WHAT CAN WE TEACH USING SAND?

❖geology ⊛geography ≈physical processes ⊄chemistry ★biology & more

Use sand samples from many sources to illustrate basic concepts or processes in earth and marine science, and to practice research skills. Sand can help us demonstrate:

- ★Regional, national and international geography – Where in the world are sands? Sands are found on beaches and in dunes, rivers, lakes and rock formations all over the world. Look for similarities and differences in location, compare and contrast geology, climate and other factors.
- ★Geology – The composition and geological origins of sands can tell stories of continental drift and tectonic processes, the rock cycle, weathering and erosion, principles of uniformitarianism and stratigraphy, paleontology, even the location of ancient seas & sea level changes.
- ★Physical – Sand is affected by processes of water, wind and marine erosion; grains are moved and sorted by wave and wind energy, carried by river and ocean currents and by wind.
- ★Chemistry – Chemical profiles of minerals (mineralogy), their solubility and other reactions with the environment; what has happened to sand grains during chemical weathering can help us understand environments of the present and past.
- ★Biology – Some sand grains are actually marine life remains, from present day or ancient forms of aquatic life. Beaches can reveal the diversity, abundance and ecology of organisms that dwell in water.
- ★Human uses of sand – From industry to art, and the impacts of human activities on beaches dunes.
- ★And, much MORE

Notes to educators:

- ✧ Sand samples: Obtain sands from your local area; ask fellow teachers, students, family and friends to collect a tablespoon of sand on their travels. These can serve as your core collection. You can also purchase sand samples from earth science educational suppliers, or from on-line sand collection associations. Build your collection further by trading samples, your students can get involved here with your supervision (and parental permission, as needed).

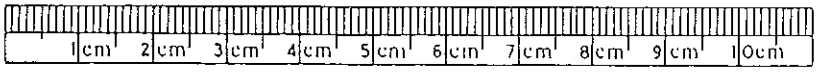
- ✧ Web-based variation: Use virtual collections to augment your classroom sand collection. Using your core collection as reference material, have students frame hypotheses about virtual samples that look similar or different.

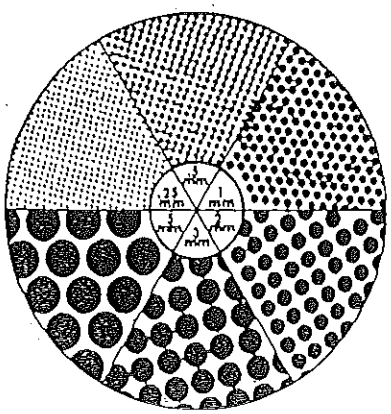
- ✧ **Some basic generalizations apply to exercises in this lab:**
  - **Calcium carbonate composition indicates biological origins of sand grains.**
  - **Degree of sand grain roundness indicates greater weathering, a function of age or distance traveled; composition influences the rate of weathering.**
  - **Sand grain size is positively related to energy of water movement, the larger the grains the stronger the wave movement needed to move them.**

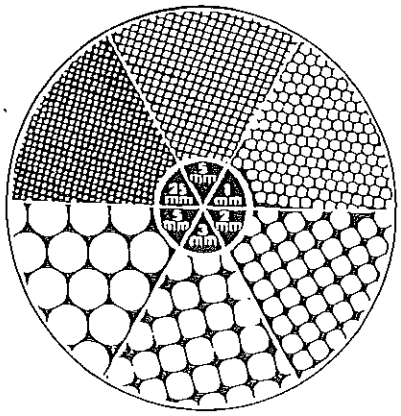
Who studies Sand?

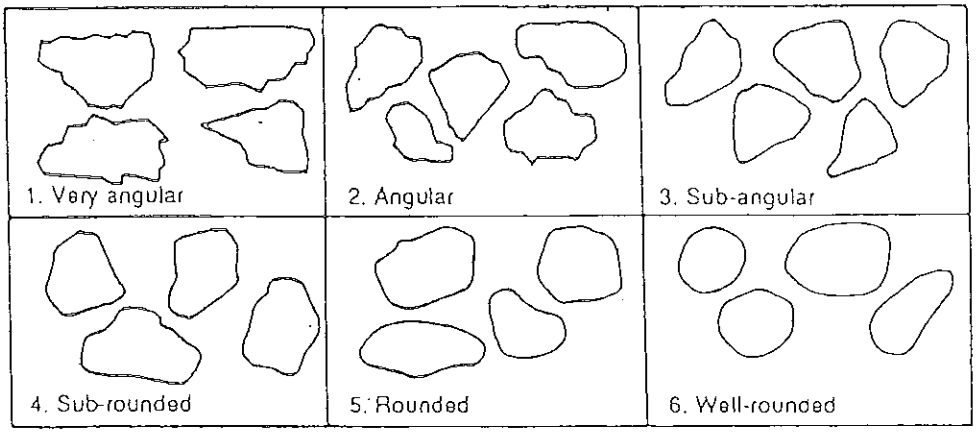
Are there sand experts? Yes! There are earth scientists, oceanographers, and biologists who make a serious study of sand. Geologists that specialize in sand are called *arenologists*. Physical and geological oceanographers may study the way sands and coastlines move. Biologists could be looking at the marine life that contribute to sand, or at sand as a habitat for life forms. There are also amateurs that study sand as a hobby, they are called *arenophiles* or *psammophiles*. Both professionals and hobbyists have contributed to the wonderful sand resources now available on the web.

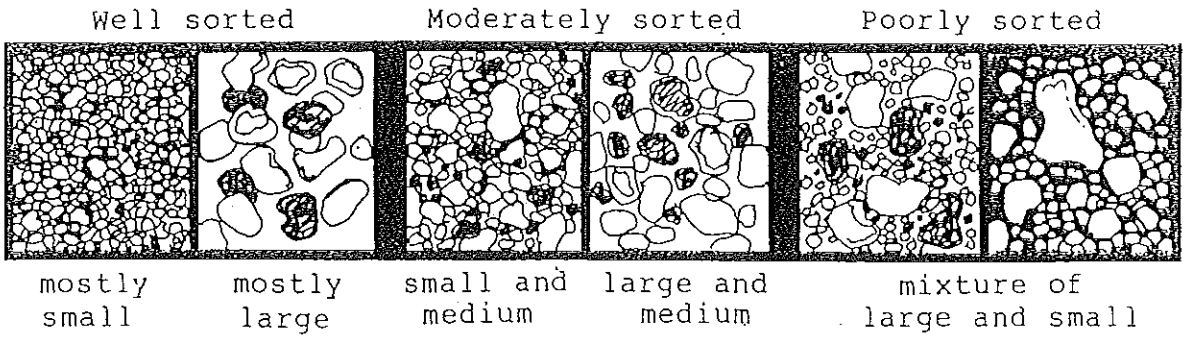
Centimeters (cm); 1 millimeter = $\frac{1}{10}$ centimeter











What can we learn from sand?

Before considering learning activities using sand, here are a couple thoughts about managing sand in an education setting.

1. Cut a good size hole in the middle of an index card. Place clear tape or contact paper on one side over the hole. Then sprinkle sand sample in the hole where the sticky side of tape is exposed. Don't make the sample so thick that you can't easily see individual grains of sand. Label the card with either where the sample came from - or an identifying code (e.g., "A" , "Sample 2", etc.). You now have an easy way distribute samples ready for students to use and store them between uses.

2. Alternatively you could either (a) place the sand samples in sealed petri dishes, or (b) glue to half of a glass microscope slide (with the other half for placing a label).

3. Expand your collection by collecting on your own adventures. But also tell students, colleagues, friends, and relatives. You will be amazed at how quickly your collection can grow. (And you may hear about some great adventures.)

4. Other equipment that may be useful, depending on the activity: hand lenses and/or dissecting microscope (10x or 20x); magnets; weak acid (weak HCl; white vinegar; meratic acid - 1 cup with 4+ cups of water).

Here are some ideas for lessons involving sand.

I. Rock cycle: When teaching about rock cycle, take a few minutes between weathering of rocks and formation of sedimentary rocks to include sediments. Show students different sand samples and ask them to think about where the sand material came from. Have them rub two pieces of sandstone together and look at the particles that are produced. Have them mix sand and glue together to make sandstone-like objects. Help them see sand as a critical part of the rock cycle.

II. Compare and Contract: Have students look at different sand samples and describe how they are different (colored particles, size of particles, shape or smoothness, diversity of particles in each sample). You can also have them report on how they are similar, despite their differences. For example, how are they different from samples you show them of gravel, clay, or non-geological groups.

A. With younger children the focus may be on improving skills of description, recognizing groups and categories, identifying patterns, developing scientific questions and hypotheses.

B. Older students can engage in more complex tasks like those described below.

III. Sorting: Sediments on a beach come in a variety of sizes. If 80+ % of the grains are about the same size the sand is said to be **well sorted.** But if there is a wide variety of sizes it is said to be **poorly sorted.**

Possible reasons to be poorly sorted:

1. Sand moved by a strong river current.
2. Material eroded from a nearby bluff.
3. Material from a landslide.
4. Material from loose glacial till.
5. If it contains a great deal of freshly broken shell material.

Possible reason for well sorted sand:

1. Beach has a limited source of material available to it.
2. Sand from river cutting through sandy terrain
3. Material traveled a great distance and already lost easily weathered materials.
4. Beach is exposed to longshore transport. (Waves have plenty of time to distribute material according to

size and weight.)
Have students observe sand with a hand lens and decide on how well sorted the sample is. Then have them develop a hypothesis about the conditions under which the sand was transported and collected.

IV. **Shape of Sand**: The shape of sand grains can reflect their origin, age, and travel.
Sand shape range from disc-shaped and oblong to almost spherical. They can also vary from sharply angular to very smooth and rounded.
Angular grains indicate that the sand is young, recently broken from its source rock, and the source is nearby. There has not been enough time for the particles to wear smooth or have the less resistant minerals dissolve away.
In contrast, very old grains are well weathered. (called "mature sands"). Only the most resistant minerals remain and the surfaced may look etched or frosted. These grains are smooth and rounded. They have been carried long distances from their source.
The mineral content can make a big difference. Very hard minerals such as quartz round more slowly then softer minerals like calcite that makes up limestone
Have students observe the shape of sand with a hand lens and decide if the same is made of young sand or mature sand. Ask them what it might meant to have a sand sample which contains distinctly different degrees of roundness in one sample. (It would be due to a mixing of grains from two sources.)

V. **Determining general source of sand**: Some simple observations of sand can generally be used to identify whether the sand came from the land or the sea.
Terrigenous sand (from land) come from rocks that have been weather. Many are from weathered granite and contain clear quartz, with smaller amounts of light and dark colored grains. Sands from volcanic rock often are glassy and black, but may include grains that are olive green or brick red. They are made primarily of silica-based minerals and there fore show no reaction to acid.
Sand from the ocean include a large amount of fragments from plants and animals that live in shallow water near shore. Waves coming ashore carry pieces of coral, stony seaweed, seashells, and other parts of sea creatures. (These may be mixed in with continental sand brought to the shore by rivers or near shore erosion.) Much of the **biogenous sands** (from living things) are made of calcium carbonate, which reacts with acid producing small bubble of carbon dioxide gas.
The test: Put a small sample of sand in a small dish and flood with acid. It may be helpful to use a magnifying glass to observe bubbling. If it bubbles the sand contains biogenous grains. If it does not bubble, it is terrigenous. Once students have these results and observe the appearance of the sand grains, have them speculate on the source (e.g., river in middle of continent; shore of volcanic island in ocean; beach along Gulf of Mexico ?).

VI. **Identify Minerals**: Students with more familiarity with types of rocks and minerals can identify the components of the sand. Here are some of the more common components:

Clear or translucent - - quartz
Thin shiny sheets - - - mica
Black, prism-shaped - - - hornblende
Multi-colored grains: pink, gray, white, black - - - granite
pink, tan, peach - - - k- fledspar
black and magnetic - - magnetite
dull black or dark gray - - - basalt

Fragments with many rounded holes - - - coral
Rod or tubular spines in variety of colors - - - sea urchin spines
Fragments of clam, mussel, and oyster shells in a variety of colors

SAND...

Beaches are made up of bits of materials washed onto the shore by waves. Most beaches are made of sand, but sand can be made up of many different things. From beach to beach what the sand looks like depends on many things, including where it came from, what it is made of and how it made its way onto the beach. Every grain of sand has its own sory and history. Each grain is a tiny world in itself!

BE A SAND DETECTIVE!

You will need: some sand, a magnifying tool, pencil, a copy of this lab booklet.

My sand comes from _____ **(if known).**

1. What's in your sand? Look carefully at your sand with the magnifier. Circle the things you think might be in your sand.

Bits of rocks Pieces of shells Pieces of coral

Pieces of glass Pieces of plants

Other things (name them): _____.

2. What color is your sand? Again, look closely with your magnifier. The colors of your sand grains can tell you what rocks or particles your sand is made of. Check off the colors you see in your sand

_____ Clear or frosty white rocks (quartz).

_____ Peach, beige or reddish brown (usually feldspar).

_____ Shiny black (magnetite or basalt). Test for magnetite with a magnet!

_____ Gold, silver or brown (usually mica).

_____ Green (olivine).

_____ Pink to dark red (garnet).

_____ White, pink or milky color (probably pieces of shells or corals).

3. What other colors did you find in your sample? List them.

_____

4. Where do you think your sand ORIGINALLY came from?
The color of a sand grain can tell us about where it came from. Based on the colors in sand, check off where your sand sample might have come from.

_____ Clear, frosty white, brown, gray, silver, red, beige, peach and black grains mixed together come mostly from mountains.

BONUS QUESTION: How do these grains get from the mountains to the beach? _____

_____ All black or green sand is usually from the lava of volcanoes.

BONUS QUESTION: Name one U.S. state with volcanoes _____

_____ White, milky or cream colored grains are usually bits of seashells.

_____ White or pink sand is usually from coral reefs in the ocean.

_____ Brown woody pieces or green sand might be from plants that came from thesurrounding land or ocean.

_____ Colored glass or plastic bits is from human garbage.

5. Sand Shape - Draw a picture of one or two of your sand grains.

6. How old is your sand? When sand first breaks off from rocks, shells or coral it is usually very pointy and rough. As time goes on, the sand grain tumbles around in the ocean getting smooth and round. Smooth round grains are the oldest! Circle the grain shapes pictured below that best matches the grains in your sample. (River sand is often young sand, ocean sand is often old.)

So is your sand young, old or middle-aged? _____Why? _____

_____

7. Surf's Up! Waves wear sand down too. Based on grain shape, check off if you think your sand came from a beach with big, small, or no waves at all.

_____ Big grains of sand are probably from a beach with big, powerful waves that churn up rocks, shells and coral. Big waves also wash away the small grains.

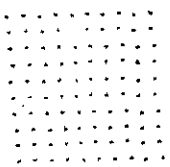
_____ Small grains are probably from a beach with small, gentle waves. Small, fine grains of sand may also be from sand dunes. Wind carries the grains there, but they are generally small and light.

_____ Tiny grains are probably from beaches with little to no wave action.

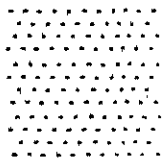
8. How big are your sand grains?

Compare your sand sample to the size charts below. Imagine the black dots are grains of sand. What sizes do you find in your sample? Circle them.

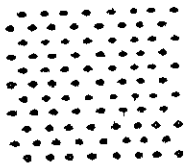
Particles from 0.06millimeters (mm) to 2.0mm are considered to be sand.



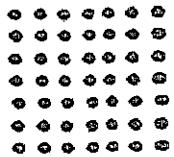
Size 2
0.25 mm



Size 3
0.5 mm

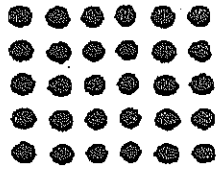


Size 4
1.0 mm

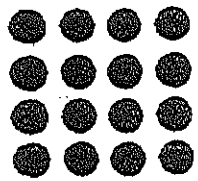


Size 5
2.0 mm

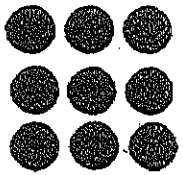
Particles larger than 2.0mm are considered gravel.



Size 6
3.0 mm



Size 7
5.0 mm



Size 8
7.0 mm

9. **Do you have mostly sand or gravel?** Draw a picture of your sand grain sizes in the box.

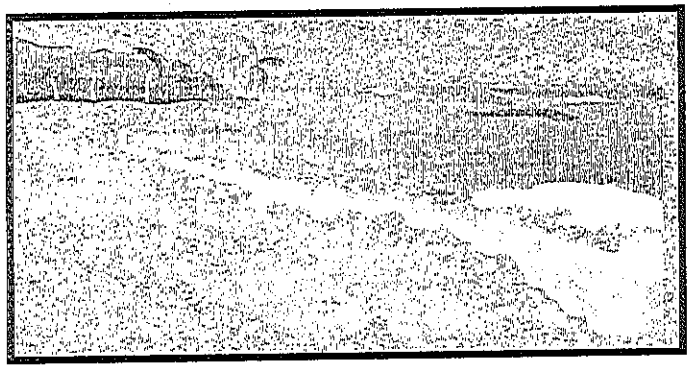
10. **Feel the beachy breeze!** Wind can break up sand particles and make them more round, smooth and all about the same size. Is your sand from a windy beach or a beach with little wind?

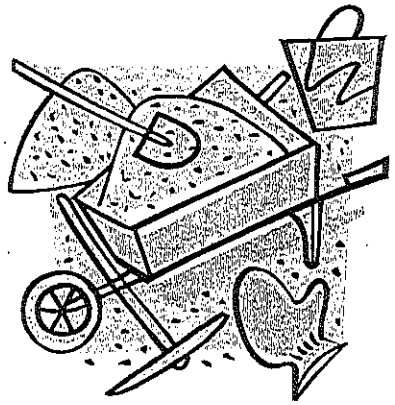
_____ Yes, my sand grains are mostly the same size, my sample came from a windy beach!

_____ No, my sand grains are all different sizes, my sample came from a beach with little wind.

This activity booklet was created by the staff of the Education Program at the NJ Sea Grant Consortium. Look for our other projects all about the sea at
www.njseagrant.org

The Science of SAND





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