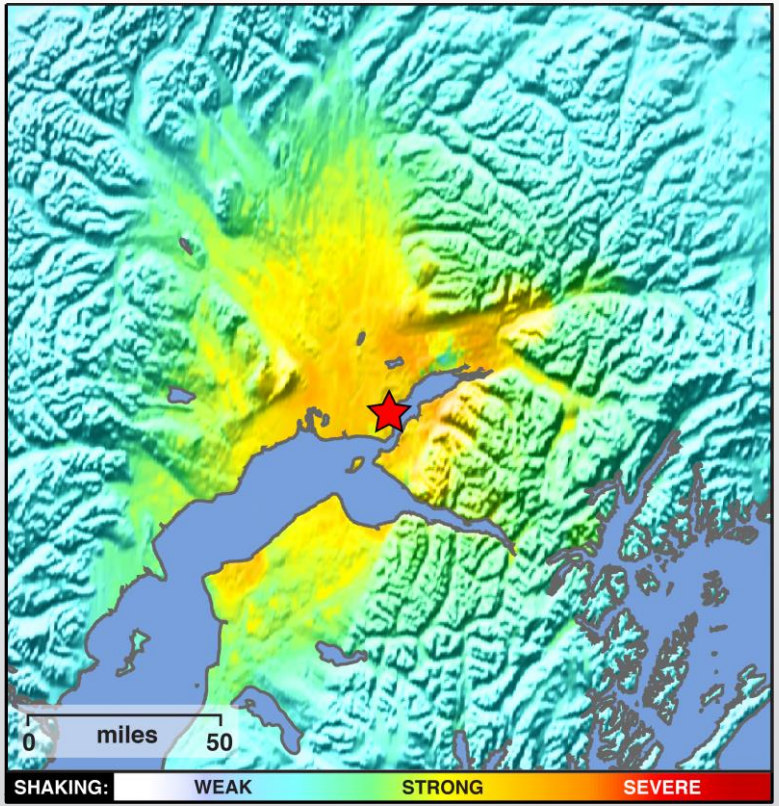
Alaska Earthquake Center response to the M7.1 November 30, 2018 Anchorage Earthquake

Dr. Natalia Ruppert




ALASKA EARTHQUAKE CENTER

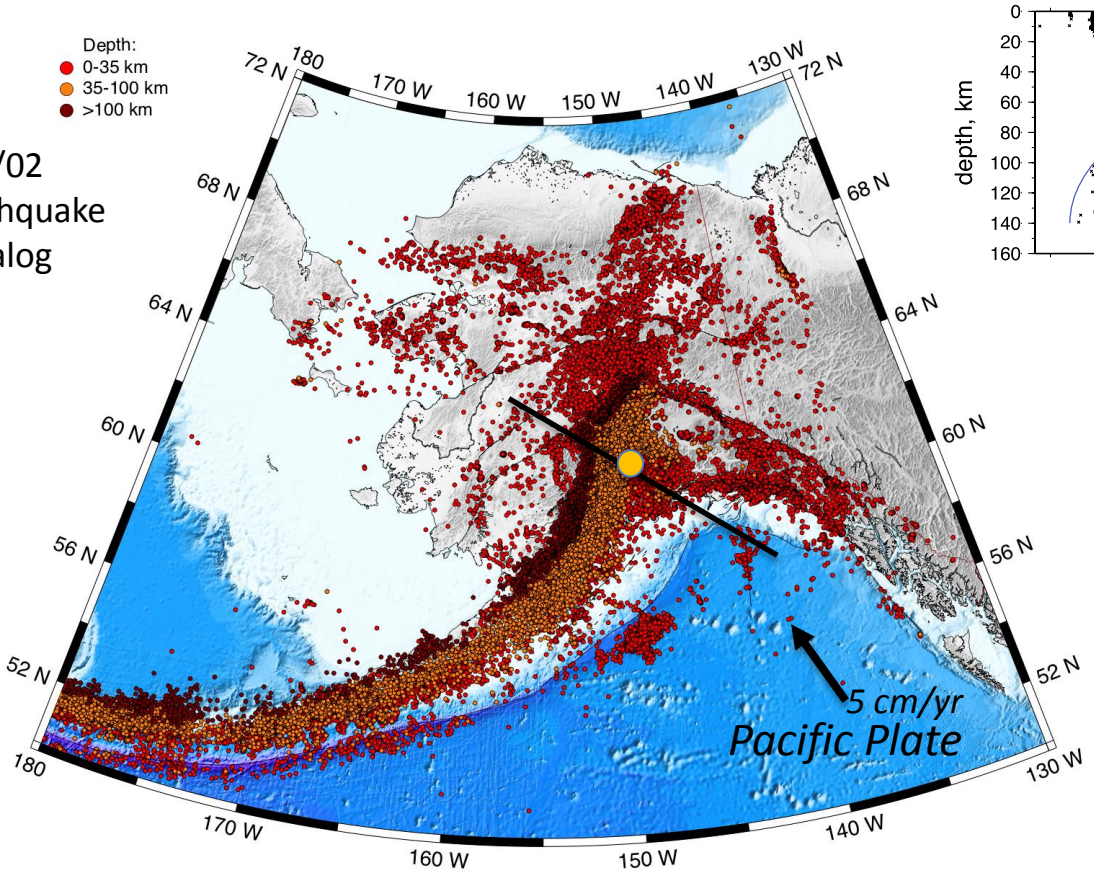
Impacts

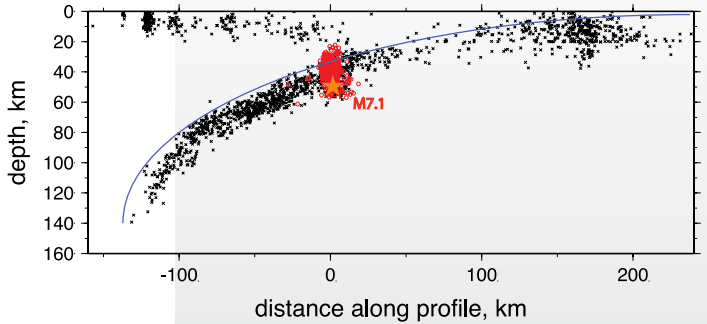


- The most damaging earthquake in Anchorage in over 50 years.
- It affected half of the state's population and is the most impactful earthquake in Alaska since the 1964 M9.2 event.

Tectonic Setting

2017-2019/02
Alaska Earthquake
Center Catalog





November 30, 2018 Mw=7.1 earthquake was a normal faulting intraslab event within the subducting Pacific plate.

Response focus areas for AEC

- Acquisition, archival and processing of strong motion data (Anchorage network and regional sites);
- Processing and reporting of aftershocks;
- Social media updates and interactions;
- Communicating with print, radio and TV media.

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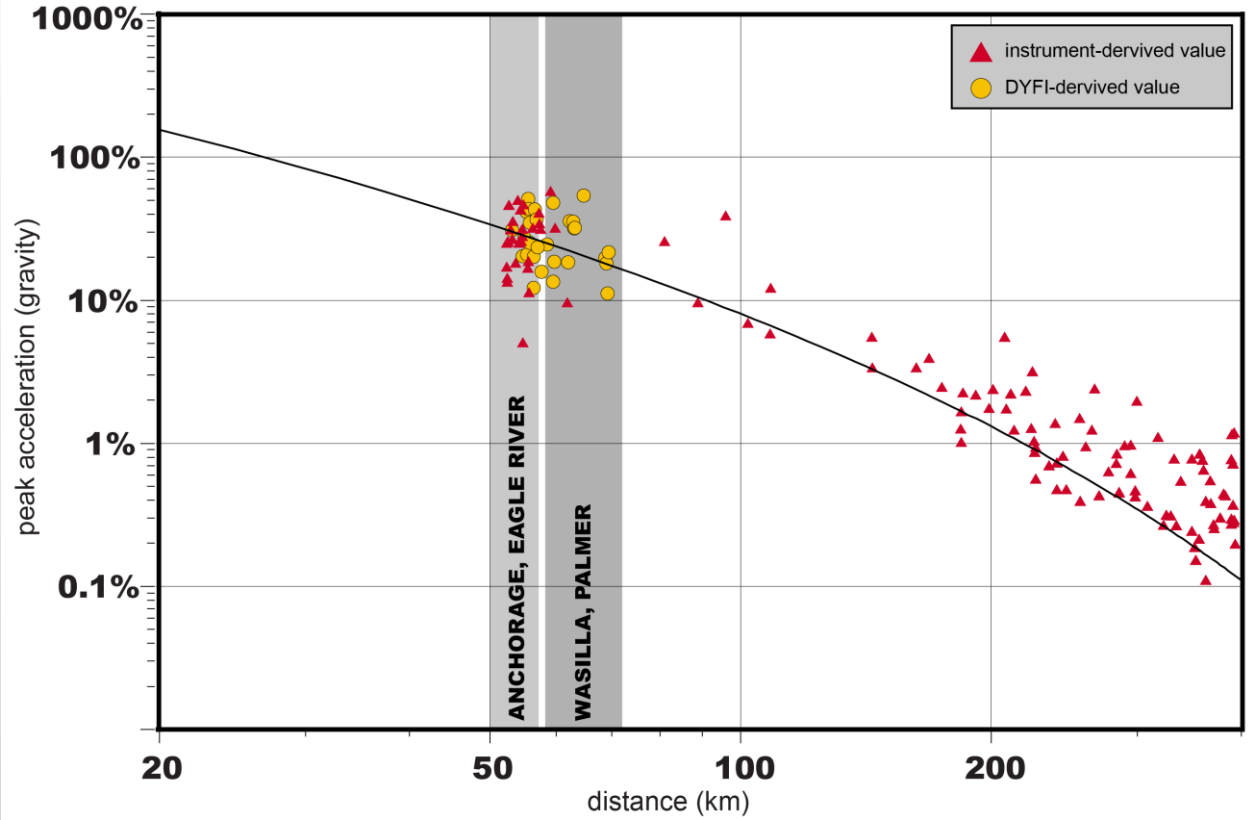
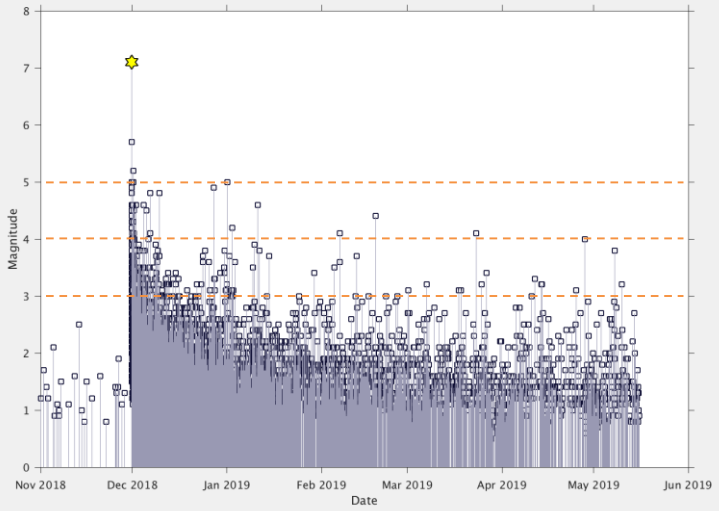
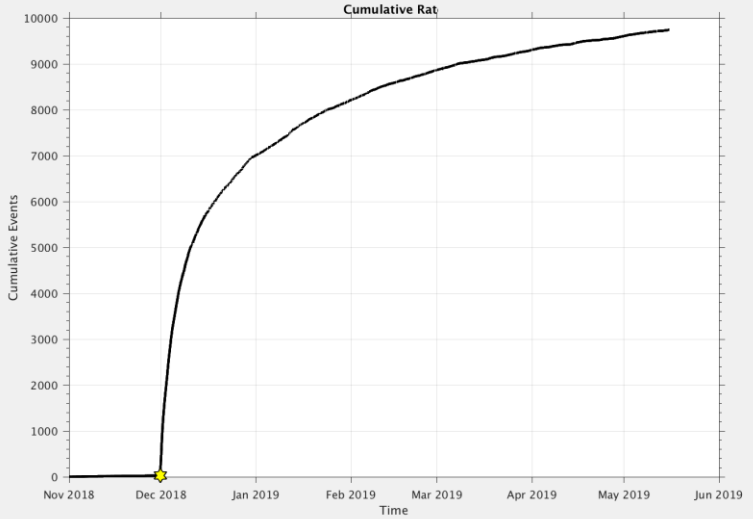
Strong Motion Recordings



Aftershock Processing

- ~9,900 aftershocks in 5.5 months;
- ~350 with M>=3 – felt;
- 42 with M>=4 (last one on April 28);
- 7 with M>=5 (last one on January 13);
- We estimate it will take 2.5 years before aftershock rate returns to the background level.





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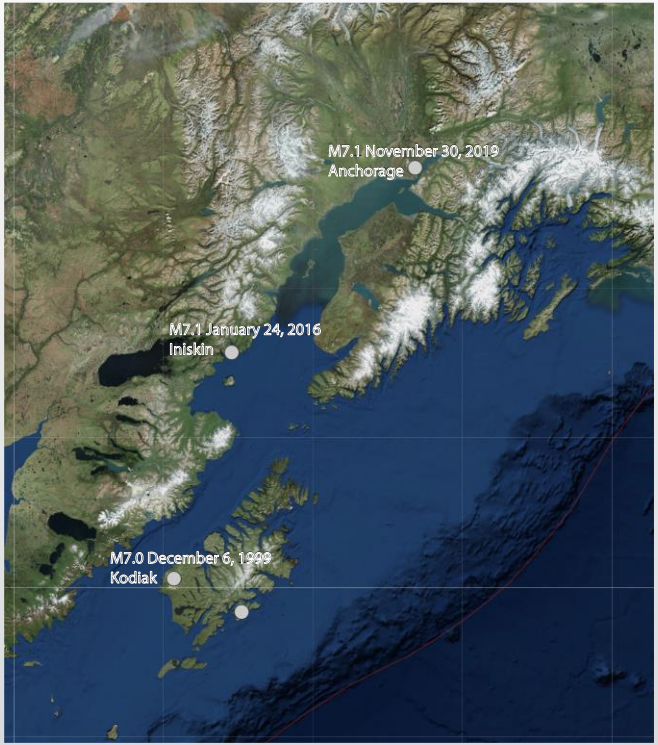
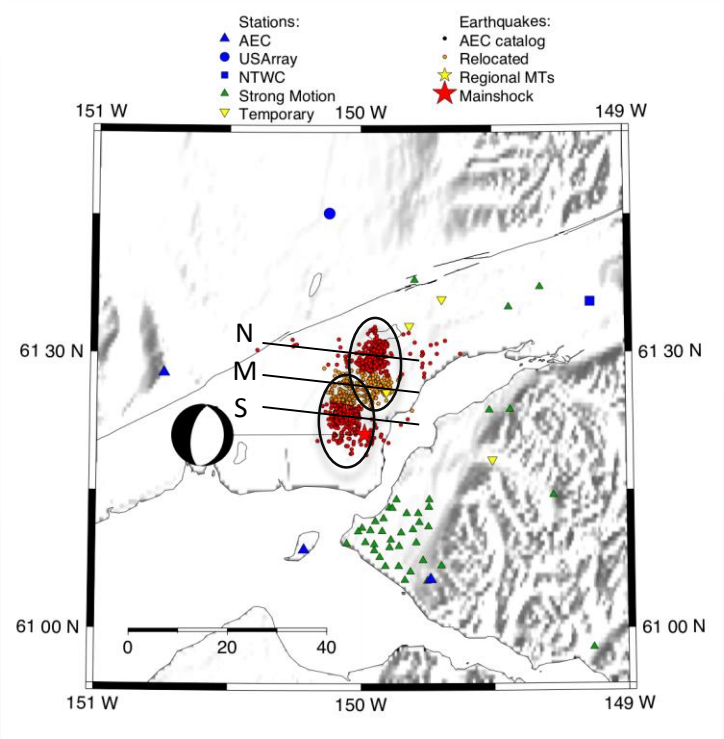
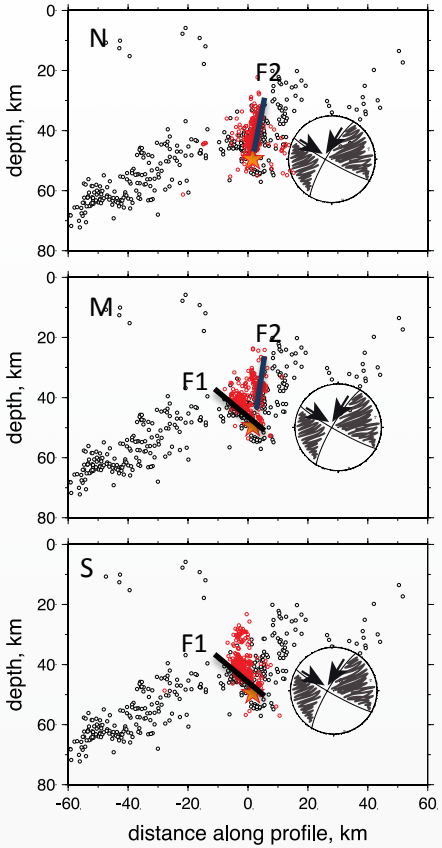
Southern Alaska Intraslab Earthquakes

	1999 Kodiak EQ	2016 Iniskin EQ	2019 Anchorage
Source mechanism	strike-slip	strike-slip	normal
Depth	46 km	126 km	47 km
Mw	7.0	7.1	7.1
Largest aftershock	6.4 and 6.5	4.7	5.7
M>=4 aftershocks	21	12	~40
Mc	1.9	1.8	1.4
b-value	0.6	1.05	0.75



Aftershock Relocations





Relocated background M>=2.5 earthquakes and ~900 aftershocks

Two trends are identifiable:
(1) East-dipping southern cluster and (2) nearly vertical west-dipping northern cluster.

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Future Work

Call for Papers: SRL Focus Section on the 30 November, 2018 Anchorage Earthquake

SEISMOLOGICAL RESEARCH LETTERS

Seismological Research Letters (*SRL*) announces a Focus Section on the 30 November, 2018 Anchorage earthquake. The M7.1 intraslab earthquake struck under Alaska's most densely populated urban area, and generated the strongest ground motions in south-central Alaska since the M9.2 Great Alaska Earthquake. The normal-faulting rupture originated inside the subducting Pacific Plate and generally propagated upward and northward toward the plate interface. The mainshock was followed by an extremely active aftershock sequence, with thousands of events recorded in the following months. Strong ground motions across the Anchorage and Matanuska-Susitna Valley areas caused major impacts to the built environment and local economy, estimated in the hundreds of millions of dollars. In this *SRL* focus section, we invite contributions from all fields addressing an array of topics including, but not limited to, the mainshock source, aftershock analysis, rupture propagation, ground motion observations, geodetic data analysis, geotechnical impacts to the built environment, ground failures, hydrologic response, tsunami assessment, etc. We also seek perspectives that address community preparedness, mitigation measures, resiliency to seismic hazards and lessons learned.

Guest editors for this focus section are:

Natalia Ruppert, University of Alaska Fairbanks, naruppert@alaska.edu
Robert Witter, US Geological Survey, rwitter@usgs.gov

Interested authors, please send inquiries and notices of intent to Natalia Ruppert at naruppert@alaska.edu

Important dates:

Submission Deadline: 19 July 2019 (early submissions are encouraged and will be processed immediately upon submission)
Acceptance Deadline: 1 November 2019
Published Issue: *SRL* January-February 2020

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Event time: 8:29:29 AKST

Text Message
Fri, Nov 30, 8:31 AM

aecrt@giseis.alaska.edu / EQ alarm 15660 / Ml 6.58, Nov 30th 17:29 UTC, 45.7 km, 18 ph., 13 km NNW of Anchorage

PRELIMINARY EARTHQUAKE PARAMETERS

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* The following parameters are based on a rapid preliminary assessment and changes may occur.

* Magnitude 7.2
* Origin Time 0829 AKST Nov 30 2018
  0929 PST Nov 30 2018
  1729 UTC Nov 30 2018
* Coordinates 61.3 North 149.8 West
* Depth 17 miles
* Location 30 miles SW of Palmer, Alaska
  10 miles N of Anchorage, Alaska

Is that real? 13km from Anchorage?

11/30/18, 8:33 AM

Yes, I felt it in Fairbanks.

AEIC Duty • 11/30/18, 8:35 AM

Yes. Felt it here too

Matt • 11/30/18, 8:35 AM

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Facebook, 8:31-8:35

Carrie Bon
November 30, 2018

That was massive in Kasilof

6 1 Share

Dori Tee-Cranmore
November 30, 2018

Lots of damage inside. Long and hard shaking in Wasilla off Seldon. Power is out

2 1 Share

Faith Emily
November 30, 2018

In eagle river. Everything came off the walls

4

Carey Lynne Cozelos
November 30, 2018

Huge quake on Mouldon our entire car, house, trees shook

7 1 Comment

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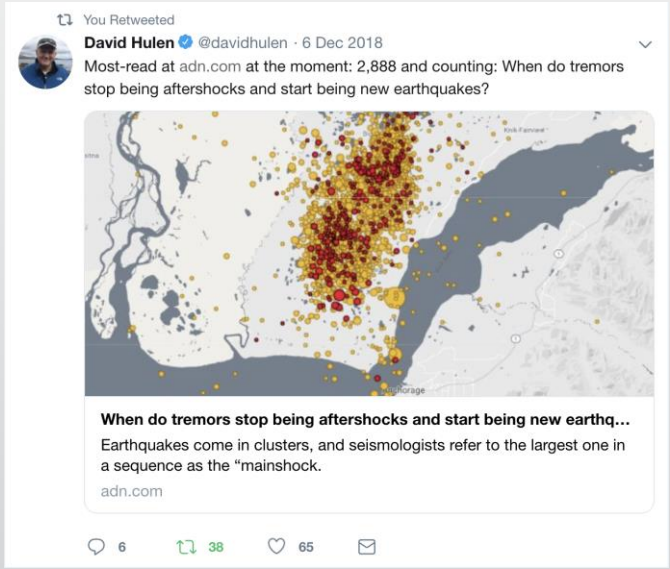
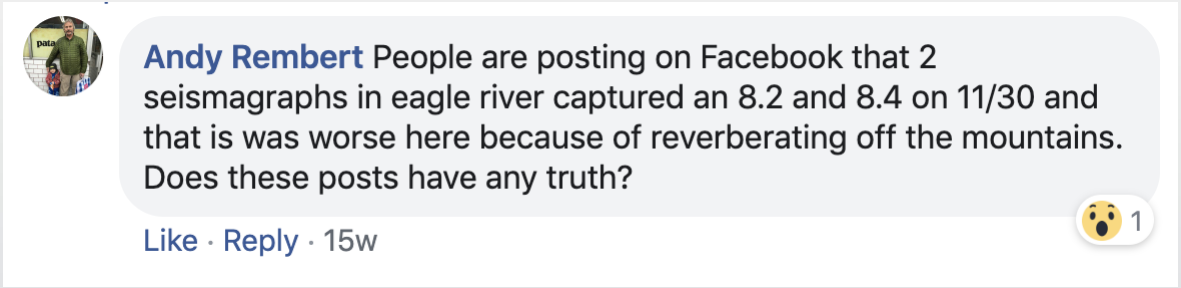
Twitter: How we use it

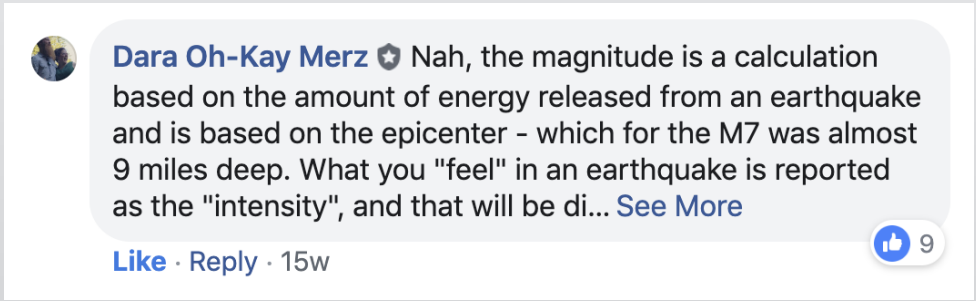
- 8K members before -> 13,095 after
- No automation
- Mostly one-way communication
- Engage reporters to improve sourcing of stories



Facebook: How it uses us

- 6K members before -> 12,837 after
- Responsive, two-way communication
- Discussion forum





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How was Nov. 30 different?

1. Chaotic information environment
2. Viral earthquake predictions
3. Months of felt aftershocks
4. Psychological impacts

1. Chaotic info environment

Chaotic info environment:

- News was scarce at first
  - Newsrooms were damaged
  - Power was out
  - Government was slower to communicate
- Massive influx of new users seeking info

How could we lessen chaos:

- Share basic earthquake info and set aftershock expectations
- Pass on credible news with added context
- Amplify announcements from city and state offices with much smaller audiences

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Amplification

You Retweeted

Chugach Electric @chugachelectric · 30 Nov 2018

Our outage map is working again, so you can track outages on our website. Crews will continue to assess and inspect, and restore power as they can. Our focus is on safety.

Outage map is here: chugachelectric.com/outages

3 49 55

You Retweeted

AK Regional Hospital @AlaskaRegional · 30 Nov 2018

Alaska Regional Hospital remains open and all of our patients and staff are safe. We are continuing to assess damage, however our emergency room remains open. All elective procedures have been cancelled through the weekend.

2 39 59

You Retweeted

Alaska DOT&PF @AlaskaDOTPF · 30 Nov 2018

Anchorage Shelter Update: The Dena'ina Civic and Convention Center has lost access to utilities. Those that are seeking shelter and cannot reach their home are now advised to make their way to the Egan Civic & Convention Center.

73 52

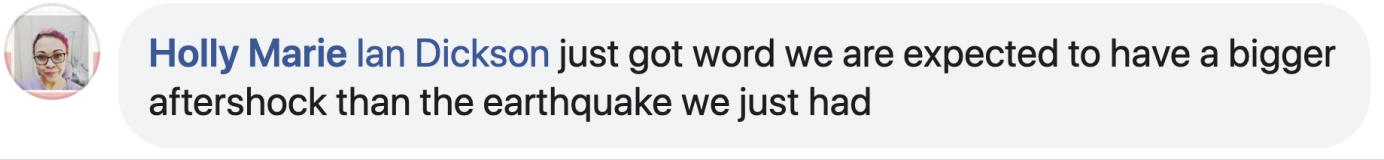
You Retweeted

Alaska DHSS @Alaska_DHSS · 30 Nov 2018

Natural disasters like today's Southcentral Alaska earthquake can be especially traumatic for children and youth. Here is some helpful information about how to reassure children from the National Association of School Psychologists,

2. Viral earthquake predictions

- Three instances:
  - One on Nov. 30 (origin unknown);
  - Two in January (quakeprediction.com).
- Predictions jumped from social media to print and television .
- Followers asked us directly to address the rumors.



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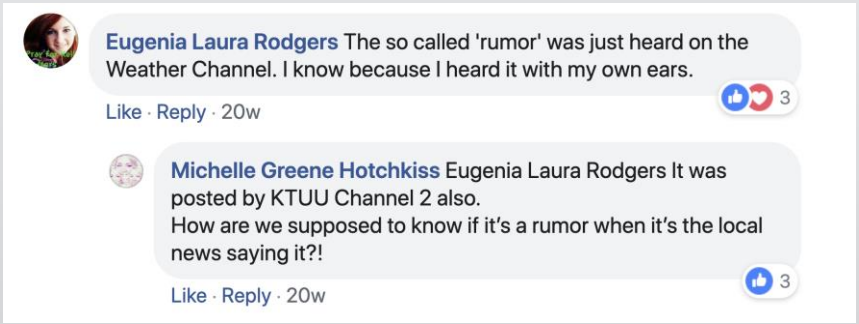
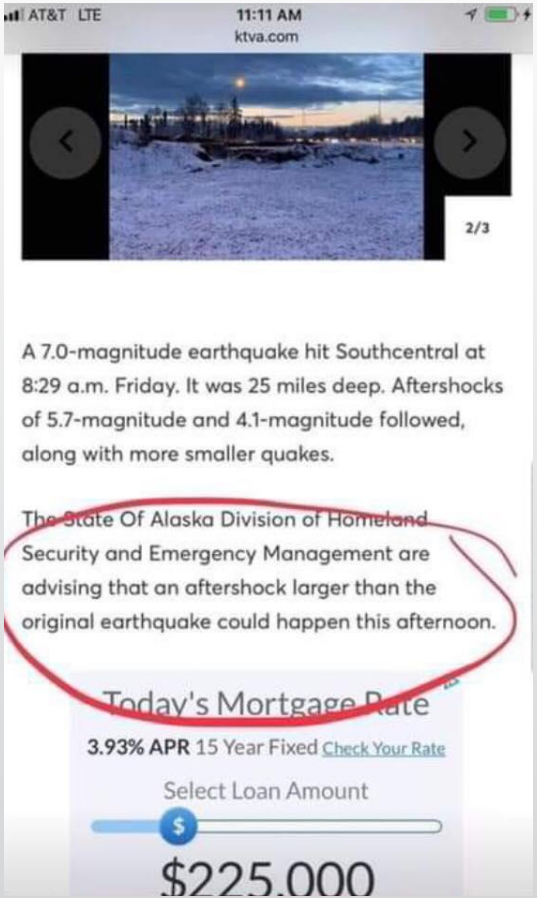
Three hours after the quake





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Responding

AK Earthquake Center @AKearthquake · 30 Nov 2018

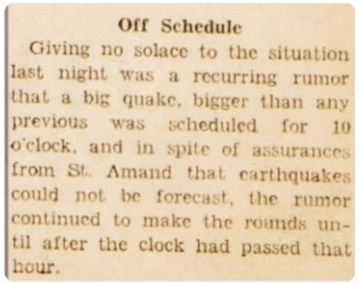
A message from Mike West, Alaska's state seismologist, concerning the false rumors about a predicted larger earthquake:

> There are a lot of rumors, especially out there in social media land, about a very specific large aftershock that some people have predicted including a timeframe. This rumor is entirely unfounded.
>
> What we DO know is that aftershocks will continue for quite some time. They will generally be smaller than what was felt this morning and, as time goes on, their rate of occurrence will decrease. Anytime an earthquake of this size occurs, there is a low but non-zero chance that another earthquake of similar or larger size could occur. That is true this time as well. However, detailed rumors about any particular earthquake are simply not true.

18 357 465

AK Earthquake Center @AKearthquake

Great find from UAF seismologist Carl Tape. This is from the front page of the October 16, 1947 edition of the @newsminer, concerning the M7.2 Healy earthquake. Sound familiar?



Off Schedule

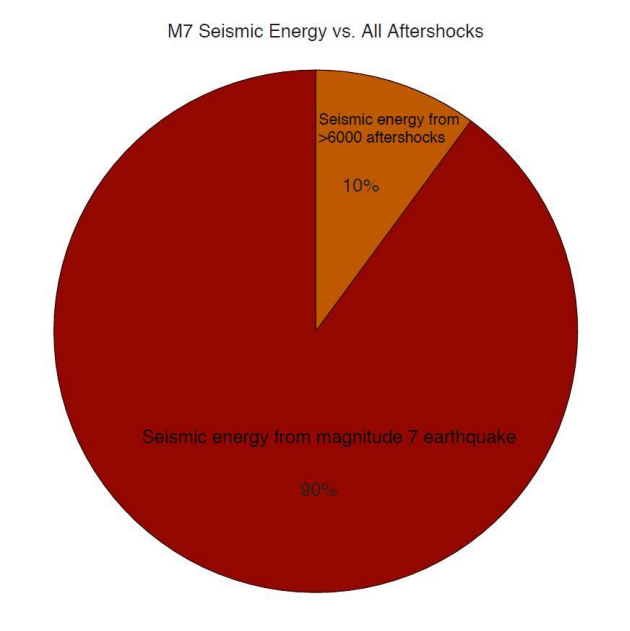
Giving no solace to the situation last night was a recurring rumor that a big quake, bigger than any previous was scheduled for 10 o'clock, and in spite of assurances from St. Amand that earthquakes could not be forecast, the rumor continued to make the rounds until after the clock had passed that hour.

Science

Prediction of another big Anchorage quake 'not founded in reality,' Alaska seismologists say

Author: Madeline McGee Updated: January 9 Published January 8

3. Many felt aftershocks



- Most people do not know what to expect from an aftershock sequence.
- People need confirmation and reconfirmation that the sequence is what we would expect.
- There is a strong desire for aftershock forecasts.
- The aftershock sequence generated far more work than the mainshock.

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4. Psychological impacts

AK Earthquake Center @AKearthquake · 30 Nov 2018

We tend to lean on the image of the resilient Alaskan, but some will be dealing with fear and anxiety from this earthquake for a while. If this describes you, know that a lot of people are in the same boat. It's a normal, common reaction to a very sudden, very frightening event.

17 126 356

Anchorage

Earthquake anxiety overwhelms some Anchorage mental health clinics already stretched thin

Author: Madeline McGee Updated: December 18, 2018 Published December 17, 2018

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Alaska DHSS survey

Did any of your children experience increased anxiety or other distress following the earthquake?

Answer Choices	Number	Percentage
Yes	985	59.16%
No	617	37.06%
I prefer not to say	63	3.78%
Answered	**1665**	
Skipped	**1355**	

Following the earthquake, have you had an increase in any of the following? (Select all that apply.)

Answer Choices	Number	Percentage
Worry	1620	54.92%
Trouble sleeping	1538	52.14%
Anxiety, fear, or distraction	1810	61.36%
Panic attacks	479	16.24%
None	653	22.14%
Other stress or mental health-related symptoms (please specify)	377	12.78%
Answered	**2950**	
Skipped	**70**	

Source here

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These are real impacts

Wendy McCabe It broke my heart hearing children terrified today at the community center on base.

Like · Reply · 19w

2

Christina Parrish I saw a therapist today & was prescribed anti-anxiety meds. Hoping this helps my nerves.

Like · Reply · 19w

3

Denise Maples Man I am not feeling safe

Like · Reply · 17w

1

I am really freaked out over all this. Is there anything you can say to me to make me feel better? I'm absolutely terrified and have had no sleep I can't take much more

Olive Anderson Henninger Stacy Stinson yeah I'm the same way. I cant relax at night. I hate the anticipation.

Like · Reply · 19w

2

Melodee Mc Intyre Darlene Fischer I had PTSD before the quakes, now I'm a complete basket case

Like · Reply · 16w

4

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Two lessons

- We should cultivate working relationships with social media people from emergency management and other government sectors.
- We make it our business to talk about preparedness for physical impacts. There is a need for more public discussion of psychological impacts.

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Reactions

Kathryn L. Bolak I'd to express my gratitude and appreciation for all the work you and your crew are doing here to keep us updated. You've significantly helped to alleviate the stress and worry many of us have been experiencing with all these aftershocks. I hope you have a wonderful Christmas!!!💖🎄⛄

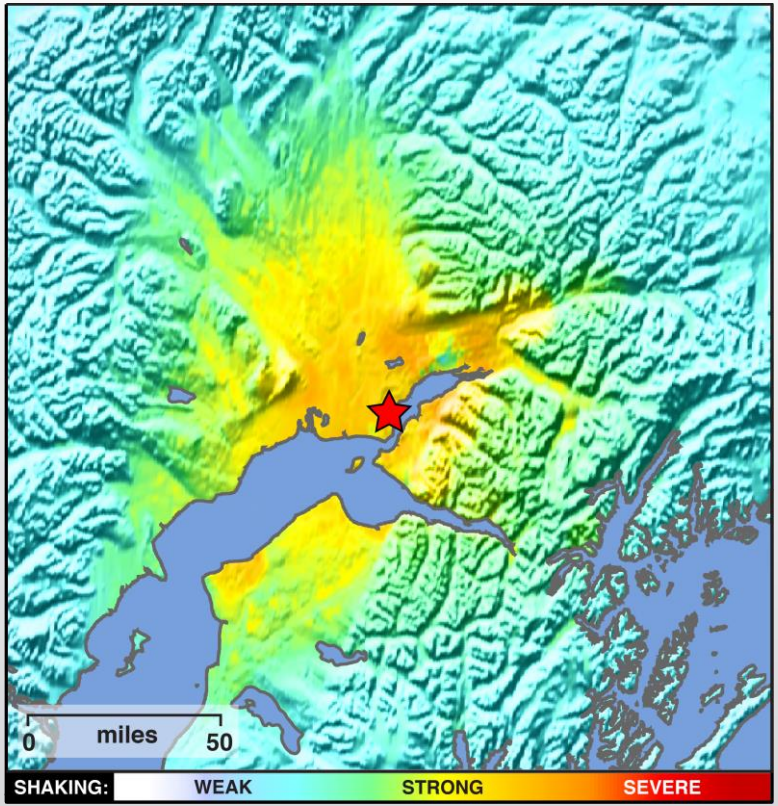
Like · Reply · 17w

8

Jolene Thomas Thank you Ian and you're crew. Definitely the place I go to check up on the quakes. It's been great to have this place to get accurate information, knowledge, and other people sharing how they feel. It's been super comforting during this time - definately made it easier. Thank you

Like · Reply · 14w · Edited

3



- Questions?

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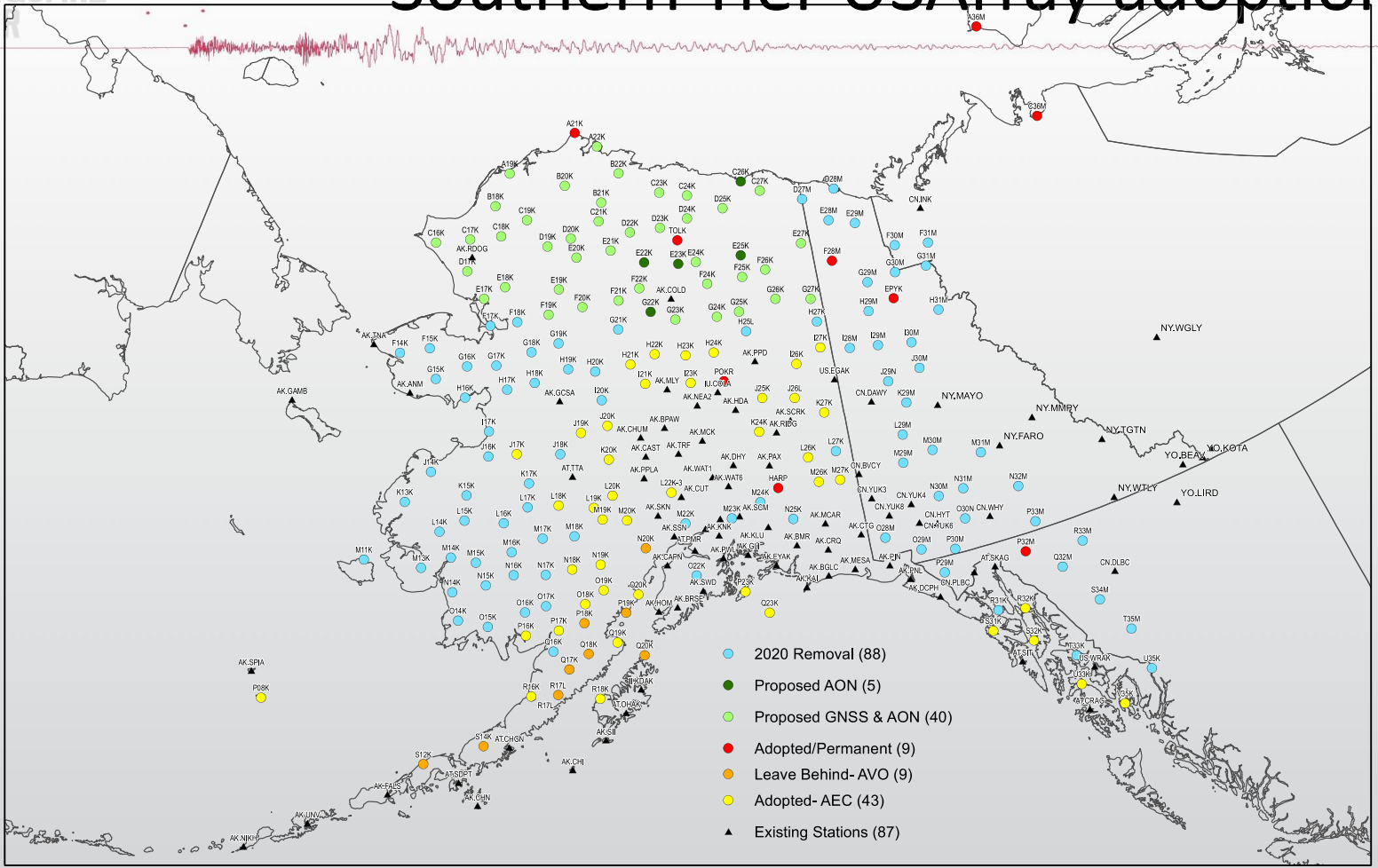
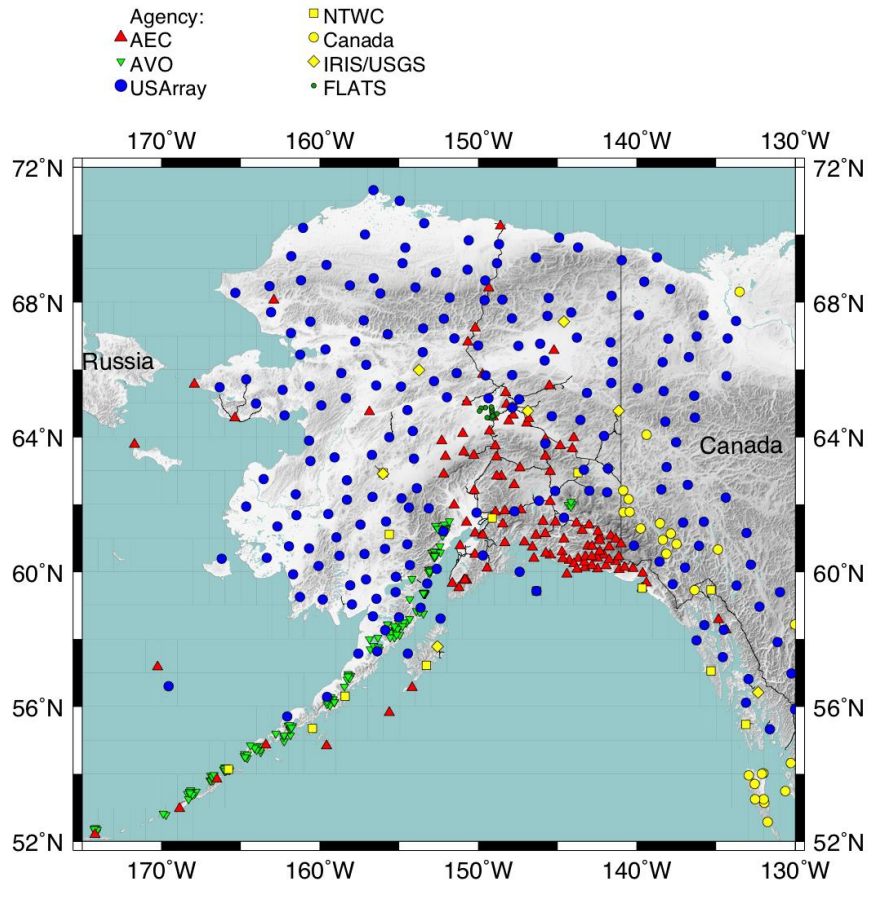
Southern Tier USArray adoptions




Agency:
AEC
AVO
USArray
NTWC
Canada
IRIS/USGS
FLATS
170°W
160°W
150°W
140°W
130°W
72°N
68°N
64°N
60°N
56°N
52°N
Russia
Canada

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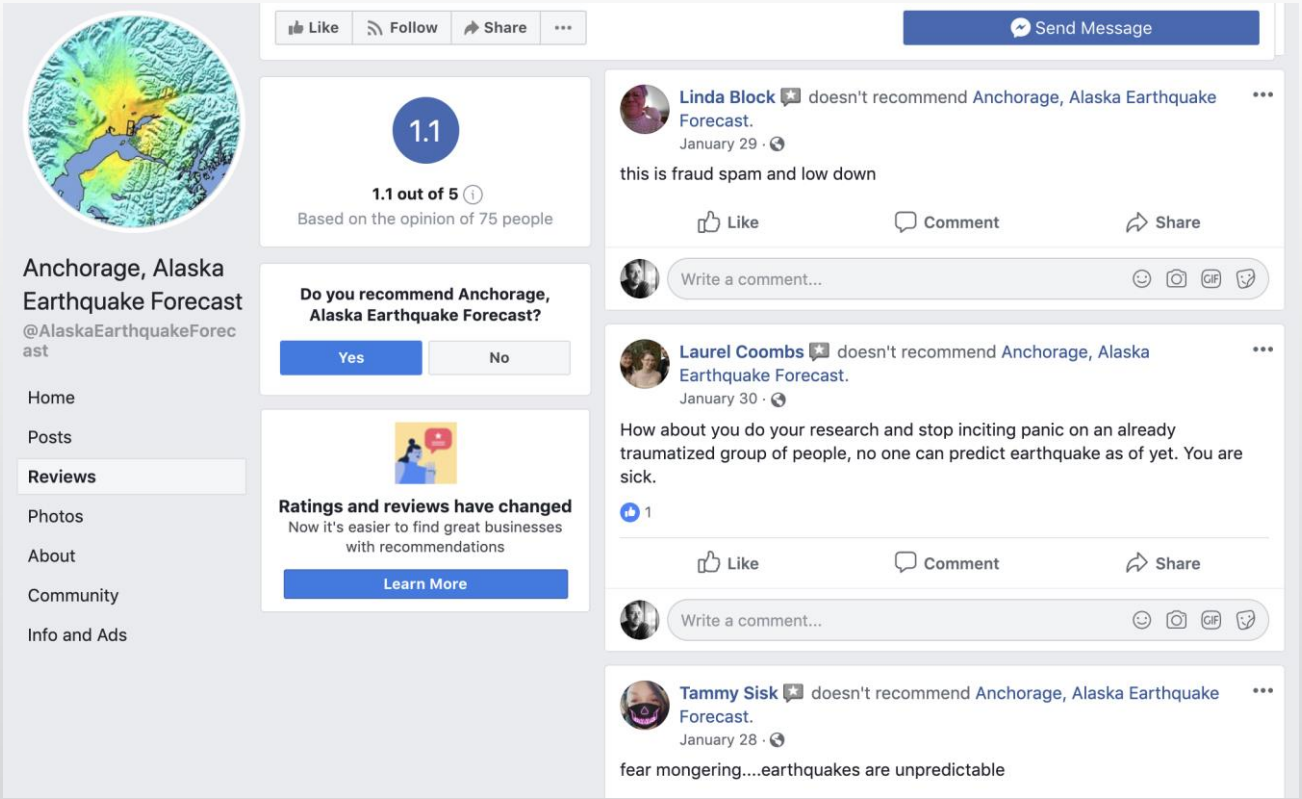
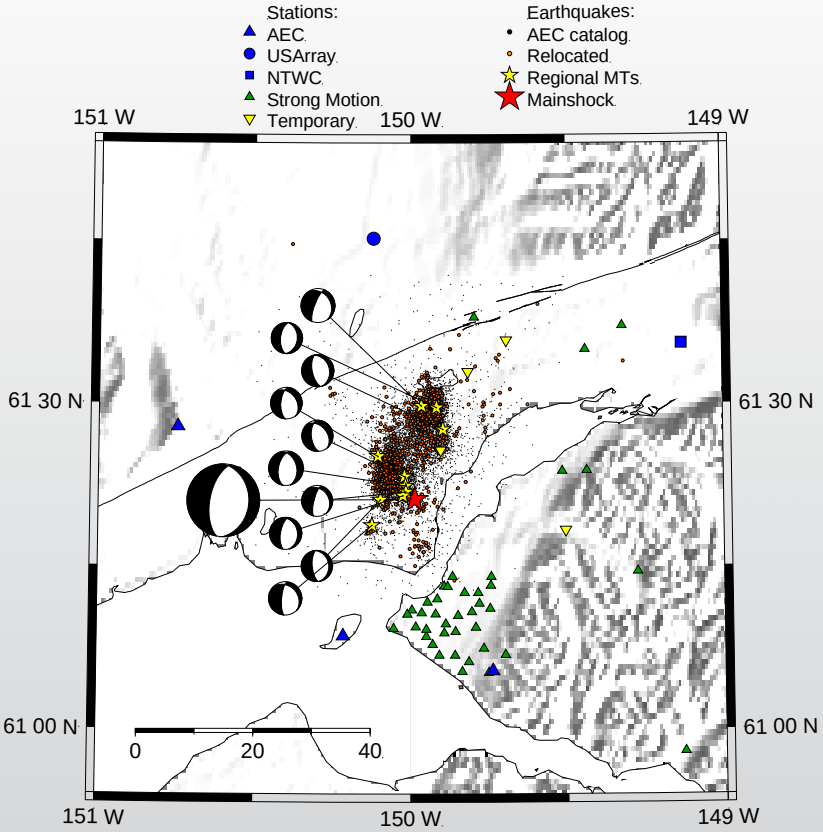
Take that L, quakeprediction.com



Aftershock Moment Tensors



- The resulting focal mechanisms are remarkably similar with no systematic differences between those located within the northern and the southern segments.

Discussion: Two fault segments or one?

Two fault segments:

- Aftershocks form 2 clusters with different dipping angles: shallower-east-dipping southern cluster and steep west-dipping northern cluster.
- Finite source modeling indicates 2 pulses of energy release 4 sec apart, possibly related to first coming from the southern and second from the northern fault segments.

Single fault plane:

- Finite fault modeling (NEIC; Liu et al., 2019) indicates that the data can be fit well with a single fault plane.
- Mainshock and aftershock fault plane solutions are remarkably similar with no systematic differences between the northern and southern clusters.

East- or west-dipping fault plane?

- NEIC finite model: East-30 degree-dipping plane is preferred.
- Liu et al: West-65 degree-dipping plane is preferred.
  (Both east and west-dipping planes match main characteristics of the geodetic and seismological observations, and the difference in fitting errors is very small. However, west-dipping plane is found to better explain details of teleseismic data. The hypocenter, however, is much deeper than any other studies indicate and slip region does not coincide with the aftershock region.)

- If assume a single fault plane, what does complexity in the aftershock distribution indicate?

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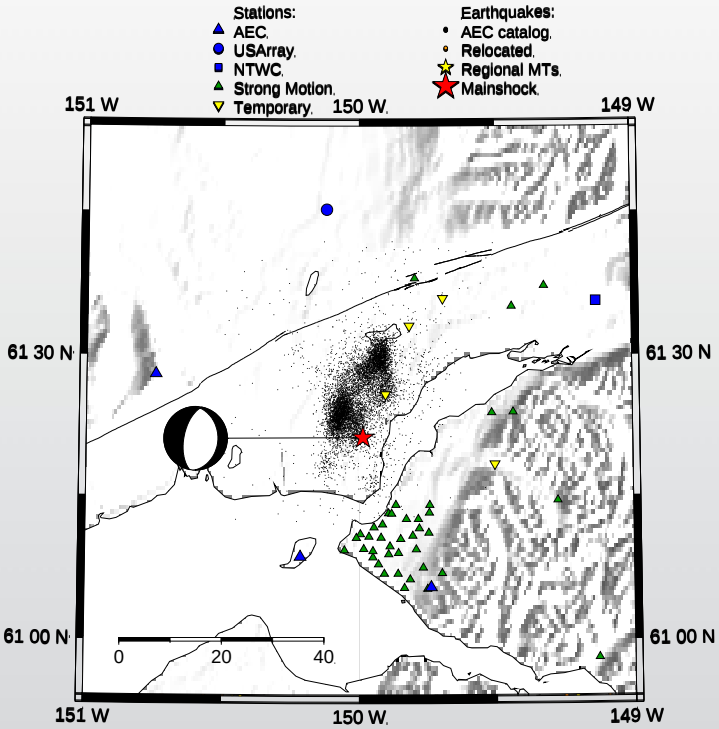
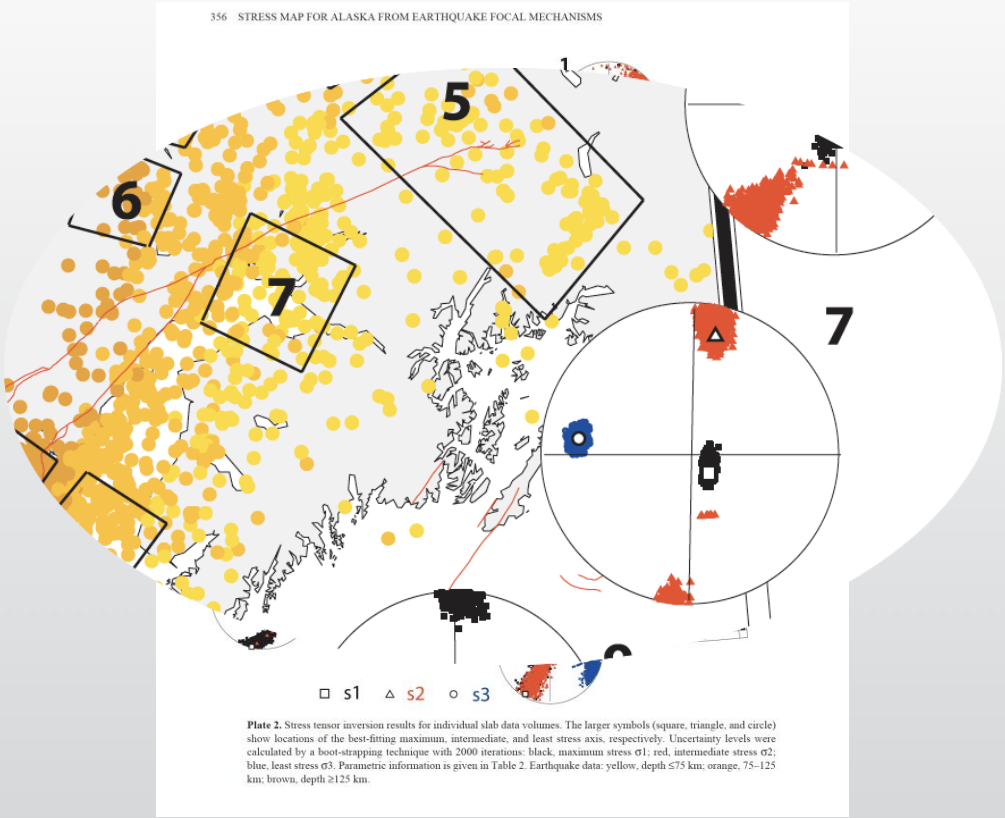
Conclusions

- The November 30, 2018 Mw 7.1 Anchorage earthquake was the most impactful in Alaska in over 50 years.
- The mainshock generated a vigorous aftershock sequence with over 9,000 aftershocks with magnitude of completeness of 1.4 reported by the Alaska Earthquake Center within first 4.5 months. Over 300 aftershocks were felt.
- The aftershocks form two distinct clusters: shallower-east-dipping southern cluster and steeply-west-dipping northern cluster. The southern cluster aligns with one of the nodal planes of the mainshock. The aftershock zone is 20 km wide and 25 km long.
- Fault plane solutions for the mainshock and aftershocks are remarkably similar and do not indicate any systematic differences between the southern and northern clusters.
- We expect aftershock sequence to continue for at least a year.




Tectonic Setting cont.

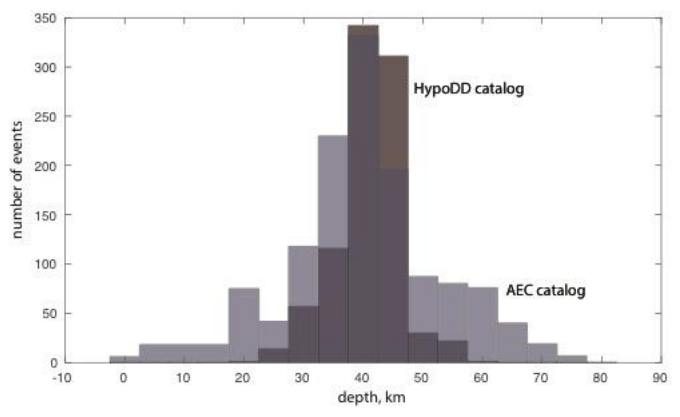




Ruppert, 2008

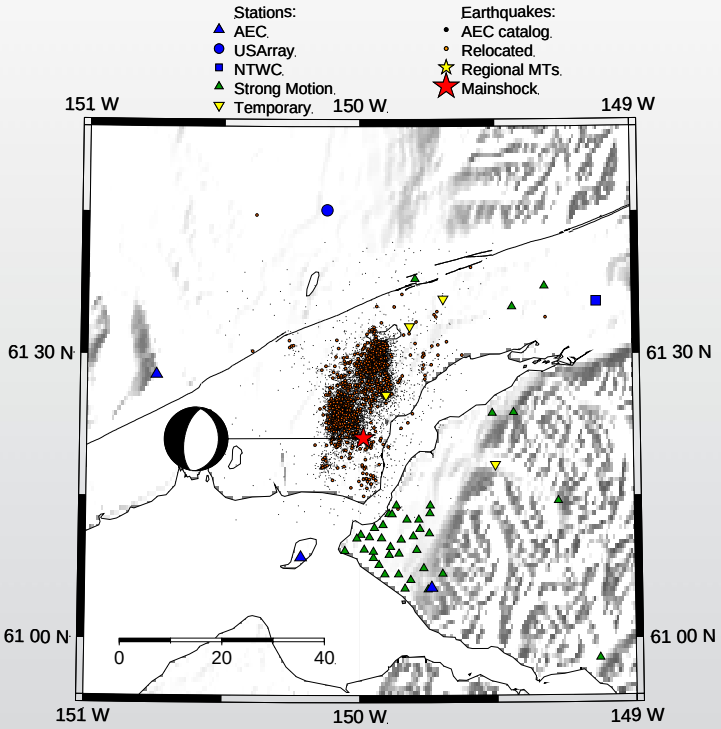
Aftershock Relocations

	AEC catalog	hypoDD
Depth range all	1-77 km	22.2-61.3 km
Depth range d_5-d_{95}	19-62 km	30.5-48 km
Mainshock	46.7 km	49.5 km



- ~900 M>=2.5 relocated aftershocks.
- The relocated aftershock depths range between 22.2 and 61.3 km, with 95% of events being below 30.5 km or above 48.0 km.
- The aftershocks clearly fall within the seismically active part of the subducting Pacific plate beneath Anchorage. The mainshock is located at 49.5 km depth near the deepest and southernmost extent of the aftershock zone.

Aftershock Relocations



- We use double difference relocation algorithm hypoDD (Waldhauser and Elsworth, 2000) to relocate ~900 M>=2.5 aftershocks and ~600 background M>=2.5 earthquakes that occurred within the past 10 years.
- In additional to regional seismic stations, we incorporate picks from the Anchorage strong motion network and temporary USGS aftershock monitoring sites.
- The relocated aftershocks do not align along a single plane but rather form two distinct clusters.