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A unit in earth science and conservation

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BOSTON UNIVERSITY
SCHOOL OF EDUCATION

Service Paper

A UNIT IN EARTH SCIENCE AND CONSERVATION

Submitted by

Ralph A. Howard
A.B. Holy Cross College, 1937

In Partial Fulfillment of Requirements for
the Degree of Master of Education

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Reader: - John G. Read, Professor of Education
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A UNIT IN EARTH SCIENCE AND CONSERVATION

INTRODUCTION

The search for non-mathematical science concepts of interest to and within the grasp of General Course students should not overlook the Earth Sciences. This unit is chiefly concerned with the geological branch of Earth Science. Here is a field which supplies out-of-door activities, specimens to handle and collect, and a starting point for the study of one's own community. Geology can be studied and taught with the aim of increasing the student's enjoyment of state and national recreation areas and of arousing his interest in their protection and extension. It is also a science that can impress upon all the slowness of soil formation and the necessity for preventing erosion. This last impression and attitude is the chief aim of the unit, together with the aim of having the students acquire some technical knowledge of how to maintain the soil's fertility and keep the soil in place.

This unit was designed for a group of twelve to fifteen boys whose I. Q.'s range from 90 to 110. The Physical Science classes have consisted of this size and type group for several years. They are General Course students in Grade 11. They dislike having anything to do with books, but will work well with an explicit study guide, and are willing to watch demonstrations and examine concrete objects. An attempt was made to capitalize on their natural interest in rocks and minerals by beginning the unit with these, using a collection of thirty-seven minerals obtained from
the geology department of the Harvard Museum, together with several collections of minerals and rocks borrowed from the Children's Museum. A field trip was made to Purgatory Chasm, Sutton, Mass., to a conglomerate outcropping on the Franklin-Wrentham line, and to South Franklin for samples of felsite which underlie parts of the area. Another trip included a quarry in Roxbury, the Children's Museum, the Harvard Museum, and the Museum of Science. A third trip took them to the Norfolk Agricultural School, where they were given a two-hour talk and demonstration by Mr. Harold Barker, Soil Chemist at the school. The boys were very appreciative of Mr. Barker's willingness to give so much time to such a small group.

Others whose patience and generosity in supplying materials assisted greatly in assembling the unit were: Mr. L. W. Currier, U. S. Geological Survey, Room 513, 100 Nashua St.; the highway engineers and water engineers on the 7th and 5th floors in the same building; members of the clerical staffs of the Massachusetts Development and Industrial Commission, 20 Somerset St., Mass. Dept. of Conservation, Division of Parks and Recreation, 15 Ashburton Place; Trustees of Public Reservations, 50 Congress St.; and Dr. Clifford Frondel, Dept. of Mineralogy, Harvard University, 12 Geological Museum, Oxford St., Cambridge 38, Mass.
NEED FOR THE STUDY OF THE OUTDOORS

Scientists and educators agree that the problem of conservation is of major importance to the world today. The Twenty-ninth Yearbook of the American Association of School Administrators calls attention to this problem. It emphasizes that "all methods of disseminating conservation information...will be needed, including a well-planned program of conservation education in all of the nation’s schools." The United Nations Scientific Conference on the Conservation and Utilization of Resources emphasizes not only this same idea but also the fact that conservation must be thought of in terms of the world as a whole.

To introduce the conservation part of the unit, several good films are available free of charge except for return postage from The United States Department of Agriculture Soil Conservation Service, Upper Darby, Pa. These are:

- Topsoil 10 minutes
- Water 9 minutes
- Erosion 10 minutes
- Soil and Water Conservation 9 minutes

These are 16 mm. sound and can be scheduled for one period. Also:

- The River, sound, 35 minutes. This film was claimed the world’s finest documentary at the 1938 International Exposition of Cinematographic Art.

These films are described more fully in the List of Available
Films.

The extent of man's control over the gradational processes of the earth is taught in this unit by means of study guides prepared for twenty-four pamphlets which are easily obtainable. These pamphlets deal mainly with three phases of conservation which are applicable to this unit. These are:

1. Prevention of erosion by controlling water.


And a third phase of conservation, which while not dealing directly with gradational processes, is of great importance:

3. Prevention of waste by maintaining the fertility of the soil.

Much of the material stressed in these pamphlets should be of interest to every farmer and gardener. Many suggestions are given that could be carried out on Franklin farms. The questions and projects were worked out with this aim in mind. Although some of the questions in these twenty-four guides deal with the same problems, no two questions are alike. They suggest the importance of soil conservation to the average American and the responsibility of each citizen in safe-guarding our country's resources.
CHAPTER I
GENERAL STATEMENT OF THE UNIT

THE UNIT: Earth Science helps us to understand and to use properly the resources of the soil. The mineral ingredients of soil come originally from rocks and ores. The processes of soil formation are slow. Natural erosion cannot be controlled by man, but accelerated erosion can be controlled. We can analyze soils and restore nature's balance by returning lost minerals, nitrogen, and humus.

DELIMITATION OF THE UNIT:

1. Rocks are made up of a variety of minerals.
2. Rocks may be formed by the cooling and solidifying of molten materials.
3. Rocks may be formed by the cementing and compacting of sediments.
4. Rocks may be metamorphosed by heat and pressure.
5. Rocks at or near the earth's surface are being broken up mechanically or chemically.
6. As a result of weathering, rocks release their minerals into the soil.
7. The soil is being worn away by the action of moving water and air.
8. Topographic maps help to reveal facts about land contour and the work of water.

9. Erosion of valuable soil may be prevented by diminishing the speed of water flow.

10. Running water is the most important agent modifying the land surface of the earth.

11. Forests help to diminish the speed of water flow.

12. Dams, such as those on the Tennessee River, help to diminish the speed of water flow.

13. Terracing, contour plowing, furrowing, and strip cropping help to diminish the speed of water flow.

14. Erosion of valuable soil may be prevented by putting the land only to the type use for which it is adapted.

15. The Soil Conservation Service of the United States Department of Agriculture works to save soils everywhere in the United States.

16. In Massachusetts, Soil Conservation Districts assist farmers in the conservation of soil, and soil resources, and the control of erosion.

17. Chemistry has made possible an exact maintenance of the fertility of the soil.
INDIRECT LEARNING PRODUCTS:

Appreciations

1. The surface of the earth is continually changing. There are no "everlasting hills".
2. Dirt is not cheap.
3. Soil is produced over the ages by nature's slow processes.
4. The earth is very old.
5. Man has disturbed nature's balance between soil formation and soil erosion, so that now erosion is by far the more rapid process in many areas in which man lives.
6. Millions now depend for survival upon conservation of the soil.

Interests

Students displayed at least transitory interest in mineral collecting and identification, landforms, maps, soil analysis, and the improvement of their own land.

Attitudes

1. Conservation legislation should be supported.
2. Farmers should seek help from scientifically trained people to protect their land and increase their yield.
CHAPTER II
UNIT ASSIGNMENT

STUDY GUIDE FOR EARTH SCIENCE UNIT

1. Examine a piece of quartz from Blanchard's Quarry, Uxbridge, or Fletcher's Quarry, Milford. How many different types of grains can you see? What are the four most common minerals in granite rock? What are the glassy grains? The yellowish or pink grains? The black specks? The thin flakes that you can separate with your fingernail? (1:27)

2. Look at the samples of rose quartz, milky quartz, and smoky quartz. Can you see through them? Try scratching them with a knife blade. Now rub a sharp edge of quartz against the flat part of the knife blade, using considerable pressure. Which scratches which? Therefore, is quartz harder or softer than steel? How would you describe their luster, or surface appearance? See 2:279 for words customarily used to describe luster. What is the shape of quartz crystals? (1:8-9) Why are the grains of quartz in granite not in this shape? (1:30-31) Besides these samples what are 5 other varieties of quartz? (2:284) Find samples of these in the collection of rocks and minerals from New Hampshire and the collection from Harvard University. Beach sand is mostly quartz grains. Judging from the hardness of quartz and granite rock, would you expect sand to be formed rapidly by wave action, unequal heating, or ice freezing in crevices?

3. Look at the labeled samples of feldspar. Notice their shape and color. What are the elements that make up this mineral? Harder or softer than steel? For what is this mineral used? (2:292) What is clay? (1:14)

4. The dark material in granite is hornblende, which has about the same hardness as a knife blade. What elements not found in feldspar or quartz may account for its dark color? (2:293)

5. The two samples, muscovite and biotite, are much alike in composition except for what two elements in biotite? Try scratching these samples with your fingernail and with a copper penny. What are the uses of muscovite mica? (2:293)
6. Examine the minerals in the hardness scale box. Which of these can you scratch with your thumbnail? With a penny? With a jackknife blade or file? Arrange these labeled minerals in order from softest to hardest on the basis of this test: 1 ______ 2 _____ 3 ______ 4 ______ 5 ______ 6 ______ 7 ______ 8 ______ 9 ____ 10 ________ Now check and make corrections by consulting (2: 280).

Topaz, hardness 8, and diamond, hardness 10, are absent from this collection. Your fingernail is hardness 2.5; a penny 3.5; a knife or file 5.5.

7. Take a sheet of the 16" by 14" paper and make five vertical columns and nineteen horizontal ones of the same widths as the model on the bulletin board. Label the columns:

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Color</th>
<th>Luster</th>
<th>Streak</th>
<th>Hardness</th>
<th>Uses</th>
</tr>
</thead>
</table>

See 2: 278-281 for words to describe these properties of minerals. Fill in these columns for the common rock-forming minerals listed.

Quartz
Feldspar
Muscovite Mica
Biotite Mica
Hornblende
Olivine
Calcite

Try to fill in columns 2, 3, 4, and 5 before looking up the mineral in Thompson pp. 281-296. You can quickly check your work when you look up the minerals for their uses. Also look at the display from the Children's Museum, which gives you a quick idea of some uses.

Now continue this list with minerals which have more economic importance, namely:

Gypsum
Talc
Fluorite
Malachite
Azurite
Chalcopyrite
Sphalerite
Galena
Pyrite
Hematite
Magnetite
Bauxite

8. What is the difference between a rock and a mineral? Rocks are classified as igneous, sedimentary, and metamorphic, according to how they are formed. How are igneous rocks formed? (2: 315)

9. About how hot is lava? What is this molten material called when it is below the surface of the earth? What are two theories as to what causes this heat within the earth? (3: 23)
10. What is a crater? a caldera? (2: 297) a fissure eruption? (2: 306-7) What is the chief gas in magma? What is the general sequence of events in a big volcanic eruption of the explosive type? (3: 28-32)

11. How is magma thought to get to the surface? Why do earthquakes and eruptions occur in the same general regions? In what general areas are volcanoes distributed about the earth? (3: 50-55 or 4: 353-5)


14. Compare the shapes of the cemented rocks in breccia and puddingstone. How was each formed? (Display card)

15. All rock on the surface of the ground is subject to the action of the atmosphere and other agents which begin to break the rocks up into smaller rocks and fragments. This process is called weathering. What are three agents of physical (mechanical) weathering? Explain how rocks are broken up by each of these. (2: 130-134)

16. Which ingredients in rocks are subject to oxidation? Account for the red, brown, and yellow colors in rocks and soils. Into what mineral does feldspar break down? What ingredients of rocks are dissolved by water containing carbon dioxide? A soil formed by the weathering of granite will contain what materials? (2: 134-136)

17. Weathered fragments of igneous rocks may be carried along by swift streams and deposited in beds layered one above the other. Here the particles become cemented together; if the particles were mostly sand, ______ is formed; if the particles were of mud, ______ is formed. The three most common cements are ______

18. If the rock has been formed of skeletons of sea organisms, ______, or ______ may be the result. How can you tell that there is a grain in sandstone if you cannot see it? What are the uses of sandstone and limestone? (2: 33-34)

19. When subjected to some heat and great pressure within the earth both igneous and sedimentary rocks are changed or metamorphosed. Thus slate is a metamorphic rock formed from ______, marble from ______, banded gneiss from ______, schist from ______.
quartzite from ______, and soapstone from ______. For what is soapstone used? (2: 350-354)

See folder "Volcanoes" for pictures of Vesuvius erupting, Paricutin, Etna, Hekla, Villarrica, Kilauea, Haleakala, Cotopaxi, folded rock strata and earth's crust.

See folder on "Weathering" for pictures of talus slopes and wind work.

20. How is carbonic acid added to ground water? What minerals may be combined and dissolved by carbonic acid? How can some sandstones be disintegrated by solution? (5: 63-64)

21. What size particles can be moved by water flowing at a speed of one mile per hour or less? By water flowing two to five miles per hour? What is the ratio between the speed of water flow and the size of particles moved? (5: 64)

22. In what respect is a stream like a file? What is meant by stream gradient? What are two characteristics of a youthful stream? Of a mature stream? When is a stream at base level? Why can it not cut any lower? Can a stream be in all three stages of development at the same time? How can a river wear down mountains located far at the side of the river valley? (5: 65)

23. How can a river increase its length at the end where it flows into the sea? The land built up here is called a ______.

24. How can a river increase its length at the end or ends away from the sea? This process is called ______. What is a divide? (5: 78-80)

25. What is the shape of the valleys of youthful rivers? Of mature rivers? Why do so many people live on a river's floodplain? (5: 80-88)


27. See folder on "Rivers" for pictures of young, mature, and old rivers, floodplains, and Mississippi delta levees. In the picture of the Rio Grande, what are the loops in the river called? The crescent-shaped lake is called an ox-bow lake. How was it formed? What is preventing the formation of another
ox-bow lake in the upper right hand corner of the picture?

28. If the spaces between grains of sand and clay near the surface of the ground are dry, how can the soil near the surface be moist? This moisture is called ______ ______. (5: 131)

29. What is ground water? What is the water table? Upon what type rock is the ground water resting? How nearly does the water table conform to the surface of the ground? (5: 131-132) Where is the water table in relation to the surface of the ground in the case of a swamp? Of a lake? Of a stream? Of a well? In what four ways may ground water get to the surface? (2: 179-183)

30. Can the water table rise or fall? Give two factors that can make it fall? How can ground water become contaminated? In making a well, what two rules are wise to follow? What is a true artesian well? (5: 132-142) How does ground water promote slope creep and landslides? (2: 193-194)

31. How can a river flowing out of a lake eventually destroy the lake? How can a river flowing into a lake eventually destroy the lake? In what ways are lakes valuable? (5: 159-161)
INTRODUCTION TO TOPOGRAPHIC MAPS

32. You are probably familiar with road maps and know that it is no problem to show roads, rivers, lakes, swamps, and railroads on a map. To make a map showing hills and valleys, however, we must show more than length and width; we must also show height. We need a way of showing three dimensions on a flat surface.

If we were standing on a level plain looking at a nearby hill, we could draw the hill as shown at (a) below.

(a)

To show the height of various parts of the hill we could draw lines around it so that each line would be 10 or 20 feet higher than the one below it, and put numbers on the lines, as shown at (b) below.

(b)
If the plain on which we were standing was 600 feet above sea level we would label the base line 600 instead of 0, and change the other figures, as shown below.

Notice that the hill sticks up a little above 640 feet but not enough above to warrant another line. So the hill is said to have an altitude or elevation of between 640 and 650 feet. Any place along the line marked 610 is 610 feet above sea level, and the same with places on the other lines.
Now let us imagine we are looking down on this hill from an airplane. Since it is a round hill, the altitude lines are seen as circles and the circles are smaller nearer the top of the hill.

Again we can see that the hill is higher than 640 feet but less than 650, since there is no 650 circle.

A hill might have the shape drawn below, with one side steeper than the other:
Looking down on this hill the contour lines would appear farther apart on the left side, and closer together on the right, or steeper, side. Of course, many hills will be more irregular than this one.

Now take the topographic map of the Franklin Quadrangle, and after looking it over, answer these questions from the reverse side:

1. What is meant by culture? Printed in what color?
2. What is meant by relief? Printed in what color?
3. With what symbol and in what color are swamps indicated?

Now take the study guide for the Franklin Map and answer the questions relating to the front of the map.
STUDY GUIDE FOR USE WITH THE TOPOGRAPHIC MAP
OF
FRANKLIN QUADRANGLE

33. Write the answers to the following questions on this sheet:

1. (a) What is the scale of miles used in this map?
   (b) By means of the scale, measure the distance from the top of Bright Hill to the top of Pigeon Hill.
   (c) Use the ruler to find out how many miles it is from the eastern edge of the map area to the western edge.
   (d) What is the longitude of the eastern edge? Of the western edge?
   (e) How many minutes of longitude does the map cover? To find out, subtract the longitude of the eastern edge from the longitude of the western edge. 71° 30' means 71 degrees 30 minutes. Since there are 60 seconds of arc in a minute of arc, we can change one of the minutes into seconds, which gives us 71° 29' 60", and makes it possible to subtract the longitude of the eastern edge from this.
   (f) Would one degree of longitude here cover as many miles as one degree of longitude at the equator?

2. (a) Find the distance from the bottom to the top of the map in minutes of latitude.
   (b) Find the same distance in miles.
   (c) Divide miles by minutes to find out how many miles to a minute of latitude. Carry to four decimal places to insure an accurate final answer.
   (d) Multiply this answer by 60 to find out how many miles to a degree of latitude.
   (e) Now multiply this last answer by 360 to find out how many miles it is around the earth via the poles. The meridional circumference of the earth is 24,901 miles. If you do not come within 100 miles of this, check your measurement and your figures.
   (f) Would the number of miles to a degree of latitude vary as one approached the equator?

3. In Franklin, does the compass point east or west of true north? By how many degrees? This difference is called the compass ________.

4. Altitude or elevation means distance above sea level; height means distance from the top to the bottom of an object.
Hill | Altitude | Height
--- | --- | ---
Bald Hill | | |
Millers Hill | | |
Forge Hill, southwest crest | | |
Forge Hill, northeast crest | | |
Bright Hill | | |

5. (a) Which side of Millers Hill is the steeper? How do you know?  
(b) What is your elevation right now, if this floor is 30 feet off the ground?  
(c) How far are we below the standpipes on Hillside Road?  
(d) Can you tell from this map why the water pressure at Unionville is the highest anywhere in the town water system?

6. How do contour lines show in which direction a river is flowing?  
In what direction does Dix Brook flow? Uncas Brook? The headwaters of Mine Brook?

7. At which end of Beaver Pond is swampy land found? Can you suggest a possible reason for this?  
Why are a small dam and spillway necessary at the southern end of Silver Lake?

34. On the shelves are twenty-four piles of illustrated pamphlets, with which you will be working for the next few days. In each pamphlet is a study guide containing questions, completion exercises, matching exercises, and True-False exercises. All the material in these guides is important and useful, and to do A-level work you should complete at least twenty of them. However, only twelve are required for passing; these are lettered A, C, E, G, H, I, L, M, T, U, W, and Y. It is suggested that you begin with these, and do as many more as you can.
STUDY GUIDE - A

Water and Our Forests

United States Department of Agriculture

1. Why do the small, frequent floods do more agricultural damage than the larger, more spectacular floods? pp. 3 - 4

2. Explain the meaning of the Chinese proverb: "To rule the mountain is to rule the river." pp. 7 - 14

3. What happens to the soil when the plant cover or humus is destroyed by fire? pp. 11 - 12

4. Explain the causes of erosion in Figure 8, Figure 9, and Figure 11. pp. 11 - 15

5. What has led to the abandonment of thousands of acres in at least three major sections of the United States? pp. 15 - 18

6. What is meant by the term "protection forests?" Where can we find examples of these "protection forests" in Massachusetts? pp. 18 - 23, 26

7. How does science aid in protecting the soil against the force of untamed water? pp. 20, 23

8. Explain the following statements:
   a. Managing forest land for timber products alone, no matter how efficiently, may not always bring the fullest benefits to all the people.
   b. The health and economic security of nearly all Americans depend to a great extent on how well our forests are managed. pp. 23 - 29
STUDY GUIDE - B

Farm Land Development: Present and Future by Clearing, Drainage, and Irrigation

United States Department of Agriculture

1. Mark the following statements either true or false:

a. All unused land should be developed for farming. F

b. Many areas of woodland, if cleared and drained, could be used for crop production. T

c. Massachusetts has about 19,000 acres of undeveloped land which could be drained for crop production. T

d. Farm drainage and clearing methods can be used only in low areas of land. F

e. There is not enough accessible water to irrigate the land which is suitable for irrigation. T

f. Development of land by clearing and by drainage is a new method. F

g. The development of a productive farm from forest land frequently requires a long period of time. T

h. The depression had no influence on land clearing. F

i. Nearly two-thirds of the total land in organized drainage districts is in the Midwest. T

j. Removal of silt is a major cost in maintaining drainage. T

pp. 3 - 18
2. How may farm units in Massachusetts increase in size?  
pp. 21 - 22

3. Where are the greatest opportunities for expanded farming in the Northeast? Why?  p. 23

4. Develop this topic sentence: Creation of new farms depends heavily on drainage, flood control, and irrigation.
STUDY GUIDE - G

Influences of Vegetation and Watershed Treatment On Run-Off, Silting, and Stream Flow

United States Department of Agriculture

1. What is meant by the term "natural circulation of water"?  
   p. 4

2. How does the structure of the earth's surface prevent many floods?  
   pp. 4 - 6

3. Why is the humus of such value to the soil?  
   pp. 9 - 11

4. What are the principal factors influencing the effect of rainfall? Which one is the only one under the control of man?  
   pp. 15 - 16

5. What are the effects of clearing and cultivating without water and soil conservation measures?  
   pp. 28 - 32

6. Why is fire the most destructive agency of natural cover?  
   pp. 35 - 36

7. Explain this statement: Damage by sediment deposition on soils is a very important problem.  
   pp. 56 - 59

8. What is the value of the soil conservation experiment stations established by the Department of Agriculture?  
   pp. 68 - 69

9. What other conservation research is being carried on by other departments?  
   pp. 70 - 76
10. Define the following terms:
   a. Run-off
   b. Shoaling
   c. Infiltration
   d. Sedimentation
   e. Seepage
Safe Water For The Farm

United States Department of Agriculture

1. Figure 2, page 4, shows two earth strata diagrams. Which one is a possible source of good water? Why? pp. 2 - 5

2. By what method can rain water be used in farm cisterns? pp. 11 - 12

3. How can you determine the amount of water necessary for any size farm? pp. 12 - 13

4. Fill in the blanks: About ____ gallons of water are required to furnish the equivalent of one inch of rainfall for each ____ feet in a home garden. p. 13

5. Explain the various ways of storing water. What are the advantages of storage? pp. 39, 43 - 45
STUDY GUIDE - E

Food At The Grass Roots

Department of Agricultural Relations - TVA

1. Give several reasons why Congress established the TVA regional agency in 1933. pp. V - VI, 1 - 3, 92

2. Why was the Tennessee Valley chosen as a site for Federal aid and experiment? pp. 7 - 8, 18 - 19, 49 - 50

3. Describe a phosphate-deficient region. How does the picture change when adequate amounts of phosphate are added to the soil? pp. 9 - 15, 25, 35 - 48, 52

4. Why was water control so important to the Tennessee Valley farmers? pp. 19 - 23

5. What scientific problems faced Ivan Range, a young Washington County farmer? What has he accomplished so far? pp. 55 - 58

6. Complete the following: The TVA supplies the farmer with _____ if he provides an equal amount of _____. p. 63

7. Fill in the chart:

   Test-Demonstration Ladder

<table>
<thead>
<tr>
<th>Runge</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.</td>
<td>5.</td>
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<tr>
<td>4.</td>
<td>4.</td>
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<tr>
<td>3.</td>
<td>3.</td>
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<tr>
<td>Rungs</td>
<td>Results</td>
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<td>2.</td>
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<td>1.</td>
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pp. 63 - 65, 70 - 71

8. Explain at least four major recommendations for better farming discussed at length in this report.
STUDY GUIDE - F

Shall We Spend $2,000,000,000 More On The Colorado?

E. Churchill

1. Why is the Colorado River termed the "life line of the Southwest"?
   p. 28

2. What states are already fighting over the water-rights?
   pp. 28 - 29, 45

3. What is wrong with this often repeated statement?
   "Boulder Dam has harnessed the Colorado River."
   pp. 28 - 29, 45 - 49

4. How have other projects threatened the Boulder Dam water supply?
   p. 45

5. How have dams taken all the value out of silt? Why does silt still remain a great problem to the river engineers?
   p. 46, 48

6. What do you think of the plan to invest huge sums of money in additional dams and irrigation projects? Give reasons for your answer.
First Things First

United States Department of Agriculture

1. Why is it necessary to study your land before you start to use it? pp. 1 - 2

2. What is meant by the phrase "physical inventory of your land?" pp. 3 - 7

3. Why is it important to determine the soil depth before you plant any crops? pp. 4 - 5

4. How does the slope of your land influence its use? p. 6

5. Where can you obtain help when you decide to make your own land inventory? p. 7

6. What valuable types of information will be included in your farm blueprint? pp. 7 - 8
STUDY GUIDE - H

Our Remaining Land

United States Department of Agriculture

1. Why is productive land called our most valuable resource? p. 2

2. What two things make land productive? p. 2

3. What effect has soil erosion had on productive land in general? How much of our land is subject to erosion if it is not protected? p. 4

4. How would you define the term "soil conservation"? p. 5

5. What are the indirect benefits of soil conservation? p. 5

6. When did our government first begin to realize that erosion was a major problem in this country? What did Congress do about it? pp. 6 - 7

7. If you decided to have a farm blueprint made how would the Soil Conservation Service technician help you? pp. 9 - 11

8. In 1948 plans had been made for the better use of what percent of our farm land? p. 11
STUDY GUIDE - I

Conservation of Massachusetts Soils
Massachusetts State College Extension Service

1. Name three reasons which account for the low state of fertility in Massachusetts uplands. p. 3

2. Explain what is meant by "subsoil farming." p. 3

3. Fill in the following chart:

<table>
<thead>
<tr>
<th>Causes of accelerated erosion in Massachusetts</th>
<th>Methods of preventing erosion</th>
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pp. 4 - 6, 11 - 15, 16 - 19

4. Why is erosion prevention extremely important in Connecticut? pp. 6 - 9

5. What methods of soil conservation could be used by Franklin farmers? pp. 11 - 15

6. Do you know of any farm where these methods are in use?
7. In about one hundred words explain the following statement:

"Erosion of Massachusetts soils is widespread and in some localities a serious problem."
What Is A Conservation Farm Plan?

United States Department of Agriculture

1. Complete the following statements:
   a. Soil Conservation Service plans are designed to _____ and to _____.
   b. The district governing body of the Soil Conservation Service is made up of _____.
   c. Your application for a plan must be approved by _____.
   d. A map made by a soil scientist is called _____.
   e. The map will show how every acre is to be used and _____.

   pp. 2 - 3

2. How would you classify the land on your farm or the land on your neighbor's farm? Why?  pp. 4 - 5

3. What conservation treatments could be applied to woodland? What conservation treatments to pasture land?  p. 6

A Method Of Estimating The Economic Effects Of Planned Conservation On An Individual Farm

United States Department of Agriculture

1. Explain this statement: "Farm management and conservation planning are complementary aspects of good farming". pp. 1 - 3

2. Crop rotation benefits the land in two ways: _____ and _____.
   p. 3

3. What is meant by the phrase "carrying-capacity of a pasture"? pp. 3 - 5

4. Complete this statement: Improvement in the quality of roughage may increase _____. p. 5

5. Explain this statement: "The cost of controlling erosion will vary with the seriousness of the conditions". pp. 16 - 19


7. What is the most satisfactory type of subsoil? Why? p. 20

8. Explain this statement: Erosion not only affects the farmer, but affects society as a whole. p. 21
STUDY GUIDE - L

Our American Land: The Story of Its Abuse and Its Conservation
United States Department of Agriculture No. 596

1. What are the differences between natural erosion and accelerated erosion? p. 4

2. Why is the erosion problem worse in the southern part of the United States? p. 4

3. What is meant by the phrase "maintaining the productivity of the land"? pp. 5 - 6

4. List and explain at least five of the "tools of conservation". pp. 6 - 8, 21 - 25

5. Tell whether the following statements are true or false:
   a. Soil conservation districts are local units of government which operate under State Laws. T
   b. Local farmers have no authority. F
   c. Farmers have cooperated in order to protect their lands. T
   d. The Soil Conservation Service makes out conservation plans for each farmer. T
   e. The Federal government does not help the Conservation Service. F
   f. Conservation plans are limited to only a few conservation measures. F
g. The Soil Conservation Service makes plans only for the present improvement of our land.

h. Class IV and Class V land is used for "cash crops".

i. Crop rotation is often used with strip cropping.

j. Conservation farming plans fit the land, fit the farm, and suit the farmer.

pp. 8 - 30
STUDY GUIDE - M

More Food From Fewer Acres

J. I. Case Co.

1. Give several reasons why agriculture may be called our most important industry. p. 2

2. One hundred years ago eighty percent of the people lived on farms; today eighty percent of the people live in cities or towns. Explain this change. p. 3

3. How does machinery aid in carrying out our conservation measures? pp. 4 - 7, 10 - 15

4. What are the raw materials necessary for the production of food-stuffs and materials for clothing? p. 4

5. The green top growth of grasses and legumes is often plowed under. Why? pp. 4 - 5, 8


7. Why is our practice of hilling potatoes a conservation measure? p. 10

8. Why should alfalfa be cut soon after the blooms start? p. 12

9. Of what value to the farmer is a silo? p. 14
1. Astonishingly, many things we use in our everyday life are made or partly made from farm products. Match the following correctly.

a. felt hat  
   soybeans

b. paste  
   peanuts

c. automobile steering wheel  
   honey

d. synthetic wool  
   trees and cotton

e. rayon  
   sweet potatoes

f. soap  
   milk

g. golf balls  
   castor oil

h. airplane lubricant  
   soybeans

i. paint  
   milk

j. explosives  
   corn

k. margarine  
   flax

l. ink  
   cottonseeds

pp. 3 - 14

2. Of what value is the chemurgist to the farmer?  p. 4

3. Why is the soybean called "the versatile soybean"? How does this bean affect your life?  pp. 8 - 9

4. Complete this statement: Cottonseeds used to be thrown away; today they are worth over _____ to the southern farmers.  
   p. 10
5. Why was Dr. George Washington Carver known as "the goober wizard"?
   pp. 11 - 12

6. After reading this pamphlet does conservation of our natural resources seem more important to you? Why?
STUDY GUIDE - 0

The Land Renewed; The Story of Soil Conservation

W. Van Dersal and E. Graham

1. Why is the condition of the soil of such importance to each one of us? p. 11

2. Define soil structure. Give two reasons why good soil structure is very desirable. p. 13

3. Explain what you think must have happened to the land shown in the picture on page 18.

4. How much money has erosion cost us in the last ten years? p. 19

5. How were the farmers themselves responsible for the "dust bowl"? p. 27

6. What soil conservation measure was used at least three thousand years ago? p. 31, 41

7. Explain the difference between "straight furrows" and "level furrows". Where can you find examples of each? p. 37, 39

8. Why are many soil conservation measures aimed at getting more humus into the soil? pp. 53 - 63

9. Is the "burning over" of land good for the soil? pp. 50 - 51, 81

10. How can the farmers and scientists work together on soil conservation measures? pp. 101 - 109
1. Explain one example of the effects of soil abuse on a civilization.  
pp. 6 - 10

2. How much time is required to form one inch of soil? Explain the process of soil formation.  
pp. 10 - 11

3. Is this statement true or false? "The migration of men to the city is based upon fertile soils." Explain your answer.  
pp. 12 - 13

4. What is meant by the statement that we have surpassed the world in soil exploitation?  
pp. 13 - 14

5. Give three reasons why the U. S. Soil Conservation Service is of such great value.  
pp. 14 - 15

6. What can we do in this town in the interests of soil conservation?  

7. What percent of our farm land today needs some type of conservation treatment?  
p. 20

8. Write a short essay using this topic sentence: A fertile soil is a nation's fundamental resource.
STUDY GUIDE - Q

We Are Plowing A New Dust Bowl

Wessel Smitter

1. What section of the country has been nature's richest gift to the farmer? Why? What is its best crop? p. 12

2. What caused the dust bowl in the thirties? pp. 64 - 65

3. Why do many of the United States Soil Conservation men fear we are heading for another dust bowl in the near future? p. 13

4. Why is the "big operator" farmer a menace? p. 64

5. How did the real farmers cooperate with the Soil Conservation Service men? Why has this cooperation decreased since 1947? p. 64
Revolution on the Farm
John Dos Passos

1. What is meant by a "revolution in agriculture"?
   p. 97

2. How does the "upward spiral" work?
   p. 98

3. What is the value of nitrogen to the farmers of Iowa?
   p. 98

4. Farmers have discovered a way to use corncobs to great advantage.
   Describe this method.
   p. 98, 101

5. The land in Poverty Ridge, Platte Valley, Iowa, used to sell for
   fifteen dollars an acre. Now it is worth more than one hundred
   dollars an acre. Why?
   p. 101
STUDY GUIDE - S
Pastures To Hold And Enrich The Soil

United States Department of Agriculture No. 1900

1. Explain the following statement: "The process of making topsoil is very complex". pp. 1 - 2

2. Why is putting land into properly managed pasture called a soil-building practice? pp. 1 - 4, 11 - 12

3. Complete this statement: Using land in accordance with its use capabilities requires as a general principle that _______.

4. Complete this statement: Classification of land as pasture land is determined by _______. pp. 5 - 10

5. Why is the scarcity of pasture land a national problem? Give at least three reasons. pp. 3 - 5, 14
1. Explain this statement: "Strip cropping is a combination of good farming practices". pp. 1 - 15

2. State three principal advantages of the strip cropping system. pp. 1, 16 - 22

3. How can strip cropping be used to advantage on the farms in this part of the state? pp. 22 - 31

4. What rotations are used in this locality?

5. On what type land is strip cropping one of the most effective conservation practices? pp. 5 - 6

6. Write a short explanation of this statement: "Strip cropping in different localities takes on various field patterns". pp. 22 - 46
STUDY GUIDE - U

Legumes In Soil Conservation Practices

United States Department of Agriculture No. 163

1. Why are "cover crops" important? pp. 2 - 3, 7 - 8

2. Complete the following:
   
   a. _____ is a perennial vine suitable for the control of steep gullies.
   
   b. _____ is a perennial used as a permanent strip or buffer crop in this district.
   
   c. With the exception of ____, ____ , and ____ summer annuals are rarely used north of Missouri.
   
   d. A growing crop of ____ will protect soil which does not freeze in winter.
   
   e. The best crop for soil improvement of sandy land is ____.

   pp. 2 - 8

3. Why is the prevention of erosion a more important problem than soil improvement? p. 8

4. Name and explain the three main values of legumes. p. 8
1. Explain why tall fescue is a good grass for conservation farm planning:
   a. For pasture land
   b. For cropland
   c. For steeply eroded land
   d. For waterways
   pp. 2 - 3

2. Complete these sentences:
   a. Tall fescue left on the land two or more years develops ____ that ____.
   b. As a result the soil is improved and ____.
   c. Tall fescue grows best on soils rich in ____.
      p. 4
STUDY GUIDE - W

Use The Land And Save The Soil

United States Department of Agriculture


2. How many Federal regional agencies are there in the United States? What is the work of these regional offices? pp. 4 - 5

3. What soil and water conservation problems would be typical of this area? pp. 6 - 7

4. Why is an aerial photograph the first step in farm conservation planning? p. 8

5. What factors determine crop rotation planning? pp. 10 - 11

6. Explain the value of grassed waterways. p. 13

7. If you adopt soil and water conservation measures how long do you have to wait before your income increases? p. 14

8. List and explain some of the ways of controlling streams. p. 16
STUDY GUIDE - X

Liming Soils

University of Massachusetts Extension Service

1. Complete the following:
   a. Massachusetts soils are naturally ____.
   b. Lime is the source of two plant foods — ____ and ____.
   c. Soils become acid because ____.
   d. Soil acidity can be measured by ____.
   e. The ideal soil reaction figure is ____.
   f. Soils are more acid during ____.
   g. Too much lime is bad because ____.
   h. To discover how much lime your soil contains it is necessary to ____.
   i. Magnesium limes are best because ____.
   j. Soils high in organic matter require more lime because ____.

2. What is the best way for the average farmer to get his lime?

p. 8
VISIT TO THE CHILDREN'S MUSEUM
60 BURROUGHS ST., JAMAICA PLAIN, MASS.

Geology Room

1. Notice the large slab of polished Quincy granite. At the turn of the century this dark, coarse-grained rock was famous. But for building purposes reinforced concrete is cheaper and just as strong and monument lettering stands out better on lighter stone, so today only one of the thirty Quincy quarries is in operation.

2. Volcanic breccia and Roxbury conglomerate both consist of large particles cemented together by finer materials. What is the difference in the shape of the large particles in these two rocks?

3. You are visiting the geology room with a friend, who notices the boulder containing the diabase dike. "Are the two halves of this rock stuck together with tar?" she asks. Answer this silly question.

4. Notice the striated boulder. Why couldn't we find any striations at Purgatory Chasm, although this is probably a glacial trough?

5. In Arizona, book ends are made from quarters of petrified log sections. The tan colored petrified wood is preferred; book ends made from it sell for twenty dollars a pair, while those made from more brightly colored wood sell for somewhat less. Did the wood in these buried logs actually turn to stone?

6. Describe the process by which fossils are made.
VISIT TO HARVARD MUSEUM

OXFORD ST., CAMBRIDGE, MASS.

Geology Section

As you can see by studying the plan of the Mineralogy Room of the Harvard Museum, there are many more minerals than we have studied in class, but the number of important ones is not overwhelmingly larger. You will have copies of the Mineralogy Handbook with you to look up any minerals with which you are not familiar. If any interest you which are not in this pamphlet, jot down the names and look them up in (?) tomorrow.

1. Be sure to notice the Uranium Ores. What color is uraninite? This oxidizes or alters to what colors? What color is carnotite?

2. The gold collection was given to the Museum without any provision for safekeeping. It was necessary to sell part of the gold to buy the burglar-proof display case. Yes, it is burglar-proof. If we are here at closing time you may see the attendant lowering the glass-covered case and the cover coming down.

3. What is the shape of quartz crystals? How do they differ in shape from calcite crystals?

Geology Rooms

4. Notice the sample of Quincy granite. See the logs of petrified wood on the floor and in case #10. Also the gneiss in #13.

5. What is amber? Of what use in beryl? Look at the pegmatites in cases #4, 5, and 6. What is a pegmatite? (5:15)

6. Observe the four or five coarse-grained igneous rocks. They are:

   1_____  2_____  3_____  4_____

   5_____.


7. Six fine-grained igneous rocks to be seen in this room are:
8. Four glassy igneous rocks are:
9. What is tuff?
10. In the case displaying sedimentary rocks we see that sand, clay, and pebbles may become ________, ________, and ________, respectively.
11. How is marble formed? How do coquina limestone and chalk differ in origin? What is chert?
12. When subjected to great heat (but not enough heat to melt them) and pressure within the earth
   Sandstone is metamorphosed or changed to _______.
   Shale changes to ________.
   Conglomerate shows _________.
   Limestone changes to ________.
   Granite changes to ________.
   Peridotite changes to ________.
   Actinolite schist and talc schist change to ________.
13. Some minerals of metamorphic rocks seen here are:
14. List six evidences of glaciation in the Boston basin:
15. See the glacial striae on the large slab against the wall. Also explain the cause of the columnar jointing of the basalt columns.
16. See the ripple marks in shale and sandstone. See the raindrop marks.
17. What five types of weathering are shown in examples here?
18. Be sure to see the meteorites in the meteorite room. In the same room list the works of water shown by the water windows.
VISIT TO THE NORFOLK AGRICULTURAL SCHOOL
WALPOLE, MASS.
Soil-Testing Laboratory

You have all seen sulfuric acid \( \text{H}_2\text{SO}_4 \), which is strong enough to dissolve iron nails; and boric acid \( \text{H}_3\text{BO}_3 \), which is weak enough to be used as an eyewash. Note that both of these acids begin with \( H \) which stands for the Hydrogen atom. There are hundreds of acids, but all of them are acid because when mixed with water they produce charged Hydrogen atoms, called Hydrogen ions. Strong acids produce many \( H \) ions; weak acids produce few. To measure the strength of acids accurately, a unit called the \( \text{pH} \) unit was devised. In the \( \text{pH} \) scale, which runs from 0 to 14, 7 is the neutral point, 6 is slightly acid, 5 is more acid, 4 is still more, and so on down to 0.

You are also aware that some substances such as lye, are alkaline, that is, they will neutralize acids. In the \( \text{pH} \) scale, a solution or soil of \( \text{pH} \) is slightly alkaline, a solution of \( \text{pH} \) 9 is more so, and so on up to 14. Just remember 0 is very, very acid, 7 is neutral, and 14 is very, very alkaline.

Use this guide during the demonstrations and write answers to the questions on these sheets.

1. What is the most important part of the topsoil, for farming purposes?
2. Describe the proper way of taking a soil sample.
3. How many samples should be taken from a field? According to what plan? What container is most convenient for sending samples?
4. Why should the soil sample be sifted before testing? Give two reasons.
5. A small paper cup is half-filled with soil and enough distilled water added to make a mixture having the consistency of heavy cream. Why must distilled water, not tap water, be used?
6. The glass-electrode potentiometer measures the acidity of this solution directly. What \( \text{pH} \) is most suitable for growing potatoes? For alfalfa?
7. Exactly why is an acid soil toxic to some plants?

How much lime is required on an acre to change the \( \text{pH} \) from one value
to the next, as from 5 to 6.

8. What is the advantage of buying lime from the local Production and Marketing Administration? Why has the U. S. Government set up this agency?

9. What would be the effect of spreading too much wood ashes on a potato field?

10. How often should fields be tested? In the event that a field was too alkaline, which seldom happens around here, how could it be acidified?

11. The tests for other important elements in the soil are based upon the amounts of soluble nitrates, phosphates, etc., in the soil. As you will see, 1 measure of soil is put into the test tube, 15 cc. of distilled water and a few drops of a weak acetic acid solution are added and the mixture shaken for one minute. This stimulates the action of water dissolving soil ingredients. The mixture is then filtered, and the filtrate is tested for nitrogen, phosphorus, potassium, calcium, etc., using various color tests. What is meant by a 5-8-2 fertilizer? If a fourth number is added, to what element does it refer?

12. Why is daylight preferable when one is testing soils?

13. Why is it a good idea to sow a cornfield to winter rye or vetch in the fall?
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<thead>
<tr>
<th>STUDENT REFERENCES</th>
<th>Ref. No.</th>
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<tr>
<td>Cormack, M.B., <em>The First Book of Stones</em>, Franklin Watts, Inc. 1950.</td>
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</table>
PAMPHLET REFERENCES ON
SOIL CONSERVATION


C Influences of Vegetation and Watershed Treatment on Run-off, Siltting, and Stream Flow, - U.S. Department of Agriculture, Forest Service and Soil Conservation Service, No. 397, 1940.


H Our Remaining Land: We Can Use It and Save It, - U.S. Department of Agriculture Soil Conservation Service, No. 79, 1949.


R  Revolution On The Farm, - John Dos Passos, 1948.
S  Pastures To Hold And Enrich The Soil, - U.S.Department of Agriculture, No. 1900, 1945.
V  Using Tall Fescue In Soil Conservation, - U.S.Department of Agriculture, No. 254, 1949.
W  Use The Land And Save The Soil, - U.S.Department of Agriculture Soil Conservation Service, No. 71, 1949.
OPTIONAL ACTIVITIES

1. Many of the surface features of our locality are due to the glacial ice sheets which formerly covered the region. Read (2: Chapter XIII, pp. 196 - 224) for information on glaciers and glacial effects. Of what are kames and eskers composed? What is the origin of the gravel in our gravel banks? The hill gravel pit of the Franklin Cement Block Co. is a kame. What is an erratic?

Now examine the map of the surficial geology of the Brockton Quadrangle. A glance at the Index to Topographic Maps reveals that the Brockton Quadrangle is due east of the Franklin one, and only three removed from Franklin.

How many of the eleven color codes in the Explanation of this map refer to features shaped by the glacier?

In what type place are glacial striae found?

About how long are the drumlins shown on this map? Which end of a drumlin is the steeper end? How does the drumlins' alignment compare with the direction of the glacial striae?

What is the shape of the eskers shown here?

What is an outcrop?

Now let us look at the surficial geology of the Pawtucket Quadrangle, which is the one directly south of ours. Since only a few quadrangles in Massachusetts have had this type map completed, we are fortunate that two of them are so close.

What surface feature present in the Brockton area is absent in this one?

Notice the location of Sneech Pond and Diamond Hill; in the outcroppings there, numerous minerals can be found.

2. Read pp. 20 - 22 in The Geology and Ground-Water Resources of the Pawtucket Quadrangle, R.I., and compare this with the clipping from the Woonsocket Call of March 15, 1951, which deals with mineral resources of the same area. Notice especially the last sentence of the newspaper report.

Look in the "Glaciers" folder for pictures of a glacier's source,
tributaries, lateral and medial moraines, glacier's snout, glacial lakes, U-shaped valleys, moraine damming mountain stream in Andes, and icebergs.

3. Make a rock and mineral collecting trip to the Diamond Hill and Sneech Pond areas. Label each mineral with the locality in which it was found as you collect it. Try to find the indicated striae in the two places north of Sneech Pond. Consult 8 - pp. 17, 18, 21, 31, and 32 for what to look for. Make a list of minerals and features and their directions. Transportation will be supplied.

4. Perhaps you would be interested in estimates of the age of the earth. Read the pamphlet How Old Is the Earth? by H. E. Vokes, to find the answers to these questions:

1. On what do geologists base their time scale? Into what five major sections is this time scale divided?
   pp. 3 - 5

2. Why are fossils of such major importance to the geologist? Who discovered their importance?
   p. 6 - 7

3. Why is the Grand Canyon of the Colorado "the greatest single window through which we may obtain a glimpse into the geologic past"?
   pp. 7 - 11

4. What is an unconformity? (5: 259 - 260) How can we estimate the lapse of time between the deposition of the lower and upper layers in an unconformity? Why is the unconformity at the top of the Proterozoic layers in the Grand Canyon so interesting?

5. How can the age of uranium deposits be calculated?
   pp. 17 - 22

6. How can the age of rocks be estimated from their helium content?
   pp. 22 - 24

7. What is the estimated age of the earth according to these geological studies?

5. If you are interested in dinosaurs, read DINOSAURS, a pamphlet by Edwin H. Colbert of the American Museum of Natural History. Answer these questions:

1. How have we learned about the structure of dinosaurs?
   pp. 4 - 6

2. Where do the dinosaurs belong in our geologic time scale?
3. For about how many years did the dinosaurs rule the land? p. 7

4. Compare the size of the dinosaurs with that of elephants and whales. p. 11


6. There were many kinds of dinosaurs. What were some of the differences among the various species? pp. 11 - 24

7. Why did these animals disappear? p. 26

8. What was the next group of animals to develop on the earth? p. 9, 27

6. Send a sample of soil from your farm to the Norfolk Agricultural School for analysis. Bring the analysis to class and report on methods, cost, etc., of following the recommendations of the School.

7. Send a letter with a dollar in it to School Children, Cripple Creek, Colorado, for a chunk of gold-bearing ore from a gold mine. You will be helping them to finance a new school.

8. Visit the Hall farm on South Street to see the conservation measures described in the Franklin Sentinel of Dec. 7, 1950. The newspaper clipping is on the bulletin board.

9. Read THE EARTH'S CHANGING SURFACE pamphlet and make a list of all the agents changing the earth's surface mentioned in this booklet.

10. Consult Compton's Pictured Encyclopedia to secure the 1948 figures on erosion:

   a. How many tons of soil are lost each year in the United States by wind and water erosion?
   b. Rains remove annually ___ times as much plant food from the soil as is taken by crops.
   c. About _____ of all American farms are already seriously eroded.

11. Make a sketch of your farm. Classify each type of land. What conservation measures could be started?
12. Prepare a class report on one of the following conservation projects:
   a. Central Valley Project
   b. Missouri Valley Authority
   c. Boulder Dam
   d. Tennessee Valley Authority
   e. Grand Coulee Dam

13. Visit a fire tower and interview the fire watcher, or visit a state forest and interview the state forester or a state fire warden. Locations of fire towers and state forests are shown on the Map of State Forests and Other State Reservations. Report to the class on what you learned.
CHAPTER III
TEST FOR EARTH SCIENCE UNIT

PART I

Directions: Select the word which makes each sentence correct. Place the letter (which is just before) that word in the numbered space at the right-hand side of the paper. Do not write the word, only the letter.

1. The luster of a mineral may be described as (a) conchoidal (b) greenish (c) glassy. 1. __
2. Streak is important in recognizing minerals because the mineral may have a different (a) color (b) luster (c) fracture when powdered. 2. __
3. A common green mineral in igneous rocks is (a) malachite (b) emerald (c) olivine. 3. __
4. Feldspar metamorphoses to (a) marble (b) kaolin (c) slate. 4. __
5. The hardest of the following three minerals is (a) feldspar (b) calcite (c) gypsum. 5. __
6. Steel will scratch (a) quartz (b) corundum (c) flägrite. 6. __
7. Very red or yellow-colored soils contain much (a) aluminum (b) iron (c) cinnabar. 7. __
8. Very red or yellow-colored soils are less fertile than colorless or black soils, because the latter contain more (a) minerals (b) volcanic ash (c) humus. 8. __
9. An example of a sedimentary rock is (a) slate (b) shale (c) breccia. 9. ___
10. The grains in a sedimentary rock may be cemented by (a) magma (b) quartzite (c) calcium carbonate.

11. The most effective agent of mechanical weathering today is (a) frost (b) cold rain (c) glaciers.

12. Rocks containing calcium carbonate will slowly dissolve in water containing dissolved (a) salt (b) oxygen (c) carbonic acid.

13. If the speed of a stream doubles, it can move (a) 2 times (b) 64 times (c) 1000 times as much as solid material.

14. The least noticeable type of mechanical erosion is (a) sheet erosion (b) gullying (c) run-off.

15. To raise crops most efficiently a farmer needs (a) a green thumb (b) a strong desire to be a farmer (c) chemical analysis of his soil.

16. To change the acidity of the soil from pH 7 to pH 6 we could spread (a) lime (b) sulphur (c) ammonium sulfate, on the soil.

17. Rich soil may be covered with unfertile material by (a) harvests (b) floods (c) spring thaws.

18. Forest fires in the mountains may be followed by (a) storms (b) earthquakes (c) floods.

19. Practically all underground water came (a) down from the surface (b) up from the ocean by capillary action (c) from underground rivers.

20. We can control run-off most easily by controlling (a) type of storm (b) type of soil (c) type of plant cover.

21. The greatest amount of agricultural damage is caused by (a) flash floods (b) small, frequent floods, (c) thunder storms.

22. Reservoirs are often made unusable because of (a) sedimentation (b) drainage (c) rainfall.

23. Erosion and run-off problems often originate on lands which have been (a) reforested (b) overgrazed (c) irrigated.
24. The development of a productive farm from forest land requires (a) only a few weeks (b) a long period of time (c) about a year. 24.  

25. Removal of silt is a major cost in maintaining (a) drainage (b) watersheds (c) cisterns. 25.  

26. Massachusetts has about (a) 50 (b) 20,000 (c) 1 million acres of underdeveloped land which could be drained for crop production. 26.  

27. Humus of great value is made by (a) organic matter (b) moisture content (c) lime. 27.  

28. In regions deficient in (a) potash (b) sulphur (c) phosphate animal and plant growth is extremely poor. 28.  

29. The Colorado River is controlled by (a) Grand Coulee (b) Boulder Dam (c) Norris Dam. 29.  

30. Most cultivated crops grow best on (a) shallow soil (b) sandy soil (c) deep, dark-colored soil. 30.  

31. Land is made unsuitable for cultivation by (a) humus (b) a hardpan layer (c) a gentle slope. 31.  

32. Good topsoil and (a) water (b) weathering (c) plowing make land productive. 32.  

33. Much of the land in Massachusetts is not very fertile because (a) it is subsoil (b) it has not been used enough (c) the climate is bad. 33.  

34. One of the most rapid forms of erosion is caused by (a) sheet erosion (b) soil stripping (c) ice. 34.  

35. Erosion prevention is extremely important in Connecticut because of the serious damage caused by (a) biologic (b) gully (c) sheet erosion. 35.  

36. Strip cropping is best when combined with (a) terracing (b) rotation of crops (c) contour farming. 36.  

37. The problem of soil erosion is most serious in (a) New England (b) the Far West (c) the South. 37.  

38. The term "Soil Conservation" means (a) the scientific use of land (b) the proper cultivation of land (c) the fertilization of land. 38.
39. It takes (a) 10 years (b) 200 years (c) 400 years and more of natural soil building to form one inch of soil. 39._____

40. The most effective cover crop is a combination of grasses and (a) corn (b) legumes (c) potatoes. 40._____

PART 2

Directions: On the numbered lines at the right-hand edge of the page place the letter of the word which goes best with each numbered phrase.

A. Feldspar 41. Pile of rock fragments at base of cliff. 41._____
B. Muscovite 42. Hill of gravel left by glacier. 42._____
C. Pyrite 43. Lab tables and sinks 43._____
D. Erratic 44. Sidewalls for houses 44._____
E. Moraine 45. Electrical insulation 45._____
F. Gypsum 46. Aged copper roofs 46._____
G. Talus 47. Fool's gold 47._____
H. Malachite 48. Wood ashes 48._____
I. Talc 49. Scouring powder 49._____
J. Lime 50. Ice-moved boulder 50._____

PART 3

Directions: Indicate to which class each of the following rocks belongs by placing the correct letter in the numbered blank spaces. Letters may be used more than once. Example: Sandstone is a sedimentary rock, so we would place the letter B in the blank space to the right of No. 50 sandstone. 50 B
51. Soapstone
52. Slate
53. Gneiss
54. Obsidian
A. Igneous
55. Limestone
B. Sedimentary
56. Conglomerate
C. Metamorphic
57. Basalt
58. Marble
59. Chalk
60. Gabbro

PART 4

Directions: Indicate which phase of stream development is described by placing the correct letter in the blank space beside numbers 61 to 70.

61. Wide flood plain
62. Meanders
A. Youthful stream 63. Beginnings of a flood plain
B. Mature stream 64. No flood plain
C. Stream in old age 65. V-shaped valleys
66. Natural levees
67. Swamps and lakes in uplands
68. Many falls and rapids
69. No falls or rapids
70. Rather straight course
PART 5

Directions: Add the word that completes the statement:

•••••••oe••••••••••

71. Chalcopyrite is a mineral containing the valuable metal _______.
72. Galena is a mineral containing the valuable metal _______.
73. Sphalerite is a mineral containing the valuable metal _______.
74. Hematite is a mineral containing the valuable metal _______.
75. Bauxite is a mineral containing the valuable metal _______.
76. The word used to describe the shape of the land is _______.
77. The only part of the soil that can be used for growing crops is called the _______.
78. Ridges of glacial sand and gravel are called _______.
79. Glaciers produce ____-shaped valleys.
80. Uranium deposits furnish important clues to the age of the earth because we know the rate of _______ of uranium.
81. Although an unconformity represents a gap in the record of the rocks, we can estimate the lapse of time it involves by means of the _______ in the rocks.
82. Dinosaurs were more closely related to the _______ than to the mammals.
83. It is believed that changes in _______ wiped out the dinosaurs.
84. Phosphorus can be added to the soil in the form of _______.
85. A conservation measure taken on the Hall farm in South Franklin is _______.

67
86. Tests for minerals in the soil are based upon the _______ produced when the dissolved mineral compounds are mixed with certain reagents.

87. Crops remove less plant food from the land than _______ removes.

88. Dams are good for preventing erosion, but _______ are better.

89. Write a 100 word paragraph on "Why Soil Conservation Pays".
CHAPTER IV

EVALUATION OF THE UNIT

The pictures on pages 70 and 71 show that in this community, as perhaps in many, it cannot be taken for granted that everyone knows and practices erosion prevention. Even the simplest soil-saving procedures need to be taught, and a Science class seems an appropriate place to teach them. Several of the boys in the class were farmers or had worked on farms, and most of the rest had gardens. Therefore, it was rather easy to interest them in a unit on the soil.

Activities guides to the museums were found superior to lecture tours, in that the students were less susceptible to distraction when examining the exhibits in small groups and talking things over among themselves.

The lesson on the Topographic Map of the Franklin Quadrangle was well received except for the exercises on latitude and longitude. The boys required excessive help in doing the figuring. This might mean that the exercises were too difficult for Grade 11, or that General Course students just do not like mathematics. In either case, the time spent on this feature of the maps was not rewarding.

Three of the pamphlet references were unsatisfactory because
they did not have the right format to capture the interest of high school students. They were also too technical for this particular group. These were: Farm Land Development, Influences of Vegetation, and A Method of Estimating the Effects of Planned Conservation; pamphlets No. 2, 3, and 11.

The unit emphasized the fact that natural gradational processes cannot be prevented and that the erosive forces in the atmosphere, in moisture, in temperature changes, and in gravity are always at work. Studying these omnipresent forces from the geologist's point of view seemed to strengthen the realization of how surely they can destroy the ignorant and uninformed farmer, and the conviction that all known modern methods must be used to minimize their effect. Most of the boys evinced great interest in, and all enjoyed, this experiment in combining Earth Science and Conservation.
Downhill rows in a Franklin potato patch, showing nascent gullies

Cornfield on same hillside, with gullies forming between the rows
Downhill furrows on a large Franklin farm

Part of conglomerate ledge near Mill River, Wrentham
BIBLIOGRAPHY

TEACHER'S REFERENCES

- American Association of School Administrators - Twenty-Ninth Yearbook Conserva­tion Education in Our American Schools. 1951.
  A general survey of the need for conservation and a résumé of what has been accomplished. Includes specific guides for schools and reference and film lists.

- Association for Supervision and Curriculum Development of the N.E.A. 1948 Yearbook Large Was Our Bounty: Natural Resources and the Schools.
  A study of school conservation practices. Stresses the importance of conservation in our plans for the future.

  Discusses educational principles and the need for conservation.


  Places to go on mineral collecting trips.


  General survey of conservation principles.


Fink, Ollie E. Conservation for tomorrow's America. Ohio Division of Conservation and Natural Resources, Columbus, Ohio, 1944.


Includes the principles and problems of conservation and suggestions for teaching.

Osborn, Fairfield *Our Plundered Planet* Little Brown, Co. 1948.
Story of man's destruction of natural resources. Discussion of what can be expected in the future.

Petrology without the use of the microscope for students of geology, engineering, mining, or architecture.

Factual information on conservation measures.

Renner, George T. *Conservation of natural resources: An Educational Approach to the Problem* John Wiley and Sons 1942.


Discussion of the question of man's ability to beat the problem of erosion.

Smith, Guy-Harold, editor *Conservation of Natural Resources* John Wiley and Sons, Inc. 1950, with 21 contributors.


Scope of problem on erosion. How science helps the farmer.


Whitaker, J. Russell *Life and Death Of the Land* George Peabody College Press 1946. The story of how our resources have been destroyed.


VISUAL AIDS LIST

Geology films suitable for use with this unit are listed below. All are 16 mm. sound. Number refers to number of reels (10 minutes). Initials refer to sources; these are explained at end of the list.

Alaska's River of Ice 1 Color (B) Source, structure and movements of an Alpine valley glacier.

Birth of a Volcano 1 (S) Story of Paricutin.

Earth's Rocky Crust 1 (EBF) (MDE) Formation of igneous, sedimentary, and metamorphic rocks, weathering.

Geological Work of Ice. 1 (EBF) (MDE) Ice fracturing rock. Advance and retreat of glaciers.

Ground Water 1 (EBF) Artesian systems, springs, water table, caves.


Mountain Building 1 (EBF) (MDE) Explains diastrophism, faults, anticlines, synclines, geosynclines, and unconformities.

Story of the Mountains 4 (I) Changes in the earth's surface by volcanoes and earthquakes.


Wearing Away of the Land 1 (EBF) Processes which move the soil from one place and build it up in another.

What Makes a Desert 1 (I) Factors creating a desert. Reclamation by irrigation.

Work of Rivers 1 (EBF) Erosion cycle of surface water; cycle of a river.

Work of Running Water 1 (EBF) (MDE) Formation of deltas and flood
plains. Aerial pictures.

Explanation of INITIALS

(B) Baily Films, Inc., 2044 N. Berando St., Hollywood 27, California.


(I) Ideal Pictures Corporation, 28 E. 8th St., Chicago 5, Illinois.


CONSERVATION FILMS LIST

These are all 16 mm. sound films, free except for postage charges. Initials are explained below.

Erosion 10 min. SCS The story of man-made erosion.
Harvests for Tomorrow 27 min. SCS How to rebuild soil in New England.
In Common Cause 20 min. SCS Soil Conservation Districts at work.
Know Your Land 13 min. color SCS Classification of land and how to use it.
The Living Rock 30 min. color TVA Relation between people's needs and needs of the land.
Muddy Waters 9 min. SCS Man's abuse of the soil in Southwest.
People Together 35 min. color SRF How people can work together for soil conservation.
Permanent Agriculture 30 min. IH Simple procedures like terracing, contouring etc.
Planning to Prosper 22 min. color AC Latest developments in farming practices.
The Plant Speaks; Soil Tests Tell Us Why 10 min. color API How to take soil samples and where. Value of soil tests.
The Plant Speaks Through Deficiency Symptoms 25 min. color API
The Plant Speaks Through Leaf Analysis 18 min. API
Raindrops and Soil Erosion 21 min. color SGS Surface run-off erosion.
The River 35 min. SGS The story of the Mississippi River, its
past and present condition.

Save That Soil 11 min. Soil conservation measures, use of legumes, fertilizers.

Soil and Water Conservation 9 min. SCS Proper land use and conservation measures.

Strips and Curves 22 min. color JIC How strips prevent erosion.

This Is Our Land 28 min. E Soil destruction in the United States.

Topsoil 10 min. SCS The story of one of America's richest treasures.

Water 9 min. SCS The values of water, and its powers of destruction when uncontrolled.

Water for a Nation 20 min. SCS Water conservation methods in different regions.

What's in the Bag 18 min. NFA Sources of supply for nitrogen, phosphoric acid and potash.

Explanation of INITIALS

AC Allis-Chalmers Manufacturing Co., Photographic Dept., Tractor Division, Milwaukee 1, Wisconsin.

API American Potash Institute, 1155 Sixteenth St., N.W. Washington 6, D.C.


JIC J.I. Case Co., Inc., Racine, Wisconsin, or 360 W. Jefferson St., Syracuse 1, New York.

NFA National Fertilizer Association, 616 Investment Bldg., Washington 5, D.C.


SRF Sears Roebuck Foundation, Peoria, Illinois.
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CONTENTS OF THE CHILDREN'S MUSEUM LENDING DEPARTMENT COLLECTION:

COMMON MINERALS AND THEIR USES

12 Pictures
12 Cards

Cinnabar and Galena mounted with mirror and lead reindeer
Native copper, Azurite and Malachite with copper penny
Talc with can of talcum powder
Bauxite with aluminum measuring spoons
Kaolin and Feldspar with glazed dog and dish
Hematite with miniature iron rail
Carbon: diamond ring, anthracite coal, bituminous coal
Pyrrhotite and Graphite with nickel-plated screw and pencil
Halite and Chalk with piece of blackboard chalk
Chrysolite with asbestos fiber and asbestos tile
Cassiterite and Sphalerite with tin plated clamp and lead strip
Sulphur candle

CONTENTS OF THE CHILDREN'S MUSEUM LENDING DEPARTMENT COLLECTION:

GEOLOGY OF THE BOSTON BASIN

14 Cards with pictures
10 Cards with Rock Samples:

Quincy Granite, Polished and Unpolished
Breccia and Roxbury Puddingstone
Diabase in Limestone and an Eroded Pebble
Fossil Coral and Fossil Sea Urchin
Sandstone and Quartzite
Coquina and Limestone and Marble Samples
Clay, Shale, Slate
Specimen of Folded Rock
Rock with Glacial Striations
Squantum Tillite