SCIENCE MATTERS

Grade Six
Earth Science

Earthquakes and Volcanoes

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Earth Science: Earthquakes and Volcanoes

Introduction and Conceptual Flow Narrative

Introduction: This *Grade 6 Earth Science Unit* focuses on earthquakes and volcanoes and is recommended to be taught following the *Grade 6 Earth Science Unit: Plate Tectonics.* Earthquakes and volcanoes are two of the visible signs of plate tectonics. The unit addresses the California Science Standards for 6th grade for the topics of Earthquakes and Volcanoes as well as Investigation and Experimentation. By the end of the unit students will know: Geologic events, such as earthquakes and volcanoes result from movement of the plates. Every plate boundary is a dynamic place resulting in changes to the earth's surface. Earthquakes are sudden motions along the breaks in the crust called faults and that volcanoes and fissures are locations where magma reaches the surface. Epicenters of earthquake can be determined by a variety of measures. The effects of the earthquake on any region varies, depends on the size of the earthquake, the distance of the region from the epicenter, the local geology, and the type of construction. Earthquake preparedness includes planning construction of buildings, location of buildings, and gathering supplies for a potential earthquake. Major features of California geology are formed by seismic activity in the form of volcanoes and earthquakes.

The *Grade 6 Earth Science Unit on Earthquakes and Volcanoes* is presented to students through a series of investigations using indirect evidence (models) and direct evidence, experiments, active learning experiences, researching using a variety of sources, questions, and assessments. Assessments include: pre-, post- and 4 formative assessments.

Conceptual Flow Narrative: The *Grade 6 Conceptual Flow Narrative for Earth Science: Earthquakes and Volcanoes* builds on the concepts presented on the conceptual flow graphic by describing the concept(s) addressed in each lesson and the links that connect each lesson to the next. Lessons are linked to the previous lesson and the lesson that follows via a conceptual storyline to enable the development of student understanding as they progress from one concept to the next.

After students have completed the **Pre-Assessment**, they begin their exploration of earthquakes and volcanoes with **Lesson 1, "Earth Shaking Events"** where historical earthquakes and volcanoes are plotted. Distances from Carpenteria and Santa Barbara are determined providing a foundation of experience relatively close the student's environment. The lesson concludes with a risk-level analysis of the Carpenteria/Santa Barbara area based on historical earthquake activity.

In the previous lesson students learned that earthquake activity has a historical record along plate boundaries of the San Andreas Fault. **Lesson 2, "Fault Formations"** uses clay models to show how earth materials are squeezed and pulled in different directions

during an earthquake. Push boxes are used to demonstrate the land formations that result from pushing of Earth materials.

Lesson 3, **"A Model of Plate Faults,"** links the exploration of forces in the Earth in Lesson 2 to identification of faults that are formed by the plate movement. During lesson 3 students build a fault model and use the model to explore and demonstrate formation of normal, reverse thrust, and strike slip fault characteristics.

In **Lesson 4, "Up and Down Blocks,"** students' link lesson 3 concept of different movements causing blocks of Earth materials to move in three basic directions. The paper models built in lesson 4 indicate how the rock layers have moved overtime by earthquakes either pulling, compressing or sliding blocks of Earth materials.

Having learned that blocks of Earth move in Lesson 4, students in **Lesson 5 "Slip Sliding Along"** explore evidence of the San Andreas strike-slip fault that moves between the boundary of the Pacific and North American plate.

Optional **Lesson 5a " Spaghetti Fault Model"** deepens understanding of forces that cause movement and break rocks along the boundary forming the San Andreas strike-slip fault. The simple apparatus uses moving wood blocks and increasingly greater amounts of spaghetti to model how rocks break through movement along a strike slip fault.

Formative Assessment #1: Assessing Faults In Formative Assessment #1 students demonstrate their understanding of the three fault models that are used to explain changes in the Earth. Students are asked to relate the fault models to different forces in the Earth. Student answers about critical concepts of forces and resulting faults provides feedback to the teacher for any adjustments in teaching/learning in later lessons.

Lesson 6 "Wave Watching" introduces how energy is transmitted through the earth in the form of seismic waves. The waves are classified as body and surface waves. Body waves (primary P and secondary S) have different movements and are explored in lesson 6 through a model of students standing in a row and Slinkys.

Lesson 7, "Earthquake Waves: Wave Notes" includes multiple explorations of how primary and secondary waves as well as surface waves travel through different Earth materials. A model using a ring stand, paper clips and rubber bands demonstrates S waves while a penny dropped through different materials models how waves can be altered by a change in Earth materials.

Formative Assessment #2: "P Waves, S Waves and Surface Waves" is an opportunity for students to draw and explain the differences between the types of waves. This assessment is important for understanding how different travel speeds of P and S waves can be triangulated to find the epicenter of an Earthquake.

Identifying different speeds of waves in the previous lessons are linked to triangulating data to find the epicenter in **Lesson 8 "Finding the Epicenter".** Students find the epicenter of earthquakes by using speeds of S and P waves. The difference in the speeds helps triangulate data. A circle is drawn around the areas with the same speed indicating where the epicenter should be drawn.

Lesson 9 "Wattsville and Mercalli Booklet" shows students how observations of phenomena can indicate the intensity of an earthquake in a location and identify the area where the earthquake originated. Students become familiar with the Mercalli scale of measuring intensity of earthquakes by the objects the earthquake moves. A role-play of a radio show is used to model how callers might call in with observational data. The data is then used to identify origination of the earthquake.

Lesson 10 "Richter Scale" builds understanding of the scale used to indicate intensity and duration of an earthquake. Richter scales are often reported on the news and the scale is built on a logarithmic scale increasing by ten with each change in number. A model using spaghetti and a comparison to time is used to build understanding of the exponential increase in number.

While the last three lessons developed understanding of how to find epicenters and the multiple scales used to describe earthquakes; this lesson focuses on how building styles can limit damage. **Lesson 11, "Earthquake Building and Shaking Contest"** introduces the concept that different building practices limit damage from earthquakes. The concept is explored through a variety of videos and equipment where students build a structure that can be tested on a "shaking table".

Since we cannot predict earthquakes, we can prepare for possible damage. Building on the Lesson 11 concepts of using triangles and cross members to strengthen buildings, **Lesson 12 " Earthquake Preparedness"** prepares students to gather supplies for an earthquake kit. Areas in homes and schools where objects may fall are also identified as a precaution.

Formative Assessment #3: Earthquake Informational Brochure
The series of lessons 1-12 develop two concepts including; 1) Plate motion subjects boundaries to stress and 2.) Seismic activity in the form of earthquakes can be measured in a variety of ways. The student-developed product of an informational brochure includes a score guide with data/concepts for inclusion.

Lesson 13 "Ring of Fire" introduces volcanoes as another type of seismic activity that alters the surface of the Earth. Patterns of volcano locations on the ring of fire are linked through mapping, videos, and discussion to locations of major earthquakes. The next lesson explores how volcanoes change the surface of the Earth.

Lesson 14 "Volcano Models" develops concepts including how volcanoes alter the

exterior surface of the Earth and the interior of the volcano. Models using an apparatus that shows the surface changes build ideas of new visible landforms. Movement inside the volcano including vents and tubes is explored using materials that move material under pressure through a model of a volcano.

Understanding of the seismic activity in volcanoes is deepened in **Lesson 15, "Eruptions and Volcano Types**" where models simulate quiet and explosive eruptions. Different types of eruptions form characteristic volcano landforms. Students use simple materials that model variations in the speed of the energy release from a volcano.

The previous lesson introduces the concept that differences in eruption speeds result in a variety of volcano landforms. **Lesson 16 "Landforms from Volcanoes"** develops concepts of characteristics of major volcanoes including shield, composite/stratovolcano and cinder cone. Students use criteria to sort pictures of volcano landforms.

Formative Assessment #4: "Volcanoes, Landforms, and Eruptions Assessment" provides an opportunity for students to explain what they know about volcanoes, eruptions, and resulting landforms through a choice of a project. The assessment includes directions outlining choices for the task and the scoring rubric. Students self select the type of measure to show understanding.

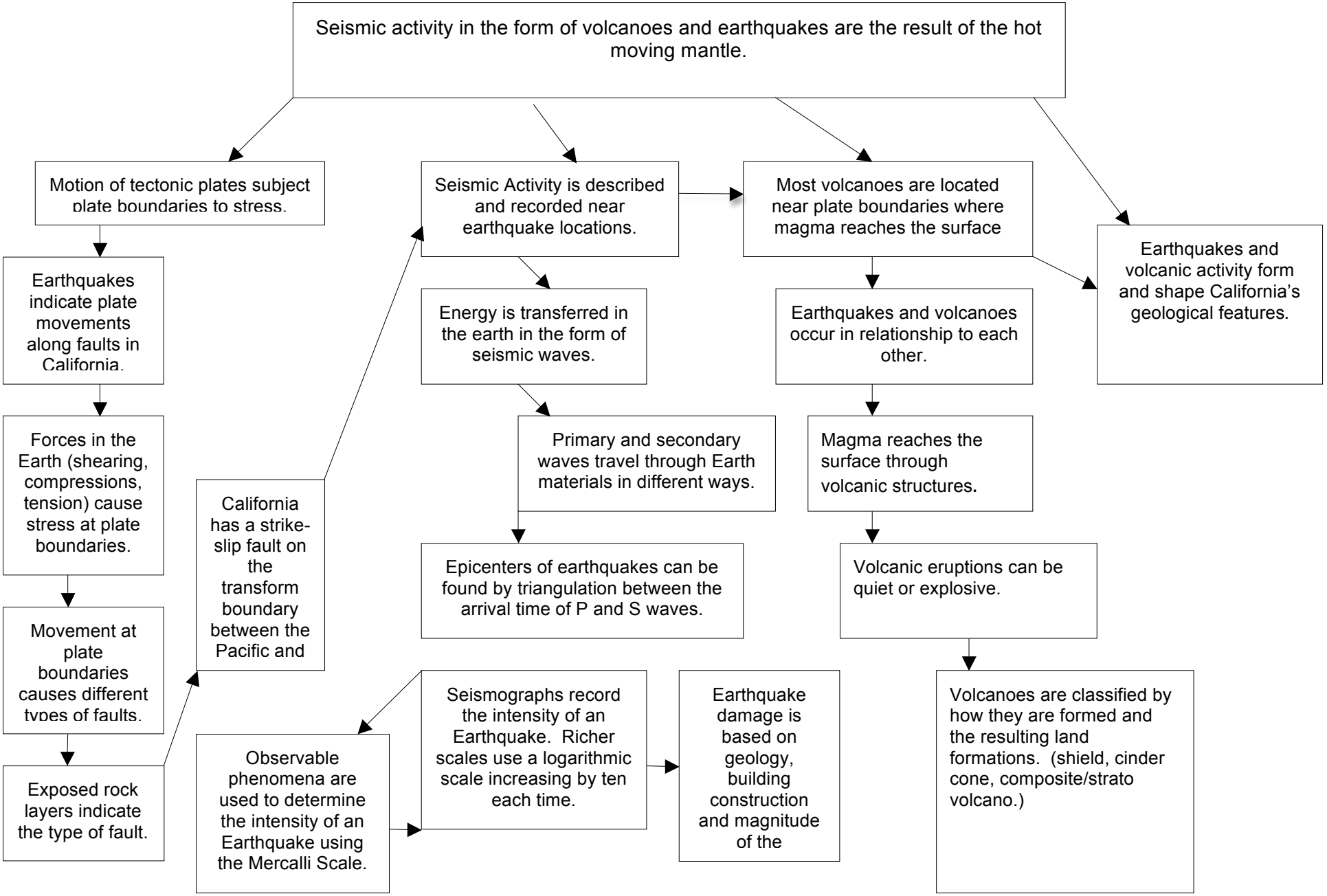
Lesson 17 " Seismic Activity and California Landforms" links the concept that seismic activity forms many California landforms. Patterns of earthquakes from Lesson 1 are used to introduce this lesson showing the overarching idea of the unit that "Seismic activity in the form of earthquakes and volcanoes are the result of the hot moving mantle".

Upon completion of the 17 lessons, students take a **Post-Assessment** to determine their overall understanding of the concepts presented in the unit.
There are two options for the post assessment. The first is a multiple choice and justified response **6F Post Assessment** the second **is 6F Post Performance Assessment.** This performance assessment was used in the Plate Tectonics Unit. Students will review concepts of plate tectonics and link fault patterns from the Earthquake and Volcano Unit. Items selected for scoring would focus on faults and fault patterns on the San Andreas Fault.

Grade Six Planning Guide

Grade Six lessons are multi day and need additional time for particular lessons. This guide is intended to provide approximate days/sessions needed for each lesson.

Lesson	*Time	Lesson	Time
**Pre-assessment*		**6.12 Earthquake Preparedness** ** Formative Assessment #3*	1 day
6.1 Earth Shaking Event	1-2 days	**6.13 Ring of Fire**	1-2 days
6.2 Fault Formations	1-2 days	**6.14 Volcano Models**	1-2 days
6.3 A Model of Plate Faults	2 day	**6.15 Eruption Types**	1 day
6.4 Up and Down Blocks	2 days	**6.16 Landforms from Volcanoes** **Formative Assessment #4*	1 day
6.5 Slip Sliding Along	1-2 days	**6.17 Seismic Activity and California Landforms**	1 day
6.5a Spaghetti Fault Model **Formative Assessment #1*	1 day	*Options:* ** Post Assessment* **Post-Assessment Performance*	
6.6 Wave Watching	1-2 days		
6.7 Earthquake Waves: Wave Notes **Formative Assessment #2*	1-2 days		
6.8 Finding the Epicenter	1 day	.	
6.9 Wattsfille and Mercalli Booklet	1 day		
6.10 Richter Scale	1 day		
6.11 Earthquake Building Shaking Contest	3 days		


Seismic activity in the form of volcanoes and earthquakes are the result of the hot moving mantle.
Motion of tectonic plates subject plate boundaries to stress.
Seismic Activity is described and recorded near earthquake locations.
Most volcanoes are located near plate boundaries where magma reaches the surface
Earthquakes and volcanic activity form and shape California's geological features.
Earthquakes indicate plate movements along faults in California.
Energy is transferred in the earth in the form of seismic waves.
Earthquakes and volcanoes occur in relationship to each other.
Forces in the Earth (shearing, compressions, tension) cause stress at plate boundaries.
Primary and secondary waves travel through Earth materials in different ways.
Magma reaches the surface through volcanic structures.
California has a strike-slip fault on the transform boundary between the Pacific and
Epicenters of earthquakes can be found by triangulation between the arrival time of P and S waves.
Volcanic eruptions can be quiet or explosive.
Movement at plate boundaries causes different types of faults.
Seismographs record the intensity of an Earthquake. Richer scales use a logarithmic scale increasing by ten each time.
Earthquake damage is based on geology, building construction and magnitude of the
Volcanoes are classified by how they are formed and the resulting land formations. (shield, cinder cone, composite/strato volcano.)
Exposed rock layers indicate the type of fault.
Observable phenomena are used to determine the intensity of an Earthquake using the Mercalli Scale.