Discovering the Inca Ice Maiden
Read & Explore! kits are designed to bring science and social studies topics to life through reading. Each kit contains ten copies of a critically acclaimed book, detailed lesson plans that touch upon a variety of curriculum areas and skills, a set of relevant overhead transparencies, reproducible activity sheets, and a classroom map. The detailed lesson plans and accompanying materials will help you integrate the book’s subject across the curriculum.

Read & Explore! materials are flexible. Use them to teach a whole unit or focus on one or two lessons that will enrich your teaching of a topic. The lessons are designed both to reinforce the content covered in the book and to expand on it, as well as to help your students develop a variety of skills. The lessons can be adapted for use with a single student, small student groups, or, if students share the books, your whole class. Additional copies of the book can be purchased in sets of ten.
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SYNOPSIS

Discovering the Inca Ice Maiden

In Discovering the Inca Ice Maiden, Johan Reinhard recounts his discovery of a 500-year-old frozen mummy of an Inca girl who was about 14 when she died. "A frozen body is like a time capsule," Reinhard writes, "which allows scientists to look back into the past and find out things difficult to know otherwise."

Reinhard's book begins with the story of his discovery of a frozen mummy near the summit of the volcano Nevado Ampato in the Peruvian Andes. He writes about his harrowing efforts to bring the mummy safely down the mountain, and he describes the work of scientists from around the world who study the remains of the girl who becomes known as the Inca Ice Maiden. The results reveal details about the Inca civilization that flourished in the high Andes around the time of Columbus.

MATERIALS INCLUDED IN THIS KIT

- Ten softcover copies of Discovering the Inca Ice Maiden
- Teacher's guide with six lesson plans designed for students in grades 5-8, six reproducible activity sheets, correlations to national standards, and a list of relevant Internet sites
- Five overhead transparencies
- Map of Peru
- Map of the Inca Empire
- Photograph of Machu Picchu
- Photograph of an Inca rope bridge
- Photograph of a quipu maker and his handiwork
- Poster-size map of South America
Introducing the Book

Discovering the Inca Ice Maiden is the story of a chance encounter on a frigid mountaintop in the shadow of an erupting volcano. Before your students read the book, take their imaginations to that mountaintop. Dramatize two pictures in the book, releasing just enough information for your students to feel like participants in the adventure of climbing Ampato and discovering the Inca Ice Maiden.

Ask students to open Discovering the Inca Ice Maiden to page 7 and to look at the picture while you say: “For several hours you’ve been climbing a mountain in Peru, South America. Your legs are tired, and you’re cold. The mountain is quite high, so the oxygen is thin. You’re gasping for air. But you keep climbing because you’re looking for clues on the mountaintop. You’re looking for statues, bits of pottery and clothing, tools. They are all clues to understanding the culture of the Inca, the native people who climbed this mountain hundreds of years ago.”

Then have students look at the picture on page 17 while you say: “You see something lying on the ground surrounded by ice. Is it a backpack dropped by another mountain climber? You move closer. You can see that it isn’t a backpack. It’s a bundle wrapped in cloth. What is it?”

Now ask students to turn to page 18 and to read the first sentence. As they look at the photograph of the Ice Maiden, explain that air on mountaintops is so cold that when the girl died, her body froze. Over the centuries, her frozen body remained intact and did not decay.

Finally, have students think of questions they have about the story. Their questions may include the following: Who was the girl? When and why did she die? Was she carried to the mountain after dying somewhere else, or did she die on the mountain? Why was the bundle lying out in the open? How long had it been there? What did the people who found her do next? Have students write their questions in their notebooks. Tell them they will be looking for answers as they read the book.
Digging Up the Past

CORRELATION TO STANDARDS

Language Arts
- Build an understanding of texts, of themselves, and of the cultures of the U.S. and the world
- Comprehend, interpret, evaluate, and appreciate texts

Geography
- The World in Spatial Terms (1)
- Places and Regions (4)

Social Studies
- Time, Continuity, and Change

Science
- Evidence, models, and explanation
- History and nature of science

TIME: One class period

OBJECTIVES

- To define “artifact” and “archaeology”
- To understand how archaeologists recover artifacts and analyze them to gain insights into the past

MATERIALS

- Discovering the Inca Ice Maiden
- The Map of Peru overhead transparency
- The Map of the Inca Empire overhead transparency
- A copy of the “Digging Up the Past” activity sheet for each group of students

BACKGROUND INFORMATION

The frozen mummy of the Ice Maiden, surrounded by Inca artifacts, gave Johan Reinhard and other researchers new insights into Inca culture. Archaeologists gather and analyze artifacts—objects made or modified by people of the past—to learn more about the life and customs of a particular society. Artifacts can be weapons, ornaments, cooking utensils, clothing, or other objects. They can range in size from a pin to a pyramid. Artifacts are clues to what people of the past thought was important and how they did things. Since people have always thrown things away, ancient garbage heaps are rich sources of artifacts.

Burial sites also are important to archaeologists. Items were often buried with the dead to help in the afterlife or to symbolize a person’s importance. Johan
Reinhard discovered that the Inca burial sites he has excavated, high in the Andes mountains, are doubly protected. The icy cold has preserved the artifacts and the mummies, and the inhospitable mountain location has prevented looting of the sites. Reinhard says, "It seems as if the Incas left the artifacts behind on the mountain only moments ago. The past feels like the present and becomes vividly alive."

**The Lesson**

**Introducing the Lesson**

Ask students why archaeologists are interested in studying peoples and cultures of the past, in general, and the Inca, in particular. (Possible answers: (1) to learn about ancient people and how they lived, providing insight into their successes and mistakes; (2) to learn how they designed and constructed buildings and what materials they used; (3) to learn more about ourselves as we compare cultures.)

Display the Map of Peru overhead transparency. Ask students to describe the location of Peru (on the west coast of South America). Now show the Map of the Inca Empire overhead transparency. Point out that the boundaries of the Inca Empire extended beyond those of Peru today. Explain to students that the Inca lived more than 500 years ago. Then have one student locate where the frozen mummy of the Inca Ice Maiden was found (Ampato).

Now ask students to turn to the Timeline on page 46 of *Discovering the Inca Ice Maiden* and find the date of the Inca Ice Maiden's death. Explain that ca. is an abbreviation for the word "circa" (from the Latin word meaning "around") and is used with dates when it is impossible to be more precise. Ask students to calculate the approximate year the Ice Maiden was born if she was 14 when she died: (1455)

**Teaching the Lesson**

Have students read the definitions of the words "artifact" and "archaeology" in the Glossary on page 47 of *Discovering the Inca Ice Maiden*. Ask them to restate the definitions in their own words, giving examples of artifacts.

Review some of the artifacts that were found with the Ice Maiden and consider how they helped archaeologists learn about the Inca. Divide the class into groups of two or three, and have each group study the pictures of artifacts and read the text describing them on pages 15, 24, 25, 29, 34, 36, 40, 41, and 44 of *Discovering the Inca Ice Maiden*.

Discuss with your students this statement by Arcadio Mamani, one of Johan Reinhard's climbing assistants: "Nothing should be taken from the mountain without something being given in return." Explain that some local people think the mountain is sacred and that offerings should be made to the mountain gods. Students should understand that archaeologists help to preserve artifacts so that others may learn about ancient cultures.
To help students understand the type of information we can learn from artifacts, discuss what can be learned from a child's sandal, shown on page 44. Ask students: "What is it?" (A sandal) "What is it made of?" (Some kind of rope) "Where was it found?" (At a burial site on Ampato) Ask students what the sandal tells us about the Inca. Students may infer that Inca children did not go barefoot; that the Inca had the materials and skill to braid fiber into different kinds of rope (the sole and straps of the sandal); and, that because the sandal was found with other artifacts at a burial site, the sandal may have had some personal or ceremonial significance.

Distribute copies of the "Digging Up the Past" activity sheet to groups of two or three students. Have students in each group work together to complete the activity sheet. Review their answers.

Concluding the Lesson

Have students choose one of the Inca artifacts shown in Discovering the Inca Ice Maiden and ask them to write a paragraph or poem about the artifact, imagining what it meant to the person who made it or used it. Ask students to write why they think the artifact was left on the mountain.

Suggestions for Assessment

Students' responses on the "Digging Up the Past" activity sheet and their writing assignments can be used to assess their understanding of what constitutes an artifact and why artifacts are important. Completion of the "Digging Up the Past" activity sheet is also a measure of a student's ability to locate information.

Activity Sheet Answers

1. (g) shell statue with feathered headdress; 2. (e) outer cloth of the Ice Maiden's bundle; 3. (b) wooden poles; 4. (a) Ice Maiden's shawl; 5. (c) cloth bags containing maize kernels and a maize cob.

Extending the Lesson

Ask students to use library and Internet resources to investigate other important archaeological finds related to the Inca, such as the discovery of Machu Picchu by Hiram Bingham in 1911. Students might also investigate Central American cultures, such as the Maya and the Aztec.
READ & EXPLORE: Discovering the Inca Ice Maiden

Name ________________________________

Digging Up the Past

- Read the descriptions below of five artifacts, and select a letter from the list of artifacts that best fits the description. Use information in Discovering the Inca Ice Maiden to confirm your answer.

a. Ice Maiden's shawl
b. wooden poles
c. cloth bags containing maize kernels and a maize cob
d. Inca jug struck by lightning
e. outer cloth of the Ice Maiden's bundle
f. silver llama figurine
g. shell statue with feathered headdress

1. The color of this artifact, lying in the open on the slope of Ampato, caught the attention of Johan Reinhard and his assistant, Miguel Zárate, and led them to the discovery of the Inca Ice Maiden.

Artifact: ________

2. This artifact was analyzed and found to contain the pollen of 17 plants.

Artifact: ________

3. These artifacts appear to be proof that the Inca used tents.

Artifact: ________

4. This artifact has been called “one of the best preserved Inca female textiles.”

Artifact: ________

5. These artifacts, which held food offerings to the gods, were found in the open near the frozen mummy of the Inca Ice Maiden.

Artifact: ________
Inca Mountains

CORRELATION TO STANDARDS

Language Arts
- Build an understanding of texts, of themselves, and of the cultures of the U.S. and the world
- Comprehend, interpret, evaluate, and appreciate texts

Geography
- The World in Spatial Terms (1)
- Places and Regions (6)
- Environment and Society (15)

Social Studies
- Culture
- People, Places, and Environment

TIME: One–two class period

OBJECTIVES
- To explore the challenges faced by people living at high elevations
- To understand the importance of mountains in Inca culture

MATERIALS
- Discovering the Inca Ice Maiden
- The Map of Peru overhead transparency

- 11 sheets of scrap paper
- Markers
- Drinking straws cut in half; a half straw for each student
- A copy of the “Inca Mountains” activity sheet for each student

BACKGROUND INFORMATION

Land that rises more or less abruptly to at least 1,000 feet above the surrounding area is classified as a mountain. Mountains usually have a wide base and a narrow peak, or ridge. A series of mountains is called a mountain range. The Andes form the longest mountain range on land, stretching more than 4,000 miles along the western edge of South America.

A mountain environment of steep slopes, intense cold, and thin air presents unique challenges to human life. Breathing at high elevations can be difficult. Changes in elevation can cause moderate to severe reactions in humans, such as headaches, nausea, nosebleeds, and loss of appetite. However, the body can adjust, or acclimatize, to living at high elevations. The Inca were able to live at high elevations. Today, the Andean Indians live in the Andes of Peru. The bodies of the Indians have adapted in several ways. The number of red blood
cells, the body’s oxygen carriers, in the Indians is above average. Furthermore, their lungs are larger than average, which helps them pull in more of the oxygen that is scarce at high altitudes.

**THE LESSON**

**Introducing the Lesson**

Briefly remind students how people are affected by the environment in which they live. For example, discuss the differences between living in a hot place and living in a cold place. Then read the following scenario to the class: You’ve been climbing all day. Your feet hurt. In fact, your whole body hurts. It’s getting extremely cold. Breathing has become difficult. You begin to think, “What’s going on here? Am I getting sick?”

Ask students what the problem might be and how it might relate to the environment. Once students have shared their thoughts, review the background information in this lesson. Explain that because air is thin at high elevations, there is less oxygen available to sustain the body. Breathing becomes difficult. Sometimes visitors to regions of high elevation get headaches and experience dizzy spells. However, the body can adjust, or acclimatize, to living at high elevations. The Inca were able to live at high elevations.

**Teaching the Lesson**

**Elevation**

How high were the mountains where the Inca lived? To help students understand the role elevation played in the Inca culture, have students prepare a chart showing the elevations of various locations around the world.

Display the Map of Peru overhead transparency and identify the following sites: Cuzco (a modern city, once the location of the Inca capital), Machu Picchu (the preserved ancient city of the Inca), and Nevado Ampato (the summit burial site of the Inca Ice Maiden).

Introduce the word “elevation,” a measurement of the distance between sea level and a place on the surface of the earth.

Have students make an elevation chart. Tape eleven sheets of letter-size scrap paper to the wall or floor, running end to end with no spaces between the sheets. (The chart will be slightly more than ten feet long.) Have students mark six-inch increments on the chart. Every six inches will equal roughly a thousand feet. The chart will run from sea level to more than 20,000 feet. Each inch on the chart will equal about 157 feet. Explain that the bottom of the chart represents sea level. With a marker write “Lima, Peru” at approximately the three-inch mark. (Lima’s elevation is 475 feet.) Next, ask students if they know of any other cities near sea level. Here are a few:
Miami, Florida—10 feet
Seattle, Washington—10 feet
Baltimore, Maryland—20 feet
San Diego, California—20 feet
Boston, Massachusetts—21 feet

Ask a student to write the name and elevation of one of these cities at the bottom of the chart.

Now ask for volunteers to write the names and elevations of each of the following locations at the approximate elevation on the chart:

**London, England**—245 feet (1.5 inches)
**Atlanta, Georgia**—1,050 feet (6.3 inches)
**Asheville, North Carolina**, in the Appalachian Mountains—1,985 feet (11.9 inches)
**Kathmandu, Nepal**, in the Himalayas—4,500 feet (2 feet, 3 inches)
**Denver, Colorado**, in the Rocky Mountains, called the Mile-High City—5,280 feet (2 feet, 8 inches)
**Machu Picchu, Peru**, in the Andes—about 8,000 feet (4 feet)
**Cuzco, Peru**, in the Andes—11,210 feet (5 feet, 7 inches)
**Lhasa, China**, in the Himalayas—11,975 feet (6 feet)
**Nevado Ampato, Peru**, in the Andes, uninhabited summit burial site of the Inca Ice Maiden—20,700 feet (off the chart at 10 feet, 4 inches)

Have students identify the approximate elevation of their school (or nearest city) and place it at the correct height on the elevation chart. Calculate the differences between the elevation of the school, Cuzco, and the summit of Ampato, where the Inca Ice Maiden was buried.

**Breathing at High Elevations**
To provide students with a hint of the physical challenges associated with living at high elevations have them experience what it feels like to need more oxygen.

**Note:** Check with your school health official on whether students with asthma or other breathing difficulties should participate in this activity.

Ask students what kind of difficulty they think they might experience if they traveled to the Andes or any of the world's high mountains. Then distribute the straws you have cut in half, one to each student. Have students run in place for about 60 seconds. Then have them place the straws in their mouths and briefly try to breathe through the straws. What did they experience? How might this experience be similar to the experience of breathing at high elevations? Would the Inca have had the same difficulty breathing? Conclude this activity by reminding students that the Inca lived in the Andes for a long period of time, and they adapted to the low level of oxygen.

**Living in the Region of the Ice Maiden**
Living among high volcanic peaks meant the Inca faced other difficulties besides thin air. The climate at high elevations poses unique challenges to people living there. This activity will help students understand how climate conditions in the high Andes influenced Inca culture and beliefs.
Ask students if they know of any unique weather conditions that are present high in the mountains. How does the climate make mountain living difficult? As students brainstorm, write their answers on the board. (Possible answers: Cold temperatures, snowstorms and blizzards, difficulty moving on snow and ice, wind, lightning, difficulty keeping warm.)

Ask students how the sometimes violent mountain conditions could have affected what the Inca believed. If they had lived in ancient times, what might the students have believed about these mountains? Review Johan Reinhard’s comment on page 30: “Throughout the Andes, lightning represents the power of the mountain gods. Mountain gods are said to use it to kill those who offend them or to strike down their livestock. They also use lightning to empower people who will become priests.”

Concluding the Lesson

Distribute copies of the “Inca Mountains” activity sheet. Have students work in groups of two to three to find the correct answers.

SUGGESTIONS FOR ASSESSMENT

Use the student elevation and breathing activities and the answers to questions 1-3 on the “Inca Mountains” activity sheet to assess whether students understand the concepts of elevation and the physical impact higher elevations can have on humans.

Use the questions 4-6 on the activity sheet to assess whether students understand why the region might have held a spiritual significance for the Inca.

Activity Sheet Answers

1. 20,700 feet; 2. 19,200; 3. Grass doesn’t grow at that elevation. It was carried there on the backs of llamas and humans as part of the ceremony in which the Ice Maiden was sacrificed. 4. The ceremony was possibly an appeal to the gods of the volcano to keep the volcano from erupting or to bring rain. 5. The number of human sacrifices on the mountain indicates it was a sacred place. Lightning frequently struck the summit. This was seen as a powerful signal from the gods. 6. Volcanic ash blowing from Nevado Sabancaya caused the snow on Ampato’s summit to melt, which in turn caused Ampato’s summit to collapse, exposing the mummy.

EXTENDING THE LESSON

Ask students to investigate other cultures that exist in high elevations, such as those of the people of Tibet and Nepal. The Sherpas of Nepal, who often accompany climbers on Mount Everest, are known for their ability to work vigorously at high altitudes.

Students can also find out more about people who live near active volcanoes, such as those living on the islands of Montserrat, Hawaii, and the Philippines.
Inca Mountains

Look at the illustration of Nevado Ampato and Nevado Sabancaya on page 12 of *Discovering the Inca Ice Maiden*. Read about the mountains on page 5 and about Inca sacrificial burials on pages 11, 27-30, and 36-38. Then answer these questions.

1. At what elevation on Nevado Ampato was the Inca Ice Maiden originally buried?

2. At what elevation were other mummies found?

3. Why was Johan Reinhard surprised to see grass at 20,400 feet on Ampato? How did the grass get there? Why was the grass there?

4. What do anthropologists think was the purpose of the ceremony in which the Inca Ice Maiden was sacrificed on Ampato?

5. Why do researchers think the summit of Ampato was an important religious site for the Inca?

6. What changes in the summit of Ampato were caused by volcanic ash from Sabancaya? How did the changes on Ampato’s summit contribute to the discovery of the Inca Ice Maiden?
Lesson 3

Meeting the challenges of living in rugged mountainous terrain, the Inca built terraces, bridges, and roads. In this lesson, each group of students studies one problem of mountain life and proposes solutions. They compare their solutions to those of the Inca.

Taming the Landscape

CORRELATION TO STANDARDS

**Language Arts**
- Gather, evaluate, and synthesize data

**Geography**
- Places and Regions (4, 6)
- Human Systems (10)

**Social Studies**
- People, Places, and Environment

**TIME:** One class period

**OBJECTIVE**
- To learn about architectural solutions the Inca developed for living in mountainous terrain

**MATERIALS**
- The Map of the Inca Empire overhead transparency
- The Machu Picchu overhead transparency
- The Inca Rope Bridge overhead transparency
- A copy of the "Taming the Landscape" activity sheet for each student
- A copy of the "Inca Bridges" reading sheet for each student
- A copy of the "Inca Roads" reading sheet for each student
- A copy of the "Inca Terraces" reading sheet for each student
- A sheet of letter-size scrap paper for each student
- Colored markers and colored pencils
- Masking tape
- Two pieces of clothesline, each 20 feet or more in length

**BACKGROUND INFORMATION**

The engineering achievements of the Inca still astonish people today. The high, rugged Andes dominated the landscape of the Inca Empire, which lasted from about A.D. 1200 to 1532. Working without wheels and without a written language, the Inca devised ways to grow crops on the steep mountainsides and to travel throughout their empire.

In order to cultivate crops, the Inca built a series of massive stone walls, or terraces, that created level areas for planting and protected topsoil from erosion. The Inca used llamas to carry building materials up the mountains and to carry soil to fill the planting areas.
Travel in mountain regions is laborious, dangerous, and sometimes nearly impossible due to deep ravines and steep terrains. To cross the ravines, the Inca built rope bridges of hand-braided fibers and vines. To ease their climb in steep terrain, the Inca built roads that zigzagged up the mountains. An extensive network of roads linked all parts of the Inca Empire.

"Taming the Landscape" activity sheet to students in each group. Have students record the problem they were assigned on their activity sheet. As you circulate among the three groups, ask the following questions and suggest the following experiments.

**Farming**

Encourage students to model the problem by folding their sheets of scrap paper in half to form a tent-shaped "mountain." Ask students what problems they might face if they tried to grow crops on the side of a mountain. (Answers might include: Washing away of crops; difficulty cultivating and harvesting on a steep incline.) Ask students what kind of soil they would expect to find on a mountain slope. (Thin layer of soil, if any; very rocky.)

Encourage students to propose different solutions using materials available to the Inca. (Remember that the Inca did not have the wheel.) If the group is having trouble figuring out a solution, suggest that the students fold one side of their "mountain" five or six times to form a series of "steps." Ask students how they think these steps, or terraces, could help solve the problem of farming on steep slopes. (Answers might include: They catch water runoff; they prevent erosion of the soil; they provide flat surfaces for easier cultivation.)

Distribute copies of the "Inca Terraces" supplemental reading sheet to members of this group. Students should understand that the Inca constructed terraces by moving massive rocks into place and fitting them closely to create retaining
walls. Ask them to list other necessary steps in the construction and maintenance of terraces. (These include: Bringing soil to the terrace to fill it; maintaining the stone walls.) Now have the group complete the "Taming the Landscape" activity sheet and prepare a presentation for the class on how the Inca solved the problem and the advantages of their solution. Encourage students to find out more about Inca terraces by using library and Internet resources. Show members of the group the Machu Picchu overhead transparency they will use in their class presentation, but for now do not show it to the rest of the class. (See Concluding the Lesson.)

Bridges
Suggest that students in this group fold sheets of scrap paper into a series of V-shaped ridges to model the problem posed by ravines. Encourage group members to discuss quick, simple ways of bridging ravines with materials available in a nonindustrialized society. (Ideas might include: Tying a rope from one side to the other and then going across by hanging from the rope and advancing to the other side hand over hand; wedging a long log between the sides of the ravine and then, relying on balance, walking across the log.)

After students have proposed solutions, distribute copies of the "Inca Bridges" supplemental reading sheet to the group and have them complete the "Taming the Landscape" activity sheet.

Have students model the experience of crossing a deep ravine on an Inca rope bridge. Stick a long piece of masking tape to the classroom floor. Have students imagine that the tape is a bridge over a ravine more than a hundred feet deep. Have several students walk along the length of the tape. Remind them that the "bridge" is swaying in the wind and that they must be perfectly balanced in order to cross it! Now, stretch a length of clothesline along each side of the masking tape "bridge." Have four students each hold one end of the clothesline to form two handrails as other students walk across the bridge. Ask students to describe the difference in crossing the ravine on a bridge with and without handrails.

Have the group members prepare their presentation for the class on how the Inca solved the problem and the advantages of their solution. Encourage students to find out more information about Inca bridges by using library and Internet resources. Show members of the group the Inca Rope Bridge overhead transparency they will use in their class presentation, but for now do not show it to the rest of the class. (See Concluding the Lesson.)

Roads
Suggest that students in this group fold their scrap paper in half to form tent-shaped "mountains." Ask students what problems they would face if they wanted to build a road that went straight up and over a mountain. (Answers may include: It would be too steep for llamas or humans to climb; avalanches and snowfall could block the road; rains could wash it out.) Remind students that their solutions can use only materials available to the Inca. (Blasting a tunnel through
the mountain is not an option.) Students should decide that a zigzag road, or switchback, would be the best way to surmount steep terrain, even though it would be longer than a straight road.

After students have proposed different solutions, distribute copies of the “Inca Roads” supplemental reading sheet and have the group complete the “Taming the Landscape” activity sheet. Ask group members to prepare a presentation for the class on how the Inca solved the problem and the advantages of their solution. Encourage students to find out more about Inca roads using library and Internet resources. Show members of the group the Map of the Inca Empire overhead transparency they will use in their class presentation, but for now do not show it to the rest of the class.

**Concluding the Lesson**

A representative of each group will describe the problem, the group’s solution to the problem, the Inca’s solution to the problem, and any advantages of the Inca’s solution. Each group will display and discuss the appropriate overhead transparency as part of its presentation and distribute the remaining copies of the appropriate supplemental reading.

**Farming (Terraces):** Point out the retaining walls of the terraces on the Machu Picchu overhead transparency. Using information from the “Inca Terraces” supplemental reading and other sources, the group should be able to describe how terraces solve the problem of growing crops on a mountainside.

**Bridges:** Explain that the Inca Rope Bridges overhead transparency shows a photograph of a bridge in use today. It is made of braided vine and fiber cables just as bridges used in the time of the Inca Ice Maiden. Using information from the “Inca Bridges” supplemental reading and other sources, the group should explain how a bridge like this was made and how it might feel to walk across it. Then have group members guide their classmates across the masking tape bridge.

**Rocks:** Point out the extensive number of roads shown on the Map of the Inca Empire overhead transparency. Using information from the “Inca Roads” supplemental reading and from other sources, the group should describe how switchbacks solved the problem of building a road in steep mountains.

**SUGGESTIONS FOR ASSESSMENT**

Students' participation in their group, their group's presentation to the class, and their answers on the “Taming the Landscape” activity sheet can be used as tools to assess their understanding of the Inca’s engineering achievements.

**EXTENDING THE LESSON**

Have students research and report on the importance of road systems in the Inca and Roman Empires, comparing the building techniques used by each.
Taming the Landscape

1. Describe the problem your group is investigating.

2. Draw an illustration of the problem on the back of this activity sheet.

3. Describe some of the ideas your group has proposed to solve the problem.

4. Summarize in a paragraph how the Inca solved the problem.

5. List some advantages to the Inca’s solution.
Supplemental Reading

Inca Roads

- Taming the Landscape

"Inca roads in the highlands were especially designed for the challenging terrain. Switchbacks scaled the steepest slopes, much like their modern counterparts. Sometimes paved with smooth stone, the thoroughfares were often supported by retaining walls that have lasted for more than 500 years."


- Children of the Sun

"A vast network of highways linked all parts of the Inca Empire. Along these thoroughfares moved mobile army units, accompanied by pack trains of llamas and by chasquis, specially trained runners who relayed memorized news and the orders of the empire between carefully spaced tambos, or way stations. These messengers formed a communications system that could guarantee one-day delivery for every 140 miles of road. Often the Inca [ruler] himself, bedecked in splendor and borne on a golden litter, traveled along the roads."

Supplemental Reading

Inca Bridges

Taming the Landscape

"The most visible and enduring monuments of ancient South American civilization are the marvels of engineering that helped tame the landscape and bridge the rivers of the Andean area... The most amazing achievements of engineering are to be found in the roads, bridges, storehouses, fortified towns, and way stations built by the Inca.

Given the raw materials and tools available to them and their predecessors, these accomplishments seem almost miraculous. What they did achieve was largely due to their organizational abilities.... The deepest ravines they conquered with the world’s first known suspension bridges—swinging constructions of braided fiber and vine cables anchored to pillars on opposite sides of a chasm."


"Peruvian villagers still cross the... Apurimac River on a bridge first built in Inca times. Its hand-plaited cables, anchored to stone pillars, must be replaced each year—a chore the Incas imposed on local communities."


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Supplemental Reading

Inca Terraces

Taming the Landscape

"The most visible and enduring monuments of ancient South American civilization are the marvels of engineering that helped tame the landscape...of the Andean area....In the highlands the massive stone terraces transformed the steep Andean slopes into fertile fields.

The anonymous Inca engineers achieved artistic immortality with the design of massive masonry walls that incorporated stones weighing more than 100 tons. The irregular but fastidiously finished blocks interlock so perfectly that the joints between them appear as mere hairlines."


"Skillful terracing created level surfaces for growing maize and other crops and protected topsoil from erosion. Houses of adobe, stone, and straw often lined the upper terraces; stairs plunged to garden plots below."

Lesson 4

Counting on a Quipu

In this hands-on activity, students learn about an important device for Inca communication—the quipu. Students create quipus with strands of yarn and learn how quipus were used for record keeping.

CORRELATION TO STANDARDS

Language Arts
- Understand and respect diversity in language use, patterns, and dialects

Geography
- Human Systems (10)

Social Studies
- Culture

TIME: One class period

OBJECTIVES

- To learn about the quipu, an important form of Inca communication
- To use a quipu to convey personal information
- To explore a form of human communication

MATERIALS

- The Quipu Maker overhead transparency
- A copy of the "Counting on a Quipu" activity sheet for each student
- Nine 12-inch strands of yarn for each student

BACKGROUND INFORMATION

The Inca did not have a written language for recording events or information. One of the ways they maintained records was with a quipu (KEY-poo), a device made of a woolen string with smaller strings attached and knotted. Quipus provided a variety of information, such as crop yields, population counts, and the number of people available to serve in the military and to build roads. Quipucamayos (KEY-poo-cah-MY-ohs) were specialists who maintained the quipu system of record keeping.

The spoken language in the Inca Empire was Quechua (KETCH-oo-ah), which served as a unifying force among the Empire's 20 varied and far-flung cultures with their dozens of local dialects. The language is still spoken today by the Quechua, descendants of the Inca who live in the Andes of Peru, Ecuador, and Bolivia.
THE LESSON

Introducing the Lesson

Ask students to identify some of the ways people communicate today. (Besides speaking and writing—the most common methods of communication—we also communicate through art, film, clothes, whistles, lights, sign language, and physical gestures.)

Teaching the Lesson

Tell students that they will be learning about an important form of communication used by the Inca—the quipu, with its “language” of knots.

Display the Quipu Maker overhead transparency. Explain that since the Inca did not have a written language, they made quipus to help keep a record of such things as crop yields and population counts. Each knot, or series of knots, on the braided woolen strands of a quipu provided information.

Tell students that they are going to make quipus to record some personal facts. Pair students and have them sit opposite their partner. Distribute three pieces of yarn to each student. Explain that they will braid the three strands to make the topmost, or horizontal, strand of their quipu. To braid the yarn, tie the three strands of yarn together in a knot at one end. One student holds the knot while the other braids. When the braid is completed, knot the end. Once one braid is completed, students reverse the holder-helper roles and braid the other student’s yarn.

Hand out the “Counting on a Quipu” activity sheet and review it. Explain that each student’s braided quipu will hold six fact strands. Pass out six more strands of yarn to each student. Direct them to work independently to tie the six strands to the horizontal braid so that they hang from the braid. The six strands should be equally spaced along the braid. Then have the students tie knots along each of the six strands in order to convey information, as shown in the “Quipu Key 1” section of the activity sheet.

Concluding the Lesson

Have students use the space provided on the “Counting on a Quipu” activity sheet to create another quipu key. Additional information might include a student’s likes/dislikes, eye color, favorite subject in school, favorite sport, or number of people living in the student’s house.
SUGGESTIONS FOR ASSESSMENT

Determine students' understanding of quipus by observing their creation of quipus and their interpretations of the quipu key on the activity sheet.

EXTENDING THE LESSON

Tell students that Quechua was the language spoken by the Inca. The Quechua language helped unify the Inca Empire, which included 20 different cultures and dozens of local dialects. Quechua is still spoken by the Quechua, descendants of the Inca who live today in Peru, Ecuador, and Bolivia.

Give students the following list of Quechua words. Encourage them to use the Quechua words in class.

Hello—Winish (We-nish)
Good-bye—Aywalla (I-wah-yah)
Please—Camay (Kah-nyi)
Thank you—Diyosolupá
(De-yoh-soh-loo-päh)
Sunday—Intichau (In-tee-chaw)
Monday—Killachau (Ke-ya-chaw)
Tuesday—Atipachau
(Ah-tee-poo-chaw)
Wednesday—Qoyllurchau
(Coll-lurr-chaw)
Thursday—Illapachau
(ill-ah-poo-chaw)
Friday—Ch’askachau
(Chaz-kah-chaw)
Saturday—K’uychichau
(Ke-chie-chaw)
Counting on a Quipu

- Using Quipu Key 1, place knots along each of the six strands of your quipu to convey information about yourself.

**Quipu Key 1**

First string = gender (1 knot = female, 2 knots = male)
Second string = age (1 knot for each year)
Third string = month of birth (January = 1 knot, December = 12 knots)
Fourth string = grade (1 knot for each grade)
Fifth string = number of siblings (1 knot for each sibling)
Sixth string = number of pets (1 knot for each pet)

- Create another key to convey additional information about yourself.

**Quipu Key 2**

First string =
Second string =
Third string =
Fourth string =
Fifth string =
Sixth string =

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Lesson 5

Students discover the key role technology plays in helping scientists gather information about ancient remains. They learn how scientists used technology to examine the Inca Ice Maiden without disturbing her clothing.

Archaeology & Technology

CORRELATION TO STANDARDS

Language Arts
- Comprehend, interpret, evaluate, and appreciate texts

Social Studies
- Science, Technology, and Society

Science
- Understandings about scientific inquiry
- Understandings about science and technology
- Science as a human endeavor

TIME: One class period

OBJECTIVES

- To show how scientists use technology to gather information
- To show how the use of technology increased our understanding of the Inca Ice Maiden

MATERIALS

- Discovering the Inca Ice Maiden
- A copy of the “Archaeology and Technology” activity sheet for each student

BACKGROUND INFORMATION

Archaeologists are like detectives. They use various clues to try to piece together what an ancient civilization was like. Today, various types of technology have enabled archaeologists and other scientists to examine ancient remains in greater detail than ever before and with less disturbance to the remains.

For example, scientists can use CAT scans and microscopes to analyze thin sections of bone that can reveal the relative health of a deceased person. Chemical analyses of tiny pieces of stomach tissue determine the person’s diet. Age can be established by examining the growth of teeth. CAT scans make it possible to examine the skeleton and internal organs without removing any clothing.

DNA analysis can establish links between people of ancient times and people today. The Ice Maiden’s DNA was extracted and analyzed. Scientists determined that her DNA was of extremely high quality, which means they can “better compare her DNA with that of other individuals, both past and present.”
THE LESSON

Introducing the Lesson

Write on the board Johan Reinhard's statement from page 17 of Discovering the Inca Ice Maiden: “A frozen body is like a time capsule, which allows scientists to look back into the past and find things difficult to know otherwise.” Ask students to speculate on what scientists might learn from analyzing the Ice Maiden's frozen mummy and what tools scientists might use to study it. After students have had a chance to speculate, explain that scientists used various types of technology to analyze the frozen mummy. Results revealed the foods she ate before she died, her approximate age when she died, the approximate years in which she lived, and, from DNA analysis, the means to find her relatives who may be alive today.

Now ask students to turn to the Glossary on page 47 of Discovering the Inca Ice Maiden. Work with students to make sure they understand the definitions of mummy, carbon-14 dating, CAT scan, X-ray, and DNA.

Teaching the Lesson

Distribute copies of the activity sheet "Archaeology and Technology" to each student. Explain that when scientists first began work on the frozen mummy of the Ice Maiden, they didn't know anything about her. Using various types of technology, they were able to answer the questions listed on the activity sheet. The answers to question 1 are provided. To understand how question 1 was answered, have students turn to page 34 of Discovering the Inca Ice Maiden. Read the caption at the top of the page: "The X-ray of the ice maiden's skull also showed the presence of shawl pins, and this was our first proof that the mummy was a girl." Point out that students can find answers to the rest of the activity sheet questions on pages 34-36 and pages 41-44 of Discovering the Inca Ice Maiden.

Concluding the Lesson

Ask students: “Why was it so important to keep the mummy frozen?” (If it thawed, the body would start to deteriorate and valuable information could be lost.) “What technology keeps the mummy frozen today?” (Computer-controlled air-conditioning units constantly monitor temperature and humidity.) “Why is the mummy still frozen?” (Keeping the mummy frozen will allow future researchers with more sophisticated equipment a chance to analyze the Ice Maiden.)
SUGGESTIONS FOR ASSESSMENT

The “Archaeology and Technology” activity sheet can be used as a tool to assess students’ understanding of how technology was used to gather information about the Inca Ice Maiden. Students’ answers on the activity sheet are also a measure of their ability to find information in the book.

Activity Sheet Answers

1. X-ray; 2. Age: Dental X-rays, about 14 years old when she died; 3. Last meal: Tissue extraction from stomach with needle, meal of vegetables within 6-8 hours before dying; 4. Disease: CAT scan, no evidence of disease; 5. Malnutrition: CAT scan, no evidence of malnutrition; 6. Growth: CAT scan, normal skeletal growth; 7. Approximate age of mummy: Carbon-14 analysis, about 530 years—plus or minus 50 years; 8. Known relatives: DNA analysis, special variant in Ice Maiden’s DNA will allow better comparison to individuals who might be related.

EXTENDING THE LESSON

Ask students to report on Johan Reinhard’s ongoing investigations of Inca burial sites by reading pages 128-135 in the July 1998 National Geographic magazine.
# Archaeology & Technology

How did scientists answer these questions about the Inca Ice Maiden? Complete the chart below using information from pages 34-36 and pages 41-44 of the book, *Discovering the Inca Ice Maiden*. The answers to questions 1 and 4 have been provided.

<table>
<thead>
<tr>
<th>Question</th>
<th>Technology Used</th>
<th>Results and Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Gender?</td>
<td>X-ray</td>
<td>Found shawl pins; Female</td>
</tr>
<tr>
<td>2. Age?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Last meal?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Disease: Yes or No?</td>
<td>CAT scan</td>
<td></td>
</tr>
<tr>
<td>5. Malnutrition: Yes or No?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Growth: Normal or Abnormal?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Approximate age of mummy?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Known relatives?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Lesson 6

What we know about the world of the Inca Ice Maiden is largely due to the existence of artifacts buried with her. In this lesson, students select objects that could give future scientists a meaningful view of our culture.

Time Capsule

CORRELATION TO STANDARDS

Language Arts
- Communicate with different audiences for a variety of purposes

Geography
- Places and Regions (4, 6)

Social Studies
- Culture
- Individual Development and Identity

BACKGROUND INFORMATION

Time capsules, in some form, have been around for as long as there have been people. The largest ones are the pyramids of Egypt. Some time capsules are people, such as the Inca Ice Maiden or other Inca mummies, whose bodies contain information about their cultures that can be unlocked through analysis.

Some time capsules are intentional messages to the future about the culture that created them. For example, a time capsule was buried at the 1964 World's Fair to be opened in the year 6964. Inside are objects intended to tell something about the people who lived on earth in 1964—a newspaper, a bikini, a Beatles record. Another time capsule containing 20th-century items contains a full-size Volkswagen!

The objects and natural materials of everyday life, however simple, can thrill people of a later time who are looking for clues to the way life was lived “back then.” The simplest things can have meaning in the future—a strand of hair or a drop of blood, dirt, a dried plant, or a jar of air. From one 200-year-old sealed coffin, researchers have extracted air that revealed information about the environment of the 18th century.

OBJECTIVE

To select objects from our time that communicate information about our culture

TIME: One class period

MATERIALS

- Discovering the Inca Ice Maiden
- A copy of the “Time Capsule” activity sheet for each group of students
- pencil and paper
- access to the school Web site (optional)
- large plastic container or containers (optional)
THE LESSON

Introducing the Lesson

Ask students to recall some of the artifacts Johan Reinhard and other archaeologists discovered with the Inca Ice Maiden. Refer to the Index on page 48 of Discovering the Inca Ice Maiden for a list of artifacts and their corresponding page numbers. Write the names of a few of the Inca artifacts on the board and pose this question: What if archaeologists of the future wanted to learn about us? What objects from our time would we want them to find?

Teaching the Lesson

Have students work in groups of two or three. Distribute copies of the "Time Capsule" activity sheet to each group. Have each group complete the activity sheet by selecting five objects they would put in a time capsule to represent their lives. You may wish to suggest some of the following objects:
- a T-shirt or hat
- jewelry
- a videotape of a favorite TV show
- an audiocassette or CD of a favorite musician
- a favorite computer game
- a CD
- photographs or a videotape of your class
- ticket stubs from a favorite concert or movie
- postcards and/or greeting cards
- a newspaper article about your hometown or school
- a map of your town and state
- a strand of hair (contains DNA)

Concluding the Lesson

Allow each group to share its selections and the reasons they were chosen with the rest of the class.

SUGGESTIONS FOR ASSESSMENT

The "Time Capsule" activity sheet can be used as a tool to assess students' understanding of the importance of artifacts in communicating information about a culture. Students should be able to connect the discussion of objects from their world to what they learned about Inca artifacts in the first lesson of this guide.

EXTENDING THE LESSON

Have students create one or more of the following time capsules: A time capsule of pictures (cut out or drawn) along with written descriptions of the items selected; a virtual time capsule posted on your school's Web site; or an actual time capsule made of a decorated plastic container with a selection of items inside.

Find out more about the biggest time capsules of the past—the pyramids. Egyptian pharaohs were buried with necessities for their next life.

Investigate the contents of the recording placed aboard the Voyager spacecraft, which will carry information about earth beyond the solar system.
Time Capsule

- Describe five objects that you would put in a time capsule to represent your life in the late 20th/early 21st century. Explain your reasons for each choice.

1. **Object:**
   - **Reason:**

2. **Object:**
   - **Reason:**

3. **Object:**
   - **Reason:**

4. **Object:**
   - **Reason:**

5. **Object:**
   - **Reason:**
The Internet can help you and your students broaden your understanding of the topics addressed in this guide. As Web site addresses change frequently, we recommend that you preview the sites before assigning them to students.

For further information about Johan Reinhard's research, photographs, films, and publications, access:
- http://www.mountain.org/reinhard/

For further information about the 1995 Ampato expedition, access:

To visit the Ice Maiden museum (in Spanish) in Peru, access:
- http://www.ucsm.edu.pe/~santury/

For a description of the special unit designed to preserve the Ice Maiden, access:

For photographs and information about Inca artifacts, access:

For information about the analysis of the Inca Ice Maiden's DNA, access:

For photographs of the ruins of Machu Picchu, access:
- http://www.he.net/~mine/inca

For information about exploration of the Andes and other mountains, access:
- http://www.mountain.org/andes.html

For information about cultures of the Andes, including songs and poetry in Quechua, access:
- http://www.andes.org/
National Standards

IRA/NCTE Standards for the English Language Arts

1. Build an understanding of print and nonprint texts, of themselves, and of cultures of the U.S. and world
2. Read literature from many periods in many genres to build understanding of human experience
3. Comprehend, interpret, evaluate, and appreciate texts
4. Communicate effectively with a variety of audiences and for different purposes
5. Employ a wide range of strategies and use different writing process elements
6. Create, critique, and discuss print and nonprint texts
7. Gather, evaluate, and synthesize data to communicate their discoveries
8. Gather and synthesize information to create and communicate knowledge
9. Understand and respect diversity in language use, patterns, and dialects
10. Use their first (non-English) language to develop competency in English language arts
11. Participate as members of a variety of literacy communities
12. Use spoken, written, and visual language to accomplish their own purposes

National Geography Standards

I. THE WORLD IN SPATIAL TERMS
   1. Maps and other geographic tools for information in a spatial perspective
   2. Mental maps and spatial context
   3. Spatial organization of the Earth

II. PLACES AND REGIONS
   4. Physical and human characteristics of places
   5. Regions interpret Earth's complexity
   6. Culture and experience influence perceptions of places and regions

III. PHYSICAL SYSTEMS
   7. Physical processes shape patterns of Earth's surface
   8. Characteristics and distribution of Earth's ecosystems

IV. HUMAN SYSTEMS
   9. Human populations
   10. The nature and complexity of Earth's cultural mosaics
   11. Patterns and networks of economic interdependence
12. Human settlement
13. Forces of cooperation and conflict that shape Earth’s surface

V. ENVIRONMENT AND SOCIETY
14. Human actions modify the physical environment
15. Physical systems affect human systems
16. Meaning, distribution, and importance of resources

VI. THE USES OF GEOGRAPHY
17. How to apply geography to interpret the past
18. How to apply geography to interpret the present and plan for the future

VII. PRODUCTION, DISTRIBUTION, AND CONSUMPTION: The study of how people organize for the production, distribution, and consumption of goods and services

VIII. SCIENCE, TECHNOLOGY, AND SOCIETY: The study of relationships among science, technology, and society

IX. GLOBAL CONNECTIONS: The study of global connections and interdependence

X. CIVIC IDEALS AND PRACTICES: The ideals, principles, and practices of citizenship in a democratic republic

Curriculum Standards for Social Studies

I. CULTURE: The study of culture and cultural diversity

II. TIME, CONTINUITY, AND CHANGE: The study of the ways human beings view themselves in and over time

III. PEOPLE, PLACES, AND ENVIRONMENTS: The study of people, places and environments

IV. INDIVIDUAL DEVELOPMENT AND IDENTITY: The study of individual development and identity

V. INDIVIDUALS, GROUPS, AND INSTITUTIONS: The study of interactions among individuals, groups, and institutions

VI. POWER, AUTHORITY, AND GOVERNANCE: The study of how people create and change structures of power, authority, and governance

National Science Education Standards

I. UNIFYING CONCEPTS AND PROCESSES: Evidence, models, and explanation

II. SCIENCE AS INQUIRY: Understandings about scientific inquiry

III. PHYSICAL SCIENCE

IV. LIFE SCIENCE

V. EARTH AND SPACE SCIENCE

VI. SCIENCE AND TECHNOLOGY: Understandings about science and technology

VII. SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES

VIII. HISTORY AND NATURE OF SCIENCE: Science as a human endeavor

Discovering the Inca Ice Maiden