# HOW A MOVING GLACIER CHANGES THE LAND pdf

## 1: How Glaciers Shape the Land

*Glaciers not only transport material as they move, but they also sculpt and carve away the land beneath them. A glacier's weight, combined with its gradual movement, can drastically reshape the landscape over hundreds or even thousands of years.*

The rocks in the foreground were dropped by a retreating glacier, and the mountains in the background have been carved by glacial action. Reed Glaciers can sculpt and carve landscapes by eroding the land beneath them and by depositing rocks and sediment. Glacial Erosion This diagram shows how glaciers can erode bedrock. Abrasion involves scratching the bedrock with debris in the basal ice. Plucking is removal of entire chunks of rock. Courtesy of Rocky Mountain National Park Glaciers can shape landscapes through erosion, or the removal of rock and sediment. They can erode bedrock by two different processes: The ice at the bottom of a glacier is not clean but usually has bits of rock, sediment, and debris. It is rough, like sandpaper. As a glacier flows downslope, it drags the rock, sediment, and debris in its basal ice over the bedrock beneath it, grinding it. This process is known as abrasion and produces scratches striations in bedrock surface. The bedrock beneath a glacier often has cracks in it that were there before it was ever covered in ice. These cracks may grow beneath the glacier, and eventually join with one another. When this happens, entire chunks of rock can break off and be carried away by the ice. Glaciers can also erode sediment. This can happen in a number of ways, including downward creep of the glacier ice into the sediment, freezing of water in sediments to the base of the glacier, and squishing the sediment around beneath the weight of the ice. Glacial Deposition Moraines are piles of sediment deposited by glaciers. As the ice melts, it drops the rocks, sediment, and debris once contained within it. Additionally, when glaciers ice melts, the water it generates can move and rework sediment. This is called glacial outwash.

## 2: Second grade Lesson Glaciers Create Big Changes-- Let's Write About It!

*Today we are going to go back 12 thousand years to the Ice Age to take a look at how glaciers move and how they change the land. How many of you have ever watched the movie Ice Age? Ice Age was a movie that takes place during ice age times.*

Sea levels in Alaska are not rising, but dropping precipitously due to a phenomenon known as glacial isostatic adjustment. But a new study out in the Journal of Geophysical Research shows that in places like Juneau, Alaska, the opposite is happening: How could this be? During the glacier heyday 19, years ago, known as the Last Glacial Maximum, the Earth groaned under the weight of heavy ice sheets thousands of feet thick, with names that defy pronunciation: The displaced mantle flows into areas surrounding the ice sheet, causing that land to rise up, the way stuffing inside a couch will bunch up around your weight. The Laurentide Ice Sheet, which weighed down most of Canada and the northern United States, for example, caused an uplift in the central to southern parts of the U. Elsewhere, ancient glaciers created forebulges around the Amazon delta area that are still visible today even though the ice melted long ago. As prehistoric ice sheets began to melt around 11, years ago, however, all this changed. The surface began to spring back, allowing more space for the mantle to flow back in. The most dramatic examples of uplift are found in places like Russia, Iceland and Scandinavia, where the largest ice sheets existed. In Sweden, for example, scientists have found that the rising land severed an ancient lake called Malaren from the sea , turning it into a freshwater lake. At the same time, places that were once forebulges are now sinking, since they are no longer being pushed up by nearby ice sheets. For example, as Scotland rebounds, England sinks approximately seven-tenths of an inch into the North Sea each year. Similarly, as Canada rebounds about four inches each decade, the eastern coast of the U. A study published in predicted that Washington, D. Some of the most dramatic uplift is found in Iceland. Residents already feel the dramatic impacts of this change. On the positive side, some families living on the coast have doubled or tripled their real estate: Uplift will increase the amount of rocky sediment in areas previously covered in water. For example, researchers predict that uplift will cause estuaries in the Alaskan town of Hoonah to dry up, which will increase the amount of red algae in the area, which in turn, could damage the fragile ecosystems there. In addition, some researchers worry that the rapid uplift in Alaska will also change the food ecosystem and livelihood for salmon fishers. At the same time, there are a lot of new salmon streams opening up in Glacier Bay, says Eran Hood, professor of environmental science at the University of Alaska. As the ice recedes, salmon is recolonizing. As our gargantuan glaciers melted, the continents up north lost weight quickly, causing a rapid redistribution of weight. He likened the phenomenon to a spinning figure skater extending their arms to slow themselves down. Glacial melt may also be re-awakening dormant earthquakes and volcanoes. Large glaciers suppressed earthquakes, but according to a study published in in the journal Earth and Planetary Science Letters, as the Earth rebounds, the downward pressure on the plates is released and shaky pre-existing faults could reactivate. In Southeast Alaska, where uplift is most prevalent, the Pacific plate slides under the North American plate, causing a lot of strain. Researchers say that glaciers had previously quelled that strain, but the rebound is allowing those plates to grind up against each other again. Melting glaciers may also make way for earthquakes in the middle of plates. One example of that phenomenon is the series of New Madrid earthquakes that rocked the Midwestern United States in the s. Now that the ice sheets have melted, however, the mantle is free to bubble up once again. In the past five years, Iceland has suffered three major volcanic eruptions, which is unusual for the area. Some studies suggest that the weight of the glaciers suppressed volcanic activity and the recent melting is times more likely to trigger volcanic eruptions in places like Iceland and Greenland. Scientists are still trying to create an accurate model of glacial isostatic adjustment, says Richard Snay, the lead author of the most recent study in the Journal of Geophysical Research. He and colleagues have developed new equations for measuring isostatic adjustment based off of a complex set of models first published by Dick Peltier, a professor at the University of Toronto. In Alaska, global warming means less snow in the wintertime, says Hood.

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## 3: Second grade Lesson How Do Glaciers Change the Shape of the Land?

*Glaciers Are Solid Rivers. A glacier is a large accumulation of many years of snow, transformed into ice. This solid crystalline material deforms (changes) and moves. Glaciers, also known as "rivers of ice," actually flow. Gravity is the cause of glacier motion; the ice slowly flows and eforms (changes) in response to gravity.*

Glacier Explanation final copy paper Engage! Sharing their knowledge orally as a whole class helps them remember what we have done and gets them interested in what we are about to do. We have learned that scientists share their ideas. We call this communicating ideas. Yesterday we learned how glaciers can help shape the land. How does this happen? Next I have my students pull out their notes from yesterday see student sample from the previous lesson. They will use these notes and the diagram to both help jog their memory of the task and also to use some of the language that they have written down. So they should have the two papers in front of them. I want them to be able to pull the ideas from their own notes to help them fill out the explanation organizer. Using this explanation organizer helps the children get their ideas in sequential order since it has time-order words to help them. It also helps keep their ideas on track to write a procedural text on how glaciers shape the land. I continue with my directions. I would like you to write an explanatory paragraph that tells how a glacier shapes the land. To help you do this you need to use your notes from yesterday. Take a look at your notes and reread what you have written. Look at your diagram to help you. As part of the Common Core, the children are expected to write an explanatory text which has an introduction, uses facts and definition to make a point and then have a conclusive sentence. Writing an explanation of how glaciers help change the land will be practice of that goal. On the organizer, you will see the words first, next and finally. These are time-order words that help someone who is reading your work to understand the sequence in which things happened. It helps make things clearer for the reader and it also will help you to keep things in order when you are writing. Having the children vocalize what they are going to write before they write helps them to formulate their ideas so they can write them down with ease. It helps the reluctant writer to be able to focus their ideas and get them started in the right direction. After the children have practiced using the words first, next and finally with their partner, they go on ahead and write their ideas on the organizer. I ask my children how this organizer helps them. They all feel like using it is really beneficial. Click to see student student sample A and student sample B. Now I would like you to use your ideas you have written down to write your final paragraph from. You should use the time-order words as part of your paragraph, such as first, next and last. This will help the reader understand what you have written. When you write a paragraph, you need to remember some things. What do good writers do to write paragraphs correctly? Here is a list that we come up with: The kids are involved in the learning and are very connected to this writing project. It motivates them to write more clearly since this is what they have been learning about. It also builds a common connection between the two disciplines. Glacier Explanation final copy paper final copy student sample A final copy student sample B-- 3 pages Sharing and Communicating Ideas 15 minutes Since my writers have many diverse entry points, it takes some much longer than others. So when children have finished their writing, they can begin on drawing and coloring their pictures. Some children need some extra time to finish up on their work, and do so at another time. When all have finished, we take turns sharing their work. The children take turns up at my special stool with our lab coat on. The lab coat we use is an old adult lab coat that has been cut down to child size.

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## 4: Melting Glaciers Are Wreaking Havoc on Earth's Crust | Science | Smithsonian

*Over hundreds of thousands of years, glaciers make many changes to the landscape. These slow-moving rivers of ice begin high on mountains. As they slide downhill, they carve deep, U-shaped valleys, sharp peaks, and steep ridges.*

Glacial landforms and features Photo by: At present, glaciers cover roughly 10 percent of the land area. A vast majority of that glacial ice overlies much of the continent of Antarctica. Most of the rest covers a great portion of Greenland; a small percentage is found in places such as Alaska, the Canadian Arctic, Patagonia, New Zealand, the Himalayan Mountains, and the Alps. Glaciers are not landforms. The action of glaciers, however, creates landforms. It is a process known as glaciation. Glacial ice is an active agent of erosion, which is the gradual wearing away of Earth surfaces through the action of wind and water. Glaciers move, and as they do, they scour the landscape, "carving" out landforms. They also deposit rocky material they have picked up, creating even more features. The work of present-day glaciers, however, is slow and confined to certain areas of the planet. Less obvious but far more reaching has been the work of Ice Age glaciers. The shape of the land A glacier is a large body of ice that formed on land from the compaction and recrystallization of snow, survives year to year, and shows some sign of movement downhill due to gravity. Two types of glaciers exist: Two continental glaciers are found on Earth: Glacial landforms and features: Words to Know Ablation zone: The area of a glacier where mass is lost through melting or evaporation at a greater rate than snow and ice accumulate. The area of a glacier where mass is increased through snowfall at a greater rate than snow and ice is lost through ablation. A relatively small glacier that forms in high elevations near the tops of mountains. A sharp-edged ridge of rock formed between adjacent cirque glaciers. The sliding of a glacier over the ground on a layer of water. A bowl-shaped depression carved out of a mountain by an alpine glacier. A glacier that forms over large areas of continents close to the poles. A deep, nearly vertical crack that develops in the upper portion of glacier ice. The gradual wearing away of Earth surfaces through the action of wind and water. A large boulder that a glacier deposits on a surface made of different rock. A long, snakelike ridge of sediment deposited by a stream that ran under or within a glacier. A deep glacial trough submerged with seawater. A general term for all material transported and deposited directly by or from glacial ice. The smooth and shiny surfaces that are produced on rocks underneath a glacier by material carried in the base of that glacier. The rapid forward movement of a glacier. A U-shaped valley carved out of a V-shaped stream valley by the movement of a valley glacier. The transformation of the landscape through the action of glaciers. A large body of ice that formed on land by the compaction and recrystallization of snow, survives year to year, and shows some sign of movement downhill due to gravity. A continuous layer of till deposited beneath a steadily retreating glacier. A shallow glacial trough that leads into the side of a larger, main glacial trough. A high mountain peak that forms when the walls of three or more glacial cirques intersect. The movement of ice inside a glacier through the deformation and realignment of ice crystals; also known as creep. A steep-sided, conical mound or hill formed of glacial drift that is created when sediment is washed into a depression on the top surface of a glacier and then deposited on the ground below when the glacier melts away. A shallow, bowl-shaped depression formed when a large block of glacial ice breaks away from the main glacier and is buried beneath glacial till, then melts. If the depression fills with water, it is known as a kettle lake. A moraine deposited along the side of a valley glacier. A moraine formed when two adjacent glaciers flow into each other and their lateral moraines are caught in the middle of the joined glacier. The water from melted snow or ice. A general term for a ridge or mound of till deposited by a glacier. A valley glacier that flows out of a mountainous area onto a gentle slope or plain and spreads out over the surrounding terrain. Fine-grained rock material produced when a glacier abrades or scrapes rock beneath it. The elevation above which snow can form and remain all year. The long, parallel scratches and grooves produced in rocks underneath a glacier as it moves over them. A small lake that fills the central depression in a cirque. A moraine found near the terminus of a glacier; also known as an end moraine. The leading edge of a glacier; also known as the glacier snout. A random mixture of finely crushed rock, sand, pebbles, and boulders deposited by a glacier. An alpine glacier flowing downward through a preexisting stream valley. Both types of glaciers create landforms through erosion. These erosional features may be as large as the Great Lakes of North America or as small as scratches left in pebbles. As a glacier moves, it scours away material underneath it, plucking up rocks, some of which may be house-sized boulders. This material then becomes embedded in the ice at the base of a glacier. As the glacier continues to move, the embedded material abrades or scrapes the rock underneath. The slow scraping and grinding produces a fine-grained material known as rock flour. It also produces long parallel scratches and grooves known as striations in the underlying rocks. Because they are aligned parallel to the direction of ice flow, glacial striations help geologists determine the flow path of former glaciers. Another small-scale erosional feature is glacial polish. This is a smooth and shiny surface produced on rocks underneath a glacier when material encased in the ice abrades the rocks like fine sandpaper. Moving ice sculpts a variety of landforms out of the landscape. Larger-scale erosional features include bowl-shaped, steep-walled depressions carved out of the side of mountains. These depressions are called cirques pronounced SIRKS , and the relatively small alpine glaciers that fill them are called cirque glaciers. If the glacier melts and a small lake fills the central depression in a cirque, that lake is known as a tarn. When the walls of three or more glacial cirques meet, they may form a high mountain peak known as a horn. When a cirque glacier expands outward and flows downward through a stream valley that already exists, it becomes a valley glacier. Through erosion, valley glaciers turn V-shaped stream valleys into U-shaped glacial troughs. Smaller valley glaciers, known as tributary glaciers, may form alongside a main valley glacier and eventually flow into it. The shallower glacial troughs created by these glaciers are known as hanging valleys. A valley glacier that flows out of a mountainous area onto a gentle slope or plain and spreads out over the surrounding terrain is a piedmont glacier. A valley glacier may flow all the way to a coastline, carving out a narrow glacial trough. If the glacier melts and the valley fills with seawater, it is known as a fjord pronounced fee-ORD. Glaciers leave their mark on the landscape not only through erosion, but also through deposition. Deposition involves carrying loose materials from one area and leaving, or depositing, these materials in another area. Depositional features are created by the release of rocky material from a glacier. They vary widely in scale and form. All sediment rock debris ranging from clay to boulders deposited as a result of glacial erosion is called glacial drift. Like a stream, a glacier picks up and carries sediment particles of various sizes. Unlike a stream, a glacier can carry part of that sediment load on its bottom, its sides, or its top sediment on top has fallen onto the glacier from the valley walls. Another difference between the two is that when a stream deposits its load of sediment, it does so in order of size and weight: When a glacier deposits sediment, there is no such order. The particles are unsorted, with large and small particles mixed together. This random mixture of finely crushed rock, sand, pebbles, and boulders deposited by a glacier is referred to as till. Since a glacier can carry rocks for great distances before depositing them, those rocks generally differ from the surrounding native rocks in that area. In fact, because they are derived from a very large area eroded by a glacier, glacial deposits contain the widest variety of rock types. A glacially deposited large boulder that differs in composition from the rocks around it is called an erratic. A deposit of till that forms a ridge or mound is called a moraine meh-RAIN. Moraines deposited along the sides of alpine glaciers are called lateral moraines. When two valley glaciers converge to create a single larger glacier, their opposing lateral moraines merge to form a ridge that Major features of glaciation, or the action of glaciers on a landscape. This is a medial moraine. A moraine deposited at the leading edge of a glacier, marking its farthest advance, is a terminal or end moraine. Finally, a continuous layer of till deposited beneath a steadily retreating glacier is a ground moraine. Another common glacial landform is the drumlin. This tear-drop-shaped hill forms underneath a glacier.

## 5: Glacier - Wikipedia

*Additionally, when glaciers ice melts, the water it generates can move and rework sediment. This is called glacial outwash. To learn more about glaciers, glacier features, and glacial landforms, see the Glaciers & Glacial Landforms Page.*

Glaciers and Ice Sheets Glaciers and Ice Sheets Glaciers and ice sheets are perennial accumulations of ice and snow that flow downslope, slowly, due to their own weight. These terrestrial land-based ice masses often are classified by size as either glaciers, ice caps, or ice sheets. Glaciers, the smallest of the terrestrial ice masses, originate in high mountain basins, called cirques, or may be fed by ice caps or ice sheets. Glaciers flow within mountain valleys. Although glaciers are generally thought of as polar entities, they also are found in mountainous areas throughout the world, on all continents except Australia, and even at or near the Equator on high mountains in Africa and South America. Ice caps are small, high-altitude ice masses that form when glaciers completely fill their subglacial valleys and coalesce join together. Ice sheets also blanket the land surface but are much larger than ice caps. The Antarctic ice sheet covers millions of square kilometers and in places can reach more than 4 kilometers 2. Parts of the Greenland and Antarctic ice sheets rest on bedrock that is near or below sea level; other parts are pushed out to sea where they calve break off , forming icebergs. Ice sheets form only at high latitudes, whereas glaciers are found from the poles to the tropics. A glacier moving down a valley changes the shape of the valley sides and floor. When a glacier reaches the ocean or a large lake, large pieces can break off, or "calve," to form icebergs. Smaller pieces of ice are known as bergy bits and growlers. The temperature of ice within a glacier changes with depth. Snow falling on the surface of a glacier is the same temperature as the air at the surface. As more snow falls, the older snow is pushed down into the glacier, taking that surface temperature with it. In polar regions, where air temperatures are very cold, ice near the surface of a glacier is also very cold. But with depth, ice temperature increases because the ice is being warmed from below by geothermal energy from Earth. Many alpine glaciers are isothermal of a nearly uniform temperature , and are very near the melt temperature throughout. Glaciers are big conveyors, moving ice and rock from a high-elevation accumulation zone to a lower-elevation ablation zone. In the ablation zone, summertime melting removes the winter snow and perhaps some of the underlying glacier ice as well. The boundary between the areas of net accumulation and net ablation at the end of the summer season is called the equilibrium line. The downstream terminus end point of a glacier is found where the rate of ice flow is equal to the rate of ablation. Where the glacier ends in the ocean or a lake, mass also is lost to iceberg calving. Ice flows like a very thick fluid. While very near the surface, a glacier is brittle and it cracks; but deeper within the glacier, the weight of the overlying ice causes the ice crystals to creep past one another, to "deform. Pushing down slowly on the deck at a small angle causes the higher cards to slide past the lower cards. The same pattern emerges in most glacier ice: The rate at which a glacier deforms depends on its thickness i. The warmer the ice becomes, the faster it deforms. In locations where the basal ice warms to the melting point, the resulting liquid helps the glacier to slide over its bed. Glaciers transport large volumes of sediment and rock over time. The rock material may be carried at the surface, in the interior, or at the base of the ice. All sizes of rocks are carried together. Eventually, the ice-transported sediments are deposited at the downstream edge, along the sides, or at the base of the ice due to melting. These deposited sediments are called glacial till. Unlike water-deposited materials which are well-sorted, glacial deposits are unsorted, which means that the sediments are deposited just as they were carried, as a mixture of sizes. Glacial deposits form till sheets and different types of moraines. Many moraines are ridge-like piles that form as rock and sediment arrive at the outer edge of the glacier as a result of the sediment being transported through the flowing ice. When a glacier maintains the same size for a long time, large moraines are formed. These ridges often are easy to find in glacial valleys, and can be used to track changes in a glacier over time. Ground As glaciers move over bedrock, they sculpt the surface by grinding and polishing rock surfaces and by plucking blocks of bedrock from the overridden outcrops. This photograph shows the contact between one small area of the Mendenhall Glacier and the rocky ground of southeast Alaska. On a larger scale, till sheets form where sediments carried near the bottom of an ice sheet melt out, to be left behind on the subglacial bedrock. Till sheets cover much of the upper midwestern United States, leaving a record of the past glacial ages. Evidence of Ice Flow As they move, glaciers shape the land surface. Rock fragments pulled along at the base of the ice scour the bedrock, smoothing it but also leaving deep scratches called striations. Where large rock pieces push and bump along the bedrock surface, they chip out pieces of the bedrock, leaving chatter-marks and gouges behind. When an ice sheet or glacier is gone, glacial geologists can use the geometry of striations, chattermarks, and other similar features to infer in what direction the ice flowed. Glaciers remove those piles and wear down the bed beneath, changing the "V" shape into a "U. The downstream steepening is due to a process called plucking. In that process, meltwater formed on the upstream side of the bump flows around to the downstream side, where it may refreeze, helping to wedge loose rocks from the hill. The bottom of the ice sheet then freezes to the loose rocks and carries them away, steepening the downstream end of the bump.

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## 6: Why do they move? | National Snow and Ice Data Center

*Over time, an alpine glacier can change a V-shaped mountain valley into a U-shaped valley with a wider, flatter bottom. Some glaciers extend all the way down into the lower land at the.*

Some things stay the same while other things change. Then they will model the movement of glaciers by using clay and a "glacial" ice cube filled with sand and pebbles. They will observe, diagram and then write notes about what they have observed during this modeling. In order to do this, they need to have a basic knowledge of how events shape the land. In this lesson, they will be learning specifically about the movement of glaciers and how they shape the land. Also as a science practice and part of the NGSS, the children are expected to understand and develop models. In this lesson the children will be using a hands-on process to model how glaciers play a role in shaping the land. As part of the science practices, they will be obtaining and evaluating information. As part of a cross-cutting concept, this lesson helps the children to understand that some things stay the same and others change. I figured my family would not appreciate sand in their ice cream. Here is an informational website that will help give you valid insight of how glaciers have shaped the landscape. How many of you have ever watched the movie Ice Age? Ice Age was a movie that takes place during ice age times. Do you think the movie was fictional or informational? The Ice Age really happened, but the movie is, of course, fictional. I thought it would be fun to take a look at how the movie shows glaciers moving and compare it to how glaciers really move. I show the children a clip from the movie Ice Age. It shows a character named Scrat who accidentally starts the Ice Age and puts glacier ice in motion. I divide the children into groups of three. Since I wanted the children to work at their own tables, I simply divide them by table groups. One person from each of the groups comes to the front table to get one stick of clay and a paper towel. First I show them how to make a model of the land. Take the clay and roll it into a ball. Roll it back and forth to create a thick hot dog shape. Take the rolling pin and roll over the hot dog lengthwise so it has a long rectangular shape. This will be a model of the land. Place the land on the paper towel. This will absorb any of the melting glacier that overflows on the side. Next you need to read the directions at the top of the page that I just gave you. Then go ahead and follow those directions. Look closely at what is happening and draw a diagram that shows what you notice. Then write down your observations. We will be doing a writing activity using this information, so the more detailed notes that you take will help you write this information. By filling out this sheet, the children will be using one of the science practices, obtaining information. They are also using models to help them understand a concept that is abstract for them. The children are amazed and enlightened about what they are observing see photo 1 and photo 2. They can actually see why this process has happened. What do you notice happening? Can you see anything being left behind? Why do you think that is happening? What happens to the surface of the land? How can you tell? What would eventually happen to the rocks at the bottom of the glacier if you repeated this experiment for a long time? How do you think this model helps you to understand what you are learning? Asking these questions helps them understand modeling and help them connect that learning to the actual process. It also helps them start to evaluate their observations and put them into a useable context.

# HOW A MOVING GLACIER CHANGES THE LAND pdf

## 7: How Glaciers Work | HowStuffWorks

*As glaciers slowly moved down mountains and hills, their immense weight "scraped" the landscape over time, and created valleys and deposits of minerals.*

Erosional landforms[ edit ] Erosional landforms As the glaciers expanded, due to their accumulating weight of snow and ice , they crush and abrade scoured surface rocks and bedrock. Starting location for mountain glaciers Cirque stairway: U-shaped valleys are created by mountain glaciers. When filled with ocean water so as to create an inlet , these valleys are called fjords. Examples include glacial moraines , eskers , and kames. Drumlins and ribbed moraines are also landforms left behind by retreating glaciers. The stone walls of New England contain many glacial erratics , rocks that were dragged by a glacier many miles from their bedrock origin. Built up bed of a subglacial stream. Feature can be terminal at the end of a glacier , lateral along the sides of a glacier , or medial formed by the emerger of lateral moraines from contributary glaciers. Braided stream flowing from the front end of a glacier. Ice Age Trail and Giant current ripples Glacial lakes and ponds[ edit ] Lakes and ponds may also be caused by glacial movement. Kettle lakes form when a retreating glacier leaves behind an underground or surface chunk of ice that later melts to form a depression containing water. Moraine-dammed lakes occur when glacial debris dam a stream or snow runoff. Depression, formed by a block of ice separated from the main glacier, in which the lake forms. A lake formed in a cirque by overdeepening. A series of lakes in a glacial valley, formed when a stream is dammed by successive recessional moraines left by an advancing or retreating glacier. A lake that formed between the front of a glacier and the last recessional moraine. Ice features[ edit ] Apart from the landforms left behind by glaciers, glaciers themselves may be striking features of the terrain, particularly in the polar regions of the earth. Notable examples include valley glaciers where glacial flow is restricted by the valley walls, crevasses in the upper section of glacial ice, and icefalls â€”the ice equivalent of waterfalls. Disputed origin[ edit ] The glacial origin of some landforms has been questioned. In the case of Norway the elevated paleic surface has been proposed to have been shaped by the glacial buzzsaw effect. However this proposal is difficult to reconcile with the fact that the paleic surface consist of a series of steps at different levels.

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## 8: How Glaciers Change the Landscape (U.S. National Park Service)

*Most glaciers move just millimeters each year. The world's fastest glacier isn't timed with a stopwatch. You need a calendar. The Jakobshavn Glacier in Greenland spent many years moving between 5, and 6, meters per year.*

Cirque glaciers form on the crests and slopes of mountains. A glacier that fills a valley is called a valley glacier, or alternatively an alpine glacier or mountain glacier. Only nunataks protrude from their surfaces. The only extant ice sheets are the two that cover most of Antarctica and Greenland. Some drain directly into the sea, often with an ice tongue , like Mertz Glacier. As the ice reaches the sea, pieces break off, or calve, forming icebergs. Most tidewater glaciers calve above sea level, which often results in a tremendous impact as the iceberg strikes the water. Tidewater glaciers undergo centuries-long cycles of advance and retreat that are much less affected by the climate change than those of other glaciers. The ice of a polar glacier is always below the freezing point from the surface to its base, although the surface snowpack may experience seasonal melting. A sub-polar glacier includes both temperate and polar ice, depending on depth beneath the surface and position along the length of the glacier. In a similar way, the thermal regime of a glacier is often described by its basal temperature. A cold-based glacier is below freezing at the ice-ground interface, and is thus frozen to the underlying substrate. A warm-based glacier is above or at freezing at the interface, and is able to slide at this contact. Further crushing of the individual snowflakes and squeezing the air from the snow turns it into "glacial ice". This glacial ice will fill the cirque until it "overflows" through a geological weakness or vacancy, such as the gap between two mountains. When the mass of snow and ice is sufficiently thick, it begins to move due to a combination of surface slope, gravity and pressure. A packrafter passes a wall of freshly exposed blue ice on Spencer Glacier, in Alaska. Glacial ice acts like a filter on light, and the more time light can spend traveling through ice, the bluer it becomes. In temperate glaciers, snow repeatedly freezes and thaws, changing into granular ice called firn. Under the pressure of the layers of ice and snow above it, this granular ice fuses into denser and denser firn. Over a period of years, layers of firn undergo further compaction and become glacial ice. Glacier ice is slightly less dense than ice formed from frozen water because it contains tiny trapped air bubbles. Glacial ice has a distinctive blue tint because it absorbs some red light due to an overtone of the infrared OH stretching mode of the water molecule. Liquid water is blue for the same reason. The blue of glacier ice is sometimes misattributed to Rayleigh scattering due to bubbles in the ice. Glaciers are broken into zones based on surface snowpack and melt conditions. The equilibrium line separates the ablation zone and the accumulation zone ; it is the altitude where the amount of new snow gained by accumulation is equal to the amount of ice lost through ablation. The upper part of a glacier, where accumulation exceeds ablation, is called the accumulation zone. Ice in the accumulation zone is deep enough to exert a downward force that erodes underlying rock. After a glacier melts, it often leaves behind a bowl- or amphitheater-shaped depression that ranges in size from large basins like the Great Lakes to smaller mountain depressions known as cirques. The accumulation zone can be subdivided based on its melt conditions. The dry snow zone is a region where no melt occurs, even in the summer, and the snowpack remains dry. The percolation zone is an area with some surface melt, causing meltwater to percolate into the snowpack. This zone is often marked by refrozen ice lenses , glands, and layers. The snowpack also never reaches melting point. Near the equilibrium line on some glaciers, a superimposed ice zone develops. This zone is where meltwater refreezes as a cold layer in the glacier, forming a continuous mass of ice. The health of a glacier is usually assessed by determining the glacier mass balance or observing terminus behavior. A slight cooling led to the advance of many alpine glaciers between and , but since glacier retreat and mass loss has become larger and increasingly ubiquitous. In this case, the impediment appears to be some distance from the near margin of the glacier. Ice-sheet dynamics Glaciers move, or flow, downhill due to gravity and the internal deformation of ice. At the molecular level, ice consists of stacked layers of molecules with relatively weak bonds between layers. When the stress on the layer above exceeds the inter-layer binding strength, it moves faster than the layer below. In this process, a glacier slides over the terrain on which it sits, lubricated by the presence of liquid water. The water is created from ice that melts under high pressure from frictional heating. Basal sliding is dominant in temperate, or warm-based glaciers. Although evidence in favour of glacial flow was known by the early 19th century, other theories of glacial motion were advanced, such as the idea that melt water, refreezing inside glaciers, caused the glacier to dilate and extend its length. As it became clear that glaciers behaved to some degree as if the ice were a viscous fluid, it was argued that "regelation", or the melting and refreezing of ice at a temperature lowered by the pressure on the ice inside the glacier, was what allowed the ice to deform and flow. James Forbes came up with the essentially correct explanation in the s, although it was several decades before it was fully accepted. This upper section is known as the fracture zone and moves mostly as a single unit over the plastically flowing lower section. When a glacier moves through irregular terrain, cracks called crevasses develop in the fracture zone. Crevasses form due to differences in glacier velocity. If two rigid sections of a glacier move at different speeds and directions, shear forces cause them to break apart, opening a crevasse. Beneath this point, the plasticity of the ice is too great for cracks to form. Intersecting crevasses can create isolated peaks in the ice, called seracs. Crevasses can form in several different ways. Transverse crevasses are transverse to flow and form where steeper slopes cause a glacier to accelerate. Longitudinal crevasses form semi-parallel to flow where a glacier expands laterally. Marginal crevasses form from the edge of the glacier, due to the reduction in speed caused by friction of the valley walls. Marginal crevasses are usually largely transverse to flow. Moving glacier ice can sometimes separate from stagnant ice above, forming a bergschrund. Crevasses make travel over glaciers hazardous, especially when they are hidden by fragile snow bridges. Crossing a crevasse on the Easton Glacier , Mount Baker , in the North Cascades , United States Below the equilibrium line, glacial meltwater is concentrated in stream channels. Meltwater can pool in proglacial lakes on top of a glacier or descend into the depths of a glacier via moulins. Streams within or beneath a glacier flow in englacial or sub-glacial tunnels. Friction makes the ice at the bottom of the glacier move more slowly than ice at the top. Velocity increases with increasing slope, increasing thickness, increasing snowfall, increasing longitudinal confinement, increasing basal temperature, increasing meltwater production and reduced bed hardness. A few glaciers have periods of very rapid advancement called surges. These glaciers exhibit normal movement until suddenly they accelerate, then return to their previous state. During these surges, the glacier may reach velocities far greater than normal speed. In glaciated areas where the glacier moves faster than one km per year, glacial earthquakes occur. These are large scale earthquakes that have seismic magnitudes as high as 6. In a study using data from January through October , more events were detected every year since , and twice as many events were recorded in as there were in any other year. They are linked to seasonal motion of glaciers; the width of one dark and one light band generally equals the annual movement of the glacier. Ogives are formed when ice from an icefall is severely broken up, increasing ablation surface area during summer. This creates a swale and space for snow accumulation in the winter, which in turn creates a ridge. List of glaciers and Retreat of glaciers since Black ice glacier near Aconcagua , Argentina Glaciers are present on every continent and approximately fifty countries, excluding those Australia, South Africa that have glaciers only on distant subantarctic island territories. Mountain glaciers are widespread, especially in the Andes , the Himalayas , the Rocky Mountains , the Caucasus , Scandinavian mountains and the Alps. Mainland Australia currently contains no glaciers, although a small glacier on Mount Kosciuszko was present in the last glacial period. During glacial periods of the Quaternary, Taiwan , Hawaii on Mauna Kea [36] and Tenerife also had large alpine glaciers, while the Faroe and Crozet Islands [37] were completely glaciated. The permanent snow cover necessary for glacier formation is affected by factors such as the degree of slope on the land, amount of snowfall and the winds. Even at high latitudes, glacier formation is not inevitable. Areas of the Arctic , such as Banks Island , and the McMurdo Dry Valleys in Antarctica are considered polar deserts where glaciers cannot form because they receive little snowfall despite the bitter cold. Cold air, unlike warm air, is unable to transport much water vapor. Even during glacial periods of the Quaternary , Manchuria , lowland Siberia , [38] and central and northern Alaska , [39] though extraordinarily cold, had such light snowfall that glaciers could not form. This is because these peaks are located near or in the hyperarid Atacama Desert. As glaciers flow over bedrock, they soften and lift blocks of rock into the ice. This process, called plucking, is caused by subglacial water that penetrates fractures in the bedrock and subsequently freezes and expands. This expansion causes the ice to act as a lever that loosens the rock by lifting it. If a retreating glacier gains enough debris, it may become a rock glacier , like the Timpanogos Glacier in Utah. Abrasion occurs when the ice and its load of rock fragments slide over bedrock and function as sandpaper, smoothing and polishing the bedrock below. The pulverized rock this process produces is called rock flour and is made up of rock grains between 0. Abrasion leads to steeper valley walls and mountain slopes in alpine settings, which can cause avalanches and rock slides, which add even more material to the glacier. Glacial abrasion is commonly characterized by glacial striations. Glaciers produce these when they contain large boulders that carve long scratches in the bedrock. Similar to striations are chatter marks , lines of crescent-shape depressions in the rock underlying a glacier. They are formed by abrasion when boulders in the glacier are repeatedly caught and released as they are dragged along the bedrock. The rate of glacier erosion varies. Six factors control erosion rate:

## 9: Glacial landform - Wikipedia

*For instance, massive glacier retreat has been recorded in Glacier Bay, Alaska. Glaciers that once terminated in the ocean have now receded onto land, retreating far up valleys. Over the past several decades, scientists and researchers have begun to capture data and photographic evidence of this recession over time.*

Glaciers range in size from football fields to over a hundred kilometers long, occur on every continent and in 47 countries, and are harbingers of our changing climate. Simply stated, a glacier is a large, slow-moving mass of ice. While there are many types of glaciers, they can be divided into two categories: Alpine glaciers are found in a mountainous region and flow down valleys. The Greenland and Antarctic ice sheets are examples of continental glaciers. Smaller masses of ice, called ice caps, are also considered continental glaciers. Alpine glaciers are further classified by their shape as well as the surface they flow onto. A few types of alpine glaciers include: Piedmont glaciersoccur when a glacier extends down a steep valley onto a relatively flat plain. The defining characteristic of a piedmont glacier is the bulblike lobe that forms at the terminus end of the glacier. The Malaspina Glacier, located in Alaska, is a classic piedmont glacier. Tidewater glaciers occur when a glacier flows down a valley and reaches out into the sea. Tidewater glaciers calve numerous icebergs. Courtesy of beadwomen via Flickr. Hanging glaciersare also known as ice aprons. They cling to steep mountainsides and are wider than they are long. This type of glacier is common in the Alps. Courtesy of Alaskan Dude via Flickr. Glaciers form in areas where cold temperatures allow snow to build up over many years such as the polar and high-altitude alpine regions. The snow is compressed and compacted, becomes granular, and eventually becomes denser snow called firn. Over time, the weight and pressure of the accumulating snow causes the firn to become a thickened mass of ice. Glacial ice forms from compacted snow. Image courtesy of Luis Maria Benitez Wikimedia. Dense glacial ice looks somewhat blue because the air spaces in the layers have been compressed. Less compressed and less dense ice appears white. Alpine glaciers flow down valleys, and continental glaciers flow outward in all directions from a central point. Glaciers move by two mechanisms: Internal deformation occurs when the enormous mass of a glacier causes it to spread out due to gravity. Sliding occurs when the glacier slides on a thin layer of water at the base also known as subglacial water. This water comes from melting due to the intense pressure at the base of the glacier, or from water that has seeped through cracks in the glacier. Glaciers typically move slowly, with changes only noticeable over months or years. However, glaciers may surge â€” move forward several meters per day â€” for weeks or months. In , the Hubbard Glacier in Alaska surged at the rate of 10 meters per day for several months! Friction at the base of a glacier causes the underside to move more slowly than the top. Crevasses may be small or quite large, and they pose a real hazard to anyone moving about on a glacier. Measuring snow thickness in a crevasse on Easton Glacier, North Cascades. Photo courtesy of Wikimedia Glacial erosion Glaciers primarily erode through plucking and abrasion. Plucking occurs as a glacier flows over bedrock, softening and lifting blocks of rock that are brought into the ice. The intense pressure at the base of the glacier causes some of the ice to melt, forming a thin layer of subglacial water. This water flows into cracks in the bedrock. As the water refreezes, the ice acts as a lever loosening the rock by lifting it. Glacial plucking and abrasion. Meltwater streams of many glaciers are grayish in color due to high amounts of rock flour. Above-freezing temperatures created a meltwater stream on the Scott Glacier, Antarctica. Glacial erosion is evident through U-shaped valleys with flat bottoms. Mountain valleys typically have a sharp V-shape, and the glaciers deepen, widen, and smooth them. Fjords are also formed in this manner.

# HOW A MOVING GLACIER CHANGES THE LAND pdf

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