Lesson # 11

Lesson Plan
Revised 10/05

Earthquakes and Quicksand

Grade Level: 3 - 4

Teachers, this is a basic lesson plan that you may modify at your discretion.

Modifications to video: There may have been changes to the lesson plan since the video was made. This lesson plan reflects the latest updates made as a result of suggestions from teachers who have presented the lesson during the daytime program. Please continue to send us your ideas!

Overall educational objective: Students will practice earthquake safety procedures. Planning and preparation before an earthquake will lessen the panic that results in a crisis situation.

Associated Standard and CORE Objective:

- 3030-30 Students will recognize various geological features and investigate geological processes.
- 3030-0302 Describe the effects of earthquakes on geological features.
- 3030-0501 Identify safety practices at home and at school. Identify safety practices related to power lines.
- 3040-0502 Compare compaction and moisture retention of various soils.

Specific performance objectives: Students will be able to identify safety measures to follow in an earthquake, explain how liquefaction feels, and how saturated, sandy ground would act during an earthquake. They will be able to draw parallels between liquefaction and quicksand.

Material List

- 1 - earthquake machine
- 1 - liquefaction machine
- 1 - extension cord
- 2 - maps (with liquefaction areas marked)

- 1 - Earthquake Safety -What to Do (master on last page)
- 1 – Container with sand & several wood blocks
- 2 – Angle-cut wood blocks

Teacher Provides:

- World globe

Lesson Activities:

1. Use the globe to discuss what an earthquake is and how they are caused. Have the students discuss some of the geological features formed by earthquakes (mountains, valleys, gorges).
2. Describe faults as linear fractures or cracks in earth's surface layer (crust) caused by earthquake pressures from inside the earth.
3. Using angle-cut blocks (one in each hand). Demonstrate vertical fault slipping by pressing the two angled faces together and causing one to ride upward against the other.
4. Using rubber foam piece as demonstrator, simulate an upheaval in earth's crust. (Place piece flat on table and press inward from two opposite sides until it buckles upward in center). Place this item at student work center along with slip-fault blocks.
5. Demonstrate the earthquake machine and have students observe the correlation between the intensity of the quake and the height of the rods which represent buildings.
6. Display container of sand with wood blocks and place it snugly atop the earthquake machine after removing the 3 rods, then demonstrate its use. Station at a work center for students, at appropriate time, to creatively erect wood block structures in the sand and observe effects of "quaking" at different intensities. (Please monitor for careful use of machine).
7. Discuss earthquake preparation and have students act out what they would do in an earthquake by having an earthquake drill. See included Earthquake Safety sheet (make copies for the students to take home).
8. Demonstrate the liquefaction machine. Pump water through the liquefaction machine, and then bump the column, showing how a heavy object will drop out of sight when the saturated sand is vibrated. Make comparisons to what happens during an earthquake when loose, sandy soils lose the ability to support buildings.
9. Pump water through the liquefaction machine to demonstrate quicksand. Have each student put his or her arm in the sand to feel the effect of quicksand. Consult Junior Engineering Staff for operation instruction.

 

10. Call attention to the career fields that are related to this module. Discuss how students might prepare for occupations that interest them. Note the career links at the end of this lesson.
11. Allow time to clean up. At the end of the day, list any materials that are missing and tape the list to the outside of module box.

Extension Activity:

Teachers may want to bring several hard boiled eggs from home, and use them to illustrate what the earth' s crust might look like. By cracking the egg students can see how the cracks rub against each other, but still remain intact because of the soft inside layer.

Background Information:

Earthquakes are vibrations produced in the earth' s crust, causing rock layers to suddenly rupture and then rebound. The vibrations can cause destruction ranging from the barely noticeable to the catastrophic. Six kinds of shock waves are generated in the process. Two are classified as body waves, which travel through the earth' s interior, and the other four are surface waves. The waves can be further classified by the kinds of motions they impart to rock particles. Primary compressional waves (P waves) send particles oscillating back and forth in the same direction as the waves are traveling. Secondary or transverse shear waves (S waves) impart vibrations perpendicular to their direction of travel. P waves always travel at higher velocities than S waves, so whenever an earthquake occurs, P waves are the first to arrive and to be recorded at geophysical research stations worldwide.

The majority of the vibrations causing earthquakes originate from the movement of the Earth' s tectonic plates. Tectonic plates are rigid divisions of the outer surface of the earth (**lithosphere**) that move over a weaker layer (**asthenosphere**). The plates are about 100 km thick, and the continents, which are 40 km thick, rest on the plates and move with them. Occasionally the hot **asthenosphere** of the Earth finds a weak place in the lithosphere to rise buoyantly as a plume, or hot-spot. In cross section, the Earth releases its internal heat by **convecting**, or boiling much like a pot of pudding on the stove. Hot asthenospheric mantle rises to the surface and spreads laterally, transporting oceans and continents as on a slow conveyor belt. The speed of this motion is a few centimeters per year, about as fast as your fingernails grow. The new lithosphere, created at the ocean spreading centers, cools as it ages and eventually becomes dense enough to sink back into the mantle. The **subducted** crust releases water to form volcanic island chains above, and after a few hundred million years will be heated and recycled back to the spreading centers.

Earth' s solid surface shows many of the features caused by plate tectonics. The oceanic ridges are the asthenospheric spreading centers, creating new oceanic crust. Subduction zones appear as deep oceanic trenches. Most of the continental mountain belts occur where plates are pressing against one another.

There are three main plate tectonic boundaries: extensional, transformational, and compressional. Plate boundaries in different localities are subject to different inter-plate stresses, producing these three types of earthquakes. Each type has its own special hazards.

At spreading ridges, or similar extensional boundaries, earthquakes are shallow, aligned strictly along the axis of spreading, and show an extensional mechanism. Earthquakes in extensional environments tend to be smaller than magnitude 8.

At transformal boundaries, earthquakes are shallow, running as deep as 25 km; mechanisms indicate strike-slip motion. Transforms tend to have earthquakes smaller than magnitude 8.5. The San Andreas fault in California is a nearby example of a transform, separating the Pacific from the North American plate. At transforms the plates mostly slide past each other laterally, producing less sinking or lifting of the ground than extensional or compressional environments.

At compressional boundaries, earthquakes are found in several settings ranging from the very near surface to several hundred kilometers depth, since the coldness of the subducting plate permits brittle failure down to as much as 700 km. Compressional boundaries host Earth' s largest quakes, with some events on subduction zones in Alaska and Chile having exceeded magnitude 9. Sometimes continental sections of plates collide; both are too light for subduction to occur.

Nevada has a complex plate-tectonic environment; all three of extensional, transformational, and compressional motions are going on at high rates nearby. As a result, the active part of the North American plate is eating slowly into the stable regions to the east. The Great Basin shares many features with the great Tibetan and Anatolian plateaus. All three areas have large areas of high elevation and are rifting and extending broadly. This is unlike oceanic spreading centers, where rifting is concentrated narrowly along the plate boundary. As a result, Nevada hosts hundreds of active extensional faults and several significant transform fault zones as well. While not as actively or rapidly deforming as the plate boundary in California, Nevada has earthquakes over much larger areas.

Terminology

1. **Lithosphere** - outer layer of the earth.
2. **Asthenosphere** - fluid-like layer beneath the lithosphere.
3. **Mantle** - molten rock found beneath the Earth's crust in the asthenosphere.
4. **Convection** - process by which, in a fluid being heated, the warmer part of the mass will rise and the cooler portions will sink.
5. **Subduction** - places on the Earth's surface where one land mass slides beneath another.
6. **Tsunami** - a wave of water created in the ocean from the vibrations of an earthquake, sometimes referred to as a tidal wave. An inland wave created by an earthquake is known as a seiche.
7. **Hypocenter** - the origin of the earthquake.
8. **Epicenter** – point where an earthquake reaches the earth's surface.
9. **Liquefaction** - is caused when sandy, wet, loose soils react to vibrations and temporarily act like a liquid. Large areas of the Wasatch Front would be vulnerable to this effect during an earthquake, such as lower lying areas of the valleys and areas with high water tables. The soil loses its bearing strength during liquefaction and heavy objects (roads, buildings) sink, while light objects (buried tanks, pipelines) rise to the surface. Liquefaction is similar to quicksand, however the sand in quicksand vibrates because of water bubbling to the surface.

Safety precautions: Be ready to steady the students on the liquefaction table as they may lose their balance. Allow no more than two students next to the machine at a time.

Classroom organization: Because there is not a lot of hands-on in this display, it is imperative that you alternate students who are participating. If there is anything that can be done by a student, it is recommended that you take advantage of that opportunity to involve as many students as possible. It is also important that everyone be situated so they can see what is going on. If it is possible, arrange chairs so that everyone can see and participate in an orderly fashion, thus creating an ideal learning environment.

Internet References:

- Utah Geological Survey: Liquefaction - http://www.ugs.state.ut.us/liquefy.htm
- Plate Tectonics, the Cause of Earthquakes - http://www.seismo.unr.edu/ftp/pub/louie/class/100/plate-tectonics.html
- SciQuest NetLink - http://www.enviroweb.org/carnegie

References:

- Popular Science v250, June '97, p.126 "Earthquake!" This article gives general information about earthquakes and why they happen.
- Audubon v92, May '90, p.126-132 "Quicksand! Makes a Good Story." This article describes the facts about quicksand: myths are dispelled, and how it all works is described.

Teacher tips: Have the students identify earthquake hazards in the classroom.

Please make your students aware that this lesson relates to the following:

Career Fields:

Science, Technical, Social-Humanitarian

Occupations:

- **Civil Engineer**: Plan, design, and oversee the construction and maintenance of roads, railroads, airports, bridges, harbors, channels, dams, irrigation projects, pipelines, power plants, and water supply and sewage systems. They may work in areas of design, research, construction, or teaching.

  Education: Bachelor's Degree

- **Insurance Claim Representative:** Investigate claims, negotiate settlements, and authorize payments to claimants. They determine whether the customer's insurance policy covers the loss and the amount of the loss covered.

  Education: Bachelor's Degree

- **Geologist**: Study the physical aspects and history of the earth. They identify and examine rocks, study information collected by remote sensing instruments in satellites, conduct geological surveys, construct maps, and use instruments to measure the earth's gravity and magnetic field. They analyze information collected through seismic studies. They also search for oil, natural gas, minerals, and ground water.

  Education: Bachelor's Degree

- **Seismologist:** Interpret data from seismographs and other geophysical instruments to detect earthquakes and locate earthquake-related faults.

  Education: Master's Degree

- **Teacher**: Instruct students in English, mathematics, science, and social sciences. They plan teaching activities, evaluate students' work, record grades, and meet with parents.

  Education: Bachelor's Degree

*** Taken from Occupational Outlook Handbook 1998-1999**.

Earthquake Safety - What to Do

What to Do <u>Before</u> an Earthquake

A. PREPARE YOUR HOME -
   - Identify possible hazards and reduce their risk.
   - Remove heavy objects from high shelves.
   - Anchor top-heavy furniture and appliances to the wall or floor (especially water heater).
   - Secure shelves.
   - Avoid hanging objects from the ceiling.
   - Know where shut-off valves and power sources are and how to turn them off.

B. DEVELOP A RESPONSE PLAN FOR HOME/SCHOOL/WORK -
   - Determine "safe"areas.
   - Hold regular earthquake drills.
   - Decide on a family meeting place at home.
   - Identify an out-of-state contact in case your family is separated when an earthquake occurs.
   - Put together a 72 hour survival kit.

What to Do <u>During</u> an Earthquake

- **STAY CALM** - having a plan will help you stay calm.
- **STAY PUT** - if inside, stay inside. If outside, stay outside.
- **TAKE COVER** - if inside, get under a desk, bench, table, or supported inside doorway. If there is nothing to get under, sit next to an interior wall and cover your head with your arms. Stay clear of windows, bookcases, china cabinets, mirrors, fireplaces, or anything else that could fall or spill on you. Turn off nearby appliances. In public places, **DO NOT** rush for the doorway. Move away from display shelves. Don't use elevators. If outside, get into the open, away from trees, buildings, walls, and power lines. If in a car, pull over to the side of the road and stay in the car. Stay clear of bridges, overpasses, power lines and buildings. Watch for falling debris.

What to Do <u>After</u> an Earthquake

- ADMINISTER FIRST AID.
- CHECK FOR UTILITY DAMAGE; TURN OFF ONLY IF NECESSARY.
- USE TELEPHONE ONLY FOR MEDICAL EMERGENCIES.
- BE PREPARED TO EXPERIENCE AFTERSHOCKS - further damage possible

Richter Scale Intensity

1. - Probably not detectable by humans but detectable by instrument.
2. - Mildly detectable by humans.
3. - Slight motion detectable by humans.
4. - You know there is an earthquake.
5. - Ditto only bigger!
6. - Structural damage may occur.
7. - Serious!

Review Questions:

1. What occurs during liquefaction? What happens to the water table?
2. If you' re building a house what areas would be good (eg. bedrock) and what areas would be bad (refer to geology maps indicating high liquefaction potential in Utah.)
3. What should you do if an earthquake occurs?
4. What are the three types of tectonic plate boundaries?
5. What type of geological structures (eg. mountains, valleys, volcanoes) are produced by each tectonic plate boundary?
6. Can we predict where and when earthquakes will occur?

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