

Teacher Lesson Plan

LESSON 3. Where did the oceans go?



Capitan reef rises above the desert.

NPS photo

Overview

In this lesson, students will examine two common external factors that control geologic landscapes: climate and tectonics. When complete, students should understand the role of each in the geology of the Guadalupe Mountains and in modern geologic events.

Grades

9-12

Objectives

The learner will:

- Understand the external forces that aid landscape evolution.
- Apply this understanding to the Guadalupe Mountains and Carlsbad Caverns National Park, the Delaware basin area, or your local geography.

Duration

2 Labs (60 min/ each)

Vocabulary

Internal mechanisms, external mechanisms, external forces, lithology, feedbacks, landscape evolution, mineralogy, lithology, fractures, feedbacks, climate change, tectonics, carbon dioxide, water vapor, methane, eccentricity, sea level, glacier, convection, ecology, hydrologic cycle, oceanic cycle, gas cycle, tilt, precession, obliquity, climate, evaporation/condensation rates, ocean bottom water, ocean surface water, precipitation, climate change, Milankovitch cycles, conveyor belt, greenhouse gas, solar energy, El Niño, uplift, orogeny, structure, fold,

fault, compressional stress, extensional stress, syncline, anticline, hanging wall, foot wall, normal fault, reverse fault, evaporite, extinction, extinct, ice cores, ocean cores, tree rings, pollen records, paleontological records, speleothems, archaeological records, glacier, speleothems, Pleistocene Epoch, groundwater, sulfuric acid, volcanics, uplift, Cretaceous Period, physiographic provinces

Materials

- Global Geography slides (slides #11-18)
- Clay (3 sticks for each pair of students)
- Structure slides (slides #112 – 115)
- Science notebooks

Background information

While landscape evolution is dependent upon internal mechanisms to control the ways in which it changes (mineralogy, lithology, fractures, etc.), external driving mechanisms are responsible for causing landscape changes. While there are many geologic responses to external forces and feedbacks associated with each, the primary external mechanisms for landscape change are climate change and tectonics.

Climate change is driven by changes in incoming solar energy, which affects the global hydrologic, oceanic and gas cycles. Levels of solar energy fluctuate regularly over various time spans. The most recognizable fluctuations in solar energy, or solar cycles, are the Milankovitch cycles that occur approximately every 21,000 years, 41,000 years, and 100,000 years due to alterations in the Earth's precession (the wobbly path traced out by Earth's spinning axis which varies), tilt, and eccentricity around the sun, respectively. These cycles alter the Earth's climate by increasing or reducing the energy that drives global cycles such as some atmospheric cycles (by increasing or decreasing greenhouse gases such as carbon dioxide, water vapor, methane, etc.), the hydrologic cycle (through increasing temperature and changing evaporation/ condensation rates which in turn change the global cloud and ice coverage and thus lead to a rise or fall in sea level), and the ocean cycle, or ocean conveyor belt (a global circulation of the oceans that mixes the warm water with the cold water). An example of a climate change due to a change in the oceanic cycle is El Niño, which occurs every 3 to 7 years due to shifting of the warm surface water in the Pacific Ocean.

Each of these cycles affects the global climate and in turn alters regional ecology and geology. Thus, geological and ecological records are excellent measures of past climate changes. Records that are reliable measures of past climate changes are rock records (geology), ice cores, ocean cores, tree rings, pollen records, paleontological records, speleothems, and archaeological records.

Tectonics also plays a major role in shaping the global landscape. While plate tectonics is a major force in forming and shaping the global landmasses, small scale structural changes in regional geology also play a large role in the evolution of landscapes. Plate tectonics affects landscapes through either compressional or extensional stresses. These stresses create folds, bends, or wrinkles in rock layers, and/or faults, fractures in rocks where one body of rock slides past another, in the rocks they are acting upon. Folds may be simply divided into two major types: those where rocks are buckled up into a hump, called anticlines, and those where layers of rock are folded into a U-shape, called synclines. There are also several different types of faults, however all faults are described by the relative motion of the upper side of the break,

called the headwall or hanging wall, in respect to the lower side or the footwall. A normal fault is a fault in which the hanging-wall block moves down the fault slope in relation to the footwall whereas a reverse, or thrust fault, is a steeply dipping fault on which the hanging wall slides up relative to the footwall.

Both climate change and tectonics have affected the geology and ecology of the Guadalupe Mountains and Carlsbad Caverns National Park area since the Permian Period. At the end of the Permian Period, the sea level in the area dropped leaving behind thick evaporite deposits. At this time, a massive global extinction also occurred and nearly 90% of all life on the Earth, such as most of those fossils seen at Guadalupe Mountains and Carlsbad Caverns National Parks, became extinct. Millions of years later, in the Cretaceous, a shallow sea returned to North America leaving marine deposits in mid-continent America once again. During the last million years, in the Pleistocene Period, North America has been subjected to glacial advances—the most recent of which occurred a mere 18,000 years ago. While the glaciers did not advance as far south as New Mexico and Texas, the climate in the region is believed to have been considerably cooler and wetter. It was at this time that many of the cave decorations, or speleothems at Carlsbad Caverns National Park were probably formed.

Tectonics also played a large role in the formation of the Guadalupe Mountains and Carlsbad Cavern. After the Capitan Reef was formed in the Permian Period, the basin filled with evaporites and other sediments. However, during the Tertiary Period, regional uplift began to raise the sturdy Permian deposits and the overlying material was eroded off. This increasing uplift allowed the groundwater, rich in sulfuric acid from the mixing of H₂S gas with the oxygen in the water to lower in level and carve out the lower caves. Therefore, caves deepest in the mountains are those most recently formed. These caves are later believed to have been decorated during the moister Pleistocene Epoch when the abundant water flowed through the rocks, dissolved some of the limestone, and redeposited the calcite as cave decorations or speleothems.

Preparation

Read the background information and the article, watch the video, review plate tectonics and make sure students have play-doh or modeling clay.

Procedure

The teacher will:

- Define climate change.
- Discuss different mechanisms for climate change (solar flux and Milankovitch cycles, ocean conveyor belt, greenhouse gases, etc.) and show the paleogeography changes through time.
- Divide class into four groups with the following headings and have each person in the group research a topic under the heading (these topics may be modified depending on the size of the class and the resources available):
 - Causes for past climate changes
 1. Solar fluctuations
 2. Ocean fluctuations
 3. Tectonics (mountain building and volcanics)
 4. Greenhouse gases
 - Records of climate change

1. Ice cores
 2. Marine cores
 3. Tree-rings
 4. Speleothems
- Environments in the Guadalupe Mountains and Carlsbad Caverns National Park through time
 1. Permian Period
 2. Cretaceous Period
 3. Pleistocene Epoch
 - Future Climate Change
 1. Potential causes
 2. Possible effects
 3. Potential cures
- Have each group present research and then individual students should write a summary/thought paper on what past climate change may tell us about the future climate.
 - Review plate tectonics. Discuss how this might have affected the Guadalupe Mountains and Carlsbad Caverns National Park.
 - Discuss the smaller scale effects this has on a local region (define types of folds and faults—these may be demonstrated in front of the class with foam).
 - Split students up into pairs and have them model each of the folds and faults in three layers of rock made out of clay. Have them draw the cross-sections of these features in their science notebooks.
 - Look at the present configuration of the Guadalupe Mountains and Carlsbad Cavern—discuss the role of tectonics in the formation of these features.

Assessments

- Presentations
- Lab report

Extensions

- Have students construct paper fault models from the USGS (<http://wrgis.wr.usgs.gov/docs/parks/deform/7modelsa.html>)
- Have students research some of the famous faults and folds (San Andreas Fault in California, the Black Hills dome, etc.).
- Research the tectonic activity in your area—are there faults? Are there folds?

Bibliography

Bebout, D.G. and C. Kerans. 1993. *Guide to the Permian Reef Geology Trail, McKittrick Canyon, Guadalupe Mountains National Park, West Texas. Guidebook 26.* Austin, TX: Bureau of Economic Geology.

Caves Reveal Climates Project Proposal:
<http://www.ncdc.noaa.gov/ogp/papers/gonzale.html>

Hill, C.A. 1996. "Geology of the Delaware Basin Guadalupe, Apache, and Glass Mountains New Mexico and West Texas." Permian Basin Section – SEPM. Pub. No. 96-39.

Marshak, S. 2001. *Earth Portrait of a Planet*. New York: W.W. Norton & Co.
NOAA's "Paleo-perspective" webpage:

<http://www.ngdc.noaa.gov/paleo/globalwarming/home.html>

Paleogeography and geologic evolution of North America

<http://www2.nau.edu/rcb7/nam.html>

Rubrics for teachers

<http://rubistar.4teachers.org/>

Additional reading and other resources

Climate Internet links: <http://www.istl.org/01-fall/internet.html>

Student Worksheet

LESSON 3.

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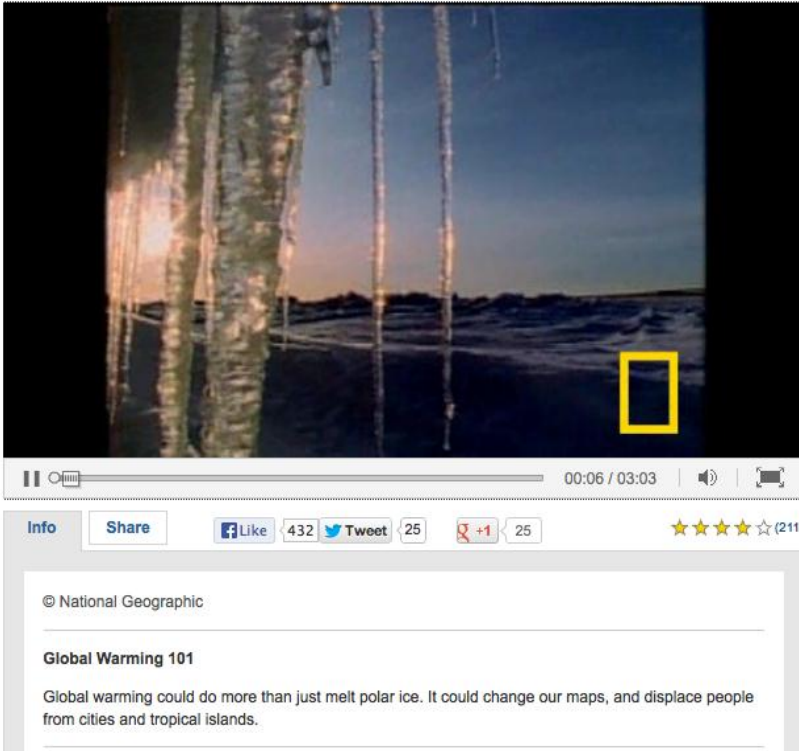
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Vocabulary

Internal mechanisms, external mechanisms, external forces, lithology, feedbacks, landscape evolution, mineralogy, lithology, fractures, feedbacks, climate change, tectonics, carbon dioxide, water vapor, methane, eccentricity, sea level, glacier, convection, ecology, hydrologic cycle, oceanic cycle, gas cycle, tilt, precession, obliquity, climate, evaporation/condensation rates, ocean bottom water, ocean surface water, precipitation, climate change, Milankovitch cycles, conveyor belt, greenhouse gas, solar energy, El Niño, uplift, orogeny, structure, fold, fault, compressional stress, extensional stress, syncline, anticline, hanging wall, foot wall, normal fault, reverse fault, evaporite, extinction, extinct, ice cores, ocean cores, tree rings, pollen records, paleontological records, speleothems, archaeological records, glacier, speleothems, Pleistocene Epoch, groundwater, sulfuric acid, volcanics, uplift, Cretaceous Period, physiographic provinces

Activity 1.1. Getting to know Climate Change

Global Warming: Global Warming 101



Part 1. Write down your definition for Climate Change. After the allotted time, share your answers with your classmates sitting nearby and choose the definition you think is most accurate. Write it down in your notebook.

Part 2. Watch the video Global Warming from National Geographic

(<http://video.nationalgeographic.com/video/environment/global-warming-environment/global-warming-101/>). Make any corrections in your definitions based on what you have learned from the video.

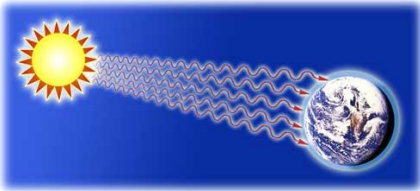
Part 3. Watch the video again and answer the following questions:

- How has the Earth's climate fluctuated for 2.5 million years?
- How has the planet's temperature risen during the last century?
- What do scientists believe it's driving the temperatures up?
- What do release huge amounts of CO₂ and other gases into the atmosphere?
- List two of the Greenhouse gases.
- What is the Greenhouse Effect?
- According to the video, indicate which of the following topics are evidences from global warming:
 - The industrial revolution
 - The strength of very warm years
 - Higher levels of greenhouse gases
 - The shrinking of Arctic sea ice
 - The Greenhouse effect
 - The fossil fuel consumption
 - Human activity
- Which year was the warmest in measured History? And the second?
- Indicate what can be the consequences of global warming.
- What can you do to reduce the impact of global warming?

Activity 1.2. Mechanisms for climate change

Mechanisms for climate change include a variety of natural changes of features as solar fluxes, Milankovitch cycles, ocean conveyor belt, greenhouse gases and paleography. If you want to be introduced to these concepts, complete the following basic worksheet.

A. Solar Fluxes



Read the extract from the article “What do really know about the Sun-climate connection?” from researchers at the Danish Meteorological Institute in Denmark and answer the questions.

ABSTRACT

The Earth's climate has always been changing. This is documented in historical as well as in geological records. The reasons for these changes, however, have always been subject to discussions and are still not well understood. In addition to natural climate changes the risk of human influence on climate has recently been seriously considered by the Intergovernmental Panel on Climate Change. Any factor that alters the radiation received from the Sun or lost to Space will affect climate. The Sun's output of energy is known to change over an 11-year cycle, and variations over longer periods occur as well. A number of correlations between solar activity variations and climate changes, some more significant than others, have been reported but they have traditionally been accompanied by a considerable skepticism among scientists because a plausible physical mechanism to account for these correlations has not yet been found. The most immediate cause of climate changes would be changes in the total irradiance of the Sun. This, however, would either imply unrealistically large variations in total solar irradiance or a higher climate sensitivity to radiative forcing than normally accepted. Therefore other mechanisms have to be invoked. The most promising candidate is a change in cloud formation because clouds have a very strong impact on the radiation balance and because only little energy is needed to change the cloud formation process. One of the ways to influence cloud formation might be through the cosmic ray flux that is strongly modulated by the varying solar activity.

INTRODUCTION

The Sun is the source of the energy that causes the motion of the atmosphere and thereby controls weather and climate. Any change in the energy from the Sun received at the Earth's surface will therefore affect climate. During stable conditions there has to be a balance between the energy received from the Sun and the energy that the Earth radiates back into Space. This energy is mainly radiated in the form of long wave radiation corresponding to the mean temperature of the Earth.

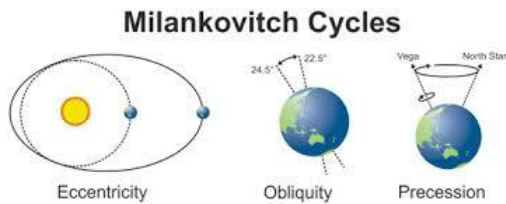
From historical and geological records we know that the Earth's climate has always been changing. Sometimes such changes have been relatively abrupt and have apparently had large sociological effects. It is therefore natural that our society is interested in future climate changes and in particular is concerned about a possible influence on climate of society itself. This concern is associated with the effect of the increasing amount of greenhouse gases, in particular CO₂, which is due to human activities related to the burning of fossil fuel.

The determination of the natural climate variability is therefore of decisive importance for a credible estimation of the man-made signal and hence for possible political decisions regarding initiatives to mitigate the effects of the increased amount of greenhouse gases. The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environmental Program (UNEP). This Panel in 1990 published a report about the scientific basis for the assessment of the found climatic changes and their causes. The report concluded that it was presently not possible to ascribe unequivocally the found changes in climate to the enhanced greenhouse effect since the size of the global warming is of the same magnitude as natural climate variability.

Questions:

1. Underline or highlight the words you don't know and look them up on the dictionary.
2. Invent a different title for this article.
3. Circle the factors that can cause a change in Earth's climate:
 - a. Animal growth
 - b. Total irradiance of the Sun
 - c. Mountain formation
 - d. Cloud formation
 - e. Human influence
 - f. IPCC
 - g. Sun's output of energy
4. What does IPCC stand for? Describe its role.
5. Summarize the article in 5 sentences.

B. Milankovitch cycles:

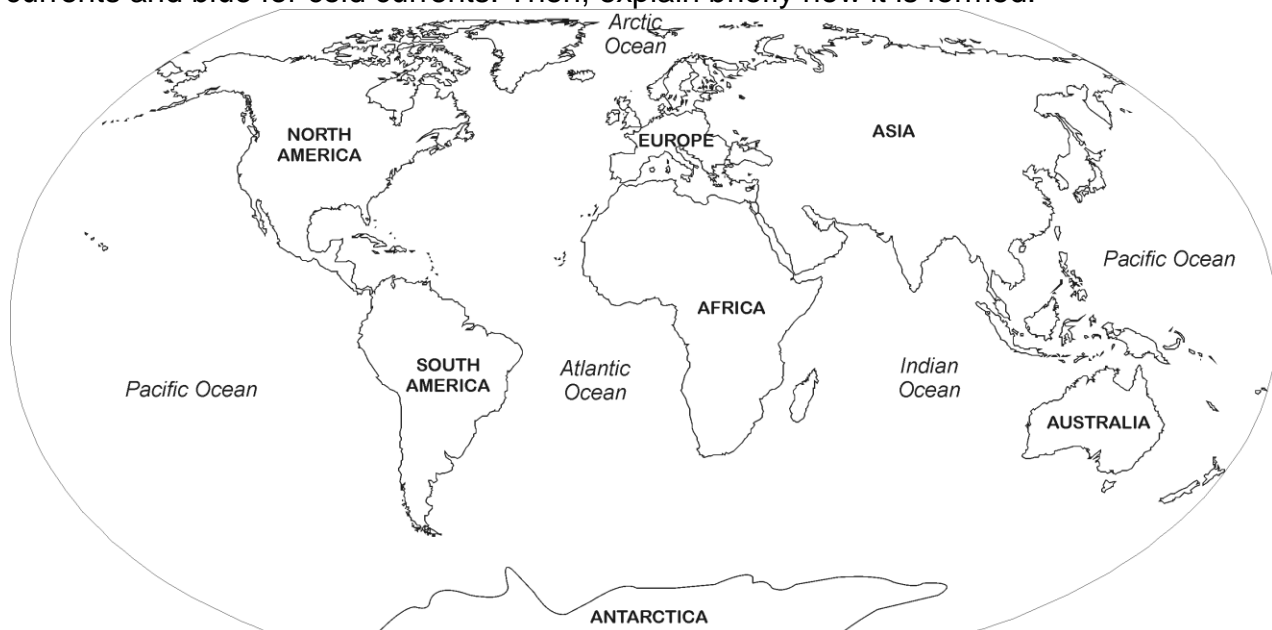


Go to http://highered.mcgraw-hill.com/sites/0073369365/student_view0/chapter16/milankovitch_cycles.html

And watch the animation of Milankovitch cycles from McGraw Hill. List three cycles in the orbit of the Earth that can make the global climate to change.

C. Ocean conveyor belt

C.1. In the following world map, draw the oceanic conveyor belt using a red marker for warm currents and blue for cold currents. Then, explain briefly how it is formed.



C.2. Imagine you're a scientist and you have to write a report for National Geographic about how the climate change can affect the ocean currents or vice versa. To help you out with this task, use the following template:

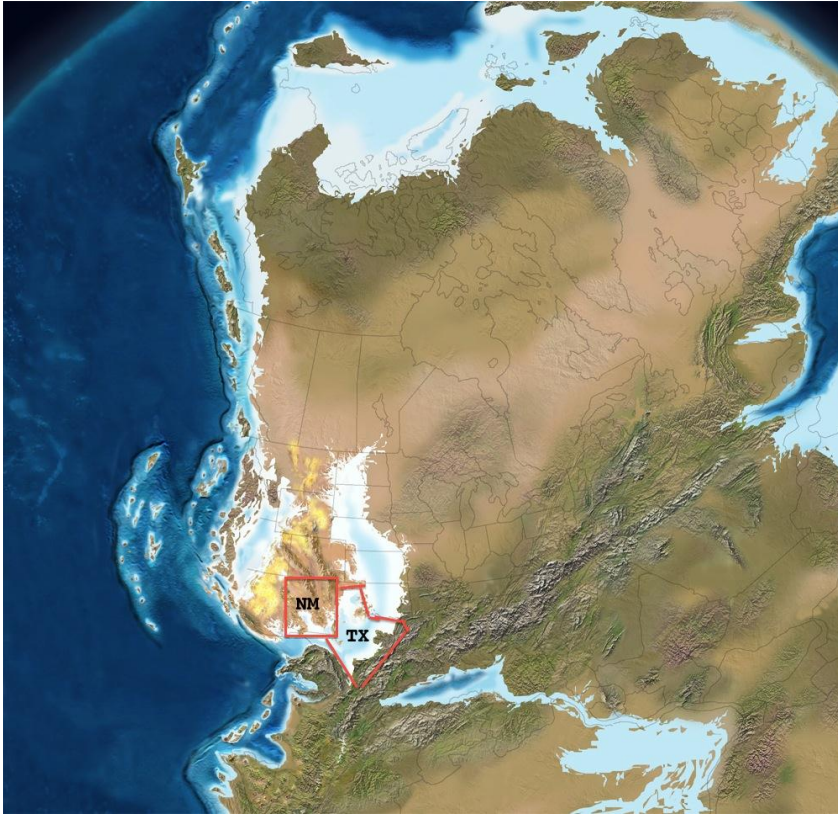
- Introduction: present where you work and what kind of research you're conducting.
- Development

- Ocean acidification
- Sea level rise
- Ice caps melting
- How climate change affects
 - Ocean salinity
 - Reefs

- Conclusion

D. Paleogeography changes through time

Paleogeography is the study of how the continents positions and the distribution of mountains and seas have changed through time. Examine the maps of North America during the Permian and Triassic periods. Write down the changes you observe in the NM and TX environment, indicating if these areas were covered by seas or there were mountain ranges and/or land. Investigate also the climate at those times.



Permian Period

Triassic Period



Activity 1.3. Climate change at the Guadalupe

Create a *power point* presentation about one of the following topics:

- Causes for past climate changes
 - Solar fluctuations
 - Ocean fluctuations
 - Tectonics (mountain building and volcanics)
 - Greenhouse gases
- Records of climate change
 - Ice cores
 - Marine cores
 - Tree-rings
 - Speleothems
- Environments in the Guadalupe Mountains and Carlsbad Caverns National Park through time
 - Permian Period
 - Cretaceous Period
 - Pleistocene Epoch
- Future Climate Change
 - Potential causes
 - Possible effects
 - Potential cures

Then, you are going to show it to the class. You can use some of the following web sites listed below. The grading rubric can help you to know what is expected from your presentation.

Web sites:

<http://epa.gov/climatestudents/basics/past.html>

http://en.wikibooks.org/wiki/High_School_Earth_Science/Climate_Change

<http://edugreen.teri.res.in/explore/climate/causes.htm>

<http://www.climate.gov/teaching/resources/education/high-school-9-12>

<http://www.epa.gov/climatechange/science/indicators/index.html>

<http://www.ncdc.noaa.gov/paleo/slides/>

<http://www.nps.gov/gumo/naturescience/geologicformations.htm>

<http://www.nps.gov/cave/naturescience/geologicformations.htm>

<http://www.epa.gov/climatechange/science/future.html>

<http://climate.nasa.gov/effects>

Oral Presentation Rubric: Power Point Presentation

CATEGORY	4	3	2	1
Collaboration with Peers	Almost always listens to, shares with, and supports the efforts of others in the group. Tries to keep people working well together.	Usually listens to, shares with, and supports the efforts of others in the group. Does not cause \"waves\" in the group.	Often listens to, shares with, and supports the efforts of others in the group but sometimes is not a good team member.	Rarely listens to, shares with, and supports the efforts of others in the group. Often is not a good team member.
Preparedness	Student is completely prepared and has obviously rehearsed.	Student seems pretty prepared but might have needed a couple more rehearsals.	The student is somewhat prepared, but it is clear that rehearsal was lacking.	Student does not seem at all prepared to present.
Listens to Other Presentations	Listens intently. Does not make distracting noises or movements.	Listens intently but has one distracting noise or movement.	Sometimes does not appear to be listening but is not distracting.	Sometimes does not appear to be listening and has distracting noises or movements.
Content	Shows a full understanding of the topic.	Shows a good understanding of the topic.	Shows a good understanding of parts of the topic.	Does not seem to understand the topic very well.
Speaks Clearly, posture and eye contact	Speaks clearly and distinctly all (100-95%) the time, and mispronounces no words; looks relaxed and confident and establishes eye contact	Speaks clearly and distinctly all (100-95%) the time, but mispronounces one word; stands up straight and establishes eye contact	Speaks clearly and distinctly most (94-85%) of the time. Mispronounces no more than one word; sometimes stands up straight and establishes eye contact.	Often mumbles or can not be understood OR mispronounces more than one word. Slouches and/or does not look at people during the presentation.

Adapted from <http://rubistar.4teachers.org/>

Activity 1.4. It's my fault! Fold it, please!

FAULTS AND FOLDS LAB REPORT

QUESTION: Are faults and folds caused by the same kind of forces? Go to:

<http://www.williamsclass.com/SixthScienceWork/FoldFault/FoldFaultGeologyNotes.htm>

BACKGROUND RESEARCH: Go to the web site indicated above the title and write down the definitions of fault and fold. Then, describe the types of faults and folds we can find in nature.

HYPOTHESIS: Form your own hypothesis based on your findings.

EXPERIMENT

- MATERIALS: 3 different colors of modeling clay or play-doh, wax paper, knife, rolling pin

- PROCEDURE:

- Roll out each of the colors and flatten them onto a sheet of wax paper with the rolling pin.
- Place the layers on top of each other (you can leave the wax paper between the layers).
- Trim the edges so you can cut the clay into 5 different rectangles with the knife.
- Make the models of faults and folds. Three rectangles will represent the types of faults (normal, reverse and strike-slip) and two rectangles will represent the common types of folds (syncline and anticline).

RESULTS: Complete the data table. And describe what you found out after carrying out the experiment.

CONCLUSION: Was your hypothesis supported by your results?

DATA TABLE:

	TYPE	DRAWING
FAULT	NORMAL	
	REVERSE	
	STRIKE-SLIP	
FOLD	ANTICLINE	
	SYNCLINE	

Answer Key

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Part 2. Watch the video Global Warming from National Geographic (<http://video.nationalgeographic.com/video/environment/global-warming-environment/global-warming-101/>). Make any corrections in your definitions based on what you have learned from the video.

Answers will vary.

Part 3. Watch the video again and answer the following questions:

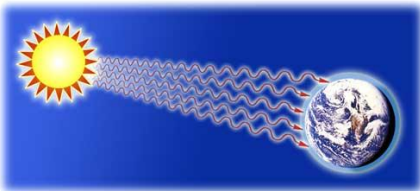
- How has the Earth's climate fluctuated for 2.5 million years?
Cycling from ice ages to warmer periods
- How has the planet's temperature risen during the last century?
The planet's temperature has risen unusually fast about 1.2 to 1.4 °F
- What do scientists believe it's driving the temperatures up?
It's human activity that's driving the temperatures up, a process known as global warming.
- What do release huge amounts of CO₂ and other gases into the atmosphere?
Factories, power plants and cars
- List two of the Greenhouse gases.
Carbon dioxide and methane
- What is the Greenhouse Effect?
It is the natural process by which greenhouse gases trap heat near the earth. It begins with the energy the Sun irradiates to the Earth.
- According to the video, indicate which of the following topics are evidences from global warming:
 - The industrial revolution

- The strength of very warm years
 - Higher levels of greenhouse gases
 - The shrinking of Arctic sea ice
 - The Greenhouse effect
 - The fossil fuel consumption
 - Human activity
- h. Which year was the warmest in measured History? And the second?
1998; 2005
- i. Indicate what can be the consequences of global warming.
The sea level will rise, there will be more frequent hurricanes; there will be more common severe droughts in warm areas; and species unable to adapt would face extinction.
- j. What can you do to reduce the impact of global warming?
Cutting greenhouse gases and saving energy around the house (changing the bulbs to low consume and driving fewer miles in the car)

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ABSTRACT

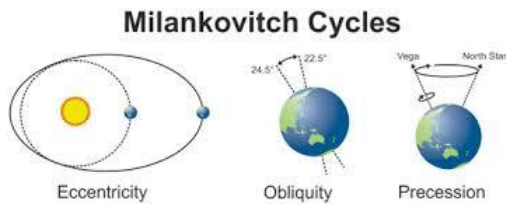
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reported but they have traditionally been accompanied by a considerable skepticism among scientists because a plausible physical mechanism to account for these correlations has not yet been found. The most immediate cause of climate changes would be changes in the total irradiance of the Sun. This, however, would either imply unrealistically large variations in total solar irradiance or a higher climate sensitivity to radiative forcing than normally accepted. Therefore other mechanisms have to be invoked. The most promising candidate is a change in cloud formation because clouds have a very strong impact on the radiation balance and because only little energy is needed to change the cloud formation process. One of the ways to influence cloud formation might be through the cosmic ray flux that is strongly modulated by the varying solar activity.

INTRODUCTION

The Sun is the source of the energy that causes the motion of the atmosphere and thereby controls weather and climate. Any change in the energy from the Sun received at the Earth's surface will therefore affect climate. During stable conditions there has to be a balance between the energy received from the Sun and the energy that the Earth radiates back into Space. This energy is mainly radiated in the form of long wave radiation corresponding to the mean temperature of the Earth. From historical and geological records we know that the Earth's climate has always been changing. Sometimes such changes have been relatively abrupt and have apparently had large sociological effects. It is therefore natural that our society is interested in future climate changes and in particular is concerned about a possible influence on climate of society itself. This concern is associated with the effect of the increasing amount of greenhouse gases, in particular CO₂, which is due to human activities related to the burning of fossil fuel. The determination of the natural climate variability is therefore of decisive importance for a credible estimation of the man-made signal and hence for possible political decisions regarding initiatives to mitigate the effects of the increased amount of greenhouse gases. The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environmental Program (UNEP). This Panel in 1990 published a report about the scientific basis for the assessment of the found climatic changes and their causes. The report concluded that it was presently not possible to ascribe unequivocally the found changes in climate to the enhanced greenhouse effect since the size of the global warming is of the same magnitude as natural climate variability.

B. Milankovitch cycles:



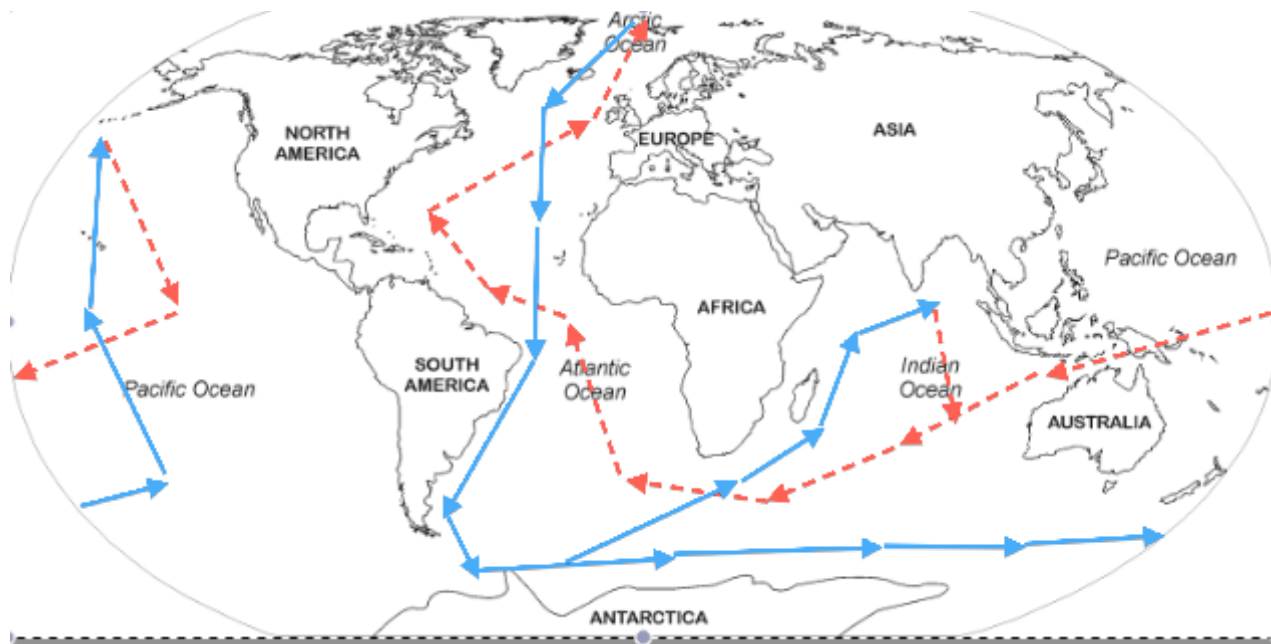
Go to http://highered.mcgraw-hill.com/sites/0073369365/student_view0/chapter16/milankovitch_cycles.html

And watch the animation of Milankovitch cycles from McGraw Hill. List three cycles in the orbit of the Earth that can make the global climate to change.

Eccentricity, axial tilt and precession.

C. Ocean conveyor belt

C.1. In the following world map, draw the oceanic conveyor belt using a red marker for warm currents and blue for cold currents. Then, explain briefly how it is formed.



Ocean conveyor belt is the constant motion of the water in the ocean due to thermohaline currents (thermo = temperature and haline = salinity). Cold, salty water is dense and sinks to the bottom of the ocean while warm water is less dense and rises to the surface. The ocean conveyor gets its "start" in the Norwegian Sea, where warm water from the Gulf Stream heats the atmosphere in the cold northern latitudes. This loss of heat to the atmosphere makes the water cooler and denser, causing it to sink to the bottom of the ocean. As more warm water is transported north, the cooler water sinks and moves south to make room for the incoming warm water. This cold bottom water flows south of the equator all the way down to Antarctica. Eventually, the cold bottom waters are able to warm and rise to the surface, continuing the conveyor belt that encircles the globe.

(From <http://oceanservice.noaa.gov/facts/conveyor.html>)

C.2. Imagine you're a scientist and you have to write a report for National Geographic about how the climate change can affect the ocean currents or vice versa. To help you out with this task, use the following template:

c. Introduction: present where you work and what kind of research you're conducting.

d. Development

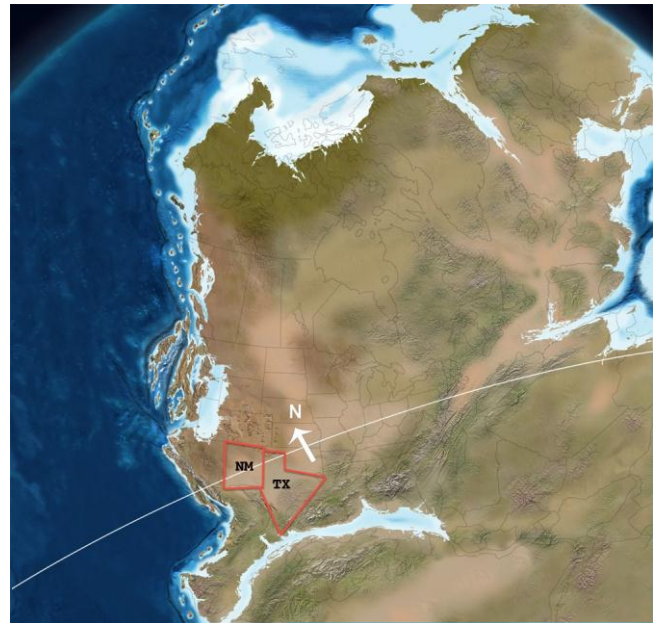
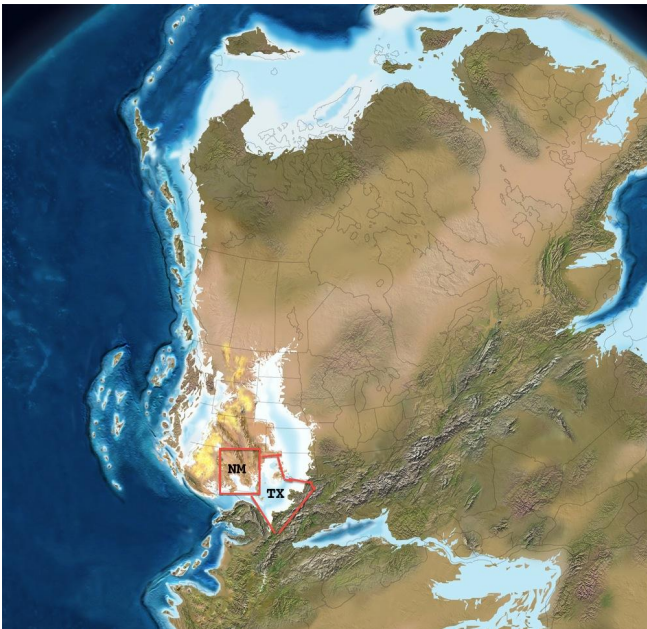
- Ocean acidification
- Sea level rise
- Ice caps melting
- How climate change affects
 - Ocean salinity
 - Reefs

d. Conclusion

D. Paleogeography changes through time

Paleogeography is the study of how the continents positions and the distribution of mountains and seas have changed through time.

Examine the maps of North America during the Permian (left hand side) and Triassic (right hand side) periods. Write down the changes you observe in the NM and TX environment during both periods, indicating if these areas were covered by seas or there were mountain ranges and/or land. Investigate also the climate in these areas at those times.



During the Permian period a sea covered New Mexico and Texas, whereas during the Triassic, the sea has receded from the land and both states are dry land. We can also see the mountain ranges (suture between the large supercontinents of Gondwana and Laurasia) during the Permian, while in the Triassic has been eroded and buried under debris.

The Permian was a glacial period in terms of climate but glaciers started to melt as the climate gradually warmed, whereas the Triassic is non-glacial period, with a hot and dry climate. In fact, the polar zones were supposed to be temperate and moist.

Activity 1.3. Climate change at the Guadalupes

Create a *power point* presentation about one of the following topics:

- Causes for past climate changes
 - Solar fluctuations
 - Ocean fluctuations
 - Tectonics (mountain building and volcanics)
 - Greenhouse gases
- Records of climate change
 - Ice cores
 - Marine cores
 - Tree-rings
 - Speleothems
- Environments in the Guadalupe Mountains and Carlsbad Caverns National Park through time
 - Permian Period
 - Cretaceous Period
 - Pleistocene Epoch
- Future Climate Change
 - Potential causes
 - Possible effects
 - Potential cures

Then, you are going to show it to the class. You can use some of the following web sites listed below. The grading rubric can help you to know what is expected from your presentation.

Web sites:

<http://epa.gov/climatestudents/basics/past.html>

http://en.wikibooks.org/wiki/High_School_Earth_Science/Climate_Change

<http://edugreen.teri.res.in/explore/climate/causes.htm>

<http://www.climate.gov/teaching/resources/education/high-school-9-12>

<http://www.epa.gov/climatechange/science/indicators/index.html>

<http://www.ncdc.noaa.gov/paleo/slides/>

<http://www.nps.gov/gumo/naturescience/geologicformations.htm>

<http://www.nps.gov/cave/naturescience/geologicformations.htm>

<http://www.epa.gov/climatechange/science/future.html>
<http://climate.nasa.gov/effects>

Activity 1.4. It's my fault! Fold it, please!

FAULTS AND FOLDS LAB REPORT

QUESTION: Are faults and folds caused by the same kind of forces? Go to:
<http://www.williamsclass.com/SixthScienceWork/FoldFault/FoldFaultGeologyNotes.htm>

BACKGROUND RESEARCH: Go to the web site indicated above the title and write down the definitions of fault and fold. Then, describe the types of faults and folds we can find in nature.

HYPOTHESIS: Form your own hypothesis based on your findings.

EXPERIMENT

- MATERIALS: 3 different colors of modeling clay or play-doh, wax paper, knife, rolling pin

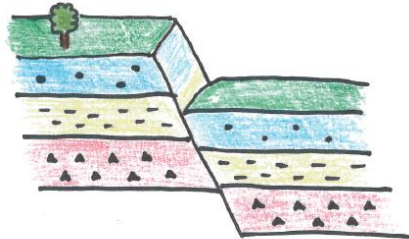
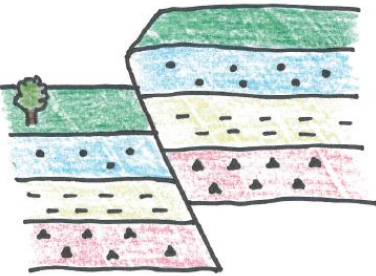
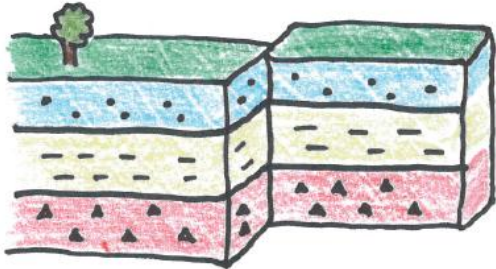

- PROCEDURE:

- Roll out each of the colors and flatten them onto a sheet of wax paper with the rolling pin.
- Place the layers on top of each other (you can leave the wax paper between the layers).
- Trim the edges so you can cut the clay into 5 different rectangles with the knife.
- Make the models of faults and folds. Three rectangles will represent the types of faults (normal, reverse and strike-slip) and two rectangles will represent the common types of folds (syncline and anticline).

RESULTS: Complete the data table. And describe what you found out after carrying out the experiment.

CONCLUSION: Was your hypothesis supported by your results?

DATA TABLE: Drawings will vary but they should be something similar to these:

TYPE		DRAWING
FAULT	NORMAL	
	REVERSE	
	STRIKE-SLIP	
FOLD	ANTICLINE	
	SYNCLINE	