

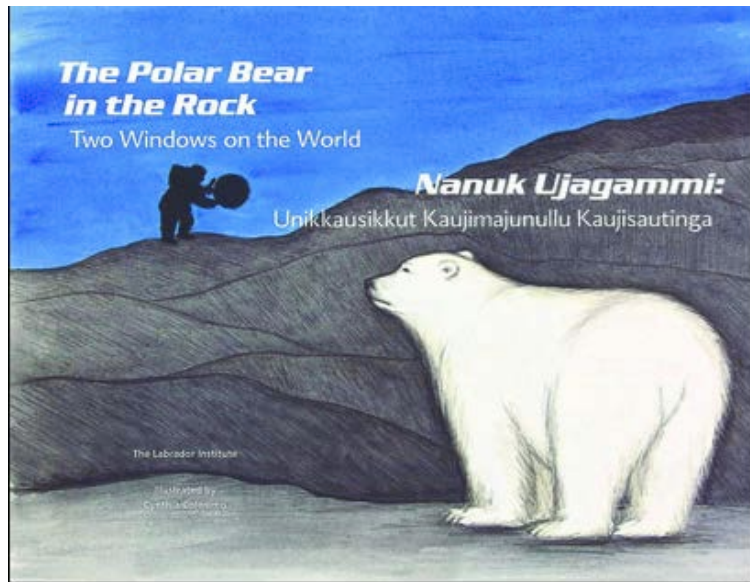
## Unit 2 Gradational Forces



# What you should know

1. In your own words explain “Gradational Forces”
2. Find a picture of rocks and landforms online and explain to your partner how you think they may have formed

# Rocks Landforms and... culture?



Beneath Mount Sophie, across the bay from Nain, sits a single white boulder that looks like a polar bear. How did it get there?

Geologists call the rock that makes the ridge (and bear boulder) anorthosite, a group of hard rocks mostly made of the mineral anorthite. Anorthite is a plagioclase feldspar. It forms when a hot liquid rock, or magma, begins to cool. At a certain temperature, anorthite begins to form crystals in the magma. If the magma stays around that temperature for a long time, large amounts of anorthite collect to form anorthosite rock like that of the bear boulder.

But there is another story. A second 'window' on the world. It is the legend of a brave Inuit hunter – too old to join a hunting party – who protected the women and children of the camp from Nanuk, the polar bear. He used the only weapon he had: his drum, or Kilautik. Beating the drum, he calmed the crying children and howling dogs and stopped the polar bear dead in its tracks.

The power and beauty of gradational  
forces

















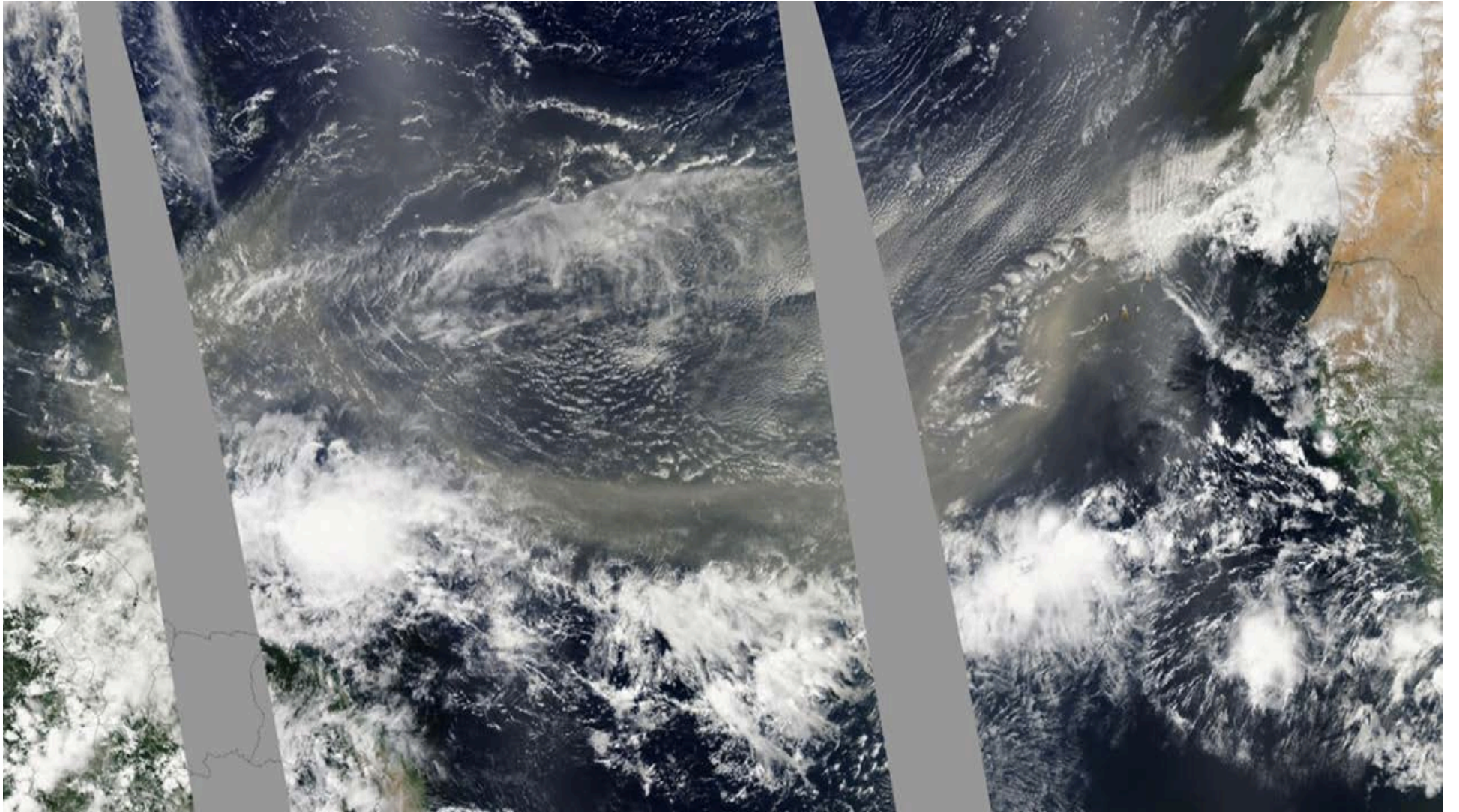














What are gradational forces?

What is being “graded” or eroded?  
Rocks mainly



- How are rocks formed?
- What are the three types of rock?
- Can these rocks change into the other types?  
Yes!

# Rocks

Igneous - [CLICK HERE](#)

Read and explain to partner in own words

Metamorphic - [CLICK HERE](#)

Read and explain to partner in own words

Sedimentary - [CLICK HERE](#)

Read and explain to partner



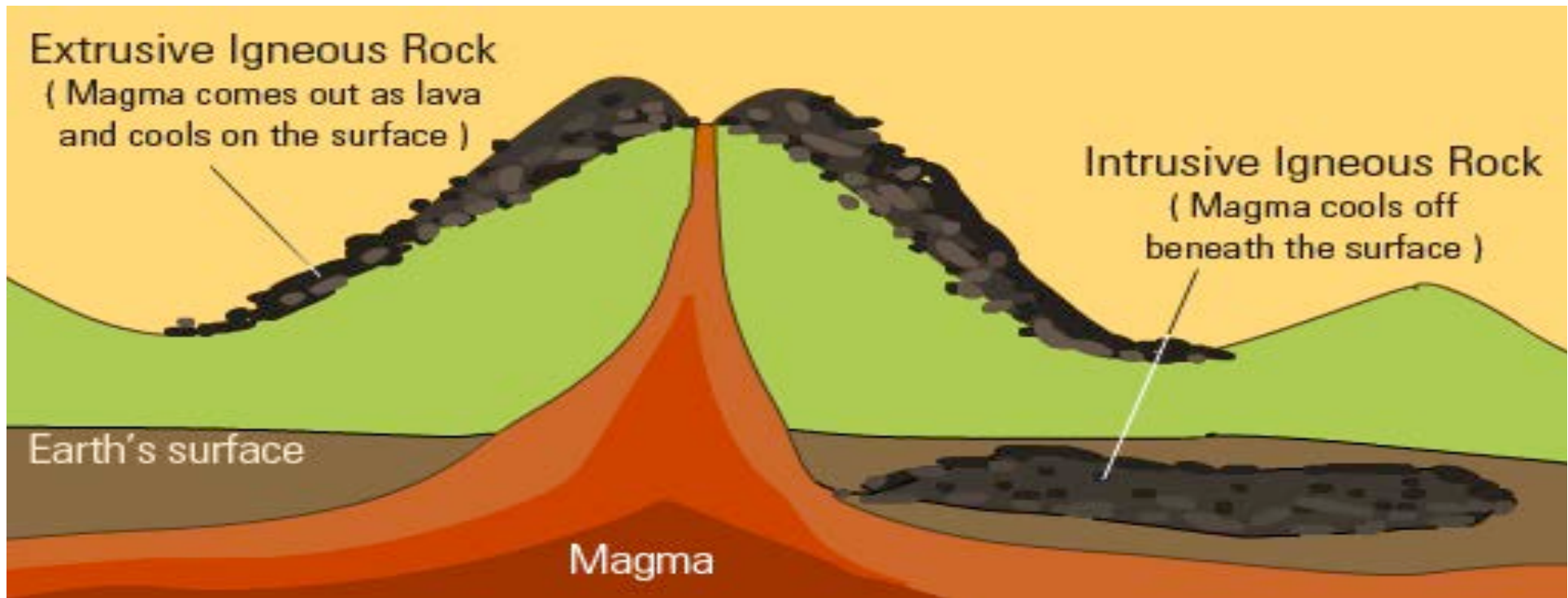


## Igneous Rocks

- Formed from the cooling of magma
  
- All rocks begin as Igneous rocks

Igneous Rock: Intrusive vs. Extrusive







Sedimentary Rocks



## Sedimentary Rocks

- Rock that has formed through the deposition and solidification of sediment
- Sediment is predominantly transported by water (rivers, lakes, and oceans), ice (glaciers), and wind.
- Sedimentary rocks are often deposited in layers—and often contain fossils (information about the past)

Two classifications of sedimentary rocks:

**a. Clastic:** formed from mechanical weathering debris  
(conglomerate, sandstone)

**b. Chemical:** water evaporates and leaves behind  
minerals that harden into rock.



Sedimentary rocks:

Clastic

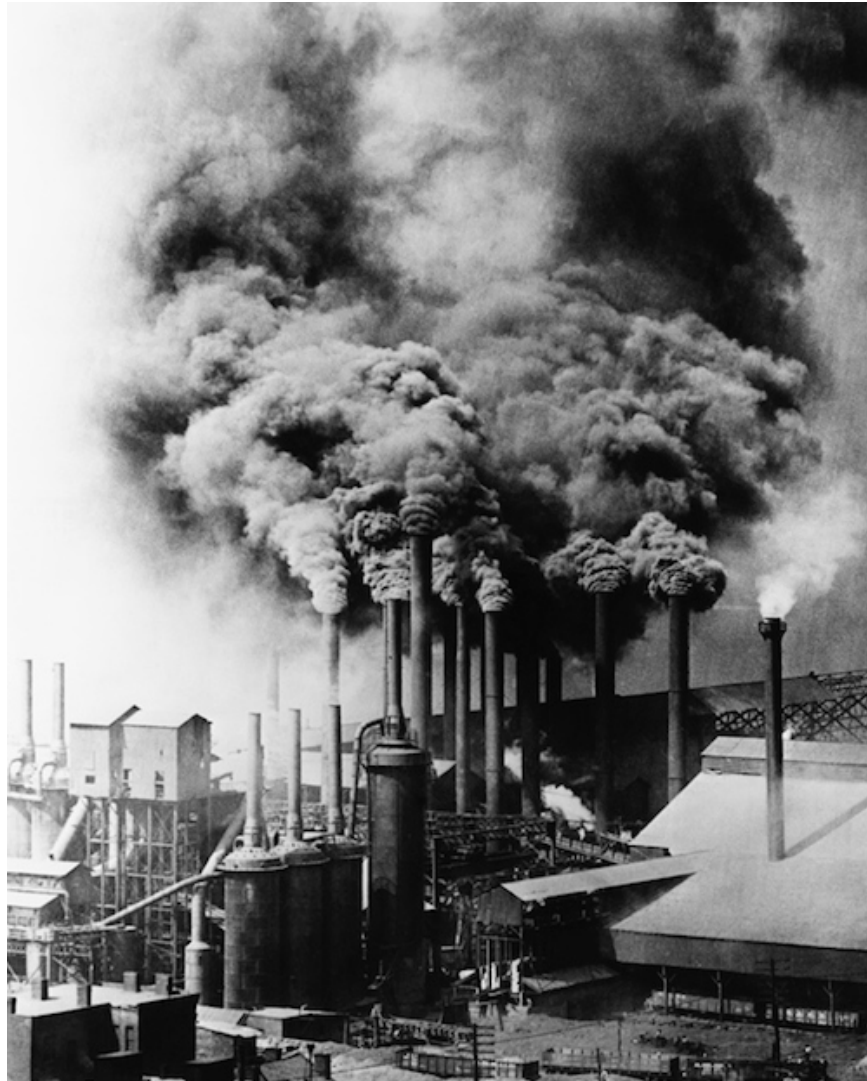


Chemical



Why are some sedimentary rocks really important in world history?

# Fossil Fueling the Industrial Revolution



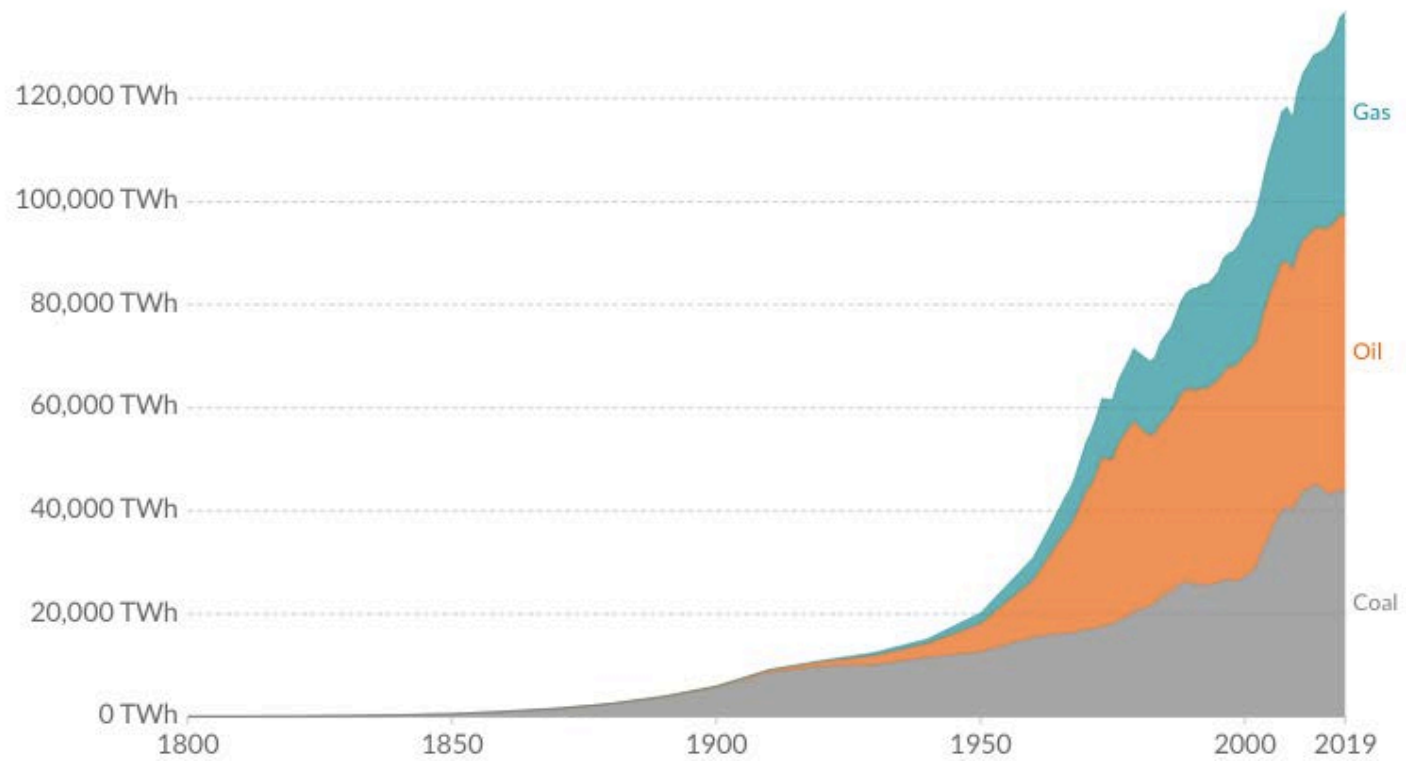


# Global fossil fuel consumption

Global primary energy consumption by fossil fuel source, measured in terawatt-hours (TWh).



Relative



Source: Vaclav Smil (2017). Energy Transitions: Global and National Perspective & BP Statistical Review of World Energy

CC BY

CHART

TABLE

SOURCES

DOWNLOAD





Focus questions:

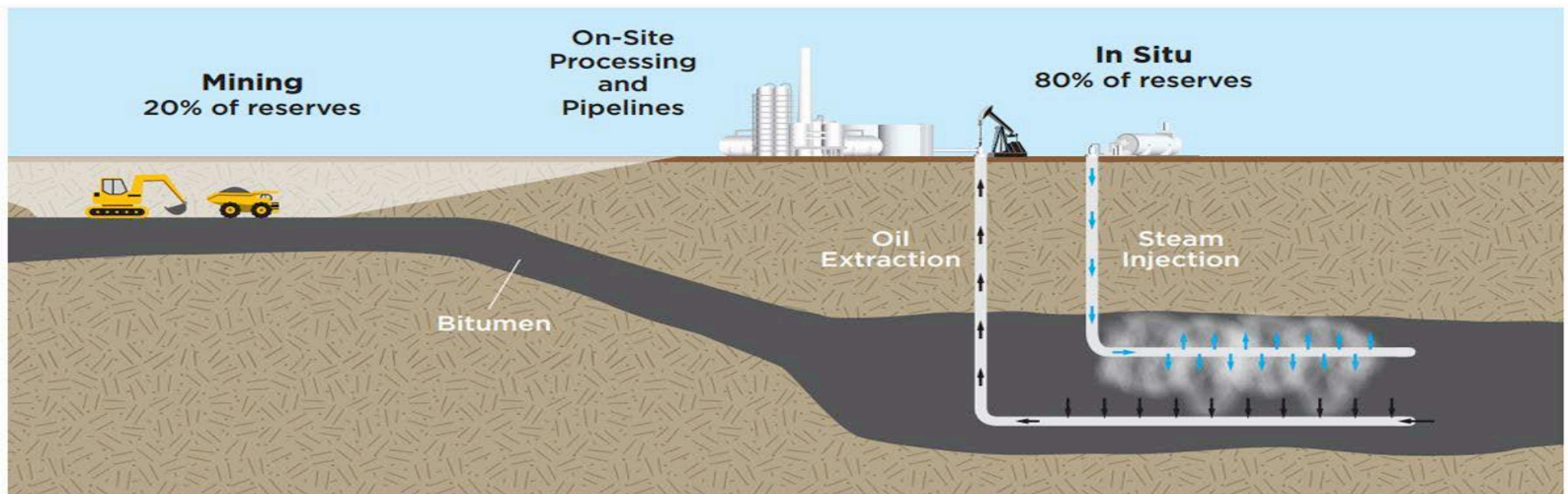
- 1) What are fossil fuels?
- 2) Why do we call them **fossil** fuels?
- 3) What is the relationship between **sedimentary rocks** and **fossil fuels**?
- 4) Why do we call fossil fuels, '***non-renewable***' resources?





Rocks and values continued....

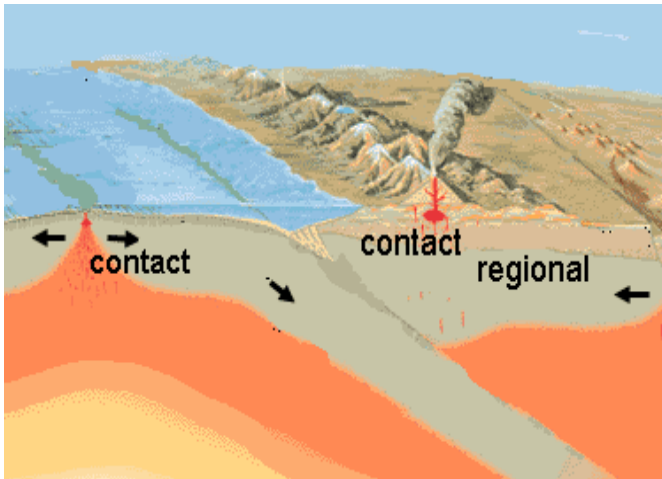
## Extracting Oil from Tar Sands



## Metamorphic Rocks

- A **metamorphic rock** is a result of a transformation of a pre-existing **rock**.
- The original **rock** is subjected to very high heat and pressure, which cause obvious physical and/or chemical changes





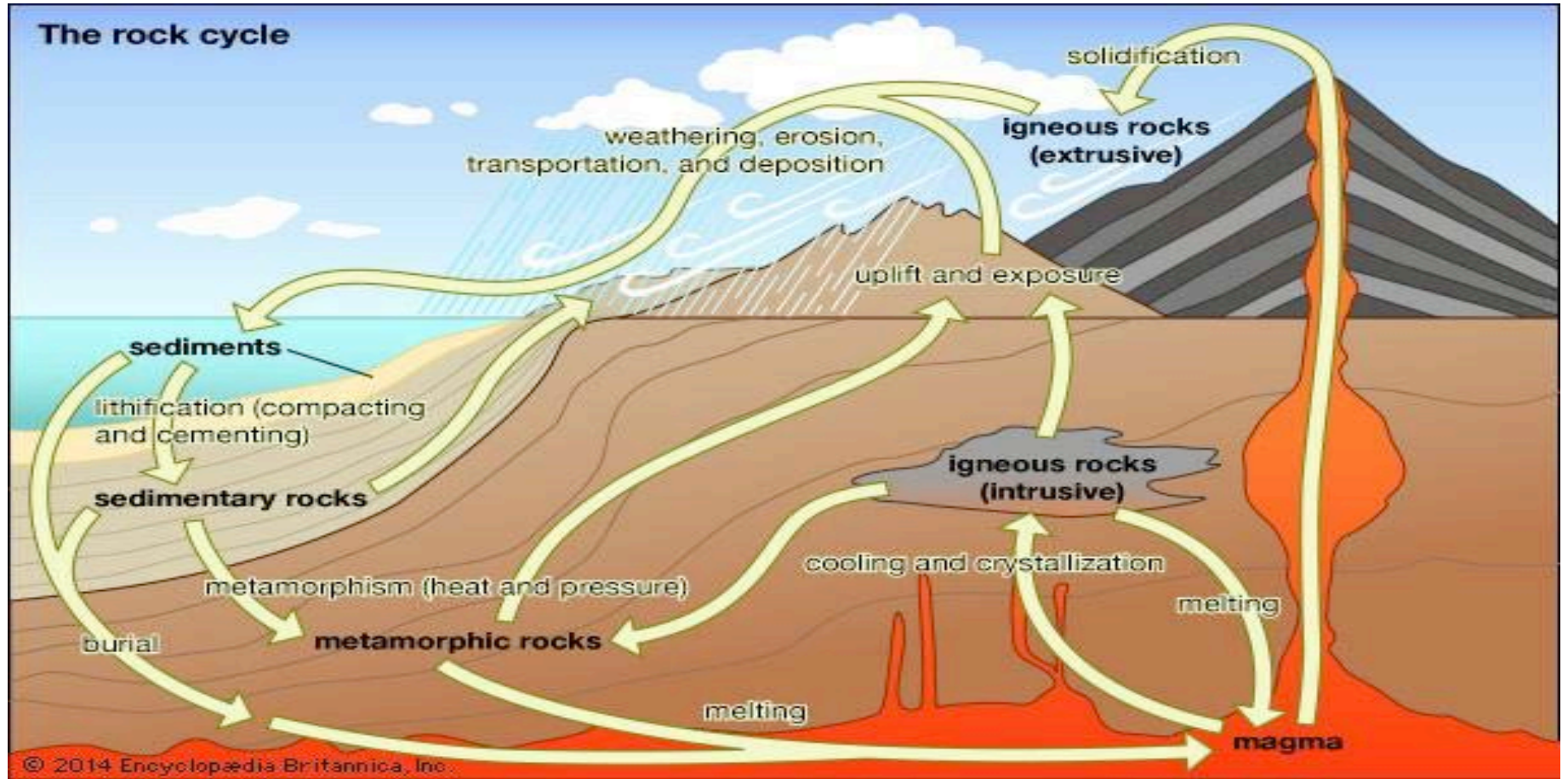
Marble mainly forms at convergent plate  
Boundaries



# Let's Create the Rock Cycle!!

1. No using your phones/devices
2. Create a rock cycle diagram that shows:
  - a. How each of the types of rock is formed***
  - b. How the different types of rock change into the others***

# The rock cycle





# Bill knows best!

- <https://www.youtube.com/watch?v=J-ULcVdeqgE&t=2s>

# Erosion and Weathering



SEDIMENTS created by WEATHERING are transported by erosion and then deposited to form new rocks like the sedimentary rocks of the Grand Canyon.





# Causes of Weathering



**PHYSICAL** changes to the rock by abrasion, ice wedging, temperature changes and plants.

**CHEMICAL** changes to the rock by naturally occurring acids in the environment.






## Physical / Mechanical Weathering

- gradual breakdown of rocks by cracking or splitting
- composition of the rock doesn't change
- minerals in the rock stay the same
- also called mechanical weathering

Oregon Sand Dunes



How did these rocks  
get smooth and  
rounded ?

Did their chemical  
composition change?

**No change = physical**



# Abrasion

Repeated banging and crashing of rocks against each other.

Makes rounded rocks like those found on a beach or riverbank.



# Abrasion

This rock was made smooth by the abrasive properties of a glacier.





# Frost Shattering/Ice Wedging

What happens when water freezes?

What do you think happens when water seeps  
into a crack in a rock and freezes?

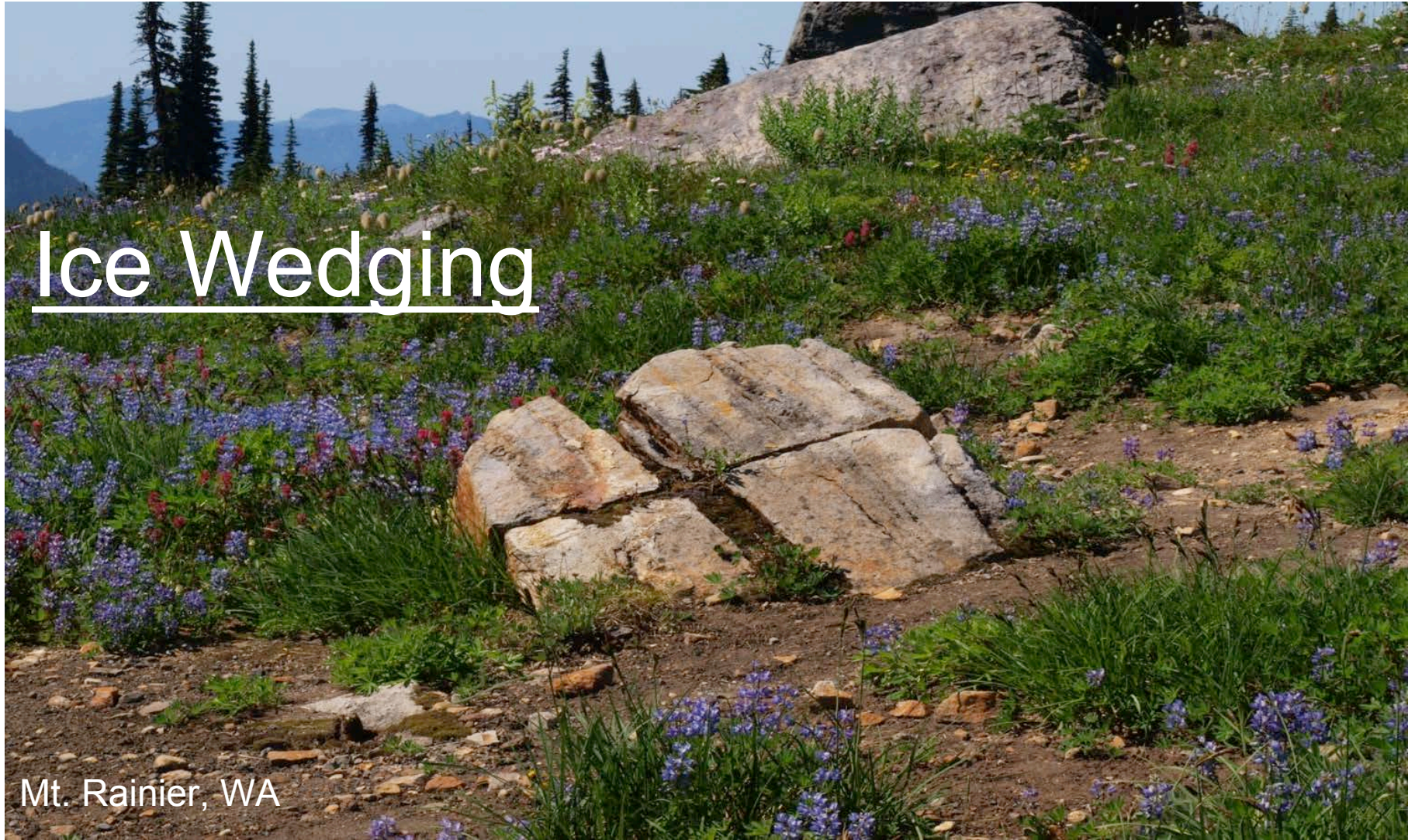
It causes the crack to get bigger and the rock  
to shatter and breakdown.



# Ice Wedging







# Ice Wedging

Mt. Rainier, WA



# Pressure Release/Exfoliation



The release of tension in the outer layers of the rock  
Common in granite where internal pressure causes the  
granite to expand and crack and fall off in layers.

Coquihalla can be seen along the Squamish & Coquihalla Highways



# Exfoliation



Coquihalla



# Biological Weathering



This tree root has caused the rock to fracture and crack. Animals can also dig burrows and expose rocks to more weathering.

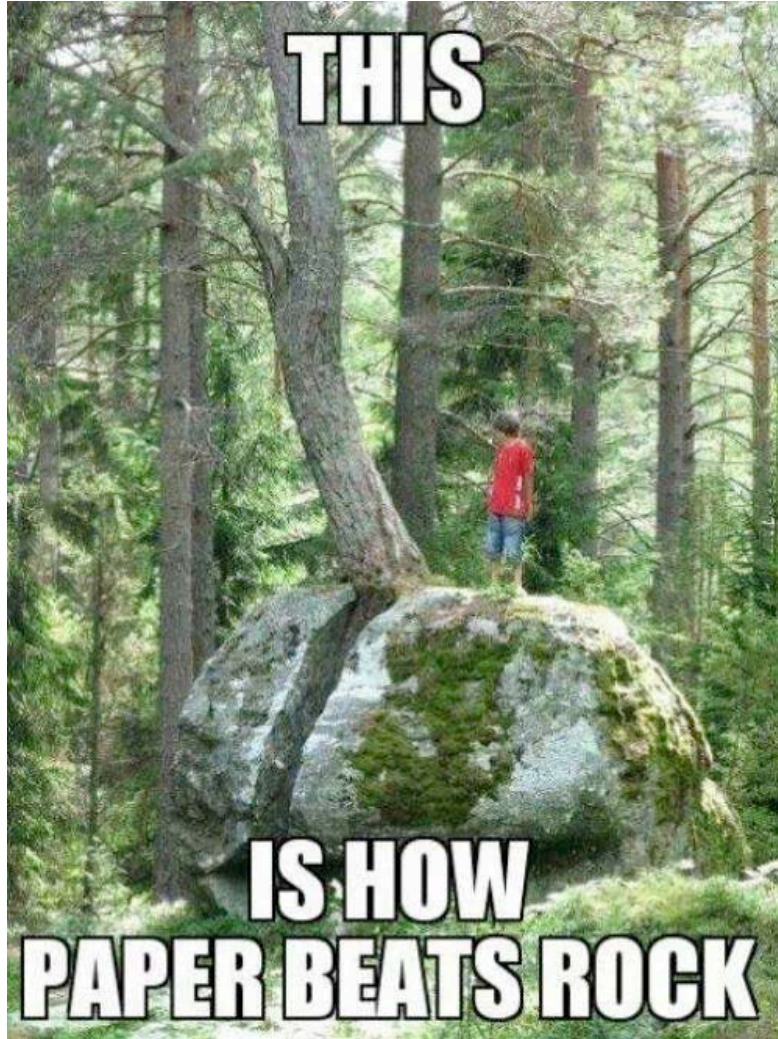


## Biological weathering examples



Photos – E. Williams





**THIS**

**IS HOW  
PAPER BEATS ROCK**



# Thermal Expansion:

- Rocks with crystal structures expand and contract when heated or cooled
- After long periods of time, rocks develop weaknesses and break down.
- Look at all our pot holes! This is caused from freezing and thawing



What happens when metal is exposed to water?

Why does this happen?

How does this relate to rocks and weathering?

A close-up photograph of a rusty nail driven into a concrete surface. The nail is significantly corroded, with a thick layer of reddish-brown rust covering its head and the upper part of its shaft. The concrete is a light grey color with some texture. The background is blurred, showing what appears to be a wooden plank and a light-colored wall.

# Chemical Weathering

the breakdown of rocks by natural chemicals to form new materials with a different chemical composition

Just like iron in a nail turns to rust, minerals in rocks can react with natural chemicals and create a new material



# Acid Rain

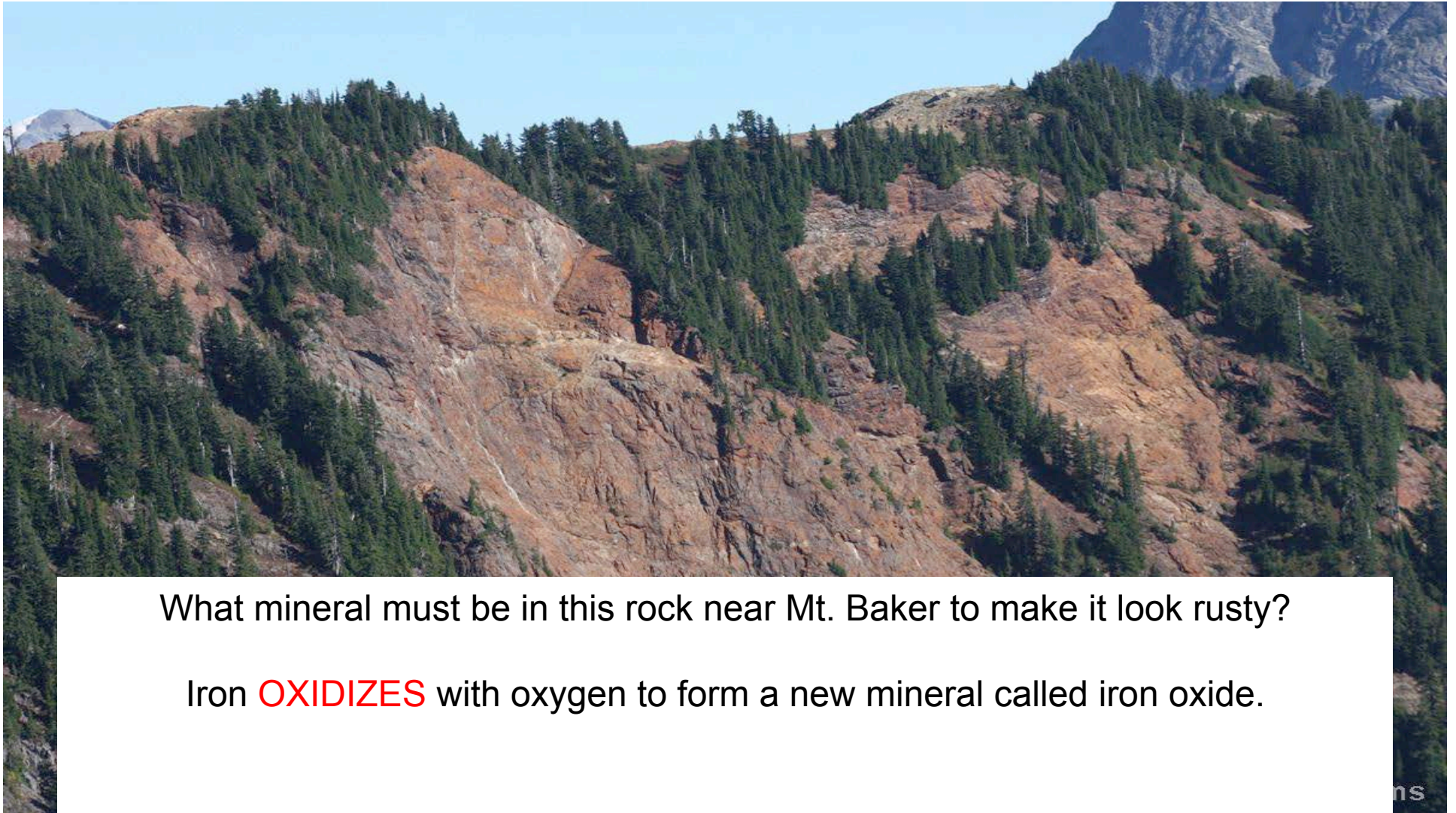
A form of chemical weathering caused by the burning of fossil fuels. Gases mix with rain to form weak acids



**What are some examples of fossil fuels?**

**How do fossil fuels create acid rain?**



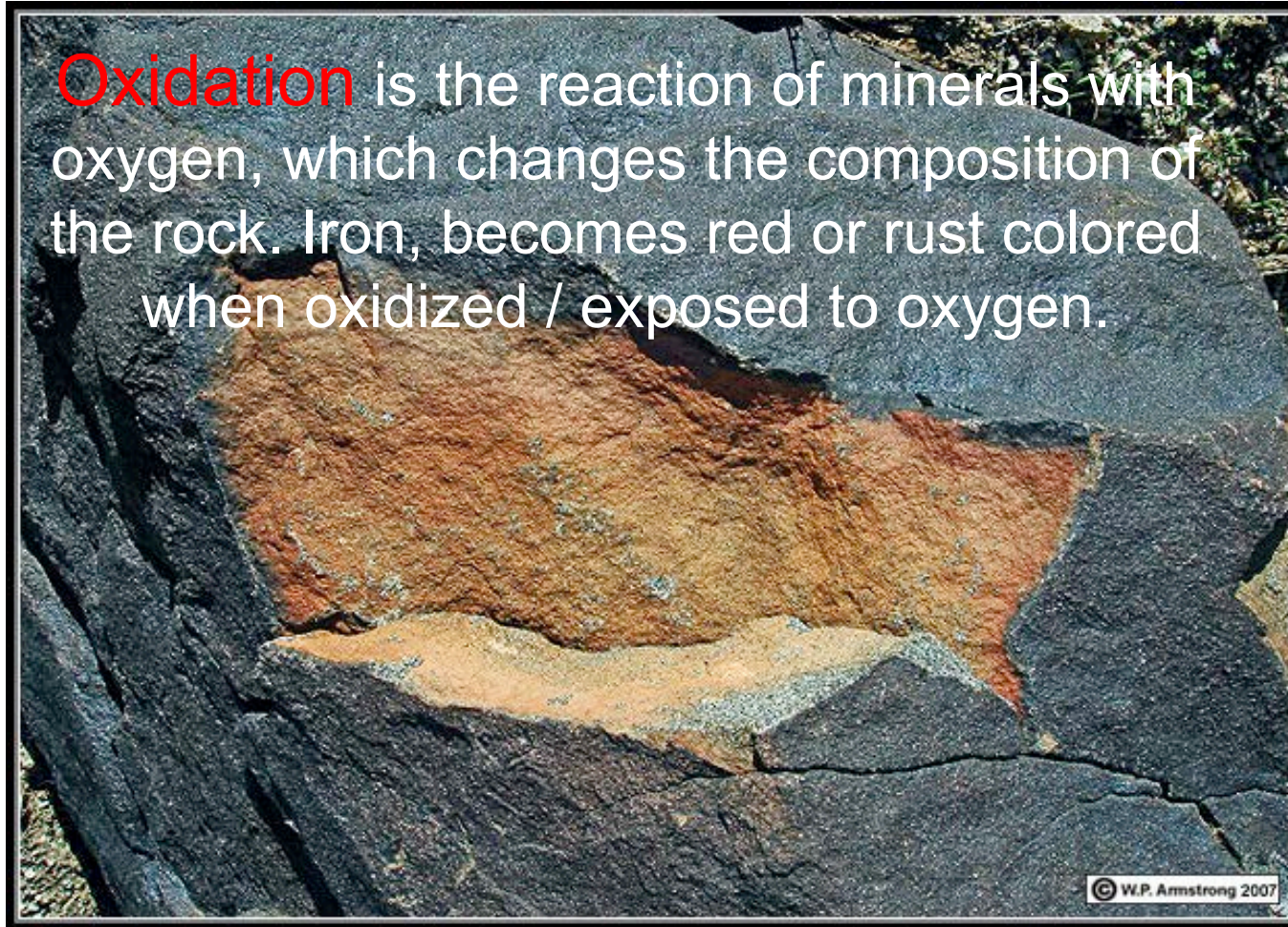


What mineral must be in this rock near Mt. Baker to make it look rusty?

Iron **OXIDIZES** with oxygen to form a new mineral called iron oxide.



**Oxidation** is the reaction of minerals with oxygen, which changes the composition of the rock. Iron, becomes red or rust colored when oxidized / exposed to oxygen.







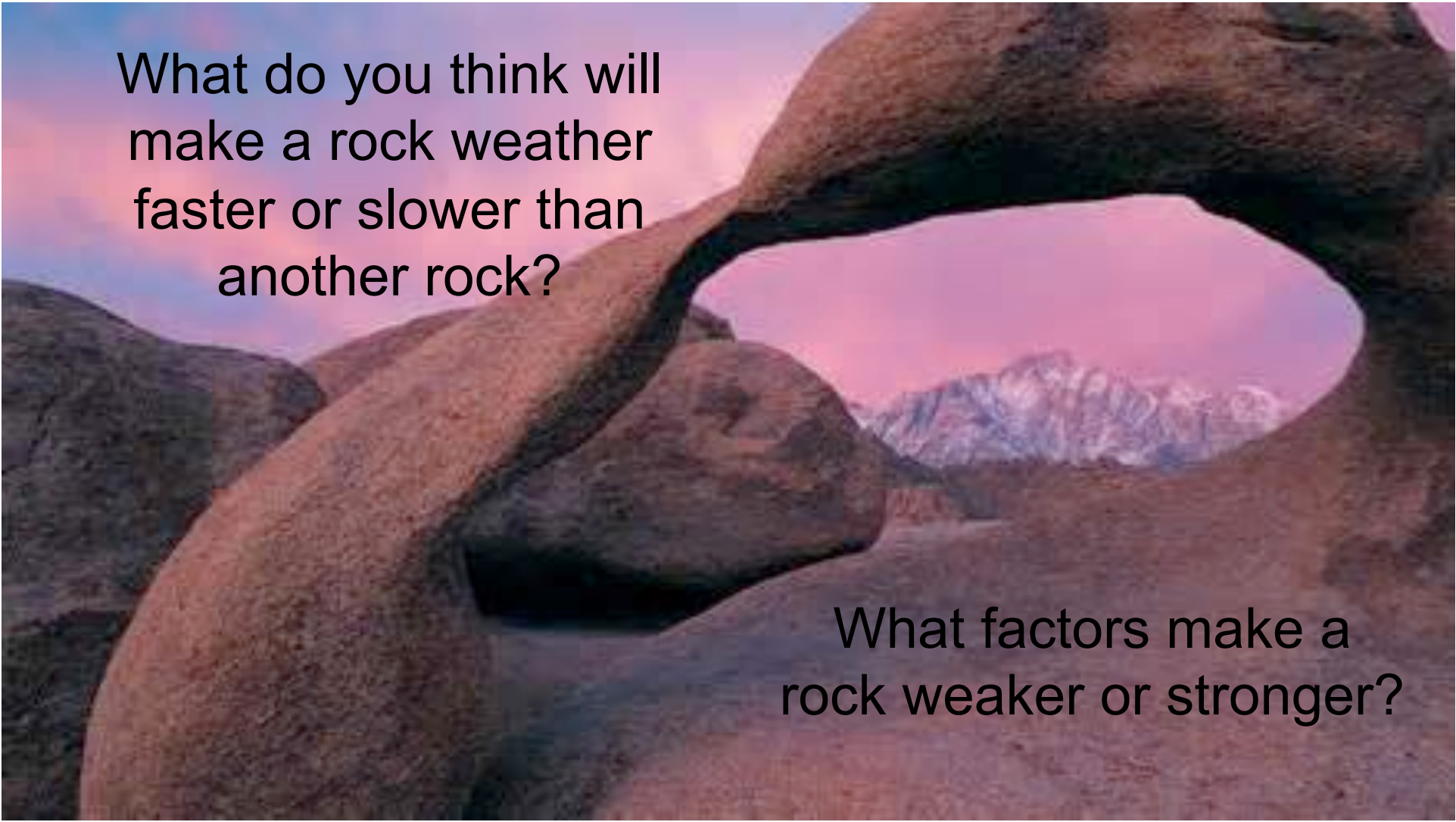
Chemical weathering can only affect the surface of rocks. The chemicals react with soluble materials, dissolving them and carrying them away in a process called **SOLUTION**.

The rocks becomes full of holes and pits.



**Solution** has affected the surface of this sandstone in California.



A photograph of a natural rock archway. The arch is formed by large, rounded, reddish-brown boulders. Through the opening of the arch, a mountain range with snow-capped peaks is visible under a clear blue sky. The foreground shows a sandy or rocky ground surface.

What do you think will  
make a rock weather  
faster or slower than  
another rock?

What factors make a  
rock weaker or stronger?



# 1. Type of Rock

This soft sandstone in Utah at Bryce Canyon is easily physically weathered.



# 1. Type of Rock

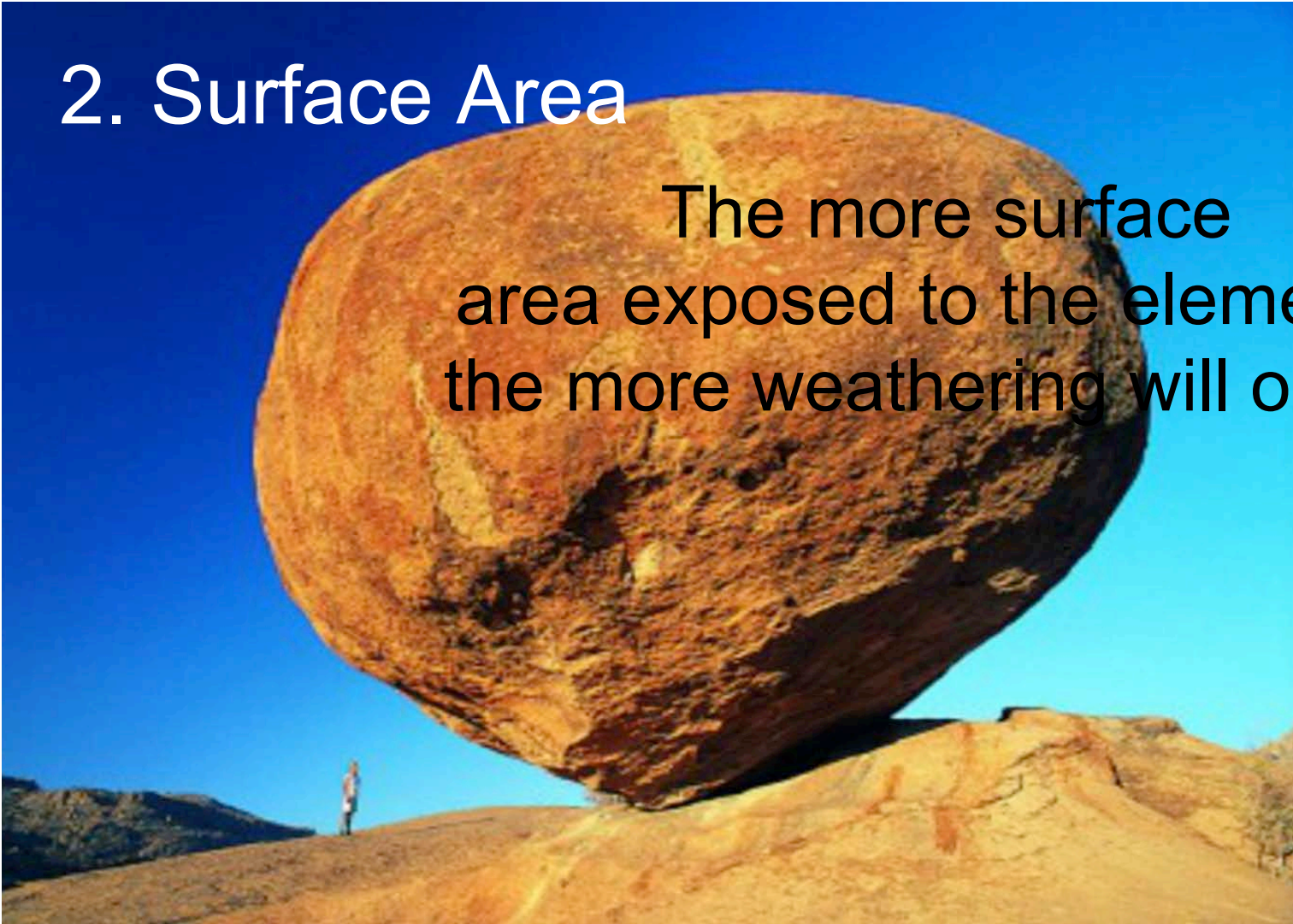
This limestone in Thailand is easily chemically weathered.





## 2. Surface Area

The more surface area exposed to the elements, the more weathering will occur.





### 3 Climate

Cold Saskatchewan winters ruins roads



Physical or  
chemical  
weathering???

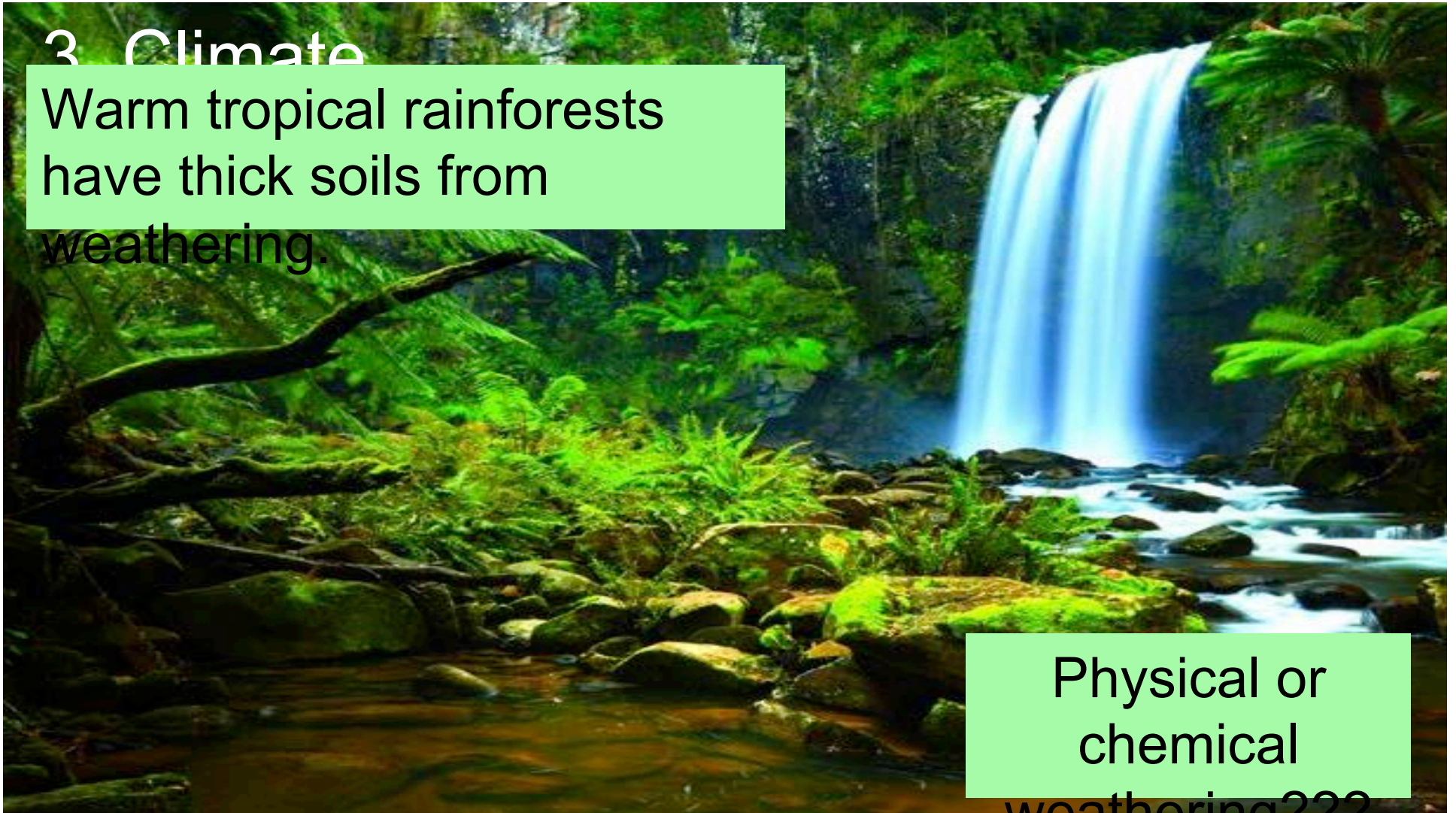


### 3 Climate

Warm tropical rainforests have thick soils from weathering.

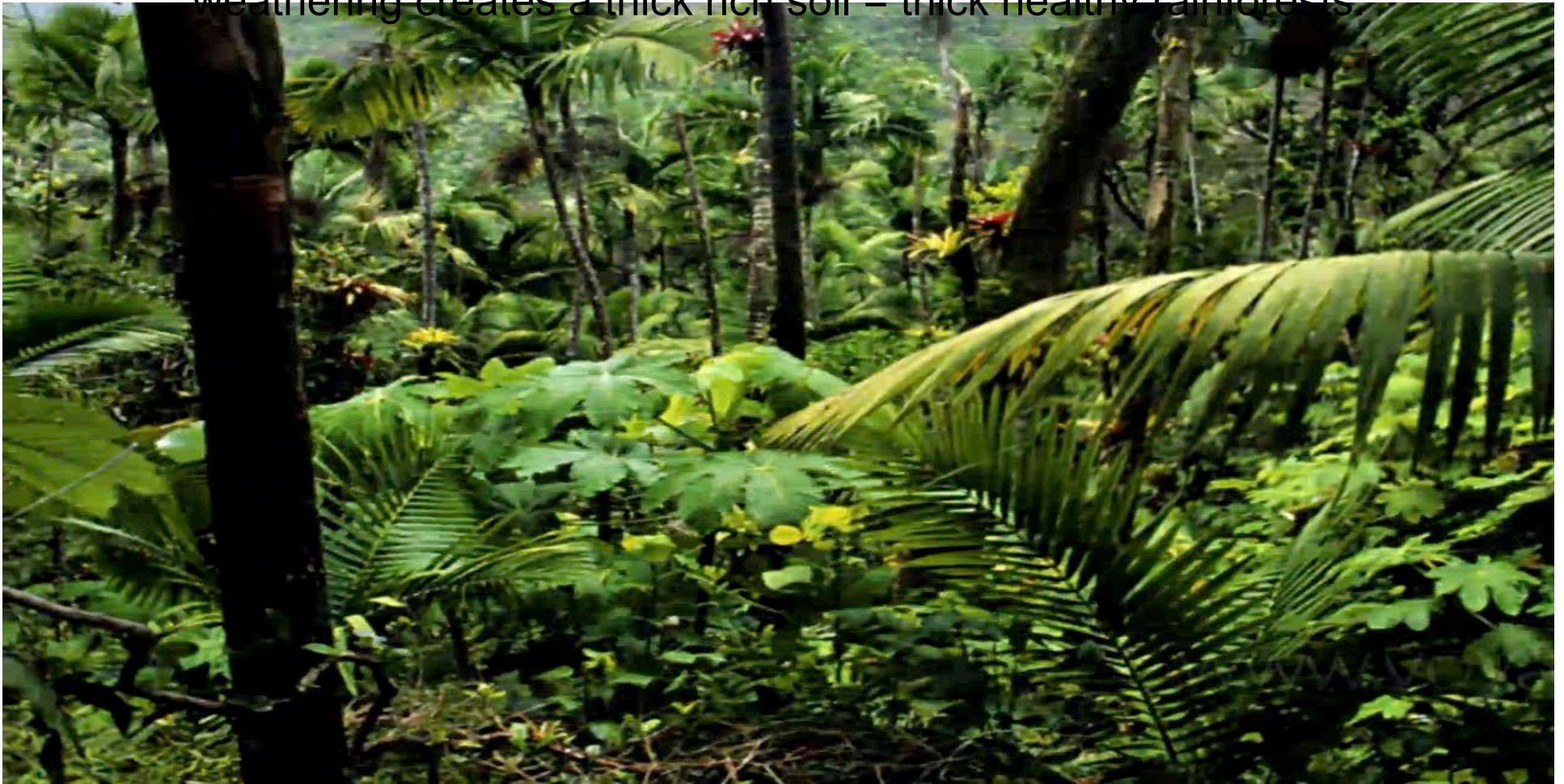
Physical or  
chemical

weathering???





Warm and wet climates are mostly weathered chemically. This chemical weathering creates a thick rich soil = thick healthy rainforests





Cold climates like the Arctic Tundra have little to no chemical weathering and therefore have very thin weak soil.



# Weathering Review...

**No change** in composition = **PHYSICAL**

ice wedging, abrasion, exfoliation, biological

**CHEMICAL**

**Change** in composition =

Natural acids attack the surface of rocks

