Lab to find the hidden treasure: The Sands of Time

Backstory:

In 1763 a sailing ship, the **St. Francis**, carrying gold and silver bullion from Columbia was blown off course and in a terrible storm that may have been the edge of a hurricane, sank off of the coast of Georgia.

3 people survived by hanging on to a large piece of wood. They were the cook - Barnaby Wells , a ship's boy - Theodosius Delmarra and a native woman – Izrana, who had been a maid to a noble Spanish woman of the powerful Orozo family. They washed up on a small island and were lucky enough to be picked up a year later by a passing ship that had put in to get some fresh water. By then the native woman also had a baby with her.

When the baby grew up, he swore he knew where the ship had gone down. His descendants live in Georgia and the surrounding states.

Scenario:

Four pawn shops in the Brunswick area have been found to contain plates and crockery that display the Orozo family crest, of a phoenix arising out of its bed of flames. The pawnshop owners displayed these items for about 200 to 800 dollars.

A student from the College of Coastal Georgia (CCGA) had noticed one and informed his History Professor, Dr. John Wells. Wells had immediately gone to go and look at the plate and then after canvassing the area found 3 more pawn shops with plates displaying the Orozo family crest. He sent 4 students with money to each shop, to buy a plate. Back at the university he knew enough to know that these were genuine.

He went back to the first pawnshop and interviewed the manager. He used his real name and asked the man if he would tell him who had left the plate with him. The man was happy to tell him that a young man, of about 23, thin, about 6ft 1in, with dark sun streaked blond hair, a small goatee, dressed like a surfer dude and with a typical sunburned appearance, had left the plate with him. He did have his address and gave it to the professor. The next 2 shops had the same information. The last pawnshop said that the bowl had been left by a tall dark haired woman in her middle 20's. They all agreed that the both the guy and the girl had a local accent and both had left the same address with all 4 pawnshops.

Now John was pretty sure that the plates had come from the wreck of the St. Francis, so he was pretty excited as nothing had been seen or heard of that wreck for 250 years. He thought that a recent hurricane had perhaps moved it slightly so that it had become accessible.

So he contacted a friend of his, who worked for the coastguard, Will Delmarra. A phone call from the first pawnshop stopped them, from leaving. A new piece had appeared and was the professor interested in buying it? It was a salt shaker and in good condition. The price was now $400, but the professor agreed and bought it. This time the seller had been the dark haired woman.

Both men agreed that it was time to visit the address and see if it was a real one. They looked it up on Google maps and it was a small house in a quiet blue collar area. It only took 20 minutes and they were outside and knocking on the door. A woman answered and John gave the woman his card and she invited them in.

There were 4 more plates with the Orozco family crest on the dining room table.

The woman said that her name was Joanna Israna and her brother David, who looked like her dad was missing. He had been gone for about a day and a half and she was now beginning to get worried about him.

She explained that an old family secret that had been handed down for generations had told them the area where the boat was. Unfortunately it only allowed them to guess between one of 4 places. David had not yet told her which one was the correct one! John still had the salt shaker. He very carefully opened it and although there was no salt in it, it was half full of sand.

Will then took over and asked her for the four locations. There had been a storm last night and perhaps her brother had been caught in it. He was a diver, but it was dangerous for divers to dive alone. Each of the 4 places had an island near to it, where David could have sought shelter.

So now they needed to find the correct place to look for the missing brother and to find the shipwreck that John knew also contained gold and silver bullion.

Back at the university John contacted an Oceanography professor, Emilio De Oros and he was able to say that each of the 4 areas had different sand.

So to save the brother and find the treasure you will need to identify which of the 4 places this sand came from.

How to set up for the lab!

You need at least 4 different types of sand and they can be very different or even better not much different. At least two of them need to be very similar but still different. Preferably the same color but not the same size grains or mix of grains or angularity.

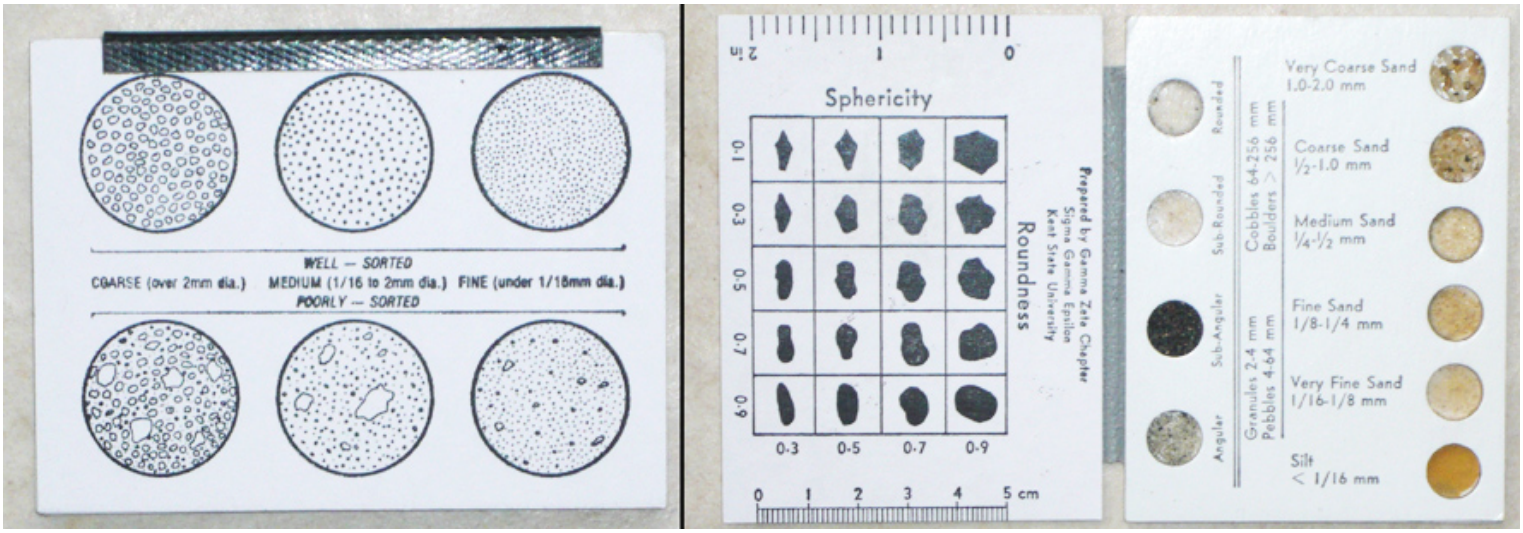
Where do you get sand from? There are a number of places that have sand. Amazon.com has the most varieties to choose from. Pet Stores, Lowes, Home Depot and Sand & Gravel companies. Try to make sure that you do not order sand that has been colored. Many sands have a typical color, like pink or red or green or black. Most sands that are easy to get, are a light tan to whitish. You may wish to get a small sized gravel and a large sized silt to give your students a good size range.

Video: This approximately 3 minute video will explain where sand comes from.

http://www.ehow.com/video_4997351_different-types-sand.html

Do not use the YouTube video on Parrotfish, it will confuse the students. Yes some sand is Parrotfish poop! Only near coral though!

You will also need the Pocket size sand Grain sizing folder or the comparator (see below on the next page).



The Pocket-Size Sand Grain Sizing Folder could be the solution. Is available from the Geological Society of America or directly from SGE* at Kent State University for a bargain price. It's a very visual reference for several ways of describing sand, first of all, of course, size. Size is the *only* character that defines a granular material as sand, and the size categories (from "very fine" to " very coarse," much like sandpaper grades) progress in multiples of two – 1/16 to 1/8 mm, 1/8 to 1/4 mm and so on up to 1.0 to 2.00 mm – simply

because nature works in multiples rather than linearly (think of a square versus a line, a cube versus a square). Anything finer than very fine sand is silt or mud, and things coarser than very coarse sand, are granules, pebbles, cobbles, and boulders.

Without Glued-On Grains That Wear Off, Chart Stands up to Repeated Use

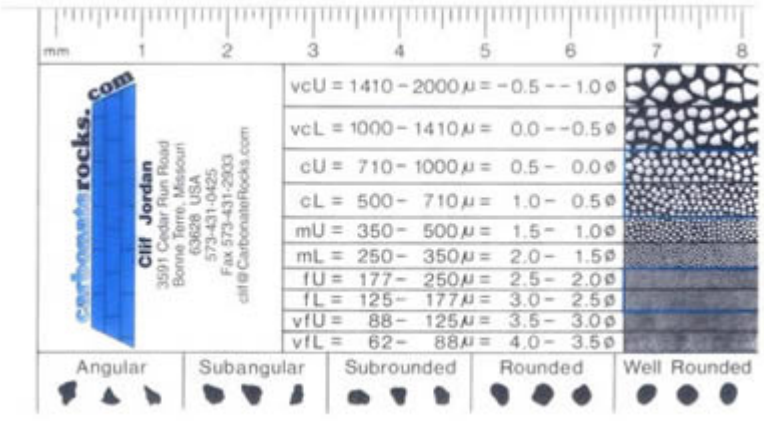
This translucent plastic comparator lets you quickly identify grain sizes; simply hold the comparator over the sample and match it to the graduated scale.

The business-card-size chart includes

- Millimeter scale
- Angularity chart
- Grain sizes in phi scale from -1.0 to +4.0
- Micron scale from 62–2,000
- Very coarse upper to very fine lower.
- Package of five.

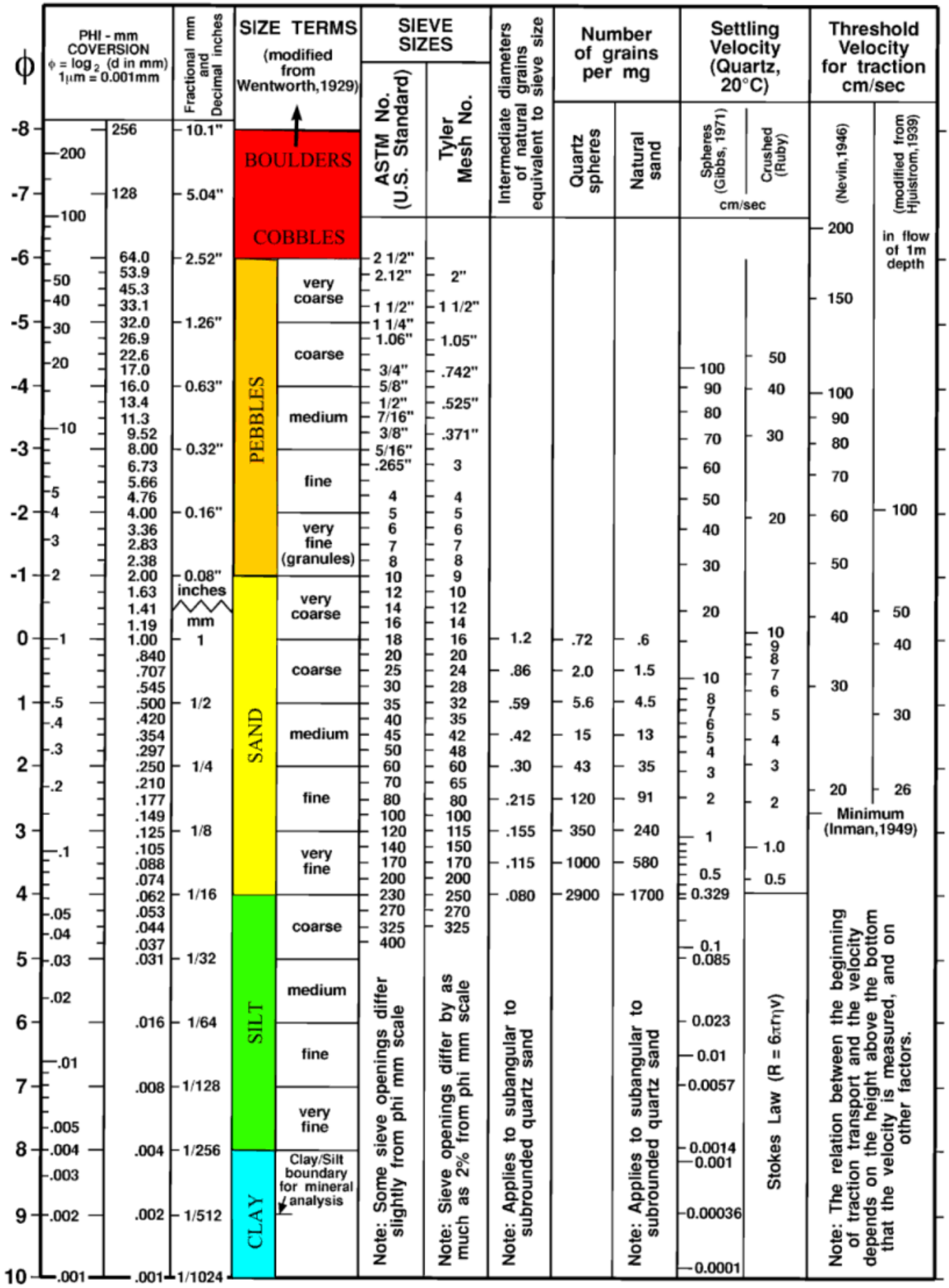
The Sediment comparators above from Wardsci are a bit expensive, but good as they are translucent.

12 V 0010 Sediment Comparators, Pkg. of 5 $22.50



The comparator above is much cheaper and is from carbonaterocks.com

The chart on the next page may be useful if you wish to explore settling rates as a way to identify a sand.


φ
PHI - mm COVERSION
φ = log2 (d in mm)
1μm = 0.001mm
Fractional mm and Decimal inches
SIZE TERMS
(modified from Wentworth,1929)
SIEVE SIZES
ASTM No. (U.S. Standard)
Tyler Mesh No.
Intermediate diameters of natural grains equivalent to sieve size
Number of grains per mg
Quartz spheres
Natural sand
Settling Velocity (Quartz, 20°C)
Spheres (Gibbs, 1971)
Crushed (Ruby)
cm/sec
Threshold Velocity for traction cm/sec
(Nevin,1946)
(modified from Hjulstrom,1939)
in flow of 1m depth
BOULDERS
COBBLES
PEBBLES
very coarse
coarse
medium
fine
very fine (granules)
SAND
very coarse
coarse
medium
fine
very fine
SILT
coarse
medium
fine
very fine
CLAY
Clay/Silt boundary for mineral analysis
0.08" inches mm
Minimum (Inman,1949)
Note: Some sieve openings differ slightly from phi mm scale
Note: Sieve openings differ by as much as 2% from phi mm scale
Note: Applies to subangular to subrounded quartz sand
Note: Applies to subangular to subrounded quartz sand
Stokes Law (R = 6πηv)
Note: The relation between the beginning of traction transport and the velocity depends on the height above the bottom that the velocity is measured, and on other factors.

Materials:

Magnifying glass, 4 types of sand. Original sand from the salt shaker (use a real salt shaker).

Index cards, scissors, sediment comparator, very clear scotch tape. Light from lamps, windows, or a torch (flashlight).

Extra: Binocular microscope or Comparison microscope

Safety:

The sand should not be small enough to cause sand in the eyes from breathing on it. Silt should also not cause this problem. Make sure that the sand does not have smaller particles in it, by allowing the sand to run from one hand to another. If a slight cloud forms then this sand should not be used!

Scissors should be used safely, as usual.

Use an apron. Goggles should not be necessary

Procedure:

1. Get an apron and put it on.
2. Working with a partner, get the equipment listed in the Materials
3. Get 2 small index cards and cut them into 5 strips.
4. Cut a small hole in each of the strips that is not larger than the width of the scotch tape.
5. Place a piece of scotch tape over the hole in the index card.
6. Take a pinch of sand and sprinkle over the glue side of the scotch tape on the index card. Do not over sprinkle!
7. Use the magnifying glass to compare angularity with the sediment comparator. Write your results in the results table
8. Compare the color. Look at the grains using some light behind the scotch tape. Holding it up to a window or the fluorescent lights in the ceiling will work. Write your results in the results table
9. Compare the size using the sediment comparator. Put your results in the results table.
10. Are there any shells or parts of shells in any of the sands?
11. Count 10 grains near each other. How many of them are clear or light grey. That is the percentage of Quartz in the sample after you put a zero on

the number. Put your results in the results table! (If you count a hundred grains instead of ten your results will be more accurate).

12. Now count the number of pink or light brown grains in the same sample, that is the percentage of Feldspar in the sample, after you add a zero. Put your results in the results table!
13. **Clear away** neatly. No sand should be left lying on tables!!!!!!!
14. Look at your results and decide which of the sands, is the same as the sand from the salt shaker. Answer the questions at the end of the paper. You can now go and find the missing brother and the treasure ship.

Results Table:

Characteristics	Sand 1	Sand 2	Sand 3	Sand 4	Treasure Sand in salt shaker
Angularity					
Color					
Size					
Percentage of Organic material					
Percentage of of Quartz					
Percentage of Feldspar					

Conclusion Questions: *Use a real sentence to answer each of these questions*

1. Which of the sands is the same as the Treasure sand?

2. Why do you think that the size of the grains is more important than the color?

3. Did all of the sands have the same angularity? Which ones had similar angularity?

4. Which sands had similar color?

5. Which sand was least like the treasure sand?

6. Did any of the sands have parts of shells in them? Which ones?

7. Could you have done this lab better? What could you have done to get a better result?

Map of Georgia Showing the coastal area

The map above does show that there are a number of islands off of the coast of Georgia!

Here are the Michigan Science Content High School expectations for this lesson.

E1.1B Evaluate the uncertainties or validity of scientific conclusions using an understanding of sources of measurement error, the challenges of controlling variables, accuracy of data analysis, logic of argument, logic of experimental design, and/or the dependence on underlying assumptions.

E1.1C Conduct scientific investigations using appropriate tools and techniques (e.g., selecting an instrument that measures the desired quantity—length, volume, weight, time interval, temperature—with the appropriate level of precision).

E1.1D Identify patterns in data and relate them to theoretical models.

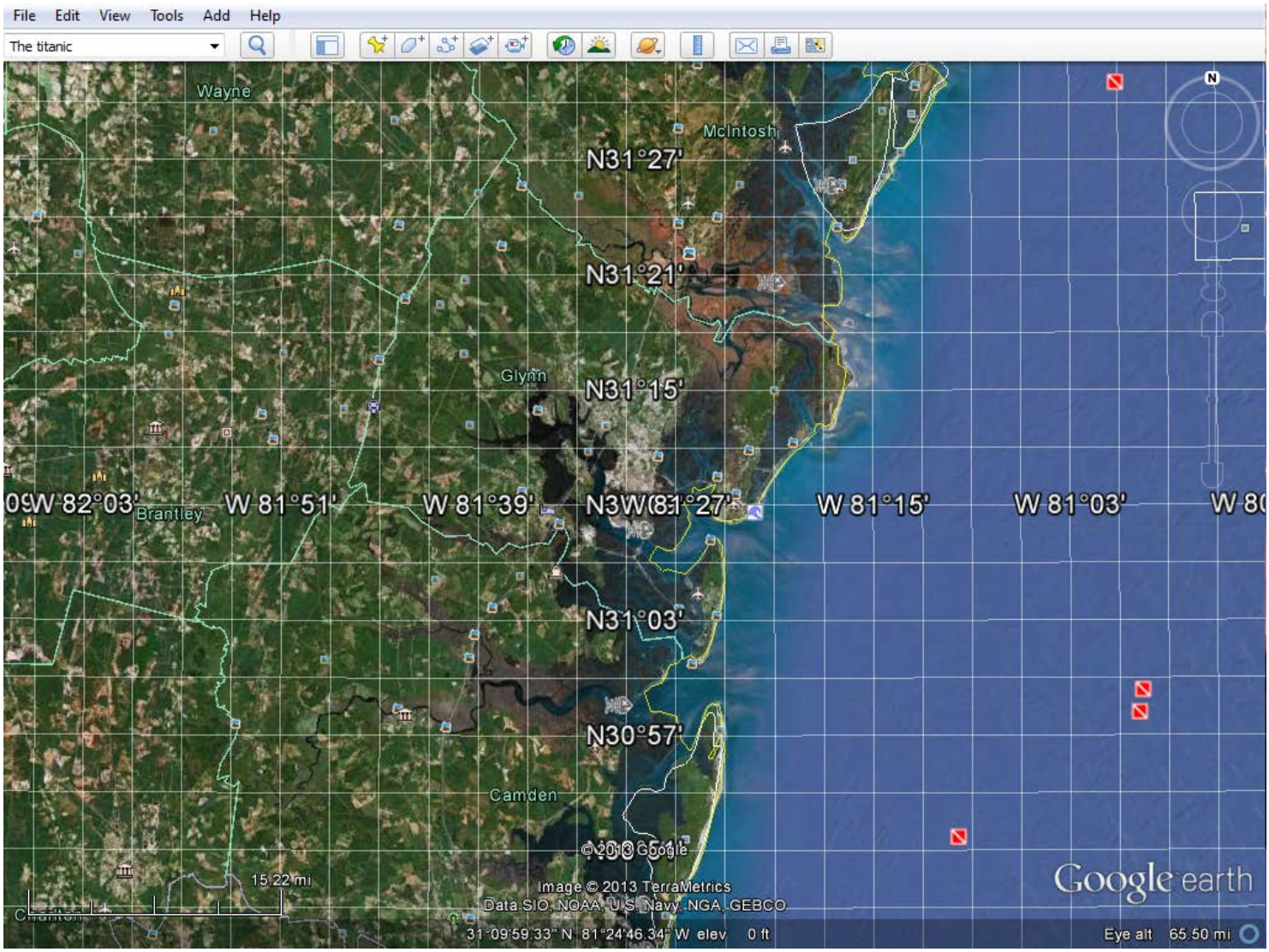
E1.1E Describe a reason for a given conclusion using evidence from an investigation.

E1.2C Develop an understanding of a scientific concept by accessing information from multiple sources. Evaluate the scientific accuracy and significance of the information.

Extension, Notes & Tips:

This can be regarded as a Forensic Geology/Oceanography lesson.

This can be a stand alone lesson, but it is more likely to be of use if it is connected to a series of lessons.



1. It should not be too difficult to make a map of an area off of the coast of Georgia, with a cross grid that contains latitude and longitude co-ordinates, with 4 or more islands on it. You may have to draw islands on it using PAINT from the programs section of your computer.
2. The above map is copied from Google Earth. Use the Print Screen and then paste (control V) to the paint window. The latitude and longitude lines are added in Google Earth in the View drop down top Menu.
3. The extent of underwater sands could also be marked in. After all we have to pinpoint the location of the island for the coastguard to go and ‘save’ the brother, who we presume has managed to reach the nearest Island to the sunken treasure.
4. An overturned boat floating at a specific latitude and longitude would be added and other details could be included so that the students would have to mark in details on the map by latitude and longitude. Examples would be reefs, masts sticking out the sea and other sunken materials at places where the sea floor is close to the surface.

5. A number of buoy's would also be useful. Ones that the brother had already set. Marking the ship or at least the place where crockery had been discovered by him. The ship itself containing the gold bullion may not yet itself have been found. It could be buried in the sands or even underneath a later sunken wreck.

6. Finding sunken ships and their latitude and longitude is yet another lesson that can stem from this exercise. Google Earth has sunken ships labeled in both lakes and seas.

7. The Ruler function at the top of the screen can then also be used to measure in miles or kilometers from a wreck to the nearest main city or the nearest land.

8. Looking at the sands that Hawaii and other places produce as breakdown products of erosion and weathering is another direction to go.

9. The production of coral reef sands by the excretion of coral rock by Parrotfish is another interesting direction and the formation of coral islands, could be part of this.

10. One other little tip! Take a few shells (you can get them online if you have none at school), Break them into a pestle and use a mortar to grind them to about the same size as your sand is. Then add them to at least one of the sands to give it 'organic content'. Your sand may of course already have some organic content, but if not it will easily give the students a chance to see what shell fragments look like using a magnifying glass and how they look different to the quartz and other grains.

I hope that you enjoy this exercise as much as I did making it!

M. Clive Wardell – March 2013