INVESTIGATION

1

Field Studies n Extended Projects

Project

INTRODUCTION

One of the major goals of this course is to let you conduct field studies or experiments that demand much more extended periods of observation than you have previously experienced. Investigation 1 is designed to give you rich ideas for choosing such an extended project and some simple guidelines to get started.

In most of your previous science classes the labs have been one or two class periods in duration, and you followed a detailed set of directions. In this course you will have the opportunity—and the challenge—of designing your own experiment or long-term study. Through these explorations you will better learn to:

- Observe environmental systems in detail
- Design and execute well-planned experiments
- Design and implement well thought out tables of data for organizing and collecting information
- Use proper techniques and equipment
- Draw conclusions based on your observed data and calculations
- Write a clear and concise report of your findings and why they support your conclusions
- Propose ways to extend your results by means of further study

Read carefully through all 12 suggested projects before choosing. Several are actual extended outdoor activities where you will collect data in the field and draw conclusions. Others will require you to analyze a system to look for patterns and some require you to keep a journal of observations over an extended period of time.

These inquiries can be tried in any order at any time of the academic year. However, it is recommended that local climate conditions dictate when some of the outdoor exercises are attempted. Most of the projects can be carried out indoors with a minimum of special equipment.

Stream Water Quality and Macroinvertebrate Population Comparison

PURPOSE

- Measure water quality conditions in a local stream or river
- Collect macroinvertebrates and correlate the fauna to stream conditions

Materials

- test kits (or CBLs) and other tools to measure:
  - water depth
  - rate of flow
  - turbidity
  - dissolved oxygen
  - pH
  - nitrates
  - water temperature
- kick net
- camera and/or drawing materials

Fig. 1-1

The abundance and kinds of macroinvertebrates populating a body of fresh water are good indicators of its overall water quality.

Procedure

Step 1 Using test kits or CBLs, measure the water depth, rate of flow, turbidity, temperature, pH, dissolved oxygen and nitrates in a stream on a regular basis. It is recommended to do so once a month through the spring. (*Note:* See Investigation 12 for a review of materials and procedures for these and related water quality tests.)

Step 2 After reading through this procedure completely, design a data table to record your observations and all test results over the study period.

Step 3 Record the conditions of the stream. Use methods such as:

- Drawing a map or taking a picture of your testing site.
- Describing what the banks are like. Are they stable? eroding? undercut? Does the water reach the base of both banks? Is the water variable over time?
- Describing the vegetation. Are the banks covered with vegetation? Does the vegetation cover the stream?
- Recording the surroundings. Are the banks wide or close to roads, buildings, parking lots, clear cuts, etc?
- Examining the stream bottom. Is it muddy, rocky, or covered in sediments?
- Analyzing any engineering. Are there bridge abutments, rip-rap, culverts, etc?
- Observing what the channel is like. Is it straight? If curved, how much so?

Step 4 Use a kick net to collect macroinvertebrates at your test site.

Step 5 Record the types of macroinvertebrates you collected and their numbers.

(Macroinvertebrates are good indicators of stream water quality. For example, stone flies, caddis flies and hellgrammites indicate good water quality; crawfish and sowbugs can be found in water of fair quality; and leeches and some snails are indications of poor water quality.)

Step 6 Graph your measured water quality data. Try to correlate these data to the macroinvertebrates you collected. Does your water testing bear out these indicators? Why or why not?

1-2 Comparison of Daily Weather Data with Microclimate Data

PURPOSE

- Collect weather data at the microclimate level and compare and contrast to the weather conditions reported locally

Materials

- instruments to measure:
  - air temperature
  - wind speed and direction
  - relative humidity
- Internet access

Procedure

Step 1 Go to a Web site that gives the local weather for your school area. One possibility:

http://www.weather.com

Step 2 Using your own weather instruments, measure the temperature, the wind speed and direction, and the relative humidity at several locations around your school grounds. At each site, measurements should be taken at ground level and at 50 cm and 1 m above ground level.

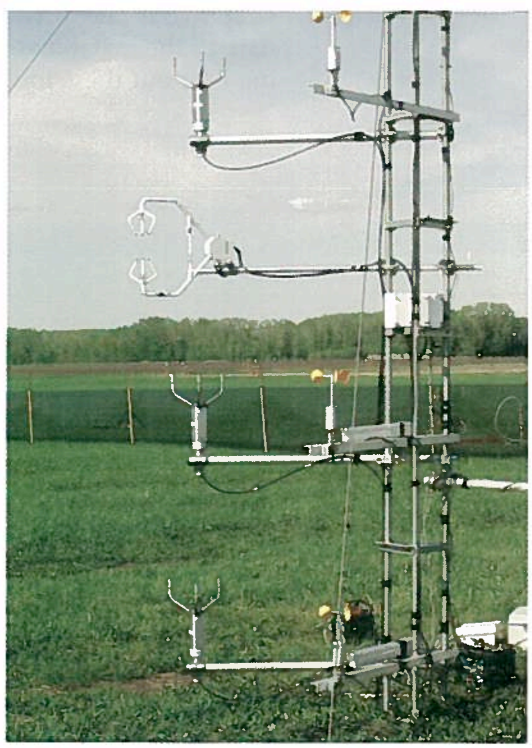


Fig. 1-2: Ground Level Weather Monitors

Step 3 After reading through this procedure completely, design a data table to record your information.

Step 4 Describe each location where you recorded your measurements. Include observations such as:

a. Is this spot in the open? Are there buildings, trees, or land forms that would influence your measurements?

b. What is the ground cover like—vegetation, soil, concrete, blacktop, brick, or other?

c. Are there any organisms that live in the immediate test area? Do they vary from site to site?

Step 5 Analyze your results.

a. Do the data implicate micro-climate involvement?

b. Do the measurements in different locations vary? If so, how and why?

c. If the area of your measurements is covered with vegetation, does it vary with location? How could the vegetation be related to the local conditions?

Hurricane Tracking and Prediction

PURPOSE

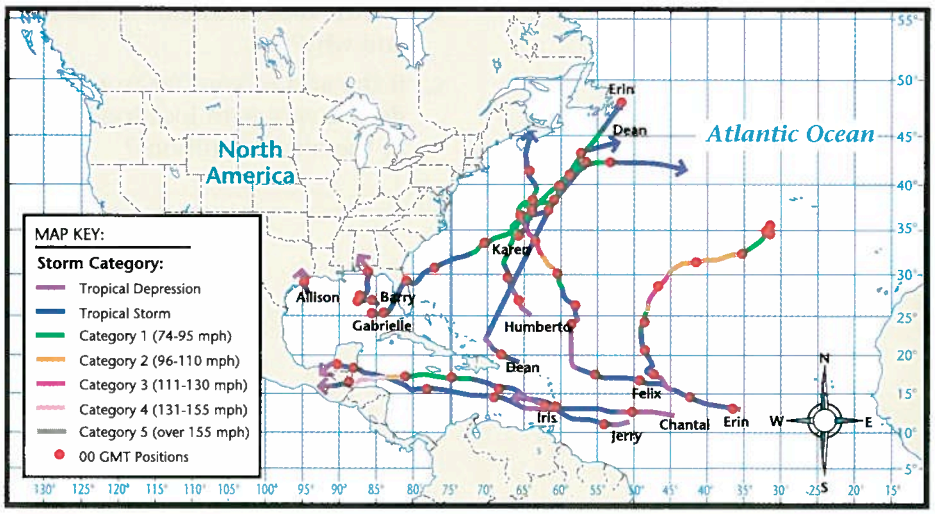
- Track and project the paths of hurricanes, using regional weather data and other factors to make predictions
- Research and analyze long-term tropical storm patterns and their impact on human communities

Materials

- Internet access

Fig. 1-3

A hurricane-tracking map for the East and Gulf Coasts over the 2001 season. Latitude and longitude scales are included for reference.



Procedure

Step 1 During the hurricane season, track the paths of hurricanes along the East Coast or, in the eastern Pacific Ocean, of tropical cyclones. Downloadable maps, which can be used to plot the storms as they occur, are found at:

http://www.usatoday.com/weather/wtrack.htm

Step 2 Various Web sites will let you monitor tracking data along with the regional weather conditions that might influence the path of the storm. The National Oceanographic and Atmospheric Administration (NOAA) is a good site at:

http://www.nhc.noaa.gov/index.shtml

This site also has tracking charts at the bottom of the page.

Step 3 Predict and map landfall for each of the hurricanes you track. What weather conditions and other factors lead you to your predictions? Justify your forecast.

Step 4 Research the following questions:

a. How do hurricanes form? Why are they usually late summer and autumn events?

b. How does El Niño affect the hurricane season?

c. Collect data on hurricane damage on the East Coast since 1900. Describe the trend in the human death toll over that time. Why has it changed in that way?

d. Collect data on property damage costs over the same time period. Why is that the trend? What has happened since 1900 to influence these results?

1-4 Testing for Tropospheric Ozone Pollution

PURPOSE

- Prepare and carry out tests for tropospheric ozone pollution
- Analyze the ozone pollution test results for local variation and possible impact on human health

Materials

- beaker calibrated in milliliters
- corn starch
- hot plate and magnetic stirrer
- potassium iodide
- filter paper

Optional:

- sling psychrometer or CBL

Procedure

Step 1 Place 100 mL of water in a beaker, then add 5 g of corn starch.

Step 2 On a hot plate with a magnetic stirrer, heat the mixture until it gels and becomes somewhat translucent.

Step 3 Remove the mixture from the heat. Add 1.0 g of potassium iodide and stir well, then let the mixture cool to a paste.

Step 4 Lay a piece of filter paper (or coffee filter) on your lab table and brush the paste on it, being sure to cover it completely and uniformly.

Step 5 Turn the paper over and repeat Step 4. The paper can now be used for testing, but it is better to allow the paper to dry in the dark. Keep away from direct sunlight. (*Lab Hint*: Fast drying can be accomplished in a microwave at low power for 30–60 seconds.)

Step 6 Cut the filter paper in 1-inch strips and store in an airtight container such as a zip-lock bag in the dark. Potassium iodide is sensitive to moisture and light. CAUTION: Wash your hands thoroughly when done. Potassium iodide, although not toxic, is a mild basic salt and can cause a skin irritation.

Step 7 Select sites near your school and/or home. The test strips should be able to hang freely, but not in direct sunlight. Try sites like your classroom, rest rooms, gym, cafeteria, teacher copying room, parking lots, etc.

Step 8 To test for ozone, moisten a test strip in distilled water and hang it at a collection site out of direct sunlight for eight hours. Then seal it in an airtight container until you are ready to measure your results.

Step 9 When you are ready to record your results, dip the paper in distilled water and observe the color. Use the color in the area of the most pronounced change. To determine the ozone concentration, you will need to determine the Schoenbein Number. For this use the following Web site:

http://teachertech.rice.edu/Participants/lee/colorscale.html

Step 10 The relative humidity affects your results because potassium iodide is moisture sensitive. High humidity gives a high Schoenbein Number. To correct for the humidity you must first determine the local relative humidity. Use a sling psychrometer or CBL or, if the humidity cannot be determined by experiment, the local weather report. Round this figure to the nearest 10%.

Step 11 Now, with you local relative humidity, go to the chart at the following Web site:

http://teachertech.rice.edu/Participants/lee/Images/graph2.jpg

Find your humidity on the *x*-axis and draw a line up to the line for the local humidity. Then draw a line horizontally to the *y*-axis to read the corrected ozone concentration in parts per billion.

Step 12 Analyze your data.

a. Did the readings change from site to site?

b. What was going on in the areas with the highest ozone readings? Was there electronic equipment or machinery? Take into account other strong oxidizers, such as oxides of nitrogen, that may influence your results.

c. Make some judgments about ozone levels in the areas you tested. Why did you get the results you recorded?

d. What are the health hazards of elevated ozone levels? What can be done to alleviate them?

e. How is tropospheric ozone different from stratospheric ozone?

1-5 Global Warming and Atmospheric CO_2 Correlation

PURPOSE

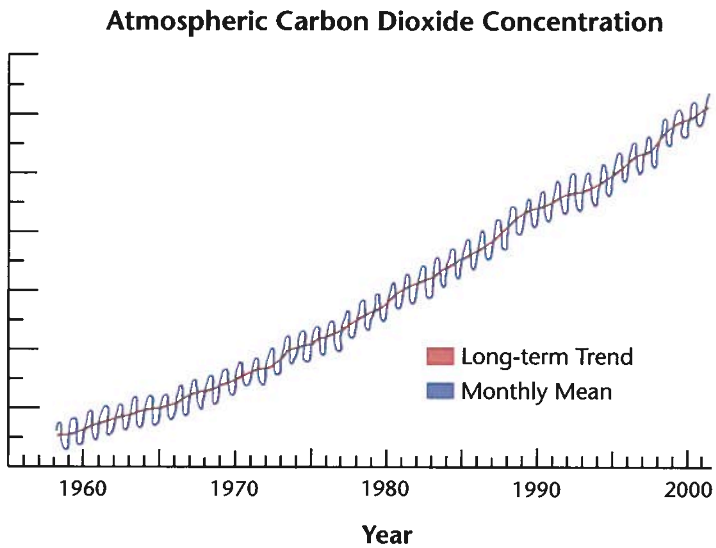
- Research carbon dioxide concentrations in the atmosphere for the last 420,000 years
- Correlate the data mathematically to global temperatures

Materials

- Internet access

Fig. 1-4

These data reveal how short-term fluxes in atmospheric carbon dioxide closely track long-term trends.



Procedure

Step 1 You will need to select intervals for data point entries over the last 420,000 years.

Step 2 Go to the following Web site and enter the years and CO_2 concentrations in a spreadsheet:
ftp://ftp.ncdc.noaa.gov/pub/data/paleo/icecore/antarctica/vostok/co2nat.txt

Step 3 Go to the following Web site and enter the years and temperatures in a spreadsheet:
ftp://ftp.ngdc.noaa.gov/paleo/icecore/antarctica/vostok/deutnat.txt
The age of the core sample is in column 2 and the temperature is in column 4.

Step 4 From the spreadsheets, make a graph. Plot time along the *x*-axis. Make two *y*-axes, one on either side of the *x*-axis. On the left *y*-axis, plot the carbon dioxide data, and on the right *y*-axis, plot the temperature records.

Step 5 Analyze your data.

- **a.** Describe how carbon dioxide concentrations and temperatures vary over time.
- **b.** Tell how the graphs change compared to each other. Is there evidence of a cause-and-effect relationship between CO_2 and temperature? Explain.
- **c.** What could cause the carbon dioxide levels to change over the time studied? How could orbital changes, plate tectonics, and/or ocean currents play a role?
- **d.** Describe patterns for any Ice Ages that occurred during the period of the study.
- **e.** Where are we today in relation to the graphed data? What lies in the near future? What in the data makes you believe in that change?

Step 6 Soils may absorb enormous amounts of carbon dioxide. Describe how changes in land usage over the last 50 to 100 years have had an effect on this sequestering ability.

Step 7 How are insurance companies and the Pentagon reacting to the impact of global warming?

Step 8 Outline five environmental effects of global warming.

1-6 Elevated CO_2 Levels and Plant Growth

PURPOSE

- Conduct an experiment on effects of CO_2 enrichment on plant growth
- Compare your experimental results with available data from related experiments on enhanced crop growth

Fig. 1-5

An experiment on free air CO_2 enrichment. Some plants respond to carbon dioxide by growing more rapidly; others show little response. Those that grow more rapidly may have a distinct advantage over the slow responders and, therefore, change the composition of local plant communities.

Materials

- 3 kinds of naturally growing plants (or crops like peas, beans, radishes, etc.)
- 6 growing chambers (such as small aquariums)
- potting soil (1 large bag)
- plastic tubing
- 3M hydrochloric acid
- calcium carbonate
- Internet access and/or print materials for research

Procedure

Step 1 Select 3 different plants that grow in your region for testing.

Step 2 You will grow the plants in growth chambers of the same size and composition. For each plant tested, you will need two containers, one for the experiment and one as a control.

Step 3 Set up growth chambers so that all have the same amount of soil. Prepare the soil in a large pail or basin so that the composition is uniform for all 6 chambers.

Step 4 The containers must be able to be loosely sealed from the room atmosphere. The only variable must be the level of carbon dioxide, so place the chambers where the temperature and sunlight are the same.

Step 5 Carbon dioxide can be produced by reacting calcium carbonate with 3M hydrochloric acid and transferring to the three experimental chambers by tubing. The volume of carbon dioxide can be calculated stoichiometrically from the amount of calcium carbonate used. The concentration of the gas can be calculated by measuring the volume of the chambers and converting the units to liters.

(*Note*: An alternate method, for direct measurement of the carbon dioxide concentration, is Vernier's Carbon Dioxide Gas Sensor. This device connects with a CBL and graphing calculator, or a Palm Pilot, or directly to your computer with Logger Pro® software.)

Step 6 Plant the seeds in the soils so that they are evenly spaced. Water the soil and add the carbon dioxide. Set up a timetable that you will follow for adding the gas over the duration of the experiment.

Step 7 Set up a journal where you can write up your procedure, show your calculations and record your observations over the course of the investigation. Measure:

- germination time
- growth rate
- leaf area
- stem branching
- amount of vegetation or produce
- other pertinent observations regarding the effect of the excess carbon dioxide.

Step 8 Analyze your findings. Compare the growth of the experimental groups to that of the controls.

Step 9 Research other experiments that seek to find the effects of elevated carbon dioxide levels on plants. What were their results? The Duke University Free Air Carbon Enrichment (FACE) study has some interesting initial findings.

Step 10 Currently, the concentration of CO_2 in the atmosphere is a little over 370 parts per million by volume (ppmv). The average rate of increase has been 1.4 ppmv per year since 1972. This would give an atmospheric concentration of over 500 ppmv in one hundred years, if the rate of absorption also stays the same.

a. Comment on the often stated claim that increased carbon dioxide levels would increase plant growth and, therefore, remove the gas from the atmosphere due to increased photosynthesis.

b. Describe some research on how crops react to the increase of the gas. What other factors, such as nutrition levels, fertilizer requirements, pests, etc., are involved?

Step 11 Describe ways in which you would change the experiment you conducted. What other results would you expect?

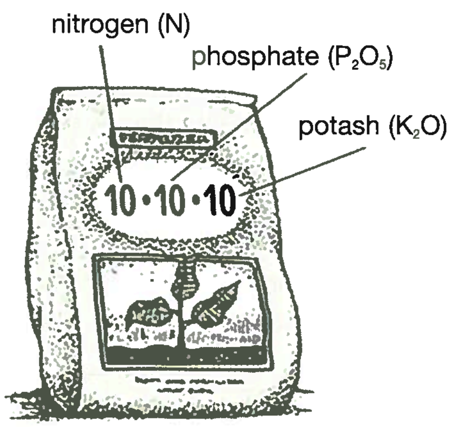
1-7 Natural vs. Synthetic Chemical Fertilizers

PURPOSE

- Compare crop samples grown from natural fertilizers with those from synthetic chemical fertilizers

Fig. 1-6

Commercial fertilizers use a numbering system to indicate the proportions of key chemical components. These products also give rates of application for various crops and soils.



Materials

- 2 small garden plots
- soil test kit
- Berlese funnel
- basic garden tools
- compost (or manure) for at least 1 meter square
- chemical fertilizer for at least 1 meter square
- crop seeds (such as peas, beans, or radish)

Procedure

Step 1 Set up two garden plots of the same size, from 1 to several meters square. They must be in an adjoining area where soil, sunlight, and terrain are uniform and should not have been artificially planted or fertilized previously. Remove any existing vegetation.

Step 2 After reading through all steps of this procedure, plan a journal where you will outline your procedure, label and map your plots, and record your data in tables.

Step 3 With a soil test kit, determine the pH and the nitrate, phosphate, and potassium levels of both plots by taking several samples from different parts of each plot. Mix the samples together before testing. Also determine the soil texture of each sample. Use a Berlese funnel to identify any soil organisms you find in each sample. Record all these data in your journal.

Step 4 In one plot add 15–20 cm of compost and/or manure to the top of the bare soil. Then, using a pitchfork or shovel, thoroughly mix it into the upper 30 cm of soil.

Step 5 On the other plot, prepare the ground by thoroughly turning over the upper 30 cm of soil with a pitchfork or shovel. Be sure to break up the big clods. Add chemical fertilizer from a garden or farm supply store at the recommended rate for your crop.

Step 6 Plant your crops at the spacing and depth recommended on the seed package. Be sure to water your crops if there is insufficient rainfall.

Step 7 Every four to five days during the growing season, measure and record the pH and the nitrate, phosphate, and potassium levels of the two plots. Using a Berlese funnel, collect, identify, and record soil organisms at the same time.

Step 8 Measure and record the growth of the crop plants in both plots.

Step 9 If it is possible, collect runoff water after a heavy rain and measure the pH and the nitrate, phosphate, and potassium levels in the runoff.

Step 10 When your plants produce a crop, measure the amount of produce from each plot. (You may opt to do a comparative taste test as well.)

Step 11 After you harvest your crop, test the soil chemistry and soil organisms one last time.

Step 12 In your journal, describe how the test measurements changed in each plot over time and if there was a corresponding change in the plants.

Step 13 Analyze your experimental results. What conclusions can you draw as a result of this experiment?

1-8 Effect of Soil Humus on Composting Rates

PURPOSE

- Compare decomposition rates of various compost materials in soils of different humus content

Fig. 1-7

A home gardener's compost pile. In soil rich with humus, millions of organisms feed on and break down organic material, both plant and animal, releasing nutrients into the soil. Soils poor in humus do not have the same ability to decompose organic matter.

Materials

- 5 or more soil test sites
- 1 soil test kit
- materials to compost, including:
  - white paper strips
  - animal food waste
  - newspaper strips
  - bones
  - aluminum foil
  - egg shells
  - vegetable waste
  - coffee grounds
  - leaves
  - grass clippings

Procedure

Step 1 Select at least five sites with varying amounts of humus, from very rich soils to very poor ones.

Step 2 After reading all steps of this procedure, set up a journal to describe your sites and procedures and to record your data.

Step 3 Using test kits, measure the pH and the nitrate, phosphate, and potassium concentrations at each site.

Step 4 At each site bury samples of each material listed above. Dig a hole about 10 cm deep for each item and then replace the soil on top.

Step 5 Draw a site map for each location so that you can easily relocate each item for observation.

Step 6 Once a week, gently remove the soil from the top of each test item to monitor it for signs of decomposition. Carefully record your observations, and then replace the soil.

Step 7 Note the rate at which each substance decays at each location. List substances from the most decay to the least decay.

Step 8 Analyze your data.

a. Does the same material appear in each list of decay rates in the same position? What did you expect, and which items surprised you by their rates?

b. At the end of your study, compare the overall decay rates of all materials to the amount of humus in the soil.

c. Which materials either did not decay or completely decayed away? How did soil chemistry affect the experiment?

d. How did food items with preservatives decay compared to those without preservatives?

Step 9 Make some comparisons to materials we place in landfills. How long do you think some of those substances take to decay? How can the process be speeded up?

Step 10 **Extension** Repeat this experiment using red worms (*Eisenia foetida*) to compost your test materials. These worms eat up to their own weight each day, and their castings are an excellent soil conditioner. The worms are inexpensive and easy to keep. You can perform this experiment in a 60 cm × 60 cm × 30 cm aquarium.

1-9 Land Use Changes in Your Area

PURPOSE

- Research and record land use changes in your state or a nearby urbanized area
- Analyze land use trends for their environmental impact

Materials

- maps of local towns and cities
- access to research library and/or local historical societies
- acetate sheets

Optional:

- GIS (Geographic Information System) mapping program

Procedure

Step 1 Select a region in your state, preferably near an urban center or large metropolitan area. Keep in mind that many cities were first built on flat land, near a coast, or along rivers, which were important for transportation, irrigation, and domestic uses. As the population grew, the town or city spread out into the surrounding countryside.

Step 2 In a notebook, make a table to document current population, total surface area, general topography, flood plains, land use, roads, and infrastructure such as parks, reservoirs, power lines, etc. (This would be a good project for using GIS if you have access to the program.)

Step 3 Research, as far back as you can, maps of the region when it was first settled. You can usually find such information in your local town hall, library, or county assessor's office. From these and other historical resources, record facts such as:

a. How many people lived there?

b. What was the surface area of the town?

c. About what percent of the land was forest, farms, wetland, waterfront buildings, stores and shops, and homes?

d. Where were the roads? What were they constructed of? Where did the materials come from? Where did the roads go?

Step 4 On a large sheet of paper, draw the oldest map you could find. Then, on sheets of clear acetate, draw more recent maps, up to the present, that can overlay the original map. In your notes, document how the land use changed over time.

Step 5 Make a general analysis of your data.

a. What happened to the best farmland? What is in its place today?

b. What percent of the land is covered with structures and pavement today, compared to the first map?

c. Describe at least five significant environmental impacts related to this development.

Step 6 An interesting map to look at is the United States at night. This is a composite of many satellite pictures of the United States. The eastern United States is awash with light and the western states are not as developed, but still not as dark as might be expected.

- Describe how the coast of California from San Francisco to San Diego compares to the surrounding region. Do the same for the east coast from Boston to Richmond.
- Describe the arrangement of lights in the midwestern United States and compare them to the east-coast pattern of lights. Why do you think those patterns exist?
- In the west, why are the lights strung out in lines? What causes that arrangement?
- Comment, based on the map, on how transportation systems affect urban and suburban development.

Fig. 1-8: Satellite Photo of the United States at Night

Step 7 Explain how modern technology can help planners prevent some of the problems of urban sprawl.

1-10 Toxic Sites in Your Neighborhood

PURPOSE

- Research and analyze environmental problems locally, determining their causes, ecological and public health impacts, and possible resolutions

Materials

- Internet access

Procedure

Step 1 For this extended study, access the following Web site:

http://scorecard.org/

It is an extensive compilation of environmental problems for every state.

Step 2 On the home page of this site, under the U.S. map, there are listed nine environmental issues to be explored by community, state, or region. Select five issues and relate them to a local area of your choosing. (Another option is to enter your zip code in the area called Find Your Community and then track the various problems outlined from that perspective to answer the questions that follow.)

Step 3 Try to link the five issues, searching for common threads:

a. What industries are involved in the problem?

b. Do the ill effects exist in your area only or are they more widespread? Explain if these are local, regional, or national problems.

c. Who regulates these industries and problems and how? Has there been progress in alleviating the problems? If so, where did the impetus come from?

Step 4 Describe the short- and long-term health effects of each issue studied.

a. Explain if these are local problems or more widespread.

b. Are any of these problems associated with **cancer clusters**, or "hot spots," where the disease rate is much higher than for the general population?

Step 5 The ninth environmental issue listed on the home page is Setting Environmental Priorities.

a. Go to that page and access the smallest region closest to your home.

b. Once you have selected a region, outline the highest health and ecological risks for that region. How widespread are the risks?

c. What can be done to correct these problems? Describe how you can personally help avoid these problems.

1-11 Effects of Gamma Radiation on Seed Growth

PURPOSE

- Conduct a controlled experiment on rates of seed germination and plant growth, comparing the rates for exposures to different levels of gamma irradiation
- Apply experimental results to related issues of commercial irradiation of food and seed products

Materials

- 8 paper cups (or other small disposable containers)
- 2 types of seeds (purchased from a supplier and irradiated at 3 exposures)

Procedure

Step 1 Prepare 8 containers for plantings seeds. You will likely be using rye grass and mung bean seeds because they germinate quickly. The seeds will have been exposed to gamma rays at 3 different exposures.

Step 2 Place your name on the containers with a grease pencil or marker pen. Identify the containers: 3 rye grass, 3 mung bean, and 1 control for each seed type.

Step 3 With a pencil, poke a few small holes in the bottom of the containers for drainage. Fill the containers ¾ full of potting soil.

Step 4 Place five seeds in each cup and cover them with a little of the potting soil. Water the containers and place them in a warm lighted place for a week.

Step 5 Design a table of data to record your observations over the time period you run the experiment. Record when the plants first break the surface and how much they grow each day. Also record any changes in physical appearance from each other and the controls.

Step 6 Plot graphs of the average growth rate for each seed type and irradiation level.

Step 7 Plot the percent germination against the irradiation levels for each seed type.

Step 8 Draw conclusions about the percent germination, rate of growth, and appearance of plants, compared to the levels of irradiation.

Step 9 The U.S. Department of Agriculture and the Food and Drug Administration now accept the use of food irradiation as the most effective and efficient way of preventing microbiological contamination.

a. Describe how your experiment could be modified and used to model a current world problem.

b. Explain how the irradiation of seeds can be a useful process for the farm and garden industries.

c. What are some environmental, social, and economical drawbacks of irradiating?

Step 10 Comment on the safety of using irradiated seeds.

a. Why, after being bombarded with powerful gamma rays, are the seeds not radioactive?

b. Why are irradiated foods safe to eat, despite some public fears?

Step 11 **Extension** For an even longer-term study, continue to grow the surviving plants until they produce their own seeds.

a. Test the second generation plants using the same techniques as above.

b. What differences in results do you observe?

1-12 The Rock Cycle, Rocks, and Soil

PURPOSE

- Collect local samples of igneous, sedimentary, and metamorphic rock to analyze and categorize
- Compare rock samples with surrounding soil samples to reach conclusions on local soil formation

Materials

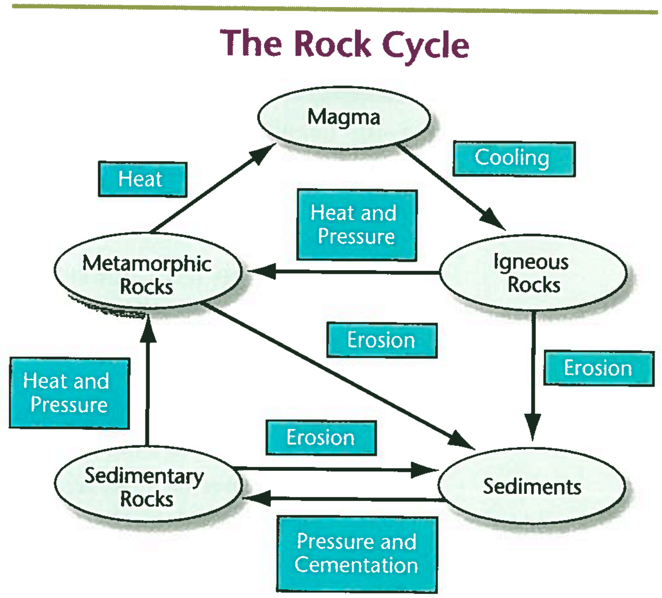
- 25–50 rock samples
- corresponding soil samples
- 100-mL graduated cylinder
- hand lens

Alternative:

- rock and mineral kit

Fig. 1-9

The surface of Earth is constantly changing, most of the time too slowly to notice. The three rock types in the Rock Cycle have two main sources: sediments from erosion, and magma, a hot, natural melt composed mostly of steam and silicates from deep in the Earth.



Procedure

Step 1 Collect 25–50 different kinds of rocks from your neighborhood or the region around your home and school. The samples should be obviously different. (If you live in an area where this is impossible, use a rock and mineral kit from your science department.)

Step 2 If you collect the rocks yourself, also collect a small bag of soil from each area where you take samples.

Step 3 As best you can, group your samples into **igneous**, **metamorphic**, and **sedimentary** types.

Step 4 Define what is meant by igneous rocks.

a. What is their source?

b. Some igneous rocks are **intrusive** and others are **extrusive**. What does this mean, and how can you tell which type your samples are?

Fig. 1-10: Granite Face of El Capitan at Yosemite National Park

c. What is meant by rock **texture**? Categorize your igneous rocks by texture.

d. Use a hand lens to examine the size of the crystals in your samples. Are they uniform in size and are they evenly distributed throughout the sample? Compare all the igneous rocks this way.

e. Are the rocks hard, brittle, or easily broken? For example, how would you categorize obsidian?

f. What is the **Bowen's Series**? Describe how the properties of the rocks change based on the arrangement of silica tetrahedrons.

g. From your knowledge of the Soil Triangle, what type of soils would your igneous rocks form? Does your soil sample bear this out? Why or why not?

Step 5 Define sedimentary rocks.

a. Where do these rocks come from?

b. Use a hand lens to describe the texture of your sedimentary rock samples.

c. Try to determine the source of the grains in your sample. Are they angular, somewhat rounded, or well-rounded? Did they form in water or on dry land?

d. Some sedimentary rocks have biological origins, such as coal and fossiliferous limestone; some are derived from inorganic chemicals like salt and gypsum; and some are made of other rock fragments. Categorize your samples. What can you tell of their origins?

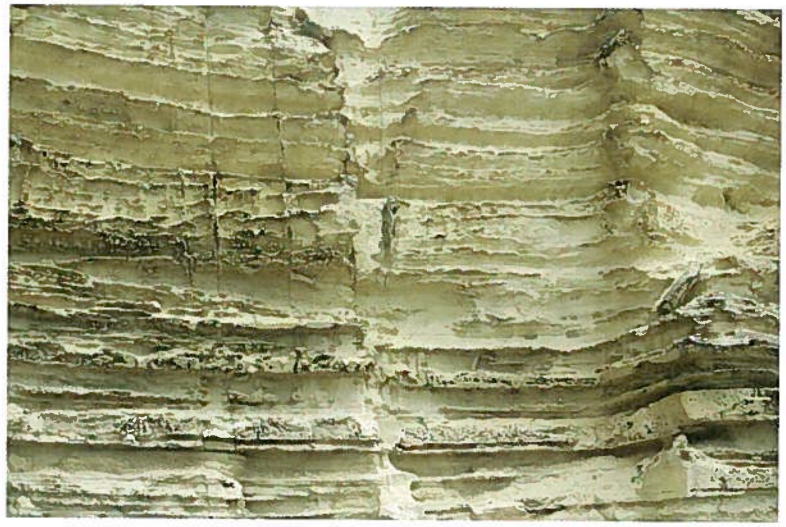


Fig. 1-11: **Sedimentary Rocks on the Island of Cyprus**

e. Only sedimentary rocks can have fossils. Describe any fossils that you find. What can you learn from them?

f. From your knowledge of the Soil Triangle, what type of soils can you expect from your samples? Will they form easily?

Step 6 Define metamorphic rocks.

a. How are they categorized?

b. Are your metamorphic samples caused by contact, hydrothermal, or regional metamorphism? How can you tell?

c. Describe some common metamorphic rocks by texture. Identify your samples in this manner.

d. How do heat and pressure play a role in the formation of your metamorphic samples? What clues do these factors give us about the geology at the time of their formation?

e. Describe how metamorphic rocks are useful to humans.

Fig. 1-12: **Folded Metamorphic Rocks, Westchester County, NY**

Step 7 Soils are made up of inorganic minerals, organic matter, water, and air. The minerals may be sorted by size and classified as sand, silt, or clay. The size of the particles is determined by several factors, including hardness of the original minerals, geologic processes that they may have been exposed to, atmospheric weathering, human pollution, and others.

a. Using a hand lens, examine the soil you collected along with your rock samples. Draw the mineral components as best you can.

b. Separate your soil into three size components by placing about 50 mL of soil in a graduated cylinder and filling it to the 75–80 mL mark with water. Shake up the cylinder with your hand over its mouth. Let it settle overnight and then separate the components.

c. Compare the grains of sand, silt, and clay to the components of your rock samples. How do they match up? What processes do you think were involved in the forming of the soil?