Standards-Based Science Education Selected Topics Seismology (ED A580) Fall 2017 Incorporated Research Institutions for Seismology and the Alaska Earthquake Center offered through the University of Alaska

Evaluation Report

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I. Background

The course was offered as a pilot in Spring of 2017 and again in the fall of 2017 through University of Alaska with co-teachers Dr. Tammy Bravo of IRIS – Incorporated Research Institutions for Seismology and Lea Gardine of the Alaska Earthquake Center. The purpose was to increase the knowledge and confidence of teachers of Native students in seismology. Course participants completed a Pre Course Needs and Background Survey, Pre and Post Knowledge Surveys, and a Post Course Reflection Survey.

This course was successfully completed by 42 teachers, which represented 36 schools, numbering 16,523 students, throughout Alaska. These schools average 63% minority enrollment, which is higher than Alaska's average 53% school minority enrollment. Minority enrollment ranged from 16% at a small private religious school to numerous schools that had 100% minority enrollment.

Syllabus

<u>Week 1: Welcome to Seismology in the Classroom!</u>

Throughout the semester you will be presented with information, materials and resources to help you bring seismology into your classrooms. We are excited to have you with us.

The course will be offered relatively asynchronously. There is no set time you need to be online to participate in the course. Your instructors, Tammy and Lea, will be progressing through the course as if there is a topic each week and have laid out the course materials as weeks. You are absolutely welcome to work ahead, but be mindful of the discussion forum and check back to read and engage with your classmates' posts. We want you all to be engaged with each other as much as the course content.

There are benchmark assignment due dates. They are outlined in the syllabus and noted in the assignments and on the course calendar. If it okay to fall behind, but assignments must be turned in by those benchmark dates. We understand extenuating circumstances arise. Please contact both Lea, lagardine@alaska.edu, and Tammy, tkb@iris.edu, to discuss options.

Lesson time requirements:

- Videos - approximately 30 minutes
- Pre-course survey - 20 minutes
- Pre-course content knowledge test - 40 minutes
- Discussions - 40 minutes
- Homework assignment - 1
- Reflection assignment - 30 minutes

Reflection Questions

1. How did you hear about this course?
2. When you hear the word earthquake, what is the first thought(s) that go through your mind?

<u>Welcome to Week 2</u>

This week we will be exploring a hands-on demonstration designed to increase students understanding of the elastic rebound theory. The lesson videos will guide you through setting up the model and how to graph and interpret the data acquired through the activity.

Lesson time requirements:

- Videos - 20 minutes
- Homework assignment - 1 hour
- Discussions - 40 minutes
- Reflection assignment - 30 minutes

Reflection Questions
1. Have you taught this lesson before?
2. If yes, will you change how you teach it in the future based on this experience? What changes will you make?
3. Was there a moment in this lesson that changed your thinking or how you will teach about rates and patterns of earthquake occurrence?
4. Do you have any questions as a follow-up to this activity?

Welcome to Week 3

This week we will be discussing Global Tectonics, Alaska Tectonics and Geologic Hazards. We will examine the world around us and look at patterns in seismicity.

Lesson time requirements:

- Videos - approximately 1 hour 20 minutes
- Discussions - 40 minutes
- Homework assignment - 1-2 hours
- Reflection assignment - 30 minutes

Reflection Questions
1. Was there a moment in this lesson that changed your thinking or how you will teach about the Earth or earthquakes?
2. What factors control how rocks respond to stress and strain? How do they relate to earthquake occurrence?
3. Do you have any questions as a follow-up to this content?

Welcome to Week 4

This week we will be discussing concepts of seismic waves and propagation, earthquake energy and magnitudes.

Lesson time requirements:

- Videos - 1 hour
- Discussions - 40 minutes
- Reflection assignment - 30 minutes

Reflection Questions
1. Was there a moment in this lesson that changed your thinking or how you will teach about seismic waves or earthquakes?
2. What are the potential consequences to your community of a large earthquake in Alaska?
3. Do you have any questions as a follow-up to this content?

Welcome to Week 5

This week we will be exploring how each part of a seismograph contributes to the recording of seismic waves. The videos will guide you through a classroom activity to demonstrate these concepts in your classroom.

Lesson time requirements:

- Videos - 45 minutes

- Homework assignment - 1.5 hours
- Discussions - 40 minutes
- Reflection assignment - 30 minutes

Reflection Questions
1. Have you taught this lesson before?
2. If yes, will you change how you teach it in the future based on this experience? What changes will you make?
3. Which seismic waves are best recorded on a vertical component seismometer?
4. Explain how a seismograph works.
5. Was there a moment in this lesson that changed your thinking about how earthquakes are recorded?
6. Do you have any questions as a follow-up to this activity?

Welcome to Week 6

Exploring Earth's structure with Occam's Razor. In this lesson we will learn about and demonstrate how the internal structure of Earth (concentric layers of different density and composition) is inferred through the analysis of seismic data.

Lesson time requirements:
- Videos with associated hands-on components - approximately 2 hours
- Discussion - 40 minutes
- Homework assignment - 1 hour
- Reflection assignment - 30 minutes

Reflection Questions
1. Have you taught this lesson before?
2. If yes, will you change how you teach it in the future based on this experience? What changes will you make?
3. Was there a moment in this lesson that changed your thinking about the internal structure of the Earth?
4. How does seismic data prove that the Earth has a layered interior?
5. Explain how this activity exemplifies the role that models play in the scientific process, especially when used in combination with observational data.
6. Do you have any questions as a follow-up to this activity?

Welcome to Week 7

This week we will work to distinguish earthquakes, seismic noise and be able to recognize features within seismograms.

Lesson time requirements:
- Videos - 30 minutes
- Discussions - 1 hour
- Reflection assignment - 30 minutes

Reflection Questions
1. What general characteristics of an earthquake can be determined by looking at the recorded seismogram?
2. This is another example that anything that puts energy into the ground will be recorded by a nearby seismometer. What could be another unusual source that you might see recorded on a seismometer?

3. Do you have any questions as a follow-up to this content?

Welcome to Week 8

This week we will learn to navigate software, extract and analyze earthquakes, save and upload data, find nearby stations.

Lesson time requirements:

- Videos - 15 minutes
- Homework assignment - 1 hour
- Discussions - 40 minutes
- Reflection assignment - 30 minutes

Reflection Questions

1. Have you used this software before?
2. Did you install the software on a personal computer or a computer in your classroom?
3. Did you have any issues installing the software or adding a station?

Welcome to Week 9

This week we will apply the S minus P method to locate earthquakes. Including: recognition of P and S arrivals, use of the software travel time tool to determine the S minus P time, epicenter location on a globe.

Lesson time requirements:

- Videos - 30 minutes
- Homework assignment - 1.5 hours
- Discussions - 40 minutes
- Reflection assignment - 30 minutes

Reflection Questions

1. Which wave is identified on this seismogram?
2. Which earthquake is further away from the recording station? How can you tell?
3. Do you have any questions as a follow-up to this content?

Welcome to Week 10

This week we will be determining the magnitude of an event and differentiating between magnitude estimates (mb, MS, mbLg). Including how to measure amplitude and period of seismic phases used in magnitude determination, how to use the Magnitude Calculator and how to find magnitude data in online catalogs.

Lesson time requirements:

- Videos - 20 minutes
- Homework assignment - 1 hour
- Discussions - 40 minutes
- Reflection assignment - 30 minutes

Reflection Questions

1. Why is knowing the distance from the earthquake to the recording station important when calculating magnitude?
2. Do you have any questions as a follow-up to this content?

Welcome to Week 11

In this lesson we will learn more about the work currently being done in Alaska through the Alaska Earthquake Center and about the EarthScope project.

Lesson time requirements:

- Videos - approximately 1 hour 20 minutes
- Discussions - 40 minutes
- Homework assignment - 1-2 hours
- Reflection assignment - 30 minutes

Reflection Questions

1. Why was the Alaska Earthquake Center established?
2. Why do you think it's important to have an Alaska based authority for earthquake information?

Welcome to Week 12

In this lesson we are going to begin by looking at two major North American earthquakes. What you will see in these case studies are examples of other tools seismologist use when studying and monitoring earthquakes. You will then dive deeper into the GPS monitoring aspect and scientists use GPS data.

Lesson time requirements:

- Videos with hands-on component - 2 hours
- Discussions - 40 minutes
- Homework assignment - 1-2 hours
- Reflection assignment - 30 minutes

Reflection Questions

1. How are global positioning satellites used to determine the location of a GPS station on the Earth's surface?
2. Do you have any questions as a follow-up to this content?

Welcome to Week 13

This week we will be discussing Hazards, Earthquake and Tsunami preparedness. We will learn more about historic tsunamis and what communities in Alaska are doing to keep their residents safe. We'll also look at what we can do in our homes and communities.

Lesson time requirements:

- Videos - 2.5 hours
- Discussions - 40 minutes
- Homework assignment - 2 hours
- Reflection assignment - 30 minutes

Reflection Questions

1. What causes a tsunami?
2. If you were in a tsunami inundation zone and you were expecting a tsunami, how long would you have to evacuate?
3. Do you have any questions as a follow-up to this content?

Welcome to Week 14 - Getting close to the finish line!

This week we will be discussing online resources for more information and activities for use in your classroom. Some of these sites present tools, resources for teachers and students, as well as news and information of current events.

Lesson time requirements:

- Videos - 45 minutes
- Discussion - 40 minutes
- Homework assignment - 1-2 hours
- Reflection assignment - 30 minutes

Reflection Questions

Question 1. Have you used any of these resources in your classroom before?

Question 2. If yes, which?

Question 3. Do you have any questions as a follow-up to this activity?

Welcome to Week 15 - We made it!

This is the last week of class. You have until January 10th to make sure everything is submitted, but we are committed to help you get everything done this week.

Lesson Requirements:

- 1 required Video (6 minutes)
- Check the Discussion Board
- Reflection assignment
- Post-course content knowledge test
- Fill out the Fee Reimbursement form
- Post-course survey

Reflection Questions

1. Best email contact
2. Do you need help with a week? (Select as many as appropriate)

II. Summary of Findings

Pre Course Needs and Background

Teachers (N=37) report their main reasons for taking the course were to get new resources to use with their students (78%) and to begin teaching more about earthquakes (76%). Other reasons were needing better activities for teaching about earthquakes (57%), wanting to develop their own background in seismology (54%), and wanting to make seismology relevant with regional information (54%).

Teacher assignments in this course range from first grade through high school and community college or librarian. They report that most students are able to grasp the idea of plates and what happens when they move. The Earth Science teachers also teach surface processes, subduction zones, volcanoes, and mountain building. They have from six to 21 years teaching and a variety of field experiences. One teacher has no science background, eight took general college science classes, 15 have undergraduate degrees, and four have Masters. Most (18) have 21-30 students, with some (6) having 16-20 students, and five having 30-35 students. All of them have felt an earthquake. Most of their schools have earthquake drills routinely (62%) or randomly (16%); 22% do not.

Most Earth Science classes in these teachers' schools are taught with one or two grade levels per class (41%) or annually (38%). Earthquakes are taught in many grades: 2nd grade (one lesson), 5th grade for one week with tornadoes, hurricanes and floods (3), 8th grade 2-3 week unit, once a year in Physical Science (2), once a year in Marine Biology (geography of the ocean floor), one month in Earth Science (5), throughout the year when events happen (8), discuss during monthly or quarterly earthquake drills (7), in Alaska history twice a year (2), once a year in plate tectonics unit (2), in Alaska science course, midterm project that 25% of students choose earthquakes, one week unit in Geography class, brief discussions (2), in high school geology class.

Teachers wanted to know more about continental drift, especially Wegner's original documents to read along with other original documents from Government agencies, hands-on earthquake labs pertaining to Alaska, ways to tie seismology into ecosystem evolution and destruction, how earth's natural forces mold and shape the interdependence within an ecosystem, data for local seismic activity, different types of quakes, how rocks relate to earthquakes, weather and atmospheric structure and processes, engineering solutions to earthquake damage, minerals, ocean, climate, geology, earthquake preparedness and any Alaska related resources to make it relevant for students. They would like maps of local faults, video of the ‘64 earthquake, the geologic history of Mat Su area, ideas for field trips to see morphology, how to get scientists into the classroom, and how to encourage community interest. Other topics of interest were plate tectonics on other planets and moons, relationship of climate change, volcanoes, fracking, carbon cycle, convection cells, and earthquake lights to earthquakes.

Teachers said they planned to use what they would learn to differentiate instruction, go into more depth, help students understand the nature and reasons for earthquake drills, learn new teaching techniques, connect knowledge to practical applications of seismology, embed cultural standards in the activities, offer interactive sessions at the local library, place-based learning, keep track of seismic activity with the class, construct earthquake structures and test them on a shake table, take a field trip to the Tsunami Center, incorporate it into our “Genus Hour” class, and hook up seismograph to the Promethean to generate interest.

<u>Pre/Post Knowledge</u>

- 37 people completed the pre knowledge survey; 33 completed the post knowledge survey.
- There were 29 questions with data (one item was corrupted so no data).
- The average pre score was 19.3 and post was 21.5.
- The overall score gain for participants in the course was statistically significant with a p value <0.001.
- Participants with total scores between 11 and 19/30 on the pre gained an average of four points (N=15); the one person who scored 10 on the pre gained 8 points. The 15 people who scored between 20 and 30 on the pre gained an average of 1 point to the post.
- Participants scored 70% or better on 12 of the 29 items with pre scores from 41%-81% and gains from 12-48% providing evidence of learning these concepts in the course.
- Participants scored 50-70% on three questions on the post.
- Participants scored highly on eight pre items so showed very little gain and not to mastery level.
- Participants made little or no gain on six questions indicating the concepts were not adequately addressed in the course or the question needs to be revised.

<u>Post Course Reflection</u>

- A total of 30 course participants completed the post-course survey.

- Participants felt the course was well organized (4.8/5), that the presenters showed evidence of preparation (4.9), that the course effectively employed a variety of instructional strategies (4.4), and overall, that the course was a valuable use of their time (4.4).
- Participants reported spending more time than expected on each week of the course with week 9 requiring the most time and weeks 3 and 6 requiring the least amount of time.
- Participants reported significant changes in their preparedness to teach about mechanisms of earthquakes, seismic waves, and Alaska earthquake hazards.
- Activities/sessions modeled during the course that participants anticipate will be the most useful to their work included Alaska Earthquake Center Recent Earthquake Map (70%), IRIS Earthquake Browser (70%), Earthquake Machine (57%), Recent Earthquake Teachable Moments (57%), and Tsunami Inundation Map Online Viewer (53%).
- Participants reported liking a number of different aspects of the course including the hands-on activities, videos, using what they learned, how the lessons were organized, getting activities to use with their students and the online tools.
- Suggestions from the participants included targeting the course for middle and high school students or making the lessons/materials/content more accessible for elementary students, reducing the use of video, and increasing the number of credits offered because of the time requirements.
- Participants reported that they would recommend this course to a friend or colleague (4.2/5).
- The best times of year for the course were any time (30%) and fall (27%).
- Participants reported being interested in being considered to receive an educational seismometer for their classroom (45%=yes; 31%=maybe).

III. Detailed Findings

III.A. Pre Course Needs and Background Detailed Results

1. Why did you decide to take this course? (check all that apply)

	#	%
Need better activities for teaching about earthquakes	21	57%
Want to develop my own background in seismology	20	54%
Want new resources to use with my students	29	78%
Want to begin teaching more about earthquakes	28	76%
Want to make seismology relevant with regional information	20	54%
Other	4	11%

2. What are the most important things you hope to learn from this course?
    - *How to teach 1st Graders about earthquakes in terms they can understand and without scaring them.*
    - *From this course I hope to be able to expand my own knowledge regarding earthquakes and thus relay that knowledge to my Second Graders through better hands-on experiences.*

- *Well, I feel like a blank slate. I hope to gain a better understanding of the science behind earthquakes and use that to support my Physical Science courses. I also hope to gain some fundamentals into Tsunamis.*
- *From this class I would like to learn more general information both for me personally and also to utilize in my classroom. I would like activities or suggestions on how to use this information in a classroom.*
- *Applying relevant and local Alaskan data to my classroom. Using new educational tools and labs for a hands on experience.*
- *I hope to learn more student friendly terminology I can use while explaining plate tectonics and other earth related phenomena to my 6th graders.*
- *I am interested in broadening my field of knowledge to share with my students and my children. I want to develop my own background in seismology.*
- *I would like to learn where fault lines are in my region, Juneau specifically. I have known for a while that we have several in the area - I would like to know where exactly they are. We have two large mining operations in the Juneau area and I am curious how are geologic history impacts those businesses in terms of exploration and discovery of mining minerals. This region was formed by several successive land formations slamming into the mainland and providing us with our beloved mountains, islands, and deep waters, but what is the trade off in terms of seismic activity and potential dangers.*
- *How to make seismology hands on in my classroom.*
- *I hope to get access to more Alaska earthquake data to use in my class.*
- *I am hoping to learn more about what seismograph data tells us about the Earth and how that information is used.*
- *I am looking forward to learning relevant and engaging activities to bring earth science and regional earthquake information into my high school earth science courses.*
- *I would like to better understand earthquakes and the processes/forces behind them. I am also looking for some new ideas to make real world connections between earthquakes and how they affect the planning and building of human habitats for my students. I am also looking for fresh ideas to relate faulting and folding to plate movements within the Earth's Crust.*

I would like to better understand earthquakes and the processes/forces behind them. I am also looking for some new ideas to make real world connections between earthquakes and how they affect the planning and building of human habitats for my students.

- *Ways to help students model the Earth, and the aspects that lead to seismic activity.*
- *I hope to better understand how seismology works. I also hope to learn what effects it has on our state. Ultimately, I hope this course will lead to a better understanding, and thus a better teaching of how plate tectonics shape the earth. I hope to build a few lessons into my Geography class about seismology in Alaska.*
- *I want a thorough understanding so I can teach to different cognitive learning levels. Of course I live in Alaska, so having a good understanding of the tools/machines used to measure earthquakes would also be useful. Since earthquakes can also be integrated with science and demonstrated as such this course is really helpful.*
- *Hands on lessons and resources for teaching Earth Science at the secondary level - Resource/Special Education, How to adapt lessons for different levels of learners. Have*

the understanding of the material so I can teach my students - so I can differentiate and modify lessons appropriately. Learning about seismology is going to be so Fun!!

- *I hope to gain ideas and content understanding that will help me develop engaging lessons and activities appropriate for Middle School-aged students relating to Seismology and Earth Science.*
- *How to engage students to learn more on their own. Instead of listening I want more doing.*
- *How to teach about earthquakes to elementary students and to increase my own knowledge.*
- *I hope to bring inquiry and information about earthquakes into the classroom for my 4th grade students. We study earthquakes and waves through our science curriculum, and I would like to make it more meaningful and better based in the scientific process.*
- *To learn more about seismology. To learn about hands-on activities that I can use in the classroom that will allow students to understand some of the concepts of seismology.*
- *I hope to have enough background knowledge at the end of this course to feel equipped to teach about earthquakes. As an elementary educator I may find myself teaching various age groups. I look forward to learning lesson/content ideas for these varying grade levels. I hope to feel confident in implementing lessons in primary as well as upper elementary school.*
- *A better understanding of Earthquake Science. Resources to purchase for a school and community library. Fun and interactive activities for students and adults that I can use in a library setting to teach others about earthquake science.*
- *How to teach children about earthquakes, Earthquakes in Alaska/Country/World, Plate Tectonics, Tsunamis, Classroom friendly activities.*
- *A direct understanding of the geology and earthquake potential of our area (Mat Su Valley) so that I can add relevance to the course for our students. Deepen m y own understanding of geology and earthquakes. Earthquake preparedness strategies for students. Hands on low cost activities to engage students. Access to experts in the field for both myself and my students.*
- *Learn more about earthquakes and have some ideas for lessons.*
- *I hope to come away with an understanding of how earthquakes take place, where they most likely occur, how they are recorded and how the data is analyzed to determine magnitude. I want to be able to share this understanding with students in a simple, grade appropriate manner with the use of hands-on experimentation and activities that cause them to be excited rather than fearful of earthquake events. I hope by the end of the course to be both knowledgeable and confident in teaching my kids all about earthquakes.*
- *I hope to learn new ways to teach my students about earthquakes and the differences between them. I would like to be exposed to labs that other educators do and any computer models that may help me depict what occurs here in Alaska and different areas of the world. My students have all experienced an earthquake, but I am not sure that they know what is really happening when one occurs.*
- *Have an ongoing interaction with my students exploring current seismic activity.*
- *Tools for classroom, better understanding of seismology.*
- *Current information and resources about earthquakes for elementary students.*

- *I am hoping to learn about exciting new resources which I can use in the spring semester with my students.*
- *I would like to be able to be more knowledgeable about earthquakes, and to glean tips for teaching the information to my students.*
- *I hope to learn something that will allow me to create engaging lessons for my Earth Science students during the seismology unit. There are lessons I already have, but more options would be nice.*
- *More about earthquakes in AK, and Anchorage. What local resources are used. What national organizations work in AK on seismology. Learn how to use Seismology equipment. Make it relevant and exciting for my 6th grade students*
- *I would like to supplement the lessons that are provided through the district for my 5th grade curriculum. The curriculum is new and I would like to gain a deeper knowledge of earthquakes so that I can teach about them more thoroughly.*

3. How is earth science generally taught at your school? (check all that apply)

	#	%
One to two grade levels per class	15	41%
Multiple grade levels per class	7	19%
Annually	14	38%
Bi-annually	4	11%
On demand	4	11%
Other	8	22%

4. How would you rate your current understanding of earthquake science? 1 (no knowledge at all) – 10 (very knowledgeable) – 5.2 average

Rating	1	2	3	4	5	6	7	8	9	10
#	2	5	4	4	4	4	6	6	2	0
%	5%	14%	11%	11%	11%	11%	16%	16%	5%	0%

5. How frequently do you teach about or discuss earthquakes in your classroom? (please clarify whether this is part of a standard course or topical discussions with students)
   - *Well, once a month (or quarterly in some schools) we conduct an earthquake drill, so the discussion about earthquakes happens around those times. (6)*
   - *In Second Grade the unit for earthquakes is only the first half of the year and only one lesson long. I am hoping to expand that a little bit after this course. The lesson approaches earthquakes, glaciers, and volcanoes as natural happenings that change the Earth.*
   - *Once a year in two classes. One in Physical Science, and one in Marine Biology when we discuss the geography of the ocean floor.*
   - *I spend a full month Earth Science with a yearlong discussion about major events that happen throughout the year.*
   - *As far as explicitly teaching the causes and effects of earthquakes, this happens minimally.*

- *I teach Alaska History, which is a semester class, so I teach seismic activity twice a year or more depending on how many sections of that class I am assigned.*
- *I teach it once a year as part of my plate tectonics unit.*
- *I teach one unit each semester (also used in relevant units) and discuss as they occur locally.*
- *Earthquakes/seismology is roughly a week long portion of an Earth Science unit in a Physical Science course that I teach yearly to Sophomores at Sitka High School. This is a required course for all students.*
- *We alternate years of having earth science in my school; one semester every other year for junior high and then as needed as an elective for high school science. We also developed an Alaska Science course in which we cover earthquakes in Alaska.*
- *I will typically spend about three to four weeks of class time examining plate tectonics, faulting and folding. I will relate these topics to forces within the Earth such as convection cells and their relationship to plate movement. After which, we spend about a week examining types of seismic waves and their effects.*
- *We do a midterm project that allows students to choose one Earth Science topic to explore. About 25% choose an aspect of Earth that can be connected to earthquakes.*
- *I teach a one-week unit on how plate tectonics shapes our earth in my Geography class. I also use earthquakes to show how humans adapt to their environment, particularly when we study regions like Japan or Indonesia.*
- *At the beginning of the year in 5th grade our theme unit is "Nature's Fury" so it is given one week along with tornadoes, hurricanes, floods etc.*
- *The curriculum rotation for Resource Science has me teaching Earth Science for a semester about every three years. However, when current events are applicable we dive in. Also during annual Earthquake drills, and actual Earthquakes.*
- *Currently I teach 7th and 8th graders with a rotation of Life Science and Physical Science every two years. For many years 6th grade has been assigned the grade level to teach Earth Science, however, starting next year the rotation is changing and I will be teaching Life Science and Earth Science. To answer the question, as of now earthquakes are rarely discussed as a part of the science curriculum I have been assigned.*
- *Topical discussions occur at least once every two weeks. Course discussions at least once a week.*
- *We have topical discussions within classes, but I don't formally teach about earthquakes.*
- *I have just briefly discussed earthquakes as part of our science lessons, but not nearly as much as I'd like.*
- *Most elementary schools I have taught in participate in the "shakeout" each year. This is sometimes the only time we discuss earthquakes. Some grade levels have standards that correlate to earthquakes.*
- *I am … I consult the community library in Pedro Bay and the school/community library in Igiugig. I will have to find out when teachers in*

I will discuss earthquakes when we have earthquakes large enough to be felt in our area even if it is not in the curriculum.

Igiugig teach or discuss earthquakes. I have never done a library presentation on earthquakes.

- *I will teach an earthquake unit during the second semester.*
- *Depends if I am teaching geology or earth science this year or not. Varies every year.*
- *I am teaching grade 5 for the first time this year, and "Dynamic Earth" is the theme for the first two quarters of the school year in our science curriculum. I have not taught it at all in the past. I have referred to earthquakes that have been felt in our area but only as a general topic of conversation with the students.*
- *I currently teach 8th grade Science in Anchorage and we have a several week unit on earthquakes/faults. I also try to discuss earthquakes as they occur. (epicenter, magnitude, depth, etc.)*
- *One chapter a year...about a week.*
- *Several times a year. Spend good amount of time on plate tectonics concepts, and earthquakes.*
- *It is not part of my teaching grade level this year however, in Social Studies, the state of Alaska is the topic to be taught. Alaska and earthquakes are relevant to each other and I would like to be more knowledgeable at both.*
- *Previously I taught our yearlong freshmen Earth Science course at … High School for 5 years. Most recently I wrote a pilot course to teach an upper-level high school Geology course for Seniors and Juniors. This past spring was the first time I was able to teach it and I look forward to teaching it a second time this coming spring semester.*
- *I cover seismology in Earth Science. I teach 4 sections a year for students in grades 9-12. Most of the students are 9th graders.*
- *Seismology is a part of the required curriculum in Earth Science. So, I teach it every year.*
- *The curriculum is presented in the first half of every school year for 5th grade.*

6. If you currently teach an Earth Science class, what topics do you feel your students are understanding well?
    - *The rock cycle and types of rocks was taught pretty extensively in 7th grade so my kids had prior knowledge of the basics.*
    - *I teach 6th grade at the elementary level which means I do not teach just 1 subject but all, including science. Currently we are studying ecosystems and I'm excited to eventually tie seismology into this in regards to the impacts earthquakes have on natural habitats.*
    - *Water*
    - *I teach the Ring of Fire, subduction zones, Deep ocean trenches, mid ocean ridges, formation of volcanoes, and the earthquakes that are associated with these factors. I feel that they are understanding the material very well.*

- *My students better understand the concepts of geomorphology. They are less abstract than many of the other topics.*
- *Students seem to understand the concept of the crust being divided into plates that can move. They also understand the variety of ways these plates can interact with one another and that earthquakes are a result of that interaction.*
- *I am not teaching earth science this year, although last year the students seemed to have a decent understanding.*

Second Graders seem to love the topic of earthquakes! They have a pretty surface understanding though, which I hope to deepen through my learning from this course.

- *I will be teaching Earth Science second semester. I feel that taking this course will greatly enhance my understanding of current knowledge which I can pass on to my students keeping them current in the cutting edge of seismology.*
- *We have started by looking at the Sun, Moon, Earth relationship, and the kids seem to have a good understanding. We will start to explore the origins of the universe, solar system, and planets more specifically in the next few weeks. I imagine that it will be harder to conceptualize this next unit.*
- *I'm basing my answer off second graders since most of my teaching years have been there. For the past two years now I have taught fifth grade which goes into earth science more. Hence the reason I'm taking more Earth Science classes. So most my information is rocks, soil, and other top layer agriculture. Now in fifth grade we are learning about earth moving parts.*
- *Students can master Earth structure, surface processes, rock formation and basic hydrology because we have access to excellent teaching resources and materials.*
- *We have just begun the school year, so it is hard to tell with the current group of students. However, in the past they have generally understood that the earth consists of plates and when those plates rub together they create an earthquake.*
- *I currently teach grade three. The closest thing I have to seismology this year is: The student demonstrates an understanding of geochemical cycles by: {3} SD1.1 recognizing that most rocks are composed of combinations of different substances. {3} SD1.2 describing the water cycle to show that water circulates through the crust, oceans, and atmosphere of Earth. The student demonstrates an understanding of the forces that shape Earth by: {3} SD2.1 identifying and comparing a variety of Earth's land features (i.e., rivers, deltas, lakes, glaciers, mountains, valleys, and islands. Also there are standards that apply to science and technology. I could see seismology being relevant there as well. (listed below). The student demonstrates an understanding of how to integrate scientific knowledge and technology to address problems by: {3} SE1.1 identifying local problems and discussing solutions. (L) The student demonstrates an understanding that solving problems involves different ways of thinking, perspectives, and curiosity by: {3} SE2.1 identifying local tools and materials used in everyday life. (L) The student demonstrates an understanding of how scientific discoveries and technological innovations affect our lives and society by: {3} SE3.1 listing the positive and negative effects of a single technological development in the local community.*

- *This is my first year teaching Earth Science in Alaska. When I have taught it elsewhere, students seem to grasp topics that are the least abstract to them for the East Coast it is often weather and atmosphere.*
- *None really. They have some idea about the rock cycle, how a volcano works, the basics of earth science.*
- *I have just started our unit in science...learning about layers of the earth...with my students. We've just gotten started on the basics and they're doing well.*
- *In my class the students seem to understand the concept that the earth has plates (although this is the first time some of them have been exposed to this concept), and that the rock cycle is part of that idea.*
- *Plate tectonics, mountain formation, sea-floor spreading, volcanism.*
- *Large forces that cause earthquakes, general plate tectonic concepts, and different types of waves that are generated. I teach a variety of grade levels so my higher performers understand much more obviously.*
- *Weather: Recording of data. Mineral Identification to some degree*
- *They are understanding triangulation and why earthquakes occur where they do.*
- *There is no general trend, as far as I can see. The best students do well at everything and the worst students do badly at everything. So, I'd say the level of difficulty is fairly uniform throughout the different units.*
- *Layers of the Earth seems to be a topic that they get a firm grasp on. They understand what an earthquake is.*

Students seem to think they know everything there is to know about plate tectonics, earthquakes, and volcanoes because they learned about them in middle school. The trick is to get them excited again and make them realize there is so much more to learn.

7. Which topics are you looking for additional resources or approaches?
   - *I am hoping to deepen my own knowledge of earthquakes and their effect on the Earth, which will then allow me to bring that knowledge to my students.*
   - *I have no idea at this time, but I will ask as I learn.*
   - *I don't know any specifically.*
   - *Continental drift, especially Wegner's original documents for my gifted kids to read along with other original documents from Government agencies. Hands-on earthquake labs pertaining to Alaska.*
   - *I'd like to be able to tie seismology into ecosystem evolution and destruction, how earth's natural forces mold and shape the interdependence within an ecosystem.*
   - *Abstract concepts that are challenging for 1st Graders to grasp.*

- *I am very interested in seismology and how it pertains to and effects the state of Alaska and the Arctic. I would like to have real time indicators or readings for local seismic activity.*
- *Hands on experiments with waves and spreading zones (divergent boundaries).*
- *I am interested in Alaska specific seismic events and any associated resources along with any ways the students can gather data. Honestly, I am interested in everything.*
- *I would like more hands-on activities for the kids to understand causes of earthquakes, how they are monitored and how they are studied.*

It has been a challenge teaching about two things in particular: how we can understand the composition of the interior of the Earth based on the different waves formed during an Earthquake, and how earthquakes are located 3-dimensionally based on multiple seismographs.

- *I am looking for up to date and current real time resources which my students can use to map earthquakes and their draw conclusions for their occurrence.*
- *Ways to connect it to current events in Alaska to make it more relevant.*
- *Anything regarding earthquake collecting data and learning the different types of quakes and land formations -strike slip etc.*
- *Everything! I know that is vague... I usually have to modify and differentiate everything I teach - so having different approaches and a variety of optional activities is super beneficial. The district has officially added the Earth Science unit to the 9th grade curriculum for a quarter this year. Otherwise Geology is an elective offering at East - if enough students sign up for it. I would love to have rock identification materials and lessons and how that relates to seismology/earthquakes and potential damage.*
- *Weather and atmospheric structure and processes.*
- *Specifically, seismology, but additional topics are good too.*
- *I would like to be able to give students a deeper scientific understanding of earthquakes, as well as allow them to use their deeper scientific knowledge to create possible solutions to earthquake damage in Alaska through an engineering project.*
- *All of it. Plate tectonics, Pangea, the Ring of Fire, all of it.*
- *I am not looking for specific resources, just hoping to have a broader understanding in order to teach in various grade levels.*
- *A basic understanding of earthquakes. Preparing for an earthquake. Why earthquake science is important/relevant to people who live on Lake Iliamna*
- *Interactive activities for a STEM lab.*
- *Geology, Mineralogy, History of the Earth*
- *Minerals, oceans, and climate.*
- *I hope to have more resources and background knowledge of plate tectonics, earthquakes, and volcanoes, especially in Alaska, so my kids may connect with the information in a more meaningful way.*
- *I am interested in showing them in more detail what happens at the boundaries of the plates and perhaps even within the plate.*

- *Reading seismographs. S waves P waves.*
- *Seismic waves in general, earthquake proof structures. How waves traveling through a mediums?*
- *Earthquakes and the causes, can we predict earthquakes, how to be prepared.*
- *Since I previously taught freshmen Earth science I am struggling to find new, different, and more challenging activities for my upperclassmen to do that they haven't already done as a freshmen.*
- *The relationship between engineering and earthquake preparedness.*
- *I am always looking for opportunities to improve student learning in any unit.*
- *I know this is an active earthquake zone. I just want to make it relevant, accessible, and interest for my students because it is relevant.*
- *I would like additional resources on everything. I am always looking for more resources to teach my students.*

8. How do you see implementing what you learn in this course in your classroom?
    - *I see myself implementing my new found knowledge by extending the time spent on earthquakes in the unit. This will allow me to create a deeper understanding within my students.*
    - *I hope to use this in a unit for both courses I mentioned before.*
    - *I see me being able to implement this information in relevant discussions, but also teaching struggling learners in a different way so they can deepen their understanding.*
    - *The use of local maps and data will be very helpful.*
    - *I hope to gain resources that I could share with them that would help to explicitly describe the power of earth's movement, such as hands on activities, access to online sources to use as teaching tools, or ideas on great field trips or guest lecturers would be great!*
    - *My students will enjoy learning more about earthquakes. I'll do hands on lessons and teach as much as I can.*
    - *I will share learned information with my students to broaden their knowledge about the state they live in.*
    - *I don't feel like I can answer that until the end of the course. I need to see it all first.*
    - *I would like to use all that I can. My concern is that I will not have enough time in my (introductory) semester class to implement everything I would like. As it is I feel that I have to leave out a lot of amazing topics/info.*
    - *I am hoping to implement what I learn in the course this spring...resources, activities, projects, etc.*
    - *Same as above, I would like to learn hands on activities for students to better understand a concept that is often hard to understand as students cannot see plate tectonics, but feel the effects.*

I would like to strengthen my students' understanding of the causes and unpredictability of an earthquake. Most of them have been practicing the earthquake drills their entire school lives but do not know exactly what that means.

- *I see myself taking from this course the resources that I gain and helping enrich my students connection between the knowledge and practical applications of seismology as it relates to their lives. I also see myself using new techniques/methods within my classroom.*
- *I imagine I will work through many of the activities that we go through for this class, and then work on imbedding cultural standards.*
- *I hope to be able to more concisely explain how seismology works to my students in future years. I also am a big believer in local learning. I hope this course will help me create a great mini-unit on Earthquakes/Volcanoes in Alaska for my students.*
- *I would implement my earthquake teachings by verbal storytelling, pictures telling and then demonstrations using materials with my science kits and reading materials. I would also love to make mini seismology*
- *I will be teaching Earth Science 4th quarter and plan on utilizing what I learn in this class for my lessons then.*
- *The next time I teach Earth Science I will incorporate what works in to the content and materials.*
- *I teach Health and PE and I can see myself talking about what I learn in this class during my safety talks and for discussion topics.*
- *Please see above. Earthquakes fit in well with the 4th grade curriculum, and I am eager to help 4th graders think critically about the information, as well as enabling them to become engineers.*

I hope to have deeper content knowledge and understanding of seismology, and Earth processes in general so that I can develop units and lessons that are engaging and fun for students in middle school.

- *I teach at a residential facility. I teach grades 7 - 12, to students who are from all over Alaska. I would like to teach them about seismology (earthquakes) in Alaska. I know that they are interested. I would also like to teach them about volcanoes. I see implementing the hands-on activities, any videos that are helpful, and readings that you provide us with.*
- *I stated the standards above where I may be able to apply this knowledge. Specifically I can see it used to teach our science/technology standards.*
- *I plan to do a library presentation (or presentations) in the villages of Pedro Bay and Igiugig. I would like one presentation aimed at older students/adults and one for younger students that would be more interactive.*
- *I am not sure how I will implement it in the art room yet, but I do plan on using it in the STEM lab.*
- *Hands on learning! Hope to get the students to see the Earthquake potential in our area and initiate a strong understanding.*
- *Depends on what I learn in this course. Some stuff I may already have or know. I suppose it depends on how this course goes. I would like to implement what I learn, so we will see.*

- *I will be able to provide more detailed, place-based information to my kids, as well as hands-on experimenting to help them understand earthquakes in a deeper rather than broader sense.*
- *Hopefully I can use the computer programs with my students to show them how earthquakes work and how the data is collected. Because I teach about earthquakes and faults it should be easy to find ways to use the new knowledge in my classroom.*
- *I hope to keep track of seismic activity with my class.*
- *Developing backwards design conceptually based unit that includes field trip to Tsunami center and constructing earthquake structures and testing with shaker tables.*
- *Students are amazed with natures wonders as I am. I would like to make our rather dull read -the book about earthquakes and find a more exciting and hands on way to teach this concept.*
- *I am excited to be able to take this course this semester and then implement as much as I can into the spring semester Geology class I teach. Perfect Timing!*
- *I'm hoping I can find some sort of meaningful shake lab that does not consume a huge amount of time.*
- *It is difficult to know how I will use the learning from this course without having learned any of it, yet. :-) I am, however, quite optimistic.*
- *I plan to use what I learn throughout this course to enhance the lessons already provided by the district.*

I will incorporate it into our Genius Hour class. Introduce it and allow the seismograph to run one day while hooked up to the Promethean board to generate interest.

9. Briefly describe your science background (degrees, classes, professional positions, etc.)

<u>Experience</u>

- 1st grade
- One-room school (all grades) 6 years (2)
- 5th grade ecosystems, variables and energy
- 7th grade science
- Middle school math and science – 15 years
- Middle school science - 13 years, 9 years
- High school science - 10 years; 20 years; many years; 6 years; 15 years; 11 years; 21 years
- Earth science 12 year and Chemistry 14 years
- College class in Natural Science
- Culture/science camps using western science techniques to evaluate why Native ways of knowing work
- Fisheries biologist 1 and Wildlife Technician (27 years)
- Hydrology and fisheries technician for the Gallatin National Forest
- A lot of field work and specimen collecting throughout western North America (especially AK).

- Worked for ADF, studying cutthroat populations in SE Alaska
- Spent many summers working in fisheries biology in Colorado
- Work for recon that coordinates the logistics for the ATA here in Anchorage.
- Worked for the USDA Forest Service for five years on a variety of research projects in Southeast Alaska
- Have spent many years in the Aleutian Region observing natural history.
- Worked for the Forest Service in Misty Fiords National Monument as an Ecosystem Monitoring technician and worked for 10 years conducting salmon research on various rivers in SE Alaska.
- Coach Science Olympiad and FLL Lego robotics
- Research background includes studies of piezoelectric crystals, investigation of optical and particle signatures of auroral forms, and spectroscopic studies of solar granulation

Science background

- None
- Basic courses in high school and/or college (8)
- AAS in Process Technology, a BS is in Physics and Astronomy, and an MS is in Space Physic
- BA Elementary Ed and Instructional Tech
- BA Elementary Ed
- BS Fisheries Science
- BS Education, minor in Physical Science
- BS Journalism
- BS Marine biology
- BS Geology (4)
- BS Natural Science
- BS Botany and Biology (2)
- BS Biology (3) minor in Chemistry
- BA Biological sciences, minor Chemistry and History
- BS Biology and Chemistry
- BA in Social science, emphasis in anthropology and geography
- BS Geohydrology and Broad Field Science
- Masters in Ecology and Evolutionary Biology
- Masters in Education (2)
- Masters in Chemistry

10. What is your average class size?

# students	#responding	Details
0-5	0	NA
6-10	2	I teach ELL support class this semester. Average 9, on a good day 14.

11-15	2	NA
16-20	6	Around 16. I mostly teach elective courses now and those tend to be smaller. The Physical Science classes are the largest Special Education numbers are different - I typically have between 12 and 25 students in a class. This year my largest class is 20 at the moment.
21-30	18	My average class size is 28 students, although this year I have only 16. It's a range, but getting larger. Around 26-34 Normally 35. This year it is probably about 28. 29 is the average. But I have one class of 23, one of 24, two classes with 33 students and finally a class of 34 25 to 28 students in fifth grade for the past 2 years.
30-35	5	30-34 this year due to budget cuts My science lab is built to accommodate 24 students. Our computers rooms/carts are equipped to accommodate 28-30 students.
35-40	1	NA

Other

- I am not currently teaching. The village of Pedro Bay has about 30 residents. The village of Igiugig has about 70 residents.
- This year, it is crazy. I am only teaching Earth Science, since all the upper level classes were cancelled for budgetary reasons. I have classes of 13, 20, 23, 30, and 31.

11. Do you have any specific questions or topics you'd like to see addressed in this class? (we may not be able to cover every topic in course materials, but may be able to create additional discussion group times or one-on-one time with the instructors)
    - *I don't have any specific questions or topics at this time, although some may pop up throughout the class.*
    - *I was wondering if there is a map of local faults around … Middle school and the Anchorage bowl in general? video of the 64 earthquake along with original geological data from the event.*
    - *Is there any relation between global climate change and tectonic behavior?*
    - *Share developmentally appropriate terms for 1st Graders learning about earthquakes*
    - *I am new to this subject and I am open to all new information.*
    - *Local seismic activity detection and how to read; the results.*
    - *Mostly looking forward to the lessons that you have prepared*
    - *I would be interested in isostasy and the increased frequency of earthquakes in Southeast and the 1964 EQ, but anything sounds great.*
    - *Mainly what was mentioned above that the students struggle understanding.*
    - *The current information on convection cells within the mantle and how this drives the crustal plates. Also it would be nice to visit the idea of cold subduction which was a new theory of plate interaction along zones of subduction.*

- *Connection between earthquakes and volcanoes, A better understanding of the carbon cycle and how it connects to seismology.*
- *It would be interesting for me to learn about the theory of plate tectonics, and what evidence led to it.*
- *Earthquake Lights?! I have seen a couple of videos from the Mexico Earthquake... I would like to know more about them- can they be used to predict? some things I've read indicate that the lights have been seen before a quake.*
- *I would like to know more about how the energy of earthquakes travels via waves, and how that energy can be mitigated to help dispel damage.*
- *What can librarians do to encourage community members and students to take an interest in and learn about earthquakes.*
- *Nothing additional at this time, I think I will learn plenty with what is listed on the syllabus.*
- *Geologic history of Alaska, particularly the Mat Su (Wasilla-Palmer) area. Ideas for field trips to see morphology and how it relates to disaster preparedness. Castle Mountain Fault - Adding relevance to the classroom, science and scientists into the classroom*
- *I can't think of any. Possibly about tectonics on other planets and moons.*
- *At this time, I haven't any questions in particular, nor topics to be addressed. However, I shall probably have many before completing this course.*
- *Does fracking cause earthquakes? What harm does it cause?*
- *Nope. I am excited to learn about anything new and different than what I have previously used in Earth Science.*
- *The effect of permafrost on dampening or amplifying earthquake waves.*
- *As much local information as possible*
- *I am happy to learn whatever is presented. I am usually able to find a way to use many things in my classroom. Sometimes I have to alter the lesson a little to suit 5th grade, but I can generally make many things work.*

12. What type of computer and operating system(s) are you using in your classroom? (examples, MacOSX, Windows11, etc.)

    Teachers

    - MacBook Pro (4)
    - MacBook Air (11)
    - Desktop Mac (8)
    - Projector
    - Document Camera
    - Windows 7 Pro
    - Windows 10 (4)
    - Windows 11 (4)
    - Lenovo
    - Dell PC laptop (3)

Students

- Chromebooks (8)
- iPads (3)
- iMacs
- Macs (3)
- iPods
- Windows 7
- Student owned computers

13. What technology do you currently have available to you and your students in your classroom?

Classroom tech (very similar answers to above question)

- Projector, interactive projector (11)
- Document camera (6)
- Computer Lab (13)
- Laptop cart (6)
- Chromebooks (17)
- MacBook (7)
- iPads (5)
- Smart board (5)
- Promethean board (4)
- Internet access (4)
- Printer (3)
- Smart tv (2)
- 3D printer
- Color laser printer
- Vernier probes
- Models
- Measuring devices
- Lab equipment
- GPS units
- Student owned computers
- Ladybug camera
- Webcams

14. Do you have any concerns about your participation in this class that you'd like us to be aware of?

- *I hope to keep up. I have six very full classes, so I am going to try my hardest!*
- *No. I had technology problems with my computer in the beginning of class so lost all my documents and wasn't able to restore. I have started over now and shouldn't have any further issues.*
- *Only concern is that I am teaching full time with coaching duties after school. I hope to find the time to compete this course.*

- *Technology isn't my strongest area so I'm hoping to better acquaint myself, learn, and stay on top of it :)*
- *My only concern is being able to construct everything on my own.*
- *Yes, I'm overbooked. Currently coaching xc. That will end on October 5th at which time I will have more time to devote to this class.*
- *I am worried about the consistency of my participation. As mentioned before, I work a second job for recon that coordinates the logistics for the ATA and we have been working on completing the array (yay!) into the fall and now working on service trips through the fall. Full time teaching (4 lab sciences this fall) in addition to maintaining IRIS logistics is quite time consuming, so my participation will be erratic unfortunately. I have already missed the first round of deadlines with balancing IRIS and full time teaching, although I am dedicated to getting my assignments in when I can. I will do my best to carve out dedicated times each week to stay on schedule, but I already foresee this to be an issue.*
- *I am a little concerned that I registered for this course two weeks after it started.*
- *I am worried I am going to get behind in my classwork. I have at least 30 students on my case load for Special Education - it takes a fair amount of time in addition to my regular teacher work to complete required case load responsibilities. I also coach Robotics, and have three children at home (one dancer and two hockey players).*
- *I joined late and I was expecting materials in the mail? Since I received none, I am completing the assignments given online.*
- *I teach Health and PE and I believe this class would be beneficial for me. However, if this isn't open to Specialists please let me know!*
- *Since I am not a classroom teacher and don't have access to kids (the school in Pedro Bay is closed) and I don't spend time in geology until May, I'll have to adapt the assignments for use in a library setting (if that's ok with you).*
- *Time management and pacing.*
- *I work two jobs and coach a team due to cutbacks from last year.*
- *Internet is a tad slow.*

15. Have you ever felt an earthquake?

	#	%
Yes	37	100
No	0	0

16. Does your school practice earthquake drills?

	#	%
Yes, routinely	23	62%
Yes, randomly	6	16%
Yes, after a sizable earthquake	0	0%
No	8	22%

17. Do you have any additional comments at this time?

- *I'm excited about this course! (3)*
- *I'm really looking forward to this class. I have lots to learn. (3)*
- *I am excited to have a PD opportunity that is actually relevant to what I teach! Thank you. I am also looking forward to refreshing all the stuff I forgot and learn about new developments since I was in school.*
- *The organization of the class looks well put together and ready for students to work at their own pace. Thank you for that.*
- *I am excited for this class and really looking forward to learning new stuff and sharing with my Science peeps at East.*

III.B. Pre/Post Knowledge Detailed Results

Overall Score Analysis with Gains

Third	Total score	N	Pre average	Post average	Gain
Bottom	10 or lower	1	10	18	8
Middle	11-19	15	15.8	20.1	4.3
Top	20-30	15	22.8	22.9	0.1

Questions with post correct answer percentage over 70%

Most participants in the course got these questions right after the course – good evidence that the course had a positive impact on their knowledge of these concepts.

Question	Pre	Post	Gain
11 Amplitude relative to distance from seismograph	81%	100%	19%
17 How scientists get evidence of center of the Earth	81%	100%	19%
18 Sources of risk in Alaska of tsunami	81%	97%	16%
21 How P waves move	70%	97%	27%
7 How P and S waves travel	46%	94%	48%
22 Direction of movement at a GPS station (from graphs)	84%	94%	10%
27 Margins that generate major tsunamis (convergent)	84%	94%	10%
2 Magnitude 8 earthquakes per year on Earth	41%	83%	42%
4 Location of tectonic plates	73%	85%	12%
6 View of Earth cut in half	57%	82%	25%
28 Triangulating a GPS receiver using radio signals	70%	82%	12%
25 Part of seismometer that does not shake during earthquake	46%	73%	27%

Questions with post correct answer percentage over 50% but under 70%
This content needs to be taught more effectively.

Question	Pre	Post	Gain
14 Where earthquakes occur most frequently on Earth (maps)	49%	67%	18%
9 Time for seismic waves from CA earthquake to reach Boston	43%	62%	19%
29 The type of energy recorded by a seismometer	22%	55%	33%

Questions with high percentage of correct answers on pre
These questions can be dropped and with this content from the course (except for review perhaps) since participants know the information.

Question	Pre	Post	Gain
3 Volcanoes and earthquakes primarily along plate boundaries	100%	100%	0%
20 Scientists' ability to accurately predict most earthquakes	100%	100%	0%
8 Source of energy of earthquakes	97%	100%	3%
5 What scientists mean by "earthquake"	95%	100%	5%
12 Length of time for waves relative to velocities and distance away	95%	100%	5%
10 How far continents move per year relative to each other	92%	97%	5%
26 Tsunami triggers	89%	97%	8%
13 Magnitude related to distance an earthquake can be felt	86%	91%	5%

Questions with small or no gains
These questions need to be examined along with the relevant course content so they can be revised, or the content taught more effectively.

Question	Pre	Post	Gain
1 Density of the Earth as a whole compared with rocks of the crust	76%	79%	3%
19 Slowest waves (P, S, surface, tsunami)	27%	36%	9%
30 Graph of likely earthquake	59%	64%	5%
15 Where earthquakes occur most often on plate map	38%	42%	4%
24 What keeps the stable part of a seismometer from moving	30%	33%	3%
23 Tsunami inundation	22%	9%	-13%

See questions and answers for all items in the Appendix.

III.C. Post Course Survey Detailed Results

Please indicate the extent to which you disagree or agree with each statement: 1 (strongly disagree) – 5 (strongly agree)

	Mean
The course was well organized	4.8/5
The presenters showed evidence of preparation	4.9
The course was poorly facilitated	1.2
I found the relative time devoted to the various course activities to be appropriate	3.7
The course effectively employed a variety of instructional strategies	4.4
I will be unable to make use of the activities in the course as part of my work	2.5
The course provided me with new science content in a way that was not overwhelming	3.9
Overall, this course was a valuable use of my time	4.4

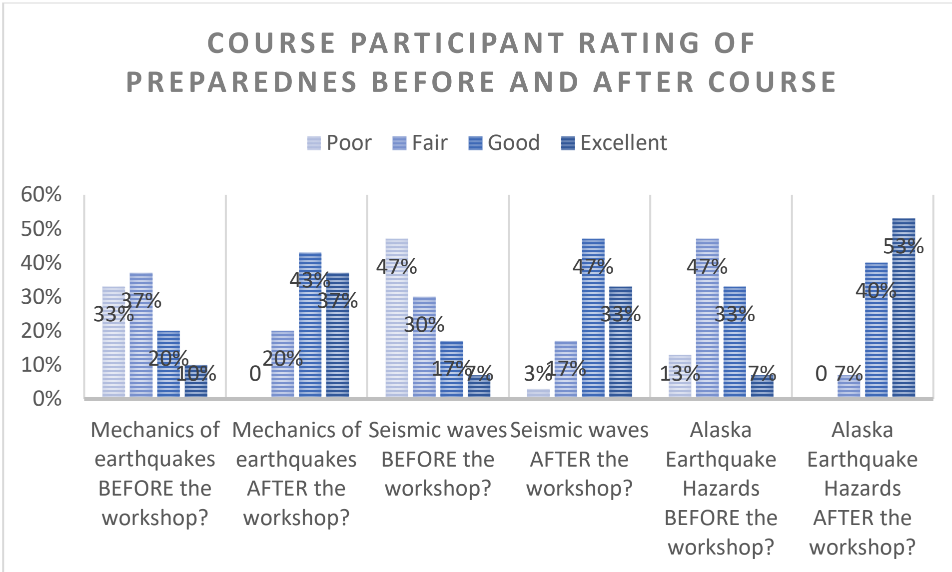
How much time did you spend per week on this course? Less – On Target - >2 hour - > 3 hours

	Less	On Target	>2 Hours	>3 Hours
Week 2: Earthquake Machine (we expected it would take approximately 1 hour)	0	37%	47%	17%
Week 3: Global Tectonics, Alaska Tectonics, Geologic Hazards Lectures, IEB activity (we expected it to take 1.5 hours)	7%	47%	30%	23%
Week 5: Build your own seismograph (we expected it to take 1.5 hours)	0	37%	47%	17%
Week 6: Determining Earth's Internal Structure (we expected it to take 1.5 hours)	7%	43%	33%	23%
Week 9: Using jAmaSeis to Calculate Distance to an Earthquake (we expected it would take 1 hour)	0	33%	37%	30%

How would you rate your preparedness to teach about : Poor – Fair – Good – Excellent

	Poor	Fair	Good	Excellent
Mechanics of earthquakes BEFORE the course?	33%	37%	20%	10%
Mechanics of earthquakes AFTER the course?	0*	20%*	43%*	37%*
Seismic waves BEFORE the course?	47%	30%	17%	7%
Seismic waves AFTER the course?	3%*	17%*	47%*	33%*
Alaska Earthquake Hazards BEFORE the course?	13%	47%	33%	7%
Alaska Earthquake Hazards AFTER the course?	0	7%*	40%	53%*

*Indicates a statistically significant difference from Before to After responses ($p<0.01$)



Which of the activities/sessions modeled during the course do you anticipate will be the most useful to you in your work? (SELECT UP TO FIVE)

	N	%
Alaska Earthquake Center Recent Earthquake Map	21	70%
IRIS Earthquake Browser	21	70%
Earthquake Machine	17	57%
Recent Earthquake Teachable Moments	17	57%
Tsunami Inundation Map Online Viewer	16	53%
Determining Earth's Internal Structure	12	40%
Build your own Seismometer	10	33%
Calculating Distance in jAmaSeis	9	30%
Seismic Wave Basics (slinky, human wave, spaghetti)	8	27%
Calculating Magnitude in jAmaSeis	7	23%
Cascadia GPS Activity	4	13%
Other	0	0

What aspects of the course did you like best?

- *Making a seismograph and earthquake simulator and the earthquake browser*
- *The videos were great, the activities were great and the digital resources were a gold mine of information.*
- *I loved the hands on activities! It really helped me to see how my students would respond.*

The videos were great, the activities were great and the digital resources were a gold mine of information.

- *I liked the Hands on Activities and Videos*
- *jAmaSeis*
- *I liked the take away resources that were easy to implement immediately*
- *I liked the direct hands on activities that I could use in my classroom, like the earthquake machine and the website resources.*
- *Earthquakes are very relevant to where I teach in Alaska.*
- *Online resources*

- *I loved that it included hands on activities that could then use in my instruction. Doing them myself allowed me to consider possible difficulties for my students or modifications I might need to make.*
- *I can actually use what I have learned. Too often that is not the case. Lots of resources.*
- *I liked the hands out activities. The videos were helpful for me, so that I could go back to them over and over again when I didn't understand the concept the first, second and third time, Ha.*
- *Building seismograph and learning the magnitude*
- *The hands-on elements of the course were the best for me.*
- *The pieces that gave me real class examples that would be student friendly.*
- *I liked how so many of the activities relied on using very hands, scientific investigation, strategies. I would assume this same aspect made the course rather overwhelming for people weak in science and/or math. It was challenging for myself at times, but I appreciated the rigor.*
- *I liked watching the videos to see the concepts illustrated.*
- *Hands on activity and data that can be used with our students. Knowledgeable presenters and presentation.*
- *Each lesson was well organized. The variety of information formats and activities. Instructor assistance whenever needed. Having to submit lessons on certain dates kept me focused and on track to complete them.*
- *JamaSeis*
- *I liked the hands on activities the best.*
- *It was great to pick up some activities to use with my students. That was what I most wanted from the class.*
- *I appreciated the modern software and online applications. I also thought the other activities such as earthquake machine and seismometer were fun.*

Each lesson was well organized. The variety of information formats and activities. Instructor assistance whenever needed. Having to submit lessons on certain dates kept me focused and on track to complete them.

- *I like the go at your own pace, the hands on activities, I really liked the feedback and discussion board, the videos were chunked well - I often watched each video multiple times.*
- *Participating in the labs. I enjoyed doing the hands on activities.*
- *Calculating distances and magnitudes*
- *Online tools*
- *The activities that I can use with students*
- *How thorough it was*
- *All the cool resources*

What suggestions do you have to improve the course?

- *Please advertise it only to middle and high school teachers, or make the course more relevant to elementary teachers. The content was much too challenging for elementary.*
- *Perhaps market it towards secondary teachers with a science background. If I didn't major in geology it would have been overwhelming just to learn the terminology.*
- *Have the Jamaseis program work well on the MacBook computers.*
- *Make the course 3 credits instead of 2*
- *I really enjoyed using real IRIS data to calculate magnitude and distance, however, the material is way above the level of my earth science class. I wish there were activities that were usable at a lower level, 7th grade or so, that could incorporate the data in a more grade appropriate manner*

- *Your videos are very monotonous, boring to watch (sorry). I would suggest you put some emotions and life into them.*
- *Give options of lessons based on the educators teaching level*
- *It would be hard to improve...the course was wonderful.*
- *Make jAmaSeis usable on line. To many hoops to get the program loaded on school computers.*

I really enjoyed using real IRIS data to calculate magnitude and distance, however, the material is way above the level of my earth science class. I wish there were activities that were usable at a lower level

- *I believe there should be a prerequisite to this class. Most of this was way over my head and much of the material to way to advance for elementary students.*
- *A slower or broken down with week 7 seismic shadow zones and pin pointing exact location*
- *This course was very video heavy. Some of the online manipulation activities were challenging, because they were not straight-forward for someone who had no experience. For example, the labeling of the waves on a seismogram was hard for me, mostly because the ones we had to label did not start in a straight-forward to challenging progression. I felt like I was just randomly placing the curved wave lines on the seismogram wherever. I understand this is an online course, but the timely feedback on whether I did something correctly or not would be helpful. This would be true for the task mentioned above with the labeling of the wave types on a seismogram. I honestly don't think that I did that correctly, but I have no way of knowing or retrying. I did enjoy this course and learned a lot regarding earthquakes, educational opportunities, and personal safety in Alaska, but I do feel like it was work heavy for the amount of credits. I do appreciate the reimbursement that is available, which helped me to stay focused and complete the activities thoroughly.*
- *Target audience seems to be upper elementary, middle, and high school. More content suitable to younger grades if available would be appreciated.*
- *Several of the weeks seemed like they took on average three hours or more for me to complete. If I were a full time student this would be what I'd expect. Trying to balance this class with my teaching planning, grading, coaching, family, and other responsibilities was quite a challenge through many weeks of the semester. I am grateful that there was welcomed flexibility in the timing. However, because I was often several weeks behind the suggested time line, I was a bit behind in taking advantage of meaningful use of the discussion board.*
- *This course was advertised as being asynchronous. While it is true that we could work through the activities at different rates, the fact that discussion boards were included meant that the discussions were not very meaningful. I don't know if someone replied to me without going back through each discussion board. I also anticipate that many of my responses will never be seen for the same reason. If a discussion board is included in the course, then it seems there should be an expectation that everyone is on the discussion board at the same time. Otherwise, it's just a waste of time for everyone. Additionally, I found the amount of time I spent on this course was way beyond other 2 credit courses I have taken (in fact, more than other 3 credit courses I've taken.) For the amount of time it takes to complete this course, I feel the number of credits needs to be increased. I also wish I had known this course was tailored more toward middle and high school teachers. I learned a lot as a teacher, but I'm not sure that I will be able to use much of it in my classroom.*
- *Some lessons took a lot longer than others, if there was some way to even it out that might be helpful.*

- *More activities for elementary school level students*
- *There were a LOT of videos. List some as optional?*
- *I was able to follow along successfully with all lessons, however some of the lessons took longer to complete than the noted timeline.*
- *If there were some way to make it less asynchronous that would be nice. If this were a once-per-week class by videoconference or in person it would have been much better for me.*
- *Longer and for more credit.*
- *Some weeks it felt like the lesson was really long, with a lot to watch. It was hard to work with the software - I ended up putting the Jamaseis on my personal computer. I am going to see about our tech people getting it to work on the school computers - have a warning about installation - it might take a while.*
- *Do more courses structured just like this one!*

How likely is it that you would recommend this course to a friend or colleague? 1 – (Not Likely) – 5 (Very Likely)

- Mean response = 4.2/5

What would be the best time of year for us to offer this course for teachers?

	N	%
Spring	3	10%
Summer	5	17%
Fall	8	27%
Winter	1	3%
Anytime	9	30%
Same time of year	4	13%

Are you interested in being considered to receive an educational seismometer for your classroom?

	N	%
Yes	13	45%
No	7	24%
Maybe	9	31%
Other	0	0

IV. Conclusions and Recommendations

The teachers enrolled in the course primarily to learn more about Alaska relevant seismology, to develop their understanding of seismology if they didn't already teach it, or to deepen their knowledge of specific concepts if they had been teaching it or had a geology background.

Teachers in the group ranged from first grade teachers to high school teachers, one who had taught community college and a librarian. Several of them had field experience in the past or ongoing work, such as with the IRIS center or as a fisheries biologist or wildlife technician.

Their pre/post knowledge gains overall were statistically significant. As would be expected from their backgrounds and teaching assignments, about a third knew several of the concepts well:

relationship of plate boundaries to earthquakes and volcanoes, earthquake prediction, energy source for earthquakes, what scientists mean by "earthquake," time for waves to travel relative to velocities and distance away, how far continents move per year relative to each other, tsunami triggers, and magnitude related to distance an earthquake can be felt. But surprisingly, the average post knowledge score for the class was 21.5/30 so there is room for improvement in knowledge gain. Questions with small or no gains were about the density of the Earth compared with rocks of the crust, the slowest waves, interpreting a graph of a likely earthquake, where earthquakes occur most often on a plate map, what keeps the stable part of a seismometer from moving, and tsunami inundation. The four elementary teachers felt like many of the activities would be too difficult for their students.

Participants rated the course highly for its organization, preparation of instructors, use of a variety of instructional strategies and overall. They reported significant changes in their preparedness to teach about mechanisms of earthquakes, seismic waves, and Alaska earthquake hazards. They anticipate they will use activities/sessions that were modeled during the course such as: Alaska Earthquake Center Recent Earthquake Map, IRIS Earthquake Browser, Earthquake Machine, Recent Earthquake Teachable Moments, and Tsunami Inundation Map Online Viewer.

Suggestions from the participants included targeting the course for middle and high school students or making the lessons/materials/content more accessible for elementary students, reducing the use of video, and increasing the number of credits offered because of the time requirements. It is recommended that the post knowledge test results be studied to determine where to strengthen the assignments so that teachers learn the concepts.

Appendix

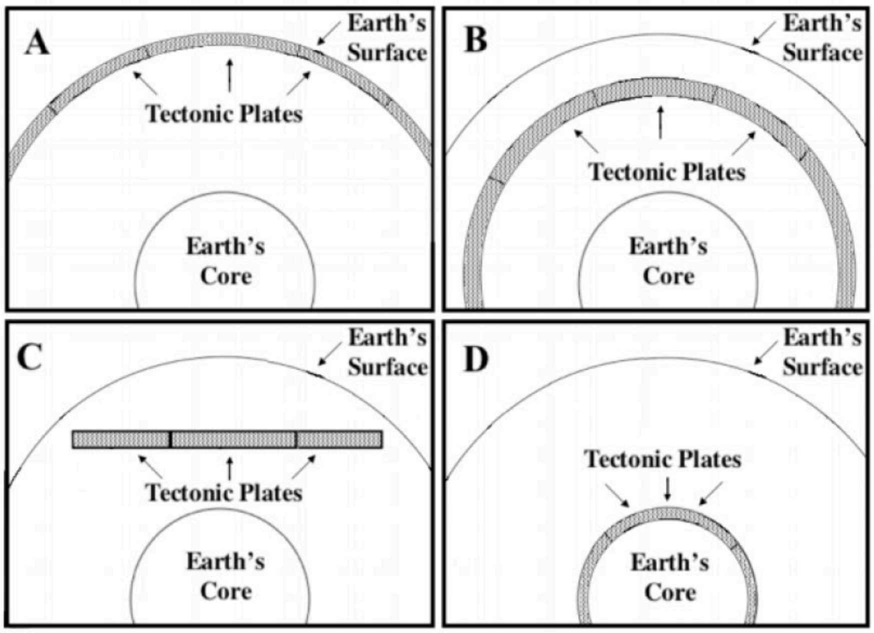
Questions with answers (identified by *)

1. Compared to the rocks that make up the Earth's crust, the Earth as a whole is _______.
   A. more dense*   B. less dense   C. about the same density

2. For the entire Earth, there are about ________ earthquake(s) per year of magnitude 8 or greater.
   A. 1*   B. 10   C. 100   D. 300

3. Many scientists believe that volcanoes and earthquakes are the result of large plates of material moving near the surface of the Earth. This idea is called the theory of plate tectonics. If the theory of plate tectonics is correct, then volcanoes and earthquakes should _______ be:
   A. evenly distributed across the surface of the Earth
   B. occur primarily along plate boundaries*
   C. occur primarily on continents
   D. occur primarily in oceanic regions

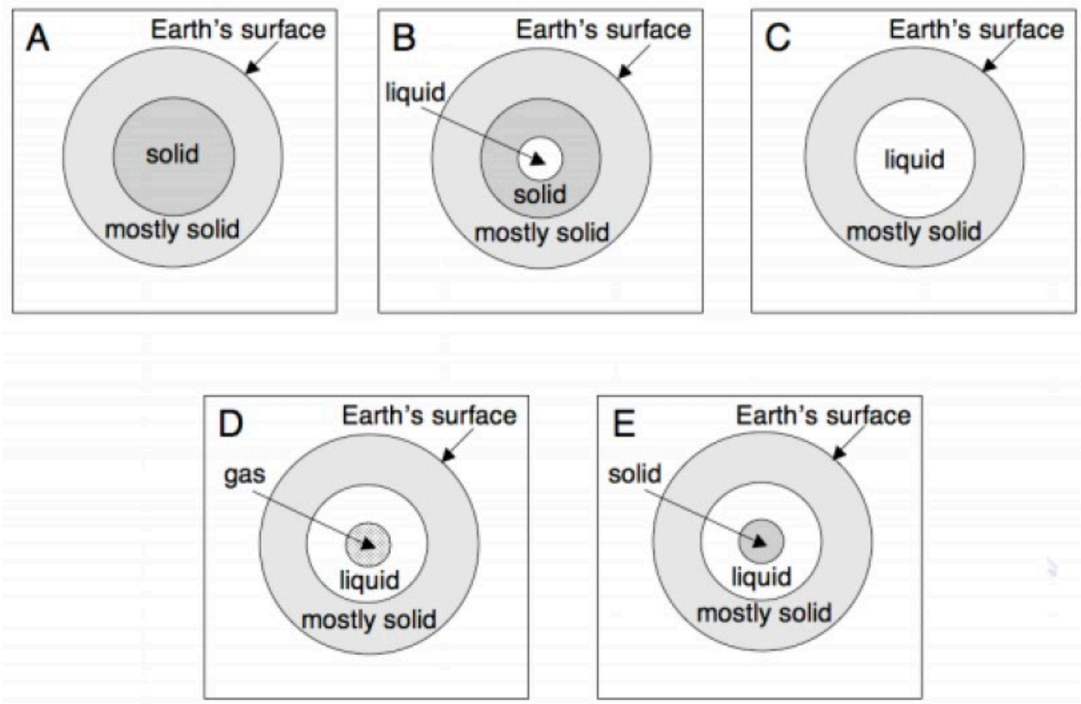
4. Which of the following diagrams most closely represents the location of the Earth's tectonic plates? A*BCD



Modified from Libarkin *et al.* (2005)

5. Which of the following best describes what scientists mean when they use the word earthquake?
   A. An ancient fracture in the Earth's crust
   B. A vibration caused by the sudden fracture of rock in the Earth*
   C. A vibration caused by a sudden change in the Earth's magnetic field
   D. A vibration caused by a sudden change in the Earth's gravitational field
   E. An eruption of hot molten rock material from the Earth's interior

6. Which of the following figures is most closely related to what you might see if you could cut the Earth in half? ABCDE*



7. Earthquakes generate different types of seismic waves. Two of the wave types are Primary (P) and Secondary (S) waves. P waves are compressional waves and S waves are transverse waves. Which of the following is true about P and S waves?

A. P waves travel slower than S waves
B. Both P waves and S waves can travel through liquids
C. P waves can travel through liquids, but S waves cannot travel through*
D. liquids
E. S waves can travel through liquids, but P waves cannot travel through
F. liquids

8. You may have seen pictures of areas that experienced great damage in a severe earthquake. To damage buildings requires energy. What do you think is the primary source of energy for earthquakes?

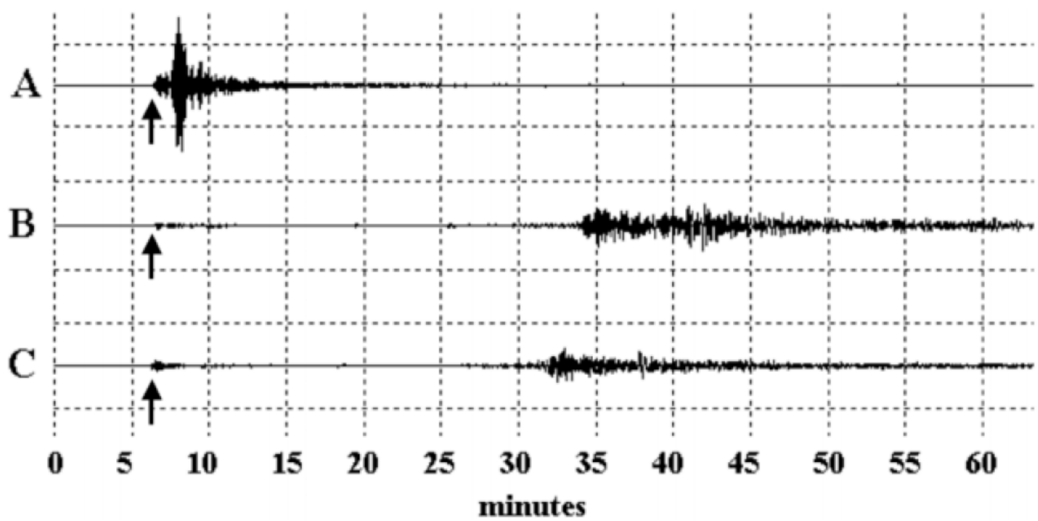
A. Stored elastic energy in deformed rock inside the Earth*
B. Electrical energy transmitted into the Earth's interior from electric
C. power stations in large cities
D. Supernatural forces
E. Unusual changes in the weather

9. When a large earthquake occurs in California, about how long do you think it takes for the first seismic waves to arrive at a station in the Boston, Massachusetts area?

A. 10 seconds
B. 2 hours
C. 7 minutes*
D. 30 minutes

10. How far do you think continents move relative to each other in a single year?
   A. A few inches*
   B. A few hundred feet
   C. A few miles
   D. Scientists do not have enough information to estimate the relative motion of continents
   E. There is no relative motion between continents

The next three questions are based on the seismograms shown below from three different earthquakes recorded by seismographs in the Boston area. All of these seismograms were recorded on the same type of seismograph, and the amplitudes are all plotted on the same scale. Arrows indicate the first waves from the earthquake that were recorded by the seismograph.



Seismogram A was recorded at Boston College from an earthquake in Plattsburg, New York (magnitude 5.1), at a distance of 322 km from the epicenter.

Seismogram B was recorded at Boston College from an earthquake in Alaska (magnitude 6.8),at a distance of 4,684 km from the epicenter.

Seismogram C was recorded at McDevitt Middle School (Waltham, MA) from an earthquake in the Vancouver Islands (magnitude 6.4), at a distance of 4,274 km from the epicenter.

11. Why is the maximum amplitude of the waves greater for A than for B and C, even though the earthquake recorded in A has the lowest magnitude of all three?
   A. Because the earthquake shown in A is closer to the Earth's core, than the earthquakes shown in B and C.
   B. Because the earthquakes shown in B and C are farther north of the equator than the earthquake shown in A.
   C. Because a magnitude 5.1 earthquake in New York is easier to record than a magnitude 6.4 earthquake in Alaska or a magnitude 6.8 earthquake in the Vancouver Islands.

D. Because the earthquake shown in A is closer to the seismograph than the earthquakes shown in B and C*

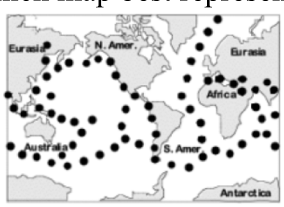
12. The earthquake generated waves on the seismogram in A only last for about 25 minutes, but the waves on seismograms B and C continue for a longer time (beyond the 60 minute duration of the graphs). Why do you think the waves in B and C continue for a longer time than the waves in A?

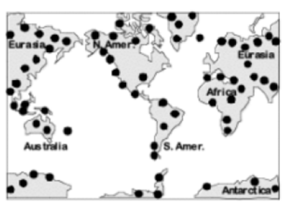
A. Because earthquakes in the northeastern United States are deeper than earthquakes in Alaska and the Vancouver Islands.
B. Because the earthquakes shown in B and C are farther north of the equator than the earthquake shown in A.
C. Because seismic waves spread out in time as they travel farther from the epicenter, due to differences in the velocities of the different types of waves in the Earth's interior.*
D. Because the climate is different in New York than it is in the Vancouver Islands and Alaska.

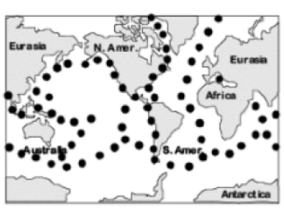
13. People reported feeling the Plattsburgh, NY earthquake (shown in A) in the Boston metropolitan area. If an earthquake occurred in the same location as this one, but it was a magnitude 6.1 earthquake rather than a magnitude 5.1 earthquake, it would be to be felt in the Boston area.

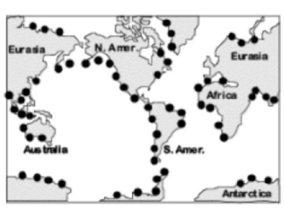
A. More likely*
B. Less likely
C. Just as likely

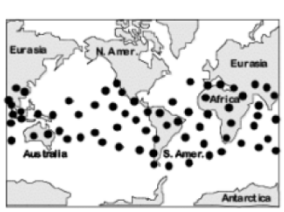
14. The maps shown below illustrate the Earth’s continents and oceans (the oceans are white and the continents are gray). The circles on each map represent possible locations of earthquakes. Which map best represents where earthquakes occur most frequently on the Earth? A*BCDE

A 

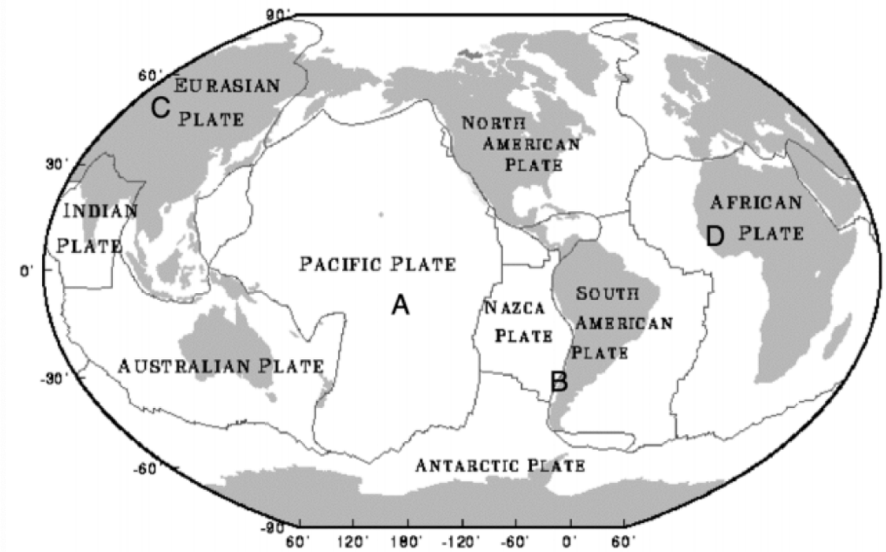
B 

C 

D 

E 

15. The following picture shows the Earth's tectonic plates. Where do you think earthquakes occur most often? AB*1CDE



~~16. Which of the following best describes what scientists mean when they use the word earthquake?~~

~~A. When an earthquake occurs, visible cracks appear on the Earth's surface.~~
~~B. When an earthquake occurs, people can feel the Earth shake.~~
~~C. When an earthquake occurs, man-made structures are damaged.~~
~~D. When an earthquake occurs, energy is released from inside the Earth*~~
~~E. When an earthquake occurs, the gravitational pull of the Earth increases.~~

17. Which of the following techniques do you think scientists can use to gather evidence about whether the very center of the Earth is mostly a solid, a liquid, or a gas?

A. Drilling through the center of the Earth.
B. Studying motion caused by earthquakes*
C. Analyzing pictures taken by satellites.
D. Scientists cannot study the center of the Earth.

18. Alaska is at risk from a tsunami from which of the following?

A. Landslides
B. Distant earthquakes
C. Local earthquakes
D. All of these*

19. Which of the following waves is the slowest?

A. P waves
B. S waves
C. Surface waves
D. Tsunami waves*

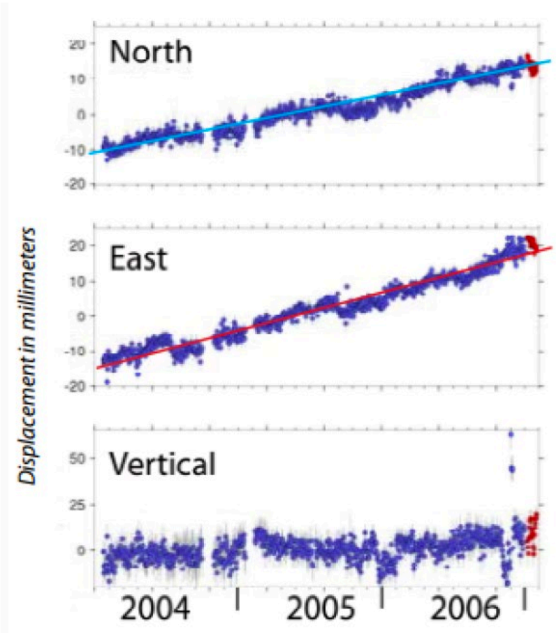
20. Which of the following statements best describes the state of earthquake prediction?

A. Scientists can accurately predict the time and location of almost all earthquakes.

B. Scientists can accurately predict the time and location of about 50% of all earthquakes.
C. Scientists can accurately predict when an earthquake will occur, but not where.
D. Scientists can characterize the seismic risk of an area, but cannot yet accurately predict most earthquakes*

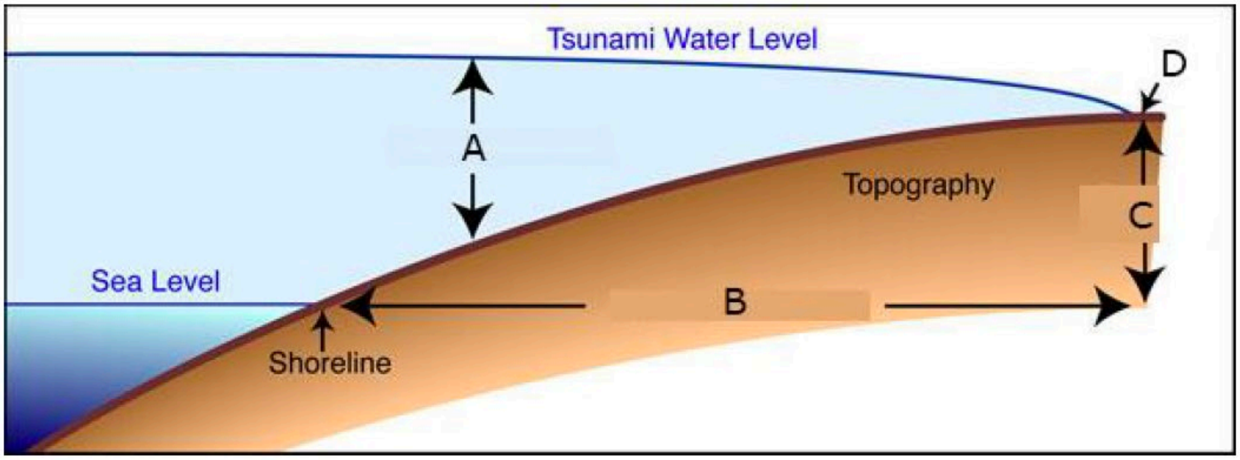
21. The type of seismic waves that arrive at the surface first and move by compressing and expanding the ground like an accordion are called:
A. S waves
B. P waves*
C. Surface waves
D. Mercalli waves

22. This graph shows data from a GPS station. What does it reveal about the station's movement from 2004 to 2007?

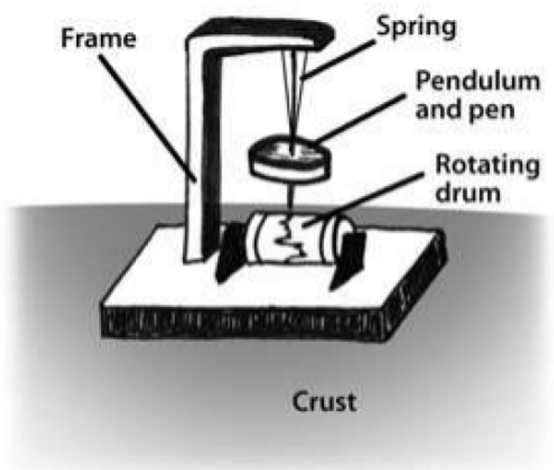


A. The station is being pushed to the North
B. The station is being pushed to the South
C. Additional stations would be needed to determine movement
D. The station is being pushed to the Northeast*

23. On this diagram, which arrow represents tsunami inundation? A*BCD



Use the following image to answer the next two questions.



24. What keeps the stable part of this seismometer from moving during an earthquake?
    A. Inertia
    B. Its mass*
    C. Gravity
    D. Its location

25. Which part of the seismometer does not shake during an earthquake?
    A. The frame
    B. The spring
    C. The rotating drum
    D. The pendulum and pen*

26. Tsunamis are triggered by what?
    A. Earthquakes
    B. Volcanic eruptions
    C. Undersea landslides

D. All of the above*

27. Most major tsunamis are generated by earthquakes along
    A. Divergent margins
    B. Convergent margins*
    C. Transform margins

28. To "triangulate," a GPS receiver measures distance using
    A. The travel time of radio signals*
    B. The travel time of light signals
    C. The travel time of a broadband signal

29. What type of energy is recorded on seismometers?
    A. Weather
    B. Earthquakes
    C. Ocean waves
    D. All of the above*

30. Which of these is most likely an earthquake? A*BCD