Bay Area Faults and Earthquakes Educator Guide

A resource for using QUEST video, audio, blogs and maps in the classroom

QUEST SUBJECTS

Life Science — Biology, Health, Environment

Earth Science — **Geology**, Weather, Astronomy

Physical Science — Physics, Chemistry, Engineering

CA SCIENCE STANDARDS

Grade 6

Plate Tectonics and Earth's Structure

1. (d) Earthquakes are sudden motions along breaks in the crust called faults.

5. (c) Lithospheric plates the size of continents and oceans move at rates of centimeters per year in response to movements in the mantle.

6. (f) how to explain major features of California geology (including mountains, faults, volcanoes) in terms of plate tectonics

Grades 9-12

Dynamic Earth Processes

3. (b) the principal structures that form at the three different kinds of plate boundaries

1. (d) why and how earthquakes occur and the scales used to measure their intensity and magnitude

QUEST MEDIA FOR TEACHING ABOUT LOCAL FAULTS & EARTHQUAKES

Read and comment on the blogs for these stories by clicking on the story link and clicking on the blog post link below the video/audio.

Experience the **San Andreas Fault Trail Exploration**
www.kqed.org/quest/exploration/san-andreas-fault-trail-exploration

- You probably know that the San Andreas Fault runs nearly the length of the state. But did you know that you can see the fault for yourself? Take a hike at Los Trancos Open Space Preserve in the Santa Cruz Mountains above Palo Alto.

Watch **Earthquakes: Breaking New Ground**
http://www.kqed.org/quest/television/view/570

- Can earthquakes be predicted? Northern California researchers are now identifying the slow-moving clues that may foreshadow violent quakes.

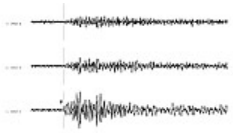
Watch **The Hayward Fault: Predictable Peril**
www.kqed.org/quest/television/the-hayward-fault-predictable-peril

- October 21, 2008, marks the 140th anniversary of the 1868 Hayward earthquake. With much of the East Bay on or near the fault, geologists and community members are working to prepare for what may be the next big one.

Listen to **The Hayward Fault: A Tectonic Timebomb**
http://www.kqed.org/quest/radio/the-hayward-fault

- The 6.9 Loma Prieta earthquake was a stark reminder that we live in earthquake country. Even though we generally are aloof to the possibility of a major temblor, the reality is that we're surrounded by active faults. One East Bay fault line has geologists particularly worried.

TOPIC BACKGROUND



We live in earthquake country. Earthquakes are part of the geologic fabric of California. The Bay Area sits on a series of active faults that include the San Andreas, Calaveras, and Hayward. Of the three major fault systems, the Hayward is of most concern to geologists.

Extending almost 40 miles from Fremont to San Pablo Bay, the Hayward Fault runs under some of the most densely populated areas in the country. More than two million people live and work along the fault. BART, major gas lines, schools and trauma centers sit on or near the fault. The Hayward Fault is a prime candidate in Northern California for a magnitude 7 earthquake within the next 30 years.

Geologists have observed the cracked lines and deformed curbs in sidewalks and streets in areas near the fault. These are evidence of creep, a phenomenon of slow movement on the surface of the fault even though deep beneath the surface the rock is stuck in place. When the rock that's locked builds up enough tension, the fault then ruptures, or slips, causing a major earthquake. The last major earthquake on the Hayward Fault was 140 years ago. Major earthquakes occur every 140 years on that fault. Now there is a great push toward earthquake preparedness. Experts are strongly encouraging people to retrofit homes and businesses and make or purchase earthquake kits to get ready for the next big one.

VOCABULARY

Earthquake
a shaking of the ground caused by the sudden breaking and shifting of the tectonic plates of Earth's outer shell

Creep
slow movement of the earth along a fault

Fault
a break in the rocks that make up Earth's crust as they move past each other

Hayward Fault
a geologic fault zone capable of generating significantly destructive earthquakes. About 40 miles long, it lies mainly along the western base of the hills on the east side of the San Francisco Bay.

San Andreas Fault a transform fault that runs approximately 800 miles through California

Geologist
a person who studies the earth

INTRO QUESTIONS

- What is an earthquake?
- What causes earthquakes?
- Where is the Hayward Fault located?
- What do you call a scientist who studies the earth and earthquakes?

FOCUS QUESTIONS

- How long is the Hayward Fault?
- What is creep?
- Why are geologists so concerned about an earthquake occurring on the Hayward Fault?
- What kind of buildings and industries are located on or near the Hayward Fault? What are "soft-story" buildings?
- How does the Hayward Fault differ from the San Andreas Fault?

For all media see:

- Segment Summary Student Sheet
  http://www.kqed.org/quest/downloads/QUEST_SegSum_StudentSheet.pdf
- Personal Response Student Sheet
  http://www.kqed.org/quest/downloads/QUEST_PersResp_StudentSheet.pdf

LESSON PLANS and RESOURCES from PBS, TEACHERS' DOMAIN and NPR

NOTE: Resources from the Teachers' Domain collection require a fast and free registration.

Earthquakes: San Francisco Teachers' Domain
http://www.teachersdomain.org/resource/ess05.sci.ess.earthsys.sanfranthreat/
The history of earthquakes in the San Francisco Bay Area is plotted on a digital map and analyzed in this video segment adapted from **NOVA**.

Earthquakes Teachers' Domain
http://www.teachersdomain.org/resource/ess05.sci.ess.earthsys.lp_earthquakes/
In this lesson, students explore the causes of earthquakes and their impact on human societies and the geology of an area.

Plate Tectonics Teachers' Domain
http://www.teachersdomain.org/resource/ess05.sci.ess.earthsys.lp_platetectonics/
Through class discussion, videos and activities, students seek connections between tectonic activity and geologic features and investigate how the theory of plate tectonics evolved.

Earthquakes Lesson Plan Teachers' Domain
http://www.teachersdomain.org/resource/ess05.sci.ess.earthsys.lp_earthquakes/
In this multimedia-infused lesson, students explore the causes of earthquakes and their impact on human societies and the geology of an area.

VISIT OUR PARTNERS

The Bay Institute
www.bay.org

California Academy of Sciences
www.calacademy.org

Chabot Space and Science Center
www.chabotspace.org

East Bay Regional Park District
www.ebparks.org

Exploratorium
www.exploratorium.edu

Girl Scouts of Northern California
www.girlscoutsnorcal.org

Golden Gate National Parks Conservancy
www.parksconservancy.org

The J. David Gladstone Institutes
www.gladstone.ucsf.edu

Lawrence Berkeley National Laboratory
www.lbl.gov

Lawrence Hall of Science
www.lawrencehallofscience.org

Monterey Bay Aquarium
www.mbayaq.org

Monterey Bay Aquarium Research Institute
www.mbari.org

Oakland Zoo
www.oaklandzoo.org

The Tech Museum of Innovation
www.thetech.org

UC Berkeley Natural History Museums
http://bnhm.berkeley.edu/

U.S. Geological Survey
www.usgs.gov

MORE EDUCATIONAL RESOURCES FOR USING QUEST MULTIMEDIA TO ENHANCE 21st CENTURY SKILLS IN TEACHING AND LEARNING

Why Use Multimedia in Science Education?
http://www.kqed.org/quest/downloads/QUESTWhyMedia.pdf
- Read about the importance of using multimedia in the 21st century science classroom.

How to Use Science Media for Teaching and Learning
http://www.kqed.org/quest/downloads/QUESTMediaTips.pdf
- A collection of tips, activities and handouts to actively engage students with multimedia.

Science Multimedia Analysis
http://www.kqed.org/quest/downloads/QUESTMediaAnalysis.pdf
- Give your students the tools to recognize the purposes and messages of science multimedia.

Create Online Science Hikes with Google Maps
http://www.kqed.org/quest/files/download/52/QUEST_ExplorationCreation.pdf
- Do you like the science hike Explorations on the QUEST site? Use this place-based educational guide to create similar science-based maps with youth.

OTHER WAYS TO PARTICIPATE IN QUEST

LOG ON

www.kqed.org/quest

LISTEN

KQED 88.5 FM San Francisco &
89.3 FM Sacramento
Mondays at 6:30am and 8:30am

WATCH

KQED Channel 9
Tuesdays at 7:30pm

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HAYWARD FAULT: TECTONIC TIMEBOMB QUEST RADIO TRANSCRIPT **NOTES/QUESTIONS**

From KQED Public Radio, I'm Susie Racho with QUEST, our weekly series exploring Northern California science and environmental stories.

It was 19 years ago this week that the earth shook so violently under the Bay Area that portions of the Bay Bridge and Interstate 880 fell down. Sixty-three people died and communities were devastated.

The downtown section of Santa Cruz is basically gone. All the old brick, unreinforced buildings have collapsed.

The 6.9 Loma Prieta earthquake was a stark reminder that we live in earthquake country. While many Californians would rather not think about the possibility of another major quake, the reality is we are surrounded by active faults. And as Andrea Kissack reports, one East Bay fault line has scientists especially concerned.

Geologists tend to be among the most reserved of scientists. But when they talk about the Hayward Fault, they do so in almost apocalyptic terms.

ZOBACK: "Because the Hayward Fault's sitting right in the middle of where people live and all our major lifelines, it's really, probably, one of the most dangerous faults in the country."

That's Mary Lou Zoback. She is principal research scientist for Risk Management Solutions, a Newark company that studies the costs of disasters.

The Hayward Fault runs 40 miles through some of the most densely populated areas in the U.S. More than two million people live in the East Bay.

BART ANNOUNCER: "Nine-car Fremont train now approaching Platform One."

On its way from San Pablo Bay south to Fremont, the fault passes under the UC Berkeley football stadium, trauma centers, major gas lines and BART routes.

ZOBACK: They have actually built this station and the parking lot right on top of the Hayward Fault."

KISSACK: "There are cracks in the pavement. Are these actually from the fault?"

ZOBACK: "Yeah, actually the Hayward Fault is a little different than the San Andreas Fault. And the difference is that the Hayward Fault creeps.

That means the fault is moving at the surface, but deep in the earth's crust, it's locked… until built-up tension causes the fault to slip. Radiocarbon dating has helped scientists to determine magnitudes from earlier quakes. They have found that major quakes along the Hayward Fault have occurred nearly every 140 years for the last two thousand. And as coincidence would have it, this October twenty-first marks the 140-year anniversary of the powerful 1868 Hayward quake. Scientists are projecting that another 6.8 quake on the Hayward Fault could cause billions of dollars in damage and leave at least 200,000 people homeless.

ZOBACK: “When one of those earthquakes occurs again we’ll be looking at maybe six feet of horizontal motion at the surface. That’s going to tear apart the roadways, the east/west roadways, the Hetch Hetchy aqueduct crosses the fault. It’s going to be offset and will have to be shut down. A BART line crosses it several times, gas pipelines. All sorts of infrastructure that we depend on is going to be destroyed, basically, by the earthquake.

A number of public buildings are undergoing retrofitting to make them more structurally sound. Area hospitals have until 2013 to meet seismic safety standards. There is a state inventory of public schools prone to collapse in a major quake, but no such list exists for private schools. And retrofitting standards for residences are confusing.

COOK: “Contractors don’t know they are doing the jobs incorrectly because they have no code to follow, they have no special licensing. They might do two a year and they don’t bother to do the research like I did after the Northridge earthquake in Los Angeles.”

Jim Cook, owner of Bay Area Retrofit in Berkeley, estimates about a quarter of the houses in the East Bay have been retrofitted, most of them, he says, incorrectly.

Cook is emerging from under an older East Bay home where he has bolted the house to the foundation and added plywood as bracing. Cook has spent years lobbying local governments to improve seismic retrofit standards.

COOK: “We probably have sixty different diagrams that we use on a daily basis to address strange framing that you find under these old houses, and they’re all done differently and you have to understand how it works and you have to know what to do when you see it.”

You can bolt your house to its foundation for about five thousand dollars or spend about 500 dollars a year for earthquake insurance with high deductibles. But what if you rent? Mary Lou Zoback says renters should be asking questions of their landlords.

ZOBACK: “Has your building been structurally evaluated? Have you done anything to strengthen it? Where is the gas shut-off valve for the apartment building?”

Renters are particularly vulnerable, says Zoback, a geophysicist who worked 28 years at the U.S. Geological Survey and who has done catastrophe modeling of risky residential buildings.

ZOBACK: “The scariest thing we found in the modeling was that the largest damage would occur to apartment buildings in the urban core of the East Bay. A lot of these are older buildings, a lot of them are tuck-under parking, but basically if you look at maps of where low-income zip codes exist and these apartment buildings, they map pretty much one to one.”

Several cities in the Bay Area are conducting studies of these so-called “soft-story” buildings and moving toward stronger retrofitting requirements. It’s hard to escape the odds of a big quake. The damage depends a lot on how people prepare. For many Californians, assembling an earthquake kit is like pulling teeth. It means we have to admit

we have set up roots on precarious ground. But just taking the time to pull together three days of water and other supplies could make a major difference.

For Quest, I'm Andrea Kissack, KQED radio news.