GPS Technology and Phosphate Mining

Introduction:

"Florida's typical phosphate ore (matrix) is found about 15-50 feet below the earth's surface and is about 10-20 feet thick. Draglines strip off the top layer of earth (known as overburden) to get at the matrix, which is then processed to separate the phosphate from the sand and clay that make up this layer of Florida."

Planning for a phosphate mine begins with prospecting, where overburden depth, matrix depth, and matrix quality are determined using core samples. Typically this kind of core sample is drilled on a 330' grid—one core sample per 2.5 acres. Each core sample is logged, tagged and sent to a pilot plant for further analysis. There the quality of the phosphate matrix is determined. The data is recorded and section maps are created to serve as guides for dragline operators.

Core samples are analyzed and mapped providing a guide for dragline operators to precisely dig phosphate deposits. GPS technology increases mining efficiency by tracking equipment and shovel and drilling positioning. This lesson allows students to become familiar with GPS technology and practice using GPS receivers. The activity is a simulation of a technique used by the mining companies to efficiently find and remove phosphate ore. Students will utilize their knowledge of directional coordinates- latitude and longitude as learned in courses such as social studies, geography, and physical and earth sciences. Students will also practice using the metric system. Students can take the skills they learn in this activity and apply them to other courses that use GPS technology.

Activity:

Student teams use a GPS receiver to navigate to the core sample target. At the target site, students remove the core sample. They measure and record the layers of earth; limestone, matrix (phosphate deposit), and overburden. After completing the chart by measuring all six bottles—they return to the classroom where they will draw a sectional core sample map of the layers of earth.

Standards:

SC.H.1.3.3	SC.H.1.3.4	SC.H.3.3.7	
SS.6.G.1.1	SS.6.G.1.4	MA.7.A.1.1	SC.7.N.1.1
MA.912.A.2.5	MA.912.A.2.1	MA.912.A.2.2	
SC.912.N.1.6	SC.912.N.3.5	SC.912.N.4.2	

Objectives:

- Use a GPS receiver to locate given waypoints on school grounds—the locations of core samples
- Record data measurements from each core sample
- Using the data collected they will draw a sectional phosphate ore location map

1855 West Main Street • Bartow, FL 33830-7718
(863) 534-7160 • Fax (863) 534-7165 • www.fipr.state.fl.us

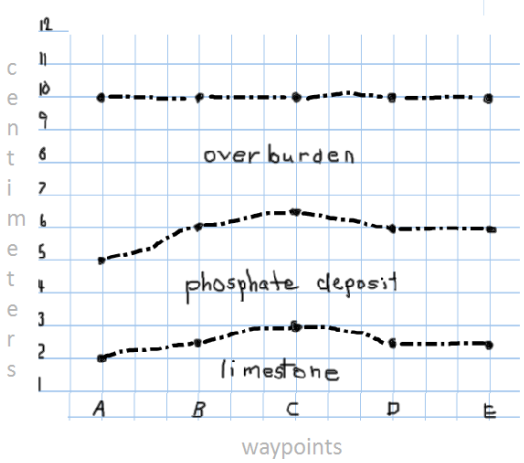
- Analyze their drawings to determine the approximate depth of the simulated phosphate deposit.
- Understand how a dragline operator analyze data from a sectional core map to know where to dig for phosphate
- Understand how GPS technology is used to make maps of phosphate deposits

Vocabulary:
matrix
overburden
prospecting
GPS (Global Positioning System)
core sample
simulation
latitude
longitude

Materials:
Set of GPS receivers
Extra AA batteries
Guide for Location Waypoints Using Garmin eTrex Receivers
Centimeter grid paper (1 per student, used in classroom)
Pencils
Clipboards
Venn diagram Compare/Contrast GPS Units
Core Sample Data Chart worksheet (per group/team's field work)
Meter stick to measure distance between waypoints
Centimeter ruler for each team

Procedure:
1. Read over your copy of *Guide for Location Waypoints Using Garmin eTrex Receivers*
2. Using the Venn diagram, as a class, compare and contrast the GPS Units that will be used today with the GPS units the students are probably more familiar with that they see used in the car. (Hold up pictures)
3. With your team, move towards to the first waypoint A core sample target.
4. When the sample has been pulled from the ground measure, in centimeters each layer starting from the bottom of the bottle.
5. Record the depth of each layer on the *Core Sample Data Chart*. Rebury the core sample for the next group
6. Using the GPS, located waypoints B, C, D and E. Student may want to rotate so that every team is not tracking the same core sample at the same time.
7. Measure in centimeters each layer starting at the bottom of the bottle for each core sample found. Rebury the core samples for the next group.
8. When teams have completed the chart, they return to the classroom to make the section map on centimeter graph paper.

9. Complete a map. Label centimeters on the left of the map (Y-axis) and the waypoints (A, B, C, D, and E) on the bottom of the map (X-axis). Place a dot for each corresponding plot (hint- you are making a scatter plot for the 3 different layers)



Data:

Fill out attached Data table

Make a map on centimeter graph paper attached

Assessment:

1. Where does the bottom of the phosphate deposit lie at waypoint A, B, C, D, and E.
2. Determine how deep it is from the top of the overburden.
3. Where does the "thickest" deposit lie—between what two waypoint locations?
4. Use the Core Sample Data Chart to average the depth of the top of the deposit. (see example below)
5. If each centimeter represents one meter of actual depth, ask what is the average depth to the top of this phosphate deposit?
6. If each centimeter grid mark between the waypoints represents 10 meters, what is the length of this cross section of core sampling?
7. Why are core samples taken rather than just starting the mining process without prospecting?
8. Why do we use models and simulations when mapping a large areas?

Extensions:

1. Use the GPS units to compare the latitude and longitude of the school to other world landmarks
2. Do a similar study using GPS units to find coordinates, collecting water samples from different sites and testing for nutrients such as phosphates.
3. Use this activity to demonstrate the difficulty in finding rare minerals and earth elements which can lead to a lesson on the use and application of these elements as

well as the demand for the limited supply. Scientific, social, political, and economic implications can be explored. (See current FIPR Institute research)

4. Have students brainstorm and test different ways in making this activity more efficient
5. Have students use and test each others' mapping skills by creating a GPS based scavenger hunt on campus.

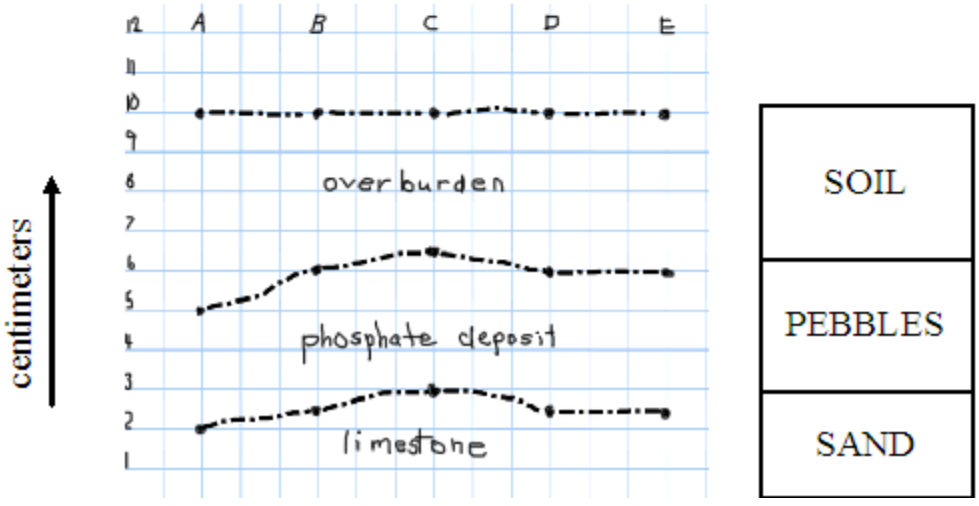
Core Sample Preparation
(Teacher Instructions)

For each team, fill up to 5 clear plastic 16 oz. water bottles with three different materials that indicate limestone bedrock, phosphate matrix and overburden /soil.

1. Label each bottle A, B, C, D, or E.
2. Use sand for the limestone layer measuring around 2-3 centimeters from the bottom of bottle.
3. Use aquarium gravel for the next layer measuring around 4-6 centimeters from the top of the sand—colored gravel would work well.
4. Use topsoil or potting soil to represent the overburden. This layer could measure all the way to the same level on each bottle, about 15 centimeters from the bottom of bottle.
5. Measure and record the levels for answer key.



6. Partially bury core samples in the ground at each waypoint—going in a straight line about 5 – 8 meters apart.



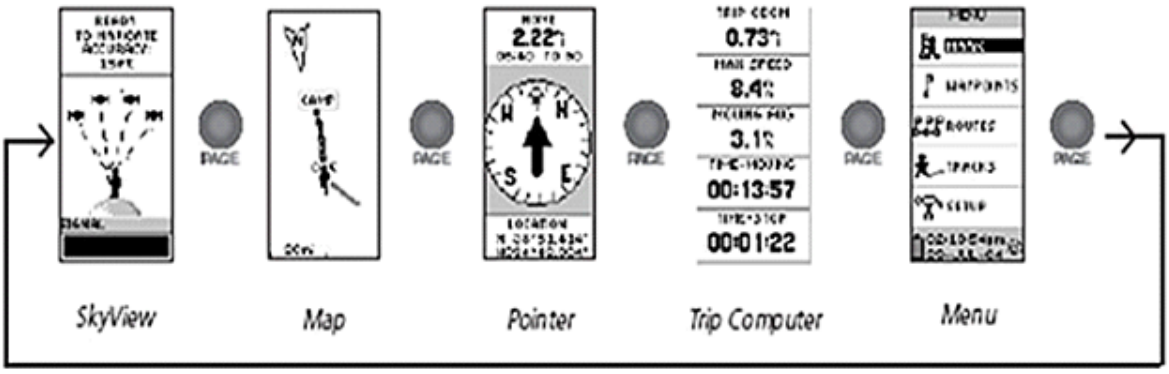
7. Record the latitude and Longitude of each core sample and put on the data table before distributing to students.

Guide for Locating Waypoints Using Garmin eTrex Receivers

(adapted from eTrex Manual)

Selecting a Page

There are five main pages or display screens: SkyView, Map, Pointer, Trip Computer, and Menu. Press the PAGE button to switch between these pages.



Marking Waypoints

The first step in the exercise is to mark your location as a waypoint.
(NOTE: The unit must be "READY TO NAVIGATE" before you mark a waypoint.)

To mark a waypoint:

- Press and hold the **ENTER** button to activate the MARK WAYPOINT page.
- The waypoint is assigned a numeric name at the time it is created. You could press ENTER and save the waypoint now, but for this exercise, you will make some changes to the waypoint first.
- The eTrex comes equipped with 31 different waypoint symbols that can be displayed on the map to help quickly identify the waypoints.

To change the waypoint symbol:

- On the MARK WAYPOINT page, press the **UP** or **DOWN** button to highlight the waypoint symbol (above the waypoint name), then press **ENTER**.
- Press the **UP** or **DOWN** button to scroll through the symbols and highlight the house symbol. Press **ENTER**.

Guide for Locating Waypoints Using Garmin eTrex Receivers (Continued)

Renaming Your Waypoint

The name can be up to six characters in length. For this exercise, you will name the waypoint "HOME".

To change the waypoint name:

- On the MARK WAYPOINT Page, press the **UP** or **DOWN** button to highlight the Waypoint
- Name '001.' Press **ENTER.** The EDIT WAYPOINT NAME Page appears.
- Press **ENTER**. Press the **UP** or **DOWN** button to scroll through the letter selections.
- Select 'H' and press **ENTER**. Repeat this process and finish the word 'HOME'.
- Press the **UP** or **DOWN** button to highlight the 'OK' field, then press **ENTER**. The MARK WAYPOINT Page appears.
- Press the **UP** or **DOWN** button to highlight the 'OK' field, then press **ENTER**. Your location, named HOME, is now marked and stored in memory.

Now that you've marked your location, it's time to go for a walk. Press the PAGE button and switch to the Map Page. Walk in a straight line for 2-3 minutes at a moderate pace and watch the Map Page. Your location is shown by the figure in the middle of the screen. As you move, the animated figure walks and a line—called a "track"—appears along the path you have just covered. If you do not see the animated figure walk, you may need to zoom in closer by pressing the DOWN button. Now take a sharp right or left turn and walk for another 2-3 minutes.

GOTO function.

The GOTO function provides you with a straight line navigation path to your selected destination.

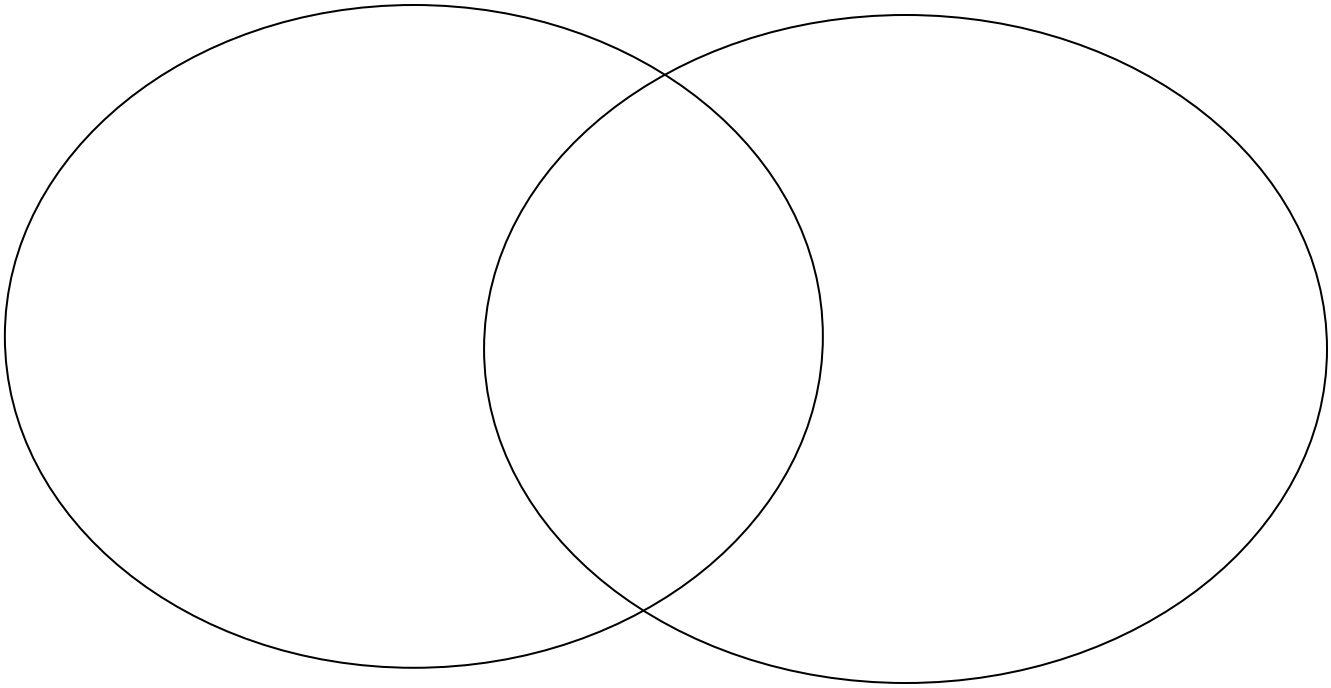
To start a GOTO:

- Press the **PAGE** button to switch to the MENU Page.
- Press the **UP** or **DOWN** button to highlight 'WAYPOINTS', then press **ENTER**. The WAYPOINTS Page appears.
- Press the **UP** or **DOWN** button to select the tab containing 'HOME', then press **ENTER**.
- Press the **UP** or **DOWN** button to select 'HOME', then press **ENTER**. The REVIEW WAYPOINT Page appears.
- Press the **UP** or **DOWN** button to highlight 'GOTO', then press **ENTER**.
- The Compass Page appears and you're ready to begin navigating!

Venn Diagram:
Compare and Contrast
GPS Units

Garmin eTrex
Receiver

Vehicle/Portable GPS unit (Tom Tom, Garmin, Magellan, etc)



https://buy.garmin.com/shop/shop.do?pID=6403

http://www.tomtom.com/en_us/products/


Broadway
TRIBECA NY
Church St
W Broadway
Chambers St
Hudson St
0.20
2:50
5:25
25
30
tomtom


Oregon

Core Sample Data Chart

	Waypoint A Lat._____ Long._____	Waypoint B Lat._____ Long._____	Waypoint C Lat._____ Long._____	Waypoint D Lat._____ Long._____	Waypoint E Lat._____ Long._____
Measure the height of the "overburden" layer in cm. (soil)					
Measure the height of the "phosphate matrix" layer in cm. (gravel)					
Measure the height of the "limestone" layer in cm. (sand)					

Core sample instructions.

1. Record the latitude and longitude where the core sample was found.
2. Measure, in centimeters, from the bottom of the bottle to the top of the "limestone" layer (sand) and record the depth in the corresponding box.
3. Measure from the top of the "limestone" layer (sand) up to the top of the "phosphate matrix" layer (gravel) and record the depth in the corresponding box.
4. Measure from the "phosphate matrix" layer (gravel) up to the top of the "overburden" layer (soil) and record the depth in the corresponding box.
5. Make sure and measure and record the depths for each core sample in order.

Adapted from Teresa Urban's Phosphate Mining: Borrowed Land Unit