# Virginia View Curriculum

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**Summary**

In this investigation students will first examine the earthquake history in Virginia and then check out the most current situation using maps from the USGS (United States Geologic Society). Students will then investigate how to best prepare for an earthquake and what can be done to prevent lost lives and lost property damage.

**Classroom Materials**

This lesson can be completed with computers loaded with ArcGIS and internet access (recommended), computers with internet access only, or without computers.

**Submitted by**

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## Contact Information

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Teacher Guide

Applicable Virginia SOLs:

ES.1 The student will plan and conduct investigations
ES.2 The student will demonstrate scientific reasoning and logic
ES.3 The student will investigate and understand how to read and interpret maps, globes, models, charts, and imagery
ES.8 The student will investigate and understand geologic processes including plate tectonics.

Teacher Preparation:

- Review the background material on Earthquakes with students.
- Follow the instructions listed in “Procedure” to use computers loaded with ArcGIS and internet access.
- If you do not have access to ArcGIS, you could complete the lesson using one of the following:
  - Internet access but no ArcGIS: Have students go to www.virginiaview.net and click on the Digital Atlas link. Scroll down to “Digital Atlas Layers” and click on “Earthquakes in Virginia between 1774 and 2003” (they are listed alphabetically). Under “Access Options” click on the link for the Interactive Web mapper. This should work for Questions 1-6. For the Group Project, have students do additional research using Google Earth or other online mapping program.
  - No computer access: Before class, print out the map located at http://gep.frec.vt.edu/Digital_Atlas_PDFs/earthquakes.pdf, the county key (attached at end of document), and visit the websites listed on questions number 8-12 and number 1 under Earthquake Preparedness, print out required information for students.
- Print the Student Worksheet.
- A key is attached.
Background Information:

An earthquake occurs when there is a release of energy in the Earth's crust due to stress or strain. This stress can be the result of tectonic plates converging (coming together), diverging (coming apart) or sliding past each other.

Most earthquakes occur along known faults, usually along plate boundaries. The San Andreas Fault in California is probably one of the best known example of a plate boundary that has frequent earthquakes. There are ancient faults that exist in many states. These faults are not as active as the current plate boundaries, however they have had earthquakes in the past and could have earthquakes in the future. The New Madrid fault in the middle of the United States is an example of an ancient fault that has not been active recently (a relative term).

The geology of Virginia involved a series of accretions (adding land to an existing continent) as proto-North America collided with proto-Africa to form Pangaea. A series of thrust faults underlay much of the Appalachian Mountains and Valleys. These faults, like the Narrows Fault, Pulaski Fault, Fries Fault and Salem thrust fault often have small (1-3 magnitude) quakes.

Earthquakes cause a substantial amount of damage to structures and buildings and roadways. Many lives have been lost do to earthquake destruction. Being prepared for an earthquake is the first step in preventing lost lives and lost property.

In this investigation students will first examine the earthquake history in Virginia and then check out the most current situation using maps from the USGS (United States Geologic Society). Students will then investigate how to best prepare for an earthquake and what can be done to prevent lost lives and lost property damage.
Procedure: (For Teacher and Students)

1. Make sure your CPS are loaded with ArcEditor or ArcMap.
2. Open up ArcMap with an empty map.
3. Click on (+) or go under File; add data
4. In the pop up window "Look in", click on the drop down arrow/menu and choose "GIS Servers" * it may be down at the bottom of the list, so keep looking, then Click Add
   *If using ArcGIS 10, in catalog click on drop down menu to "GIS Servers". In window in catalog expand folder GIS Servers, double click Add ArcGIS Server. On the first window, select “Use GIS Services.” Follow the directions in the wizard (see steps 7-9 below)
5. In the next window, select: "Add ArcGIS Server", Click add, a new pop up window "Add ArcGIS Server" appears.
6. Select "use GIS services", click next
7. A new pop up window "General" appears
   Select "internet" and type or paste URL in window: http://arc.gis.vt.edu/arcgis/services
8. Leave Authentication (optional) info blank, click "finish"
9. You will see the name arcgis on arcgis.vt.edu as a listing/choice in the "Add Data" pop up window
10. Close the "General" window
11. In the "Add Data window, click on arcgis on arcgis.vt.edu and make sure in the name field it says "arcgis on arcgis.vt.edu", and the Show of type says "Datasets and layers (.lyr)", Click ADD
12. In the new "Add Data window", click/select the folder "VA View", then ADD
13. Select : "Earthquakes" to add the earthquakes in Virginia, data layer.
14. Click on the layer name so it is highlighted : "Earthquakes" and then right click and ZOOM TO LAYER. You may have to keep zooming until you see the state of Virginia full screen on your map. Use the (+) magnifier, click and drag a box around the state of Virginia. Wait for the map to reload.
15. Expand all the data layers (click on the + box next to each name). You should get the following:
16. Be sure to name (no spaces between names, use _, if you need to space out words) and save your map frequently on your C drive in a designated folder. Under File-Click on Map Document Properties- Under the General Tab, make sure that the box near "Pathnames" is checked to "Store Relative pathnames to data sources" is selected.

17. Zoom in to the state of Virginia so it fills your map page! (hint: use the (+) magnifier and click and drag a box around the state of Virginia! You might need to do this more than once. Remember if the globe/world is spinning the program is redrawing the map. PLEASE be patient and let it redraw before you zoom in again!)
Student Worksheet

Earthquakes in Virginia

Name _____________________________  Partner's Name _____________________

1. Turn Off the "Recent Quakes" layer (uncheck the box next to the names)

What areas of Virginia have had earthquakes in the past? (Ex: Western Virginia, Coastal Region, Northern VA, etc)
_________________________________________________________________________

2. Make sure you have expanded the menu in "Earthquakes" so you can see the various colors and years of earthquakes in Virginia. (Ex: 1774 = dark blue, 1775-1850 = teal 1851-1900 = green, etc). What do you notice about the trend/spread of the earthquakes in Virginia since 1774 to 2003? (hint: Are they randomly distributed or do they seem to occur in groups/clusters?)
_________________________________________________________________________

3. Use the zoom (+ magnifier) button to zoom into the dark blue area where the first earthquake occurred in Virginia. Approximately where in the state is this location?
_________________________________________________________________________

4. Select the Identify tool (i). Click on an area. In the dialog box, Use the drop-down menu next to “Identify From:” and choose the “Counties” sub-layer. Now you can click on a county and identify it using this tool.

If using the online viewer, you may need to scroll to the right in the pop-up box to see the county name. If not using computers, you will need to use the county key to identify counties.

What are the two counties in Virginia that had earthquakes in 1775-1850?
_________________________________________________________________________

What county had the most earthquakes overall? ____________________________
5. Zoom back out to see the whole state of Virginia. Notice that the Earthquakes layer is divided into six categories/times of earthquakes in Virginia. What are the colors and the years/categories?

1) _______________________________ 4) _________________________________
2) _______________________________ 5) _________________________________
3) _______________________________ 6) _________________________________

6. Where do you notice that the most earthquakes in Virginia's past are located? _________________________________________________________________ What do you think could cause this pattern?

What time frame (years) had the most earthquakes in Virginia in the past?
______________

7. Go on the internet to the United States Geological Survey website: http://www.usgs.gov/. Click on the "Hazards" link on the top of the page. (Note: Web pages often change links, you might have to search the site to locate the same information!) Click on "Earthquakes Hazards". This will take you to the Earthquake page of the USGS, http://earthquake.usgs.gov/ Click on the Map "USA" on the far left of the page. This will take you to a map of the United States with the Latest Earthquakes in US-Last 7 days earthquakes shown.

Where (what part of the United States) have there been earthquakes in the last 7 days? ___________________________________________________________________

What is the highest magnitude listed for this time period? ___________________________ What state did that earthquake occur in? ___________________________

8. Click on the map on the STATE OF VIRGINIA. This should open another smaller map with Virginia and other neighbor states shown.
Do you see any earthquakes in Virginia? Yes or No (circle one). If yes, where was it and what magnitude was it? ___________________________________________________

9. Navigate to find out the most recent earthquake in Virginia. On the left side of web page, click on "Earthquake Lists & Maps". Go to Earthquake Information: by state. Click on Virginia. On the "Virginia Earthquake Information" page, scroll down to Recent Earthquakes and click on the link, Last Earthquake in Virginia. (Note: These links could have changed, but the information should still be available on the USGS site. You may have search the site to find it.)

When and where was the most recent earthquake in Virginia recorded?
__________________________________________________________________________

What was its magnitude? ____________________________________________

10. Navigate back to the "Virginia Earthquake Information" page. Find the Notable Earthquakes category and click on the link: Largest Earthquake in Virginia: 1897 May 31, Magnitude 5.9" and read about the Giles County Earthquake that occurred then.

How was the intensity rating of VIII assigned?
In what town was the shock felt severely? ______________________________

What was the evidence? ________________________________________________

What other places in Virginia experienced damage?

What other states also felt this quake? (hint: click on the "isoseismal map" link )

11. Go back to "Recent Earthquakes" and click on link: "Recent Earthquakes Recorded at the VTSO" to see what quakes were recorded at the Virginia Tech Seismological Observatory.

List the last 3 earthquakes recorded by location and magnitude

1) ____________________________, 2) ____________________________,
3) ____________________________

Do earthquakes in Virginia occur only in one region? ___________________

12. Navigate to the homepage of the VTSO; http://www.geol.vt.edu/outreach/vtso/ Scroll down to the "Recent Seismograms" link. Click on today's date to see what is happening at the station. You may have to enlarge the page to see the seismograph. Do you notice any p or s waves? ____________ How can you tell when an earthquake has occurred by looking at the seismogram? ____________________________

Which wave would arrive at the seismograph station first? _________________

EARTHQUAKE PREPAREDNESS
1. Go to the USGS Earthquake Preparedness Page: http://earthquake.usgs.gov/prepare/ Click on the link "Seven Steps to Earthquake Safety”. List the first 4 steps:

a) ___________________________________________________________________________
b) ___________________________________________________________________________
c) ___________________________________________________________________________
d) ___________________________________________________________________________

2. What should you do during an Earthquake?
______________________________________________________________________________

3. Where is the safest place to be during an Earthquake? ________________________________
______________________________________________________________________________

4. What should you do after an Earthquake? _________________________________________
______________________________________________________________________________

Conclusions:

1. Should Virginians be worried about earthquakes? Explain

2. What counties in Virginia should have earthquake preparedness plans?

3. What should schools do to prepare students for an earthquake event?

4. What should your family do to be prepared for an earthquake event?
Student Worksheet

Earthquakes in Virginia (key)

Name _____________________________  Partner's Name _____________________

1. Turn Off the "Recent Quakes" layer (uncheck the box next to the names)

What areas of Virginia have had earthquakes in the past? (Ex: Western Virginia, Coastal Region, Northern VA, etc)

**Southwestern Virginia, Northwestern Virginia, Central Virginia, around Petersburg, VA**

2. Make sure you have expanded the menu in "Earthquakes" so you can see the various colors and years of earthquakes in Virginia. (Ex: 1774 = dark blue, 1775-1850 = teal 1851-1900 = green, etc) What do you notice about the trend/spread of the earthquakes in Virginia since 1774 to 2003? (hint: Are they randomly distributed or do they seem to occur in groups/clusters?)

Earthquakes seem to be clustered. There are 3 areas of clusters; southwestern Va, northwestern VA, (along the Appalachian Mountains), Central Virginia between Charlottesville and Richmond. There is one old site near Petersburg.

3. Use the zoom (+ magnifyer) button to zoom into the dark blue area where the first earthquake occurred in Virginia. Approximately where in the state is this location? **Petersburg, VA**

4.

What are the two counties in Virginia that had earthquakes in 1775-1850? **Franklin County** and **Goochland County**. What county had the most earthquakes overall? **Giles County**

5. Zoom back out to see the whole state of Virginia. Notice that the Earthquakes layer is divided into six categories/ times of earthquakes in Virginia. What are the colors and the years/ categories?

1) **1774 = Dark Blue**  
2) **1775-1850 = Teal**  
3) **1851-1900 = green**  
4) **1901-1925 = yellow**  
5) **1926-1975 = dark yellow**
3) \(1851-1900 = \text{green}\)  
6) \(1976 -2003 = \text{brown}\)

6. Where do you notice that the most earthquakes in Virginia's past are located? **South western Virginia, (Appalachian Mtns)** What do you think could cause this pattern? **Series of thrust faults formed when proto-North America and proto-Africa collided to form Pangaea**

What time frame (years) had the most earthquakes in Virginia in the past? **1851-1900**

7. Go on the internet to the United States Geological Survey website: [http://www.usgs.gov/](http://www.usgs.gov/). Click on the "Hazards" link on the top of the page. (Note: Web pages often change links, you might have to search the site to locate the same information!) Click on "Earthquakes Hazards". This will take you to the Earthquake page of the USGS, [http://earthquake.usgs.gov/](http://earthquake.usgs.gov/). Click on the Map "USA" on the far left of the page. This will take you to a map of the United States with the Latest Earthquakes in US-Last 7 days earthquakes shown.

Where (what part of the United States) have there been earthquakes in the last 7 days? **Answers will vary depending on the current conditions. Most likely in California**

What is the highest magnitude listed for this time period? **Answers will vary with the current situation.** What state did that earthquake occur in? **Answers will vary with current situation. Most likely California.**

8. Click on the map on the STATE OF VIRGINIA. This should open another smaller map with Virginia and other neighbor states shown.
Do you see any earthquakes in Virginia? Yes or No (circle one). If yes, where was it and what magnitude was it? **Answers will vary with the current situation. You will need to check the site ahead of the students conducting the lab to obtain the most current data.**

9. Navigate to find out the most recent earthquake in Virginia. On the left side of web page, click on "Earthquake Lists & Maps". Go to **Earthquake Information : by state**. Click on **Virginia** On the "Virginia Earthquake Information" page, scroll down to **Recent Earthquakes** and click on the link, "Last Earthquake in Virginia". (Note: These links could have changed, but the information should still be available on the USGS site. You may have search the site to find it.)

When and where was the most recent earthquake in Virginia recorded? **Answers will vary with the current situation. You will need to check the site ahead of the students conducting the lab to obtain the most current data.**

What was its magnitude? **Answers are dependent on the current data, check site prior to students conducting lab.**
10. Navigate back to the "Virginia Earthquake Information" page. Find the **Notable Earthquakes** category and click on the link: "Largest Earthquake in Virginia: 1897 May 31, Magnitude 5.9" and read about the Giles County Earthquake that occurred then.

How was the intensity rating of VIII assigned? **The MM intensity VIII assigned to this earthquake is based on "many downed chimneys" and "changes in the flow of springs."**

In what town was the shock felt severely? **Narrows, VA**

What was the evidence? **"The surface rolled in an undulating motion, water in springs became muddy, and water in some springs ceased to flow."**

What other places in Virginia experienced damage? **"The shock was strong at Pearisburg, where walls of old brick houses were cracked and many chimneys were thrown down or badly damaged. Many chimneys also were shaken down at Bedford, Pulaski, Radford, and Roanoke, Virginia. Many chimneys were damaged at Christiansburg, Dublin, Floyd, Houston, Lexington, Lynchburg, Rocky Mount, Salem, Tazewell, and Wytheville, Virginia."**

What other states also felt this quake? (hint: click on the "isoseismal map" link) **"Charlotte, Oxford, Raleigh, and Winston, North Carolina; Knoxville, Tennessee; and Bluefield, West Virginia. Felt from Georgia to Pennsylvania and from the Atlantic coast westward to Indiana and Kentucky. Aftershocks continued through June 6, 1897."**

11. Go back to "**Recent Earthquakes**" and click on link: "Recent Earthquakes Recorded at the VTSO" to see what quakes were recorded at the Virginia Tech Seismological Observatory.

List the last 3 earthquakes recorded by location and magnitude

1) **Answers will vary with current information**, be sure to visit site prior to students conducting lab. 2)_______________________________.

3) __________________________________________

Do earthquakes in Virginia occur only in one region? **No, they occur in several regions in the state.**
12. Navigate to the homepage of the VTSO; http://www.geol.vt.edu/outreach/vtso/. Scroll down to the "Recent Seismograms" link. Click on today's date to see what is happening at the station. You may have to enlarge the page to see the seismograph. Do you notice any p or s waves?  

**Answers will vary with current data.** How can you tell when an earthquake has occurred by looking at the seismogram? **When there is a dramatic change in direction of the needle, a high peak and valley.** Which wave would arrive at the seismograph station first? **p or primary (compression waves) travel the fastest, the s wave would arrive after the p wave.**

**EARTHQUAKE PREPAREDNESS**

1. Go to the USGS Earthquake Preparedness Page: http://earthquake.usgs.gov/prepare/. Click on the link "Seven Steps to Earthquake Safety". List the first 4 steps:

   a) **Prepare: Step 1:** Secure it Now, clean out hazardous chemicals and secure possessions (TV's, Computers, etc)

   b) **Prepare: Step 2:** Make an Evacuation and Reunion Plan (Out of state contact person's info, etc)

   c) **Prepare: Step 3:** Make Disaster Kits (food, water, flashlights, first aid, etc)

   d) **Prepare: Step 4:** Is your home safe? (Check foundation, repair masonry, fix vulnerable places, etc)

2. What should you do during an Earthquake? **Do not panic, go quickly to a safe place (DROP, COVER and HOLD ON )** During earthquakes, drop to the floor, take cover under a sturdy desk or table, and hold on to it firmly. Be prepared to move with it until the shaking stops. If possible turn off gas mains and water!

3. Where is the safest place to be during an Earthquake? **On the lowest level of the building, on the floor, under a table or desk, protect yourself from falling debris. Outside in an open field, on the ground away from anything that could fall on you (watch for power lines).**

4. What should you do after an Earthquake? **After the Earthquake you should:** "Check it Out!", check for injuries and damages that need immediate attention. Make sure you are
trained in first aid and in damage assessment techniques. You should be able to administer first aid and to identify hazards such as damaged gas, water, sewage and electrical lines. Be prepared to report damage to city or county government.

Conclusions:

1. Should Virginians be worried about earthquakes? Explain **Yes, Virginia has had Earthquakes in the past and could have Earthquakes in the future.**

2. What counties in Virginia should have earthquake preparedness plans? **All counties should be prepared and have a plan, but especially counties that have had Earthquakes in the past, such as Giles County, Franklin County, Goochland County, Petersburg, VA, etc.**

3. What should schools do to prepare students for an earthquake event? **Be aware of the risk, practice Earthquake drills, educate students and staff about the proper procedures before, during and after an earthquake. Be Prepared (Follow the "Seven Steps")**

4. What should your family do to be prepared for an earthquake event? **Be prepared, follow the "Seven Steps" FEMA recommends!**
Resources


A map-based resource designed for Virginia teachers. The Digital Atlas contains many different maps pertinent to Virginia in several accessible formats.


A Federal source of national-scale maps and geographic data of many different themes, including base maps.


US Geological Survey webpage of current and historical earthquakes.

VTSO webpage: http://www.geol.vt.edu/outreach/vtso/

Virginia Tech Seismology Observatory information and recent seismographs.

Earthquake Preparedness: http://earthquake.usgs.gov/prepare/

USGS and FEMA site on earthquake safety and planning.
Appendix A: Virginia County Key; source: U.S. Census Bureau