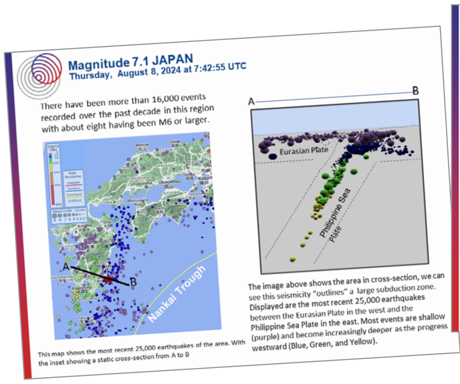
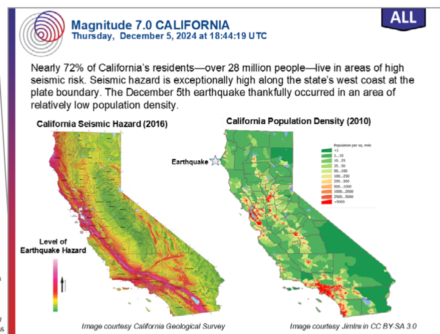
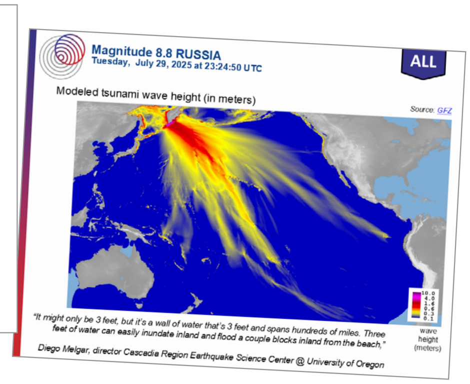
Version 4/10/26

INSTRUCTIONAL SEQUENCE: FROM DATA TO STORY

CREATING A TEACHABLE MOMENT ABOUT EARTHQUAKES







1 Class Period | 10-12 Class Periods | Year-Long Project

Small Group | Large Group

Beginner | Learner Investigation | Web-Based

AUDIENCE: Novice learning groups from grades 6 to 16.

Easily adaptable for audience and time constraints.

CONTENTS

OVERVIEW

When a major earthquake strikes, the world briefly pays attention—news spreads, people ask questions, and there is a short but powerful window of public curiosity about what happened, where, and why. *Teachable Moments* are designed to meet that moment: rapid, data-driven presentations that translate real seismic events into clear science communication for educators, students, and the public while interest is still high.

In this instructional sequence, students step into that role. Working with the same data sources scientists use—including **USGS**, **the NSF NGF operated by EarthScope**, **GEM**, and **NOAA**—they investigate a real earthquake and build their own Teachable Moment presentation that links tectonic processes to human experiences. The goal is not just to understand earthquakes, but to communicate that understanding the way scientists do: clearly, visually, and with evidence.

This lesson/resource can be used as:

- A **one period lesson** to enrich Earth science learning (Sections Engage and Explore/ Explain 1).
- A **unit** (~10-12 class periods including individual or group work time)
- A **year-long scaffolded project**, where each slide theme becomes its own short investigation culminating in a final presentation.
- A **take home or hybrid final project** where students work together in groups or alone for homework and then present in the classroom.

This resource can be modified to adjust lesson length, rigor, and/or focus for curriculum content and structure.

UNIT LEARNING GOALS

By the end of this instructional sequence, students will be able to:

1. Analyze seismic and tectonic data to describe earthquake causes and effects.
2. Interpret multiple earthquake datasets to explain patterns and impacts.
3. Explain relationships among tectonic processes, seismicity, and surface hazards.
4. Connect geoscience data to human and environmental contexts.
5. Communicate scientific findings using clear visuals and storytelling.

ASSUMPTIONS

For a more effective learning experience, it is assumed that students already have a basic understanding of the following concepts:

- What an earthquake is.
- What plate boundaries are and the differences between boundary types (convergent, divergent, transform).
- What faults are.
- The difference between an epicenter and a hypocenter.
- What magnitude is.
- What a vector is.
- Latitude and longitude.
- UTC time.

NGSS ALIGNMENT

Dimension	Middle School (6-8)	High School (9-12)
Performance Expectations (PEs)	MS-ESS2-2: Earth's Systems, MS-ESS3-2: Earth and Human Activity	HS-ESS2-1: Earth's Systems, HS-ESS3-1: Earth and Human Activity
Science & Engineering Practices (SEPs)	Developing and Using Models; Analyzing and Interpreting Data; Constructing Explanations; Obtaining, Evaluating, and Communicating Information	Developing and Using Models; Analyzing and Interpreting Data; Constructing Explanations; Engaging in Argument from Evidence; Obtaining, Evaluating, and Communicating Information
Disciplinary Core Ideas (DCIs)	ESS2.A: Earth Materials and Systems; ESS2.B: Plate Tectonics and Large-Scale System Interactions; ESS3.B: Natural Hazards	ESS2.A: Earth Materials and Systems; ESS2.B: Plate Tectonics and Large-Scale System Interactions; ESS2.E: Biogeology; ESS3.B: Natural Hazards; PS4.A: Wave Properties
Crosscutting Concepts (CCCs)	Patterns; Cause and Effect; Scale, Proportion, and Quantity; Systems and System Models; Energy and Matter; Structure and Function; Stability and Change	Patterns; Cause and Effect; Scale, Proportion, and Quantity; Systems and System Models; Energy and Matter; Structure and Function; Stability and Change

RESOURCES NEEDED

All phases: Internet-connected devices

Note: Some tools appear in multiple phases—this is intentional. Each phase lists everything a teacher needs without having to cross-reference other sections.

Engage

- Interactive Earthquake Browser (IEB)

Explore / Explain 1

- Interactive Earthquake Browser (IEB)
- Teachable Moment: 2024 M7.0 Earthquake in California
- Teachable Moment: 2024 M7.1 Earthquake in Japan
- Investigation Worksheets *(included in ZIP file download)*
- GPS Velocity Viewer

Explore / Explain 2

- USGS Earthquake Catalog
- Interactive Earthquake Browser (IEB)
- Teachable Moment: 2024 M7.0 Earthquake in California

Explore / Explain 3

- Teachable Moment: 2024 M7.0 Earthquake in California
- Deeper Dive Worksheet *(included in ZIP file download)*

Extend / Elaborate

- Birthquake WebApp *(for earthquake selection)*
- USGS Earthquake Catalog
- Teachable Moments Slide Template - *Teacher Version (included in ZIP file download)*
- Interactive Earthquake Browser (IEB)
- GPS Velocity Viewer
- InClass Animations
- Station Monitor
- Seismic Wave Viewer
- GEM OpenQuake Viewer
- NOAA Tsunami Education
- Simplified Tectonic Plate Velocities and Directions

Evaluate

- Earthquake Story Tracker Worksheet *(included in ZIP file download)*
- Presentation Rubric

Note: This unit takes a deeper dive into past teachable moment presentations. While the 2024 M7.0 California Earthquake was chosen, these other events could also be used or referred back to:

- 2025 Magnitude 8.8 Earthquake in Russia
- 2025 Magnitude 7.1 Earthquake on the Tibetan Plateau
- 2024 Magnitude 7.1 Earthquake in Japan
- 2024 Magnitude 4.8 in New Jersey
- Historical 2004 Sumatra Earthquake

ENGAGE

SPARK CURIOSITY, ACTIVATE PRIOR KNOWLEDGE, AND ESTABLISH RELEVANCE

Time: ~30 minutes

Unit Learning Goals addressed in this section:

- Analyze seismic and tectonic data to describe earthquake causes and effects.
- Connect geoscience data to human and environmental contexts.

Lesson Objective: Students will explore global patterns in seismicity using the Interactive Earthquake Browser and generate questions that will drive investigation throughout the unit.

ACTIVITY: "WHAT WOULD YOU ASK?"

Open the lesson by asking students: "If the ground shook for 10 seconds where you live... what questions would you have?"

Pause. Let students think, then turn to a partner to discuss. Collect responses as a whole group and record student questions on the board or a shared document—accept all answers.

Use their responses to set up the unit hook:

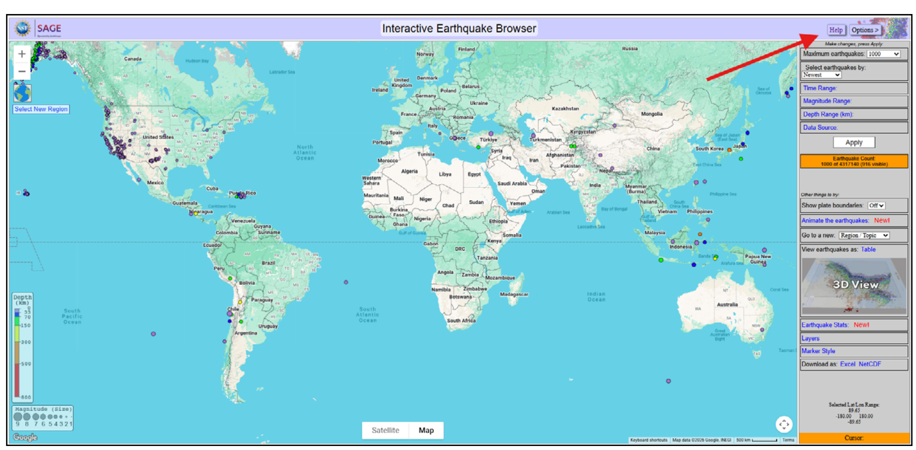
> *"Every earthquake tells a story—scientists use data to figure out what happened, where it happened, and why it matters."*

Let students know their questions will be revisited throughout the unit.

ACTIVITY: EXPLORE GLOBAL SEISMICITY WITH THE IEB

The Interactive Earthquake Browser (IEB) is an interactive map that displays earthquake event data.

For an overview of the tool and basic instructions to filter the data set on its use, click here or click the Help button in the tool itself.



Introduce the IEB as a tool that can be used to visualize earthquakes in space and time to explore patterns in earthquake occurrence. Briefly introduce students to the tool and its core functions.

Then, without further instruction, allow students to explore the IEB on their own or in pairs. The following sample questions may help frame their exploration:

1. What is the largest earthquake?
2. What earthquakes occurred today?
3. What is the oldest earthquake?
4. What are the different ways to view the data besides on the map?

Here, students are learning how to navigate, filter, and view the data in different ways so they can effectively use the tool to find and analyze data later in the lesson. Circulate around the room to ensure students are picking up on key functionality.

Using a whole-class discussion, ask students what they notice (start global, then narrow down to smaller regions, restrict by time, magnitude, and view in 3D). These discussion questions are intended to foster curiosity—do not explain yet. Just surface observations and record them on the board.

Sample discussion questions:

- *Where do earthquakes seem to cluster?*
- *Are there places with no earthquakes at all?*
- *Do they follow any shapes—lines, curves, dots?*
- *How many earthquakes do you think happen in a year? In a day?*
- *Why do you think earthquakes happen in some places and not others?*
- *What would you need to know to describe an earthquake to someone who didn't feel it?*

Wrap-up: End the instruction by asking students by asking "What additional questions do you have about earthquakes?" Accept all responses and add them to the list started earlier. Let them know that many of the questions captured today will be investigated over the course of the next several days. Leave the list visible or accessible—you will return to it at the end of the Explore/Explain 1 section.

EXPLORE / EXPLAIN 1

INVESTIGATING A REAL EARTHQUAKE

Time: ~50 minutes

Unit Learning Goals addressed in this section:

- Analyze seismic and tectonic data to describe earthquake causes and effects.
- Explain relationships among tectonic processes, seismicity, and surface hazards.

Lesson Objective: Students will analyze a real earthquake using seismic data and become familiar with the Teachable Moments format.

In this section, students encounter their first real Teachable Moment and learn the basic vocabulary scientists use to describe earthquakes—building the foundation they need to navigate data sources in the sections ahead.

EXPLORE: THE STORY OF A REAL EARTHQUAKE

When a major earthquake happens, the world briefly pays attention—people want to know what happened, where, and why. Scientists use tools like the IEB, along with other data sources, to rapidly analyze the event and communicate the science while that window of public interest is still open. That's what a Teachable Moment is—and that's exactly what you'll be building in this unit.

Students investigate a real earthquake using a Teachable Moments example. The goal is to analyze real seismic patterns, review the basic characteristics scientists use to describe earthquakes, and familiarize students with the Teachable Moments format.

Provide students with the Earthquake Investigation Worksheet *(included in ZIP file download)*. There are two options depending on the level of your students. Students will use the Teachable Moment slides as well as the IEB to answer the questions.

Students complete the first column for the 2024 M7.0 Earthquake in California – Teachable Moment as a whole class or in pairs using a guided practice approach. Students then work in pairs or individually to examine the 2024 Magnitude 7.1 Earthquake in Japan as independent practice.

EXPLAIN:

Go over answers as a whole class so students can evaluate their own understanding of the data and what information the slides offer. As you go over the answers, also review the Key Earthquake Definitions using IEB to demonstrate. **Bold terms** *in the Answer Keys show you where the definitions can be discussed and demonstrated.*

KEY EARTHQUAKE DEFINITIONS

Key Concept	Definition	IEB Demonstration
Epicenter	The point on Earth's surface directly above the earthquake.	Click an earthquake event to display its latitude and longitude.
Hypocenter (Focus)	The location underground where the earthquake begins.	Click an earthquake event to view its depth value.
Magnitude	A measurement of the energy released during an earthquake.	Click an earthquake event to display its magnitude.
Depth	The distance between the hypocenter and Earth's surface.	View the depth value and switch to 3D view to see earthquakes occurring at different depths.
Seismicity	The pattern of earthquakes occurring in a region.	Zoom in or out on the map to observe clusters and patterns of earthquakes across regions.
Plate Tectonics	The theory that Earth's outer shell is divided into large plates that move slowly over the mantle. Earthquakes commonly occur where these plates interact.	Zoom out to the global view and observe how earthquake clusters align along plate boundaries such as the Pacific Ring of Fire.
Convergent Plate Boundary	A boundary where two tectonic plates move toward each other. One plate may be forced beneath the other (subduction), often producing deep and powerful earthquakes.	Examine regions such as Japan or Chile where earthquakes form curved zones and occur at multiple depths.
Divergent Plate Boundary	A boundary where two tectonic plates move away from each other, allowing magma to rise and create new crust. Earthquakes are usually shallow.	Look at mid-ocean ridges where earthquakes form linear patterns along spreading centers.
Transform Plate Boundary	A boundary where two plates slide past each other horizontally. Earthquakes tend to be shallow but can be frequent and damaging.	Examine regions such as California where earthquakes align along a linear fault system like the San Andreas Fault.

Formative check—exit ticket or brief discussion:

- *"One pattern I noticed in earthquake locations is..."*
- *"One question I still have is..."*

Return to the student questions from Engage. Work through the board list—which ones can now be answered? Which ones require more data to address?

Teacher reference - *Sample answers to the discussion questions from Engage. Use these to guide the conversation as you work through the board list with students.*

- *Where do earthquakes seem to cluster?*
  - *Along narrow bands or lines, particularly around the edges of continents and through ocean basins. Students may notice the Pacific "Ring of Fire" even without knowing the name.*
- *Are there places with no earthquakes at all?*
  - *Yes—the interiors of large continental plates (central North America, interior Africa, Australia) have very few earthquakes. Students may be surprised that most of the map is quiet.*
- *Do they follow any shapes—lines, curves, dots?*
  - *Lines along transform boundaries like the San Andreas Fault, curved arcs along subduction zones like Japan and Chile, and linear chains along mid-ocean ridges. Some appear as scattered dots in plate interiors.*
- *How many earthquakes do you think happen in a year? In a day?*
  - *Estimates will vary widely—accept all answers here. In reality, hundreds of thousands of earthquakes occur each year, roughly 20,000 of which are felt by people. Several happen every day worldwide, though most are too small to feel.*
- *Why do you think earthquakes happen in some places and not others?*
  - *Students may say "fault lines," "volcanoes," or "where plates meet." Earthquakes occur where tectonic plates interact—at their boundaries, stress builds up as plates move toward, away from, or past each other. When that stress is released suddenly, it produces an earthquake.*
- *What would you need to know to describe an earthquake to someone who didn't feel it?*
  - *Where it happened, when it happened, how strong it was, how deep it was, and what effects it caused. Students may also suggest shaking intensity, damage, or whether a tsunami occurred.*

TRANSITION:

Explain that scientists use this basic information to begin describing an earthquake event. The next step is organizing this information so it can be clearly communicated—which is exactly what the USGS Earthquake Event Page is designed to support.

DIFFERENTIATION

Middle school: Focus on location, magnitude, and what clustering means. Prioritize visual pattern recognition over quantitative analysis. Consider framing it for students as: *"Scientists use numbers, but they first look for patterns. Today, your goal is to understand what the data shows before worrying about precise calculations."*

High school: Focus on the connection between plate boundary type, seismic patterns, and stress accumulation. Add plate velocity using the GPS Velocity Viewer and fault type analysis. Connect motion rates to seismic hazards and explore why some boundaries produce larger earthquakes than others.

EXPLORE / EXPLAIN 2

ACCESSING EARTHQUAKE DATA USING USGS

Time: ~45 minutes

Unit Learning Goals addressed in this section:

- Analyze seismic and tectonic data to describe earthquake causes and effects.
- Interpret multiple earthquake datasets to explain patterns and impacts.
- Explain relationships among tectonic processes, seismicity, and surface hazards.
- Connect geoscience data to human and environmental contexts.

Lesson Objective: Students will navigate the USGS Earthquake Event Page to identify and interpret the key datasets scientists use to analyze and communicate information about earthquakes.

Having seen what a finished Teachable Moment looks like, students now go behind the scenes to explore the raw data sources that power it—learning how scientists access and interpret earthquake information from the USGS.

EXPLORE: NAVIGATING THE USGS EARTHQUAKE EVENT PAGE

Introduce the USGS Earthquake Event Page by guiding students to a sample event (USGS California M7 Dec. 5, 2024) as a primary source scientists use to analyze earthquakes.

Finding the Example Earthquake (Teacher Demonstration)

Demonstrate how to locate the event using the USGS search tool.

Steps:

- Go to earthquake.usgs.gov/earthquakes/search/
- Set a date range around the earthquake event.
    - Start: **2024-12-04**
    - End: **2024-12-06**
- Set a minimum magnitude filter.
    - Minimum magnitude: **7.0**
- Narrow Location down.
    - Geographic Region: **World** or for best results click **Custom** and draw a box around Northern California on the map.
- Click Search.
- Select the earthquake from the results list.
    - M 7.0 - Offshore Cape Mendocino, California (Dec. 5, 2024)
- Click the epicenter dot and then the event box in the lower left to open the **USGS Event Page.**

You can let students explore on their own before guiding them through the Key Datasets on the USGS Event Page.

Ask students:

- What types of information are available on this page?
- What datasets might help explain the earthquake?

EXPLAIN: KEY EARTHQUAKE DATASETS

Now that students have explored the page, guide them through the key datasets scientists use. Explain how scientists use these datasets to understand earthquakes and communicate findings.

Key datasets to focus on:

- Magnitude and depth information.
- ShakeMap intensity maps.
- PAGER population exposure.
- Focal mechanism diagrams.
- Earthquake location and timing.

KEY DATASETS ON THE USGS EVENT PAGE

Dataset / Feature	What It Shows
Magnitude & Depth	Size (energy released) of the earthquake and how deep it occurred below the surface. *Displayed at the top of the overview page under or within the title.*
Interactive Map	Location of the earthquake (epicenter) and nearby seismic activity; *Toggle different layers (tectonic plates, population density, etc.) and the legend from the top right corner under the layers and key icons.*
Regional Information / Tectonic Summary	Description of the tectonic setting, nearby faults, and why earthquakes occur in this region. *This information can sometimes be moved to the bottom of the overview page like it is in the California M7 case.*
"Did You Feel It?" (DYFI)	Crowdsourced reports of shaking from people, used to create intensity maps of how the earthquake was experienced. The link to contribute to this dataset is called Felt Report - Tell Us! People are encouraged to report immediately after feeling an earthquake in their area. *The California earthquake is best viewed by clicking on the intensity map, which then brings up DYFI results on the Interactive Map.*
ShakeMap	Map showing the distribution and intensity of ground shaking across the region; used for emergency response and hazard assessment.
PAGER	Estimates of population exposed to shaking and potential fatalities/economic losses.
Ground Failure / Secondary Hazards (sometimes present)	Estimates of landslides or liquefaction caused by shaking.
Aftershock Forecast	Locations and timing of smaller earthquakes following the main event; shows how stress redistributes.
Origin	Exact time/depth/magnitude of the earthquake. Information on the number of stations that felt the earthquake and additional waveform information.

Moment Tensor	This displays a focal mechanism (beach ball) which can be interpreted into type of fault motion and direction of stress release (how the plates moved). *The beach ball will look different depending on if the earthquake happened on a normal fault, reverse fault, transform fault, or some combination of those.*
Finite Fault	The size and shape of the fault that ruptured, and how slip varied across it. Shows where the most energy was released and helps explain shaking patterns and earthquake impacts. You can also see the way the event affected surface movement from GPS stations.
Tsunami	See if the event generated a tsunami warning, advisory, watch, or threat.
View Nearby Seismicity	See more information on other greater than magnitude 4 events that happened within three weeks of the mainshock in this foreshock, mainshock, aftershock sequence.
ShakeAlert	ShakeAlert is a West Coast-based early warning system for the public. This section on the USGS page shows how quickly the earthquake was detected and when alerts were issued. Includes estimated warning times, shaking intensity, and how the alert compared to the actual earthquake.
Contributors	Lists the seismic networks, organizations, and instruments that provided the data for the earthquake. Shows that earthquake data comes from a collaborative network of sensors and institutions.

Explain how these datasets connect to the Teachable Moment slides: 2024 M7.0 Earthquake in California.

Many of the datasets on the USGS Event Page connect directly to a slide in the Teachable Moments format. The table below shows how scientists move from raw data to science communication.

USGS Dataset	Teachable Moment Slide
ShakeMap	Intensity Map (Slide 4 in California TM)
PAGER	Population Exposure (Slide 5 in California TM)
Moment Tensor	Focal Mechanism & Fault Type (Slide 13 in California TM)
Tsunami / Ground Failure	Hazards (Slides 6-9 and 14 in California TM)
Regional Information / Tectonic Summary	Tectonic Setting (Slide 12 in California TM)
Aftershock Forecast / View Nearby Seismicity	Aftershocks & Foreshocks (Slide 10 in California TM)

Teacher tip: Emphasize that scientists use these datasets to rapidly analyze earthquakes and communicate findings to both the scientific community and the public—exactly as students will do when they build their own Teachable Moment.

FORMATIVE CHECK

Exit ticket or brief discussion:

- *"One dataset I found on the USGS page that I didn't expect was…"*
- *"This dataset connects to the Teachable Moment because…"*

TRANSITION

Students have now seen both what a Teachable Moment looks like and where its data comes from. In the next section, they will examine the Teachable Moment slide deck more closely to understand how scientists organize this information into a clear, visual story.

DIFFERENTIATION

Middle school: Focus students on the five key datasets highlighted in this section—Magnitude & Depth, ShakeMap, PAGER, Interactive Map, and Regional Information. Encourage them to describe what they see in plain language before worrying about technical terms. The "Did You Feel It?" map is particularly accessible for MS students since it connects shaking intensity to human experience in a concrete, relatable way.

High school: Encourage students to explore the full event page independently before the guided walkthrough, including the Moment Tensor, Finite Fault, and Aftershock Forecast. Ask them to consider how each dataset connects to a specific scientific question about the earthquake—not just what the data shows, but what it helps scientists conclude.

EXPLORE / EXPLAIN 3

UNDERSTANDING THE TEACHABLE MOMENT SLIDES - DIVING DEEPER

Time: ~50 minutes

Unit Learning Goals addressed in this section:

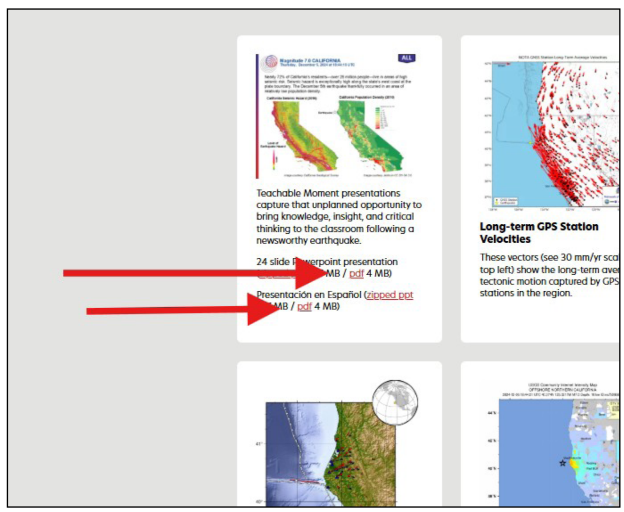
- Analyze seismic and tectonic data to describe earthquake causes and effects.
- Explain relationships among tectonic processes, seismicity, and surface hazards.
- Connect geoscience data to human and environmental contexts.
- Communicate scientific findings using clear visuals and storytelling.

Lesson Objective: Students will analyze Teachable Moments slides to determine how scientists organize earthquake information into a clear, visual explanation of an earthquake event.

With an understanding of both the finished product and its data sources, students now examine the Teachable Moment slide deck slide-by-slide to understand how scientists organize evidence into a coherent visual story—the same structure they will use in Extend.

EXPLORE: DIVING DEEPER

Working individually or in groups of 2-4, students examine the Teachable Moment slide deck more closely to understand what each slide explains about the earthquake.



Direct students to the 2024 M7.0 Earthquake in California. Have them click the **pdf** link to access the slides. *Teachers can download the slides ahead of time and handpick grade appropriate slides for students to review. Slides are marked by recommended grade level.*

Using the Deeper Dive Worksheet, students identify for each slide:

- Which question does the slide answer?
    - Where did the earthquake occur?
    - What tectonic processes caused it?
    - What seismic patterns exist in the region?
    - What hazards and impacts occurred?

- What data or visual is used, and how does it help explain the earthquake?
- Does this slide focus on Earth processes or human impacts?

Refer to the **Deeper Dive Worksheet** *(included in ZIP file download)*.

EXPLAIN: THE STRUCTURE OF A TEACHABLE MOMENT

Go over the worksheet answers as a whole class. Emphasize that scientists organize earthquake information into a sequence of visuals that each answer a specific question—together they tell the full story of an event.

FORMATIVE CHECK

Exit ticket or brief discussion:

- *"The visual on slide ___ helped explain the earthquake because..."*
- *"One thing I noticed about how scientists organize this information is..."*

TRANSITION

Explain that students will now use these same datasets and this same structure to build their own Teachable Moment presentation about a real earthquake of their choosing.

DIFFERENTIATION

Middle school: Direct students to the slides marked for All levels and focus their analysis on the four guiding questions—where, what tectonic processes, what seismic patterns, and what hazards and impacts. Encourage them to describe what each visual shows in their own words before categorizing it as Earth processes or human impacts. The ShakeMap, PAGER, and Human Connection slides are particularly accessible entry points for MS students.

High school: Direct students to the slides marked for All and HS level and encourage students to go beyond describing visuals to evaluating them—which slides make the strongest scientific argument? Which visuals are most effective at communicating complex data? Ask them to consider how the sequence of slides builds a coherent narrative, and whether they would organize the story differently. This prepares them to make deliberate structural choices when building their own in Extend.

EXTEND / ELABORATE

BUILDING YOUR OWN TEACHABLE MOMENT

Time: ~135 minutes

Unit Learning Goals addressed in this section:

- Analyze seismic and tectonic data to describe earthquake causes and effects.
- Interpret multiple earthquake datasets to explain patterns and impacts.
- Explain relationships among tectonic processes, seismicity, and surface hazards.
- Connect geoscience data to human and environmental contexts.
- Communicate scientific findings using clear visuals and storytelling.

Lesson Objective: Students will select a real earthquake and construct a data-driven Teachable Moment presentation that explains the event's causes, characteristics, and impacts using scientific evidence and effective visuals.

CORE ACTIVITY: BUILD A TEACHABLE MOMENT

Students select a real earthquake they have not already studied and create a slide deck using the Teachable Moments Slide Template provided below.

Students can work individually or in groups to create these slides.

Note: Remind students of the purpose behind the format: when a major earthquake makes the news, there is a brief window when the public is paying attention. Their Teachable Moment should be designed to meet that moment—clear, visual, and ready to communicate the science while interest is still high.

SELECT AN EARTHQUAKE:

Have students select their earthquake using one of the methods outlined below:

- **Personal connection:** Largest earthquake on or near their birthday (Birthquake WebApp).
- **Teacher-curated list:** e.g., Japan 2011 M9, Haiti 2010 M7, Turkey 2023 M7.8, Alaska 1964 M9.2.
- **Data-driven:** M7.0+, within the last 20 years, near a plate boundary (using IEB or USGS).
- **Regional focus:** Earthquakes from a specific region tied to curriculum themes.

Teacher tip: Avoid events that are too small or poorly documented. Events with clear data and visuals lead to stronger analysis.

SLIDE TEMPLATE:

Note: The template uses color coding throughout to guide teachers in shaping students' experience. *Slides are editable—include only the slides relevant to your students' level. More advanced students can be given less scaffolding within the template.*

- **Teachable Moments Slide Template** *(included in ZIP file download)*

  The following color codes are used throughout the template slides to guide teachers to help shape students' experience and should be reviewed **before students receive the template.**

  - **Template (Do not Edit)**
  - **Teacher Instructions (Delete/Edit)**
  - **Instructions for students to edit**

  Use the Slide Expectations by Level tables below to determine which slides are appropriate for your students before distributing the template.

TEACHER ROLE DURING CONSTRUCTION

Coach for clarity and reasoning rather than perfection. Emphasize:

- Short, evidence-based captions: *What does the data show? Why does it matter?*
- Proper citation of all data sources.
- Clear labeling of axes, legends, map symbols.
- Remind students: the goal is to explain each visual, not just show it.
- Model the rubric (see Evaluate section) so students understand expectations before creating their slides.

Checkpoint questions to use while circulating:

- What does this map or graph show?
- How does this data support your explanation?
- Are labels, legends, and sources clearly identified?
- Would someone unfamiliar with earthquakes understand this slide?

OPTIONAL: COLLABORATION STRUCTURES

A recommended group work strategy is listed below:

STRUCTURED GROUP WORK

Divide tasks while ensuring all students understand the full earthquake story. Frame it for students as real-world science: *"Scientists work in teams, combining data analysis, mapping, communication, and review."*

Roles:

Role	Responsibilities in Class	Related Geoscience Careers	What Professionals Do
Data Analyst	Explores datasets (USGS, EarthScope, hazard maps) and identifies patterns.	Seismologist, Geophysicist, Tectonics Researcher, Hazard Analyst	Analyze seismic and GPS data to understand plate motion, earthquake patterns, and hazard risk. Use computational tools to model Earth processes.
Slide Designer	Builds visuals, maps, and graphs; ensures readability and layout.	GIS Specialist, Cartographer, Geospatial Analyst, Science Visualization Specialist	Create maps and spatial data products that communicate geographic patterns. Use GIS software to interpret and visualize Earth data.
Science Communicator	Writes captions and explanations using evidence from the data.	Science Communicator, Public Information Officer, Earth Science Educator, Outreach Specialist	Translate complex scientific findings into language the public can understand. Work with media, schools, or agencies to explain hazards and preparedness.
Citation Checker (optional)	Ensures sources, map credits, and labels are included.	Research Scientist, Data Manager, Scientific Editor, Policy Analyst	Maintain scientific integrity by properly citing data sources, reviewing reports, and ensuring accuracy and transparency in publications.

Tip: Rotate roles every 1–2 days so students practice multiple skills.

SLIDE EXPECTATIONS BY LEVEL

Use the guide below to determine which slides are appropriate for your students' level.

MIDDLE SCHOOL (GRADES 6-8): FOCUS ON *WHERE*, *WHAT*, AND *WHO*

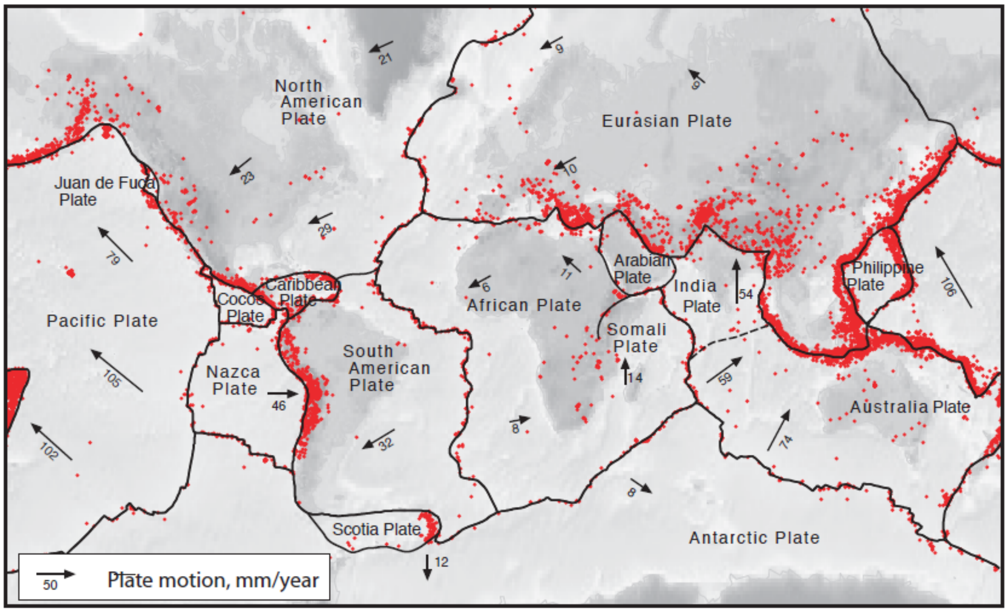
- Students focus on where earthquakes happen, what they cause, and who they affect. Prioritize interpreting visual data over numeric analysis.
- **Teacher tip:** *"Scientists use numbers, but they first look for patterns. Today, your goal is to understand what the data shows before worrying about precise calculations."*

Slide #	Template Slide #	Title	Purpose (further context provided in the template itself)
1	3	Overview	Identify and summarize the event.
2	4	Regional Geography	Describe the environment and physical setting.
3	5	Tectonic Setting	Show which plates meet here (teacher provides simplified map located in Teacher Notes below).
4	6	Historic Seismicity	Identify other earthquakes in the same region using the Interactive Earthquake Browser.
5	7	Aftershocks & Foreshocks	Explain earthquake sequences using simple examples.
6	8	Intensity Map (MMI)	Show where shaking was strongest.
7	9	Population Exposure (PAGER)	Show who was affected. Use this USGS page to further explore USGS PAGER scientific background.
8	27	Human Connection	Describe how people experienced or responded to the quake. Encourage exploration of news stories and community impact over technical detail. Students can use reputable sites like: • BBC News: https://www.bbc.com/news • Associated Press (AP News): https://apnews.com • Reuters: https://www.reuters.com • NPR: https://www.npr.org
9	28+31	Reflection & Credits	Summarize learning and cite data.

Teacher Notes:

- For the *Tectonic Setting* slide: Use this pre-labeled plate map and simplified terminology. (For Slide 3 Tectonic Setting)

Earth's outer surface is broken into what geologists call plates. In general, earthquakes occur when plates move under, over, or slide past each other. As you can see on the map below, most earthquakes occur along the edges of the large plates that make up Earth's crust. The arrows on the map indicate how fast the plates are moving in millimeters per year—about as fast as your fingernails grow.



This figure was produced in cooperation with the US Geological Survey and the University of Memphis.

HIGH SCHOOL (GRADES 9-12): FOCUS ON DATA AND GRAPHICAL LITERACY

Students engage deeply with data interpretation and tectonic modeling.

Slide #	Template Slide #	Title	Purpose (further context provided in the template itself)
1	3	Overview	Summarize event and key data.
2	4	Regional Geography	Describe landscape and setting.
3	5	Tectonic Setting	Identify plate boundaries, direction, and velocity using GPS Velocity Viewer and Plate Motion Calculator or teacher provides simplified map located in Teacher Notes below. ***Teacher Option:*** *This slide requires advanced data analysis. Teachers may choose to:* • *Explore plate motion in depth using the provided tools over several lessons.* • *Substitute with a pre-made tectonic map or EarthScope's previous Teachable Moments showing general motion directions if time or skill limits exist.*
4	6	Historic Seismicity	Show patterns of past events (Interactive Earthquake Browser).
5	7	Aftershocks & Foreshocks	Plot aftershock sequence; explain stress adjustment.
6	8	Intensity Map (MMI)	Illustrate shaking distribution and severity.
7	9	Population Exposure (PAGER)	Interpret population exposure by intensity.
8	10-13	Focal Mechanism & Fault Type	Analyze fault motion using USGS beach ball diagram and EarthScope animation.
9	14-25	Hazards	Discuss seismic, tsunami, landslide, or liquefaction impacts.

10	26	P- & S-Wave Travel Time	Interpret seismogram data and calculate wave arrival times using Station Monitor. ***Teacher Option:*** *This slide requires the students to go through some steps for analysis highlighted in the slide template notes on the slide itself, and below in the teacher notes. Teachers may choose to:* • *Walk students through the method as a class.* • *Provide students with the waveform information ahead of time,* ***or*** • *Replace this slide with a class lesson on waveforms using tools like Seismic Wave Viewer.*
11	27	Human Connection	Explore social, cultural, or economic impacts and resilience. Encourage exploration of news stories and community impact over technical detail. Students can use reputable sites like: • BBC News: https://www.bbc.com/news • Associated Press (AP News): https://apnews.com • Reuters: https://www.reuters.com • NPR: https://www.npr.org
12	29+31	Reflection & References	Summarize findings and cite data.

Teacher Notes:

- The *Tectonic Setting* slide can serve as a **mini-unit** in itself. Consider devoting a class period or more to mastering the Velocity Viewer tool, introducing GPS vectors, and connecting motion rates to stress buildup.
    - For classes needing scaffolding, provide a **partial dataset or screenshot** of plate velocities such as the image below, or drop the requirement for plate movement rate but have students explore the GPS velocities and boundary types on their own using GPS Velocity Viewer.

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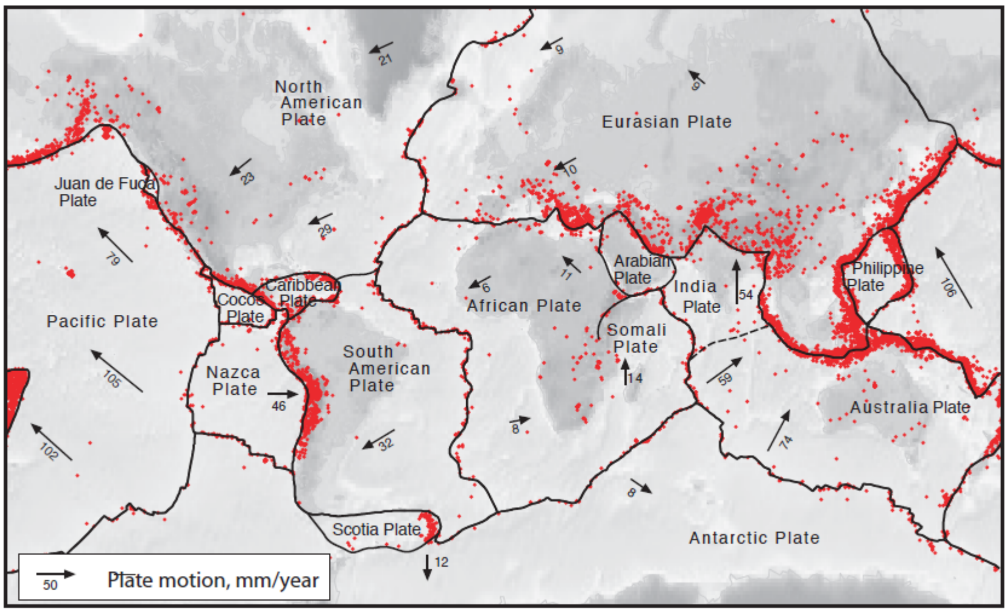

This figure was produced in cooperation with the US Geological Survey and the University of Memphis.

- The *P- & S-Wave Travel Time Slide* uses Station Monitor
    - Go to iris.edu/app/station_monitor and click on the Map on the home page.
    - Click on a seismic station near—but not immediately next to—the epicenter of your earthquake. A station a few hundred to a couple thousand kilometers away will show the clearest P and S arrivals. You can also choose a station near your school, but you may need to switch to a closer station later if the earthquake signal is not clearly visible.
    - Once a station is selected, go to Date UTC and click the calendar icon. Enter the date the earthquake occurred. Note that all times in Station Monitor are in UTC—convert your earthquake's local time to UTC for best results.

- Scan the Events on the chart list for an event that matches your earthquake—If the event does not appear, try going forward or back one day. This is more likely to be necessary if your chosen station is farther from the epicenter.
- Click on the event on the chart. A magnifying glass icon will appear on the seismograph to the left—click it to open a close-up view of the waveform for that event.
- In the close-up view, you will see the seismogram with estimated P and S wave arrivals marked. Read the arrival times from the x-axis. Subtract the earthquake's origin time (UTC) from each arrival time to calculate how long the P wave and S wave each took to travel from the epicenter to your station. (These times are estimated so they may be off which could require choosing a different station.)
- The distance between the earthquake and the selected station is displayed in the bottom right corner of the screen.

EVALUATE

COMMUNICATING EARTHQUAKE SCIENCE

Time: ~180 minutes (Assuming 6–8 five-minute presentations per class period, plus an additional period for reflection and debriefing)

Unit Learning Goals addressed in this section:

- Analyze seismic and tectonic data to describe earthquake causes and effects.
- Interpret multiple earthquake datasets to explain patterns and impacts.
- Explain relationships among tectonic processes, seismicity, and surface hazards.
- Connect geoscience data to human and environmental contexts.
- Communicate scientific findings using clear visuals and storytelling.

Lesson Objective: Students will present and interpret earthquake data to explain the causes and impacts of an earthquake, using scientific evidence, effective visuals, and clear communication.

ACTIVITY: TEACHABLE MOMENT PRESENTATIONS

Presentations: Each student or group presents their Teachable Moment presentation to their peers. Their goal is to clearly explain the science of their earthquake using accurate data, effective visuals, and a discussion of its societal impact.

Frame the presentations as real science communication: just as scientists rapidly communicate earthquake science to educators and the public while attention is focused on an event, students are doing the same—translating data into a story that a curious, non-expert audience could understand.

Audience: During presentations each student in the audience should complete an Earthquake Story Tracker Worksheet *(included in ZIP file download)*.

RUBRIC

Teacher: Score each presentation using the rubric on the following page. Adjust the weighting of criteria to reflect your instructional priorities—a middle school or mixed-ability class may weigh Visual Clarity more heavily, while a high school class may emphasize Scientific Accuracy and Data Use.

RUBRIC

Criteria	4 — Exemplary	3 — Proficient	2 — Developing	1 — Beginning	0 — Not Present
Scientific Accuracy **(Correctness of ideas)**	All explanations are accurate and clearly supported by the data. No misconceptions are present.	Most explanations are accurate. Minor errors or incomplete explanations may appear.	Some explanations are accurate, but others may be partially inaccurate or unclear.	Few explanations are accurate, and major inaccuracies or misconceptions are present.	Explanation missing.
Visual Clarity	Slides are well organized with clear titles, readable text, and labeled visuals (e.g., graphs, maps, images) that directly support and are explained in the presentation.	Slides are organized with mostly readable text and labeled visuals that generally support the presentation, though some elements may be unclear or not fully explained.	Slides include some visuals and text, but organization is inconsistent, labels may be missing, or visuals are not clearly explained.	Slides are poorly organized with hard-to-read text, missing or unclear labels, and visuals that do not support the presentation.	Slides are missing or cannot be viewed.
Data Use **(How evidence, e.g., graphs, maps, or measurements, are used to support claims)**	Multiple scientific datasets are used and clearly interpreted to support conclusions.	At least two datasets are used and generally interpreted correctly.	Data are included but are weakly interpreted or not clearly connected to the conclusions.	Minimal or incorrect use of data.	No data used.
Societal Relevance	Clear explanation of how the earthquake affected people, communities, or environments.	Mentions impacts but explanation lacks depth.	Limited or unclear discussion of impacts.	Minimal mention of impacts.	No societal relevance included.
Communication (Oral)	Speaks clearly with appropriate volume and pace, maintains eye contact, explains visuals in their own words, and engages the audience.	Speaks clearly with adequate volume, uses some eye contact, and generally explains visuals with occasional reading from slides.	Is sometimes unclear, uses limited eye contact, and relies heavily on reading from slides with minimal explanation of visuals.	Is difficult to hear or understand, reads directly from slides, and provides little to no explanation or engagement.	Presentation is not delivered or the speaker does not participate.

ACTIVITY: PUTTING IT ALL TOGETHER

Whole-Class Discussion (Post-Presentations): Facilitate a whole class discussion using the student presentations and the "Story Trackers" as evidence for broader synthesis of ideas.

1. **Comparing Evidence Across Presentations** What similarities and differences did you notice in the types of data used across presentations, and how did those choices affect how well you understood each earthquake?
2. **Understanding Patterns in Earthquakes** Why do more earthquakes occur in some places than others?
3. **Explaining Causes and Characteristics** What features of plate boundaries determine earthquake magnitude, depth, and frequency?
4. **Evaluating Risk and Preparedness** Based on what you learned, what factors make some earthquakes more dangerous than others, and how could communities use this information to prepare?

Reflection Prompt (Written): Students synthesize and summarize their learning by writing a response to the following prompt. "How do earthquakes connect Earth's internal processes to human experiences?"

Responses should address:

- What causes earthquakes at a tectonic level
- How scientists use data to understand where and why earthquakes occur
- How earthquake patterns help communities prepare
- Example:

  Earthquakes are caused by internal processes such as plate motion and the buildup of stress along faults, but their effects are experienced at the surface by people and communities. For example, data like seismic waves and earthquake location maps show where stress is released, which helps explain why certain regions experience more damage. By studying this data, scientists can better understand earthquake patterns and help communities prepare through building design and emergency planning.