GEORGIA INSTITUTE OF TECHNOLOGY — OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[X] ORIGINAL [ ] REVISION NO. ______

Project No. E-19-601 R5928-0A0 GTRC/~~GIT~~ XXX DATE 5 / 1 / 85

Project Director: W. R. Ernst School/~~Lab~~ XXX CE

Sponsor: National Science Foundation

Type Agreement: Grant MDR-8470198

Award Period: From 7/1/85* To ~~12/31/87~~ 6/30/88 (Performance) 3/31/88 (Reports)

Sponsor Amount:

	This Change	Total to Date
Estimated:	$	$ 251,425
Funded:	$	$ 251,425

Cost Sharing Amount: $ 3,745 Cost Sharing No: E-19-324

Title: Middle School Science & Engineering Project

ADMINISTRATIVE DATA

OCA Contact John Schonk x4820

1) Sponsor Technical Contact:

Mary Ann Ryan
National Science Foundation
Washington, DC 20550

202/357-7069

2) Sponsor Admin/Contractual Matters:

Dionie Henry
National Science Foundation
Washington, DC 20550

202/357-9602

Defense Priority Rating: N/A

Military Security Classification: N/A

(or) Company/Industrial Proprietary: N/A

RESTRICTIONS

See Attached NSF Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval – Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with GIT

COMMENTS:

No funds may be expended after 12/31/87 even though reports are not due until 3/31/88.

This award includes a 6 month unfunded flexibility period.

*Pre-Award cost beginning 5/1/85 have been approved through OPAS.

COPIES TO:

SPONSOR'S I. D. NO. 02.107.000.85.016

Project Director
Research Administrative Network
Research Property Management
Accounting

Procurement/EES Supply Services
Research Security Services
Reports Coordinator (OCA)
Research Communications (2)

GTRC
Library
Project File
Other Newton; Jones

GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION/CLOSEOUT SHEET

Date 8/8/88

Project No. E-19-601 243R59280A0 School/~~Lab~~ ChE

Includes Subproject No.(s) N/A

Project Director(s) W. R. Ernst GTRC/~~GIT~~

Sponsor National Science Foundation

Title Middle School Science & Engineering Project

Effective Completion Date: 6/30/88 (Performance) 9/30/88 (Reports)

Grant/Contract Closeout Actions Remaining:

- [XXX] None
- [ ] Final Invoice or Copy of Last Invoice Serving as Final
- [ ] Release and Assignment
- [ ] Final Report of Inventions and/or Subcontract:
  Patent and Subcontract Questionnaire sent to Project Director [ ]
- [ ] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other ______

Continues Project No. ______ Continued by Project No. ______

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GEORGIA TECH 1885-1985
DESIGNING TOMORROW TODAY

Georgia Institute of Technology
School of Chemical Engineering
Atlanta, Georgia 30332-0100
(404) 894-

February 27 1986

Dr. Jane O. Swafford
Program Director
Teacher Preparation Program
National Science Foundation
Washington, D.C. 20550

RE: NSF Grant No. MDR-8470198--Progress Report No. 1

Dear Dr. Swafford:

Enclosed is the progress report and attachments which you requested in your letter of February 12, 1986. If you would like to discuss this work, please call me at (404) 894-2878.

Sincerely,

William R. Ernst
Associate Professor

MIDDLE SCHOOL SCIENCE AND ENGINEERING PROJECT

NSF Grant No. MDR-8470198

Progress Report No. 1 for the time period
July 1, 1985 to February 15, 1986

by

William R. Ernst, Principal Investigator
School of Chemical Engineering
Georgia Institute of Technology
Atlanta, GA 30332

March 1, 1986

I. INTRODUCTION

The project description and objectives are stated in the original proposal and will not be repeated in this report. Attached is a copy of the project activity schedule which appeared in the proposal. The project is on schedule with a few minor exceptions. The following is a discussion of progress to date as well as plans for completion.

II. FORMATION OF ADVISORY BOARD AND SELECTION OF TEACHERS

A. An advisory board was established consisting of science supervisors from the Atlanta Metro area. The participating districts include Atlanta, Cobb Co., Fulton Co., and Marietta City. A representative of the Georgia Department of Education is also a member of the board.

B. With the help of the advisory board, two middle school teachers, Karen Humphreys and Lorraine Conway, both recognized as outstanding teachers, were hired as consultants to the project. Both of these teachers have had prior experience in curriculum development.

C. Nine other middle school teachers from the four participating school districts were selected by the project staff based upon the advice of the board. These teachers were selected from among twenty teachers who had responded to a solicitation which was sent to all middle schools in the Atlanta Metro area. Each applicant submitted a portfolio of materials developed and used in his/her class rooms. The staff selected those teachers which it felt displayed the greatest potential in the materials development area.

III. MATERIALS DEVELOPMENT

A. Professors from Georgia Institute of Technology and Georgia State University, and the two consultants began work on the prototype module based upon the manufacture of salt in July 1985. An artist was hired in December. The module is complete except for art work in the final chapters. The total module is 150 pages in length and has six chapters. Enclosed is a bound copy of chapters 1 and 2. Also attached is a Table of Contents for the six chapters and a list of the science and engineering concepts covered in each chapter. (It should be noted that the aim of module is to teach the same science concepts that students are currently learning from middle school textbooks; however, the module is designed with a central focusing point--the manufacturing process. The process is used as a means of demonstrating to the student the applications of the science concepts as he/she is learning those concepts. The principal investigator believes that this latter approach to teaching science should increase the interest of the students in learning science).

B. A second module based upon the manufacture of paper has been researched, scoped and outlined. The Technical Association of the Pulp and Paper Industry (TAPPI) which has its national headquarters in Atlanta is interested in this module. TAPPI personnel have offered their full cooperation in providing resources in the development of the module. They have opened their facilities including an extensive library to our teachers. They also have offered to publish our module after it has been written and tested.

C. The third and fourth modules are currently being researched and scoped. The themes of these modules are: "The Control of Insects" and "Products from the Oceans".

IV. TEACHER EDUCATION

A. The nine teacher participants are enrolled in either the Educational Specialist in Science Degree program or the Ph.D. program at GSU. They are taking a prescribed set of special courses at GSU and GIT which will improve their understanding of science and engineering concepts and their science writing ability.

B. In summer 1986 the nine teacher participants will be divided into teams of three. Each team will select one of the module topics (Pulp and Paper Manufacturing, Control of Insects, and Products from the Oceans). Each team will spend the summer quarter researching, organizing and writing the module. The GSU and GIT professor as well as the two consultants will serve as advisors and co-writers.

V. FIELD TESTING

A. Field testing of the prototype module was begun on February 17, 1985 in seventh grade classrooms. Consultant Karen Humphreys is testing 140 students at Mccleskey Middle School; Consultant Lorraine Conway is testing 65 students at Dickerson Middle School. Both schools are in Cobb County. Before they were introduced to the module, the students were given two pretests, one on knowledge of science concepts and one on interest in science. At the end of the field test, post testing on concepts and interest will be conducted.

B. Field testing of the prototype module will be conducted by the nine teacher participants in their school districts during Spring 1986. Pre-and post-testing will be conducted.

C. The nine teacher participants will field test their new modules in their school districts during Winter of 1987.

VI. PUBLICATION OF MODULES

Upon completion of the field tests, the modules will be revised as necessary. A detailed plan for further testing, publication and dissemination will be written and submitted to NSF for approval.

VII. PROBLEMS

A. To date neither the progress of the project nor the quality of the materials that have been developed have been severely affected by problems.

B. One minor problem was encountered because of an error in judgement by the principal investigator. It was the PI's opinion that an artist was not needed during the early phase of the prototype module development. The artist was not hired until December. As a result, a considerable amount of re-writing and redesign of the module had to be done after the artist was employed. The field testing of the module which was originally planned to begin in mid-January was delayed until mid-February.

FIG. 2 PROJECT ACTIVITY SCHEDULE AND TIME LINE

			Spring 1985 Prior to Funding Establish and Meet with Advisory Board -Survey other curriculum projects
Summer 1985 -Development of Prototype Module -Develop Files and Detailed Plan for 3 modules -Recruit Select Teachers	**Fall 1985** -Complete First Draft of Prototype Module -Complete Files and Plan for 3 modules Participants -Life Science Concepts Course -Science Writing Course	**Winter 1986** Teacher Consultants -Field Test Prototype Module Participants -Physical Science Concepts Course -Science Materials Developments Course	**Spring 1986** Revise Prototype Module Participants -Field Test Prototype -Engineering Concepts Course Psychology of Teaching Course
Summer 1986 Participants -Module Development in Collaboraton with Professors and Consultants	**Fall 1986** Participants -Module Completion	**Winter 1987** Participants -Field Test New Modules -Earth Science Concepts Course Professors	**Spring 1987** -Evaluation and Revision of Modules

OUTLINE OF PROTOTYPE MODULE

SCIENCE AND ENGINEERING CONCEPTS IN THE
MANUFACTURE OF SALT

CHAPTERS/SECTIONS	(CONCEPTS)
1. What Am I 1.1 Cubic Chemistry 1.2 What are the Effects of salt on Health 1.3 How Salt is Produced	(Chemistry of sodium chloride, salts, acids, bases, crystal structure of salt, flame detection of metallic salts, effects of salt on the body, importance of salt to life, effects of salt on plants and animals, steps in producing salt commercially, manufacturing process).
2. Salt: Where It Is and How It Got There 2.1 Salt in Water 2.2 Salt Sediments 2.3 Rock Salt	(Salinity, composition of seawater and other bodies of water, sedimentary formation, settling of particles through liquids, rock salt, how rock salt formed, salt domes, location of salt in world).
3. Methods of Recovery 3.1 Shaft Mining 3.2 Solution Mining 3.3 Solar Evaporation	Salt licks, shaft mining, solution mining, mass, weight, volume, history of mining methods, hydraulic fracturing, how a pump works, density difference between water and salt solutions, solar evaporation, mass balancing).

SCIENCE AND ENGINEERING CONCEPTS ETC. (Continued)

CHAPTERS/SECTIONS	(CONCEPTS)
4. Forming a Solution 4.1 What are Solutions? 4.2 Insolubles 4.3 Salt Solutions 4.4 What Factors Affect	(Solvent, solution, concentration, dilute, concentrated, saturated, soluble, insoluble, the Rate of Dissolving liquid-solid solutions, liquid-gas solutions, etc-etc solutions, water as a solvent, other solvents, solubility curves, temperature effect on solubility, factors affecting rate of solution, energy, agitation, surface area of a solid).
5. Separation of Solids and Liquids 5.1 Filtration 5.2 Settling 5.3 Centrifugation	(separation by size differences, density, separation by density, use of filter paper, pre-cipitation, centrifugal separation).

SCIENCE AND ENGINEERING CONCEPTS ETC. (Continued)

CHAPTERS/SECTION		CONCEPTS
6.	Crystallization and Drying	(What is a crystal, how crystals grow, crystal characteristics, identification by crystal structure, two methods of forming crystals, crystallizing sodium chloride and other salts, crystal size versus growth rate, solar evaporation, commercial solar salt production, evaporation pans, how a pan works, multiple pan evaporation method, commercial salt dryers).
6.1	What are Crystals	
6.2	Cooling Crystals	
6.3	Evaporative Crystals	
6.4	Drying	

NATIONAL SCIENCE FOUNDATION
Washington, D.C. 20550

FINAL PROJECT REPORT
NSF FORM 98A

PLEASE READ INSTRUCTIONS ON REVERSE BEFORE COMPLETING

PART I—PROJECT IDENTIFICATION INFORMATION

1. Institution and Address	2. NSF Program	3. NSF Award Number
Georgia Tech Research Corporation Georgia Institute of Technology Atlanta, GA 30332-0420	SEE/MDR	MDR-8470198
	4. Award Period From 7/1/85 To 12/31/87*	5. Cumulative Award Amount $251,425

6. Project Title

Middle School Science and Engineering Project

PART II—SUMMARY OF COMPLETED PROJECT *(FOR PUBLIC USE)*

This project is a collaborative effort among professors of engineering, professors of education and school teachers in the development of educational materials in science and engineering for middle grade students. The program has a dual nature -- a teacher education phase and materials development phase. In the education phase, the teachers take a series of courses in science and engineering concepts and science writing to prepare them for the materials development phase. In the materials development phase, the teachers work in teams with the professors in the writing of curriculum modules. During the past 2 1/2 years, four modules have been developed - each based upon a technology theme. The modules were tested in middle grade classrooms by the writers. The module subjects are sharks (179 pages), insect control (202 pages), the manufacture of salt (156 pages), and the manufacture of pulp and paper (105 pages). The latter module will be published by TAPPI Press. This project can serve as a model by which other schools of engineering can collaborate effectively with teachers in developing materials for classroom use.

PART III—TECHNICAL INFORMATION *(FOR PROGRAM MANAGEMENT USES)*

1. ITEM *(Check appropriate blocks)*	NONE	ATTACHED	PREVIOUSLY FURNISHED	TO BE FURNISHED SEPARATELY TO PROGRAM: Check (✓)	Approx. Date
a. Abstracts of Theses		X			
b. Publication Citations		X			
c. Data on Scientific Collaborators		X			
d. Information on Inventions	X				
e. Technical Description of Project and Results		X			
f. Other *(specify)* 6 books 2 reports				X	8/10/88

2. Principal Investigator/Project Director Name *(Typed)*	3. Principal Investigator/Project Director Signature	4. Date
William R. Ernst		7/21/88

NSF Form 98A (1-87) Supersedes All Previous Editions

Form Approved OMB No 3145-0058

* Extended to 6/30/88 by OPAS.

Part III -- NSF Final Report (William R. Ernst)

1.

a. Abstract of Thesis

The Middle School Science and Engineering

Concepts Project Evaluation

by

Janet Burdette

Ph.D. Candidate

Department of Curriculum and Instruction

Georgia State University

Abstract

The Middle School Science and Engineering Project involved the development of a series of science teaching units designed specifically for middle school students by nine local middle school teachers. A Curriculum Materials Development Evaluation Model containing nineteen categories was created to assure that all reasonable sources of data and information were considered in evaluating the teacher developed materials as well as the field tests conducted in middle school science classrooms. Evaluation criteria were established for each category to aid in the process of judging the merits and worth of the Middle School Science and Engineering Project. Standards for the

evaluation criteria were determined. T-test procedures were used to analyze data concerning certain evaluation criteria. The analysis indicated that the established standards were met or exceeded for most criteria. Overall the success of the project seems apparent.

b. Publication Citations (copies of all materials have been enclosed).

(1) The following material has been accepted for publication:

"The Manufacture of Pulp and Paper: Science and Engineering Concepts" by Janet Burdette, Ella Lanier, Judy Sharpe, Lorraine Conway and William Ernst, TAPPI Press, Norcross, GA. (to be published in 1988).

(2) The following material has been submitted for publication:

"A Model Science and Engineering Program Focused on Middle Grades" by William R. Ernst, Engineering Education (submitted May 23, 1988).

(3) The following materials were developed in this program but have not been published to date:

(a) "The Manufacture of Salt: Science and Engineering Concepts" by Lorraine Conway, Karen Humphreys, Ted Colton, and William Ernst.

(b) "Sharks: Science and Engineering Concepts" by Judy Goddard, Sally Hewes, Elsie Jones, Lorraine Conway and Mildred Graham.

(c) "The Control of Insect Pests: Science and Engineering Concepts" by Ted Colton, Linda Delano, Catherine Eaton, Karen Humphreys and Margaret Williamson.

(Both student and teacher editions of the above three items have been prepared.)

c. Data on Scientific Collaborators

(1) Senior staff

William R. Ernst,	Associate Professor School of Chemical Engineering Georgia Institute of Technology
Ted Colton,	Professor Department of Curriculum and Instruction Georgia State University
Mildred Graham,	Associate Professor Department of Curriculum and Instruction Georgia State University
Edward Lucy,	Associate Professor Department of Curriculum and Instruction Georgia State University
Jack Hassard,	Professor Department of Curriculum and Instruction Georgia State University

(2) Middle Grade Teachers -- Participants/Writers

Janet Burdette,	Ph.D. Candidate
Ella Lanier,	Ed. Specialist Degree in Science (EdS) Candidate
Judy Sharpe,	EdS

Catherine Eaton,	EdS
Margaret Williamson	EdS
Sally Hewes,	EdS Candidate
Judy Goddard,	EdS
Elsie Jones,	EdS
Linda Delano,	EdS

(3) Consultants

Lorraine Conway,	Teacher (deceased)
Karen Humphreys,	Teacher
Jeffrey S. Hsieh,	Professor, School of Chemical Engineering
Kay E. Rutledge,	Georgia Assessment Project
Paula G. Eglin,	Teacher
Janet Callahan,	Teacher
Peter Greaney,	Geologist
Jeff Carrier,	Professor
Bernadette Peiffer,	Teacher
Lundie Spence,	Marine Biologist
J.V. O'Connor,	Professor of Geology
L.L. Schroeder,	Georgia Department of Agriculture
Nancy Shaw,	Teacher
Nancy B. Bennett,	Teacher

d. Technical Summary

Please see the attached two documents entitled:

(1) Ernst, W.R., "A Model Science and Engineering Program Focused on Middle Grades" (Note: This is the same item cited above as Part III

b 2.)

(2) Lucy, E.C. and J. Burdette "An Evaluation of the Middle School Science and Engineering Concepts Project"

e. Enclosed Materials

The following materials were cited in earlier sections of this report. Copies of each have been enclosed.

Item: Part III

1b (2)

1b (3)(a) (student edition)

1b (3)(b) (student edition)

1b (3)(c) (student edition)

1b (3)(a) (teacher edition)

1b (3)(b) (teacher edition)

1b (3)(c) (teacher edition)

PART IV - SUMMARY DATA ON PROJECT PERSONNEL

NSF Division SEE/MDR

The data requested below will be used to develop a statistical profile on the personnel supported through NSF grants. The information on this part is solicited under the authority of the National Science Foundation Act of 1950, as amended. All information provided will be treated as confidential and will be safeguarded in accordance with the provisions of the Privacy Act of 1974. NSF requires that a single copy of this part be submitted with each Final Project Report (NSF Form 98A); however, submission of the requested information is not mandatory and is not a precondition of future awards. If you do not wish to submit this information, please check this box ☐

Please enter the numbers of individuals supported under this NSF grant.
Do not enter information for individuals working less than 40 hours in any calendar year.

*U.S. Citizens/ Permanent Visa	GI's and PI's/PD's		Post-doctorals		Graduate Students		Under-graduates		Precollege Teachers		Others	
	Male	Fem.	Male	Fem.	Male	Fem.	Male	Fem.	Male	Fem.	Male	Fem.
American Indian or Alaskan Native												
Asian or Pacific Islander												
Black, Not of Hispanic Origin												
Hispanic												
White, Not of Hispanic Origin	4	1								11		
Total U.S. Citizens	4	1								11		
Non U.S. Citizens												
Total U.S. & Non-U.S. ..	4	1								11		
Number of individuals who have a handicap that limits a major life activity.												

*Use the category that best describes person's ethnic/racial status. (If more than one category applies, use the one category that most closely reflects the person's recognition in the community.)

AMERICAN INDIAN OR ALASKAN NATIVE: A person having origins in any of the original peoples of North America, and who maintains cultural identification through tribal affiliation or community recognition.

ASIAN OR PACIFIC ISLANDER: A person having origins in any of the original peoples of the Far East, Southeast Asia, the Indian subcontinent, or the Pacific Islands. This area includes, for example, China, India, Japan, Korea, the Philippine Islands and Samoa.

BLACK, NOT OF HISPANIC ORIGIN: A person having origins in any of the black racial groups of Africa.

HISPANIC: A person of Mexican, Puerto Rican, Cuban, Central or South American or other Spanish culture or origin, regardless of race.

WHITE, NOT OF HISPANIC ORIGIN: A person having origins in any of the original peoples of Europe, North Africa or the Middle East.

THIS PART WILL BE PHYSICALLY SEPARATED FROM THE FINAL PROJECT REPORT AND USED AS A COMPUTER SOURCE DOCUMENT. DO NOT DUPLICATE IT ON THE REVERSE OF ANY OTHER PART OF THE FINAL REPORT.

SCIENCE AND ENGINEERING CONCEPTS IN THE MANUFACTURE OF SALT

Chapters 1 and 2

Field Test Edition

by

Lorraine Conway
Karen Humphreys
Ted Colton
William Ernst

Illustrated by C. Denise Gentry

February 1986

This work was developed as part of the Georgia Institute of Technology-Georgia State University Middle School Science and Engineering Project and funded by the National Science Foundation under Grant No. MDR-8470198

SCIENCE AND ENGINEERING CONCEPTS IN
THE MANUFACTURE OF SALT

Principal Investigator: William R. Ernst, School of Chemical Engineering, Georgia Institute of Technology
Co-principal Investigator: Ted Colton, Department of Curriculum and Instruction, Georgia State University
Writers: Karen Kleinschmidt-Humphreys, McCleskey Middle School; Lorraine Conway, Dickerson Middle School
Illustrations: C. Denise Gentry
Editor: Nancy K. Shaw
Advisory Board: Frances Culpepper, Martha Darden, Mildred Graham, Lowell Jacks, Donald Nesbitt, Dallas Stewart
Consultant: Jack Hassard

This material is based upon work supported by the National Science Foundation under Grant No. MDR-8470198. Any opinions, findings and conclusions or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of the National Science Foundation.

IMPORTANT

This work is intended for use by middle school and junior high school students in the classroom under the direction of a qualified science teacher. Some experiments described in the book involve chemicals or equipment that may be harmful if they are misused or if procedures described are not followed.

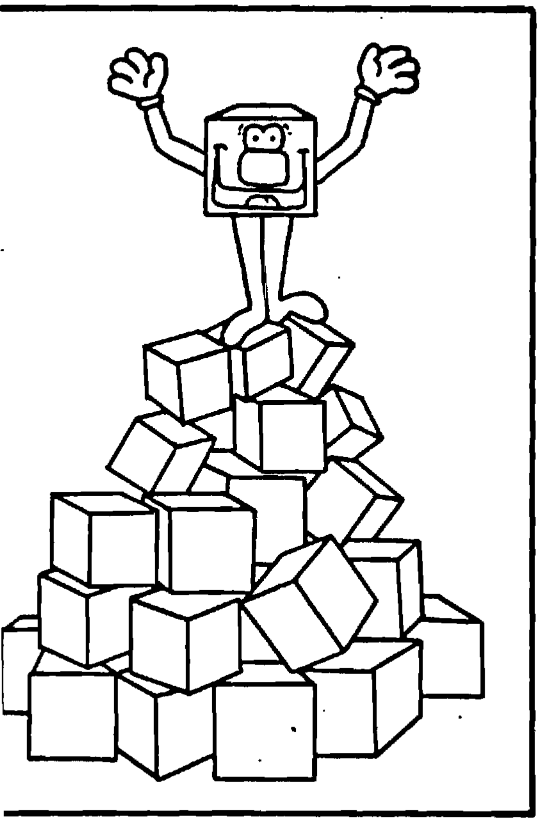
TABLE OF CONTENTS

PHASE 1

WHAT AM I?

SECTION 1.1-CUBIC CHEMISTRY

Using the following clues, tell what the topic of this unit will be:



You cannot live without me.

I am present in every cell in your body.

I was once more precious than gold.

I am used in soaps, dyes, cosmetics, photography, textiles, and about 14,000 other items.

I am made up of two different things--one part of me is explosive in water; the other part is a poisonous gas.

I have been taxed and given to workers as a salary.

My ability to lower the freezing point of water makes me useful for melting ice and snow.

When I am pure, I am a cube-shaped crystal.

As you read this section, you will learn more interesting information about this white seasoning.

After you study this section, you will be able to:

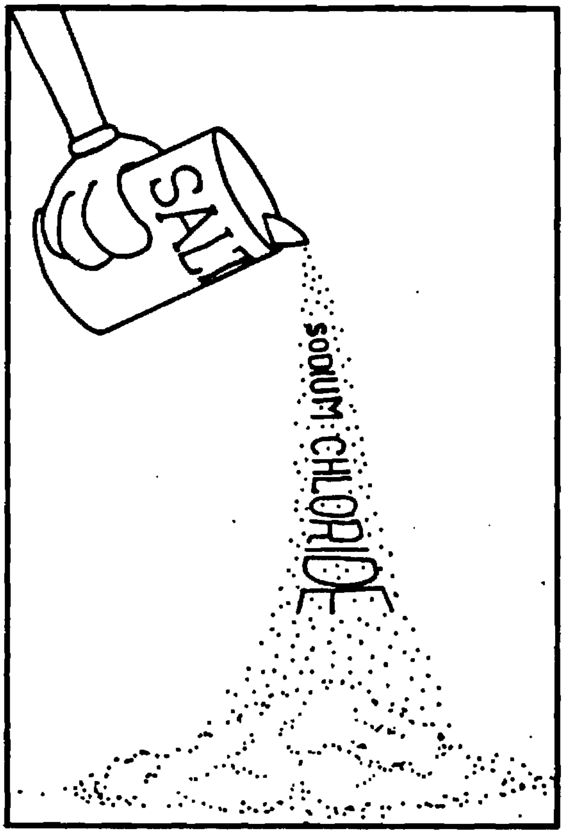
Describe the chemical composition of "table salt".

Explain the difference between sodium chloride and salts in general.

Name other common salts and identify their uses.

TABLE SALT

To a scientist, salt may mean one of two things. It will be important for you to understand the difference between these two meanings before you begin to study salt.



The word is most commonly used to describe sodium chloride. You probably know sodium chloride as "table salt". It is the salt that you sprinkle on your food.

This salt is a chemical compound that contains equal numbers of sodium atoms and chlorine atoms. Sodium can be written as its chemical symbol, Na. Sodium is a metal that explodes when put in water. Chlorine, written Cl, is a poisonous gas. When the two combine chemically, they form a stable, harmless compound, symbolized NaCl.

Sodium + Chlorine = Sodium Chloride
Na + Cl = NaCl

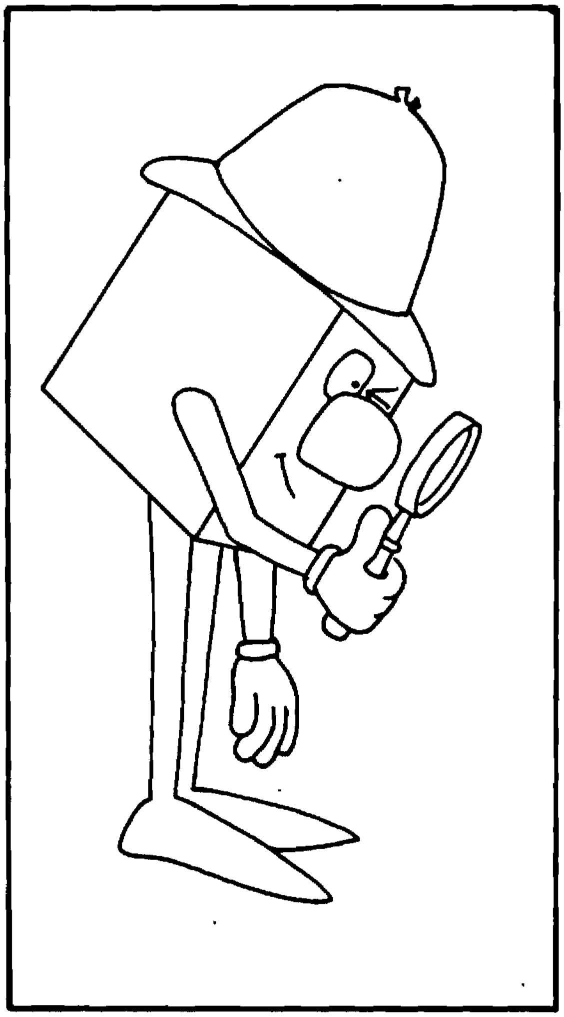
Scientists use specific tests to show if certain chemicals are present in a substance. In the following experiment you will test for the sodium and chlorine in salt.

SCIENCE IN ACTION

SALT DETECTION

Purpose:

Scientists know several ways to detect the presence of certain chemicals in a substance. To learn ways to test for sodium and for chlorine, do the following experiments.



Certain metallic salts produce colors when heated in a gas flame. These colors can be used to identify the metal in the salt. The sodium in salt can be identified in this way. Sodium burns bright yellow in a gas flame. Try the flame test for sodium and other metals as directed below.

Materials you will need:

regular Bunsen burner,
tongs,
salt,
copper sulfate,
cream of tartar,
hairpin or loop,
water,
safety glasses,
dropper,
silver nitrate.

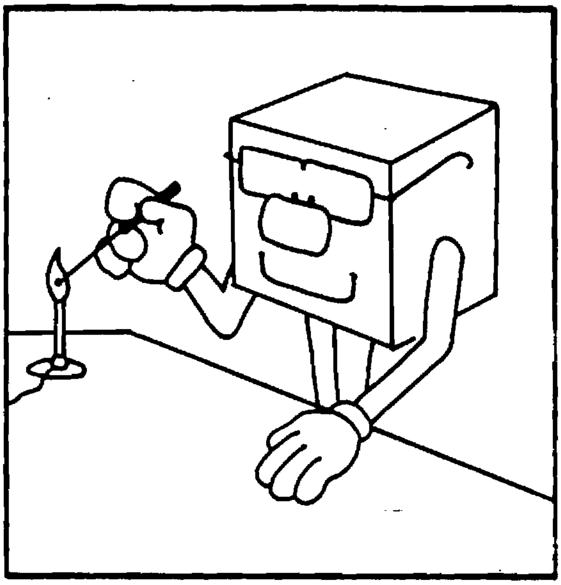
Scientist at work:

1. Put on your safety glasses and light the Bunsen burner.

2. If you do not have a loop, twist a hairpin into a loop and moisten it with water.

3. Dip the moistened end of the loop in the salt. Use tongs to hold the loop over the flame. Look for the yellow flame.

4. Repeat the process using cream of tartar and copper sulfate, instead of salt.



Interpreting your data:

Fill in the chart below.

SALT	METAL	COLOR OF FLAME
Table Salt	Sodium	
Cream of Tartar	Potassium	
Copper Sulfate	Copper	

TEST FOR CHLORINE

PROCEDURE NUMBER 2:

1. Pour about 25 ml of water in a test tube.

2. Add 4 grams (1 teaspoon) of salt.

3. Shake until the salt dissolves.

4. Using a dropper, carefully add four or five drops of silver nitrate to the salt water mixture.

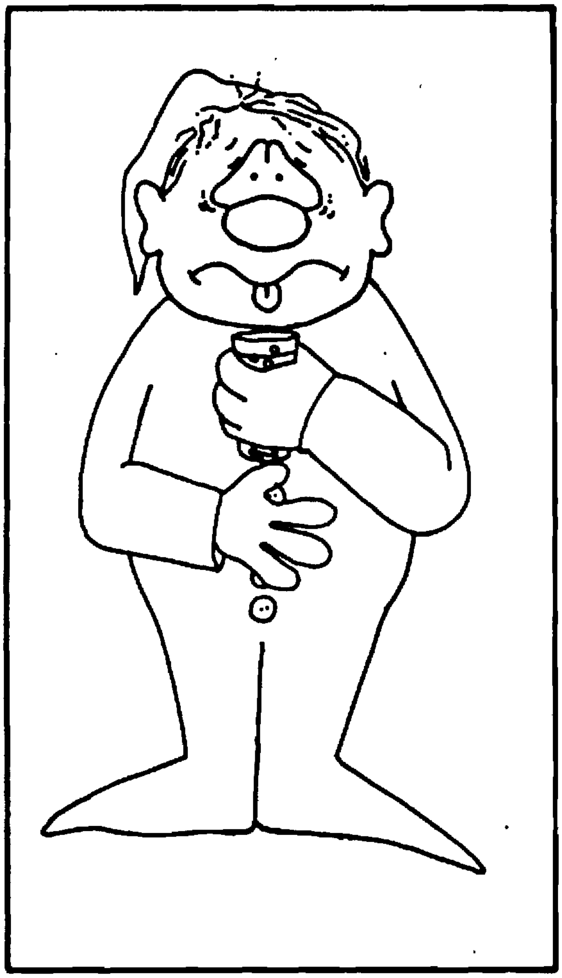
<u>SILVER NITRATE WILL STAIN CLOTHES AND FINGERS.</u>

RESULTS: 1. Describe what happened when the silver nitrate was added.

THOUGHT QUESTION

Predict what color flame would be produced if you tested sodium bicarbonate and potassium aluminum sulfate.

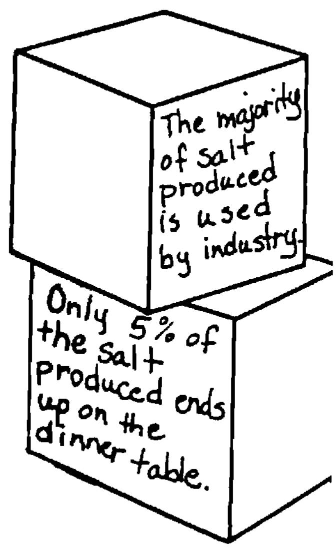
OTHER SALTS



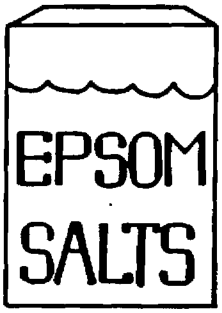
To a chemist, the word salt is also used to describe a chemical compound formed when an acid reacts with a base. You have heard about stomach acid causing discomfort for some people. To ease this pain, people usually neutralize the stomach acid with an antacid medicine. An antacid is a base--the opposite of an acid.

The process of neutralization involves reacting an acid with a base to form a new chemical. The chemical formed when an acid and a base react is a salt. Sodium chloride can be formed in a lab by reacting an acid and a base. However, because it occurs naturally, it is not necessary to make sodium chloride this way. Many other types of salts are formed using this general process.

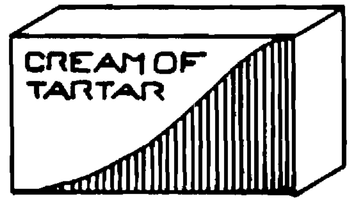
acid + base = salt + water



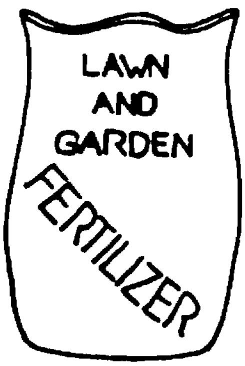
OTHER SALTS IN THE HOME



Magnesium sulfate
Used as a strong mineral laxative; to soak sore muscles

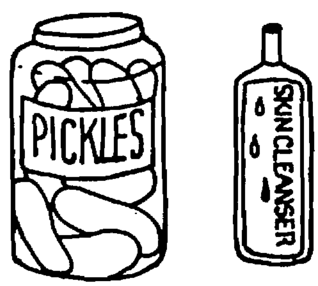


Potassium hydrogen tartrate
Used in candy and desserts to prevent sugar crystals



Aluminum sulfate
Used in fertilizers to acidify soils that are too alkaline

Benzoate of Soda
Used to slow bacterial growth in foods



Potassium aluminum sulfate
Used to harden pickles; as a skin astringent

OTHER SALTS IN YOUR HOME

Some salts are poisonous and therefore are not used for food purposes but are used in agriculture and industry. Some other types of salts are found in the home and have uses other than seasoning. Some of the more common salts are: baking soda, cream of tartar, aluminum sulfate, Epsom salts, sodium benzoate, and potash alum.

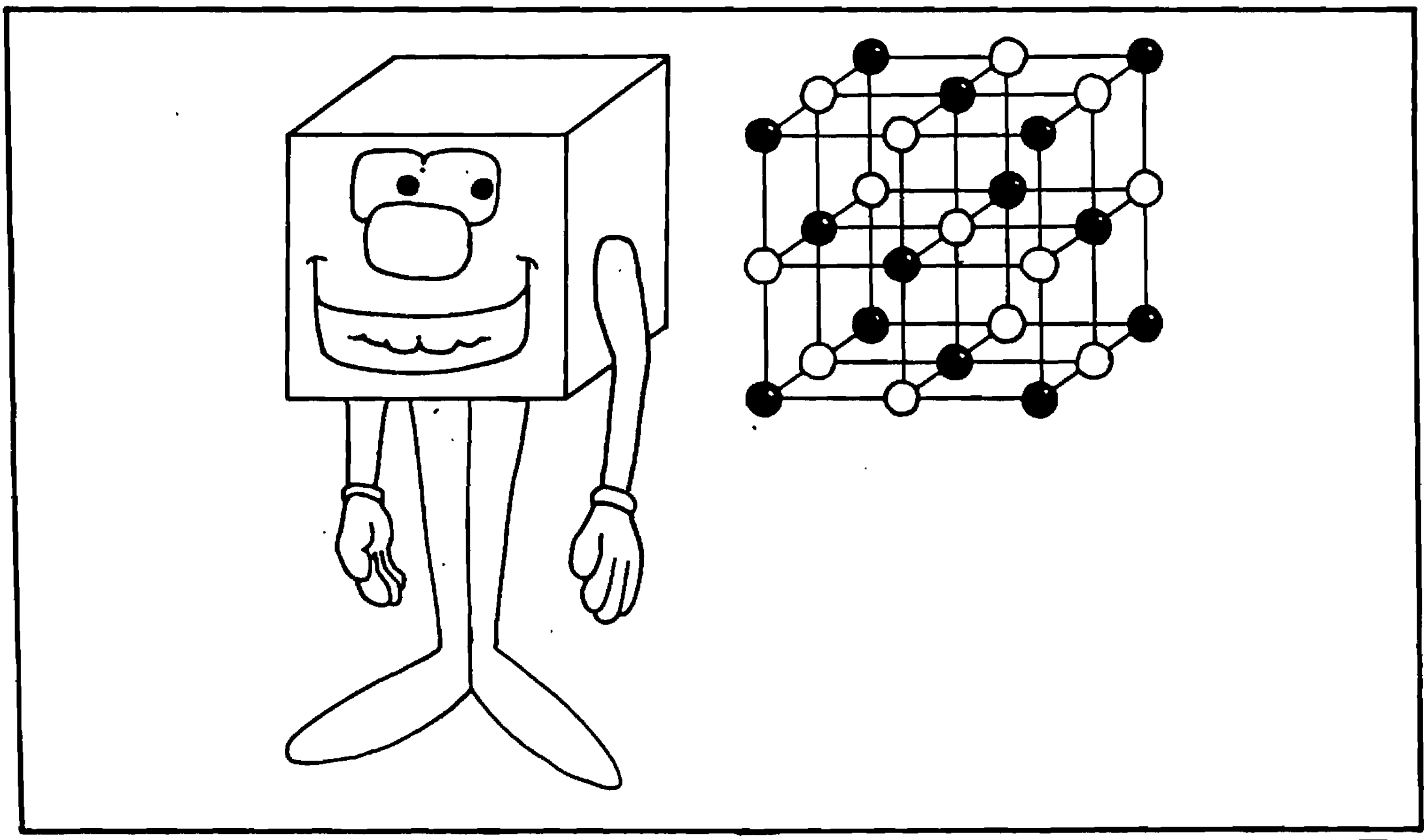
After studying the examples of other salts in the home, read the list of ingredients on the labels of different products in your home. See how many of these salts you can find. Fill in the chart to show where you found the salt and what its purpose is in that product.

SALT	PRODUCTS	PURPOSE
Magnesium Sulfate		
Potassium Hydrogen Tartrate		
Aluminum Sulfate		
Benzoate of Soda		
Potassium Aluminum Sulfate		

SALT MODEL

In the <u>solid state</u> salts are composed of <u>crystals</u>, a geometric arrangement of atoms. In a salt crystal the atoms are distributed evenly throughout the crystal formation. In sodium chloride the crystals are cube-shaped with each sodium atom surrounded by six chlorine atoms.

This illustration is a model of a crystal of sodium chloride. The black circles represent chlorine atoms, and the white circles show sodium atoms. As you can see, the crystal is arranged in a definite way with flat surfaces and straight edges. You can see this cubic structure by examining table salt under a microscope.



SCIENCE IN ACTION

SALT: A CLOSER LOOK

Purpose: Sodium chloride is made up of cube-shaped crystals. Sand is also made of a different type of crystals. Sand is mostly crystals of quartz. While all crystals have flat faces and straight edges, they do not all look alike. See if you can observe these differences by looking into a microscope.

Materials you will need: small amounts of sand and salt,
glass slide,
microscope,
straight pin or toothpick

Scientist at work:

1. Mix a pinch of salt and a pinch of sand on a glass slide. Spread out the crystals with a pin or toothpick.

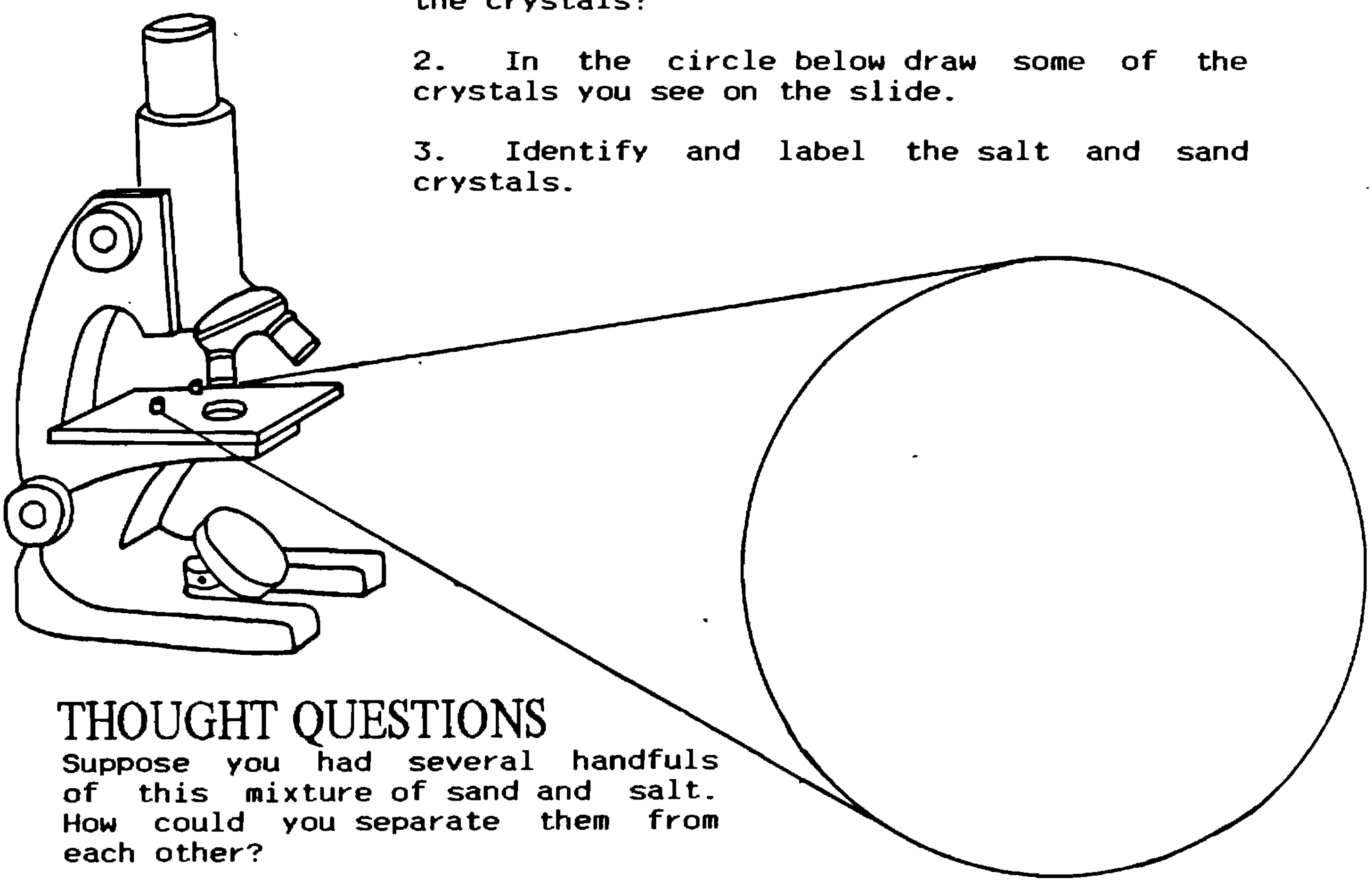
2. View through the microscope.

Interpreting your data:

1. Can you see a difference between the crystals?

2. In the circle below draw some of the crystals you see on the slide.

3. Identify and label the salt and sand crystals.

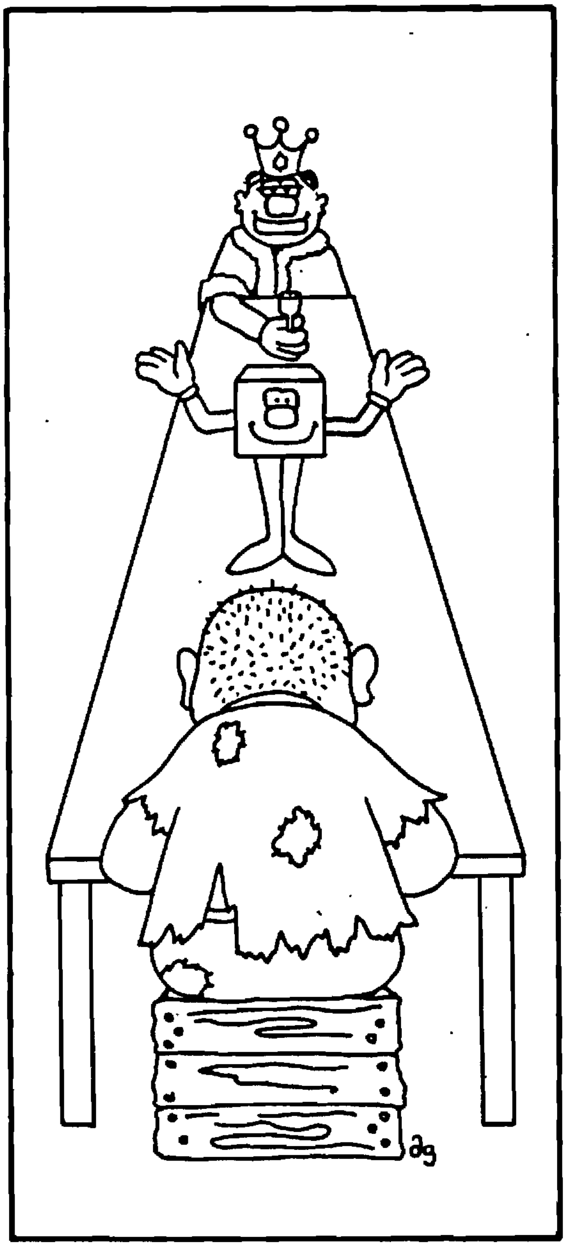


THOUGHT QUESTIONS

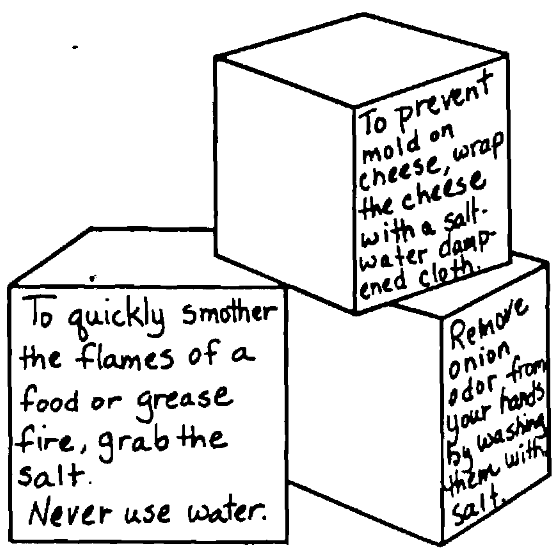
Suppose you had several handfuls of this mixture of sand and salt. How could you separate them from each other?

Add a drop of water to the slide so that the water touches the sand and salt. Examine what happens as you look through the microscope. What has happened?

SAYINGS WORTH THEIR SALT



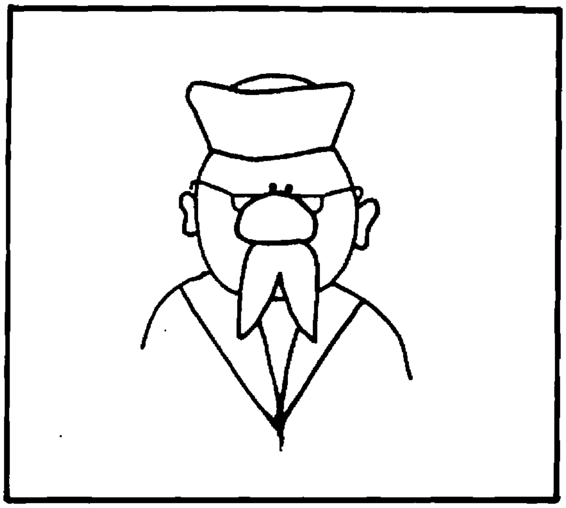
Throughout the ages, the word "salt" has been a part of many expressions. Originally, these expressions were used literally. A soldier who was "not worth his salt" had not earned his salary, which was paid in salt at that time. The people who "sat below the salt" at the table were people of lower classes, while the people seated "above the salt" were the honored nobility. The meanings of some of these expressions have changed over the years. As you read the "salty expressions on the next page, see if you can imagine what they might have meant in the past and what they mean today.



SALTY SAYINGS

Try to think of a logical meaning for each of these "salty expressions".

1. When would you take something "with a grain of salt"?

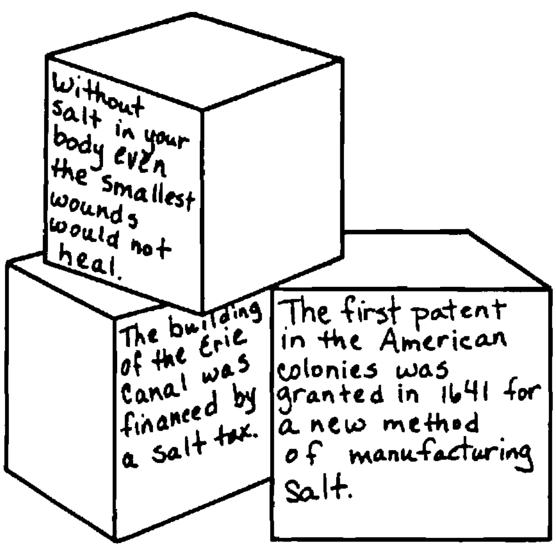


2. Who would qualify as an "old salt"?

3. Who would be considered "the salt of the earth"?

4. What does it mean to "rub salt in the wound"?

5. What does it mean if a person is "not worth his salt"?



REVIEW AND EVALUATION

MAIN IDEAS

The word "salt" has two meanings. It is most commonly used to mean "table salt" or sodium chloride.

Sodium chloride is a combination of sodium and chlorine.

The word "salt" can also be used to mean the reaction of an acid and a base.

Salts have uses in industry, agriculture and food preservation.

Sodium chloride forms a cube-shaped crystal with flat surfaces and straight edges.

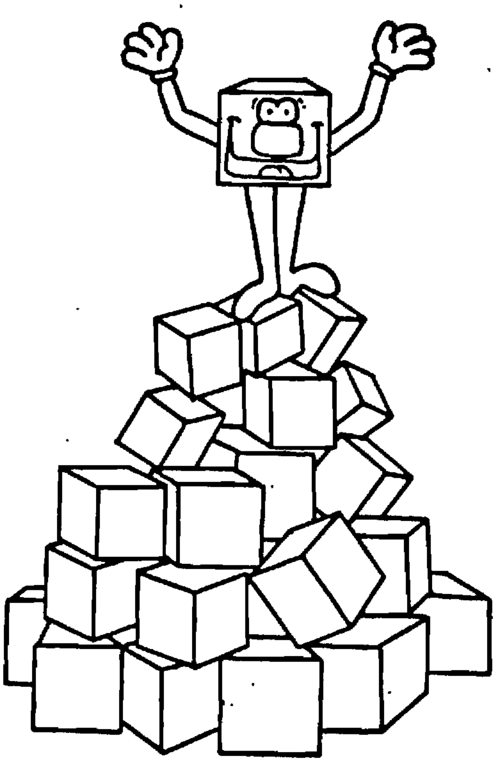
EVALUATION

Answer the following questions.

1. What is the formula for sodium chloride?

2. Describe each of the substances in table salt.

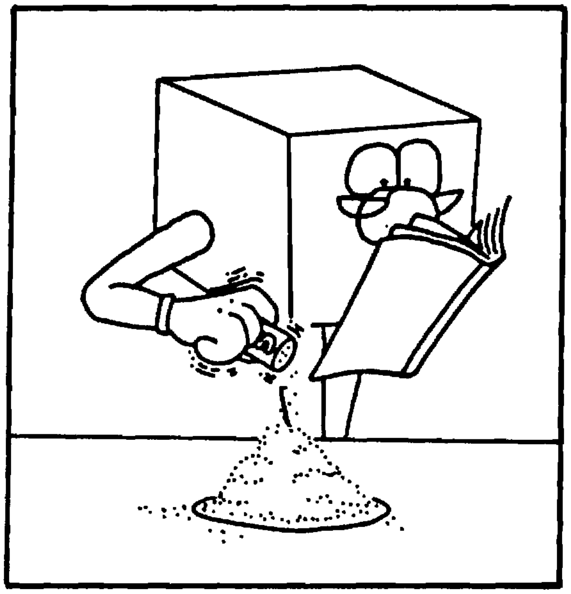
3. How are salts produced in the lab?



4. How can you neutralize an acid?

5. List three salts other than sodium chloride that are commonly found in homes. Then describe the use of each salt.

SECTION 1.2-WHAT ARE THE EFFECTS OF SALT ON HEALTH?



Have you ever heard people say that a large amount of salt is not good for you? Does anyone you know have to limit the amount of sodium he/she eats because of high blood pressure? Have you ever heard of athletes taking salt tablets because they lose so much salt by sweating during a game? Did you know that if all the salt were removed from your body, you would die within 48 hours? You will learn more about how salt affects your health in this section.

After you study this section, you will be able to:

Identify the parts of the body that depend on salt and explain why.

Estimate the amount of salt you should have each day.

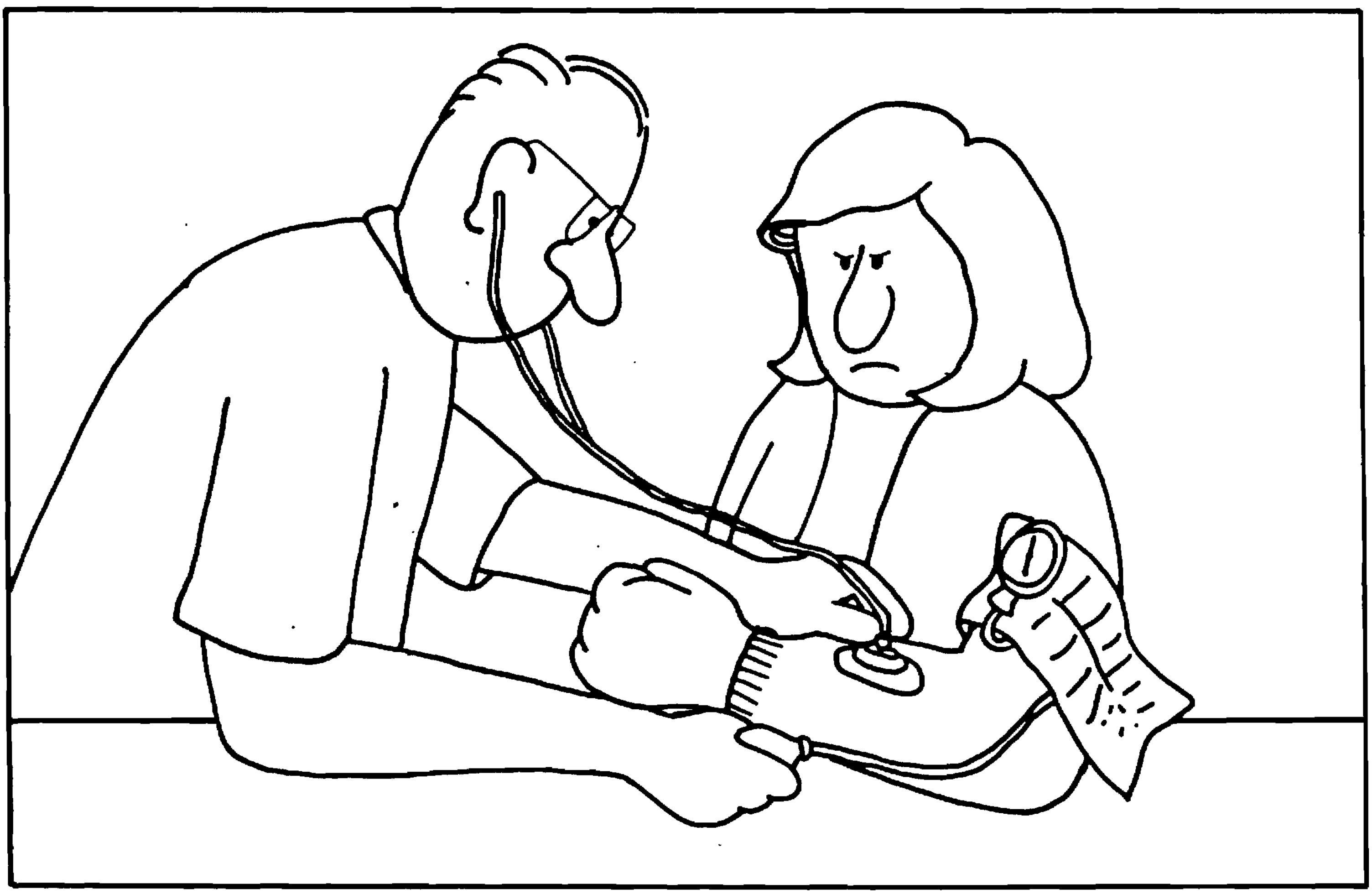
Explain why excessive sodium can be harmful.

Locate the sources of sodium in your diet.

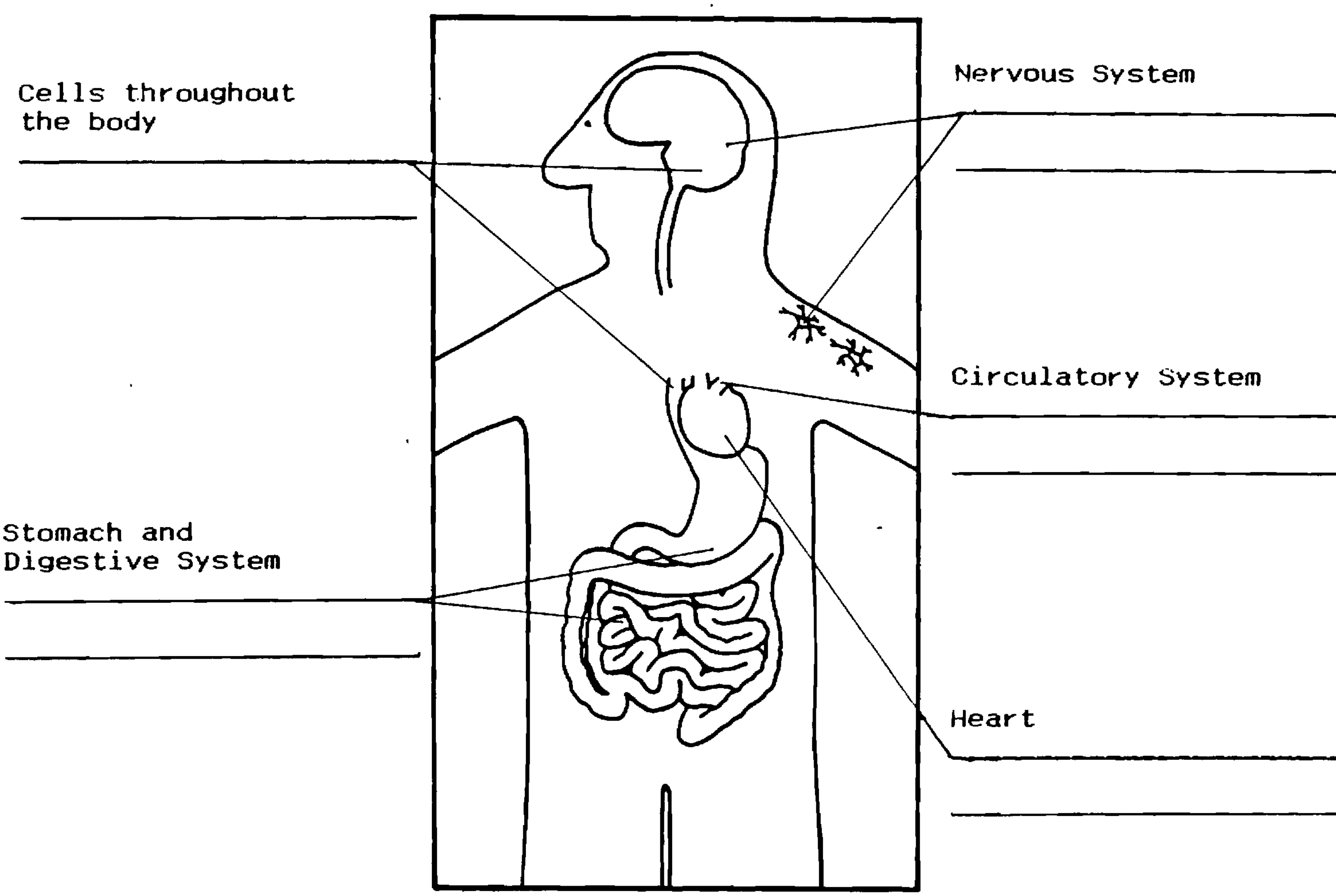
Sodium chloride is the most common salt. In this section and in all later sections, when you see the word "salt", it will refer to sodium chloride.

SALT AND THE BODY

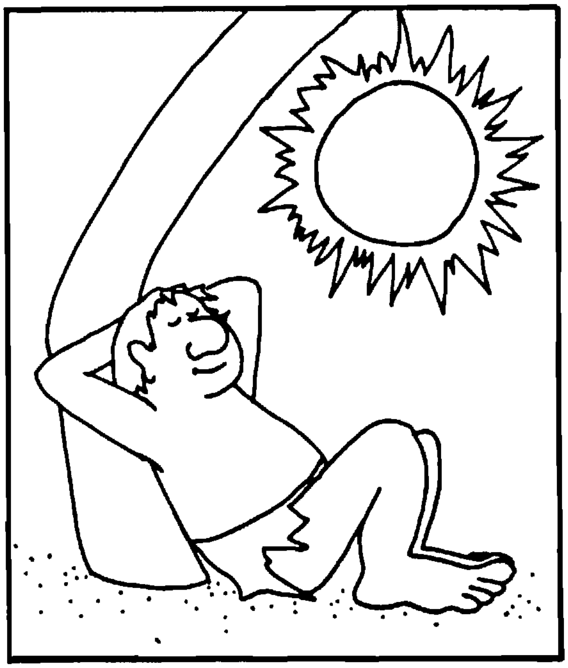
The two elements of salt, sodium and chlorine, are needed by various parts of the body. Salt controls the amount of blood and the blood pressure within each cell. Without salt to keep the blood in control, the cells would become damaged. Sodium is required for contraction of the heart and other muscles. Sodium is also needed by the nervous system to help send nerve impulses. The chlorine in salt also helps the stomach form hydrochloric acid, which aids in the digestion of your food.



The following diagram shows various body systems and parts. The names of each of these parts are listed for you. Next to each part write the reason salt is needed for that part. For help, refer to the previous page. Make sure you mention whether sodium or chlorine is the substance from the salt that is needed in each section.

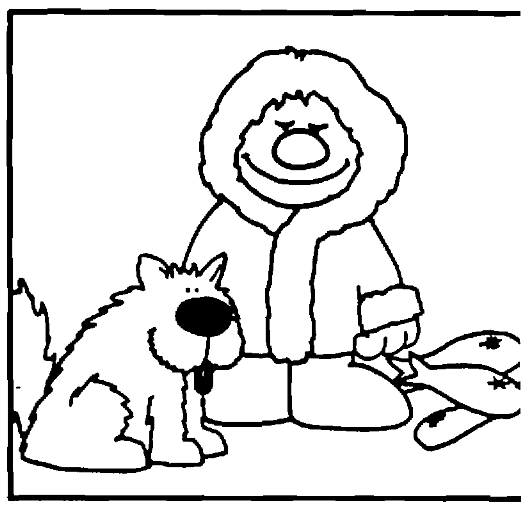


SALT NEEDS



The amount of salt a person needs each day is difficult to determine. The need changes with the amount of salt you lose by sweating. In extremely hot, humid weather the loss of sodium can be a problem for some people. The need for sodium varies. An estimate of 1/4 to 3/4 teaspoon (1.1 to 3.3 grams) of sodium per day is thought to be an "adequate and safe" intake for adults. Presently, U.S. citizens use much more than this, taking in approximately 1 to 1 and 1/4 teaspoons (4-5 grams) of sodium per day.

Scientists in health related fields are concerned about too much sodium because of its connection with high blood pressure. An estimated 25 per cent of the U.S. population may either have high blood pressure or may develop it. There is no evidence to prove that excessive sodium actually causes high blood pressure. However, a low sodium diet generally lowers blood pressure. A moderate amount of sodium generally has no effect on healthy people. In the next two experiments you will see the effects of too much salt on plants and animals.



SALT: THE EFFECT OF LARGE AMOUNTS ON PLANTS

Purpose: After reading about how our bodies need salt, you may be wondering if salt also affects plants. Different types of salt are found in fertilizers and insecticides which are beneficial to plants. However, areas that receive salty water have less productive soil. To learn what happens to plant cells that receive large amounts of salt, do this experiment.

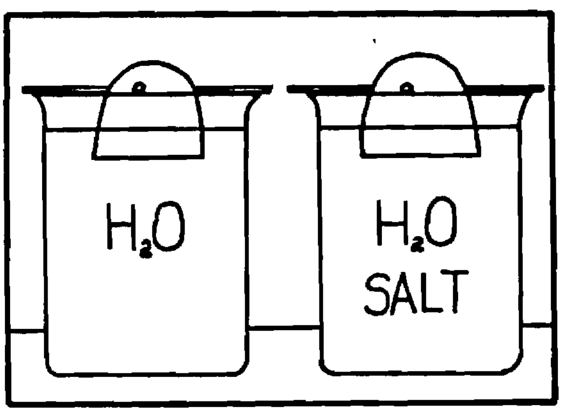
Materials you will need: Two 250 ml beakers or 2 glasses
salt,
one potato,
knife,
toothpicks,
water,
teaspoon.

Scientist at work:

1. Cut the potato in half.

2. Fill the beakers to about an inch from the top with water.

3. Fix the toothpicks in the potato halves, as shown below, so that they can hold the potato on the rim of the glass. Adjust the toothpicks or the water level so that each half of potato dips about 1/2 inch into the water.



4. Remove the potatoes for now and set aside. Add four or five teaspoons of salt to one of the beakers. Stir for a minute.

5. Carefully adjust the water level in each beaker so that the amount of water in each beaker is the same.

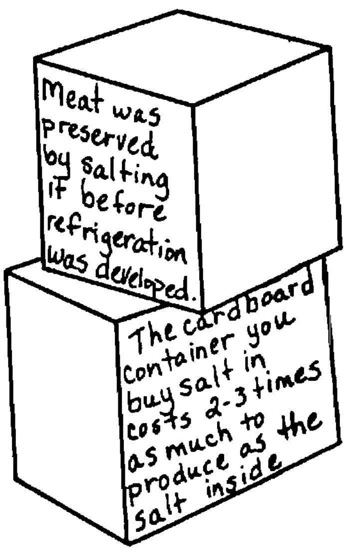
6. Place one potato half in each beaker. Leave on a counter for 24 hours. Observe what happens.

Interpreting your data:

1. Remove the potato halves and describe the appearance of each half.

2. Press the cut edge of each half. Describe the differences between the two pieces.

3. Put the two halves of the potato back together. Do they fit?
What has happened?
Draw the two halves.



4. Compare the water levels in each of the beakers. In which beaker is it higher?

5. Where do you think the extra water came from?

6. What drew the water out of the potato cells?

7. Do you think salt would have the same effect on animal cells? Why or why not?

CHALLENGE: Try this experiment on other plant tissue such as carrots, sweet potatoes, or radishes.

SCIENCE IN ACTION

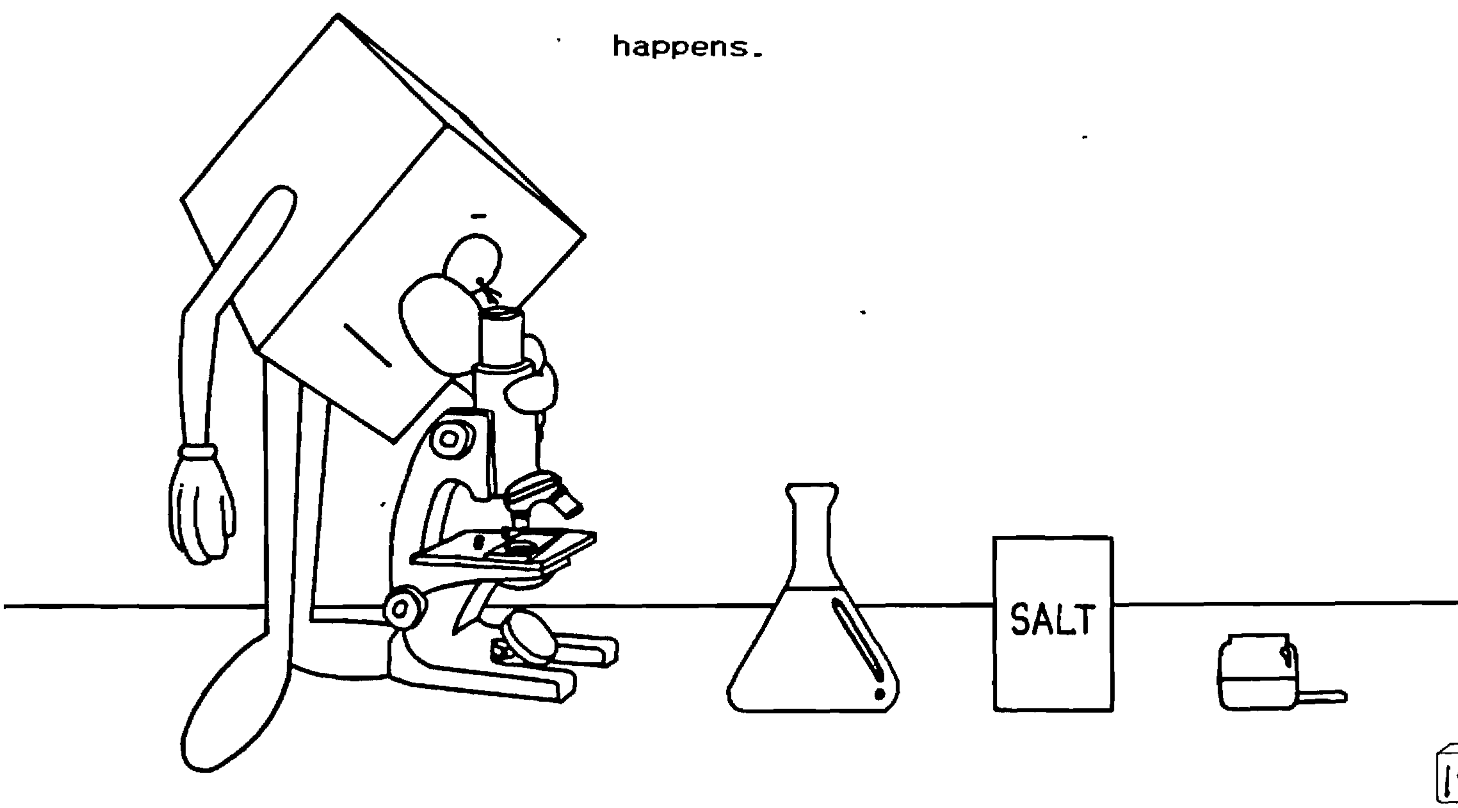
SALT: THE EFFECT OF LARGE AMOUNTS ON ANIMALS

Purpose: All animal cells need salt. Just as salt is found in small amounts in every cell of your body, it is also needed by the one-celled animals such as paramecium and amoeba. Too much salt, however, can have serious effects on animal cells or on the human body. To see the effect of an overdose of salt on one-celled animals, do the following activity.

Materials you will need: A culture of paramecium or amoeba,
slides,
eyedropper,
microscope,
salt.

Scientist at work: 1. Put a drop of the paramecium or amoeba culture on a slide and bring it into sharp focus under the microscope.

2. Add a few grains of salt and observe what happens.



Interpreting your data:

1. Were the one-celled animals affected by the salt?

2. In what way were they affected?

3. In the circles below, draw what the protozoans looked like before and after the salt was added to the slide. Try to add the names of the protozoans to your drawings.

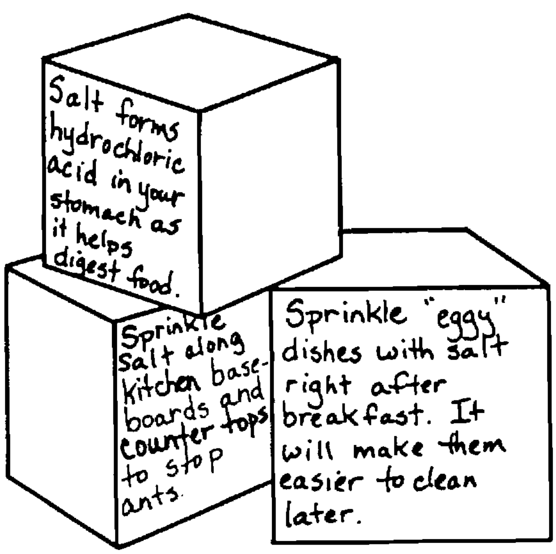
Protozoans before salt was added | Protozoans after salt was added

4. Explain how the effect of the salt on these animal cells was similar to the effect on the plant cells in the last experiment.

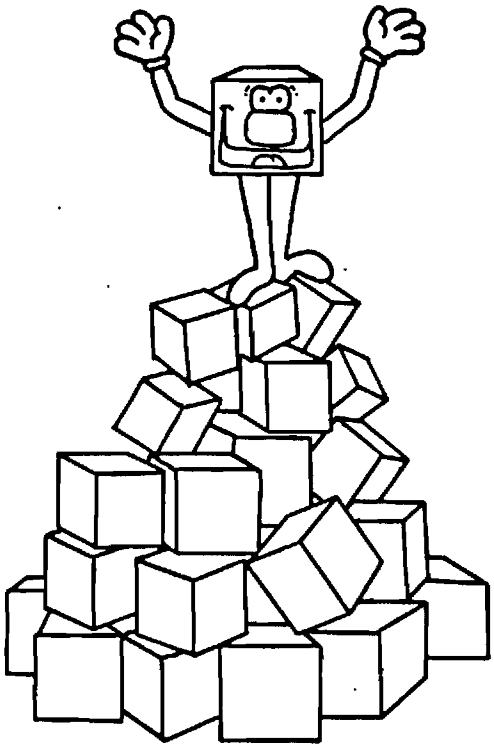
CHALLENGE: Try the same experiment but add a few grains of sugar instead of salt. What happens? Does it have the same effect on the protozoans?

SALT IN FOODS

Those people who have to restrict the amount of sodium they consume are faced with a difficult task. For table use there are several salt substitutes available, but many do not have the same taste as regular salt.. Nearly all canned and frozen foods contain salt for preserving or processing. Canners use salt in processing all types of vegetables. Salt is also used in baked products to control the yeast and in the production of cheese and butter. These sources of sodium are difficult for us to control. Many food packages sold in stores are now required to list the amount of each ingredient on their labels.



REVIEW AND EVALUATION



MAIN IDEAS

Both sodium and chlorine are needed by parts of the body.

Though salt is necessary for life, too much salt can be a problem for people with high blood pressure.

Because the need for sodium varies, the FDA has recommended a daily estimated amount of sodium. Most people in the United States exceed this amount.

Controlling salt intake is difficult because salt is added to almost all processed foods.

EVALUATION

1. Why does the amount of salt needed by the body change?

2. What is considered to be an "adequate and safe" daily amount of sodium intake for adults?

3. Large amounts of sodium are thought to be harmful for what group of people?

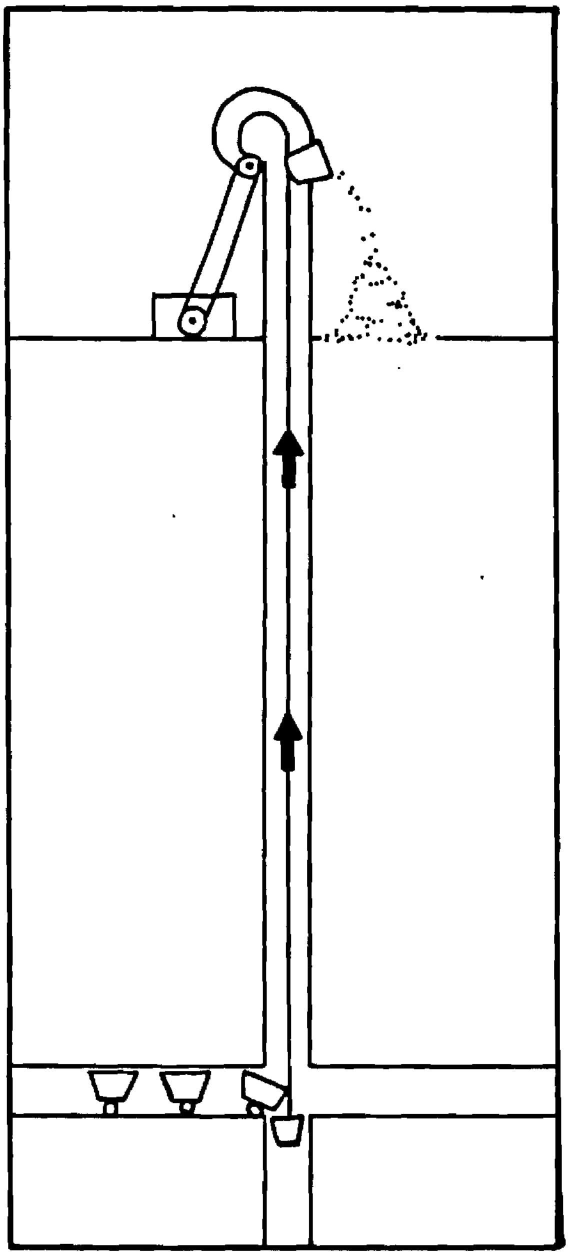
4. List three hidden sources of salt.

5. How are the effects of large amounts of salt similar in plants and animals?

SECTION 1.3-HOW SALT IS PRODUCED

Have you ever baked a cake or watched someone bake a cake? If you have, then you know how important it is to follow a recipe. A recipe explains a series of steps that must be followed in order to make something. Most things we use, including salt, are made by following a recipe. A recipe for making a product is often called a process.

After you study this section, you will be able to:



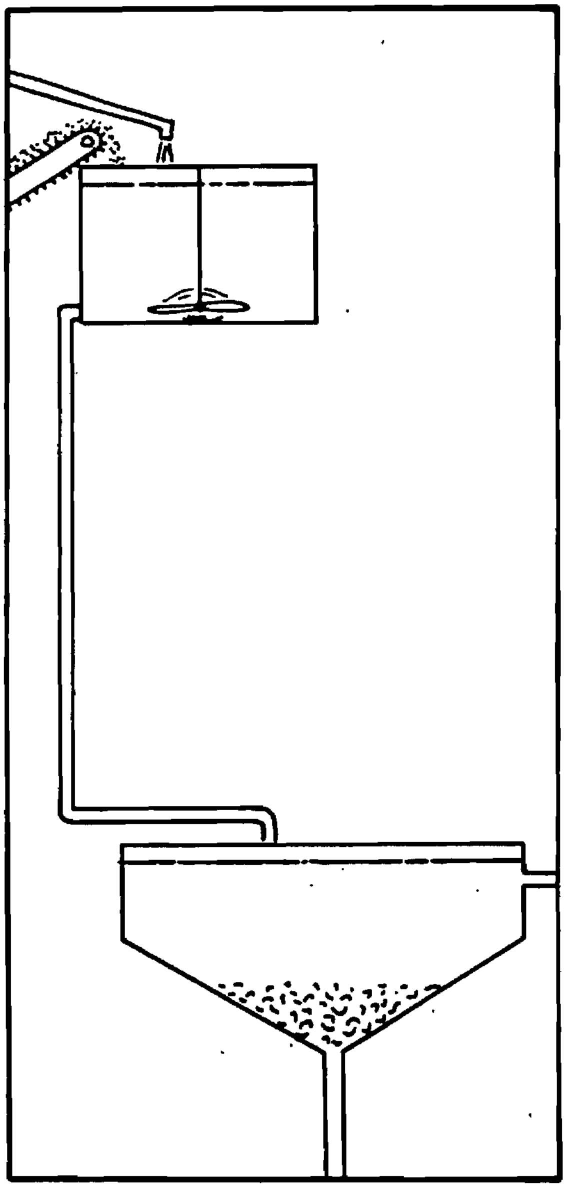
Name the steps used in the production of salt.

Follow the sequence of these steps in a drawing.

MINING

The production of pure salt begins when impure salt is taken from the earth. Salt can be found either in a solid, called rock salt, or in a liquid, called brine. Brine is another name for the salt water found in oceans or salt lakes. It also means a salt solution that contains a lot of salt. Rock salt and brine contain small amounts of matter other than salt. These foreign particles are called impurities. Pure salt can be made by following a series of steps called a manufacturing process.

DISSOLVING

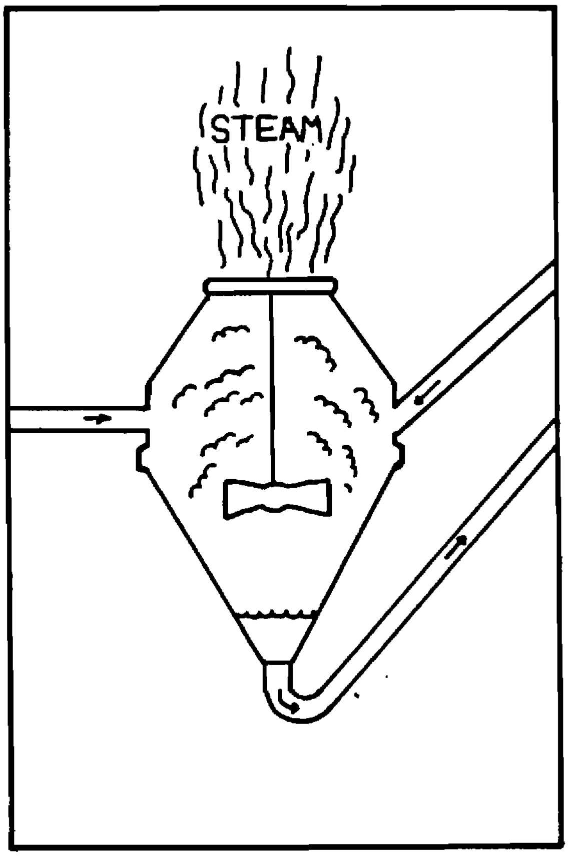


If rock salt is to be used to make pure salt, it must be taken from the earth or mined. The first step in the manufacturing of salt is called dissolving. The rock salt is dissolved in water to form brine. When brine from oceans or salt lakes is used to make salt, the dissolving step is not necessary.

SEPARATING

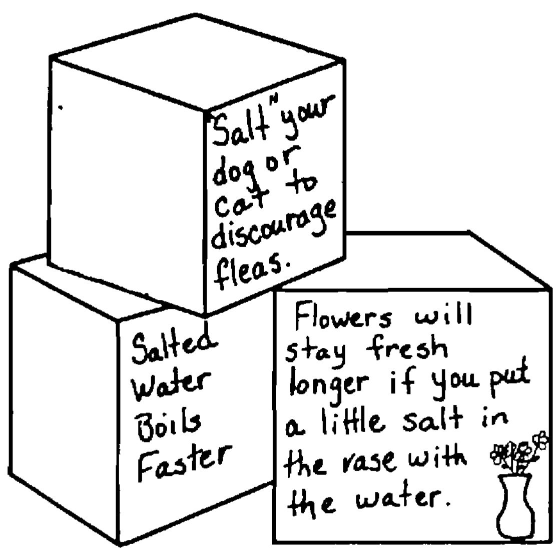
In the next step of salt production solid impurities such as small stones are removed from the brine. This step is called separation. This can be done by pumping the brine into a large tank called a separator. In this tank the solid impurities settle to the bottom and are removed from the brine. Because the solid impurities are not part of the solution, they can be removed in this way.

EVAPORATING

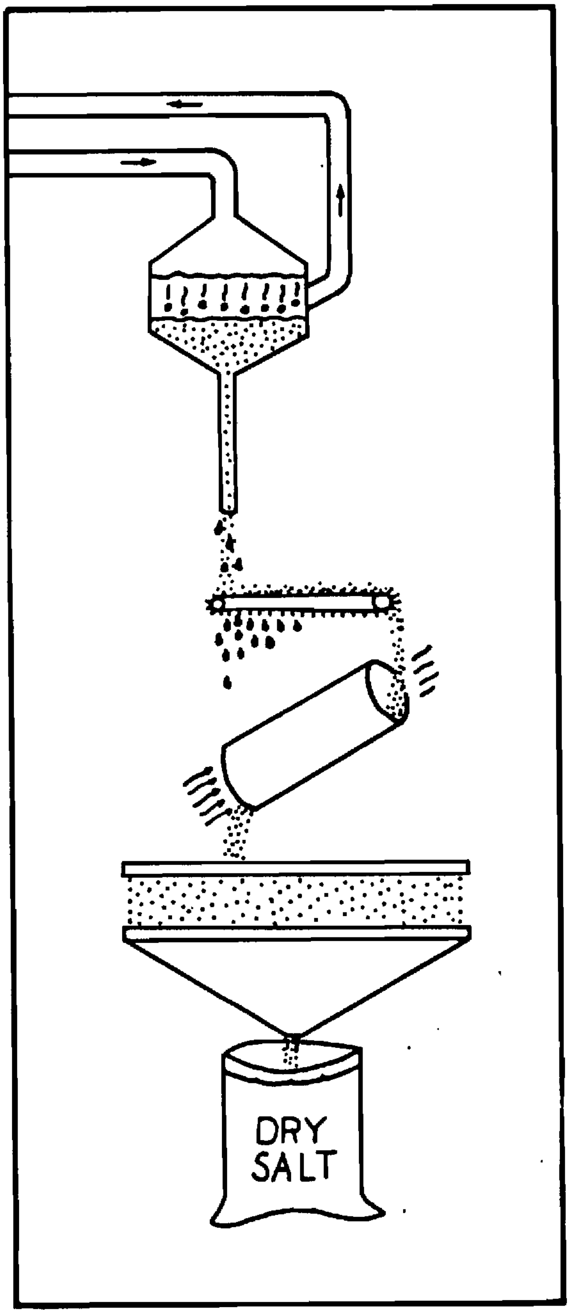


The next step in salt production separates the salt from the water. This is done by boiling the water and turning it to steam. The salt does not evaporate. Therefore, if the salt water is boiled until most of the water evaporates, solid salt crystals will remain.

Not all of the water is evaporated. If all of it did evaporate, the evaporator would get clogged up with salt crystals. Instead, just enough water is evaporated so that a mixture of salt crystals in a salt solution, or slurry, is formed.



SEPARATING



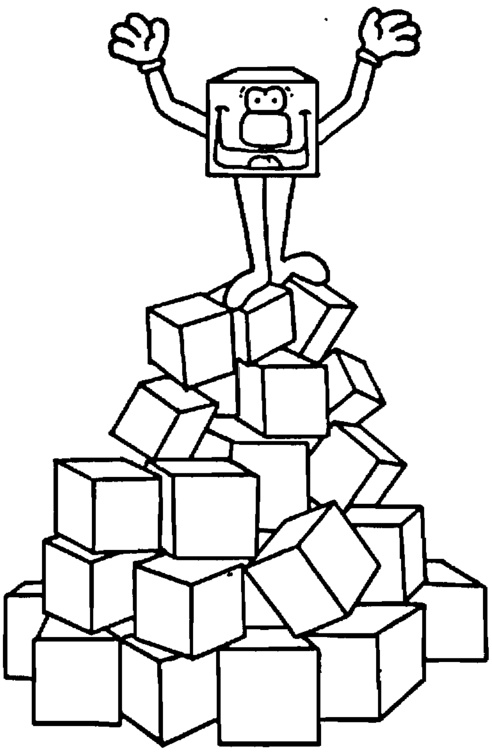
The solid-liquid slurry is then pumped to another separator. Here the salt crystals settle to the bottom. The salt solution is then removed from the top of the separator. This solution is saturated with salt and therefore, is not discarded. Instead, it is recycled to the evaporator where more water is evaporated from it.

A thick slurry containing crystals and a small amount of salt solution is removed from the bottom of the separator. It is sent to a filter which removes most of the remaining salt solution from the crystals. A filter is like a screen. Liquids can pass through the screen but solids cannot.

DRYING

The wet salt crystals that are removed from the filter are heated in a dryer, where the remaining water is evaporated. The crystals of pure, dry salt are then sifted and prepared for packaging and transporting to stores.

REVIEW AND EVALUATION



MAIN IDEAS

Pure salt is produced by following a series of steps called a manufacturing process.

The manufacturing process for salt includes: dissolving the rock salt in water, separating the solid impurities from the salt, evaporating the water and drying the salt crystals.

Filters, working like screens, separate the salt crystals from the liquid brine.

EVALUATION

Arrange the following steps to show the proper order for the manufacturing of salt.

1._____The salt solution is recyled.

2._____The salt crystals are heated in a dryer.

3._____Rock salt is removed from the earth.

4._____Solid impurities are separated from the brine.

5._____Rock salt is dissolved in water to form brine.

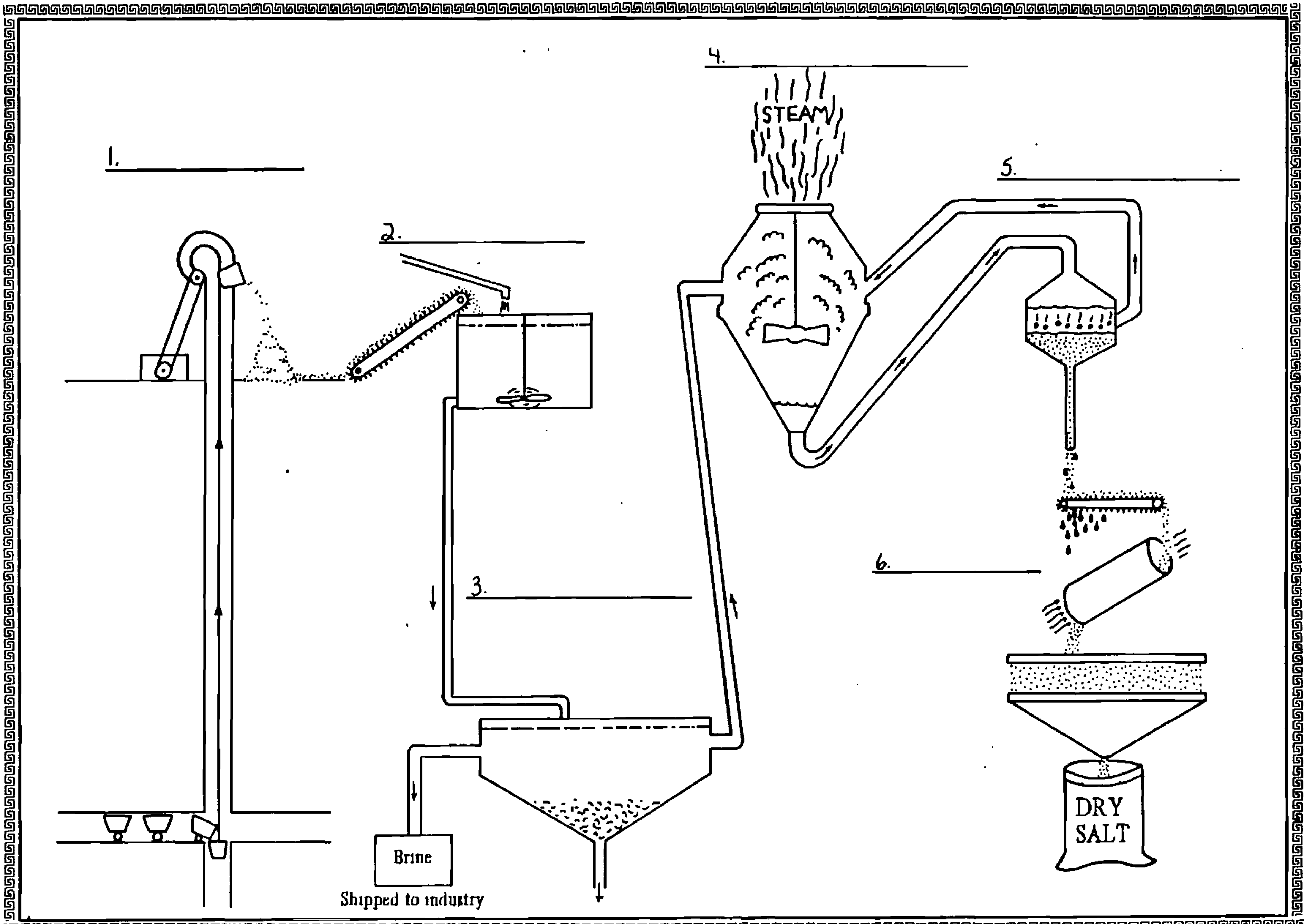
6._____Water is evaporated from the brine.

7._____A filter separates the salt solution from the salt crystals.

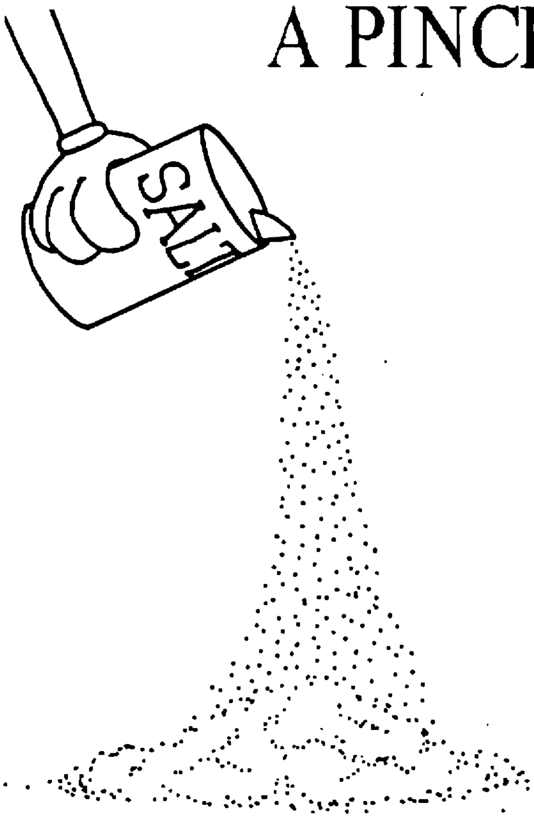
8._____A slurry of salt crystals in a salt solution forms as water evaporates from the brine.

The steps of the salt manufacturing process have been put together on the following page. See if you can label each of the steps of the process from mining to dry salt. For help, refer back to the pages in this section.

FLOW CHART FOR THE MANUFACTURING OF SALT



A PINCH OF SALT



WIELICZKA

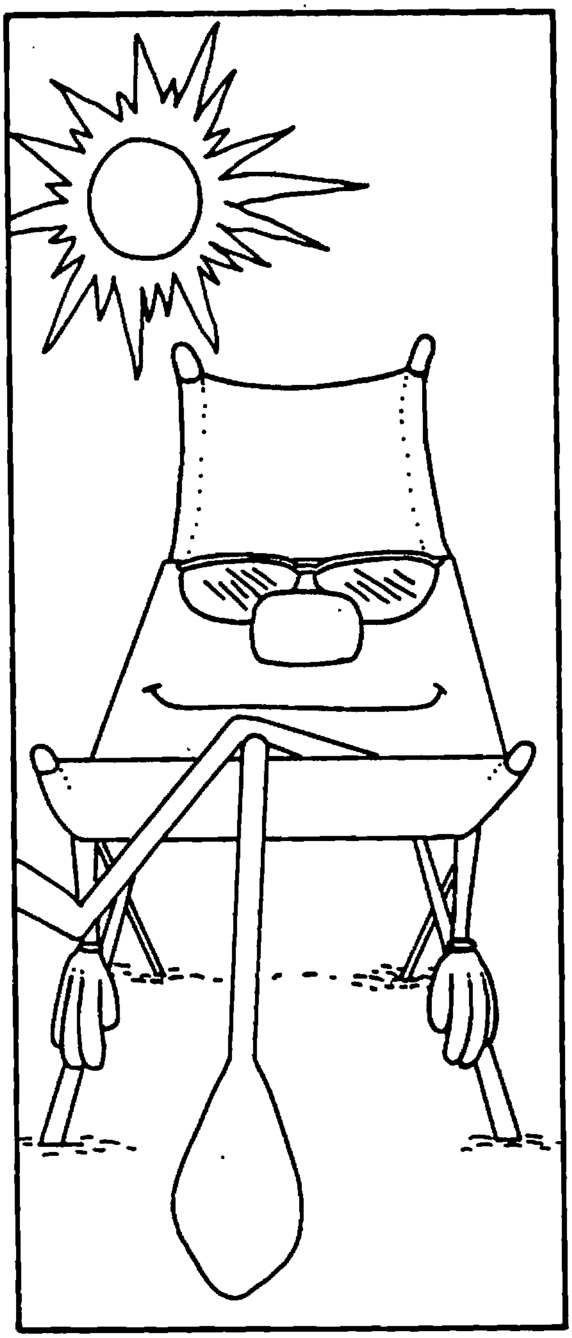
In Poland the Wieliczka mine has been producing salt for more than a thousand years. In the 17th century miners began carving works of art out of the salt. Over the years they have filled room after room with their craftsmanship. In one room, called Queen Kinga's chapel, each item is carved from salt. The salt works include statues, an altar, railings, candlesticks and even crystal chandeliers. Another smaller room is devoted to a statue of the early astronomer, Copernicus. Other chambers recall legends and honor royalty. Here, also, are the remnants of a Nazi aircraft-engine factory hidden in the mine, out of reach of Allied bombers.

This huge mine, on nine levels, serves another purpose. Almost three decades ago the mine's physician noticed that the salt miners were unusually resistant to respiratory diseases. He began assigning workers who had asthma and usually worked on the surface of the mine to work inside the mine instead. Almost all of these miners were able to breathe easier inside the mine. In 1964 he established a therapeutic center on the fifth level, about 700 feet down. Patients come here, away from temperature changes, humidity changes and pollution, to ease their respiratory ailments. The sanatorium is increasing in size with a goal of 800 beds. Patients who come here for a 24-day convalescence period also enjoy such comforts as a library, kitchen, physical-therapy area, recreation room and movie theatre.

PHASE 2

SALT:WHERE IT IS AND HOW IT GOT THERE

SECTION 2.1 - SALT IN WATER



Have you ever been swimming in the ocean and tasted the salt in the water? Sometimes the salt in the ocean water stings your eyes. Have you ever wondered why the ocean contains salt when most other bodies of water do not? The oceans contain enough salt to bury the United States a mile deep. In this section, you will learn about salt in water.

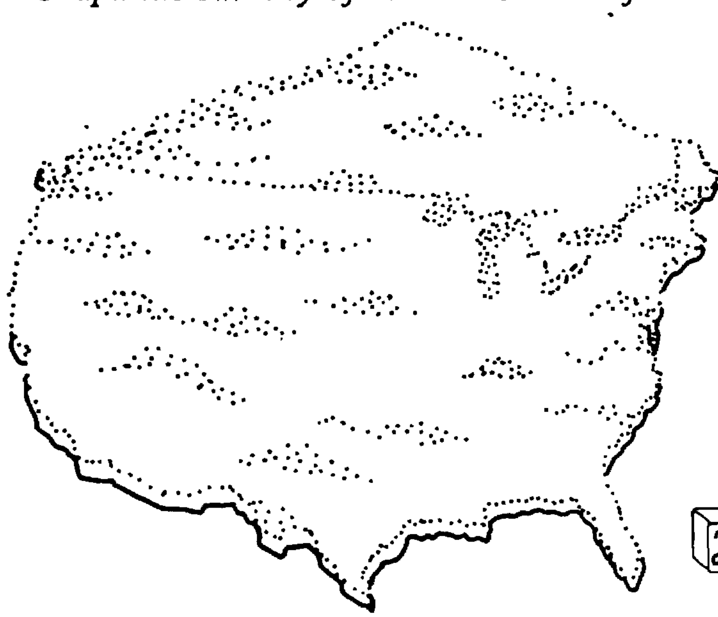
After you study this section, you will be able to:

Explain how salts accumulate in water.

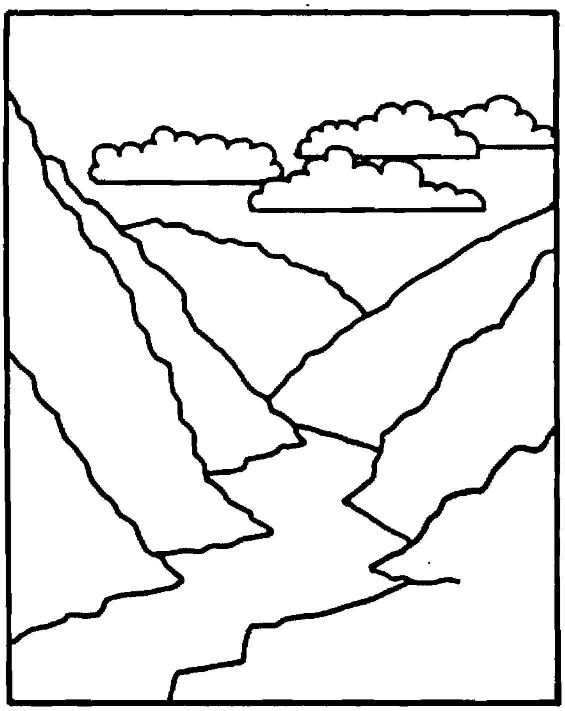
*Describe what the term **salinity** means.*

Identify various kinds of salts that are in the ocea

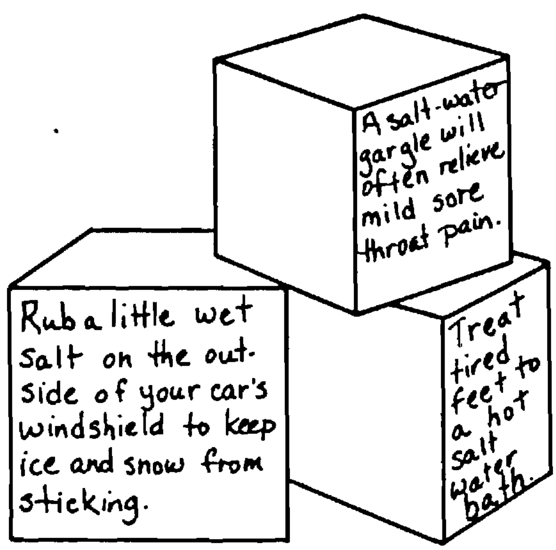
Graph the salinity of various bodies of water.



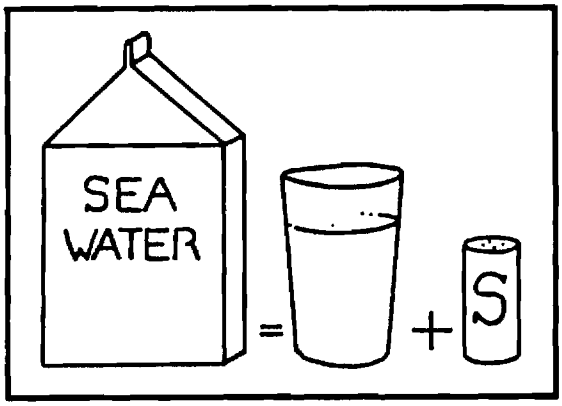
SALT TRAVELS TO THE OCEAN



Sodium chloride, or what we commonly refer to as salt, is one of the most plentiful materials within the earth's crust. Crystals of salt are found in many different types of rock and soil. A small quantity of salt is constantly being dissolved by rainwater. The oceans receive a constant supply of salt. Rainwater with dissolved salts is carried to the coast by streams and rivers. Over millions of years, the oceans have accumulated vast quantities of salt. Some ocean water is lost by evaporation. This process leaves the salt behind. Because of evaporation, the oceans have become more salty.



OCEAN SALTS AND SALINITY

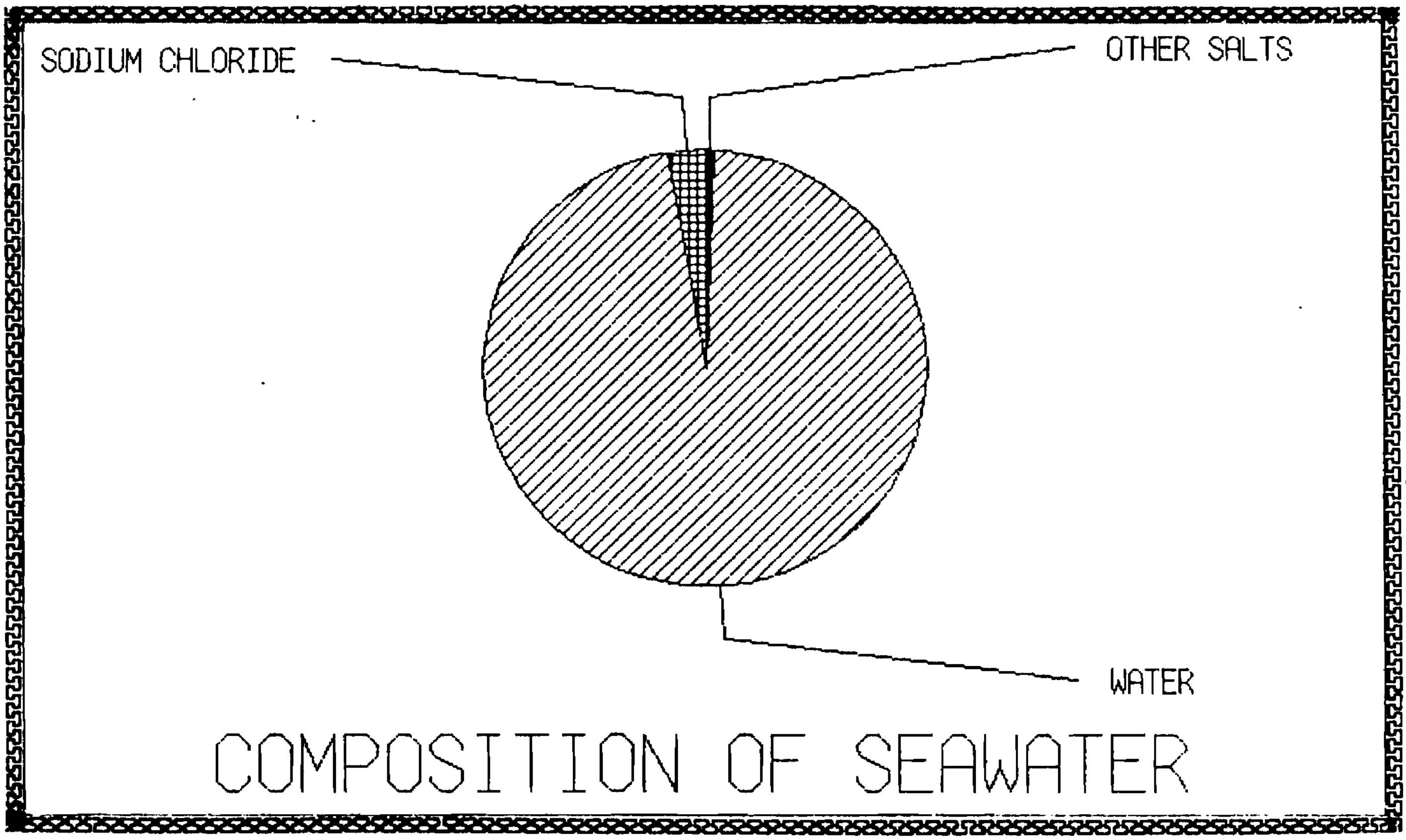


Presently, every gallon of seawater contains about a quarter of a pound of sodium chloride. But oceans contain other types of salts also. Salinity is the term used to describe the concentration of all salts in seawater. The average salinity is 34 parts of salts per 1,000 parts of seawater, or 3.4%. This means that if you were to boil 1,000 grams of seawater, 966 grams of water would evaporate. Because the salts do not boil away, you would be left with 34 grams of solid salts.

Remember that salinity refers to the concentration of all the salts in seawater. Though there are several kinds of salt in the ocean, more than three-fourths of all salt is sodium chloride.

COMPOSITION OF SEAWATER

SALTS	PARTS PER THOUSAND
Sodium Chloride	27
Magnesium Chloride	3
Magnesium Sulfate	2
Calcium Sulfate	1
Potassium Chloride	1
Sodium Bromide	trace
Water	966

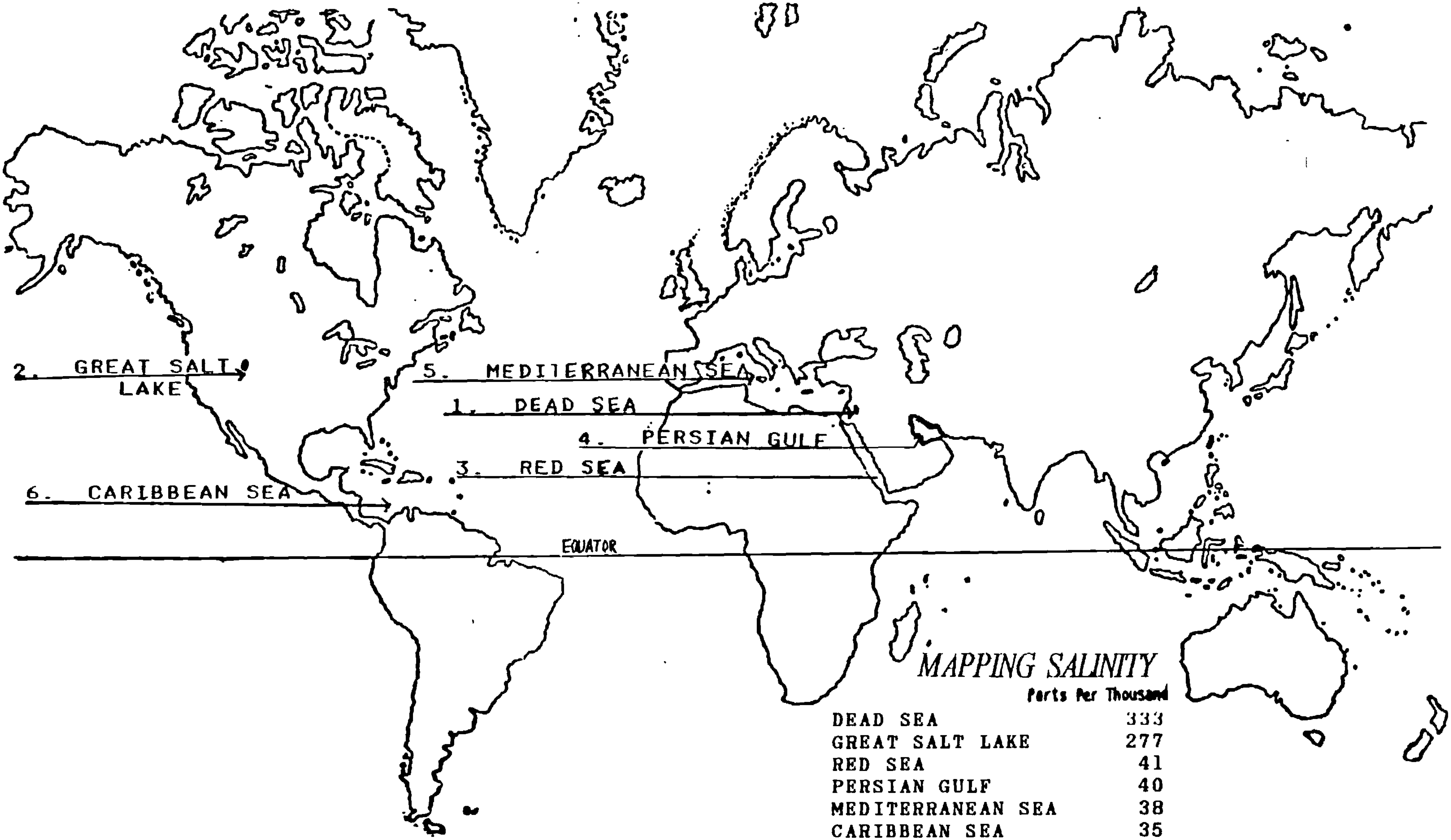


COMPOSITION OF SEAWATER

CHANGES IN SALINITY

Salinity is written as an average because incoming water and evaporation rates cause it to vary. In hot, dry areas more water is evaporated than returned through rainfall. With less water and the same amount of salt the salinity is greater. In regions where there is more incoming water from rainfall, melting snow, or rivers and streams, the amount of salt gets "watered down", and the salinity is less. In the next activity you will learn about the salinity of various bodies of water in the world.

THE SALTIEST SEAS ON EARTH



MAPPING SALINITY

	Parts Per Thousand
DEAD SEA	333
GREAT SALT LAKE	277
RED SEA	41
PERSIAN GULF	40
MEDITERRANEAN SEA	38
CARIBBEAN SEA	35
AVERAGE OF THE OCEANS	34

SCIENCE IN ACTION GRAPHING SALINITY

Use the information from the world map to make a bar graph. Notice the range of numbers before setting up your graph. You may want to number the bodies of water and include a key instead of labeling the names on the chart.

THOUGHT QUESTIONS

What factors would cause the salinity to vary within an ocean?

Can you explain why the Caribbean Sea and the Mediterranean Sea are saltier than the average of the oceans?

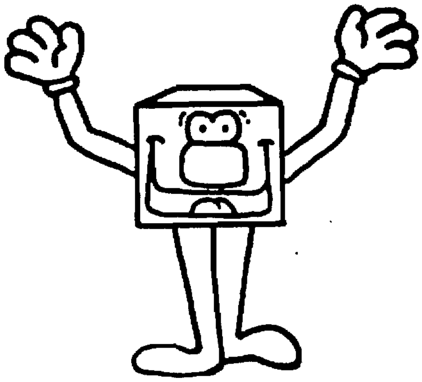
Can you explain why the Dead Sea and Great Salt Lake are much saltier than any other bodies of water?

Can you infer any other areas on the map that would be more or less salty than the average of the oceans?

How could you make mixtures of water and salt of the same salinity as the bodies of water listed on the map? (Hint- Remember in the example given 1,000 grams is total sea water: salt and water.

REVIEW AND EVALUATION

MAIN IDEAS



The oceans have accumulated salt from the land over millions of years.

When water is lost by evaporation, the salt remains. This makes the water more salty, or more concentrated.

Salinity is the concentration of all of the salts in seawater.

There are several kinds of salt in seawater.

The average salinity of the oceans is 34 parts of salt per 1,000 parts of seawater.

EVALUATION

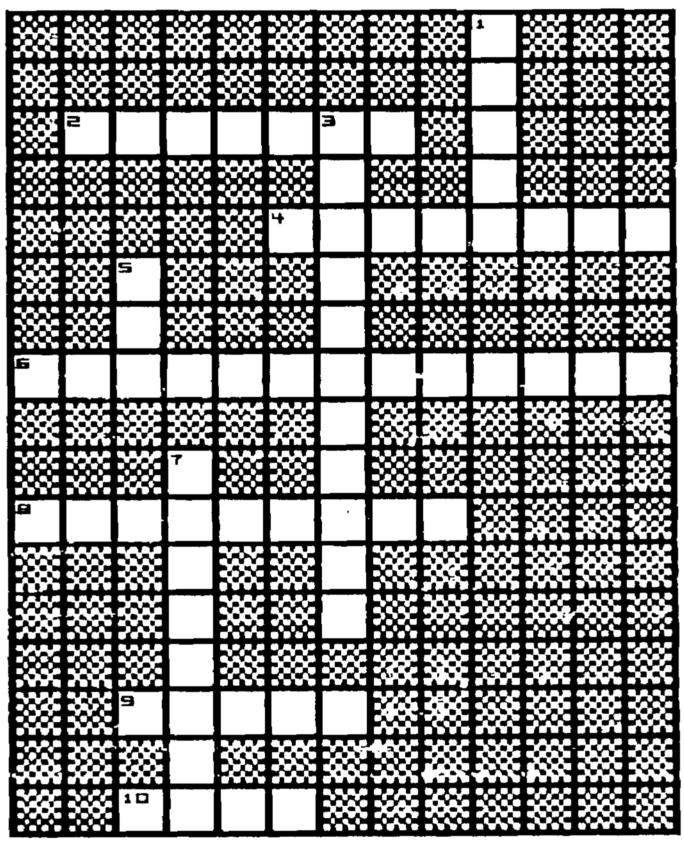
Fill in the correct term in the crossword puzzle below.

ACROSS CLUES

2. Has a salinity of 333 parts per thousand
4. The term used to describe the concentration of salts in water
6. The sea with a salinity of 38 parts per thousand
8. The chloride that makes up 3 parts per thousand of sea water
9. Salinity refers to all of the ____ in the water.
10. If an area gets lots of rainfall, its salinity will be _____________.

DOWN CLUES

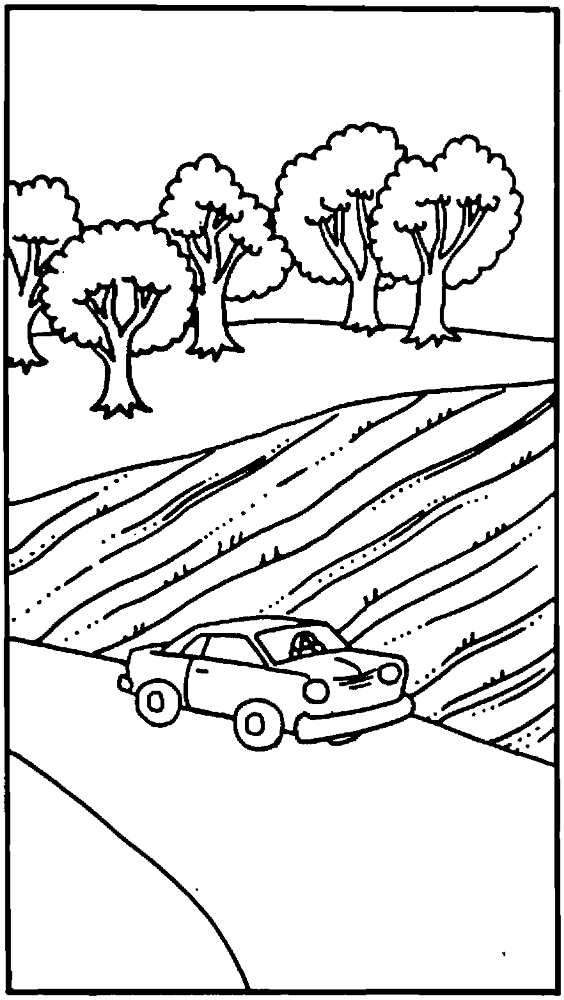
1. The average salinity of this is 34 parts per thousand.
3. Causes the amount of water to decrease while the amount of salt remains the same
5. The sea with a salinity of 41 parts per thousand
7. If lots of water evaporates, the salinity will __________.



THOUGHT QUESTION

Explain how salt accumulates in the ocean.
How does lake water differ from salt water? Why is it not salty?

SECTION 2.2 - SALT SEDIMENTS

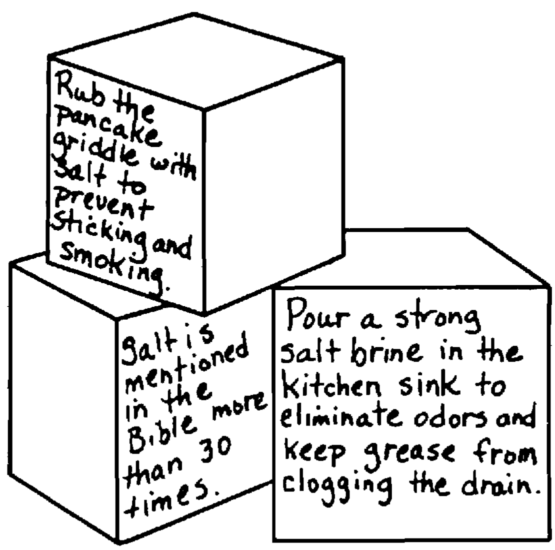


Have you ever noticed layers of different colored rock on the sides of a road? When a road is cut through an area, the land that is removed makes these layers visible. These layers show you the history of rock formation in that area. Many of these layers of rock were formed as sediments from streams and rivers. In this section you will learn how sedimentary rocks form.

After you study this section, you will be able to:

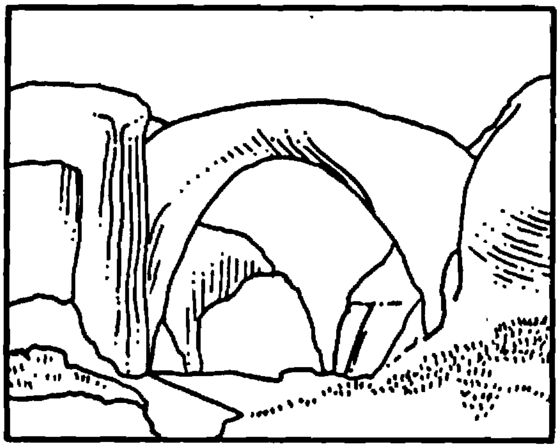
Explain how sedimentary rocks form.

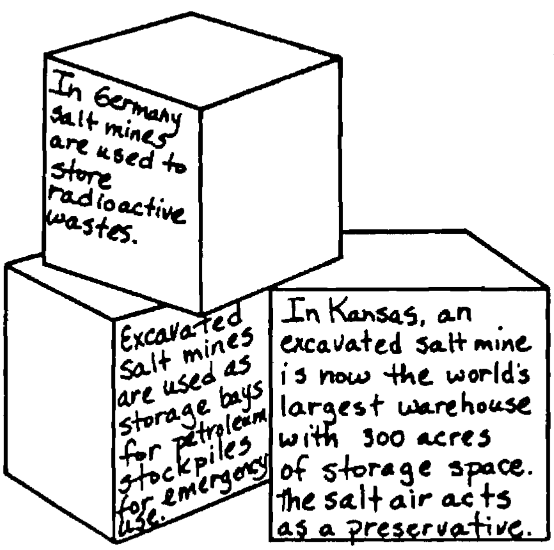
Recognize the factors that affect the formation of sediments



SEDIMENTARY ROCKS

The term sediment means matter that settles to the bottom of a liquid. Sedimentary rocks are formed from deposits of sediment. Salt deposits called rock salt are sedimentary rocks. The story of sedimentary rocks begins with the breakdown of large rocks by wind and water through a process called weathering. The large rocks are broken down into smaller rocks, which are carried away by moving wind or water. The process is slow but it is continuously working to change the earth's surface. Rock particles may be carried great distances from the original rocks by fast-moving streams. The water slows down where streams join a lake, ocean or slow-moving river. When the water slows, some of the particles settle out of the water. Because of their weight, the largest pieces usually settle first. They form a bed of rock on the bottom of the lake or river. Other sediments continue to settle to the bottom as the water slows more and more. In the next activity you will learn something about the settling of solids in liquids.





Purpose:

To see how the size of the particles affects how quickly they settle in water, do the following experiment.

Materials you will need:

large glass jar with a lid,
pebbles,
sand,
soil,
salt and
water.

Scientist at work:

1. Place several tablespoons of each material--pebbles, sand, soil and salt-- into the jar.

2. Add water to the jar until it is almost full.

3. Cap the lid tightly.

4. Shake the jar for several minutes until all the material is well mixed.

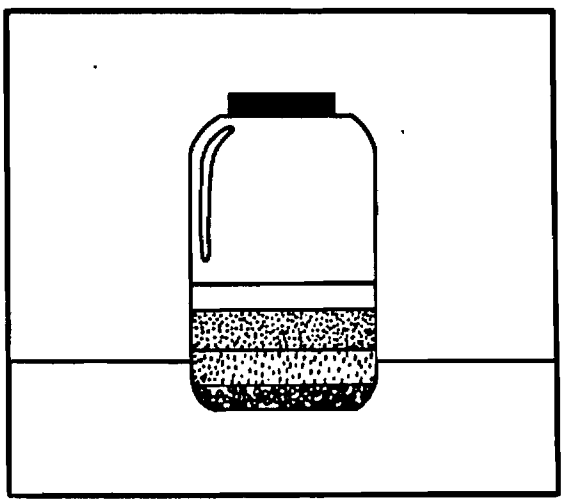
5. Set the jar down and observe what happens.

Interpreting your data:

1. Which material settled first?

2. List the order in which the sediments settled from the bottom of the jar to the top.

3. Explain why they settled in this order.



THOUGHT QUESTION

Did any of the materials which you added to the jar not settle? Why or why not?

CHALLENGE

If you want to be sure, repeat the experiment and only add the material which you think did not settle. In order to observe this one substance, do not add the other materials.

REVIEW AND EVALUATION

MAIN IDEAS

Sedimentary rocks form from particles of rocks that have been broken down by weathering.

The rock particles are carried by moving wind or water.

When the wind or water slows down, the particles drop or settle.

The size and the weight of a particle affects how fast it settles.

EVALUATION

There are several steps in the formation of sedimentary rocks. These steps are listed below. Put the steps in the correct order.

1._______Particles in water are carried great distances from the original rocks.

2._______The largest particles will settle first.

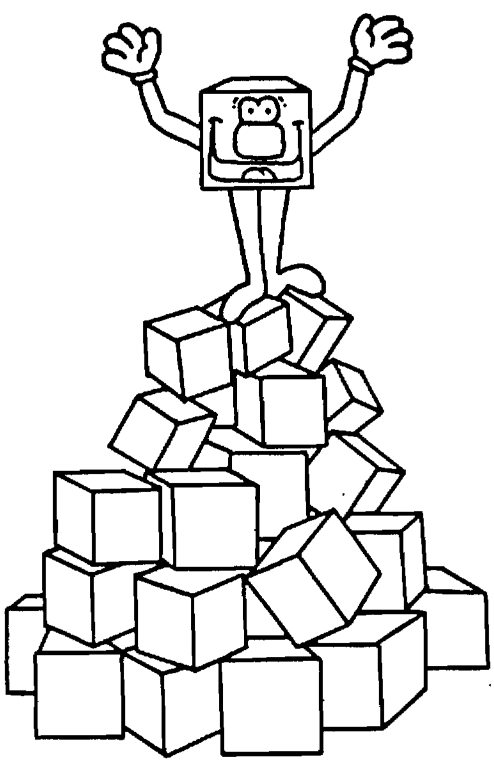
3._______Weathering breaks down rocks.

4._______A bed of rock is formed on the bottom of a river or lake.

5._______Rock particles are moved by wind and water.

6._______The water slows down.

7._______Smaller particles drop as the water slows more and more.



SECTION 2.3 - ROCK SALT

You have probably heard of rock candy, but have you ever heard of rock salt? It is the common name for the mineral halite. Geologists can identify halite by observing the cubic shape of the crystal. The flavor of salt is another obvious sign of halite. In this section you will learn about two kinds of rock salt formations found in the earth.

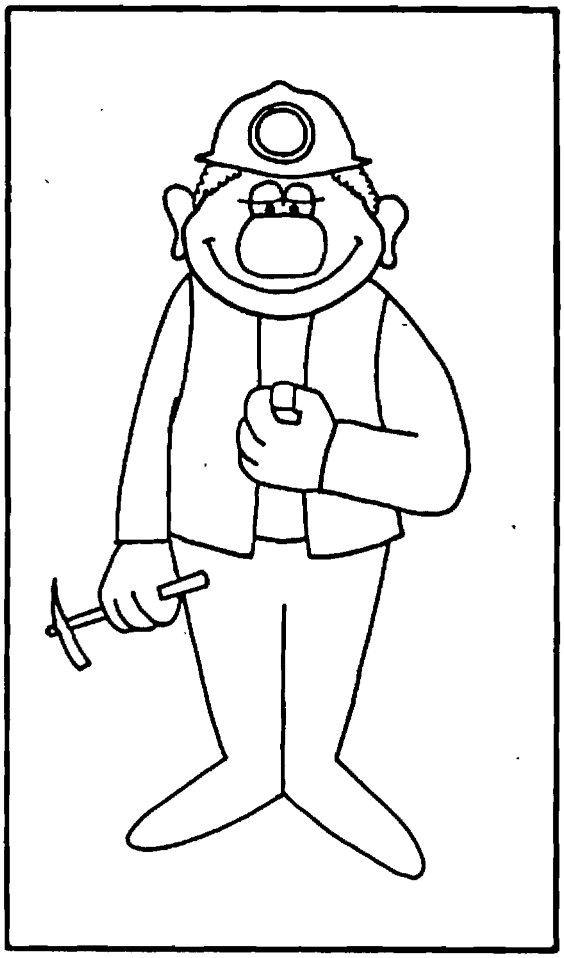
After you study this section, you will be able to:

Explain how rock salt formed.

Describe how ancient changes in climate helped to form salt beds.

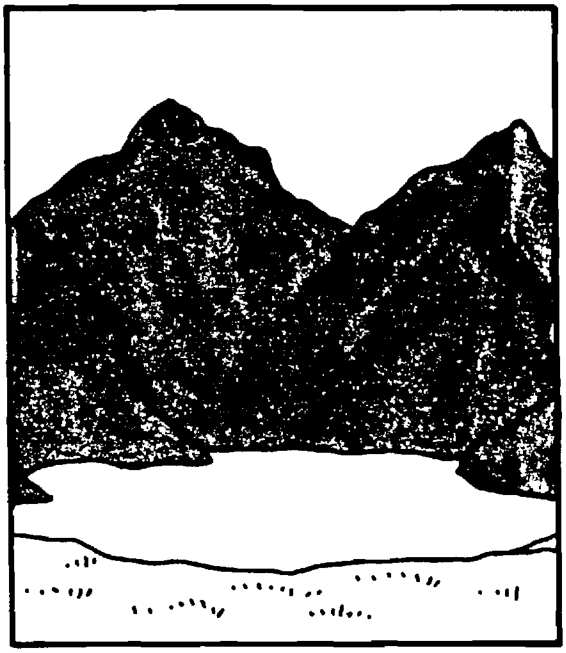
Explain what salt domes are and how they formed.

Locate different types of salt deposits.

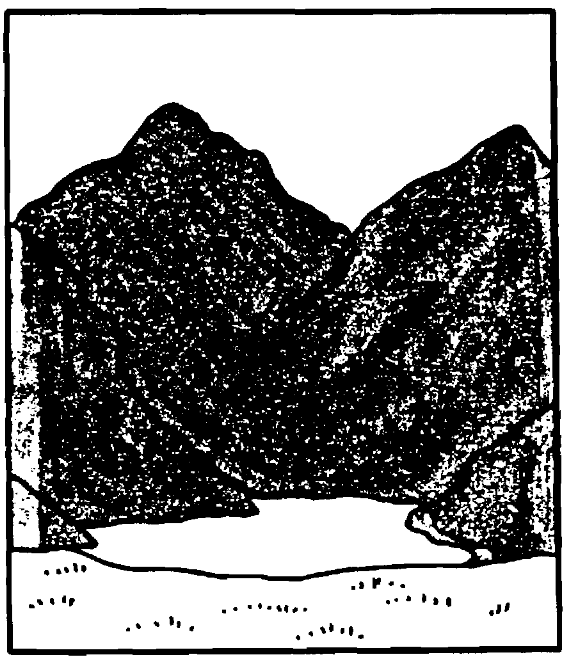


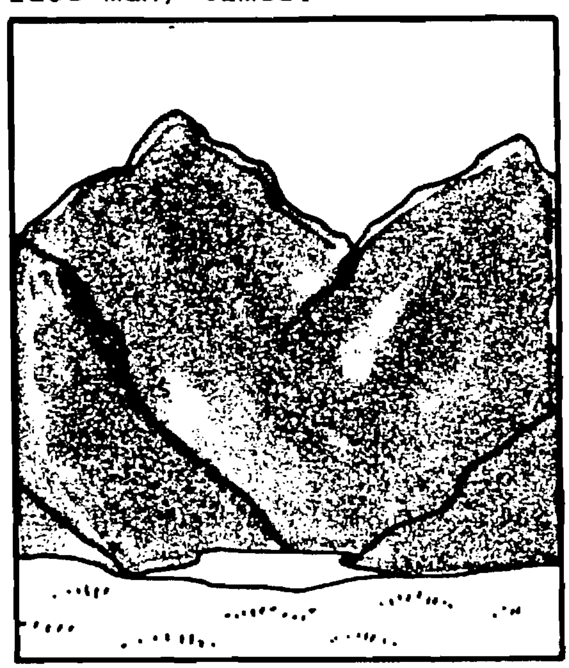
Sedimentary rocks can be formed through the evaporation of seawater. Rock salt, or halite, is one of these special types of sedimentary rock. It is very old, dating back 400-600 million years. Rock salt generally occurs in layers of relatively pure salt often separated by thin layers of impurities. Salt crystals formed when water evaporated from ancient salt lakes and seas. The crystals settled to the bottom of the salt water. The layers of salt crystals that formed were quite thick. The pressure caused by the weight of these layers caused the salt crystals to bond together and form hardened rock.

FACTORS AFFECTING SALT FORMATION

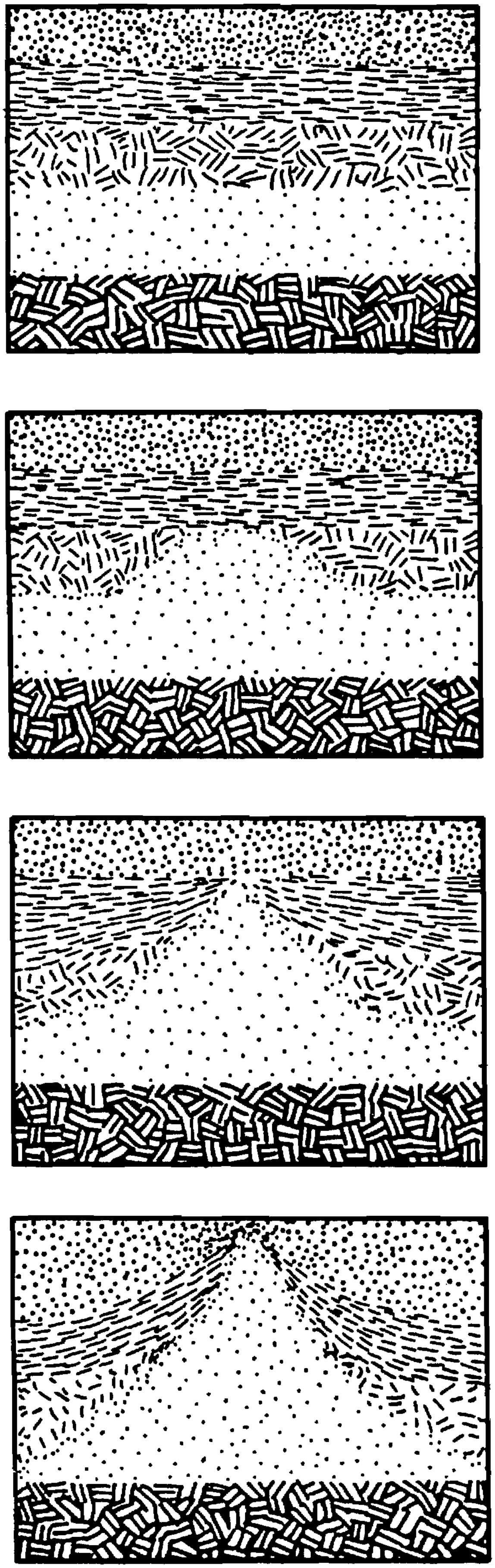


If seawater is surrounded by land with no water sources feeding it, evaporation will cause the water to dry up, leaving only the salt crystals. To obtain the great thicknesses that exist today in salt layers, this process of inland seas drying up must have been repeated many times. Many of these inland seas formed from portions of the oceans that became enclosed by land when the land formed or climate changed. The evaporation of these inland seas could have been caused by an increase in the temperature of an area or a decrease in rainfall. Other climatic changes could have also caused glaciers of ice and snow to melt. The additional water would increase the size of the oceans so they would again flood the land and refill the lakes. Over millions of years these processes could have taken place many times.



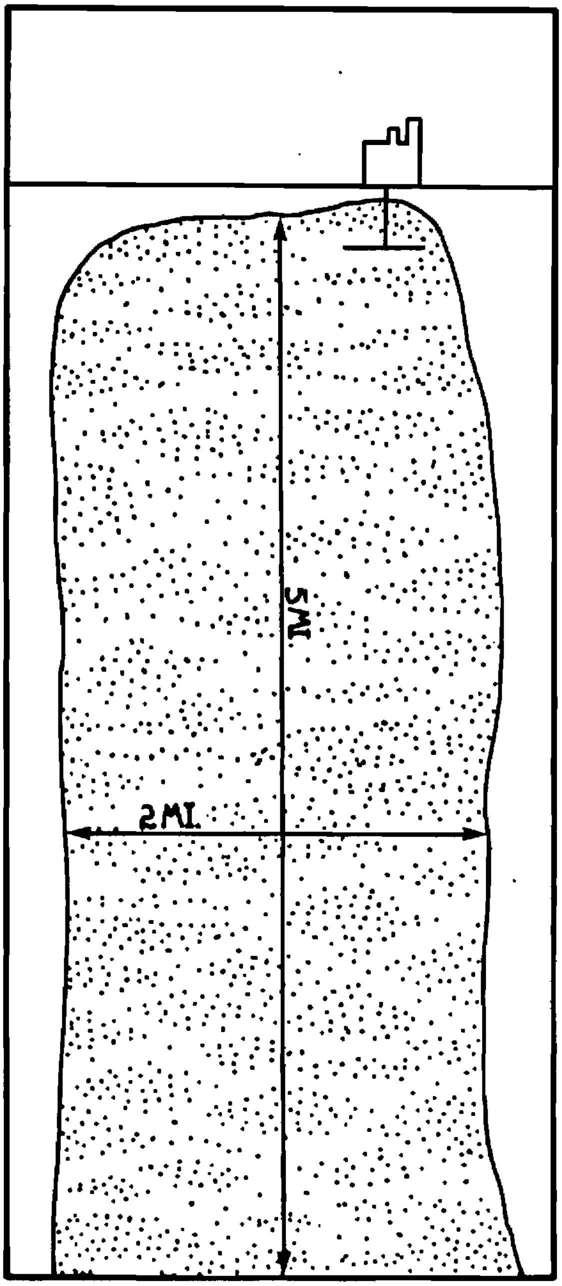


SALT DOMES



The salt dome is a rare type of salt deposit. A salt dome is a tall column of salt, perhaps a kilometer and a half (about a mile) across and as much as 5,000-6,000 meters (15,000-20,000 feet) high. Salt domes were formed when the weight of the layers of earth over the bedded salt created pressure. The pressure caused the salt to become like a soft plastic. The plastic-like salt was flexible enough to flow. Wherever the salt found a weakness in the overlying layers of earth, it started rising toward the surface. The salt was able to force its way through the rock because the salt is much lighter than the enclosing rock. When an ancient channel or fault opened up, the rocks' pressure forced the salt upward like toothpaste. The layers next to the salt seemed to be dragged upward as the salt punched its way through. If you push on both edges of this paper, you will cause it to rise in the middle in much the same way as the salt does when a salt dome forms.

LOCATING SALT FORMATIONS



Salt domes occur throughout the world. The majority are found around the Gulf of Mexico, where 329 domes have been located. One of the best known domes at Avery Island, in Louisiana, began producing salt before the Civil War. The salt here comes within 5 meters (16 feet) of the surface and has been drilled to 4,300 meters (14,000 feet).

In Iran, the salt has forced its way out to the surface of the earth. It flows out in glacier-like masses. The climate is dry; therefore, very little salt is dissolved because of rainfall. These "salt glaciers" are often the highest points of the landscape, standing out like mountains.

SCIENCE IN ACTION

LOCATING SALT FORMATIONS

Study the United States map to answer the following questions.

1. Name three states where rock salt can be mined.

2. Name three states where salt domes have formed.

3. What do you know about the history of these areas where rock salt has formed?

4. Name two states where salt lakes have formed.

5. Are there any salt domes or salt mines in your state?

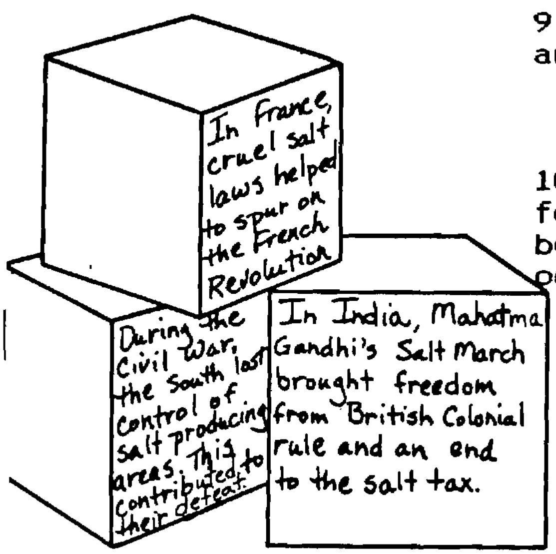
6. Name a state where solar salt is produced.

7. Name three states where salt is produced by evaporation.

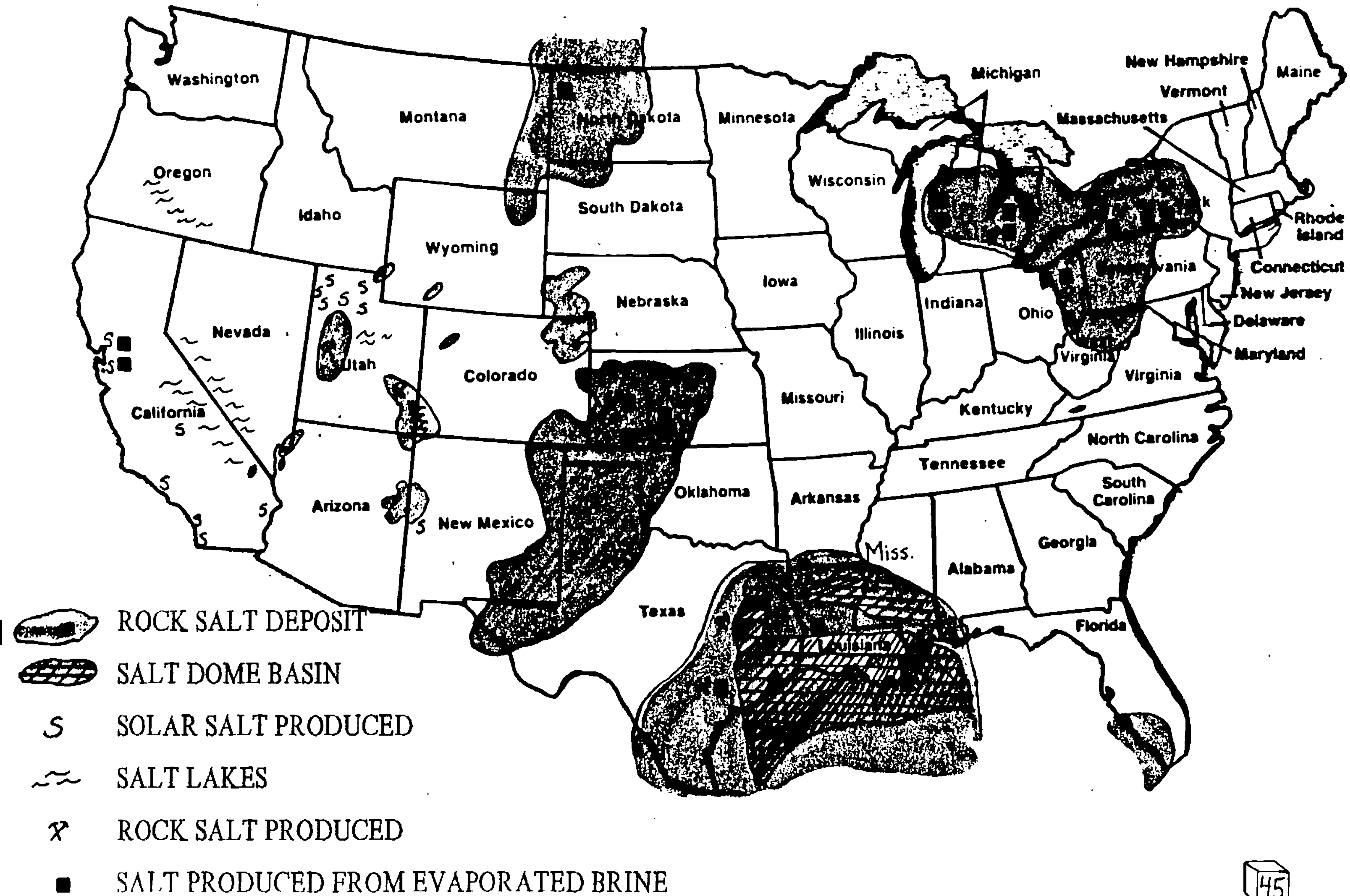
8. In what region are most of the salt domes?

9. What do you know about the history of these areas where salt domes formed?

10. Why do you think salt domes have not formed in the areas that only contain salt beds? (Hint-Remember the factors that have to occur to form salt beds and salt domes.)



SALT DEPOSITS IN THE UNITED STATES



REVIEW AND EVALUATION

MAIN IDEAS

Rock salt layers formed from the evaporation of seawater.

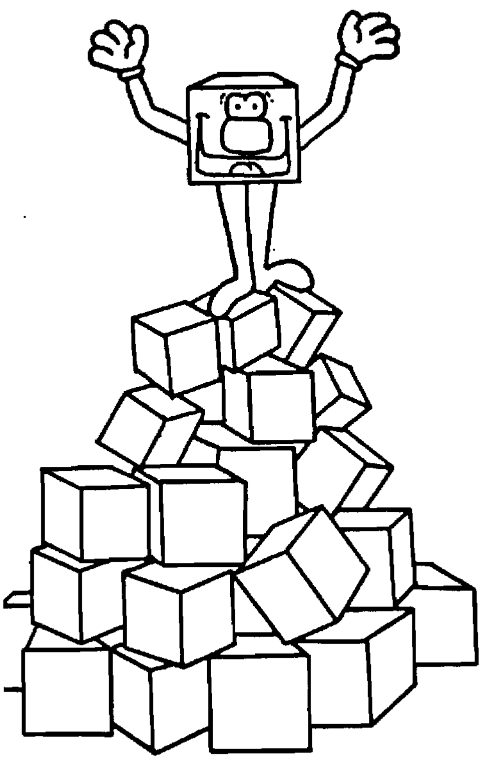
This evaporation was caused by changes in ancient climates. These changes caused ocean water to become trapped in land.

Salt domes were formed when pressure caused the salt to become like soft plastic. The flexible salt then forced its way through layers of rock to form a tall column of salt.

The majority of salt domes in the United States are found around the Gulf of Mexico.

EVALUATION

1. Describe how salt beds were formed.



2. How has the climate of the past caused salt beds to form?

3. What is the difference between a salt bed and a salt dome?

4. In three steps show how a salt dome forms. Draw and write a description of each stage.

A PINCH OF SALT

GREAT SALT LAKE

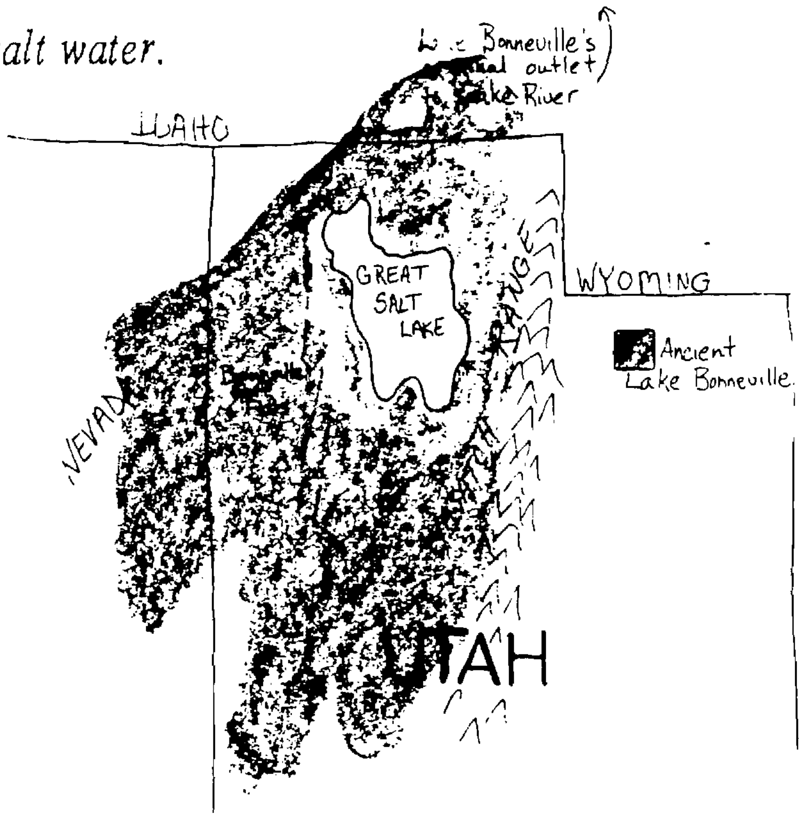
Great Salt Lake, in northern Utah, is an inland body of salt water. It was once called Lake Bonneville. This lake was formed by melting glaciers 50,000 years ago. It once occupied close to 30,000 square kilometers (about 12,000 square miles). As you can see on the map, it once covered much of western Utah and parts of Idaho and Nevada. At that time, Lake Bonneville was 305 meters (1,000 feet) deep.

When the glacier retreated, that part of the world became hotter and drier. Lake Bonneville shrank below the level of its outlet. The streams that added water could not keep up with what was lost by evaporation. As the lake lost water, it became saltier and saltier. When the water evaporated, the salt remained in large layers, or beds of solid salt.

Remains of the original lake and these beds of salt can still be seen today. The salt beds are now called Bonneville Salt Flats. The salt flats have become one of the finest automobile race tracks in the world. The level salt bed forms an ideal surface for the speedway because of the cooling effect the moisture-holding salt has on tires.

The remains of Lake Bonneville, now called Great Salt Lake, occupy only 2,435 square kilometers (about 1,000 square miles) at a depth of less than 10 meters (33 feet). The salinity of Great Salt Lake, which doubled from 1877-1935, is now close to eight times as salty as the ocean. The salt concentration of Great Salt Lake makes it impossible for a swimmer to sink.

The only creatures equipped to survive here are a particular type of fly and tiny brine shrimp. Because the shrimp hatchlings are food for tropical fish, the eggs are harvested by the bushel and sold to pet stores. The eggs can stay in storage for years and will hatch when placed into salt water.



SCIENCE IN ACTION *SALT WATER INHABITANTS: BRINE SHRIMP*

Purpose:

Brine shrimp are easily obtained at local pet shops and can be hatched in the classroom in 36 to 48 hours. They are closely related to lobsters, crabs and the larger species of shrimp; therefore they are classified as crustaceans. To demonstrate the fact that salt water is critical to the hatching of brine shrimp eggs, do the following activity.

Materials you will need:

2 sets of brine shrimp eggs,
non-iodized salt,
water,
2 transparent trays or glass jars,
eyedropper,
microscope or magnifying glass,
stirring rod or spoon.

Scientist at work:

1. Add one an a half tablespoons of non-iodized salt to one quart of water to form the brine solution. Stir to dissolve the salt.

2. In the other jar add one quart of clear water.

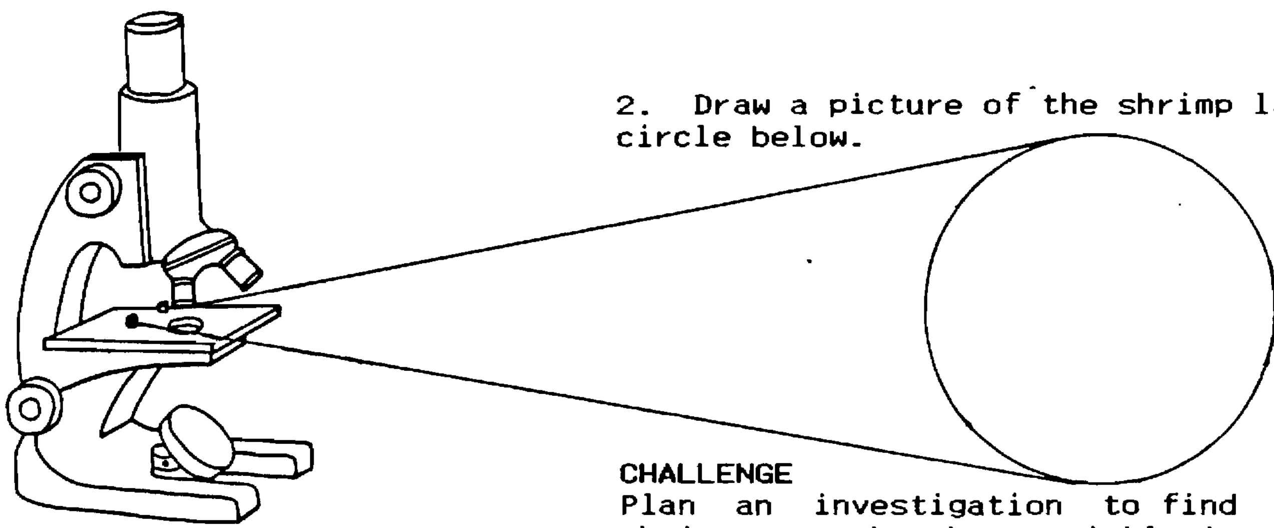
3. Add the brine shrimp eggs to both jars. Keep the temperature a constant 77 F (25 C).

4. After 36 hours check the cultures for brine shrimp larvae. Use the eyedropper to transfer water from each jar to a slide for viewing under the microscope.

Interpreting your data:

1. Did brine shrimp eggs hatch in both jars?

2. Draw a picture of the shrimp larvae in the circle below.

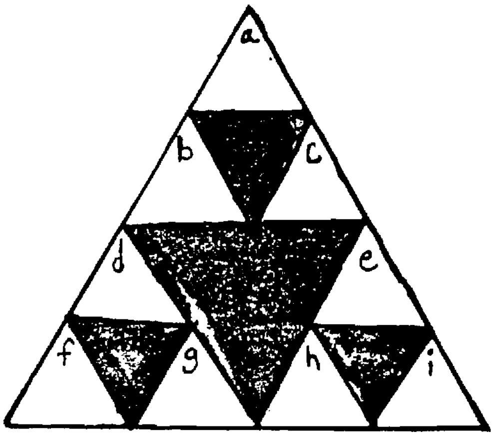


CHALLENGE
Plan an investigation to find out if shrimp eggs hatch as quickly in saltier water.

To keep some shrimp for further observations, put a pinch of dry yeast powder in the jar once a week for food.

SCIENCE IN ACTION *TEST YOURSELF WITH A MAGIC TRIANGLE*

Place the number of your answer to the lettered question in the corresponding space of the large triangle. Use each number only once; one number will not be used at all. If all your answers are correct, each side will add up to 17.



a. What has become a fine automobile race track?

b. What animal's eggs are harvested from the Great Salt Lake?

c. What body of water is saltier than the Great Salt Lake?

d. What is the area of today's Great Salt Lake?

e. What is needed to hatch brine shrimp?

f. In addition to brine shrimp, what else lives near the Great Salt Lake?

g. What formed Lake Bonneville?

h. Brine shrimp are food for what kind of animals?

i. How much saltier is the Great Salt Lake than ocean water?

1. Bonnevile Salt Flats
2. Flies
3. Eight times
4. Tropical fish
5. Brine shrimp
6. Dead Sea
7. Salt water
8. Glaciers
9. Approximately 1,000 square miles
10. 33 square miles