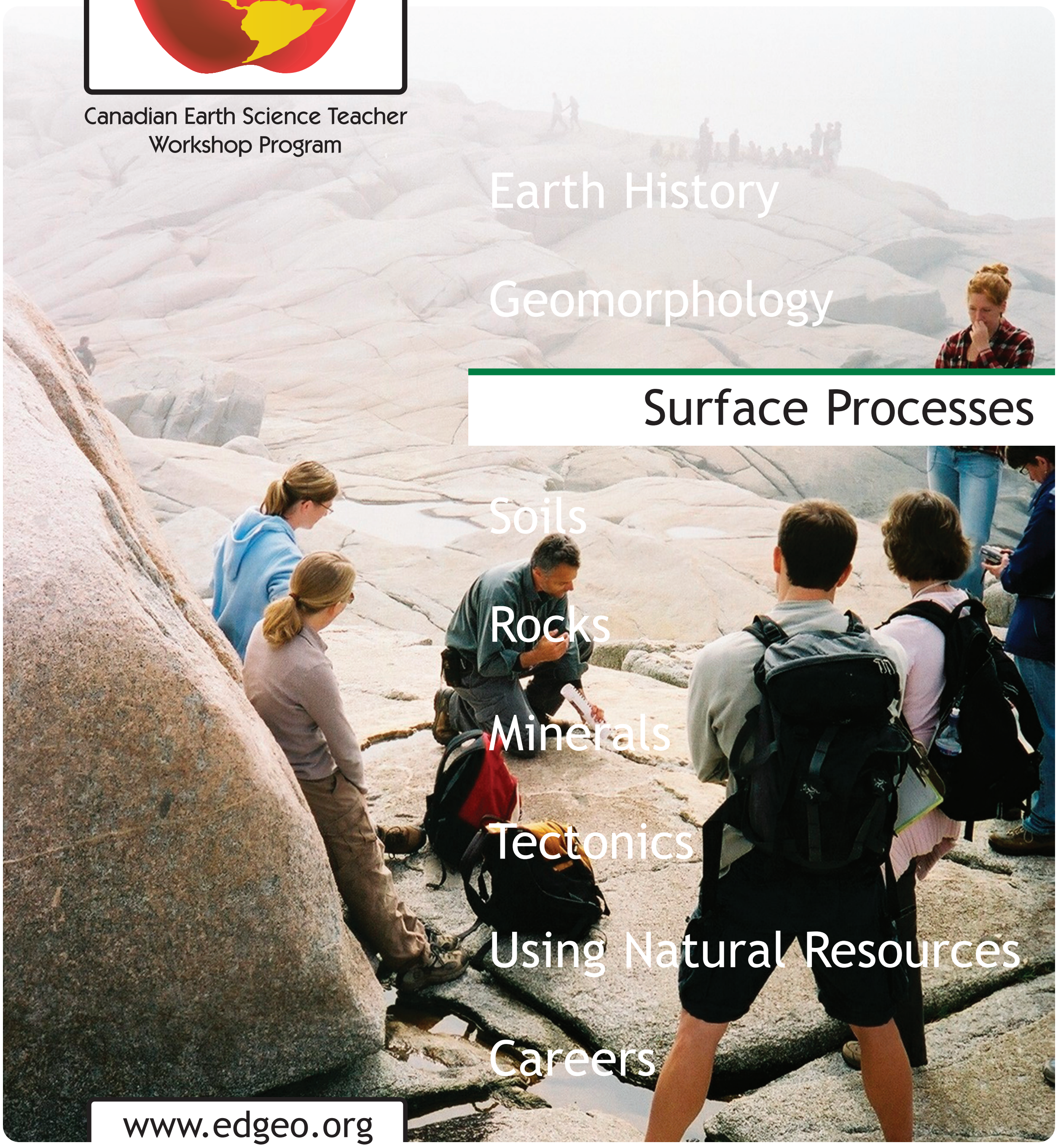
EdGEO

Canadian Earth Science Teacher Workshop Program

Bringing Earth Science to Life



Earth History

Geomorphology

Surface Processes

Soils

Rocks

Minerals

Tectonics

Using Natural Resources

Careers

www.edgeo.org

In partnership with:

Canadian Geological Foundation · 1968 · Fondation Géologique du Canada

Canada · 1842 · Geological Survey · Commission Géologique

Natural Resources Canada | Ressources naturelles Canada

ACTIVITY INDEX

Erosion by Water

Students experiment changing the angle of incline (slope) to find out the effect of the speed of water on erosion of the landscape. They observe the erosion of water flowing down a model mountain and the patterns produced.

Explanation

Erosion by water shapes much of the Earth's surface. The movement of water creates valleys, lakes, sediments, deltas; etc Water flowing down a steep slope has more energy and, therefore, causes more erosion.

Materials

Rigid cardboard, approx 30 cm square
Soil
Waterproof container, e.g. dish pan
Protractor
100 ml cup, e.g. Styrofoam cup
Water
Small stones
Student Activity Page

Caution

Wash hands after handling soil.

Clean up any spills immediately to avoid hazards.

Time

Medium

Grouping

Pairs, small groups.

Preparation

Reproduce student page and assemble materials. You can use any type of soil, collected from the natural environment or purchased.

Set up safe work areas and equipment for cleaning up water spills.

Erosion by Water

Prompt

Show the students photos of two hills: one very gentle, the other very steep. Which one would they prefer to toboggan down? Why? What will be the difference?

Delivery

1. Allow students time to experiment. Monitor their methods, discussing where necessary the need for a fair test.
2. Make sure students appreciate that the changes they see in their models occur similarly in nature, but may take hundreds and thousands of years to create any significant changes in the natural landscape.

Questions for Discussion

What might have happened to your results if you had not held the cardboard steady as you poured the water?

Where in nature will you find fast-flowing water? Slow-flowing water? What landscape features do you see in each of these areas that might be caused by water erosion?

Describe how moving water created rivers, valleys or even waterfalls on your mountain.

Where did the soil that was eroded from the mountain end up?

What effect did the stones have on how the soil was eroded?

Part 1: Slope and Speed

You are going to experiment changing the angle of incline (slope) to find out the effect of the speed of water on erosion of the landscape.

1. Work over the waterproof container to avoid spills.
2. Cover your cardboard square with soil. If your soil is too dry to stick, moisten it slightly.
3. Hold the soil-covered cardboard at an incline of 30^{o} to horizontal. Use the protractor to measure the angle.
4. Half fill the cup with water.
5. Gently and slowly pour the water onto the soil at the highest edge. Take about 10 seconds to empty the cup. Record your observations.
6. Repeat steps 3, 4, and 5 changing the angle to 45^{o} and 60^{o}.

Part 2: Create a River

1. Make a soil mountain in the centre of the waterproof container. Pat the soil smooth. If the soil is too dry to hold its shape, moisten it slightly.
2. Place some of the stones on the mountain. Gently push them into the soil so that they stay in place but are not buried completely.
3. Draw a sketch of your mountain, showing where you put the stones.
4. Half fill the cup with water.
5. Gently and slowly pour the water onto the top of the mountain. Take about 10 seconds to empty the cup.
6. Make a sketch showing the pattern made by the water as it flowed down the mountain and the places where the water eroded the soil. Label any rivers, valleys, streams or even waterfalls that were created.

Students use a model that represents an aquifer to test how pollutants can travel through an underground environment.

Explanation

Groundwater is the water source for many Canadian communities. Much of this groundwater comes from **aquifers** (underground reservoirs), which are water-filled sand and gravel deposits tens to hundreds of metres below the surface. If not properly managed, the amount of available water in an aquifer can be reduced by withdrawing groundwater at rates that exceed the rate of natural recharge. Such depletion lowers the **water table** (the level below which the ground is saturated with water), increases the pumping cost, and ultimately can drain the aquifers.

Materials

For one model:

1.89 L rectangular plastic bottle (flat-sided with a lid)
1500 ml white aquarium gravel
Piece of nylon stocking
Rubber band
2-500 ml clear plastic cups
Blue food colouring
Red food colouring
1.25 ml cocoa powder
2 L clear plastic pop bottle
Clear film canister
Small nail
Sticky tape
2 L water
Paper towels

Caution

Clean up any spills immediately.

Wash hands after this activity.

Time

Long

Grouping

Pairs, small groups.

Preparation

Prepare the "aquifer"

1. Cut away one side of the rectangular bottle.
2. Place a square, double-thickness piece of nylon over the neck of the bottle and secure in place with the rubber band.
3. Place the lid back on the bottle.
4. Fill the aquifer with the white gravel. It should come above the spout of the bottle, but not reach the very top. Note: white gravel is preferred; darker gravel makes it difficult to track the pollutants.

Prepare the "pollutant"

1. Using the small nail, punch a hole in the bottom of each film canister. Cover the hole with a piece of tape.
2. Add 1.25 mL dry cocoa and 1 drop of red food colouring.
3. Fill the canister about ¾ full of water and mix well. Place the lid firmly on the canister, and flip it over to store upside-down.

Prepare the "rain"

1. Fill a 2 L pop bottle with water and add 10-15 drops of blue food colouring. Mix well.

Prompt

1. Ask students what they think groundwater is, and have them make a quick sketch showing it. This will allow you to access prior knowledge and, more importantly, identify misconceptions which abound when it comes to groundwater.
2. Show students a diagram introducing them to the concepts of groundwater and aquifers (see information sheets).

Delivery

Lead students through the steps below:

Part 1: Make a River

1. Make sure the aquifer lid is on tight.
2. Pour in rainwater until it is just below the top of the gravel. Talk about the role of porosity in an aquifer, and how the water fills the spaces between the gravel. Explain that the top of the water surface marks the top of the water table.

3. Ask how they could make a pond in their aquifer. (Answer: They must make an indentation in the gravel that reaches down to the water table.
4. Put the cup underneath the mouth of the aquifer bottle.
5. Remove the lid of the aquifer and catch the water that flows out with the plastic cup. Tell students the mouth of the bottle, with the nylon covering, represents a riverbank, where plant cover and roots help filter water coming into the river. The cup represents a river.
6. When the flow stops, ask students how this might happen in a natural setting (Answer: low rainfall or drought). Ask what it would take to get the aquifer feeding the river again?

Part 2: Pollution

1. Make sure the aquifer lid is on tight.
2. Recharge the aquifer by pouring the water collected in the river (step 5 above) back into the aquifer. Have students make a sketch of the aquifer and the water table.
3. Talk about the pollutant in the film canister. This could represent fertilizer, sewage, a leaking oil tank, a poorly designed landfill, etc. The source can be well away from the river and still cause problems.
4. Remove the tape from the bottom of the film canister and place it, hole side down, near the back of the aquifer and at one side so that the pollution will be easily seen through the clear plastic.
5. Watch for a while and discuss what is happening to the pollution. Where does it go? What problems could this cause? Have students make a sketch of where the pollution is in the model.
6. Put the cup underneath the mouth of the aquifer bottle.
7. Remove the lid of the aquifer and catch the water that flows out with the cup. Have students carefully observe the movement of the pollution and the clarity of the water entering the river. At this point, it should be very clean.
8. Simulate rain by adding water from the rain bottle to the back of the aquifer. Just enough should be poured to recharge the aquifer and not go above the top of the gravel. When the water entering the river begins to get coloured, switch to the second cup and put the first cup aside. When the cup is almost full, replace the lid on the aquifer.

9. Have students draw a labelled diagram of the pollution plume and compare the water in the two cups.

When finished with the activity, the aquifers can be rinsed a few times and reused.

Questions for Discussion

1. How is this model like an actual groundwater system and how is it different?
2. How could we lower the water table?
3. How would lowering the water table adversely affect living things (humans, other animals and plants)?
4. Many environmentally conscious people take great care to avoid dumping contaminant directly into rivers. Why this does not guarantee a healthy river system?

Extensions

Demonstrate how a wetland system can help keep an environment healthier by placing a small amount of sphagnum moss on the surface of the groundwater model. Repeat the pollution portion of the activity. Students will observe that the pollution is absorbed into the moss rather than entering the groundwater.

Add a well by inserting a clear drinking straw at one end of the aquifer. Investigate how the level of water in the well and the water table are connected.

Design an experiment that would test how groundwater and contaminants move through different types of soil (sand, clay, glacial till, gravel).

Groundswell

WATER

Students investigate the relative absorption of gravel and cat litter, and relate this to soil properties. They design a solution to solve the problem of houses built over bentonite clays.

Explanation

Our Canadian landscape owes many of its distinctive features to being shaped by glaciers. As the massive ice sheets covering the land retreated, sediments were left behind in the lakes formed by melt water. The sediments contain clays like **bentonite**, which are highly absorbent and swell when they become wet, and shrink when they dry.

Across Canada, houses built on these glacial-lake sediments often experience problems like cracks appearing in their walls, sidewalks and driveways; their basement floor heaving; and doors and windows that won't open or close. As the bentonite clays on which they are built expand and shrink with changes in moisture content, the house foundations, sidewalks and roads shift, causing damage.

Swelling and shrinking are limited to the uppermost part of the ground, which gains and loses moisture through the year due to changes in precipitation and vegetation growth. Below this **active zone**, the ground is stable. One engineering solution is to build foundations on piles that extend through the active zone to the stable zone below.

Materials

Student Activity Page
Optional: Grow Monster (grows in water)

For each group:

Two 500 ml clear containers (see Preparation)
250 ml of gravel
250 ml of crystal cat litter
500 ml measuring jug
500 ml water
10 drops blue food colouring
Two - 15 cm rulers
Student Activity Page

Caution

Coloured water can stain if spilt on clothes. Have students wear aprons.

Clean up any spills immediately.

Time

Medium

Grouping

Pairs, small groups.

Preparation

Assemble materials and reproduce Student Activity Page. Note: The cat litter and gravel must have roughly the same grain size and shape so each will have a similar initial porosity. A significant difference in grains will affect the experimental results.

To prepare clear containers, cut off the lower 10 cm of 2 L pop bottles. Deli-style containers are also suitable.

Prompt

A few days prior to this activity, place a “growing monster” (a rubbery blob that increases in size 100-fold) in water and ask the students what this might have to do with their homes. Have a peek at it each class, but do not explain its relationship to houses until the activity is complete..

Delivery

1. Provide the groups with materials. Review the procedure and allow time for experimentation.
2. When students add water to the cat litter, they should hear a “snap, crackle and pop” as the crystals begin to expand; and they will observe the clear crystals turning blue as they absorb the blue water. These both show the property of water absorption in swelling clays in a dramatic way. They should also see a slight increase in the level of sediment in the cat litter bottle (only a few mm), but no change in the gravel bottle.
3. After completing the experiment, assign students “The Solving the Groundswell Problem” worksheet where they design a new system for protecting homes from damage by swelling clays.

Questions for Discussion

1. Which material (gravel or crystal cat litter) absorbed the most water? (Answer: The cat litter absorbed much more water than gravel, and swelled slightly when it was wet.)
2. Some clays in the ground also swell when wet, especially bentonite.
3. What would be the effect on a house built on soil that contains bentonite?
4. What practical uses (other than cat litter) might materials that expand when water is added have?
5. How does the Grow Monster relate to our houses?

Extensions

Contact local builders or a civil engineer to find out what methods they use to deal with swelling clay.

Contact city building code inspectors to ask them about rules and regulations regarding building on bentonitic clays.

Develop an activity to test different strategies for preventing structural damage when building on clays.

You are going investigate the relative absorption of gravel and cat litter, and see how this relates to soil properties. You are will investigate how this could affect houses built over certain types of soil and design a solution to help the homeowners.

Materials

2 clear containers
250 ml cat litter
250 ml gravel
2 short rulers
500 ml of water in a measuring jug
Blue food colouring

Instructions

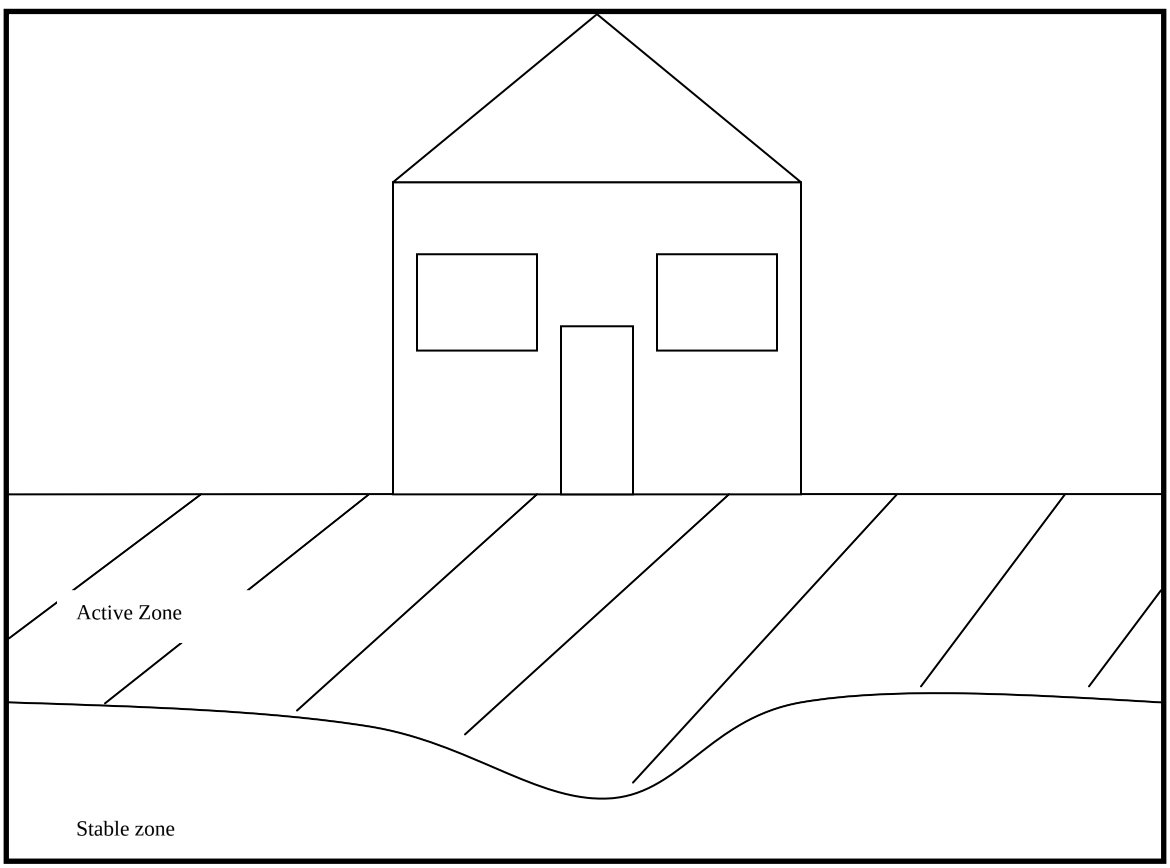
1. Place one ruler in each container so that it sits in the middle and touches the bottom.
2. Add gravel to one container and cat litter to the other. Record the height of the sediment in each container.
3. Put 500 ml water into the measuring jug and add 2 drops of blue food colouring.
4. Slowly pour water into the container filled with gravel. Take care not to move the ruler. Stop pouring as soon as the water reaches the top of the gravel.
5. Record the water level remaining in the measuring jug.
6. Subtract the volume left from the initial volume to calculate how much water the gravel has absorbed.
7. Record the height of the wet sediment in the container.
8. Slowly pour water into the container filled with cat litter. Take care not to move the ruler. Stop pouring as soon as the water reaches the top of the gravel.
9. Record the water level remaining in the measuring jug.
10. Subtract the volume left from the initial volume to calculate how much water the cat litter has absorbed.
11. Record the height of the wet sediment in the container.

Observations

	Gravel	Cat litter
Height of sediment (cm) when dry		
Initial water level in measuring jug	500 ml	
Water level in measuring jug after pouring		
Volume of water absorbed by sediment		
Height of sediment (cm) when wet		

Solving the Groundswell Problem

Devise a creative solution to the problem of swelling clays so that the walls and floors of this house do not crack. Draw your solution onto the diagram below, and explain it in words..



The Destructive Power of Ice

Students observe the destructive power of expanding ice, and simulate the abrasion from rock particles trapped in glaciers.

Explanation

A glacier is a slow-moving mass of ice formed by falling and compacting snow on mountains or in areas of prolonged cold climates. Almost all of Canada was covered by glaciers during the last glacial period. Only about 1% of Canada is covered by glaciers today: on the eastern Arctic Islands and in the mountains of British Columbia and Yukon. The action of ice has been a significant factor in creating the present-day Canadian landscape.

Materials

Expansion:

Balloon
Water
Plaster of Paris
Approximately 1 L plastic container (e.g. ice cream tub)
Access to freezer

Abrasion

Disposable cup
Gravel and sand
Water
Access to freezer

Caution

Always add dry plaster of Paris to water.

Plaster of Paris heats when setting; do not allow contact with skin.activity.

Time

3 short activities, each at least one day apart

Grouping

Expansion: whole group

Abrasion: pairs, small groups

Preparation

None

Delivery

<u>**Day 1**</u>

Expansion:

1. Put water in the balloon until it is slightly beyond flat. Squeeze out all of the air and seal the balloon.
2. Mix up plaster of Paris and put about 2.5 cm in the bottom of the plastic container.
3. Lay the balloon on the plaster, and cover it with another 2.5 cm layer of plaster.
4. Let the plaster set overnight.

Abrasion:

5. Half fill a disposable cup with gravel and sand (sediments).
6. Cover the sediment with water.
7. Place in the freezer

<u>**Day 2**</u>

Expansion:

8. Show students the set plaster. Have them feel how hard it is. Place the container in the freezer.

<u>**Day 3:**</u>

Expansion:

9. Remove the container from the freezer. The plaster should have cracked due to the expanding ice in the balloon. If allowed to thaw, and then refrozen, the plaster should crack even more. This is an example of the power of ice, such as can be observed in the many potholes in our roads in spring, and in such natural features as tundra polygons, pingos and frost blisters.

Abrasion:

10. Peel off the disposable cup.
11. Scrape the ice block slowly, in one direction, along a piece of smooth wood, shale or stiff cardboard surface.
12. Students should see the resulting scratches. Compare these to photographs of scratches made by glaciers on rocks.

Question for Discussion

How would the expansion and abrasion actions of ice shape the landscape around us?

Extension

Map present-day ice cover around the world, and research how it has changed over time.

Mapping Glacial Retreat

Students trace the retreat of the last ice sheet to that covered Saskatchewan, and map the waterways created by the melting ice and the emerging land.

Explanation

Many ice sheets have covered Saskatchewan in the past. Each new ice sheet either eroded existing landforms and sediments, or deposited new sediments on top of those left behind by the previous, or did both. Saskatchewan's present-day landscape is primarily a result of the action of the ice sheet in the Late Wisconsinian Age (about 18,000 years ago). As the ice sheet retreated, meltwater channels, glacial lakes and spillways formed. Meltwater channels carried meltwater away from the glacier, often emptying into glacial lakes. Spillways were rivers that drained glacial lakes. Both types of "rivers" created large valleys, some of which are still present today. Some of the glacial lakes left behind lake beds that later became the sites of present-day cities and towns or rich agricultural land.

Glacial Lake Agassiz was the largest and longest- lasting glacial lake in Saskatchewan. At its zenith, Lake Agassiz extended from Reindeer Lake (in northeastern Saskatchewan) to Ontario and the northern United States. Its expanse varied over time, with its northern margin following the front of the Laurentide Ice Sheet as it retreated during deglaciation. As Lake Agassiz changed in size and depth it left behind beach deposits that can be found today. Many of the large lakes in northern Saskatchewan are remainders of large glacial lakes like Lake Agassiz.

Materials

Blue and green pencil crayons
Maps showing last ice age (see Resources)
Student Activity Page (answers provided in Resources)

Caution

None

Time

Medium

Mapping Glacial Retreat

Grouping

Individual, pairs

Preparation

Reproduce Student Activity Pages and the maps (enlarge the maps for better visibility).

Prompt

Identify land and water areas on a regional map. Ask students what may have caused that pattern and if they think it has changed over time.

Delivery

Allow students time to work through the task independently.

Questions for Discussion

See Student Activity Page.

Extensions

Create a brochure trying to sell land near the shore of glacial Lake Agassiz.

Compare a present-day map with the glacial lake map sheet, looking for present-day waterways and lakes that may be glacial in origin.

Resources

Answers to Question 4 on the Student Activity Page

a. Why did the ice sheet in the Late Wisconsinian shape the topography of Saskatchewan?

It was the final ice sheet to cover Saskatchewan, and it obliterated any previous topography. No other ice sheet followed it.

b. Define each of the following parts of the date 10 ka BP

i. k	*kilo (1000)*
ii. a	*years*
iii. BP	*before present*
iv. Write out the date using only numbers	*10 000*

c. When was the ice sheet most extensive?

23 000 years ago

d. When did glacial lake Regina form?

12 000 years ago

e. When did the Qu'appelle Channel first appear?

12 000 years ago

f. When was Lake Agassiz most extensive in Saskatchewan?

9000- 9500 years ago

g. Toward what direction did the ice retreat?

Northeast

h. When did glacial lake Athabasca first appear?

8700 years ago

i. When did the site of present-day Regina first become free of ice?

12 000 years ago

j. When did the site of present-day Prince Albert first become free of ice?

11 000 years ago

Mapping Glacial Retreat

You are going to chart the retreat of the last ice sheet to have covered Saskatchewan and see how the melting ice created present-day waterways.

Materials

Blue and green coloured pencils
Map pages

Instructions

1. Colour the key on the bottom of the map pages. Use blue for the water and green for the land. Leave the ice white.
2. Trace all of the rivers and spillways in blue. The rivers and spillways are marked by a thin line and an arrow. The arrow points in the direction of flow.
3. On each diagram of the province colour the water blue and the land green.
4. Answer the following questions using the map sheet. Remember that all times are approximations.

   a) Why did the ice sheet in the Late Wisconsinian shape the topography of Saskatchewan?

   b) Define each of the following parts of the date

      10 ka BP

      i. k

      ii. a

      iii. BP

      iv. Write out the date using only numbers

   c) When was the ice sheet most extensive?

   d) When did glacial lake Regina form?

   e) When did the Qu'appelle Channel first appear?

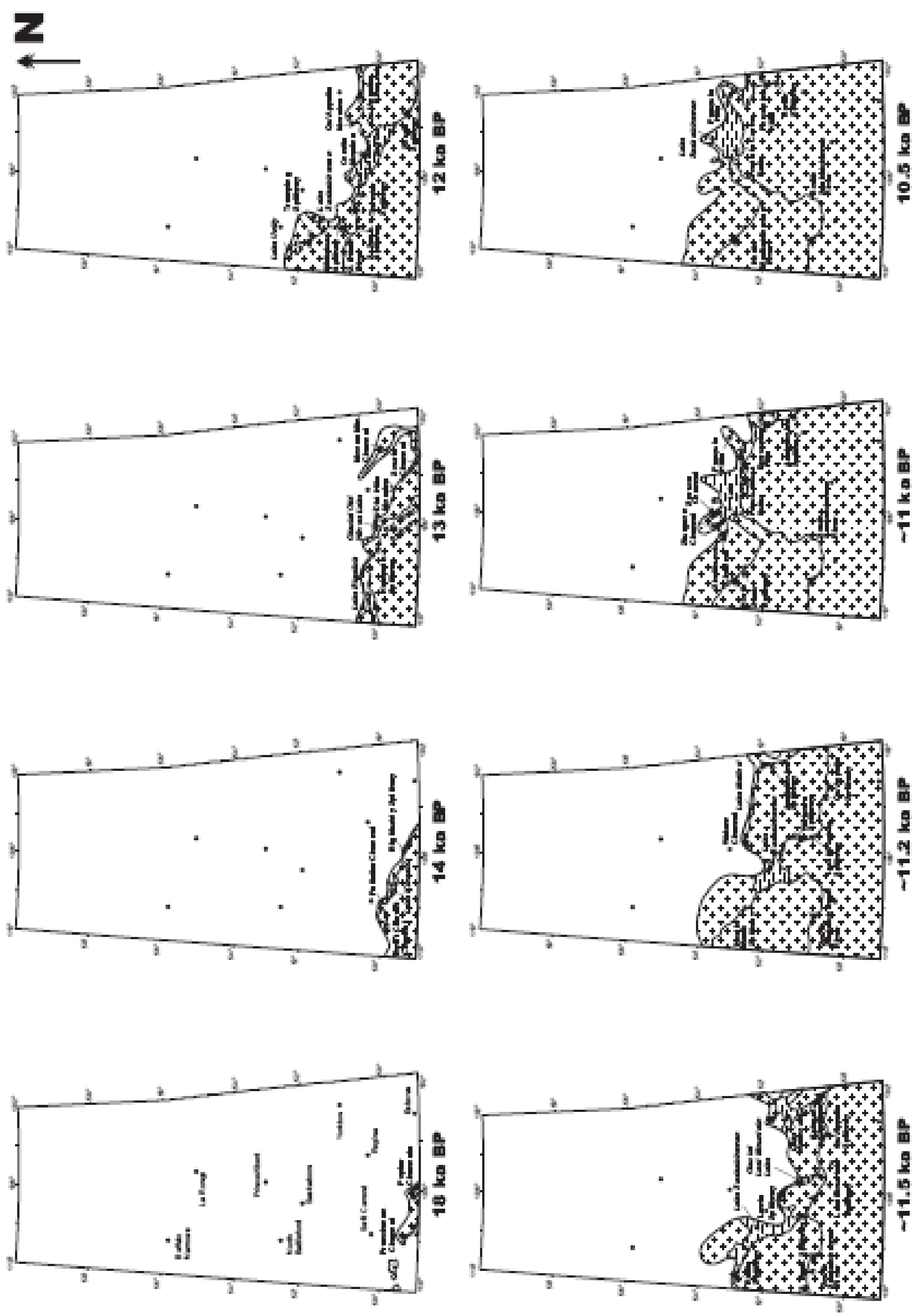
   f) When was Lake Agassiz most extensive in Saskatchewan?

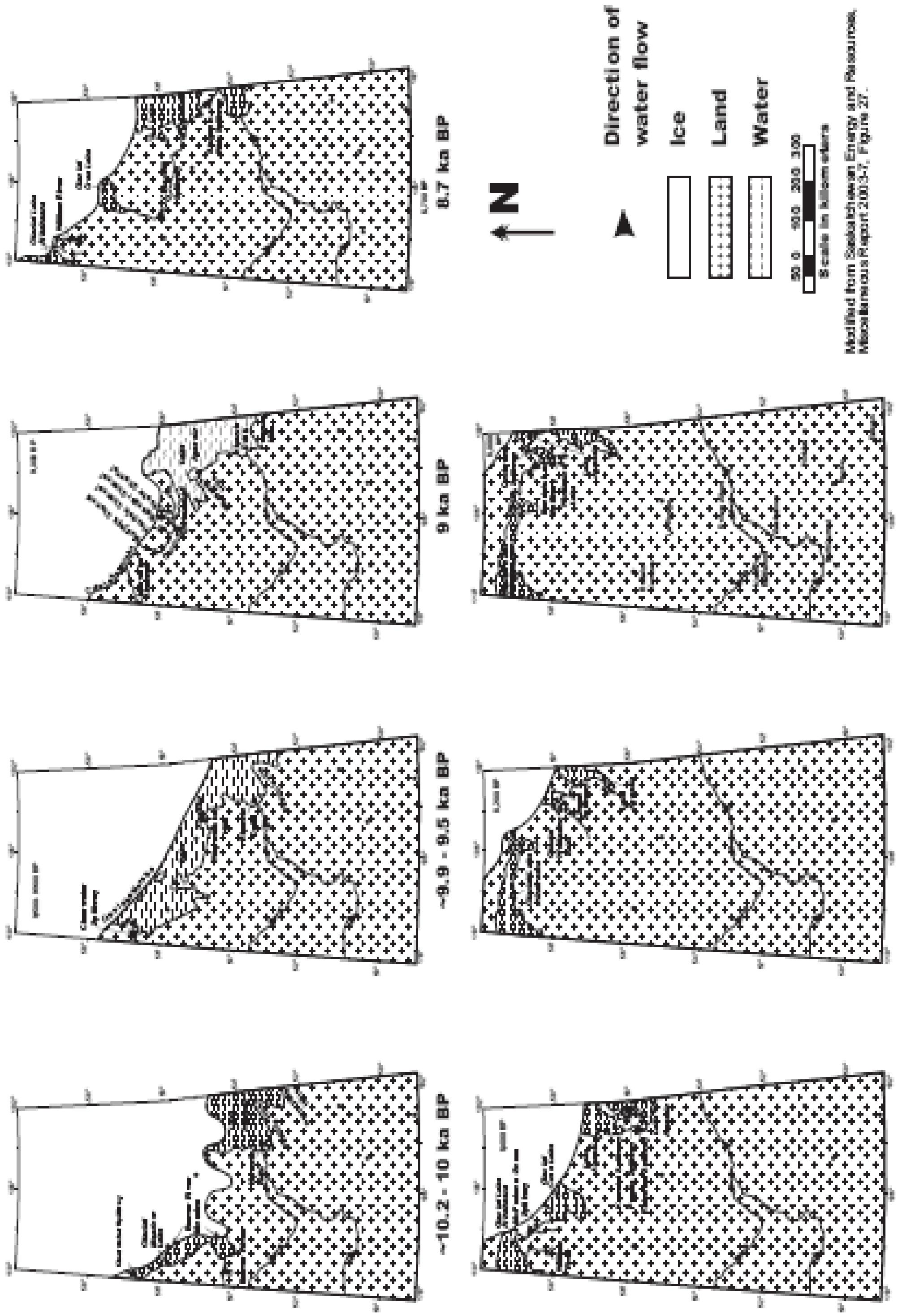
   g) Toward what direction did the ice retreat?

   h) When did glacial lake Athabasca first appear?

   i) When did the site of present-day Regina first become free of ice?

   j) When did the site of present-day Prince Albert first become free of ice?


N
12 ka BP
10.5 ka BP
13 ka BP
~11 ka BP
14 ka BP
~11.2 ka BP
18 ka BP
~11.5 ka BP


~10.2 - 10 ka BP
~9.9 - 9.5 ka BP
9 ka BP
8.7 ka BP
8.4 ka BP
8.2 ka BP
8 ka BP
N
Direction of water flow
Ice
Land
Water
50 0 100 200 300
Scale in kilometers
Modified from Saskatchewan Energy and Resources, Miscellaneous Report 2003-7, Figure 27.

Investigating Shear Strength

Students conduct experiments to determine the relative shear strength of different sediments when subjected to water.

Explanation

Sediments have different amounts of **shear strength**. This means that some are able to withstand stresses that could make their constituent grains move past one another, while others cannot. One of the major factors involved in these stresses is water. Water acts on different sediments in soil in different ways:

- The sand portion of sandy soils is made up of impermeable quartz grains. Due to this impermeability, little water is absorbed by sandy soils and water moves through the material relatively easily. This type of soil will have high shear strength.
- Soils with a high percentage of clay behave very differently when saturated with water. The clay particles (in particular, swelling clays such as bentonite) absorb the water, and become heavier and very slippery, causing the soil to have less shear strength. River slopes that have a lot of clay in their soil are more prone to landslides than those with lower clay content. .

Materials

To make sediment types:

4 L dry sand
375 ml cornstarch
375 ml gravel
1.5 L containers, e.g. ice cream buckets

For each group:

250 ml of each sediment type
Small paper plate
Plastic cup
Aluminum pie plate
250 ml spray bottle with water
Student Activity Page

Caution

Clean up any spills immediately.

Wash hands after this activity.

Investigating Shear Strength

Time

Medium

Grouping

Pairs, small groups.

Preparation

Cut a small (2 cm) notch from the rim of the paper plates to allow the water to drain.

Prepare different sediment mixtures as follows (enough for 6 groups). These quantities should provide sediments that will stand up as hills. Test them to make sure. If they crumble, add a bit more water. If they slump, add a bit more sand.

Sediment Type A: 1.5 L dry sand, 360 ml water

Sediment Type B: 1125 ml dry sand, 375 ml cornstarch, 180 ml water

Sediment Type C: 1125 ml dry sand, 375 ml gravel, 360 ml water

Label the containers clearly with the sediment type.

Prompt

Show news clippings or photos of landslides and ask students to speculate as to what causes the ground beneath us to suddenly move.

Delivery

Before students begin their experiments:

1. Demonstrate the method for making the sediment hills. If the hill collapses, build it back up and explain how certain types of sediment simply do not hold up against the pull of gravity. That is what causes landslides.
2. Demonstrate how to use the spray bottle consistently, e.g. one firm squeeze per spray; emphasize the importance of counting each time they spray the water.
3. Prompt students to pay particular attention to the type of deformation when the hill collapses: does the sediment break, crumble or slide?
4. Allow time for the students to complete their investigation.

Questions for Discussion

1. How would a landslide in sediment A be different from a landslide in sediment C? Think in terms of speed and shape of the debris.
2. Which of the sediments collapsed first? What were some of the characteristics that made it different from the other sediment samples?
3. What would you recommend a prospective homebuyer do before buying a property close to a riverbank?

Extensions

Find out some ways that engineers increase the shear strength of building materials. Design a test to apply some of these techniques to river slopes to stabilize them. Research major landslides that have occurred around the world and create a chart showing factors that each slide had in common and that made each one unique. Create a safety brochure that could apply to their community.

Note : Information on Canadian landslides can be found at: http://gsc.nrcan.gc.ca/landslides

You are going to carry out experiments to discover the relative shear strength of different sediments when they interact with water.

Materials

250 ml of each sediment type
Small paper plate
Plastic cup
Aluminum pie plate
250 ml spray bottle with water

Instructions

1. Fill the cup with one of the sediment types (A, B or C). Pack the sediment down firmly and fill the cup right to the brim. Smooth the surface.

2. Place the paper plate over the top of the cup. Firmly hold the two together as you flip the cup upside down. Put the plate down and carefully remove the cup.

3. Draw a sketch of your hill on your observations page.

4. Put the paper plate onto the aluminum pie plate.

5. Spray the top of the hill with water, counting each spray. Carefully observe the hill for signs of erosion. Continue counting the number of sprays until the hill collapses.

6. Record the number of sprays and draw a sketch of the hill after it collapsed.

7. Clean away the wet sediment and drain the water from the plates.

8. Repeat this procedure for all of the sediment types.

9. Compare your results and discuss the reasons for any differences.

Sediment Type	Before Collapse	After Collapse
A		Number of sprays of water
B		Number of sprays of water
C		Number of sprays of water

Protection from Landslides

Students apply an engineered solution to stabilize a slope prone to landslides.

Explanation

Certain types of valley slopes are prone to **landslides**. Most of these landslides move slowly (millimetres or centimetres per day), but even this slow movement is damaging to roads, houses and other structures in the area. Rapidly moving landslides are rare, but can be catastrophic.

Several factors can increase the risk of slopes being unstable:

- The slope's geology, for example, when the soil contains a high percentage of clay. When clays become saturated with water, they lose shear strength, which means they tend to slip more easily. A saturated, heavy clay layer can slip over an underlying rock layer.
- The amount of surface water, especially when there is additional surface water in the system from lawn watering, irrigation, leaking pipes and precipitation.
- Spring and early summer high-water levels increase erosion to riverbanks, which, in turn, may undercut the base of the slope and destabilize it.
- Very steep slopes, such as created by previous river erosion or landslides, make slopes more prone to downward movement.

Materials

Student Activity Page: "Losing Ground"

For each of the three groups:
2 milk cartons
1000 ml moist sand (sandcastle consistency)
2 small plastic toy animals (i.e. cows)
500 ml beaker
350 ml water
Aluminum cookie sheet
Ruler
Sponges or paper towels for cleanup

Special items for each group:

Berm group: 150 ml small pebbles (aquarium rocks)
Plant group: 4 Popsicle sticks
Pipe group: 4 straws

Protection from Landslides

Caution

Clean up any spills immediately.

Wash hands after this activity.

Time

Medium

Grouping

Pairs, small groups.

Preparation

Prepare two milk cartons for each group: Cut one side and the spout end off. With a permanent black marker, draw a line 5 cm from the end of the base and 4 cm from the top. These will be guides for students as they build the slope and a reference measuring line.

.

Prompt

1. Create two columns on the board labelled "Problems" and "Solutions."
2. Ask students to brainstorm about what could cause landslides along a river. List all suggestions under "Problems" and remind students that there are many "triggers" that can cause saturated soil to begin to move downhill. Make sure that the main factors are listed (excess water from groundwater or the surface, steepness of slope, undercutting the bank by erosion).
3. Ask students to brainstorm about possible solutions to each of the problems they identified and list them next to the corresponding problem in the "Solutions" column. These should include the use of berms, plant roots, water diversion channels or pipes.

Delivery

1. Divide students into three groups: berm, plant and pipe. Have them decide on their roles (supervisor, engineer, researcher, reporter) before starting the activity and fill out their names on the “Losing Ground” activity page.
2. Provide each group with their equipment and engineering materials, and advise them that they can only use the provided materials for their solution.
3. Give groups a few minutes to discuss strategies for preventing slope failure
4. Allow time for construction and experimentation.
5. After the experiments, ask the reporter from each group to give a brief description of their group’s solution.

Questions for Discussion

1. Was there one solution that worked better than others? Why do you think it was more successful and would this be a practical solution?
2. Why is it important to prevent landslides into rivers? (Answer: Landslides cause much sediment to enter the water. This increases turbidity and lowers oxygen,, both of which are damaging to the plants and animals in the river’s ecosystem. As well, valuable residential, business or agricultural land can be lost; roads or homes can be destroyed; and human injuries, or even fatalities, can occur.)
3. How is your group’s model different from the actual soil and rock on the banks of a river? Would your model be more or less prone to a landslide? (Answer: The students’ models would be less susceptible to sliding since there are no slippery clays involved in their models. As well, the water in their models is flowing only from the surface down, rather than seeping up from the groundwater where it might not be noticed.)
4. How did we control variables in this experiment? (Answer: Each group used the same amount of sand; the same type and size of container; lines provided a guide for the height of the slope build up; and water was applied in the same location, same amount and over the same time duration. In nature, these would all be variable.)

Extensions

Investigate how much water was needed to cause a landslide in both the un-engineered and engineered slope.

Riverfront property is extremely desirable for residential development. Identify four interest groups who may want to have input into any decisions on using riverfront property for high-rises. Have each group list pros and cons for using land on the slopes of a river and decide on a solution that will be as fair as possible to all groups.

Making sure that they are with an adult, have students explore the banks of a local river or stream and look for evidence of past, present or future landslides (undercut banks, small amounts of earth movement, tilting trees and shrubbery, etc.).

Resources

Sample Model

Your engineering team is going to come up with a solution to stabilize a slope prone to landslides.

Engineering Team Members	Role
	Supervisor
	Engineer
	Researcher
	Reporter

Materials

2 milk cartons with one side and spout end cut out
1000 ml moist sand (sandcastle consistency)
2 small plastic toy animals (e.g. cows)
500 ml beaker
350 ml water
Aluminum cookie sheet
Ruler
Sponges or paper towels for cleanup
Engineering materials

Instructions

1. As a group, plan what you will do to stabilize the slope and discuss why you think it will work. You may use only the materials that are provided.
2. Supervisor puts 500 ml of damp sand in each milk carton. Pile the sand on the bottom half of the milk cartons. The lines indicate where the slope should start and end. Sand must be very firmly packed.
3. Place the cartons on the cookie sheet.
4. Engineer constructs the group's plan to stabilize the slope in one container. This is your **engineered slope**. When finished the construction of the engineered slope, place toy animals in the same location for each milk carton.
5. The Recorder draws a "Before" picture of both milk cartons before the tests begin.
6. The Researcher pours 175 ml water at the top of the un-engineered slope. Take 5 seconds to empty the water.
7. The Researcher measures how far the sand has moved from the original lines (this represents the amount of movement at the toe and the head of the slope) and reports this to the Recorder.
8. The Recorder draws a diagram of the slope after failure and records the amount of slope movement.
9. Repeat steps 6, 7 and 8 for the engineered slope.
10. Discuss as a group what part of your solution was the most successful? What could have been improved?
11. Reporter reports findings to class.

	Un-engineered Slope	Engineered Slope
Sketch before testing		
Sketch after water added		
Amount of movement at the toe (base) of the slope		
Amount of movement at the head (top) of the slope		