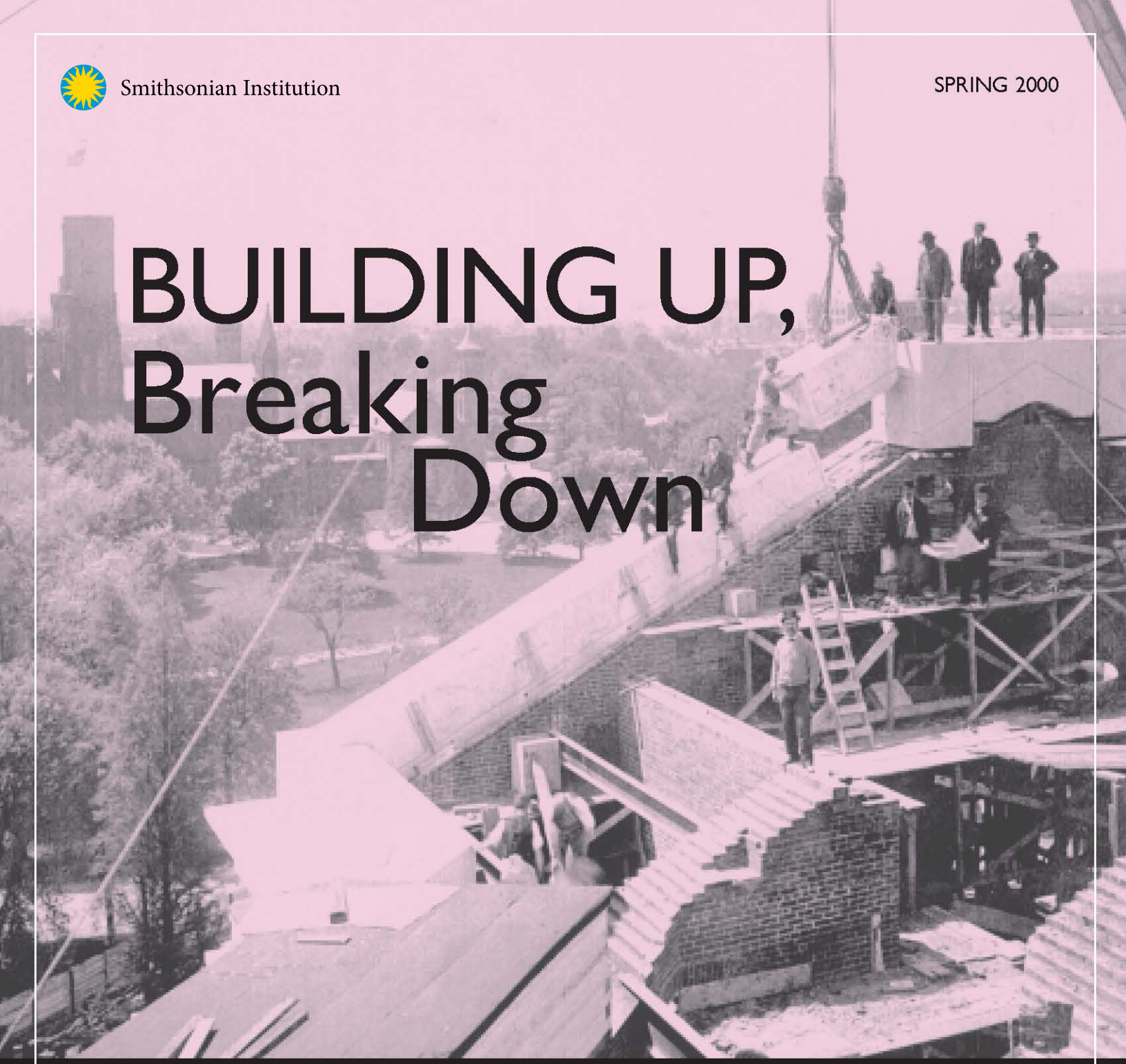
Smithsonian Institution

SPRING 2000

BUILDING UP, Breaking Down



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MINECRAFT EDUCATION EDITION

This year, Museum Day Live! features special interactive lesson plans created by Smithsonian in partnership with Microsoft using Minecraft: Education Edition. These lesson plans are designed to stimulate STEM activities in a variety of settings.

BUILDING UP, BREAKING DOWN

"It's not new that architecture can profoundly affect a place, sometimes transform it. Architecture and any art can transform a person, even save someone." — Frank Gehry

CATEGORIES: Science, History

AGES: Primary (5 - 8 years old), Intermediate (9 - 12 years old)

OBJECTIVE: Explore how buildings age. Discover how physical breakdown (such as rock fracture), chemical weathering, and pollution are all key ingredients in this discussion of the geology of the built environment.

MINECRAFT: EDUCATION EDITION EXTENSION

After touring a local museum or historical site, think about the importance of that building within the community.

- Research the history, purpose, construction materials, and upkeep of significant buildings within the community. Select one building and recreate it using Minecraft. Try to match the building materials to blocks available in Minecraft. Work in groups to create the entire town.
- Alternatively, choose a building has not aged well. Thinking about how certain materials age in specific environments, recreate the building using materials that might age better.

Related lessons and worlds: Gen City Lesson, Starter Town World

BEGIN YOUR MINECRAFT JOURNEY:

Download the trial at aka.ms/beginhere

Join our community at aka.ms/joinus

Learn to Play via our Tutorial at aka.ms/learntoplay

Start a conversation using @playcraftlearn and #MinecraftEdu

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A view of the Capitol from the Rocks Gallery of the Janet Annenberg Hooker Hall of Geology, Gems, and Minerals, National Museum of Natural History.

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The purpose of *Smithsonian in Your Classroom* is to help teachers bring to their students the educational power of museums and other community resources. It draws on the Smithsonian's exhibitions and programs—from art to zoology—to create classroom-ready materials for grades 3-8.

Each of the four annual issues takes an interdisciplinary approach to a single topic. The Smithsonian invites teachers to duplicate the materials for educational use.

This issue prepared in association with the Office of Education, National Museum of Natural History.

THE PHOTOGRAPH ON THE COVER SHOWS THE SMITHSONIAN NATIONAL MUSEUM OF NATURAL HISTORY in 1909, the year of its completion. The building itself, like all buildings, has a natural history. Its exterior is made up of pink granite mined from Massachusetts and white granite from Vermont. The steps of the front entrance are of unakite granite from a quarry in New Jersey.

Most construction materials come directly or indirectly from the earth, and therefore are subject to natural processes of breakdown. The baluster on the opposite page is a display in the museum's Rocks Gallery. It is from the oldest section of the U.S. Capitol, which, like the White House, is built of light tan Aquia Creek sandstone from Virginia. Over time, the outer surface of this stone weathers to a much darker shade of brown. The White House and this part of the Capitol are white only because they are coated with paint, which helps to weatherproof the stone. But, as this picture shows, the coating delays rather than prevents deterioration.

Building Materials

Aggregate is crushed stone, sand, and gravel (small, naturally loose pieces of rock).

Asphalt is a mixture of sand and a liquid product refined from crude oil, combined with aggregate.

Brick is a baked mixture of sand, clay, and water.

Cement is a fine, gray powder that is made by firing clay and limestone in a kiln.

Ceramic tiles are made by firing a mixture of clay, chemicals, and water.

Concrete is a mixture of cement, aggregate, sand, and water.

Dimension stones, either chunky blocks or thin slab-like panels, are quarried rock such as marble, granite, sandstone, and limestone.

Glass is made by melting a mixture of quartz sand (silica), soda (sodium carbonate), lime (baked limestone), and chemicals.

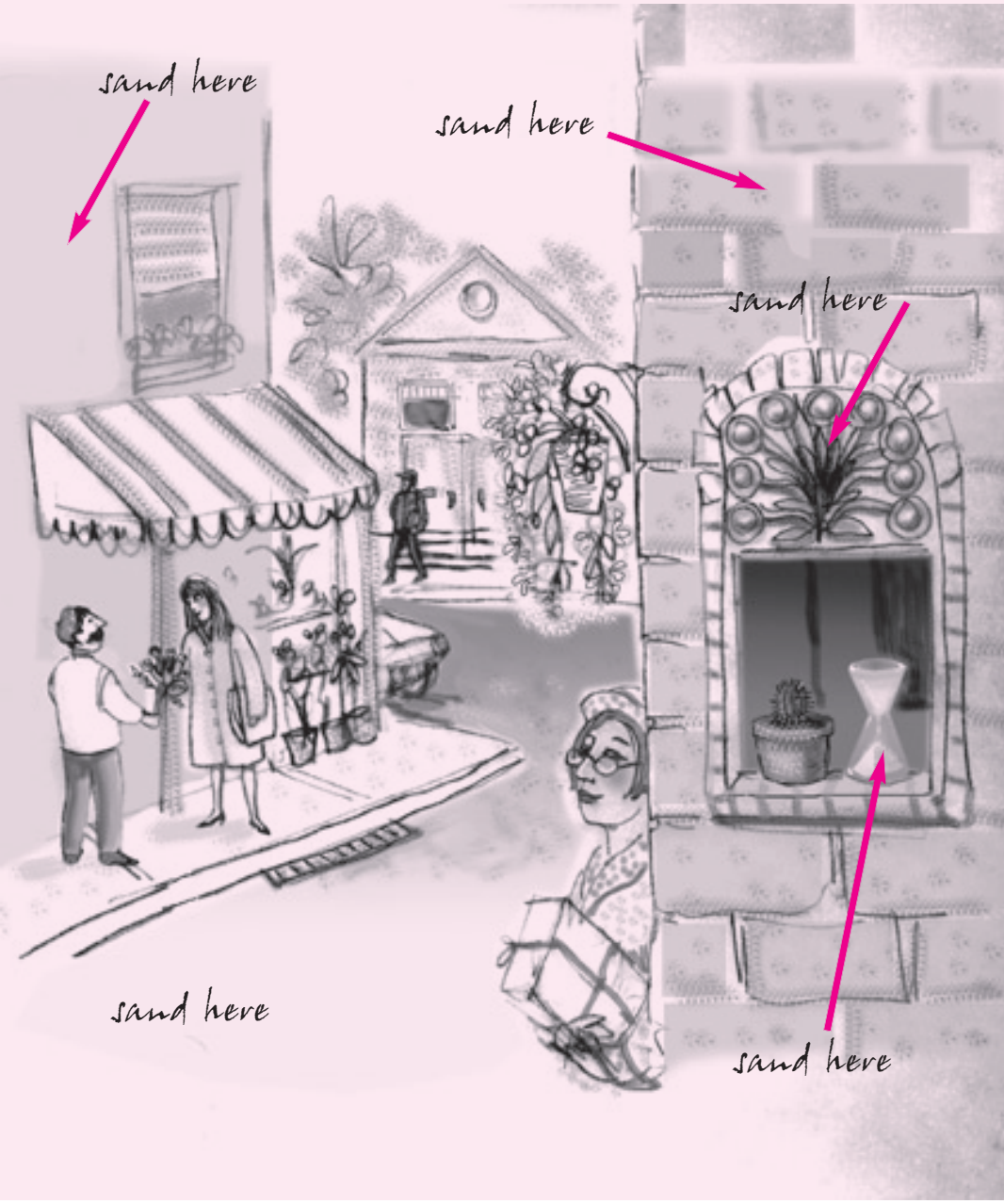
Manufactured stone is made of sturdy pieces of natural or artificial material (or both) glued or pressed together and cut into pieces of the desired shape.

Metals like steel, copper, and aluminum are manufactured from ore minerals.

Mortar is a coarse paste, often made of water, sand, and either lime or cement.

Plaster is a smooth paste, often made of water, sand, and either lime or gypsum.

Sand is used in glass, concrete, asphalt, bricks, and the mortar that holds bricks together.



In this issue's lesson plans, your students can explore their school building to learn how rocks are modified (either by nature or manufacture) into construction materials, and how these materials deteriorate over time. The culminating activity is an off-site visit to a cemetery to view the effects of weathering on a variety of monument stones.

We hope they will see that the natural environment includes buildings, and that the preservation of the environment can apply to cities and towns as well as wilderness.

What Happens to Building Materials When They Weather?

Buildings begin to break down the minute they are assembled. Weathering occurs as decomposition (chemical breakdown) or disintegration (physical breakdown) or both. One type of weathering can lead to another. For example, a physical breakdown such as rock fracture makes chemical breakdown more likely by exposing additional surface areas to damaging solutions. Chemical weathering, in turn, weakens the material, increasing the likelihood of further fracturing.

Some chemical weathering is a consequence of acids produced by living things growing on the rock. The deterioration of structures such as bridges and statues has increased dramatically in the last few decades, however, because of chemical changes that produce acid rain. Pollution from automobiles and industrial plants adds sulfur dioxide, carbon dioxide, and other gasses to the natural carbon dioxide in the air.

Leanne Wiberg

The woolly coat on the lamb adorning this infant's grave marker is disappearing bit by bit because of chemical weathering.

LESSON PLAN ONE

Rocks Build Cities

In this guided-imagery lesson, students make drawings of urban and rural environments. They use creative thinking skills together with personal knowledge and experiences to identify and interpret similarities and differences in the drawings.

Student Product

Student-made summary poster that includes:

- a pair of personal drawings taped to poster board
- names of objects common to both rural and urban environments written on poster board around mounted drawings
- a written summary statement outlining how people modify natural materials

Materials and Resources

- poster board
- drawing paper
- colored markers
- tape

Activity

1. Explain to the students that they will be drawing images and writing responses to the guided-imagery text you will be reading aloud. Assure them that you will pause and allow enough time for them to follow the specific directions as they are presented.

2. After the activity, ask students to share their paired drawings with the class. Have them mount the drawings on poster board and collectively identify which scenes are rural and which are urban. As a classroom project, compare and contrast several mounted drawings, writing student comments on the board. Have each student annotate his or her own poster in a similar fashion by naming features that appear, in one form or another, in both of the drawings.

3. After students have written these comments on their posters, ask them to discuss how they depicted natural materials adapted for use in the urban environment. Students should write a summary statement on their own posters. Statements should be simple and straightforward. For example, "rocks cemented together make buildings," "sand melts to form glass," and "river gravel is mixed with cement to form concrete."

Reading Guided Imagery Aloud

Encourage students to develop a mental picture incrementally. They will build up the picture in their minds as you read aloud. They will then illustrate their impressions.

Allow plenty of time for them to draw and think. Don't rush. Encourage thoughts about the colors, smells, textures, and sounds inspired by your reading.

Read slowly with lots of pauses. The first time through, read the text printed in bold. The second time, read the bracketed text printed in italics.

Guided Imagery

Close your eyes and listen carefully as I read to you. Keep your eyes closed until I ask you to open them. If you want to say something, raise your hand. I'll call on you. Speak to the class, and to me, with your eyes closed.

Now . . . imagine yourself on a summer's day outside **in a natural setting away from the city.** *[in a large city.]* Don't worry about how you got there . . . you're just THERE. Now, try to see yourself sitting quietly **on a rock.** *[on some steps at the entrance to a tall building in the city.]* What **does your rock** *[do the steps]* look like? Open your eyes and draw what you've imagined on your paper. Draw **your rock.** *[the steps to the building.]* Close your eyes again when you've drawn **your rock.** *[the steps.]* Your **rock is** *[steps are]* in the shade. It is hot outside. You're hungry. . . it is noon. It's lunchtime; your stomach growls.

Focus on what is around you. What objects do you see from **your rock?** *[the steps?]* Open your eyes and draw at least three of them. Draw the things you see from **your rock.** *[the steps.]* Focus on what you hear . . . write down the sounds you hear. You can write things like "leaves rustle in the wind." You may write anywhere on your drawing.

Close your eyes again. Now imagine it begins to rain; the rain comes harder and harder. . . the wind picks up strength. Do you want to stay on **your rock?** *[the steps?]* Why or why not? Where do you want to go? Open your eyes. On your paper, draw an arrow pointing to a nearby location that is not on your paper. Write a word under the arrow. The word is *to*. Draw a blank after the word *to*. Now, fill in the blank so it says "to the cave," or whatever you decide to say.

LESSON PLAN TWO

Building Bingo

This "in-school field trip" gives students hands-on experience in identifying building materials. By playing Building Bingo, they might see their school building and school grounds in a new light. The game requires them to identify the structural materials found on campus, as well as the substances used to make each material. To accomplish this task, teams of students locate interior or exterior building materials on their school grounds that they'd like to identify. They will take with them photocopies of page seven. Referring to the Natural Materials chart, they will complete the Building Materials Facts label. They will attach a label to each material they have identified.

The labels state the name of the building material and describe the source materials from which it is made. Students use the information from each of their Building Materials Facts labels to play Building Bingo by crossing off appropriate boxes on their Bingo cards. Before the team receives a "bingo," the teacher or a student mentor must verify each identification as well as check the accuracy of the information on the labels.

Student Product

- at least one completed Bingo Building card
- properly identified (labeled) building materials (approximately three to five sites)

Materials and Resources

- Building Material Facts labels
- Building Bingo cards
- Natural Materials charts

Activity

Review the idea that people adapt natural materials for use in the built environment. To do this, guide the students using copies of the Natural Materials

BUILDING MATERIAL FACTS

This material is

_____

Shows weathering Yes No
(circle one)

Made with natural materials Yes No
(circle one)

Contains or once contained:
(check box)

- ❑ sand
- ❑ refined crude oil
- ❑ clay
- ❑ quarried rock
- ❑ lime
- ❑ ore minerals
- ❑ water
- ❑ aggregate

NATURAL MATERIALS

	Water	Aggregate	Sand	Clay	Lime	Refined Crude Oil
Ceramic Tile	✓			✓ + chemicals		
Glass			✓ (silica sand)		✓ + chemicals	
Brick	✓		✓	✓		
Asphalt		✓	✓			✓
Plaster	✓		✓		✓ (or gypsum)	
Concrete	✓	✓	✓	✓	✓	
Mortar	✓		✓	✓ (optional)	✓	

asphalt	transparent	ceramic tiles	metal	holds bricks together
water + clay + chemicals	baked mixture of water, clay and sand	dimension stone	manufactured stone	plaster
melted silica sand + chemicals	solid rock from a quarry	**FREE**	concrete	brick
clay-rich square plates	contains cement powder	manufactured stone	spread on walls	contains refined crude oil
brick	made from mined ore minerals	mortar	glass	concrete

chart. Column headings on the chart list earth materials; row headings list building materials.

Review vocabulary, considering the students' knowledge level and the words that are presently familiar to them.

To Play Building Bingo:

- Students get into pairs or small groups
- One team may play several identical cards at one time; several students can mark off squares this way
- Scoring is the conventional "all in a row" (vertical, horizontal, or diagonal)
- Students may mark off more than one square at each stop
- If games finish too early, require students to mark only one square at each labeled site or adopt a bingo pattern that uses additional mark-offs

Allow students to spread out through the building to avoid the marking of an architectural component already claimed by another team. You may wish to assign a specific school section to each group to ensure that all students have a chance to identify building materials independently. You might award a suitable prize for each team's completed Building Bingo game.

LESSON PLAN THREE

Gravestone Weathering

In this lesson, a cemetery field trip allows students to examine the distinguishing characteristics of rock weathering.

While playing Building Bingo, students undoubtedly noticed the breakdown and deterioration of materials on the playground and on the buildings' exteriors. The focus of this lesson is on specific mechanisms of chemical weathering (decomposition) and physical weathering (disintegration).

The field trip is not required for the lesson, but it is highly recommended. You may find that it offers elements of discovery that static lecture plans and computer and library research cannot provide.

Student Product

- completed Physical Disintegration Data chart
- completed Chemical Decomposition Data chart

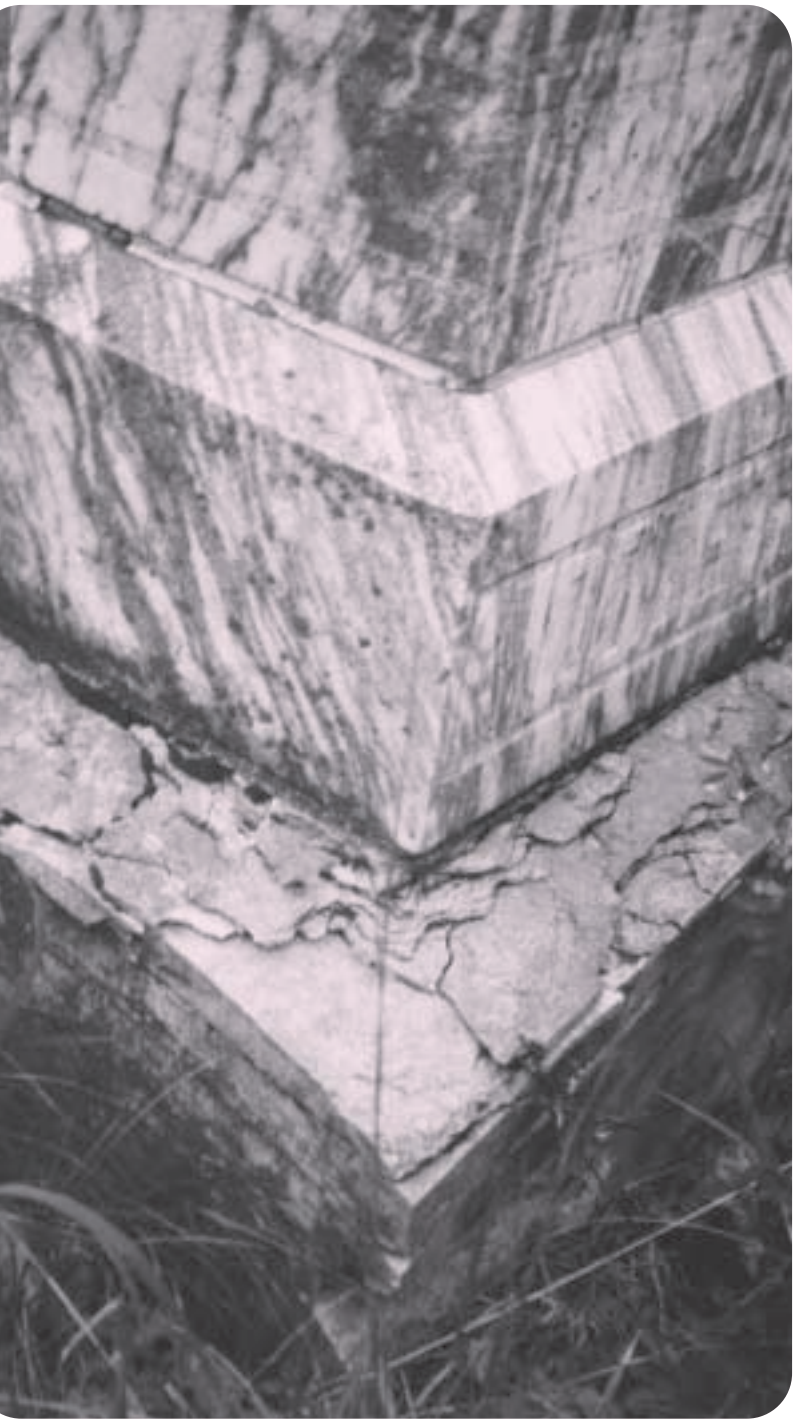
Materials and Resources

- copies of all graphics and charts

Activity

Just as an inscription on a grave marker records a person's placement in history, the physical condition of the marker bearing that inscription records geological history. The gravestone's residence time (time since installation) and composition, together with local climate and even its positioning in the cemetery, determine how well it survives to accomplish the social purpose for which it was intended.

Cultural anthropologists, folklorists, and genealogists regularly visit cemeteries to gather information. Nevertheless, visiting a grave site can be upsetting for some students. A teacher's common sense, sensitivity, and gut feelings play a major part in making this trip successful. Discuss etiquette with both chaperones and students. Visiting a person's grave site is no different from visiting someone's home.

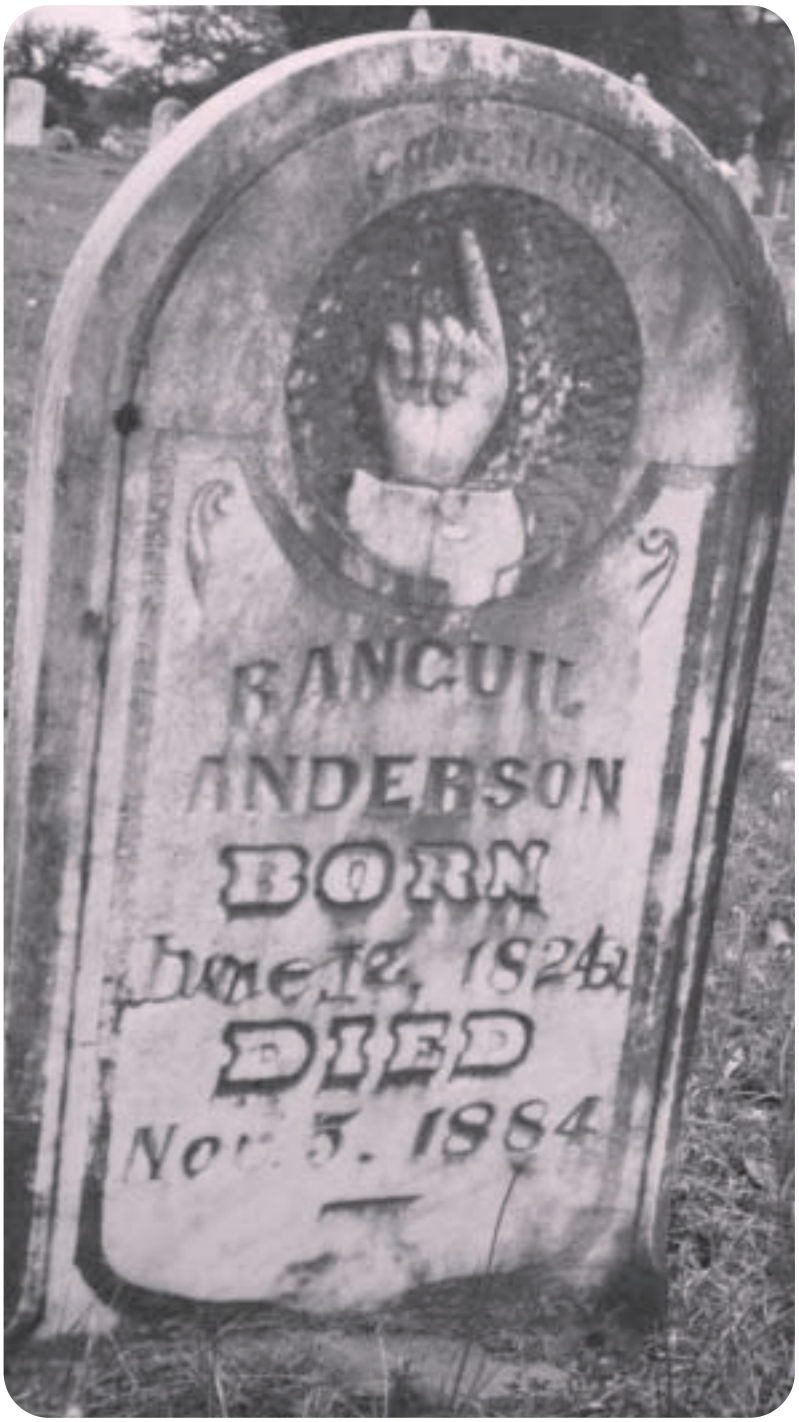


Leanne Wiberg

This close-up view of the base of a marker shows flaking and chipping caused by physical weathering.

Leanne Wiberg

This sandstone tablet is disappearing because of chemical weathering. The mineral calcite, which holds the quartz sand grains together, dissolves away. The loosened sand accumulates at the marker's base. If acidic precipitation continues to damage the stone, only a pile of loose red sand will remain.



Leanne Wiberg

Chemical weathering of this white marble marker increases the readability of its inscription. Lichens—small plants made up of two life forms—thrive in the shaded recesses where lettering and decorations have been inscribed. The gray lichens, and the organic acids they produce, darken and discolor the marble.

Setting the Scene

Discuss the significance of monuments and statues. Ask the students why we have graves and grave markers. Review the building materials they located during the Building Bingo game in Lesson Two. Ask them to predict which of these materials they'd expect to see in a cemetery, and have them support their suggestions.

Explain that a new vocabulary will be introduced to help them understand how materials—in this case, rocks used for grave markers—change over time. Guide the students in examining the illustrations that outline the processes involved in weathering. Simple words like *flaking* and *chipping* generally indicate simple concepts, but words like *oxidation* and *hydrolysis* will need reviewing.

Selecting the Site

Keep in mind that the trip should provide ample opportunity to view a variety of stone markers of different materials and different ages. Abandoned and unkempt cemeteries should be avoided. Visits to newly established memorial parks and cemeteries, or to military and county cemeteries with uniform markers, cannot provide the information needed. Obtain permission before you visit the selected site.

TEACHER TIP

Bring samples of freshly exposed *unweathered* rock to the cemetery for comparison. A good place to find this rock, of course, is a quarry. The National Stone Association can help arrange a class visit to a quarry by putting teachers in contact with regional operators. Call 1-800-342-1415 or visit the website at www.nssga.org

Student Readings and Research (two class days)

The class should examine references and background information on stone weathering and acid rain by using the library or the Internet or both. The research can be split between out-of-class assignments and in-class group work spanning two class periods. It might help to assign specific topics or research tools to individual students. Each reading might provide data on one aspect of the trip.

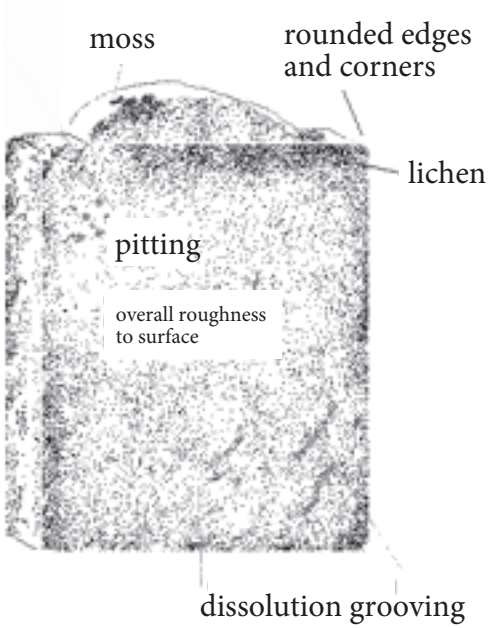
For out-of-class work, students should prepare to present and discuss their findings in class during the second research-and-reading session. They might also assess the exterior of their home, school, or place of worship for evidence of local weathering models or patterns.

Decomposition occurs when...

Breakdown at the atomic level
changes and removes minerals

chemical weathering of a marble gravestone

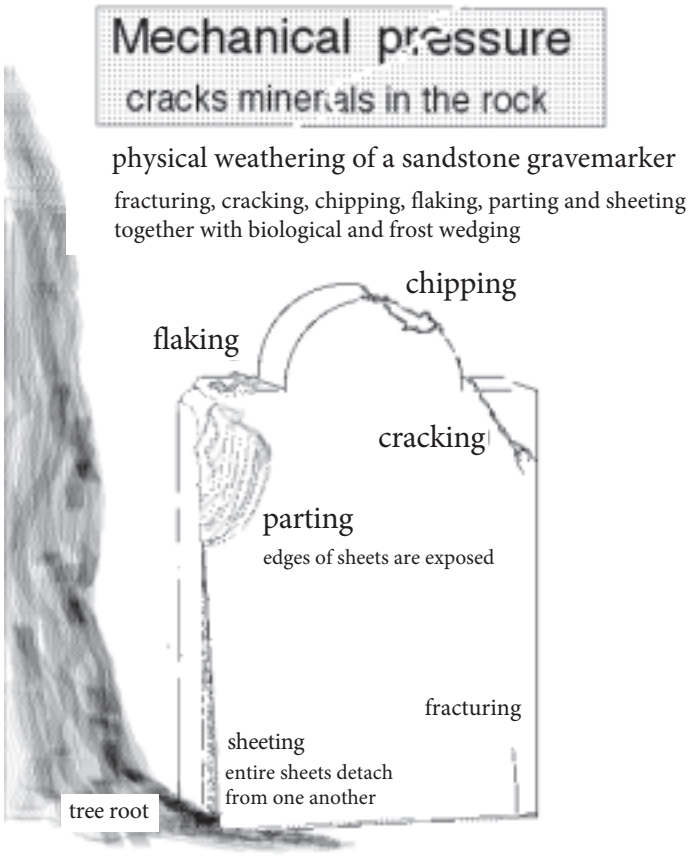
dissolution - pitting, grooving, rounding of corners
oxidation - rusting (dark stain)
hydrolysis - minerals turn to powdery clay or grainy salts
biological effects - acids given off by lichen and moss



CHEMICAL DECOMPOSITION DATA

FAMILY NAME				
DATES				
Dissolution				
Oxidation				
Hydrolysis				
Biological Effects				

Disintegration occurs when...



Cemetery Visit
(2-3 hours, including travel)

Using the Vintage Gravestones information on page fourteen, guide students in recognizing stones that belong to the same time period by their distinctive shapes and rock types. Referring to the photographic images on Gravenet will be helpful here.

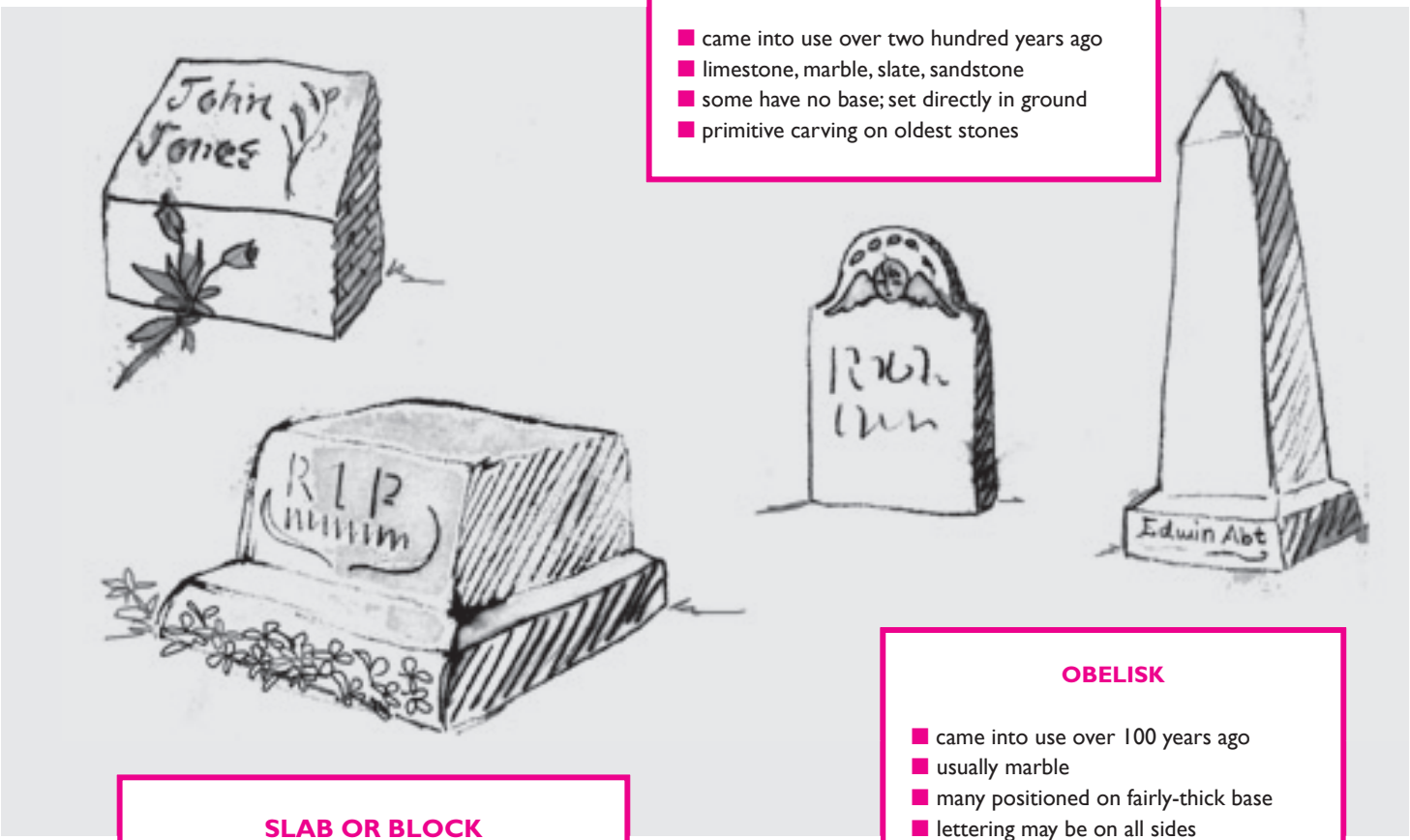
Using vintage shape as a criterion, find an old stone in a central part of the cemetery that shows pronounced chemical weathering. Marble, you will find, will show it best. Locate on the stone the chemical decomposition processes illustrated on the previous page. "Adopt" this stone as the class's chemical weathering model. Students with questions about identifying signs of decomposition can compare this stone to others they study in the cemetery.

In a similar fashion, adopt a nearby older stone as a model for the physical disintegration illustrated on this page. You might need to select both stones ahead of time. Explain to the students that they will go off on their own and use what they know about stone shapes to locate from afar a group of especially old stones. Ask

PHYSICAL DISINTEGRATION DATA

FAMILY NAME				
DATES				
Fracturing/ Cracking				
Parting				
Sheeting				
Chipping/ Flaking				

VINTAGE GRAVESTONES



SLENDER TABLET

- came into use over two hundred years ago
- limestone, marble, slate, sandstone
- some have no base; set directly in ground
- primitive carving on oldest stones

OBELISK

- came into use over 100 years ago
- usually marble
- many positioned on fairly-thick base
- lettering may be on all sides
- carving may be elaborate (urn or ball can top the obelisk)

SLAB OR BLOCK

- came into use about 50 years ago
- minimum thickness is 6"-8"
- most are granite; some are marble
- front face is polished
- hardness of granite limits detailed carving

them to approach these stones and look closely for signs of weathering. They should write headstone information on the Chemical Decomposition Data chart or the Physical Distintegration Data chart, and record the weathering processes in operation by checking appropriate boxes. Every effort should be made to document each type of weathering seen in the gravestone illustrations on pages twelve and thirteen. This may require visiting many markers.

Post-Trip Analysis

Discuss with students the fact that they have used independent study, cooperative learning, and creative presentation to understand that weathering is a natural process.

Design activities that individual students or groups can do on their own to follow up on the study. Perhaps they can conduct interviews with family members, religious leaders, or other respected adults to examine the role of preservation and citizenship in maintaining historic graveyards. They might also interview the manager of a cemetery to learn how gravestones are renovated and maintained.

Suggest specific topics for further study and enrichment, such as the geographical patterns of acid precipitation, or the exact role of water or biological processes in weathering.