

EARTHQUAKES AND PLATE BOUNDARIES: A MODEL EARTHINQUIRY ACTIVITY (46-54)

science for a changing world

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. When and where did the largest earthquake occur?

along the west coast of South America where the

late has one of the fastest relative velocities (about 1'

an provide insight into the physical and structural

Figure 7 Along the west coast of

South America, the oceanic Nazca

Plate is subducted beneath the conti-

nental South American plate. This

deep off-shore trench and the Andes

cone of convergence is marked by a

mountains. These features are prone

relationships between these two plates. You will look

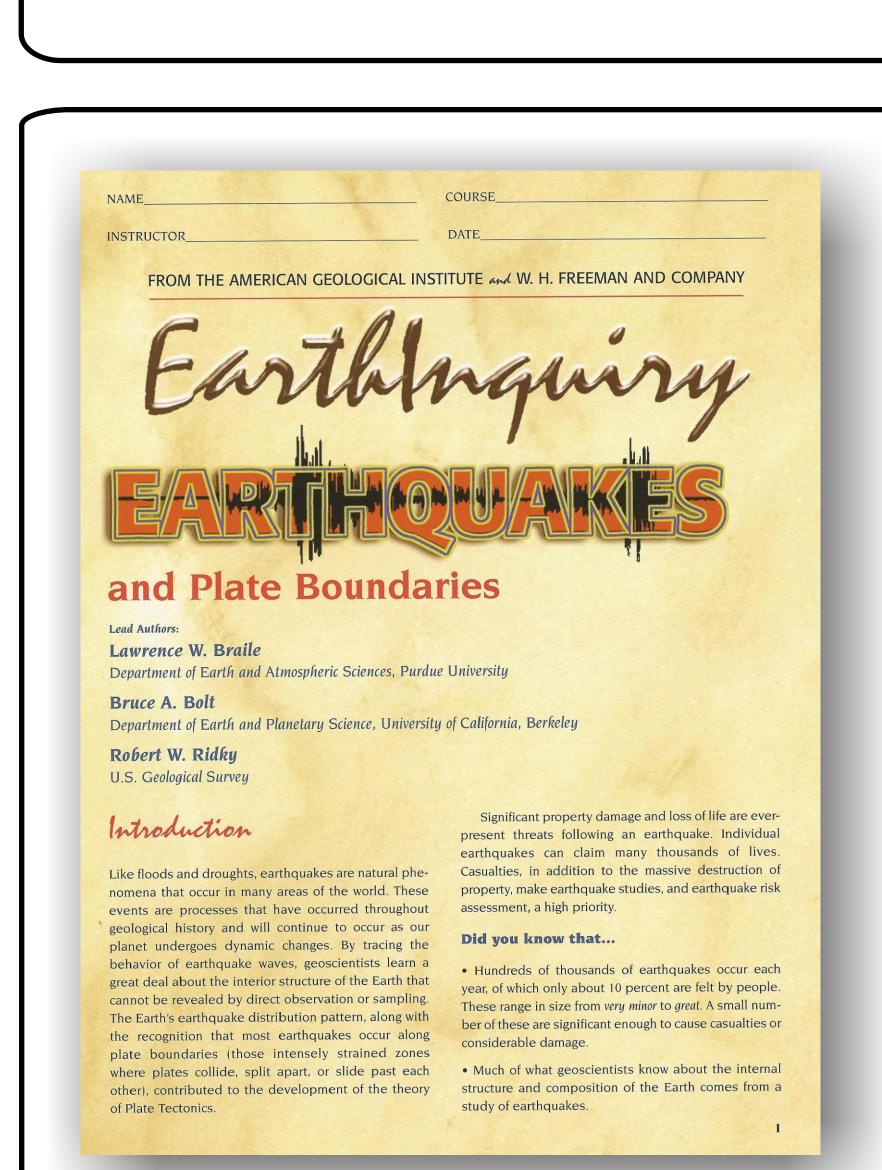
The West Coast of South America

Abstract

EarthInquiry activities are being developed by the American Geological Institute, along with geoscience instructors. They are designed to help introductory college students interact with the abundant real-time and archived geoscience data available on-line. Each activity has its own workbook, printed by W.H. Freeman and Company Publishers, that contains a Web access code, allowing students entry into the EarthInquiry web site. The EarthInquiry web site, maintained by AGI, provides students with detailed instructions on how to access and interpret the data collected in each activity. The web site also supplies supplementary information, glossary terms, and, in some cases, webbased tools to assist with numerical manipulation.

In the Earthquakes and Plate Boundaries activity, students first learn about earthquakes as natural hazards, in terms of their cost, magnitude and global distribution. This understanding is established using short media excerpts and historical statistics. Students are then introduced to the USGS National Earthquake Information Center database. Ar "Earthquake Orientation" encourages students to look at recent worldwide earthquake activity. To become more comfortable with how earthquake data is recorded and displayed, students look at the extremes in earthquake depth and magnitude over the past week. They also consider how earthquake distribution largely coincides with plate boundaries. Following a brief summary of the different types of plate boundaries, the students once again access the NEIC data to examine a seismic cross-section in western South America. Using trends in hypocenter depth, an on-line plotting utility, and an "angle calculator," students quantify the angular relationship that exists along the crosssection and develop an understanding of how earthquake distribution can be used to express the geometric relationship between Earth's

The focus of the activity then shifts north to the San Andreas Fault in California. Students compare and contrast the earthquake distribution observed in California to the distribution observed in South America. Finally, students investigate predicting earthquake hazards using spatial and temporal patterns in earthquake distribution. The Loma Prieta event (1989) is used to help demonstrate this concept.



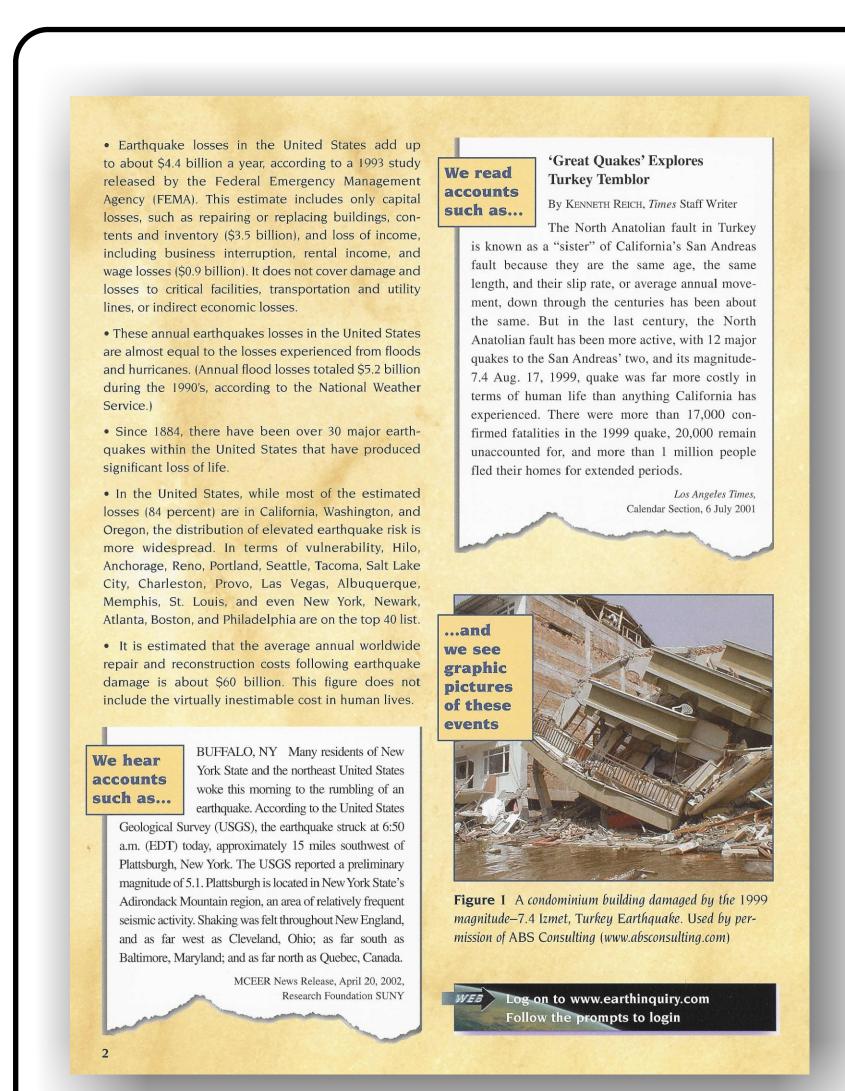
EarthInquiry is...

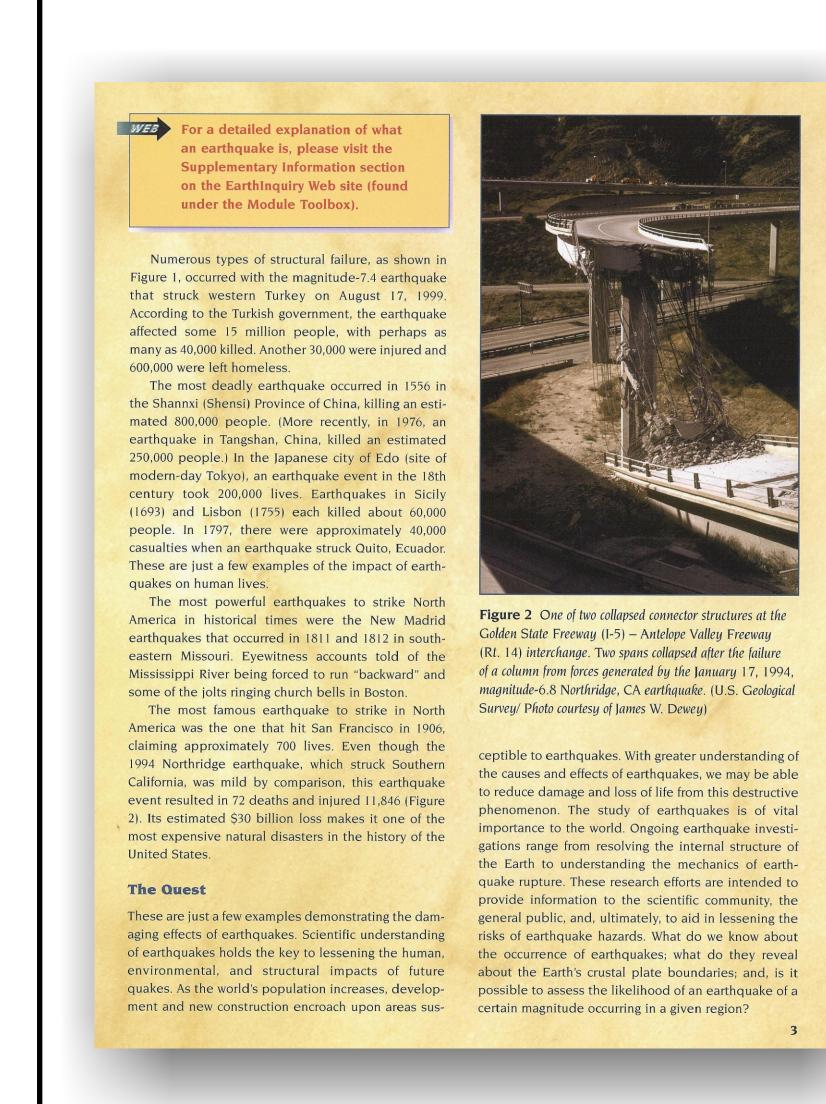
A series of web-based investigations in the Geosciences that:

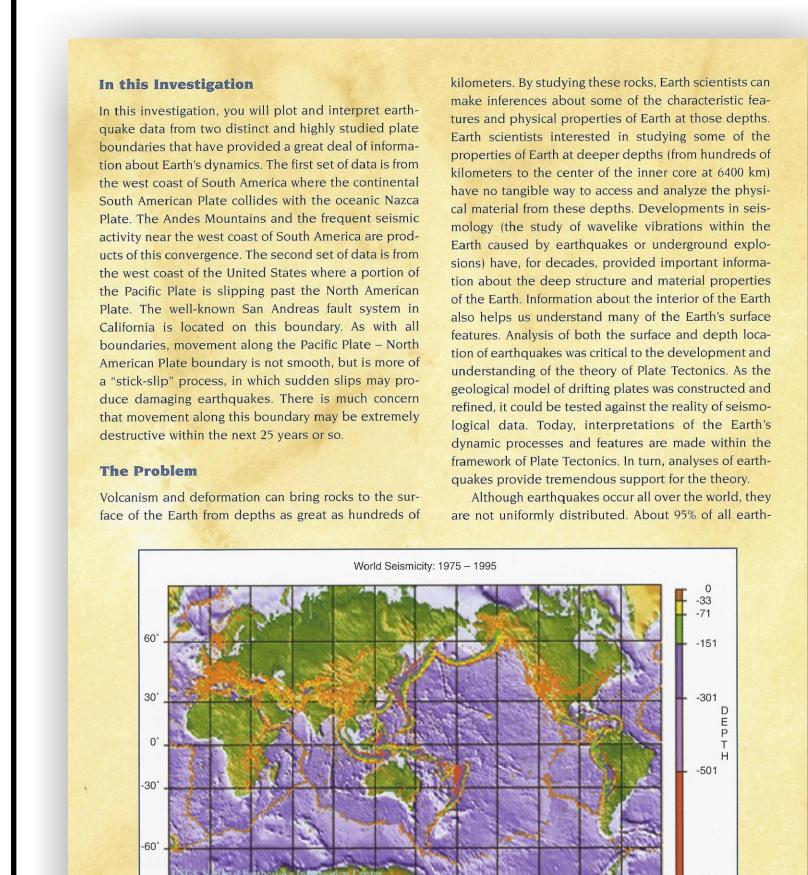
- Utilize the abundant geological data available on-line, and Target the introductory college

How does it work?

- Each activity consists of a workbook and an accompanying web
- The workbook poses questions and anchors the activity with
- The web site, maintained by the American Geological Institute, gives detailed directions for accessing and interpreting the







 $-30^{\circ} \qquad 0^{\circ} \qquad 30^{\circ} \qquad 60^{\circ} \qquad 90^{\circ} \qquad 120^{\circ} \qquad 150^{\circ} \qquad 180^{\circ} \qquad -150^{\circ} \qquad -120^{\circ} \qquad -90^{\circ} \qquad -60^{\circ} \qquad -30^{\circ}$

gure 3 Global topography and worldwide earthquake epicenters recorded from 1975–1995.

he right. (U.S. Geological Survey, National earthquake Center)

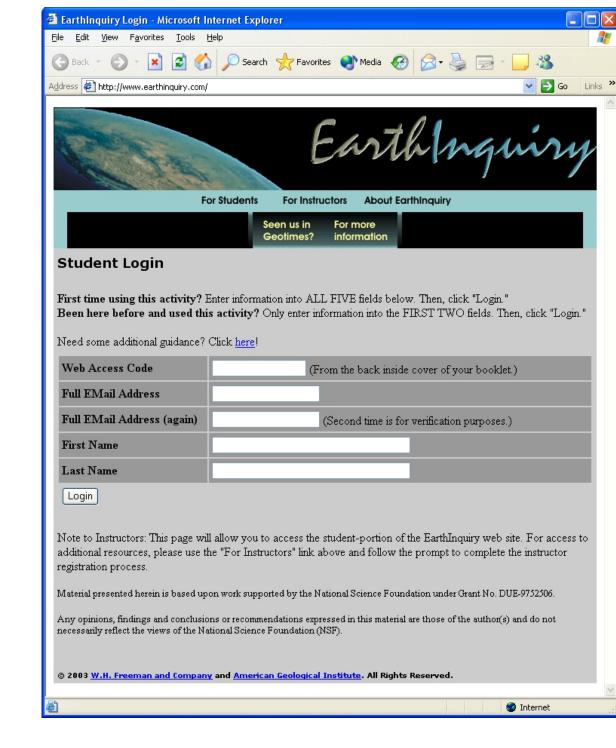
he depth of focus (hypocentral depth) of the earthquake is given in km by the color code shown to

First things first...

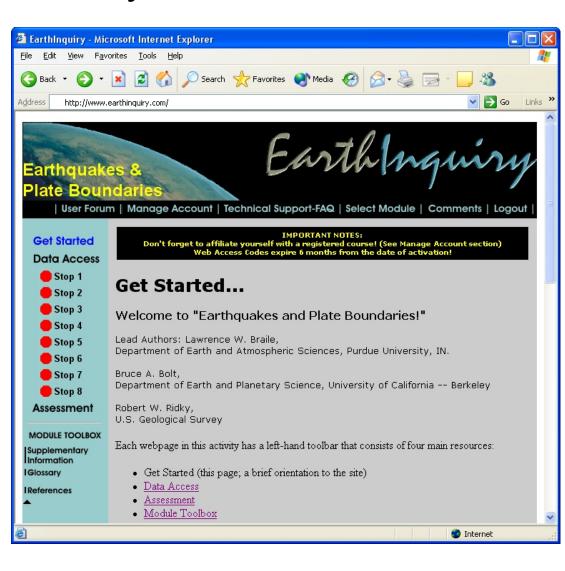
Students are introduced to the topics presented in the activity using media excerpts, historical records, and statistical data.

When it's time to go on-

Students are instructed to go to <u>http://www.earthinquiry.com</u> by a blue Web icon. When they first enter the EarthInquiry web site, they type in a unique Web access code, found on the inside back cover of each EarthInquiry booklet



The web site serves two purposes. leads students through the access to additional resources like: Supplementary Information, a Glossary, and a list of References.



Students are directed on-line whenever they need to access data, or if there is helpful information available to them. Otherwise, students focus their attention on the workbook and let that anchor and guide their

Why does this matter anyway?

In an effort to answer the "ever present question," the Quest defines the objectives of the activity and launches the investigation. The Problem grounds the investigation in a specific real-world application, outlining what students will learn by analyzing the available data.



students through the heart of the investigation, asking relevant questions and directing students to the Web to access on-line data when necessary. When students see a 🛑 In their booklet, they will go to the corresponding Stop on the web site to access and interpret data.

8. Approximately what is the depth of the deep

top of your plot) defined by your best-fit line drawn

f your plot) defined by your best-fit line drawn fro he deepest of the intermediate earthquakes

timate approximately how many earthquakes occu

termediate and deep depths, as well. Refer to the

At an intermediate depth

Earthquake Hazards

Because we know that many earthquakes are associat-

places for them to occur in the future. Knowledge of

ably state that, "Future seismic activity along the we

lates is quite certain." While this information is he

al for assessing future earthquake hazards, is it pos

etermine the likelihood of strong ground shaking

nd potential hazards at a given location. These fa

over eighty percent of the earthquakes occur along

part. Ultimately, scientists would like to identify, with

7. What is the relationship between the location of

cent earthquakes and major faults in California?

high probability, the location and time of a specific

ble to make a more "site-specific" forecast?

leepest earthquake?

through the shallow and intermediate depth earth-

Seismicity in South America

om 1975–1995 along the west coast of South America.

Figure 9 Along the west coast of North America, the Pacific

ate is slipping past the North

American plate in a north-

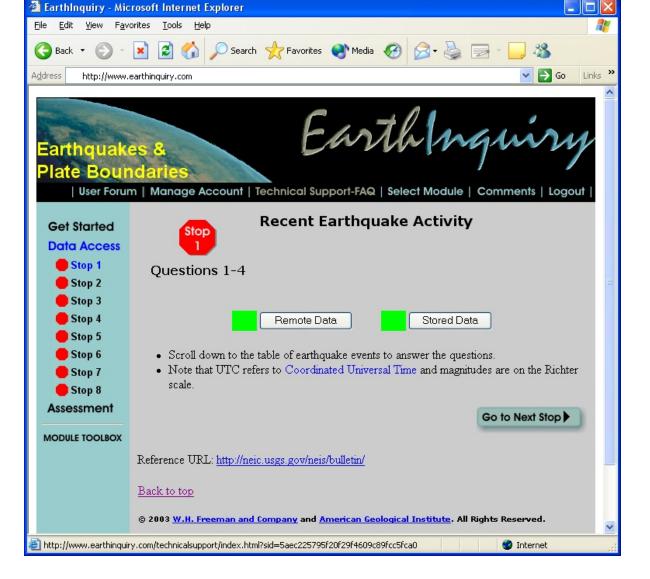
vesterly direction. The San

San Francisco (SF), CA to just

color code shown to the right. (U.S. Geological Survey

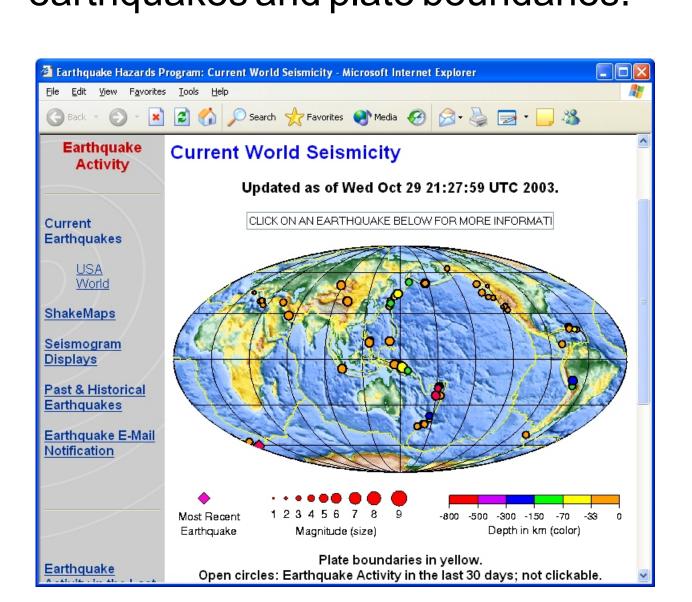
Stop 1: An Earthquake Orientation

students take an "Earthquake Orientation" and learn earthquake data using the most recent information available online. AGI stores local copies of all data necessary to complete the exercise, just in case the USGS web site is



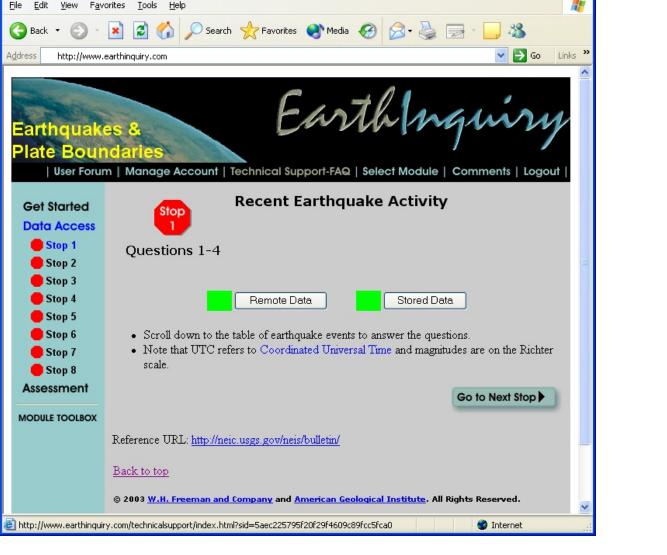
"Just-in-time" learning!

As students continue through the activity, they learn why earthquakes commonly occur along Earth's plate boundaries. EarthInquiry is not intended to replace textbooks or classroom lecture. It does, however, provide students with the information and resources necessary t make educated analyses and hypotheses about the data.



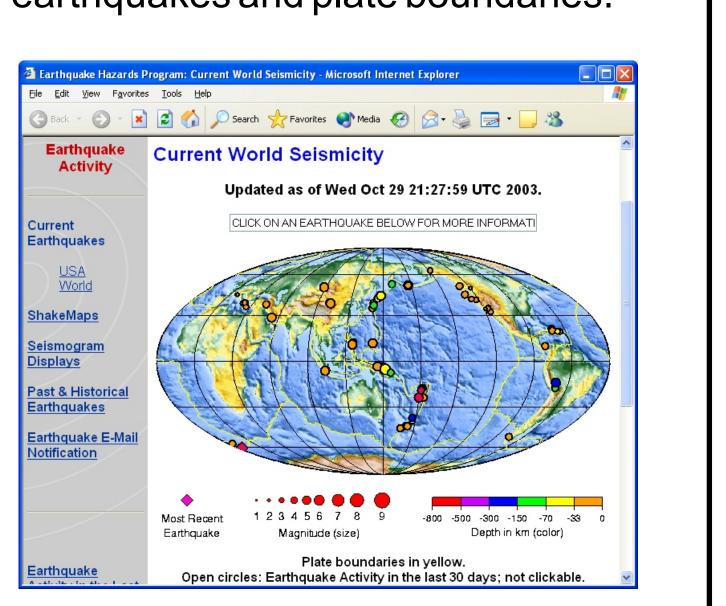
The Approach

This section of the activity walks



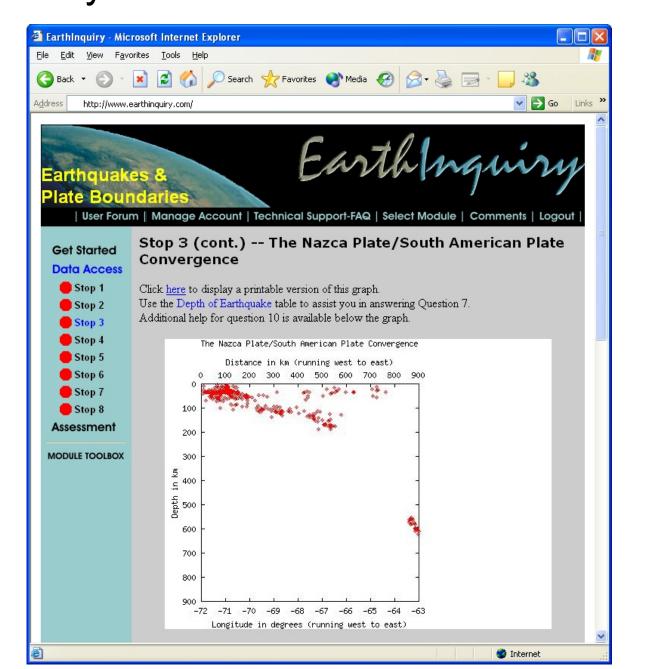
Stop 2: Connecting Earthquakes with Plate **Boundaries**

After learning about, or reviewing, the different types of plate boundaries, students look at the most recent earthquake data spatially, and start to develop a better understanding of the link connecting earthquakes and plate boundaries.

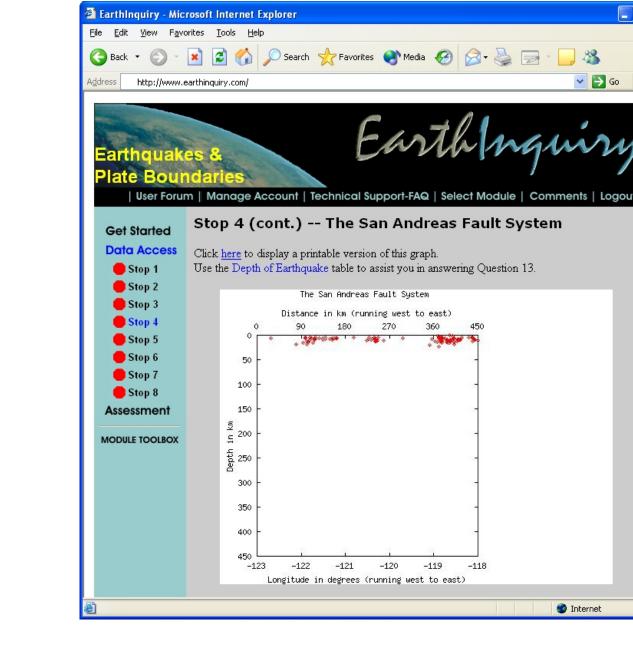


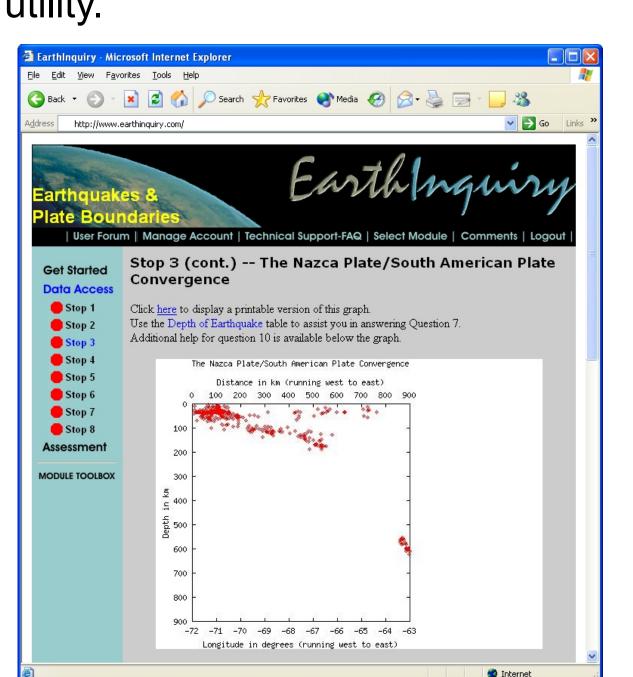
Stop 3: Collecting, Processing and Analyzing Data from the Peru-Chile

Students again access the USGS earthquake data to learn more about a seismic cross-section in western South America. Students plot hypocentral depth against distance using an on-line plotting



dents to quantify the angular relationship that exists along the crosssection. They develop an understanding of how earthquake distribution can be used to express the geometric relationship between Earth's plates.





An "angle calculator" helps stu-

Stop 4: Collecting, Processing and Analyzing Data from the San Andreas

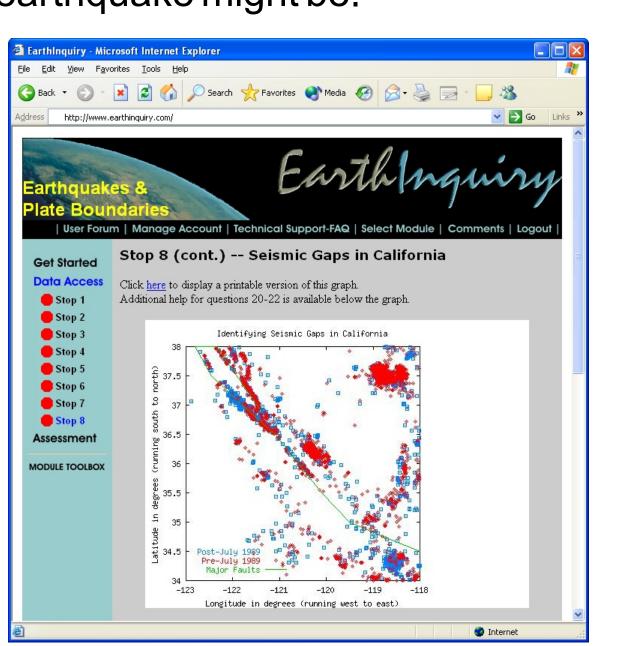
At Stop 4, students refocus their attention on the San Andreas Fault in California. Students compare and contrast the earthquakes along this transform boundary with those from the convergent boundary they studied in South America.

Stops 5-7: Looking at the Distribution Pattern of **Earthquakes**

Students start to identify patterns in the spatial and temporal distribution of Californian earthquakes. This procedure helps them to understand how an earthquake might be predicted.

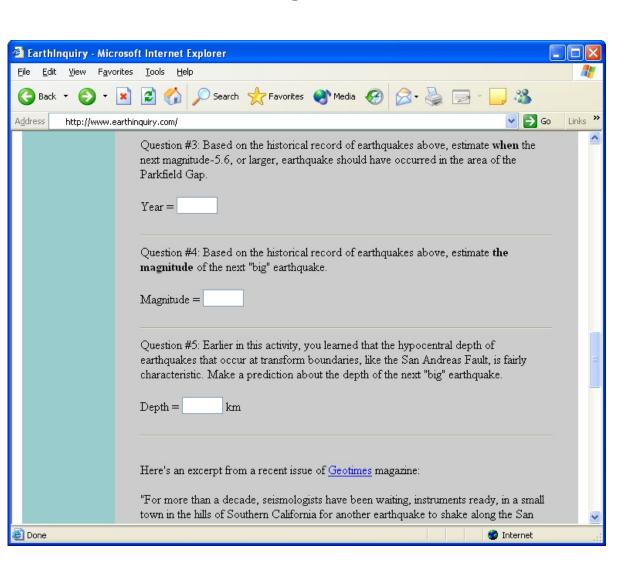
Stop 8: Seismic Gaps and the Loma Prieta Earthquake

The October 1989 Loma Prieta Earthquake is used to teach students the concept of "seismic gaps" and how they are used to help predict when and where the next "big" earthquake might be.



The Assessment: Applying what you've learned

Now that students have learned about the concept of "seismic gaps," they take this knowledge and apply it to the Parkfield Gap. This entirely on-line investigation is graded automatically, with student responses stored in a database for Instructor viewing at a later time.



EarthInquiry in your classroom!

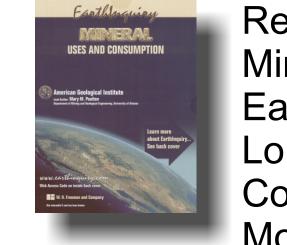
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San Francisco Bay region is about 67 percent, or about

intervals between major earthquakes along plate

have relieved some of the seismic tension in this

quake record in California, you've identified segments

along the San Andreas Fault that are currently "quiet,"

unrest. To develop the concept of "slip-deficit" further,

you will examine a region, the Parkfield Gap, that was

Is it possible to make earthquake

forecasts from plate tectonic theory?

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19. a. Identify any stretches of time (two decades or longer) that are marked by the absence of "larger"