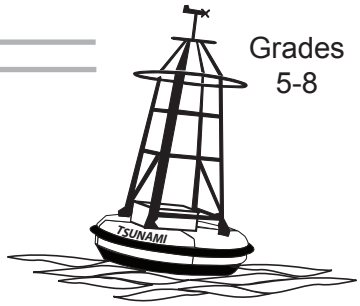
Seismic Waves

Grades 5-8



Overview:

Earthquakes are a potential tsunami generator. Scientists learn more about earthquakes by studying seismic waves. In this lesson, students explore the different types of seismic waves by modeling using various media.

Targeted Alaska Grade Level Expectations:

Science

[5-8] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating.

[6] SB4.3 The student demonstrates an understanding of motions, forces, their characteristics, relationships, and effects by making waves move through a variety of media.

[7] SD2.2 The student demonstrates an understanding of the forces that shape Earth by describing how the movement of the tectonic plates results in both slow changes (e.g., formation of mountains, ocean floors, and basins) and short-term events (e.g., volcanic eruptions, seismic waves, and earthquakes) on the surface.

[5] SG4.1 The student demonstrates an understanding that advancements in science depend on curiosity, creativity, imagination, and a broad knowledge base by investigating that scientists' curiosity led to advancements in science.

Math

[5] G-9 The student demonstrates a conceptual understanding of geometric drawings or constructions by identifying or drawing perpendicular line segments or midpoints (L) (M5.2.7)

Objectives:

The student will:

- model seismic waves; and
- differentiate among seismic waves.

Materials:

- Slinky®
- Rope or jumprope (optional)
- Gelatin
- 9x13" pans
- STUDENT WORKSHEET: "Seismic Waves"
- VISUAL AID: "Body Waves"
- VISUAL AID: "Surface Waves"

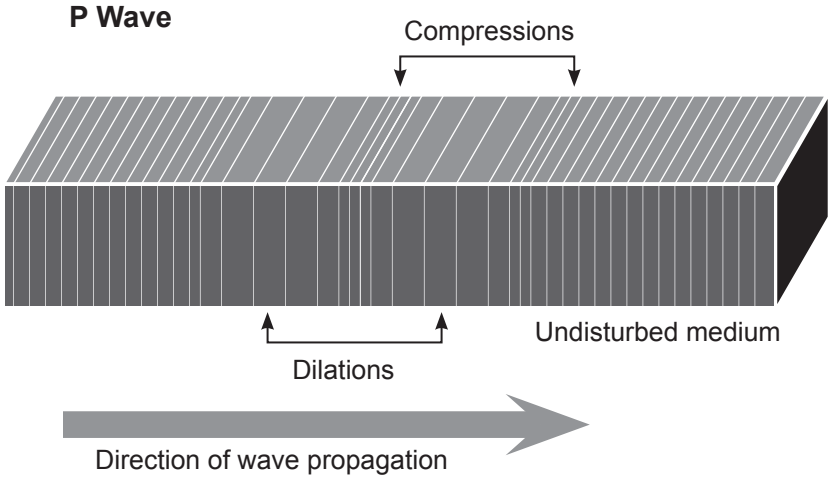
Whole Picture:

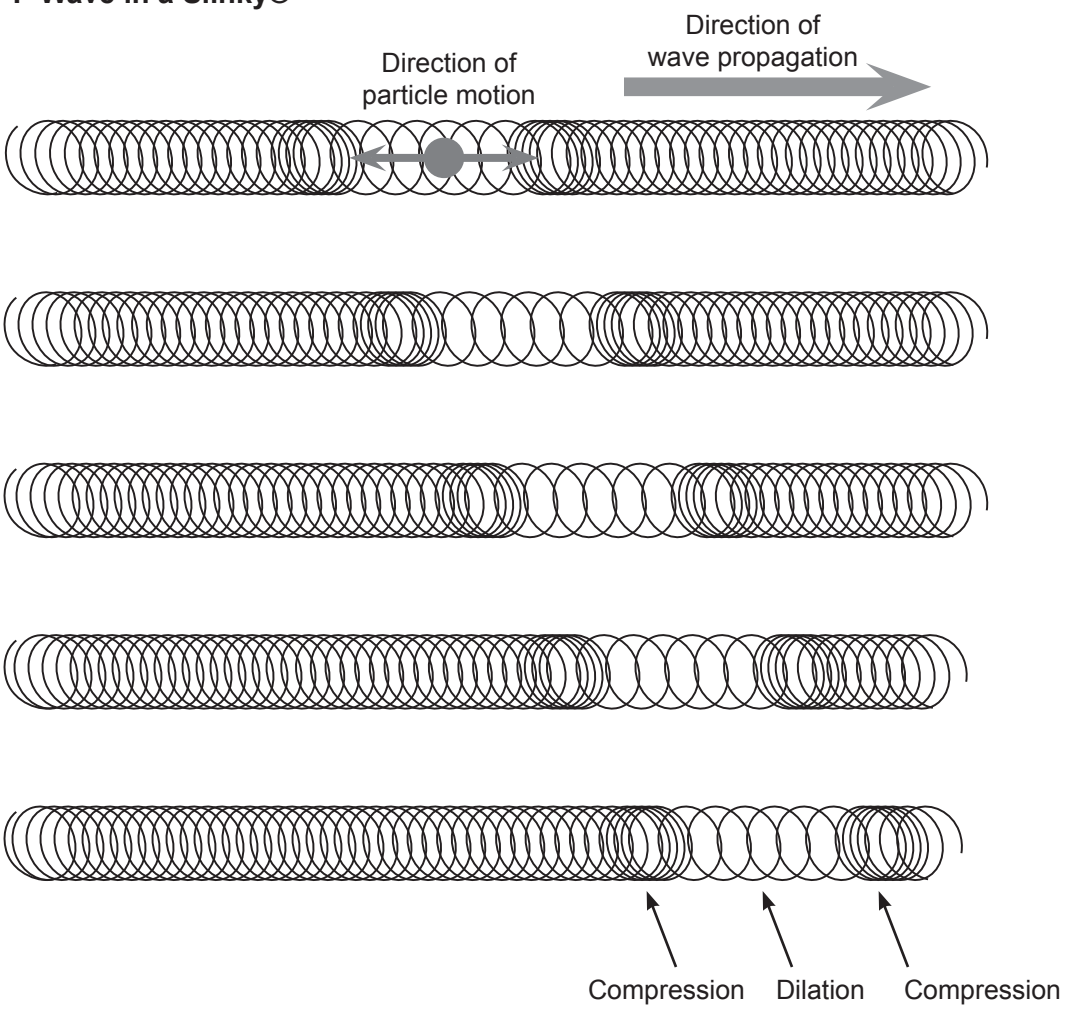
Seismic waves are waves that propagate through Earth's interior. Much of what we know about Earth comes from study of seismic waves and how they travel through different materials. Studying these waves helps us understand earthquakes and how to build things to withstand the different types of waves associated with earthquakes.

Seismic waves can be classified into two major groups: body waves and surface waves. Body waves may be classified as compressional waves (P waves) or shear waves (S waves). Body waves may also be used in identifying the epicenter of an earthquake.

P Waves

P waves are the faster of the two waves; they can travel through solid rock and liquid, as well as air. As a P wave travels through a medium (material), it causes particles to move in the same direction as the wave energy is traveling. As the waves pass through the medium, they cause compressions (shortening) and dilations (expansions). Slinkies may be used to model this type of wave.

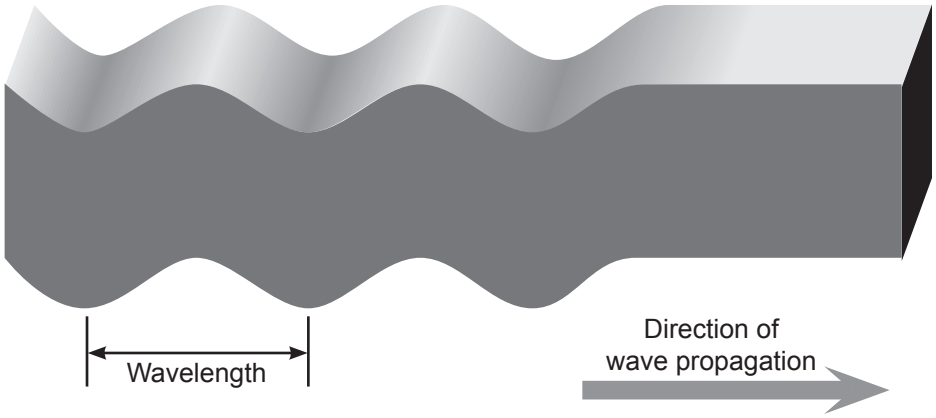




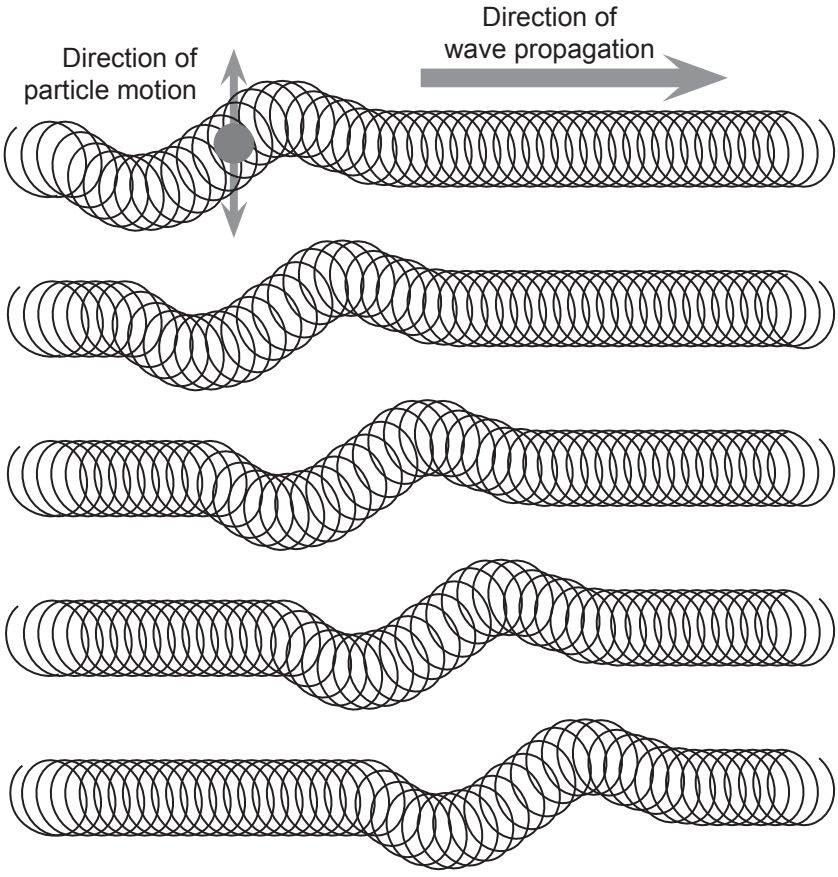
S Waves

S waves are slower than P waves. S waves only move through solid rock. As this type of wave passes through a medium, particles move perpendicular to the direction of the wave's energy path. Slinkies and rope may also be used to model this type of wave.

S Wave



S Wave in a Slinky®



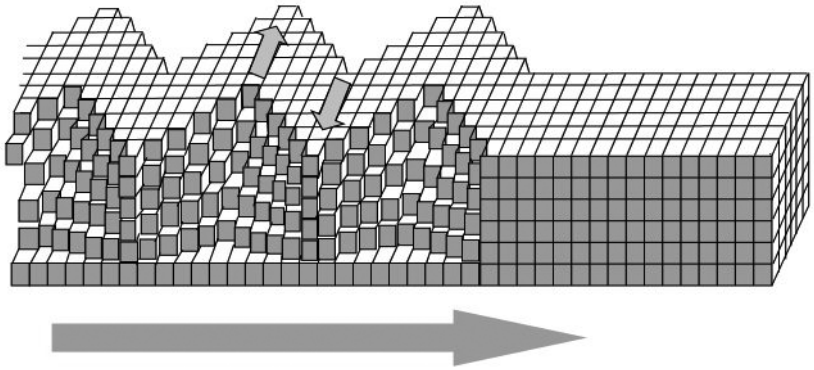
Surface Waves

P and S -waves arriving at the free surface generate waves that propagate parallel to the surface. These resulting surface waves may be classified as Love or Rayleigh Waves.

Love Waves

Love waves are named after the mathematician, A.E.H. Love, who devised the model of this wave in 1911. Love waves are the faster waves of the two types of surface waves. As Love waves propagate across the surface of Earth, the particles move from side to side, perpendicular to the path of the wave's energy.

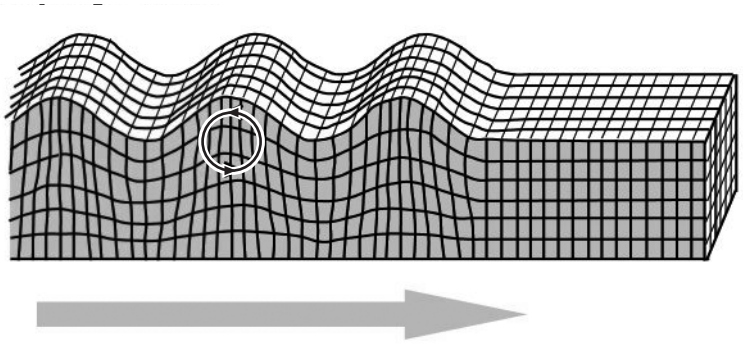
Love wave



Rayleigh waves

Rayleigh waves are the other type of surface wave. These are also called "ground rolls" in earthquakes and are similar to water waves. The difference between water waves and Rayleigh waves is that the particle oscillations in water waves move in a clockwise direction and the particles in the Rayleigh waves (solids) move in a counter-clockwise direction. As this wave moves through the solid surface of the Earth, the land moves up and down in the direction of the wave's energy path. These waves are named after Lord Rayleigh who used math to predict the existence of this wave.

Rayleigh wave

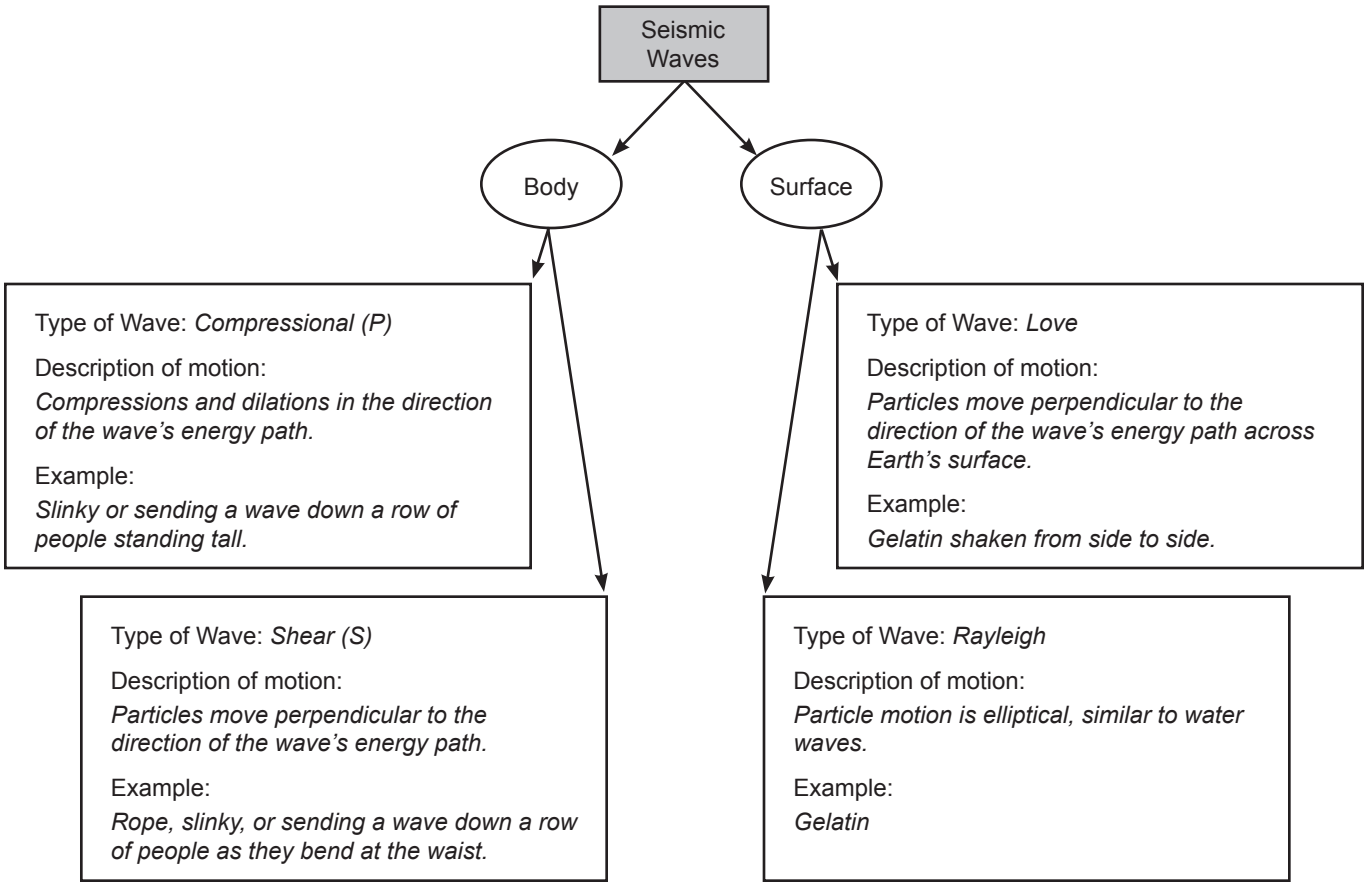


Activity Preparation:

Prepare enough gelatin in 9x13 pans so that each pair of students can have their own strip (approximately 9" x 2-3") of gelatin. Use a recipe similar to Jell-o Jigglers™.

Activity Procedure:

1. Explain students will study seismic waves. Seismic waves are waves that propagate through Earth's interior. Much of what we know about Earth comes from study of seismic waves and how they travel through different materials. Studying these waves helps us understand earthquakes and how to build things to minimize damage from earthquakes. Explain the terms perpendicular and parallel and their relationship to the propagation of energy and motion of particles.
2. Explain students will observe models of seismic waves. To guide students through the various waves, make a graphic organizer on the board similar to the one below. Fill in the information in italics as you progress through the demonstrations. You may require that students record their own notes.



3. Begin with body waves. Share the information from the Whole Picture section and display VISUAL AID: "Body Waves." Model the waves using the following media. Point out the direction of wave movement and the direction of particle motion for each wave.
   - Slinkies: Ask students to pair up with each person holding one end of the slinky. To model a P wave, one person holds the end of the slinky with one hand then hits that hand with their other hand. To model a S wave, one person moves his or her hand up and down to generate a wave. This is the same motion used to generate an S wave through a rope.
   - Students play the role of particles. They line up, shoulder to shoulder, with arms across each other's shoulders. To model a P wave, the teacher pushes the person at the end of the line. The wave should propagate through the line. To model an S wave, the teacher has the person at the end of the line bend forward at the waist.
4. For the surface waves, share the information from the Whole Picture section and display VISUAL AID: "Surface Waves." Distribute a strip of gelatin to each pair of students. To model Love waves, students must move one end from side to side. To model Rayleigh waves, students should tap the top of one end.
5. Distribute STUDENT WORKSHEET: "Seismic Waves" for student completion.

Extension Idea:

Use a stopwatch to compare the velocity of P wave and S wave propagation through a slinky and a line of students. Students should discover that the P wave propagates faster than an S wave.

Answers:

1. Seismic waves are waves that propagate through Earth's interior.
2. Much of what we know about Earth comes from study of seismic waves and how they travel through different materials. Studying these waves helps us understand earthquakes and how to build things to withstand the different types of waves associated with earthquakes.
3. P
4. S
5. L
6. P
7. S
8. R
9. L and R
10. P and S
11. L
12. P
13. P and S
14. P
15. S and L
16. R
17. L
18. P

Lesson Information Sources:

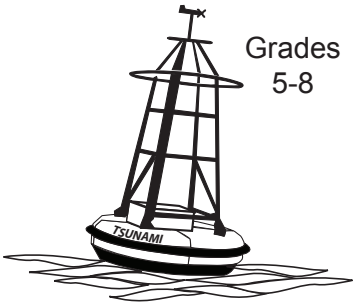
Braile, L. (2006). *Seismic Waves and the Slinky: A Guide for Teachers*. The IRIS Consortium. Accessed January 7, 2008 at http://web.ics.purdue.edu/~braile/edumod/slinky/slinky.htm.

Lillie, R.J. (1999). *Whole Earth Geophysics: An Introductory Textbook for Geologists and Geophysicists*. Upper Saddle River, N.J.: Prentice Hall.

Name:_____

Seismic Waves

Student Worksheet



Grades 5-8

1. What are seismic waves?

_____

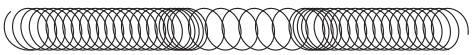
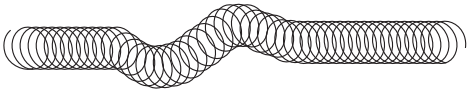
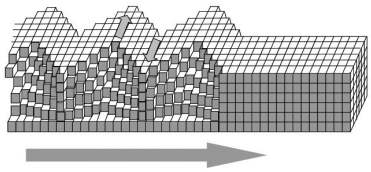
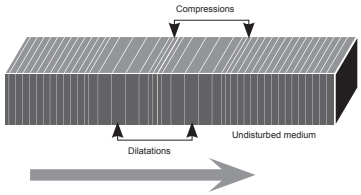
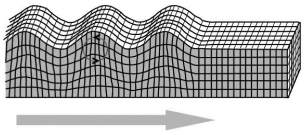
_____

2. Why study seismic waves?

_____

_____

Write P (P wave), S (S wave), L (Love Wave) and/or R (Rayleigh Wave) as they apply to each picture or statement below. [graphics: please remove the name on the wave pictures]

3. ____ 	4. ____ 
5. ____ 	6. ____ 
7. ____ 	8. ____ 
9. ____ and ____ are surface waves.	10. ____ and ____ are body waves.
11. ____ is the fastest surface wave.	12. ____ is the fastest body wave.
13. ____ and ____ are used to determine the epicenter of an earthquake.	14. ____Particle motion and direction of wave energy are parallel.
15. ____ and ____ Particle motion is perpindicular to the direction of wave energy.	16. ____ Also called a “ground roll.” Particles move in a circular motion as a wave passes through.
17. ____ In an earthquake, this type of wave causes the land to move side to side.	18. ____ This type of wave has compressions and dilations as energy passes through a medium.