EARTHQUAKES TEACHER CONTENT PACKET

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INTRODUCTION

This resource examines writings and photographs related to earthquakes from the archives of the Anchorage Museum.

Earthquakes are geologic events that cause the land to shake and roll. Small earthquakes occur around the world every day and are often only detectable by sensitive instruments. Large earthquakes are rarer, but leave enduring marks upon the land and the memory of people who experience them. In 1964, the second largest scientifically recorded earthquake shook the ground under Southcentral Alaska. This earthquake caused death and destruction that changed the history of Alaska and earthquake science throughout the world. In 2018, another large earthquake struck the same region and although it was less powerful than 1964 with zero human casualties, it nevertheless served as a reminder of the power of earthquakes in Alaska.

Southcentral Alaska experiences many earthquakes due to its location near a large, active subduction zone. In this subduction zone, the Pacific plate travelling in a northwest direction runs into and slides beneath the North American plate. As tectonic plates slowly grind against each other, friction builds between slow moving blocks of rock near the boundary. An earthquake occurs when these blocks of rock slip suddenly along a fault. This rupture releases energy in the form of seismic waves, which travel as vibrations through the earth.

Scientists describe the magnitude, or size, of an earthquake using the Moment Magnitude Scale (denoted M_w or M). The Moment Magnitude Scale relates the amount of energy released by an earthquake to a number from 1 to 10. This scale combines the wave data from seismographs with physical information about the rupture and the land. The difference between a single unit on the Moment Magnitude Scale represents multiplying the energy released during an earthquake by 32. An M7.0 earthquake releases 32 times more energy than an M6.0 earthquake.

Examining the geologic and social records of earthquakes can help us understand and prepare for future tremors.

USING THE GUIDE

Inside of this teacher's guide you will find an expanded explanation on each topic present in the booklet alongside additional information and activities.

This guide highlights writing samples and photographs found in the Anchorage Museum collection. The prompts are intended to engage 5th grade students and up with the context of the primary sources, creating deeper understanding of the geology and social connections of our unique place in Alaska.

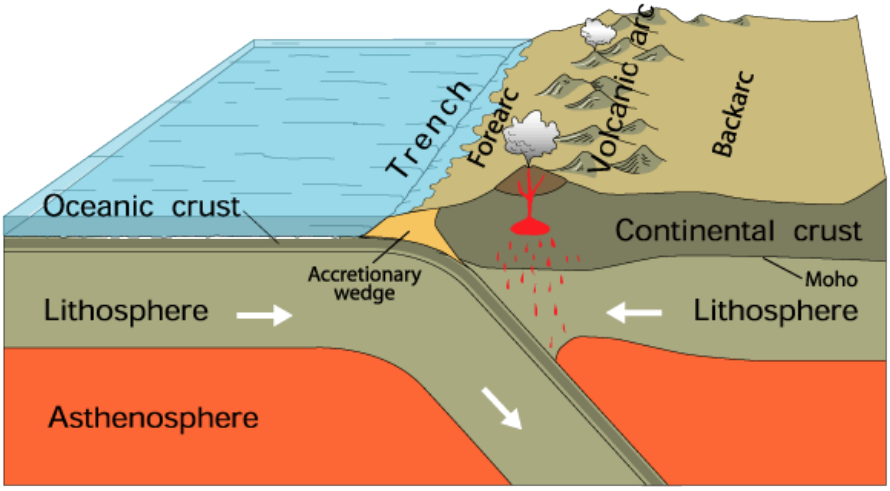
- **Explore:** Challenge students to be curious when observing the objects, artworks and information presented throughout the guide. Support students to do their own research and delve deeply. The information is intended not only to educate but to spark interest in students and encourage further exploration on these topics. *Slow down and look closely, each object has a story to tell.*

- **Discover:** Encourage students to look beyond the artworks that they see and examine the details they notice either in the guide or in the exhibitions. As you move through this resource, share the additional knowledge and information presented in this packet to allow students to develop a deeper understanding of landscapes and resources of Alaska, Alaska Native lifestyles and cultures. *Make this journal yours. Use the pages to draw, write, and note in your own way.*

- **Ask questions:** Build an inquiry-driven experience for the students. Ask students to share what they observe and/or what they may already know. As you introduce background knowledge and object information, encourage students to ask questions about what more they want to know and what they don't understand. *Be curious about the details.*

- **Connect:** Encourage students to reflect on their own life and experiences. Invite students to consider their own personal connections to what they have learned. The activities of this guide foster opportunities for such personal reflection. Ask students to share with each other what connections they have found. *Share with a friend, a family member, or mentor about your experience.*

PART I: EARTHQUAKE SCIENCE



Subduction Fault Zone Diagram, United States Geologic Service

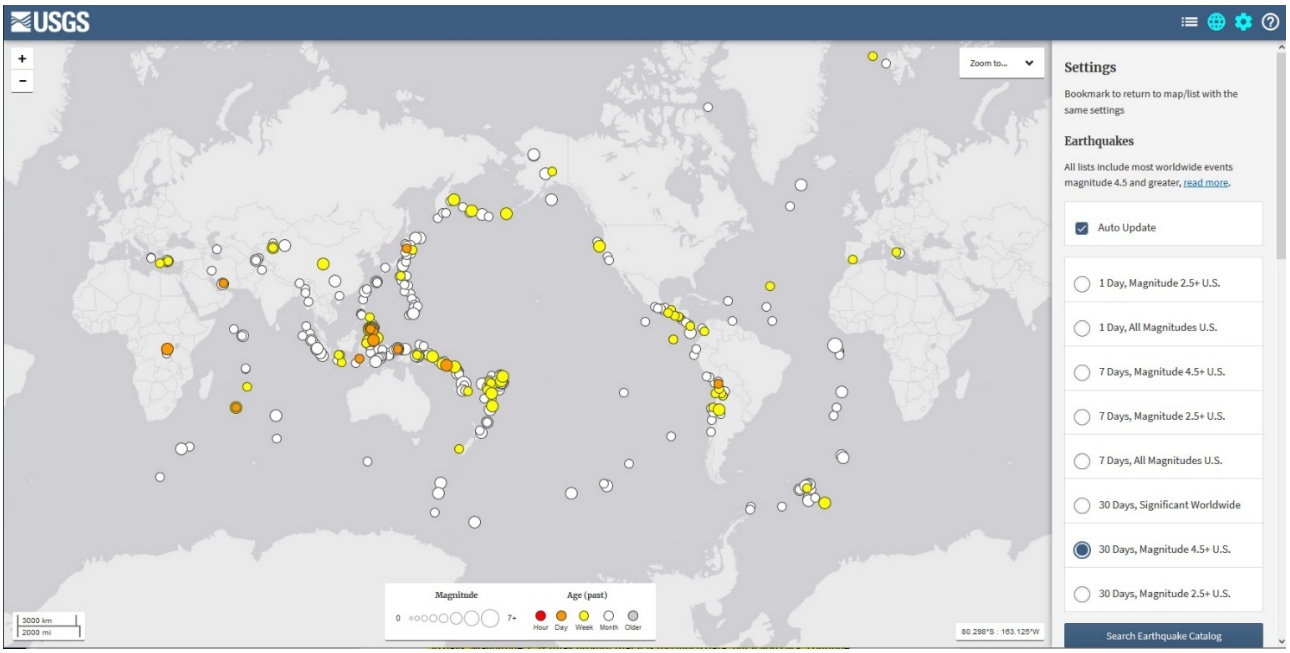
Terms

Tectonic Plates	the large, thin, and mobile pieces of the Earth's outer shell; the motion of tectonic plates is driven by the flow of hot rock in the mantle
Mantle	the dense layer of semi-solid rock lying beneath the Earth's crust; the structure of the mantle is variable: it is cooler and more brittle close to the surface (in the lithosphere) and becomes hotter and more flexible with increasing depth and pressure (in the asthenosphere)
Subduction Zone	a boundary where one tectonic plate runs into and slides beneath another plate

Learn more about the layers of the Earth from IRIS:
https://www.iris.edu/hq/inclass/animation/layers_of_the_earth

Learn more about plate tectonics from IRIS:
https://www.iris.edu/hq/inclass/animation/plate_tectonic_theorya_brief_history

ACTIVITY 1



Screenshot of recent earthquakes from the USGS earthquakes map

Open the following link: *https://earthquake.usgs.gov/earthquakes/map/*

Zoom out on the map until you can see the whole map or use "Zoom to" then select "world." Turn legend on at the bottom center of webpage. Click the gear symbol in the upper right corner to change to the following settings:

- 30 days, Magnitude 4.5+
- Plate Boundaries off

PROMPT **What do you notice? What information is this map displaying?**

Explain how this map is showing every M4.5 or greater earthquake that occurred in the past 30 days.

PROMPT **How are earthquakes distributed around the globe? Are there any areas that seem to have more earthquakes? Can we draw any conclusions about earthquakes from looking at this map?**

Change the settings to:

- 30 days, Magnitude 2.5+ (may prompt that it is too much data, but if you click 'continue anyway' it should still work)

PROMPT **What has changed on the map? What new conclusions can you draw about earthquakes with this map? Why do you think the USGS has differentiated between M2.5+ and M4.5+ earthquakes?**

Change the settings to:

- Turn on the plate boundaries.

PROMPT **What do you think these lines might represent? Is there a relationship between the location of earthquakes and the red lines?**

Watch a video (6:39 min.) from IRIS Earthquake Science about plate boundaries and earthquakes: *https://www.youtube.com/watch?v=Xzpk9110Lyw*

On the USGS earthquakes map page, zoom in on Alaska.

PROMPT **What do you notice about the patterns of earthquake locations around Alaska?**

EXTENSION ACTIVITY **Rice University has a great in-depth plate tectonics activity available free for educators online at:** *http://plateboundary.rice.edu/quick_start.html*

TERMS

Fault	a fracture or break that allows for movement between blocks of rock
Seismograph	an instrument used to detect and record the wave motion of earthquakes and other ground movements
Aftershock	a smaller earthquake which occurs in the same general area as the main seismic event; aftershocks indicate minor readjustments of the land around the fault that slipped

Learn more about faults and earthquakes from IRIS:

https://www.iris.edu/hq/inclass/animation/earthquake_faults_plate_boundaries__stress

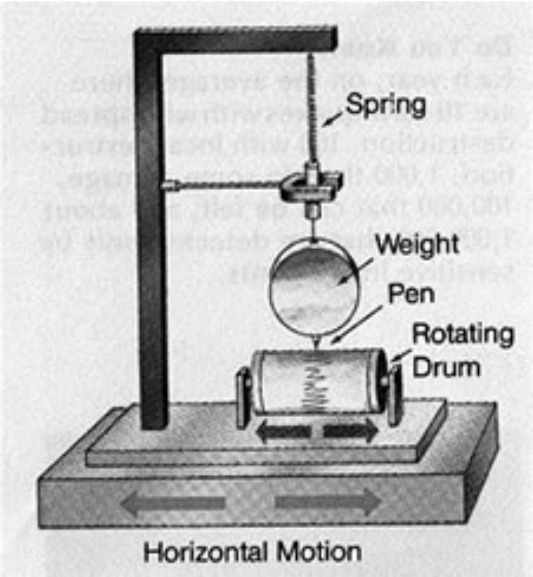
Learn more about seismographs from IRIS:

https://www.iris.edu/hq/files/programs/education_and_outreach/aotm/8/Seismograph_Background.pdf

Learn more about reading seismograms from IRIS:

https://www.iris.edu/hq/files/programs/education_and_outreach/aotm/8/Seismograph_Background.pdf

ACTIVITY 2



Drawing of a seismograph, United States Geologic Service

WATCH **Video (2:53 min) from IRIS Earthquake Science called "3-component Seismograms – Capturing the motion of an earthquake:"**
https://www.youtube.com/watch?v=Za_22xo7ZQQ

Download and open the Seismometer app for iPad or iPhone etc. Have students cause vibrations around the device.

PROMPT **What do you notice about the seismograph recording? How do different movements impact what the seismogram looks like?**

Learn more about reading seismograms from IRIS and the USGS:
https://www.iris.edu/hq/inclass/animation/guide_to_reading_a_seismogram_usgs

TERMS

The magnitude of an earthquake cannot fully describe how that earthquake will be felt. The intensity of shaking experienced or the dangers resulting from an earthquake depend on a variety of factors. These factors may include the magnitude of the earthquake, the length of shaking, the distance from the epicenter, and the makeup of the underlying rocks and soil. Local geology and the engineering of nearby structures may create other dangers such as tsunamis, liquefaction, and building collapse.

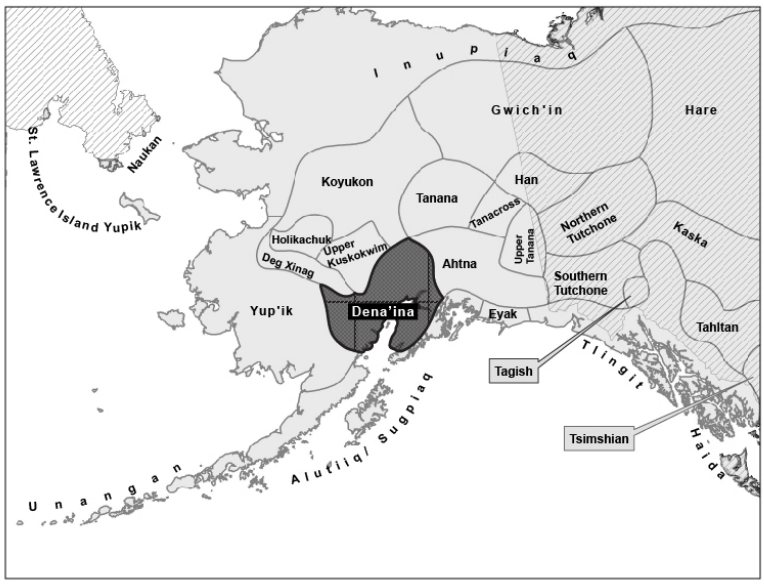
Epicenter	a point on the surface of the Earth directly above an earthquake's origin point
Liquefaction	a phenomenon common in areas of loose siol in which stress and vibrations, such as those caused by earthquakes, turn seemingly solid ground into flowing ooze
Tsunami	a wave or series of waves generated when a disturbance such as a landslide, earthquake, or volcanic eruption displaces a large volume of water

Learn more about earthquake intensity from IRIS:
https://www.iris.edu/hq/inclass/animation/earthquake_intensity

Learn more about tsunamis from NOAA:
https://oceanservice.noaa.gov/facts/tsunami.html

EKLUTNA DENA'INA* LAND

Anchorage is located on the traditional homelands of the Eklutna Dena'ina people.



Krauss, Michael, Gary Holton, Jim Kerr, and Colin T. West. 2011. Indigenous Peoples and Languages of Alaska. Fairbanks and Anchorage: Alaska Native Language Center and UAA Institute of Social and Economic Research.

Etnen ghenu	Dena'ina term for 'there is an earthquake'
Nuna aulaluni	Alutiiq (Sugpiaq) term for 'there is an earthquake'
Nuna pektuq	Yup'ik term for 'there is an earthquake'
Adgilax	Unangax^** term for earthquake
Tanax^ yaagikux^	Unangax^ term for 'the ground is quaking, there is an earthquake'
Ull'ute	Yup'ik term for 'collapse on the people in the building during an earthquake'
Qupneq	Yup'ik term for fissure

*A language that is part of the largest indigenous language family in North America, Dene. The Dene language family, which is commonly identified as 'Athabascan,' is not a word native to any of the Indigenous languages to which it refers.

**Unangax^ is the name of the Indigenous peoples of the Aleutian Islands. The name 'Aleut' comes from Russian colonizers in the 18th century.

ACTIVITY 3

Students will look at three earthquake maps centered on Anchorage to better understand seismicity in Southcentral Alaska.

Divide the class into groups of three. Each group should get a printed copy of one map with different groups having different maps. Have students look closely at the maps and discuss what they are seeing.

PROMPT **What are your first impressions of the map? What information does your map display?**

Have each group present their maps and what they learned. Dive deeper with a class discussion looking at each map individually.

Map 1: This map from the European-Mediterranean Seismological Centre displays a spread of earthquakes that occurred in Southcentral Alaska since the 1960s. The larger and darker the dot, the greater the magnitude of the earthquake. The 1964 Great Alaska Earthquake is represented by the large open circle.

PROMPT **How many M7 or greater earthquakes are represented on the map? How many M3 or smaller? What does this reveal about seismic activity in general?**

Map 2: This map from the European-Mediterranean Seismological Centre compares the depth of earthquakes that occurred in Southcentral Alaska since the 1960s. Shallow earthquakes are red and deep earthquakes are purple. The 1964 Great Alaska Earthquake is represented by the large open red circle.

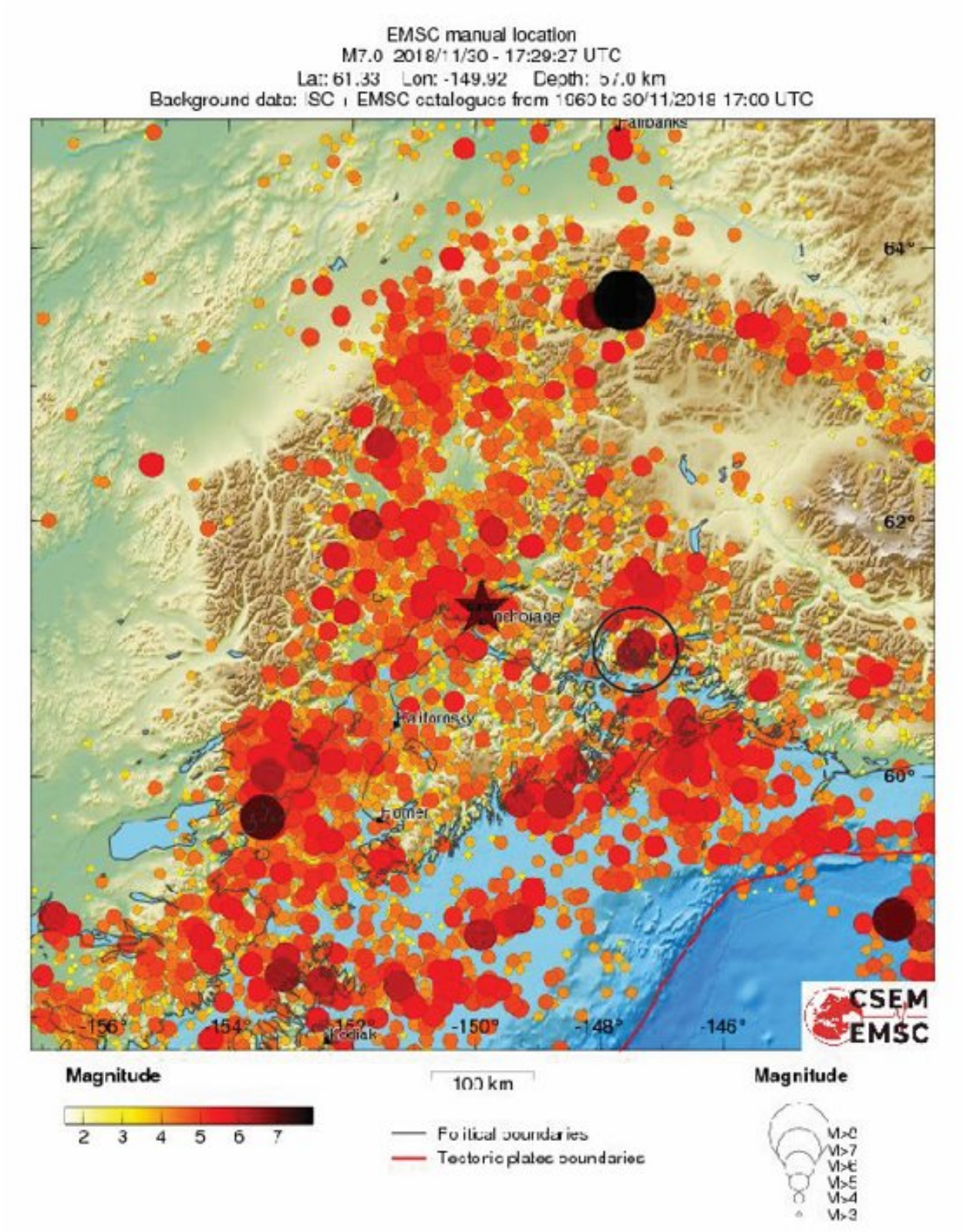
PROMPT **Do you notice any patterns of earthquake distributions and depths in Southcentral Alaska? How might earthquake depth impact how earthquakes are experienced?**

Map 3: This map from the USGS models shaking intensity from the November 2018 earthquake over Southcentral Alaska. It was produced by combining velocity and acceleration data from a network of earthquake sensors with "Did You Feel It?" reports from the general public and geologic information about the stability of local soils.

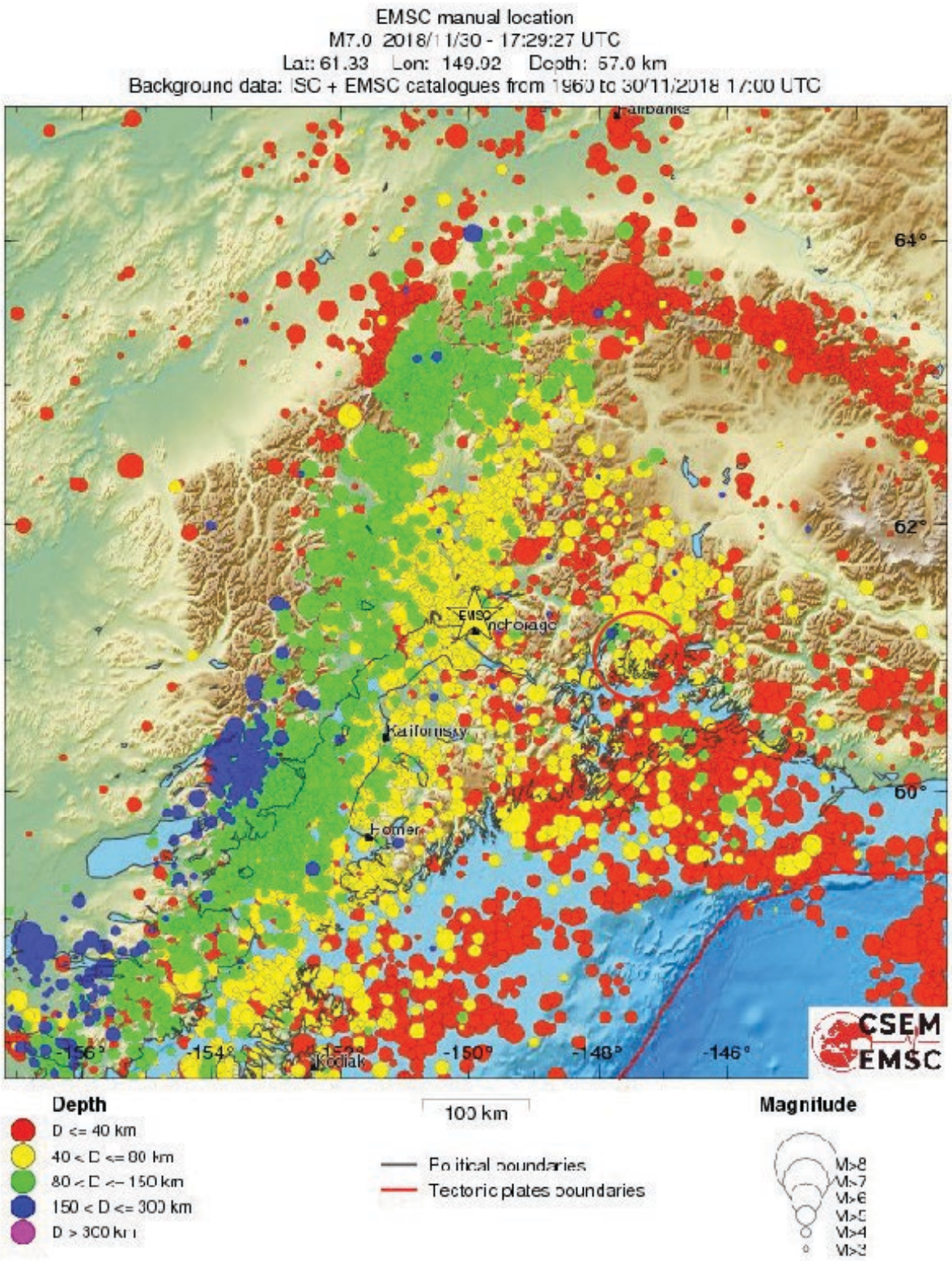
PROMPT **How does shaking intensity change as you move out from the epicenter? How does the landscape seem to affect shaking intensity?**

WATCH **Video (8:39 min) from IRIS Earthquake Science called "Regional Alaska Tectonics and Earthquakes:"**
https://www.youtube.com/watch?v=2nMiVd0zo_Y

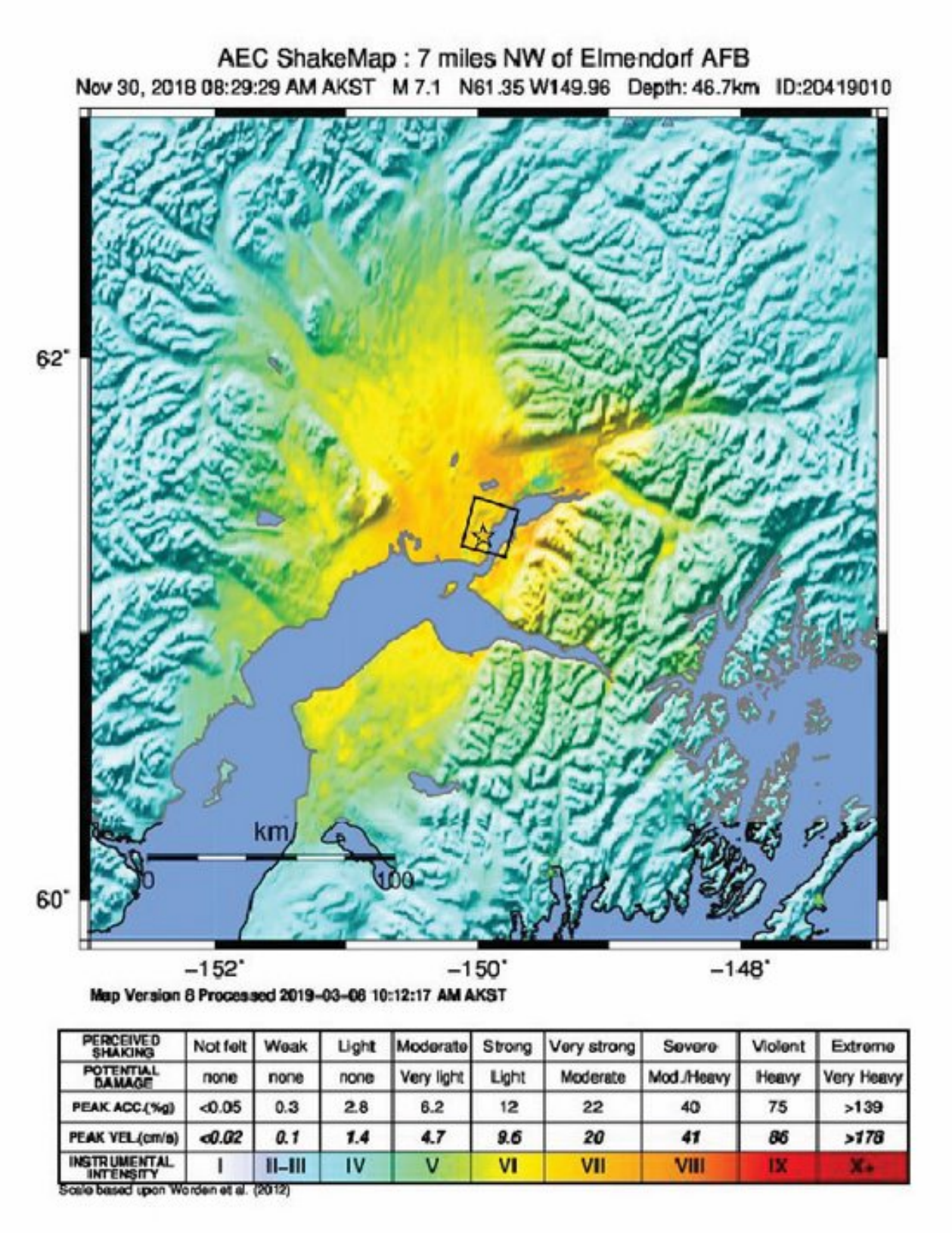
ACTIVITY 3 – MAP 1



ACTIVITY 3 – MAP 2



ACTIVITY 3 – MAP 3



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	*<0.02*	*0.1*	*1.4*	*4.7*	*9.6*	*20*	*41*	*86*	*>178*
INSTRUMENTAL INTENSITY	I	II–III	IV	V	VI	VII	VIII	IX	X+

Scale based upon Worden et al. (2012)

PART II: EARTHQUAKE PRIMARY SOURCES

Students should understand the difference between primary and secondary sources to inform how they process documentation of an event.

Terms

Primary Source	a first-hand, original account, record, or evidence about a person, place, object, or an event
Secondary Source	an account, record, or evidence obtained from an original or primary source

ACTIVITY 4

Discuss primary and secondary sources with students. Students can work individually or in small groups.

PROMPT **List examples of primary sources.**

PROMPT **Where do you find primary sources?**

PROMPT **How do you use primary sources?**

PROMPT **List examples of secondary sources.**

PROMPT **Where do you find secondary sources?**

PROMPT **How do you use secondary sources?**

Anyone who experiences an event can create a primary source.

PROMPT **What are ways you create primary sources?**

PROMPT **What are some examples of primary sources you have made?**

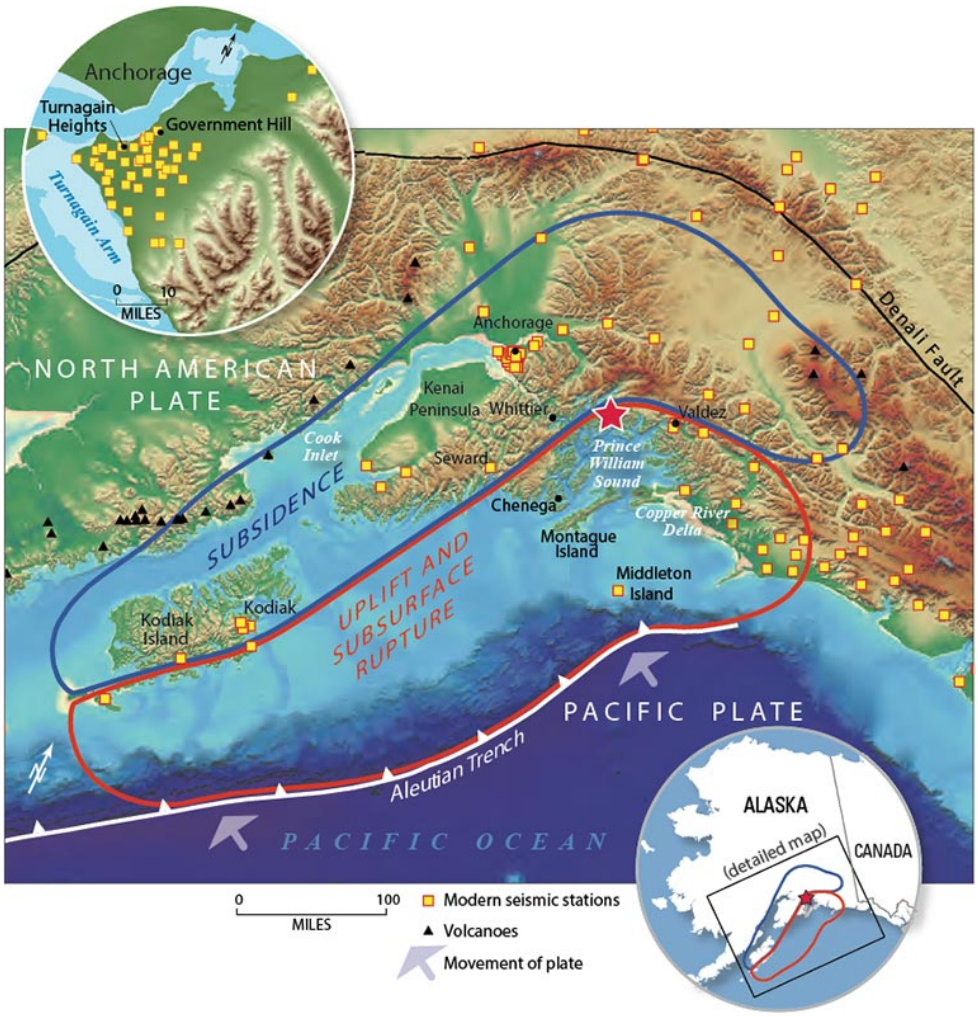
Sketch of Clock, mid-20th century, plastic, metal, gift of the United States Postal Service, 1964.2.1

This clock was recovered from the sorting room of the Anchorage Post Office during the March 27, 1964 earthquake. The hands show the time that it stopped – 5:37 p.m.

The 'Great Alaska Earthquake' began on Good Friday, March 27, 1964at 5:36 p.m. At M9.2, it is the second largest earthquake ever recorded. The earthquake's epicenter was 120 km (75 miles) east of Anchorage and it occurred at a depth of 25 km (15.5 miles). The shaking triggered tsunamis, landslides, and liquefaction, all of which caused extensive damage across Southcentral Alaska. The earthquake caused 131 fatalities, the vast majority of which resulted from tsunamis.

In 1964, the movement of plate tectonics was still an emerging theory and the underlying causes of most earthquakes were unknown. The aftershock measurements and landscape observations collected by United States Geologic Survey scientists in the weeks after the earthquake pointed to the thrust of a subducting tectonic plate as the cause of the Great Alaska Earthquake. This body of evidence validated the theory of plate tectonics as the best explanation for real-world phenomena.

The 1964 quake occurred at a pivotal moment in Alaska's growth as a state. Damage revealed infrastructure vulnerabilities which encouraged more thoughtful considerations for future development. The traumatic 1964 earthquake experiences of communities created a strong, lasting collective memory of the importance of earthquake monitoring and emergency preparedness.



Map of Southern Alaska Showing the Epicenter of the 1964 Great Alaska Earthquake (red star), United States Geologic Service

Learn more about the 1964 Earthquake from IRIS:
https://www.iris.edu/hq/inclass/animation/alaska_the_great_alaska_earthquake_of_1964

ACTIVITY 5

Locate primary sources on the website at: webpage here. For each primary source, prompt students to read closely, and answer the following guiding questions by themselves or in small groups.

Primary Source #1:

Bill and Ellyn Frye letter regarding the 1964 Alaska Earthquake (April 3, 1964); Anchorage Museum, B2013.011

1. When was the primary source created?
2. Write your initial impressions of the letter. Share with a partner:
    a. I read…
    b. I think…
    c. I wonder…
3. Describe methods of communication during and after the earthquake.
4. Compare and contrast Bill and Ellyn's earthquake experience.
5. Summarize the food and housing situation in the letter.
6. Scientist Lens: In the letter, what details might an earthquake scientist notice? What conclusions about the earthquake can we draw from these letters?

Primary Source #2:

Colleen Ryan letter to Grandma (April 15, 1964); Anchorage Museum, B2016.003

1. When was the primary source created?
2. Write your initial impressions of the letter. Share with a partner:
    a. I read…
    b. I think…
    c. I wonder…
3. What details about the earthquake and its aftermath stand out to you? Why do you think Colleen chose to include those details in her letter?
4. Describe methods of communication during and after the earthquake.
5. Scientist Lens: In the letter, what details might an earthquake scientist notice? What conclusions about the earthquake can we draw from these letters?

ACTIVITY 5 cont.

Primary Source #3:

Andrea Ramsey letter from the Andrea Ramsey 1964 Earthquake Collection; Anchorage Museum, B2017.003

Accompanying photographs from the Andrea Ramsey 1964 Earthquake Collection

- B2017.001
- B2017.002

1. When was the primary source created?
2. Write your initial impressions of the letter. Share with a partner:
    a. I read…
    b. I think…
    c. I wonder…
3. What can this letter teach us about earthquake preparation and response?
4. What do you notice about the accompanying photographs?
5. Based on the photographs, what are some specific concerns the Ramsey family may have had during and after the earthquake?
6. Scientist Lens: In the letter, what details might an earthquake scientist notice? What conclusions about the earthquake can we draw from these letters?

PROMPT **As primary sources, what are the strengths and weaknesses of personal letters like these?**

2018 ANCHORAGE EARTHQUAKE

An M7.1 earthquake shook Southcentral Alaska on November 30, 2018 at 8:29 a.m. AKST. The earthquake occurred 11 km (7 miles) north of Anchorage at a depth of about 43 km (27 miles). Within 18 days of the earthquake, nearly 5,000 aftershocks in the Southcentral area had been registered by seismic sensors.

This earthquake caused structural damage to some roads and buildings, but there were no fatalities. The 1964 earthquake was far more destructive because it released more than a thousand times more energy and shook the region for far longer than the 2018 earthquake. While the 1964 earthquake was the result of major tectonic plate interactions, the 2018 earthquake was caused by the tearing of a much smaller section within the Pacific Plate. However, the 2018 earthquake is classified as 'major' by seismologists and earthquakes of similar magnitudes have caused massive devastation in other parts of the world. Lessons learned from the 1964 quake and the adoption of strict building codes prevented more widespread destruction.

ACTIVITY 6

On December 7, 2018, the Anchorage Museum hosted Unbound: Poetry on Demand, where ten Alaska-based poets provided a poem, inspired by a word or phrase they received from museum participants, in real-time. Copies of poems were collected and compiled by the Anchorage Museum to be preserved in the archives. For each poem, encourage students to read closely, and answer the guiding questions below.

TREPIDATION

Yaa kanagwátl yá Lingítaaní
this world is spinning.
Think about a stopping point,
or even a pause, when
the oscillation might give way
to still ness.

I close my eyes and count
between the tremors,
hesitate to let out a breath
in hopes that my motion is linked.

The limbs of the trees hold no snow,
And the days reach their ends
As we tremble yet again.

--X'unei Lance Twitchell

1) What do you notice?
2) What imagery does the poet use?
3) How does this poem relate to earthquakes?

ACTIVITY 6 cont.

HIGHWAY
(FOR KRISTEN)

What is a highway
but a spine – verterba
of Subarus, Toyotas, Dodge
trucks – each filled with bones
that touch steering wheels,
each a slight curvature of
earth, hope, time paused
with a collective breath:
collective groan of the body:
collective melting of ice in fear
as vehicles, (bones) bend under
the weight of unseen breaking.
What is a highway but a spine,
but proof of this planet, our
connection to one another: so many frightened pieces
of a whole?

--Tara Ballard

1) What do you notice?
2) What do you notice about the title, form, and shape of the poem?
3) How does this poem relate to earthquakes?

ACTIVITY 6 cont.

MOTHER EARTH BREATHES

The morning was normal.
I was sighing, the cat
was snoring, the snow
was sleeping. The breath
of the day was morning-light.
breathing is never silent,
yet, its quietness tricks
me into the elephants, the seals,
the salmon. Mother Earth
breathes and my body
recalls the shift
of ancient ground
that birthed us, when
Earth broke us into being,
into a billion linked
fragments, our breath
our bond.

--Joanna Lilley

1) What do you notice?
2) Which poetic devices (enjambment, personification, etc.) does the poet use, and what meanings does it create for the poem?
3) How does this poem relate to earthquakes?

PROMPT **Do you consider these poems to be primary sources? Why or why not?**

PROMPT **As primary sources, what are the strengths and weaknesses of poetry?**

ACTIVITY 7

Have students reflect on the November 2018 Anchorage earthquake or interview someone who experienced the earthquake.

Have students ask questions like the following and write down answers:

- *What happened?*
- *Where were you (they)?*
- *Who were you (they) with?*
- *What were you (they) doing during the earthquake?*
- *What did you (they) do after the earthquake?*
- *How did you (they) feel?*
- *What damage did you (they) see?*
- *What was it like the day after the earthquake?*

PROMPT **Write your own poem about the earthquake experience. Utilize your notes from questions above as inspiration.**

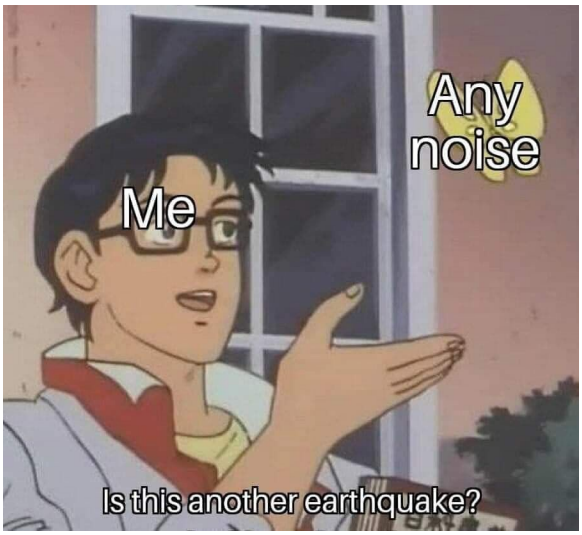
ACTIVITY 8

The November 2018 earthquake produced a variety of memes that went viral in social media. Explore memes and look closely at examples of Alaska's earthquake memes collected by the Anchorage Museum.

Terms

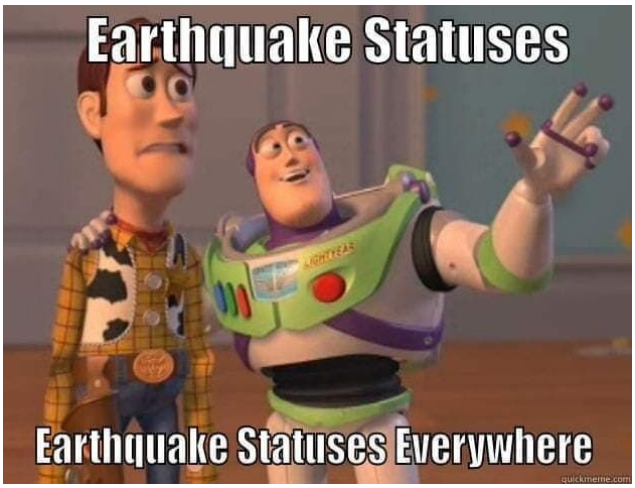
Meme an idea, style, or behavior that spreads from person to person in a culture. In the 21st century, a meme often refers to an internet meme – which is often represented as an image, video, or text and shared rapidly through social media

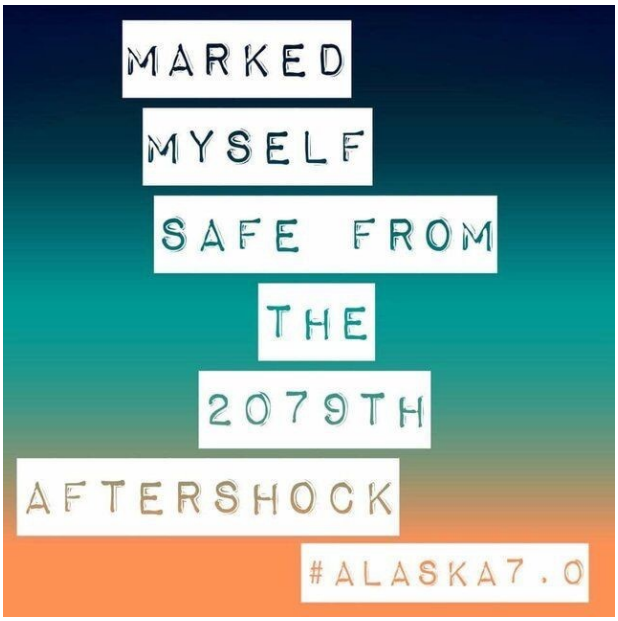
PROMPT **Write down your definition for meme or draw a meme you like or have encountered**



PROMPT **What conclusions about the earthquake can we draw from these two memes?**

ACTIVITY 8 cont.





PROMPT **What conclusions about the earthquake can we draw from these two memes?**

PROMPT **Are these memes primary sources? Why or why not?**

PROMPT **How might memes or social media in general be helpful for communication in the aftermath of an earthquake? How might memes or social media be harmful for communication?**

PROMPT **Create a meme inspired by an earthquake experience or based on an interview with someone who has (could use notes from Activity 7). Sketch an image and write an accompanying text.**

PART III: FUTURE EARTHQUAKES

Terms

Citizen science	the collection and analysis of data from the natural world by the general public often as a collaboration with professional scientists
USGS	the United States Geologic Survey, a nonpartisan natural science research branch of the US government, which is responsible for several earthquake monitoring programs
Emergency preparedness	the knowledge of and readiness for the hazards found in a particular community; includes the creation of response plans and the assembly of basic survival supplies for a disaster and its aftermath

Learn more about what to do in an earthquake from IRIS:

*https://www.iris.edu/hq/inclass/animation/earthquake_what_should_i_do_when_an_earthquake_strikes_*

ACTIVITY 9

The USGS runs a webpage called Did You Feel It? (DYFI) to help collect earthquake intensity data. Any citizen can contribute a DYFI report even if they did not feel the earthquake. The report combined with the contributors' geographic information helps the USGS understand how earthquakes are felt (or not felt) across geographic areas. Some example questions from this survey include:

- *How would you describe the shaking?*
- *How did you react?*
- *How did you respond?*
- *Did you hear creaking or other noises?*
- *Did pictures on walls move or get knocked askew?*
- Was there any damage to the building?

PROMPT **Why do you think USGS chose these questions? How might scientists use this information?**

PROMPT **The next time you feel or hear about an earthquake, contribute a report to the DYFI website.**

ACTIVITY 10

Encourage students to think about what they need to do to stay safe and connected to their loved ones during and after an earthquake.

PROMPT **What do you currently do to prepare for earthquakes and other emergencies?**

PROMPT **Based on what you have learned from the 1964 letters and 2018 earthquake experiences, what would you do to prepare for future earthquakes?**

PROMPT **What do you consider to be trustworthy sources of information during earthquakes and other crises? What makes those sources trustworthy?**

The following websites give information about earthquakes and emergency preparedness:

- *https://earthquake.alaska.edu/prepareHow did you react?*
- *http://www.muni.org/Departments/OEM/Prepared/Pages/EarthquakePrep.aspx*
- *https://www.usgs.gov/natural-hazards/earthquake-hazards/science/prepare?qt-science_center_objects=0#qt-science_center_objects*

PROMPT **Research earthquake emergency preparedness online and compile a list of resources or a pamphlet that you would give to someone who has recently moved to Alaska.**

FINAL NOTES AND DISCUSSION

Allow students time to reflect on what they have learned.

- What primary sources did they find interesting?
- What drew them to those sources?
- What surprised them or challenged them?
- What more would they like to learn?

For more teaching resources, visit ***anchoragemuseum.org/teachingresources*.**

Online Resources

Anchorage Museum Resource Center: *https://www.anchoragemuseum.org/collections/archives/*

Anchorage Museum Collections: *http://onlinecollections.anchoragemuseum.org/#/*

Smithsonian Arctic Study Center: *https://alaska.si.edu/*

Alaska's Visual Archives: *http://vilda.alaska.edu/*

Consortium Library 64 Earthquake Resources: *https://consortiumlibrary.org/blogs/64akquake/links/*

Incorporated Research Institutions for Seismology: *https://www.iris.edu/hq/*

Alaska Earthquake Center: *https://earthquake.alaska.edu/*

Bibliography

Books below are available at the Atwood Resource Center, Anchorage Museum.

EARTHQUAKES

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