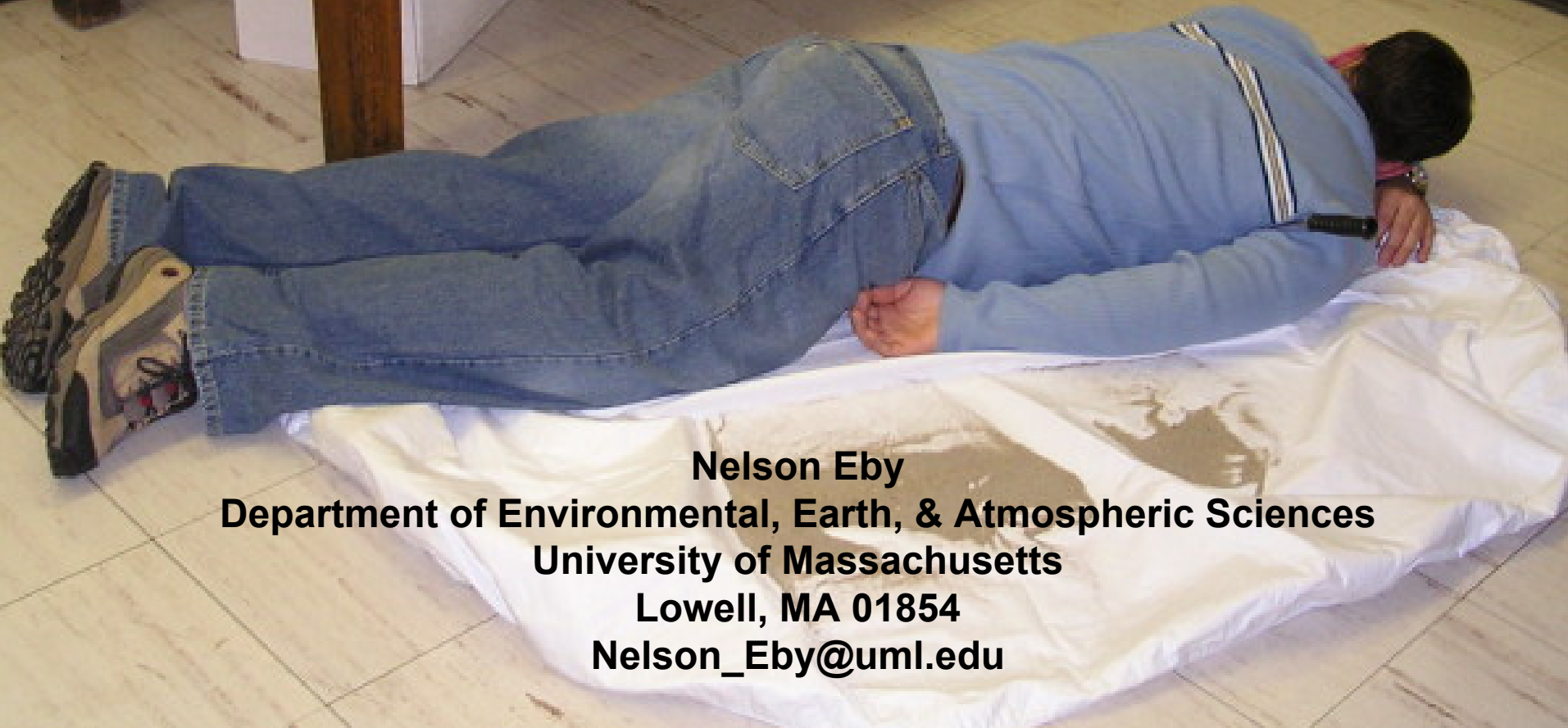


FORENSIC GEOLOGY AS A VEHICLE FOR INQUIRY-DRIVEN LEARNING: THE CASE OF THE SANDY BODY

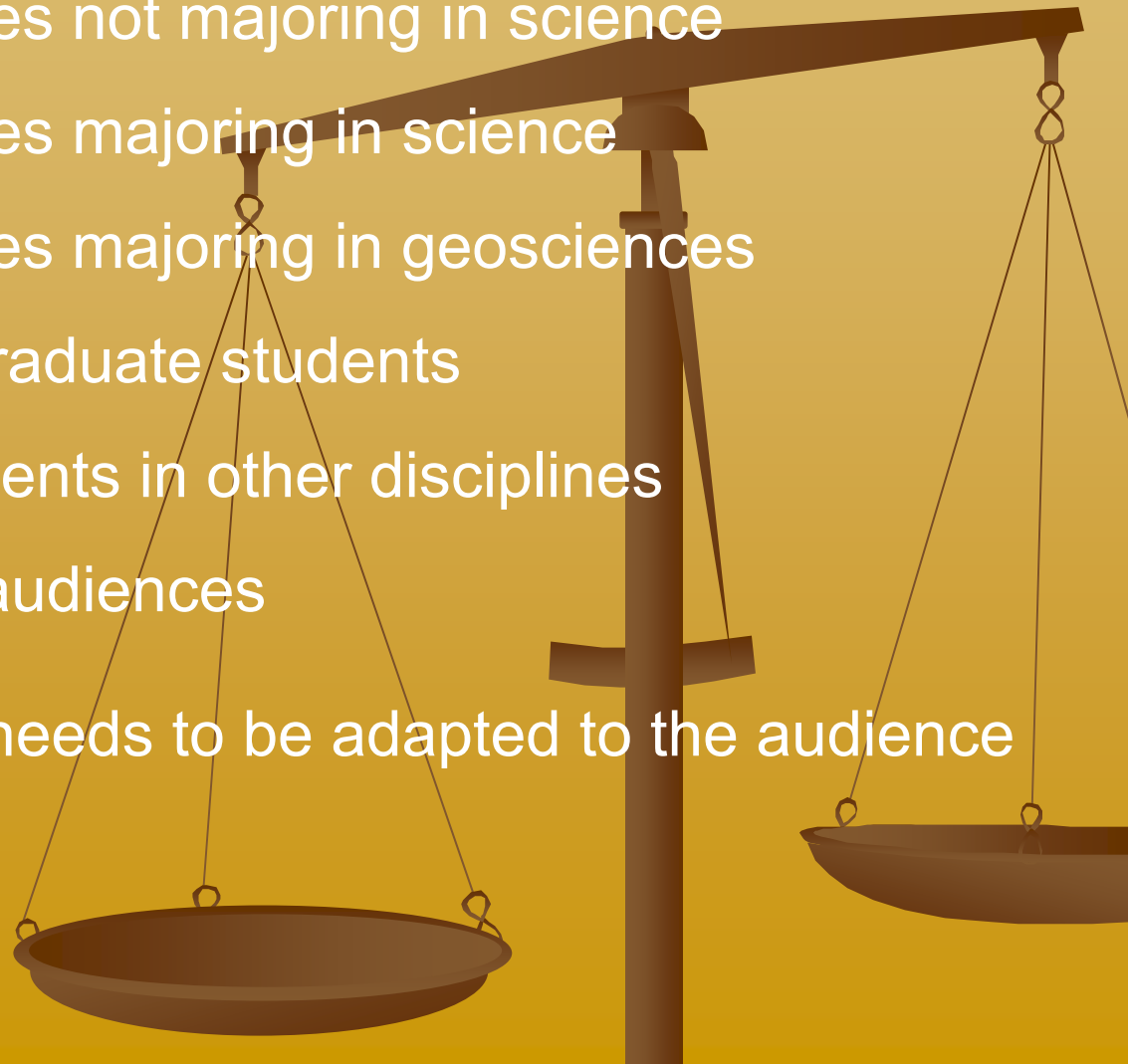


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Audience for Forensic Geology

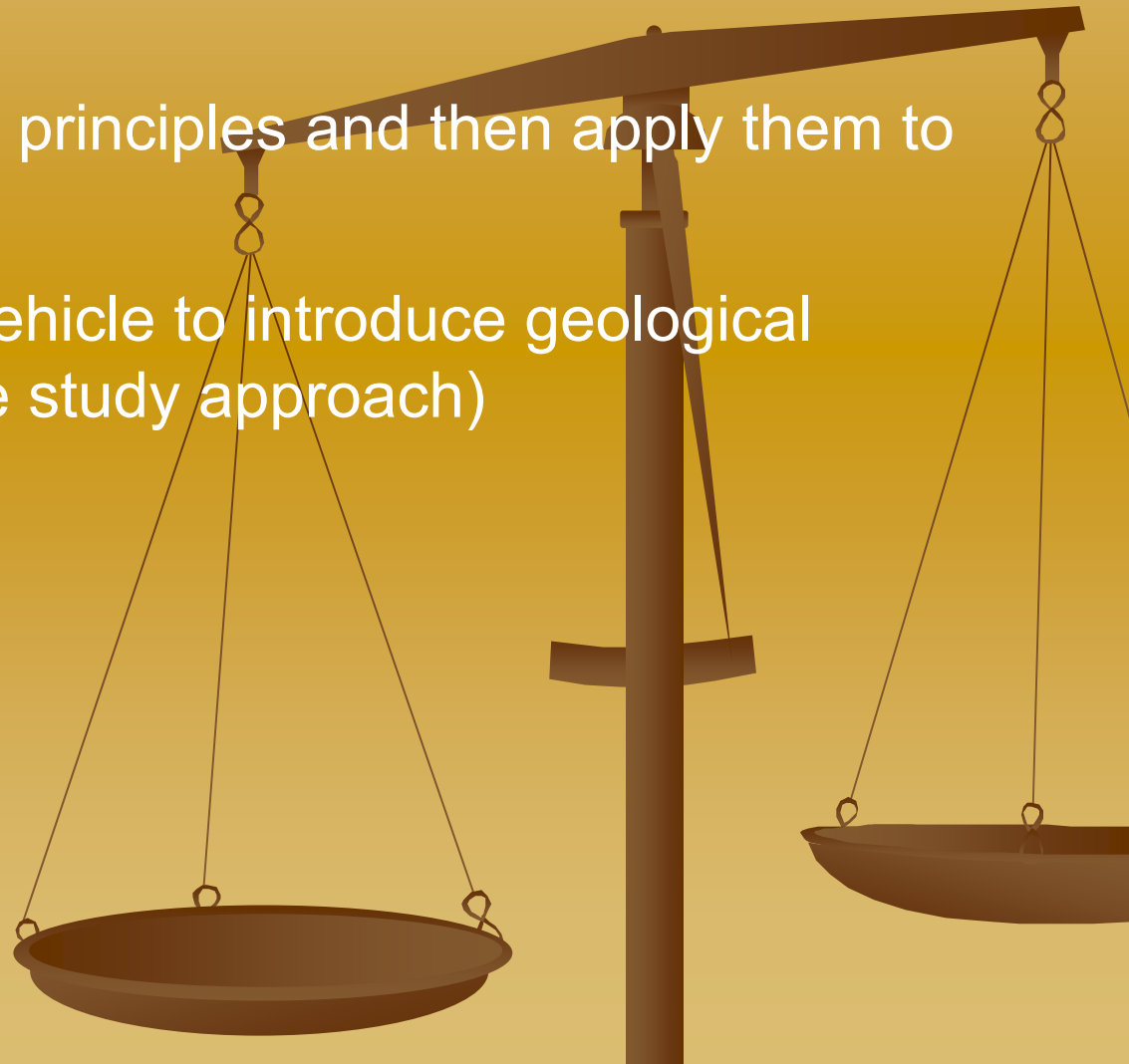
- Undergraduates not majoring in science
- Undergraduates majoring in science
- Undergraduates majoring in geosciences
- Geoscience graduate students
- Graduate students in other disciplines
- Mix of above audiences

The teaching strategy needs to be adapted to the audience



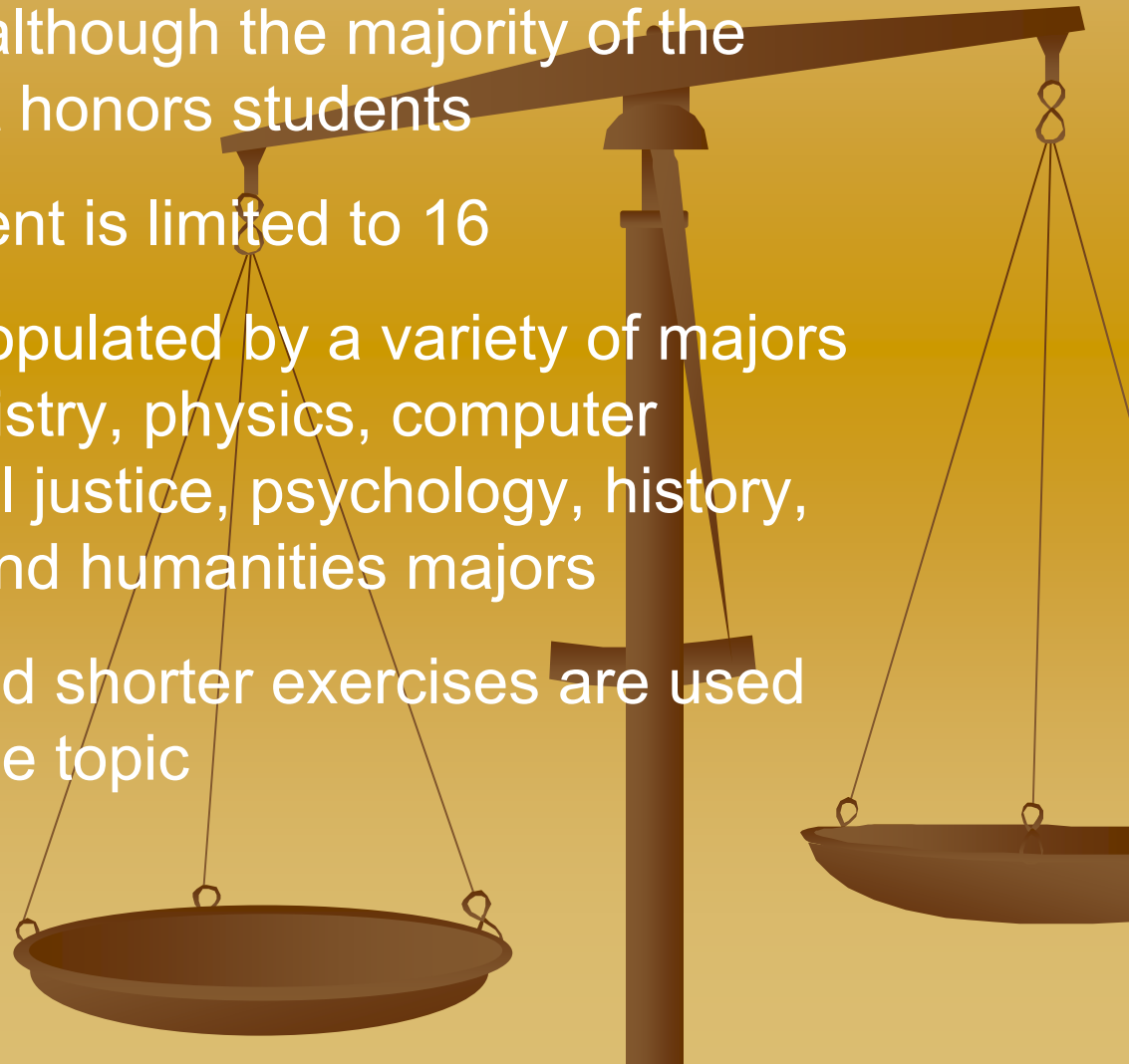
Teaching Perspective

- Develop geological principles and then apply them to solving crimes
- Use a crime as a vehicle to introduce geological principles (the case study approach)




Forensic Geology Course at UML

- Honors course although the majority of the students are not honors students
- Course enrollment is limited to 16
- The course is populated by a variety of majors – biology, chemistry, physics, computer science, criminal justice, psychology, history, and other arts and humanities majors
- Case studies and shorter exercises are used depending on the topic



Case Studies



Cases	Concepts Introduced
Sandy Body	Grain size analysis Sedimentary environments Mineral identification
Demise of the Ice Man	Geologic age Geologic maps Stable isotopes Radioactive isotopes
Contaminated Wells	Topographic maps Profiles and contouring Darcy's Law Groundwater flow Stream hydrology

Case of the Sandy Body

A student is brutally murdered and his body is dumped in a classroom.

Where did the crime occur?



The body is wrapped in a plastic cloth. Examination of the body and the plastic cloth reveal a significant amount of sand. The sand is collected for forensic analysis.



A canvas of the area around Lowell reveals that in the past 24 hours the student was seen near the Sandy Brook on St. Marks Road in Burlington.



At Crane Beach, jogging along the beach face.



Disturbed area on beach.



Jogging in the dune line at Crane Beach.



Disturbed area
on back side of
sand dune.



Collecting garnets from the beach sand at the southern end of Plum Island. It turns out the victim was a Geoscience major.



One line of evidence we can use to determine the site of the crime is to do a size analysis of the sand. Hopefully one of the possible sites will have the same size-distribution as the sand found with the body.

Sand placed in sieve set



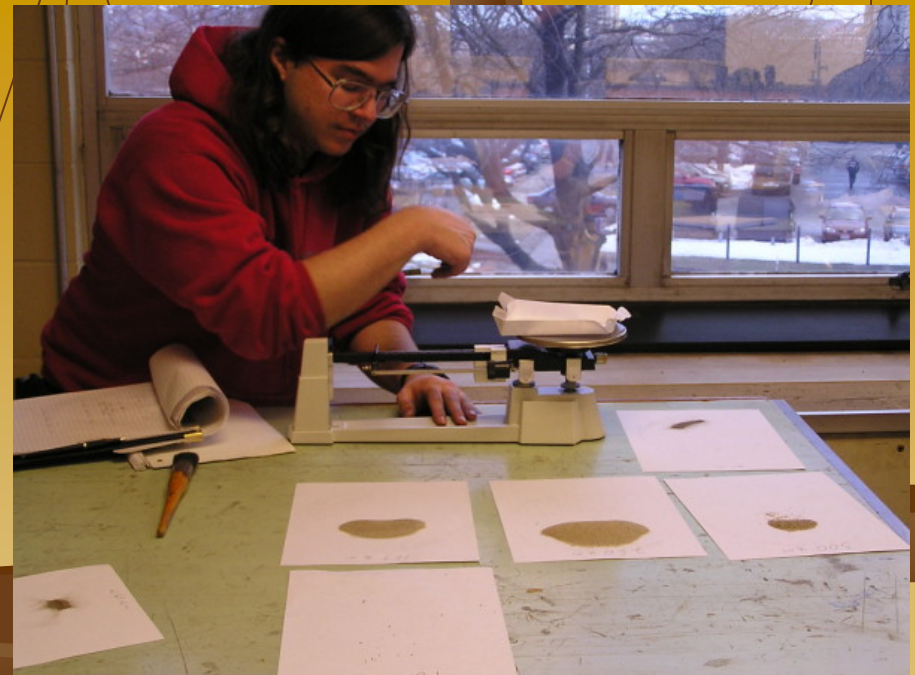
Sieve set on sieve shaker





Students removing sand from sieves prior to weighing.

Determining the weight of sand in each size fraction.





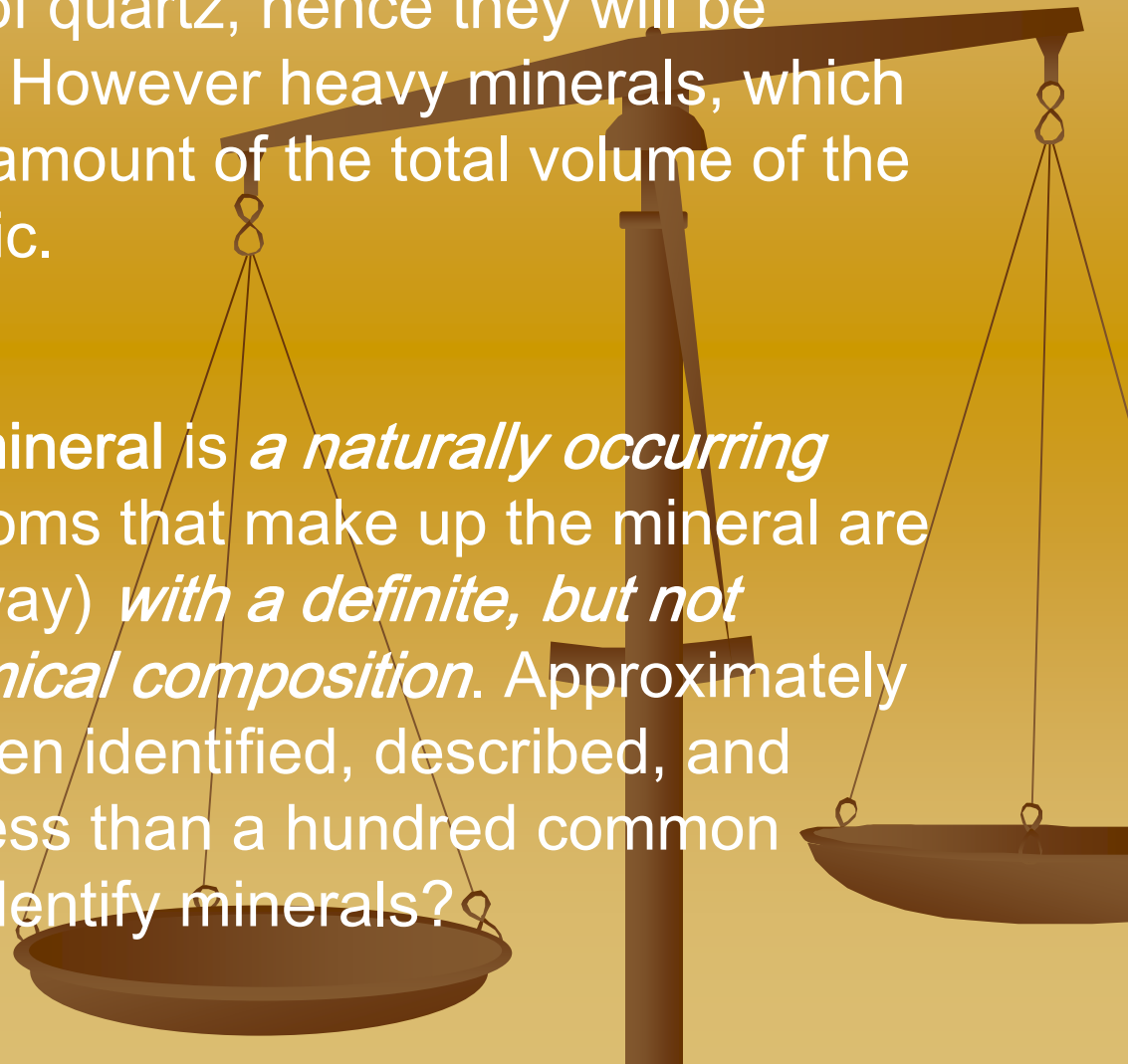
Students weighing sand.

Prepared to start
determining the weight of
the different size fractions.



Besides the sand size-distribution, another piece of evidence we can use to determine the site of the crime is the mineral content of the sand. Many, but not all, sands are largely composed of quartz, hence they will be mineralogically similar. However heavy minerals, which comprise a very small amount of the total volume of the sand, may be diagnostic.

What is a Mineral? A mineral is *a naturally occurring crystalline solid* (the atoms that make up the mineral are arranged in a regular way) *with a definite, but not necessarily fixed, chemical composition*. Approximately 3500 minerals have been identified, described, and named, but there are less than a hundred common minerals. How do we identify minerals?



Future criminologists studying the properties of minerals and learning the techniques of mineral identification.



Students using the Frantz magnetic separator to separate heavy minerals from a sand sample.



Heavy minerals separated from sand sample.



Microscopic examination of heavy mineral suite and identification of heavy minerals.



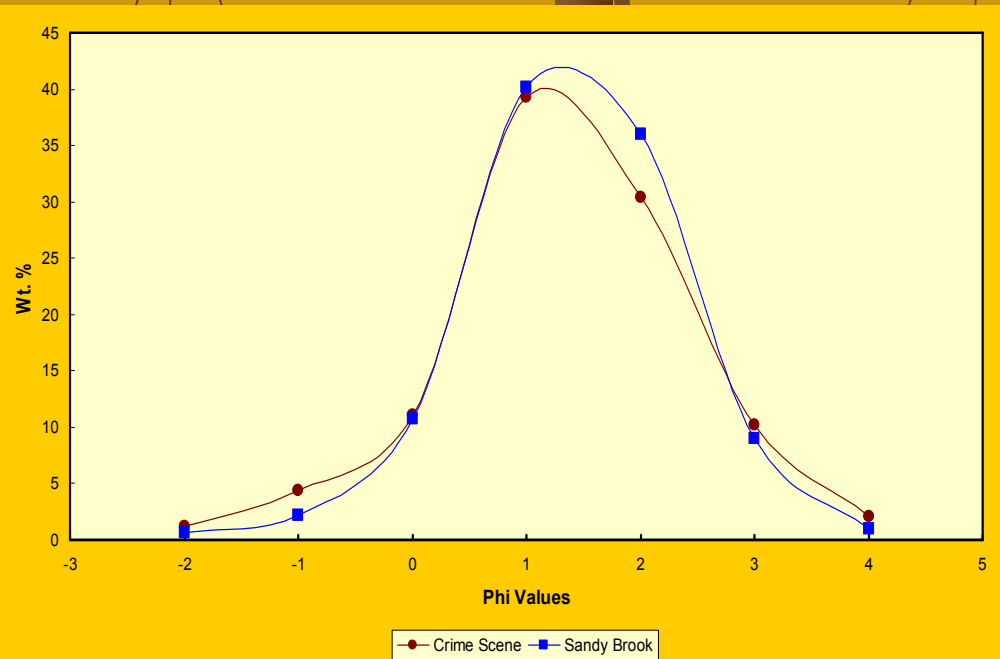
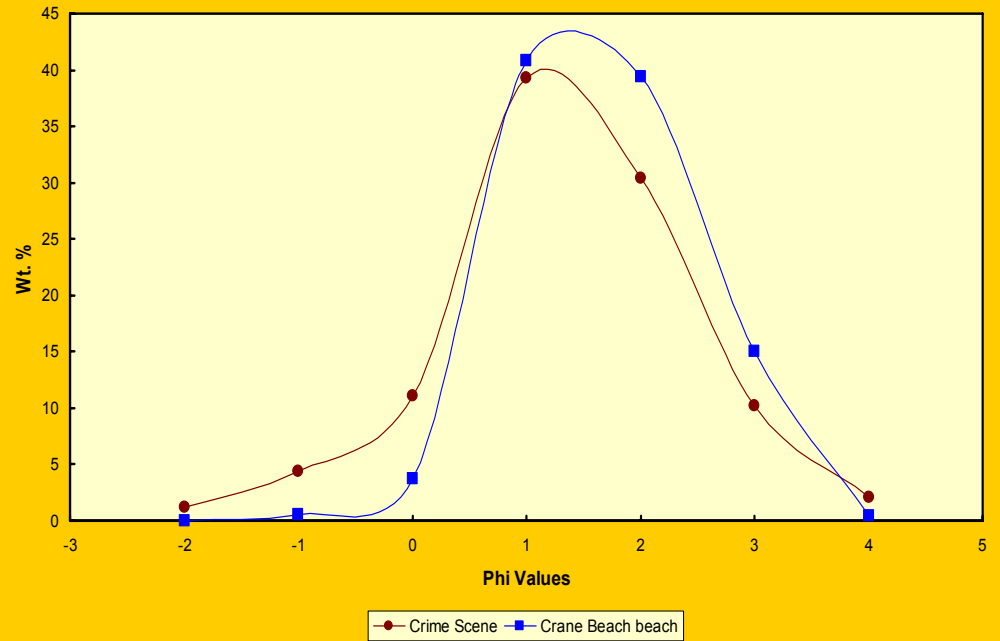


Microscopic determination of texture and mineralogy of the comparative sand samples and sand from the crime scene.

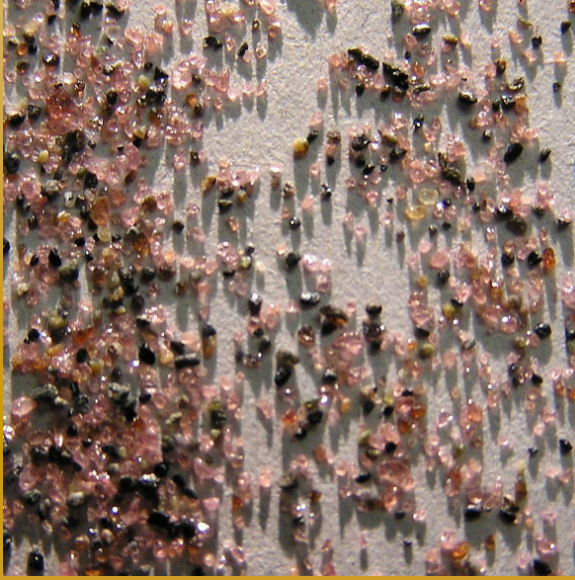


Students listing properties of each of the sand samples.

Two of the localities (Crane Beach and Sandy Brook) have similar size distributions to the Crime Scene sample, but Sandy Brook provides a closer match.



The heavy mineral suite shows that Sandy Brook and the Crime Scene sample contain very little garnet, the Crane Beach sample contains significant amounts of garnet.



Crane Beach heavy mineral suite contains abundant red almandine garnet

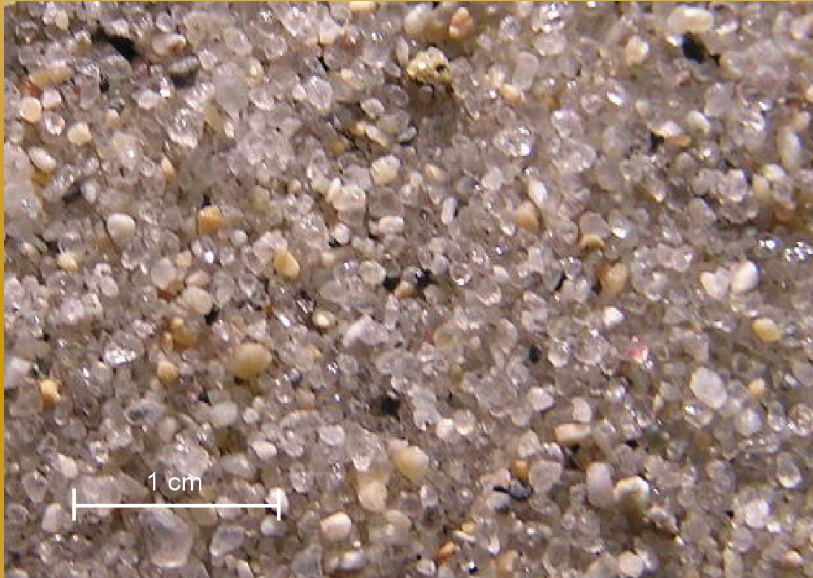
Heavy mineral suites for Crime Scene and Sandy Brook samples

Sandy Brook

Crime scene



In addition the Crime Scene and Sandy Brook grains are less rounded. Conclusion: the crime took place in the Sandy Brook area.



Crane beach

Crime scene



Sandy Brook



Using information provided by Forensic Geology students at UML, Burlington police searched an area along the Sandy Brook. During their investigations they found a disturbed area along the brook and a sneaker print.



During a routine traffic stop, a Burlington police officer noticed a pair of sand-covered sneakers in the back of the car. The driver claimed that he last wore the sneakers when walking on Sand Beach in Acadia National Park.



Is the suspect telling the truth?

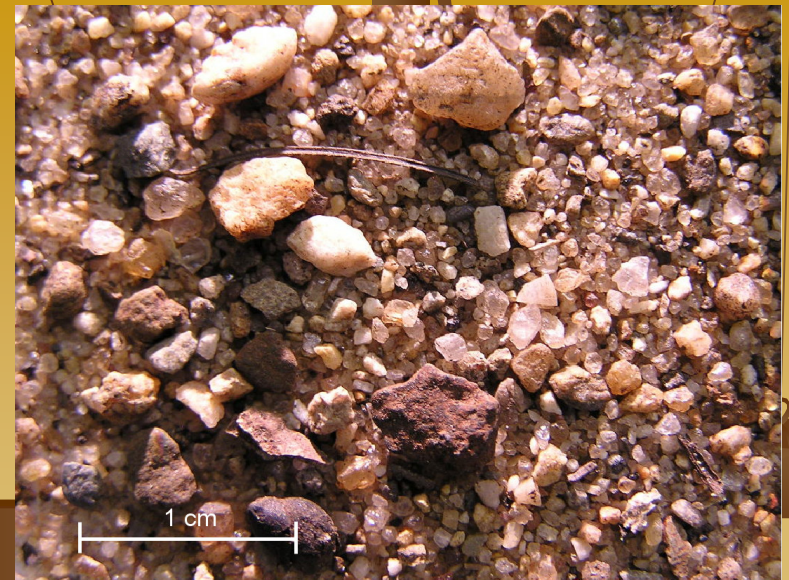
Comparison of Sand Beach and Sandy Brook sand samples with sand taken from the suspect's sneakers will reveal the answer.

Sand Beach is composed of carbonate shell material (an unusual occurrence in the Northeast). The sand on the suspect's sneakers is quartz sand.

Sand Beach

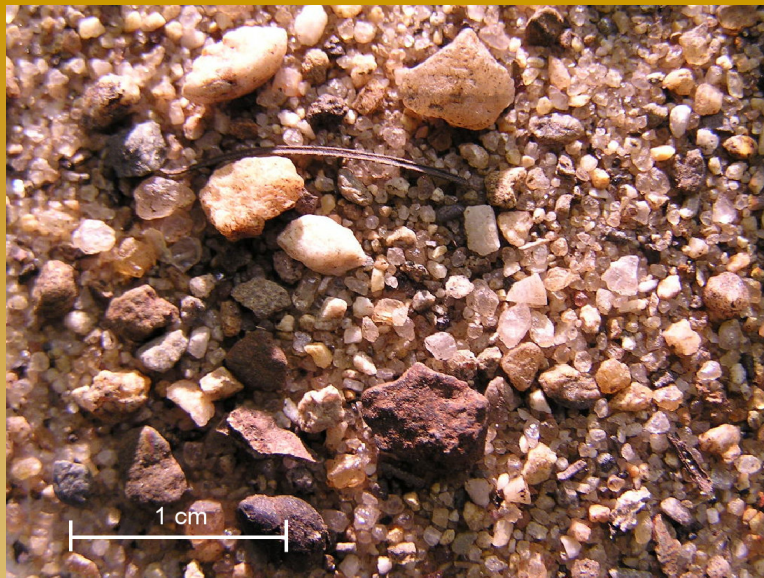


Suspect's sneakers



The sand on the suspect's sneaker is texturally and mineralogically similar to the Sandy Brook sand. The suspect is lying about where he picked up the sand and the evidence is consistent with Sandy Brook as the source. Too bad for the suspect that he didn't take a geology course.

Suspect's sneakers



Sandy Brook



How well does this approach work? (Assessment)

- Students are highly motivated and the classroom becomes a dynamic environment.
- Students will do tasks that they would only do with great reluctance in a *traditional* setting. For example, they will tackle mathematical computations.
- There is still a disconnect between collecting the data (a fairly rote procedure) and interpreting the data in terms of solving the crime. This does improve as the course progresses.
- Content exams indicate only a minor improvement over what one would expect in a *traditional* course. This approach is not a panacea re issues of student learning.

