G207 (Geology of the Pacific Northwest)
Activities Manual

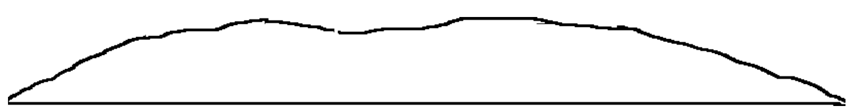
Discussion Activities

Discussion activities are mini-investigations designed to introduce geologic observation and problem solving. Though originally created for use in a classroom some can be easily adapted for field visits. Most are accompanied by web-based media listed on the web-site that accompanies this manual.

Activity 1:
Virtual fieldwork on Mt. Tabor

In this activity, you will be doing some scientific “fieldwork” with a virtual representation of a local volcano. Like any scientific investigation you will be making and recording observations, creating a hypotheses to explain something that you observed, and then devising ways to test your hypothesis. You will do by answering the following questions:

1. *Observation – What do you see?*
   To answer this question, copy the outline of the volcano shown below on a separate sheet of paper. To complete the sketch draw the boundaries of any major layers that you see, color major sections of it to show the color of the rock in each section, and write down on your drawing what you think you are looking at and any descriptions that you think are relevant. Also estimate the height and width of any



2. *Generating a hypothesis – The central part of the volcano is called the vent. Why does it look different from the rest of the volcano?*

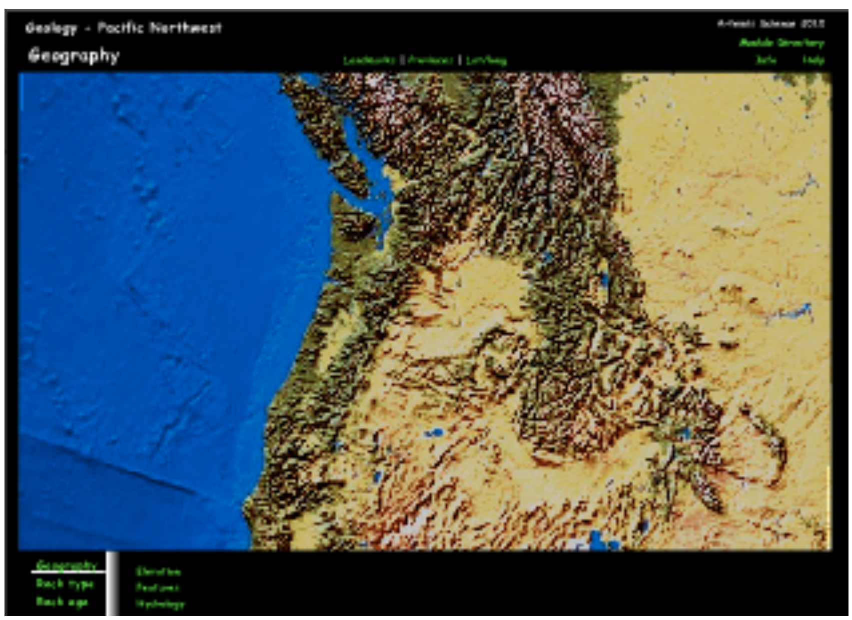
3. *Testing your hypothesis – What would you do to test your hypothesis?*

Companion media – Mt. Tabor Oregon, A virtual field site

Activity 2:
Geography of the Pacific Northwest

In this activity you will be familiarizing yourself with the geology of the Pacific Northwest. To do so use the maps in the companion media*, address the following questions.

1. *What are major mountain ranges in the Pacific Northwest? Give the place names of these ranges rather than looking up what type of mountain range they are.*
2. *What the major basins (valleys, sounds, and plains) in the Pacific Northwest?*
3. *What are the major features you find in the nearby ocean? What type of feature is each? (e.g. Gorda Ridge = Mid-ocean ridge).*
4. *Which provinces are primarily mountainous? Click on "Provinces" above the map to show the boundary of the provinces and regions on the nearby seafloor.*
5. *Which provinces largely basins?*
6. *Do you find any provinces that are difficult to identify as primarily mountainous or largely basins?*

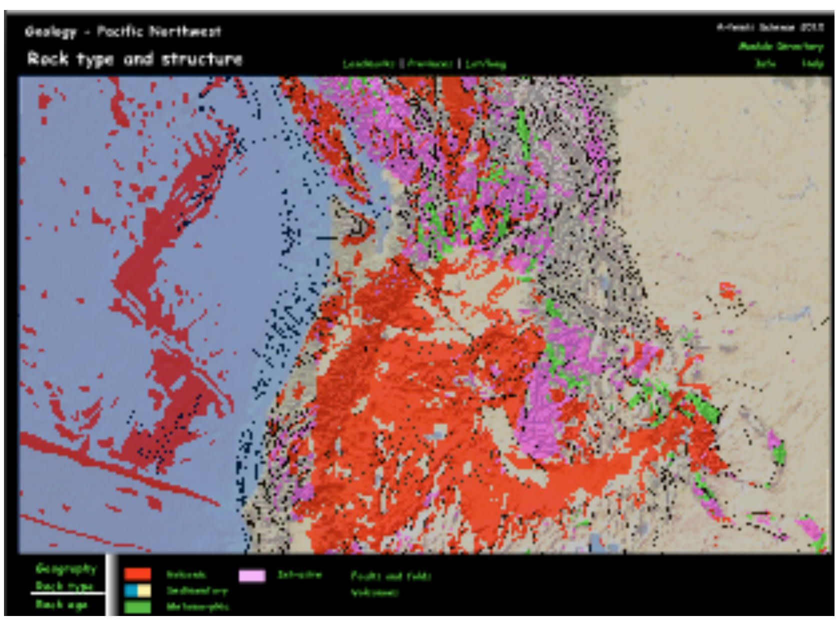


* <u>Companion Media</u>
Geologic Atlas Module from "GeoTime – Pacific Northwest"

Activity 3:
Geology and physiographic provinces of the Pacific Northwest

One of the defining characteristics of a physiographic province is its geology. In this activity you will be determining and comparing the geology of the provinces making up the Northwest. To do so use the maps in the companion media* to answer the following questions.

1. *What type of rock is dominant in the Pacific Northwest? To do this rank the four principle rock types listed on the map legend in terms of its prevalence. E.g. the most prevalent rock type is number 1 on your list, the second most prevalent is number 2, and so on.*
2. *In which provinces are volcanic rocks dominant? In which are intrusive rocks dominant? Note - The provinces are on land only.*
3. *In which provinces do you find large masses of metamorphic rock? In which do you find both large masses of metamorphic and intrusive rock?*
4. *In which provinces is sedimentary rock dominant?*
5. *Why do you think different rocks are dominant in different provinces?*

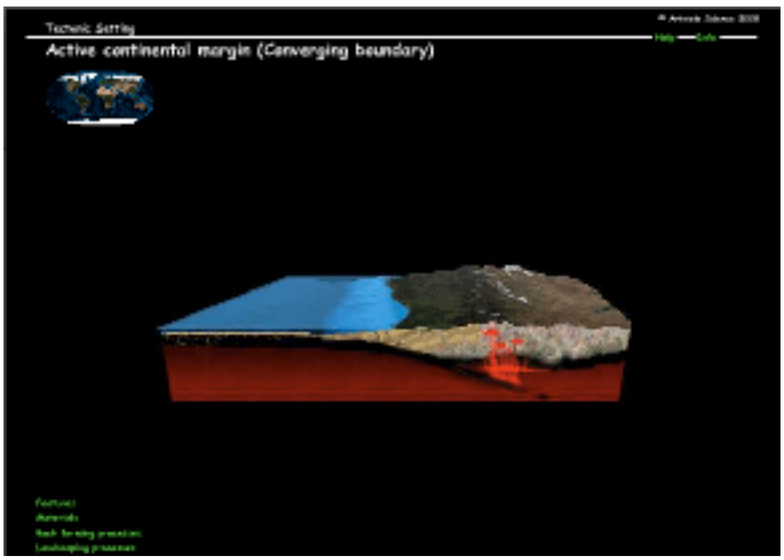


* Companion Media
Geologic Atlas Module from "GeoTime – Pacific Northwest"

Activity 4:
Landscapes and structures of an active margins

The western half of the Pacific Northwest is an active margin. To understand what this means and how it impacts geology and geography of the Pacific Northwest you will be using an interactive diagram of a generalized active margin to answer the following questions.

1. *How big is this area?*
2. *How does the right side of the scene differ from the left side?*
3. *What are the principle surface features in each side?*
4. *How deep is this block?*
5. *How does the continental crust differ from the oceanic crust?*

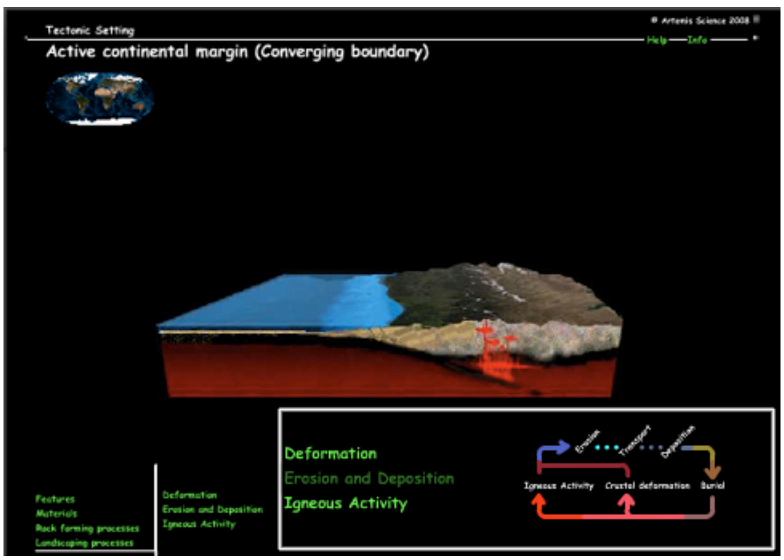


* Companion Media
Tectonic Setting – Active Continental Margin module from "GeoCycle"

Activity 5:
Internal processes shaping an active continental margin

One of the principle characteristics of an active continental margin is that volcanoes, earthquakes, faulting, and mountain building are extremely prevalent. To understand how plate motion relates to this activity you will be using the interactive diagram that you used in the previous discussion activity.

1. What kinds of faults do you find in on the continent?
2. Where do you find them?
3. Does there seem to be any relationship between the type of fault and how the crust is being stressed?
4. Where is the volcanic activity on the continent?
5. Where do you find large pockets of magma?
6. Why does the volcanic activity and crustal deformation appear where it does?

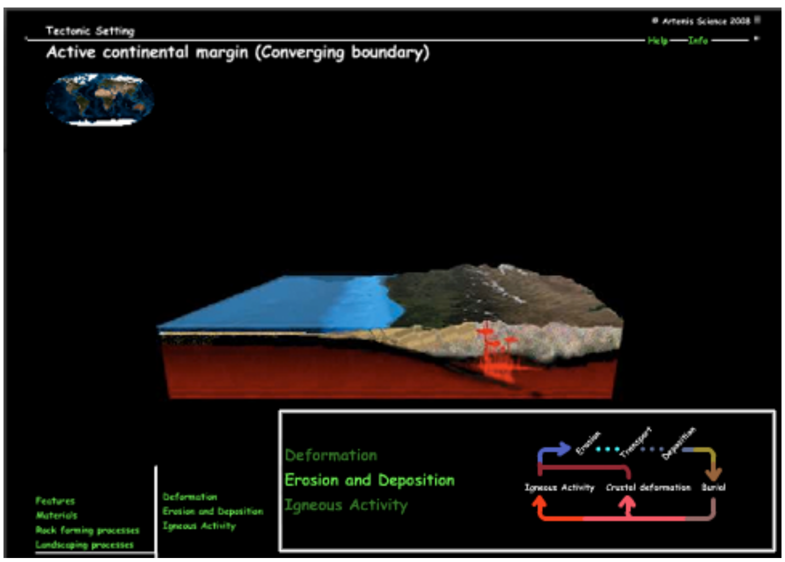


* <u>Companion Media</u>
Tectonic Setting – Active Continental Margin module from “GeoCycle”

Activity 6:
Surficial processes shaping an active continental margin

In addition to internal processes (volcanism and crustal deformation), surficial processes such as streams, glaciers, and mass wasting also shape the landscapes in an active continental margin. In this activity you will be using the same interactive diagram that you used in the last two activities to answer the following questions.

1. Where in this area is erosion dominant?
2. Where is deposition dominant?
3. Why does erosion or deposition dominate where it does?
4. What surficial processes are shaping this landscape? Where is each the most influential?
5. Why is this?

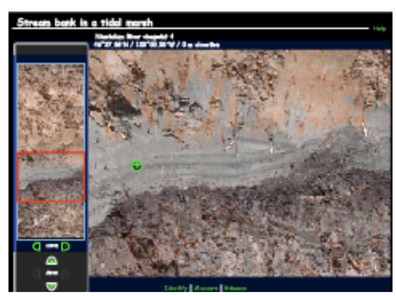


* <u>Companion Media</u>
Tectonic Setting – Active Continental Margin module from "GeoCycle"

Activity 7:
Sleuthing the geologic history of a tidal stream bank

In this activity you will be working to understand the recent geologic history of a stream bank along the Niawiakum River in southwestern Washington. To do this you will use the companion media* to answer the following questions.

1. *Environmental context: Where is this stream bank? What do you think are the five most important characteristics of this area? Click here to access the virtual tidal stream.*
2. *Outcrop description: Turn to 035° and click on the green plus sign. Draw a sketch of this stream bank. How many layers do you see? What is in each layer? How thick is each layer? Mark all this on your sketch.*
3. *Interpreting the history of this stream bank 1: Which layer is the youngest? Which is the oldest?*
4. *Interpreting the history of this stream bank 2: Which layer/layers is made up of sediment that is common to this area? What are you basing this conclusion on?*
5. *Interpreting the history of this stream bank 3: Which layer/layers is made up of sediment that looks like it came from some place else? How do you think it got here?*

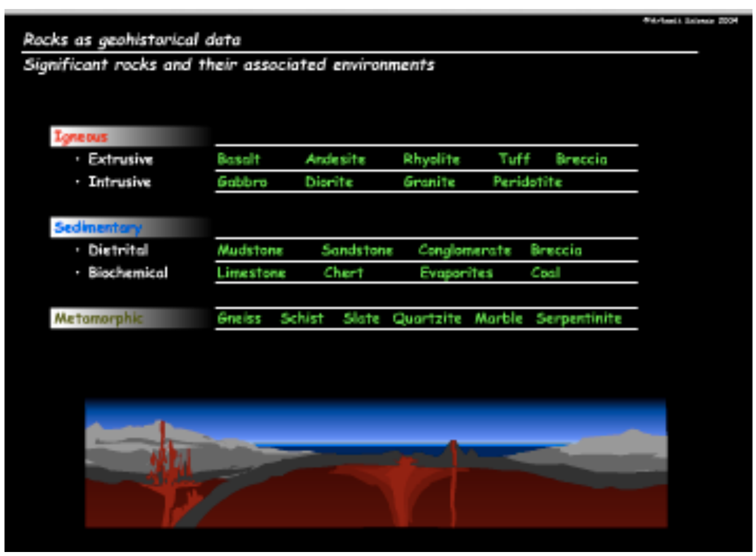


* <u>Companion Media</u>
The Niawiakum River branch of the “TOTLE in the Field” VFE (virtual field environment).

Activity 8:
Rocks as indicators of ancient environments

Individual rocks tell a story about the places from whence they come. When “read” carefully they provide a window into what the area was like at the time that they formed. In this activity you will be using an interactive rock catalog to “read” several rocks, by answering the following questions.

1. *Which igneous rocks form only on the seafloor? Which form on both land and on the seafloor? Where specifically do they form?*
2. *Which metamorphic rocks are associated with mountain building on the continents? Which are associated with volcanic activity on the seafloor?*
3. *Which sedimentary rocks are composed of sediment deposited on the seafloor? Which sedimentary rocks are composed of sediment deposited on land?*
4. *Sandstone is an indicator of what former depositional environments (places where sediment is deposited)?*
5. *How might you determine what environment the sand making up a sandstone was deposited in?*

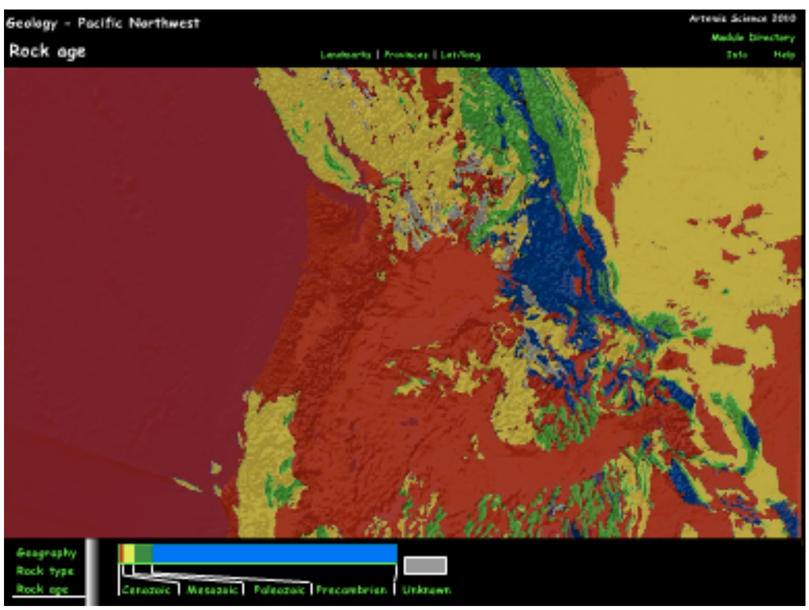


* Companion Media - Rocks as Geohistorical Indicators

Activity 9:
Sleuthing the Precambrian History of the Pacific Northwest

In this activity you will be using an interactive geologic map of the Pacific Northwest to look for evidence of what the Pacific Northwest was like prior to 570 million years ago.

1. *Where is the Precambrian rock in the Pacific Northwest? In other words what states and what physiographic provinces is it in?*
2. *How old is this rock?*
3. *What formations do you find?*
4. *What type of rock is in each formation?*
5. *Which formations could be associated with ancient continental mountain ranges or continental crust? How is the rock evidence for this?*
6. *Which formations could be associated with an ancient ocean basin or a very large lake? How is the rock and the distribution of the rock evidence for this?*

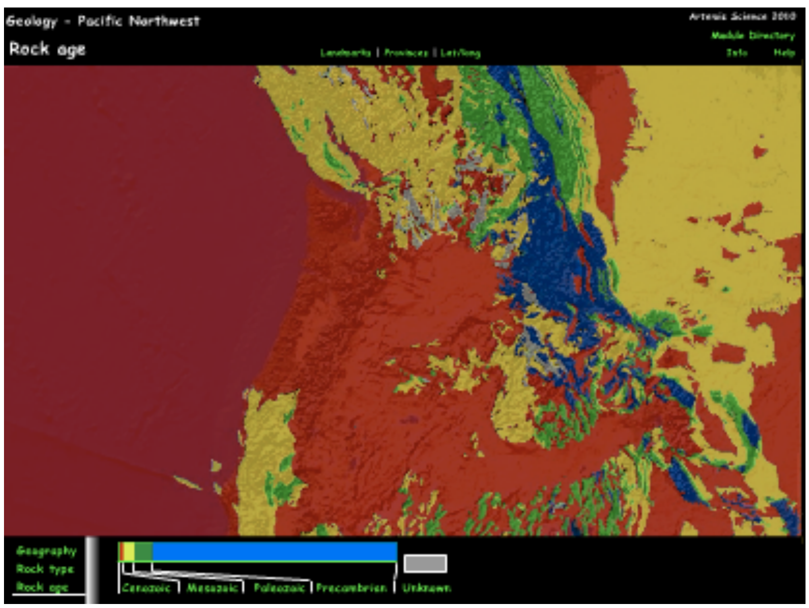


* <u>Companion Media</u>
Geologic Atlas Module from “GeoTime – Pacific Northwest”

Activity 10:
Periods of the Geologic Calendar

This session we look at approximately 470 million years of Northwest history spanning from 570 to 100 million years ago. This includes all of the Paleozoic and nearly two thirds of the Mesozoic. Using the companion media address the following questions.

1. *What are the major subdivisions (periods) of the time span that we are looking at this week?*
2. *When did each period begin? When did it end? How long was it?*
3. *Which of these time periods do you think we are the most certain about in terms of what happened? Why?*

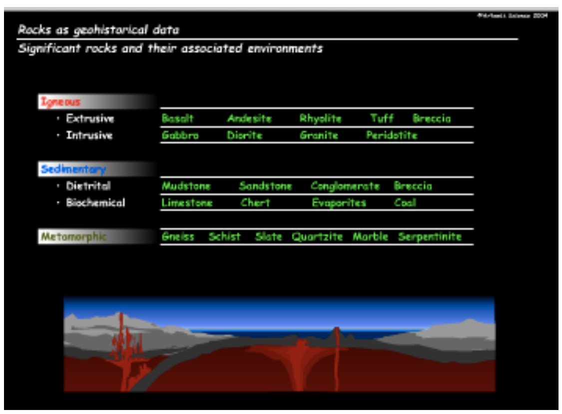


* <u>Companion Media</u>
Geologic Atlas Module from "GeoTime – Pacific Northwest"

Activity 11:
Interpreting rocks found in rock units of the Paleozoic and Early Mesozoic

Using the rock samples provided to you and the "Rocks as geohistorical data" media (click here to access this media) address the following questions.

1. *Samples 1-5 are sedimentary rocks common to Pz and Mz rock units. What is the texture and color of each rock?*
2. *In what type of environment was the sediment that now makes up the rock deposited? Use the "Rocks as geohistorical data" to answer this question.*
3. *How does the texture of each sample relate to the the environment in which the original sediment was deposited?*
4. *Samples 6 and 7 are igneous rocks common to some Pz and Mz rock units. What is the texture and color of each rock?*
5. *In what type of environment was each rock (samples 6 and 7) formed? How does the texture of the sample relate to the environment in which it was formed?*



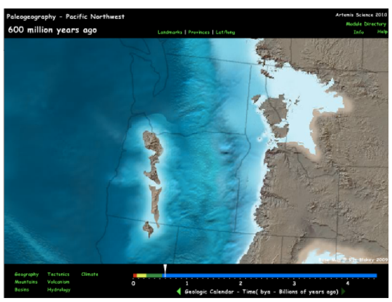
* Companion Media - Rocks as Geohistorical Indicators

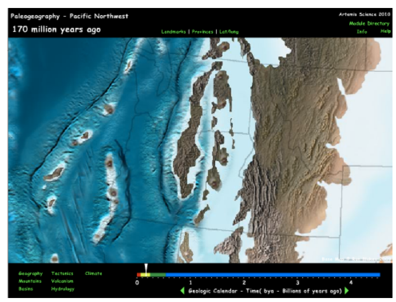
Samples
1) Sandstone, 2) Conglomerate, 3) Limestone, 4) Mudstone, 5) Chert
6) Granite, 7) Gabbro

Activity 12:
Paleogeography of the Paleozoic and Early Mesozoic

Use the maps in the paleogeographic module of “GeoTime – Pacific Northwest” to answer the following questions.

1. *How does the orientation and latitude/longitude ot the Pacific Northwest change between 600 and 170 million years ago? What is causing this change?*
2. *What happens to the shoreline of the Northwest during that period of time? At what point does the Northwest become an active margin? How does this change explain the changes that you observed in the Northwest coastline?*
3. *During this period of time several accreted terranes form. Find three successive time steps that illustrate the formation of an accreted terrane. How does this explain the changes that you observed in the Northwest coastline?*
4. *Between 540 and 410 million years ago what happens in Wyoming in terms of sea level? At what point are large volumes of sediment being deposited? When is it being eroded?*



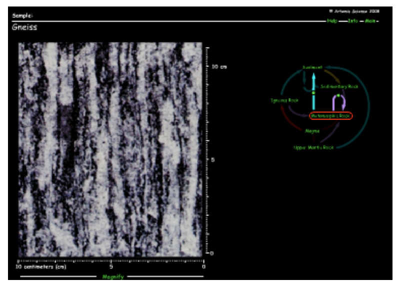


* <u>Companion Media</u>
Paleogeographic Module from “GeoTime – Pacific Northwest”

Activity 13:
Observing and Interpreting Metamorphic Rocks

Using the companion media* and the five rock samples provided to you, address the following questions.

1. *Samples 1-5 are metamorphic rocks common to Mz rock units. What is the texture and color of each rock?*
2. *What are some common proliths for each rock? Use the geologic cycle simulator to answer this question.*
3. *What range of pressures and temperatures are necessary to create each metamorphic rock?*



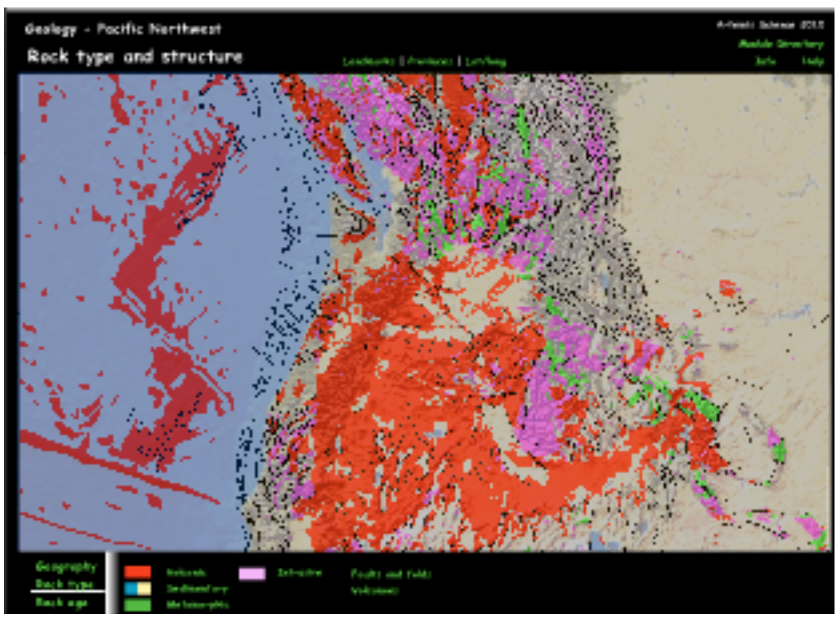
* <u>Companion Media</u>
Simulator Module from "GeoCycle"

Samples
1) Gneiss, 2) Slate, 3) Quartzite, 4) Schist, 5) Serpentinite

Activity 14:
Locating and Interpreting Metamorphic Rocks in the Pacific Northwest

Using the companion media* address the following questions.

1. *In what provinces are Mesozoic age rocks common?*
2. *In what provinces are metamorphic and intrusive igneous rocks common?*
3. *What is the relationship between these these groups? Are they the same or different?*
4. *In which of these provinces do you find prominent thrust, slip-strike, and normal faults?*
5. *How might the abundance of faults and intrusions in some of these provinces explain the abundance of metamorphic rock.*



* Companion Media
Geologic Atlas Module from “GeoTime – Pacific Northwest”

Activity 15:
Virtual Fieldwork in Accreted Terranes

Using the three Google Earth Placemarks address the following questions.

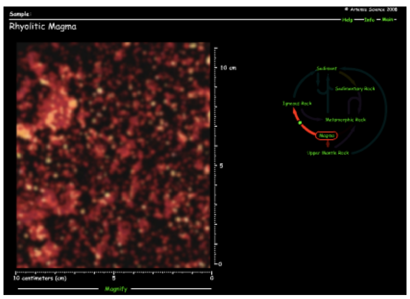
1. Describe the rock present at each site. What does it look like in hand sample (see the red box near the top of the photo)? What does it look like when you step back and look at the whole outcrop? E.g. color, layering, orientation of fractures, etc.
2. What rock found in your sample tray do you think is found at each site?
3. If the rock is a metamorphic rock, what might it once have been?
4. What stage of accreted terrane development is represented by the rock at this site?

* Companion Media
Google earth placemarks and virtual sites for Diablo Dam Overlook (North Cascades),

Activity 16:
Observing and Interpreting Intrusive Igneous Rocks

Using the companion media* and the five rock samples provided to you, address the following questions.

1. *What are the principle physical characteristics of each sample?*
2. *How do each of the intrusive igneous rocks found in your tray form? In some cases there may be more than one way to form the same rock.*
3. *Given that all of these rocks form at least 4 km below the surface, how might they have been uplifted and exposed?*



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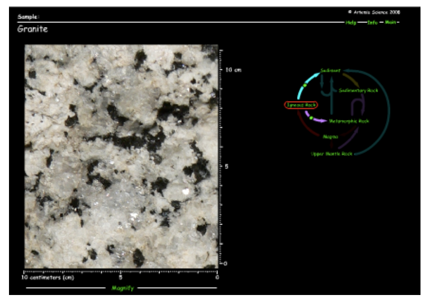


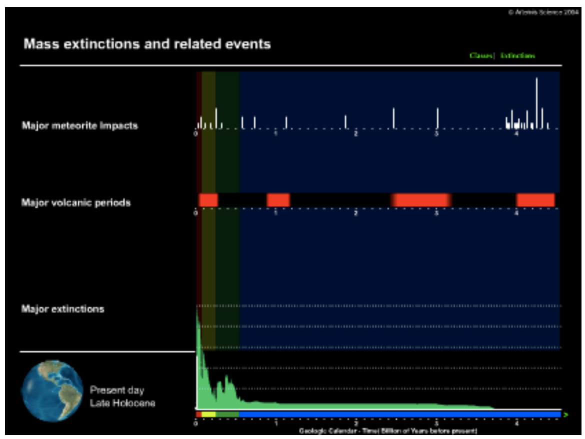
* <u>Companion Media</u>
Simulator Module from "GeoCycle"

Samples
1) Granite, 2) Gabbro, 3) Periodite, 4) Diorite

Activity 17:
Biological Extinctions and the End of the Mesozoic

Using the extinctions mode of the evolutionary timeline in the companion media* address the following questions.

1. *From the Permian to the end of the Mesozoic, how many major extinctions are recorded in the timeline?*
2. *What percentage of what organisms went extinct during each "event"?*
3. *What other events correspond to these extinctions?*
4. *How might these events have brought on, the extinctions?*

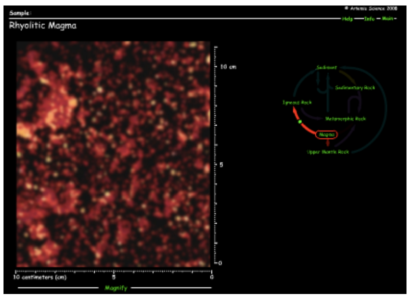


* <u>Companion Media</u>
Biological Evolution Information Module from “GeoTime”

Activity 18:
Observing and Interpreting Extrusive (Volcanic) Igneous Rocks

Using the companion media* and the five rock samples provided to you, address the following questions.

1. *What are the principle physical characteristics of each sample?*
2. *How do each of the extrusive igneous rocks found in your tray form?*



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* <u>Companion Media</u>
Simulator Module from “GeoCycle”

Samples
1) Basalt, 2) Rhyolite, 3) Andesite, 4) Tuff, 5) Obsidian

Activity 19:
Volcanoes and Volcanic Rock

Using the companion media* address the following questions.

1. *Where might each of the samples you looked in the previous activity have been formed? In other words what type of volcano might have produced each sample.*

   To begin looking for this information, select "landforms" from the menu at the bottom of the frame. This will give you the screen that you see below (Figure a). Then select a volcano from the list on the left. When you have selected a type of volcano a list will of characteristics will appear above it to the right (Figure b). "Materials" is one of the options on that list.

2. *What are the principle structural characteristics of each volcano?*
3. *How does each type of volcano erupt?*

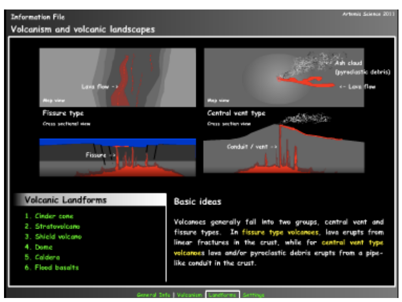


Figure a

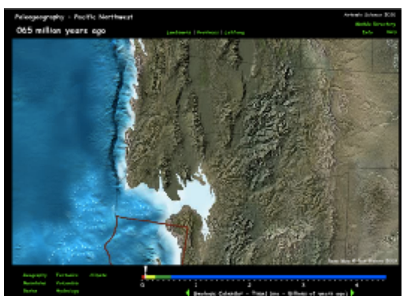
Figure b

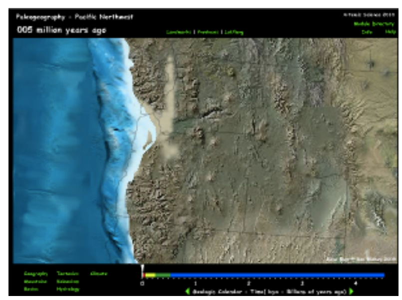
* <u>Companion Media</u>
Volcanism and Volcanic Landscapes file from "GeoTime – Pacific Northwest"

Activity 20:
The Pacific Northwest during the Tertiary

Using the companion media* to address the following questions.

1. *Between 65 and 5 million years ago, how did the geography of the Pacific Northwest Change?*
2. *Between 65 and 5 million years ago, how did the arrangement of crustal plates and plate boundaries change? To answer this select "Tectonics" from the menu in the lower left corner of the frame.*
3. *From 65 and 5 million years ago, what major volcanic episodes occurred? Where was each one and how long did it last? To answer this select "Volcanism" from the menu in the lower left corner of the frame.*



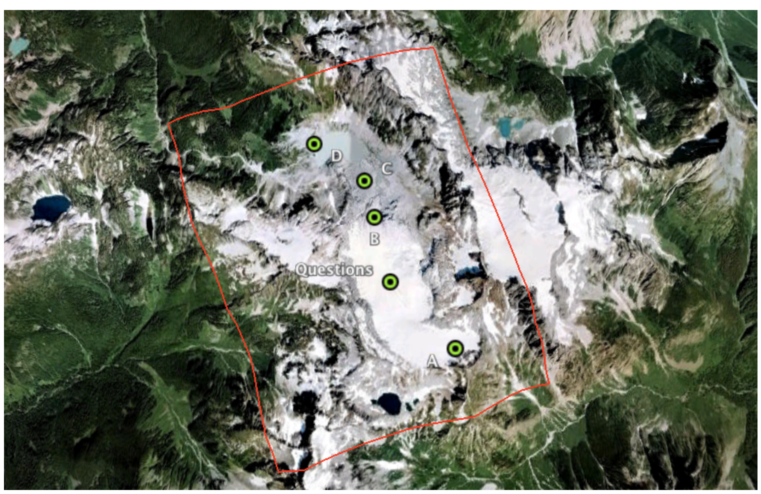


* <u>Companion Media</u>
Paleogeographic Module from “GeoTime – Pacific Northwest”

Activity 21:
A contemporary glacier - South Cascade Glacier, North Cascades Washington

Using the place marks and other overlays in this folder* answer the following questions...

1. *How many glaciers are inside the area outlined in Red? How did you determine what was glacier and what wasn't?*
2. *Find the large glacier in this area. What kind of glacier is this?*
3. *Describe the areas around points A, B, C, and D. What is longitude, latitude, and elevation of each? What is the surface around each point like? What is the surrounding valley like?*
4. *Look closely at points A and B. Both are on the glacier. How and why do the surfaces look different? Do you see any indications in either place that the glacier is moving?*
5. *How do you think rock and sediment is being transported downhill at points A, B, can C?*
6. *Point D is on the top of a natural dam that holds back water in the in the nearby lake. How much higher is Point D than the surface of the Lake? What is the Latitude and Longitude of the outlet stream? How did this natural dam form?*



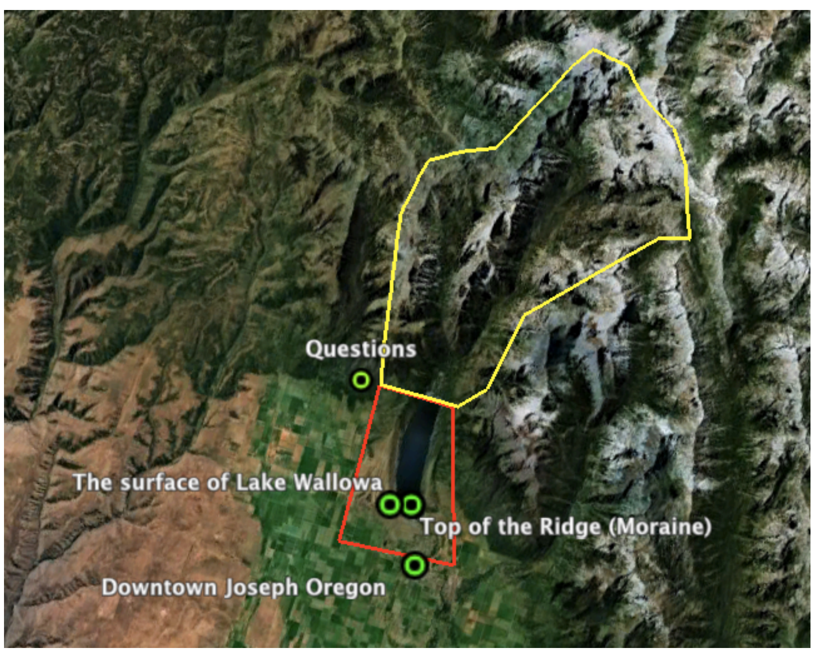
* Companion Media
Google Earth with *placemark set for this activity

Activity 22:

Lake Wallowa during the last glacial maxima(18,000 years ago)

Using the place marks and other overlays in this folder answer the following questions...

1. *How much higher is the surface of Lake Wallowa than downtown Joseph Oregon?*
2. *How much higher is the top of the ridge than the surface of the Lake and downtown Joseph?*
3. *Given that a glacier produced the ridge where do you think the end of the glacier was during the last glacial maxima? Give the position in latitude, longitude, and elevation.*
4. *Where was the beginning of the glacier? Give the position in latitude, longitude and elevation.*
5. *How is area A (Red Outline) look different from area B (Yellow Outline)?*
6. *Why do they look so different?*



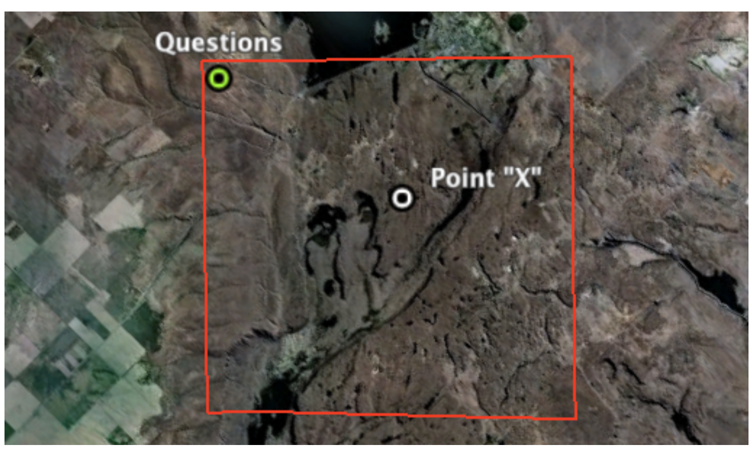
* Companion Media
Google Earth with *placemark set for this activity

Activity 23:

Grand Coulee South during the last glacial maxima(18,000 years ago)

Using the place marks and other overlays in this folder answer the following questions...

1. *Looking straight down onto this section of Grand Coulee, draw a map of the area outlined in red. Make sure to label major features (e.g. roads, lakes, canyons, or valleys. Everyone should do his or her own map.*
2. *Contained in this area is a place called Dry Falls. This is a former waterfall similar in shape to Niagara Falls. Find the falls and mark them on your map. Also determine how high and how wide the falls were. What did you look for to determine where the falls are?*
3. *Describe the area around point x.*
4. *Based on what you saw around point x, draw arrows on your map indicating which way the water flowed in this section of the Grand Coulee. What did you based your conclusions on.*
5. *Given that the area around point x is largely bare rock, what does this say about the velocity of the water through this area? What did you base your conclusion on?*



* Companion Media
Google Earth with *placemark set for this activity

Activity 24:
The Oregon-Washington coast during the last glacial maxima (18,000 years ago)

Using the placemarks and other overlays in this folder answer the following questions...

1. *How much lower was sea level during the middle of the last glacial maxima than it is now? Hint - Look for the white line marked "Pleistocene coastline"*
2. *How much further west was the coastline than it is now?*
3. *Just to the west of the Pleistocene coastline is a feature called the Astoria Canyon? How long is it? How deep is it? You may have to give several answers to the last question.*
4. *How could a canyon like this have formed? Hint - Most of this canyon probably formed during the last ice age.*
5. *What evidence would you look for in this area to confirm your hypothesis?*

* Companion Media
Google Earth with *placemark set for this activity

Activity 25:
Modeling Crustal Deformation

Using the companion media for this activity answer the following questions...

1. *What do you need to do to create a fold? Extension, compression, or shearing?*
2. *What type of fault or faults does compression produce?*
3. *What type of fault or faults does extension produce?*
4. *What type of fault or faults does shearing produce?*
5. *Draw a picture showing how faults produced by extension and shearing could appear near each other? What kinds of faults would appear in this area?*
6. *Draw a picture showing how faults produced by compression and shearing might appear in roughly the same place? What kinds of faults would appear in this area?*

→


To address these questions select “Structure” from the menu “Topics in this file” and click on the green arrows on the bottom of the screen to view specific faults and folds.

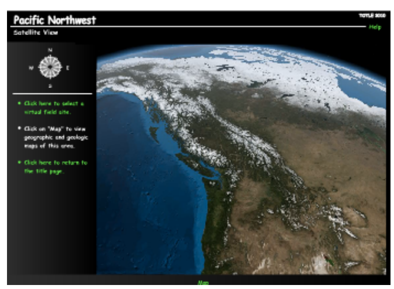
* <u>Companion Media</u>
The crustal deformation information file for “GeoCycle”

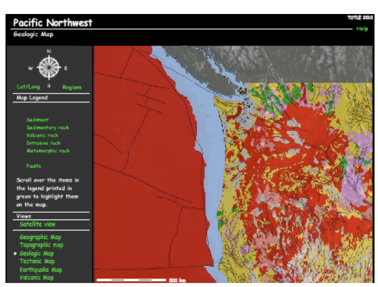
Activity 26:
Faulting in the Pacific Northwest

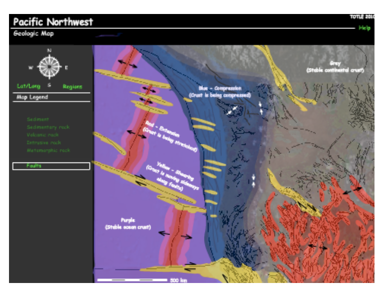
Using the companion media for this activity to answer the following questions. *What areas are being stretched (undergoing extension)?*

1. *What areas are being compressed?*
2. *What areas are being sheared?*
3. *What type of faults would you expect to find in each of these areas?*
4. *The continental shelf is largely an area where the crust is being compressed. Why are there parts of the shelf where shearing is taking place?*
5. *Above the Basin and Range is a shear zone called the Brothers fault zone. What is happening above the shear zone? Why is the crust being sheared at this place?*

To access the map you need, click on “Map” at the bottom of the screen. Select the Geologic Map from the “Views” menu and then select “Faults” from the “Map legend”…







* Companion Media
Regional Map set for “TOTLE in the Field”