FEMA

DES Montana Disaster & Emergency Services

2025 Montana Geohazards Workshop

Kalispell – May 8-9, 2025

Workshop Day 1 (May 8) Presentations

MBMG

Montana Bureau of Mines and Geology

Seismic Hazards in Montana

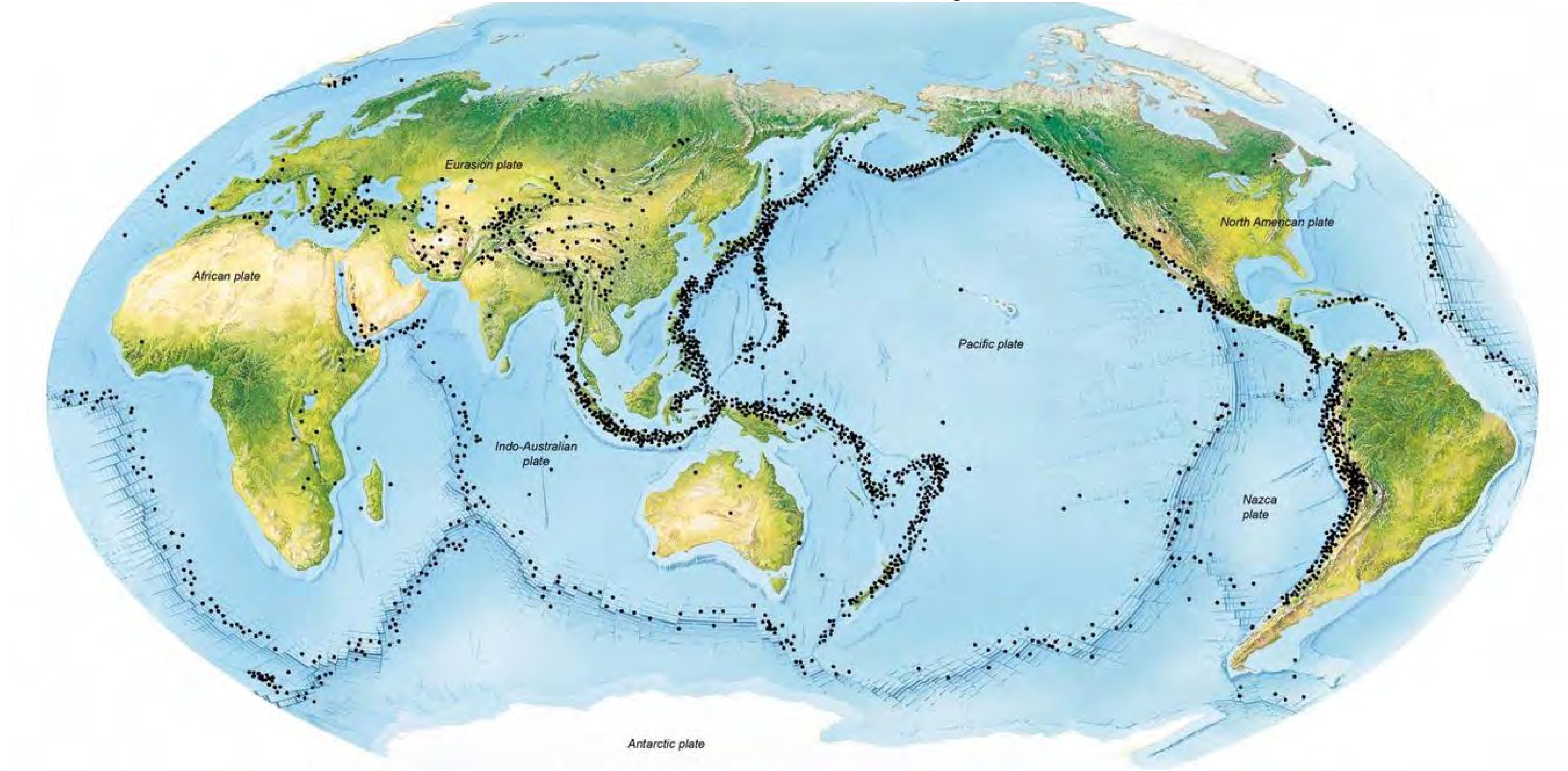
Mike Stickney
Earthquake Studies Office
Montana Bureau of Mines and Geology

Kalispell Geohazards Workshop
May 8, 2025

Global seismicity

90% occurs on plate boundaries

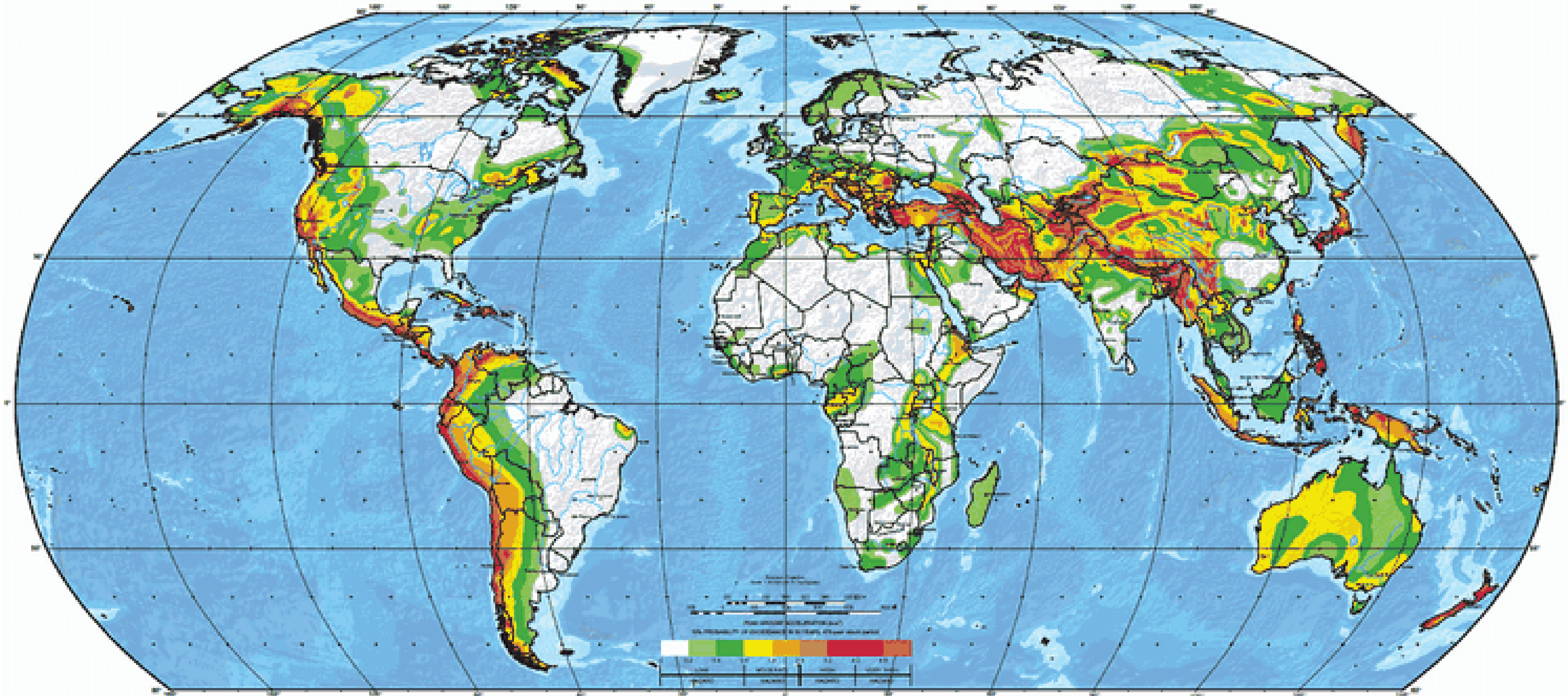
80% occurs on the Pacific Ring of Fire



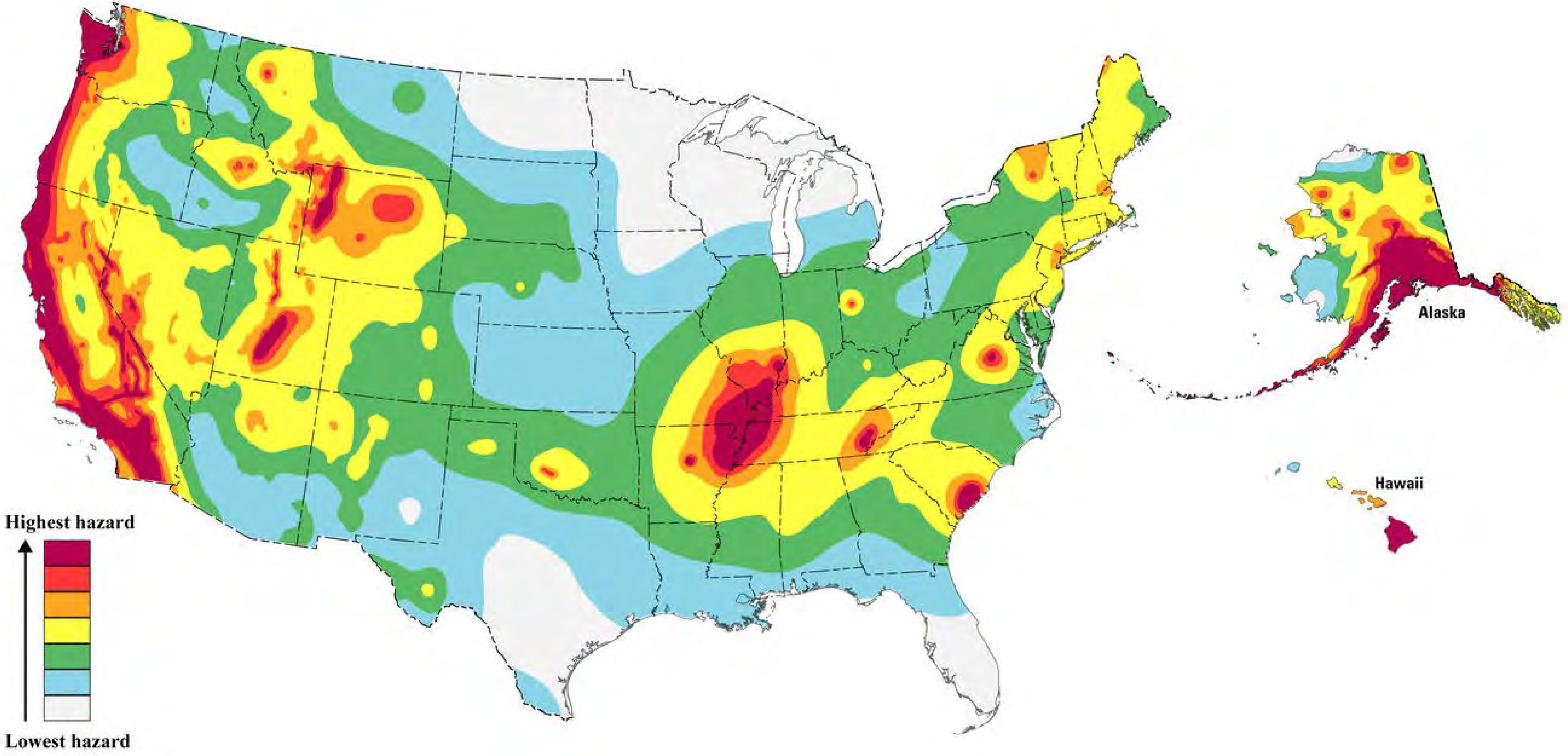
GLOBAL SEISMIC HAZARD MAP

Produced by the Global Seismic Hazard Assessment Program (GSHAP),
a demonstration project of the UN/International Decade of Natural Disaster Reduction, conducted by the International Lithosphere Program.

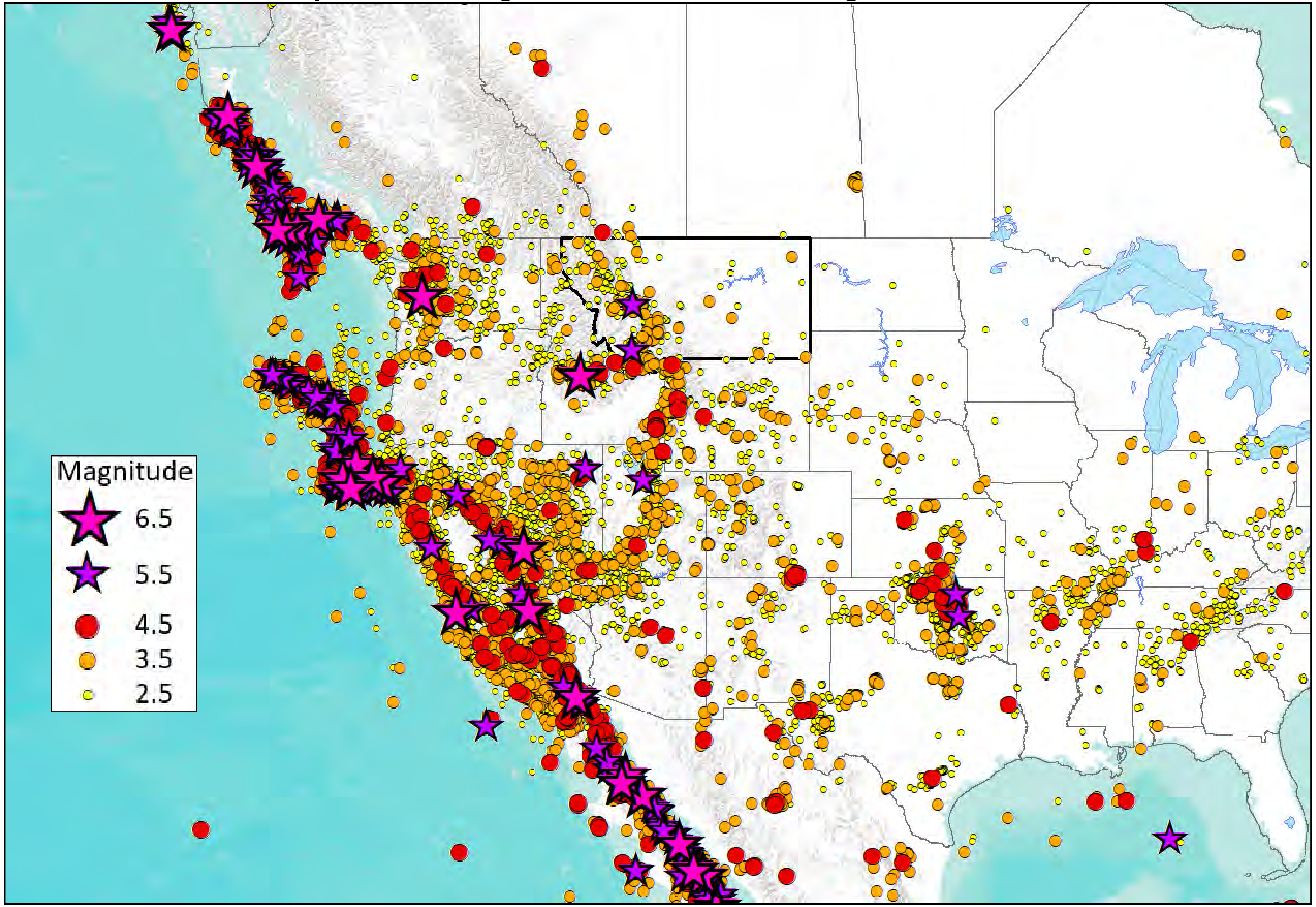
Global map assembled by D. Giardini, G. Grünthal, K. Shedlock, and P. Zhang
1999

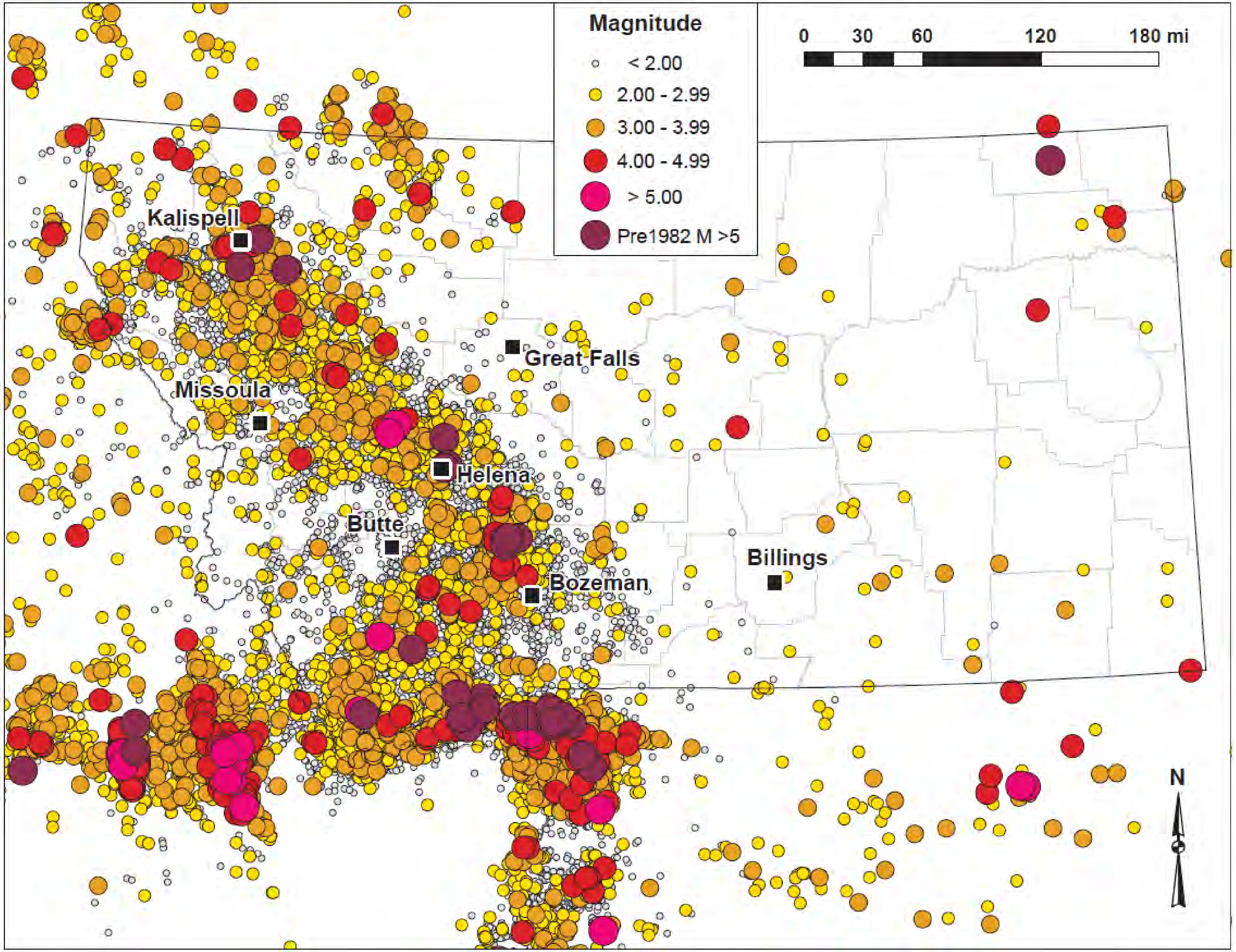


Hazard map from the 2023 50-state update of the National Seismic Hazard Model Project



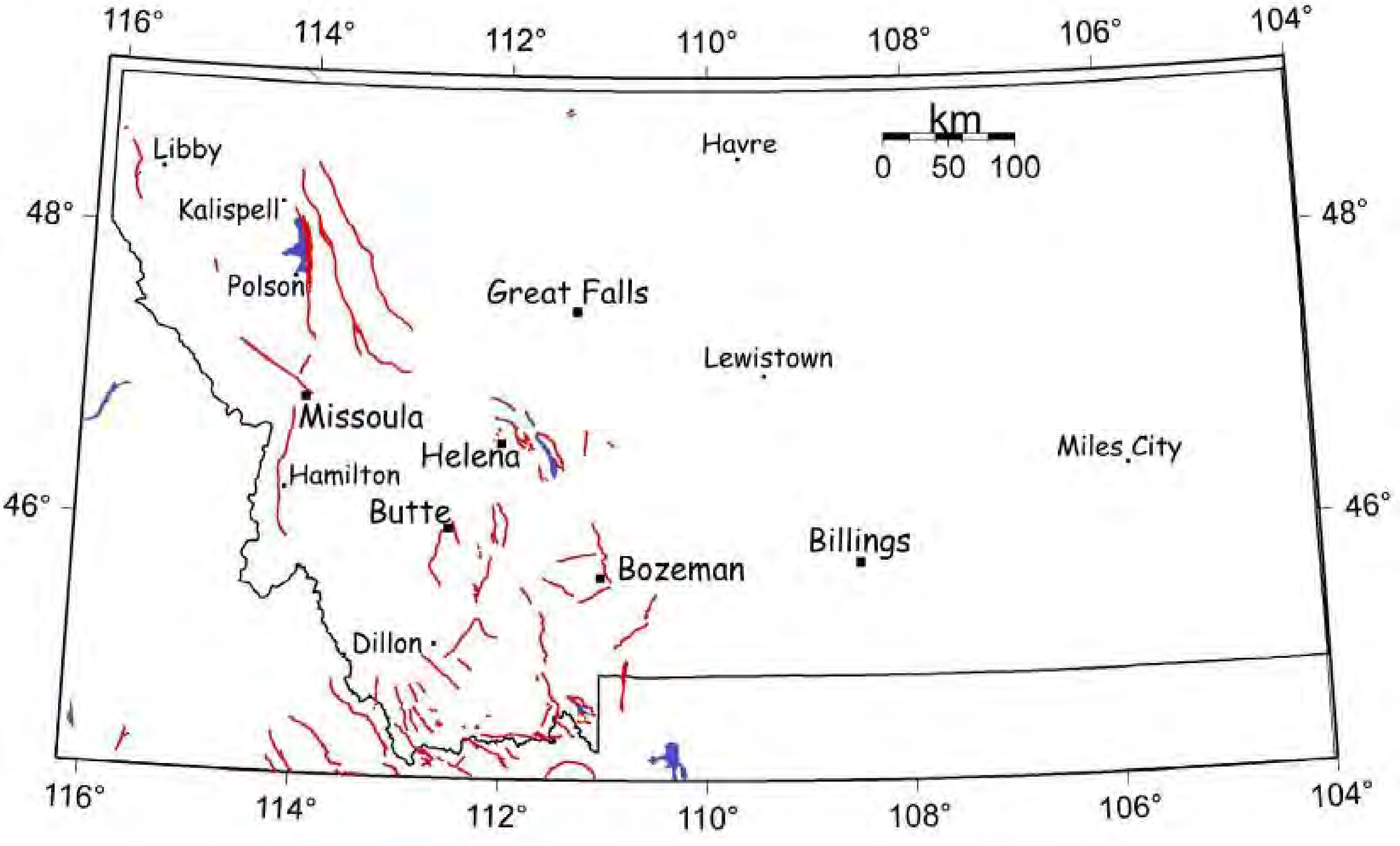
Earthquakes magnitude 2.5 and larger since 2000





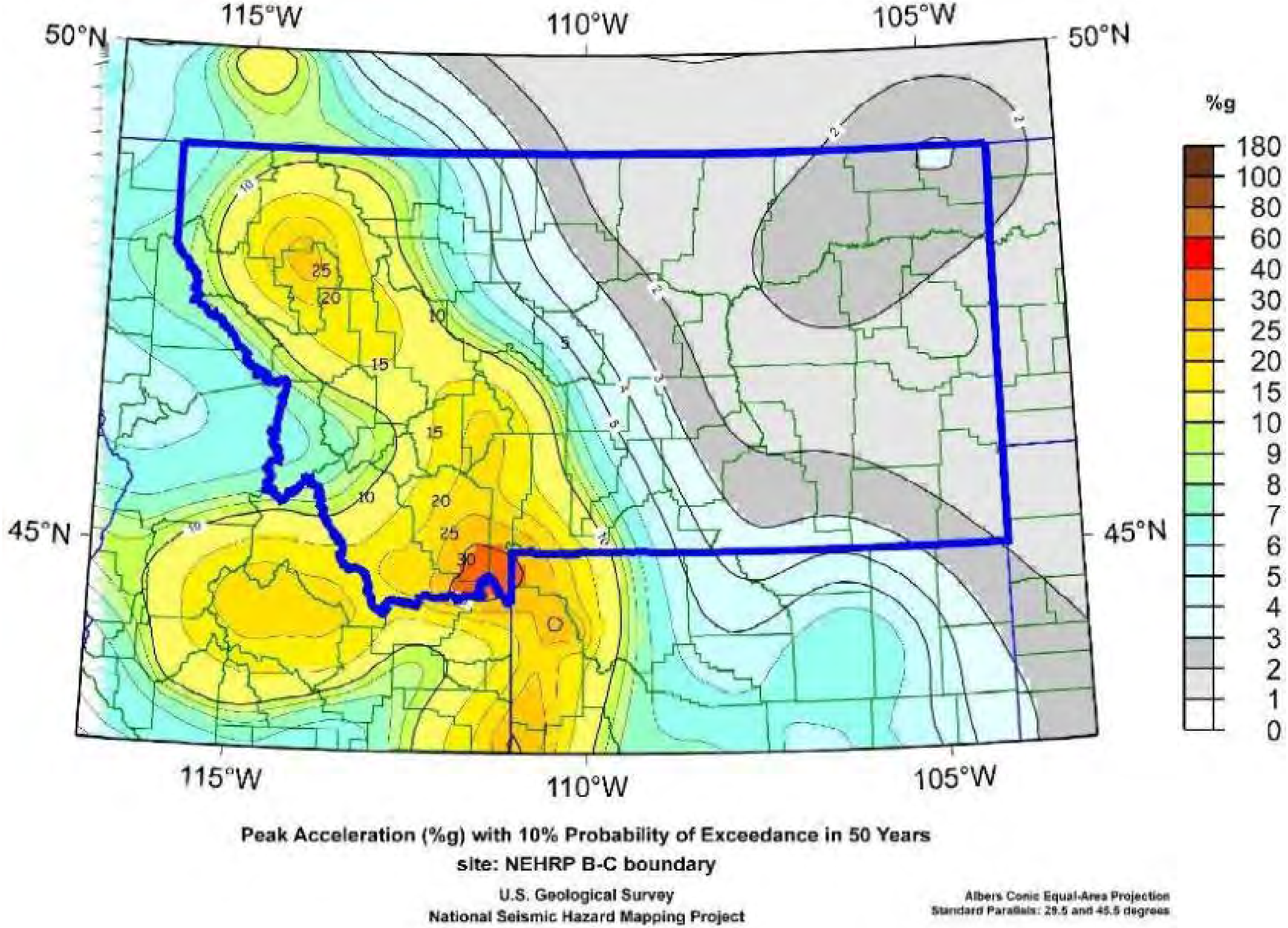
Magnitude
< 2.00
2.00 - 2.99
3.00 - 3.99
4.00 - 4.99
> 5.00
Pre1982 M >5
0 30 60 120 180 mi
N
Kalispell
Great Falls
Missoula
Helena
Butte
Billings
Bozeman

Potentially Active Faults



Montana Seismic Hazard

Source: http://geohazards.cr.usgs.gov/eq/



The high school at Three Forks, Montana, with brick walls in lime mortar was badly damaged and the walls bulged on all sides. Photo Credit: U.S. Geological Survey (J.T. Pardee).

B. DAMAGED JAIL AT WHITE SULPHUR SPRINGS, MONT.

Note shearing of brick veneer from back wall

A. ROCK SLIDE NEAR DEER PARK, MONT.

Temporary track in left foreground

A. BROKEN RAILROAD TRACK NEAR LOMBARD, MONT.

Note rebound of the broken rail. Photograph by J. P. Swarts

B. LAKE AT TUNNEL NO. 8, NEAR DEER PARK, MONT.

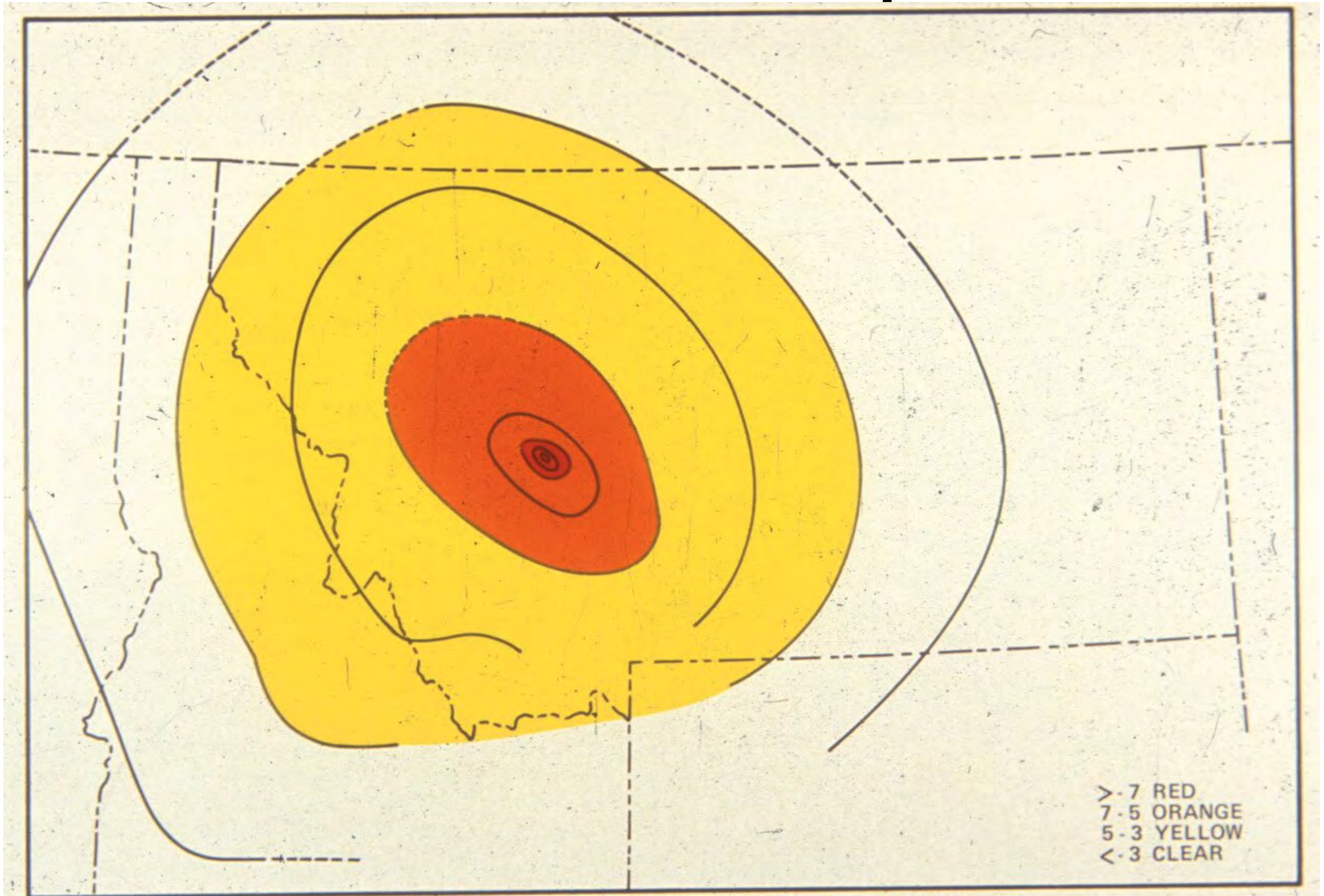
No rock falls occurred within the tunnel. Photograph by H. P. Allen

B. ROCKS ON RAILROAD TRACK NEAR LOMBARD, MONT.

Photograph by J. P. Swarts

Pardee, 1926

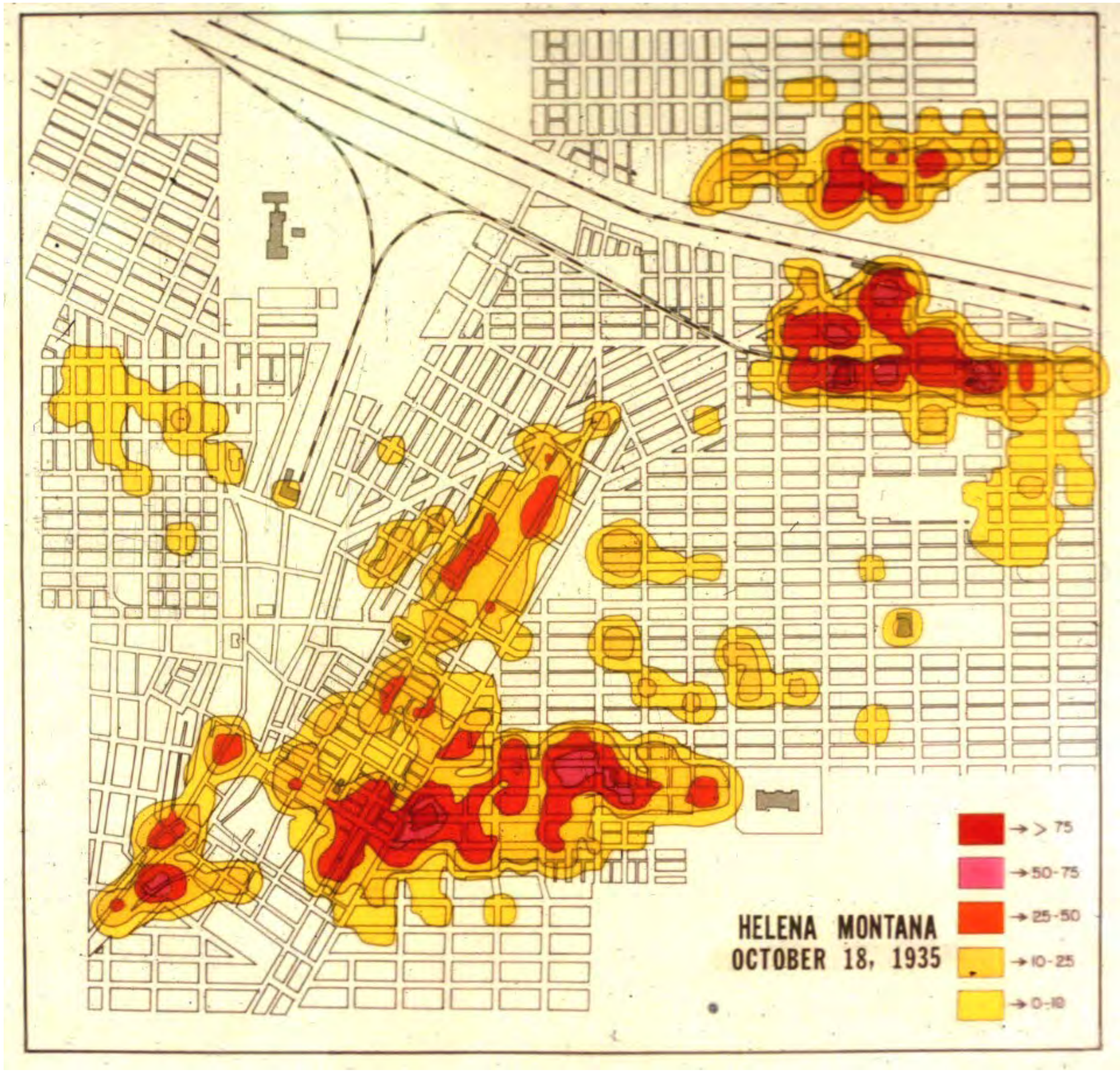
1935 Helena Earthquake

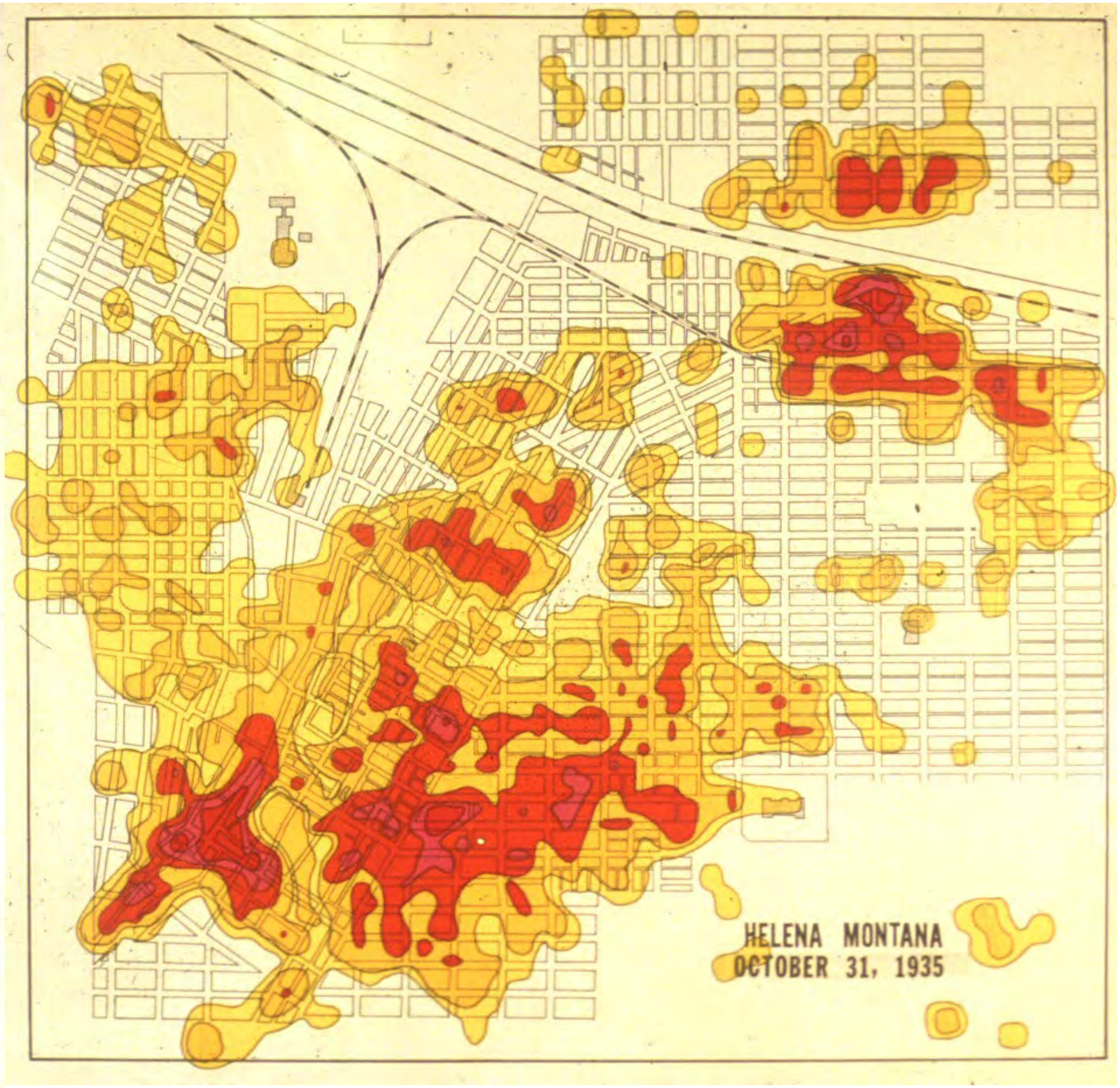


ISOSEISMAL MAP OF THE HELENA EARTHQUAKE OF OCTOBER 18, 1935.

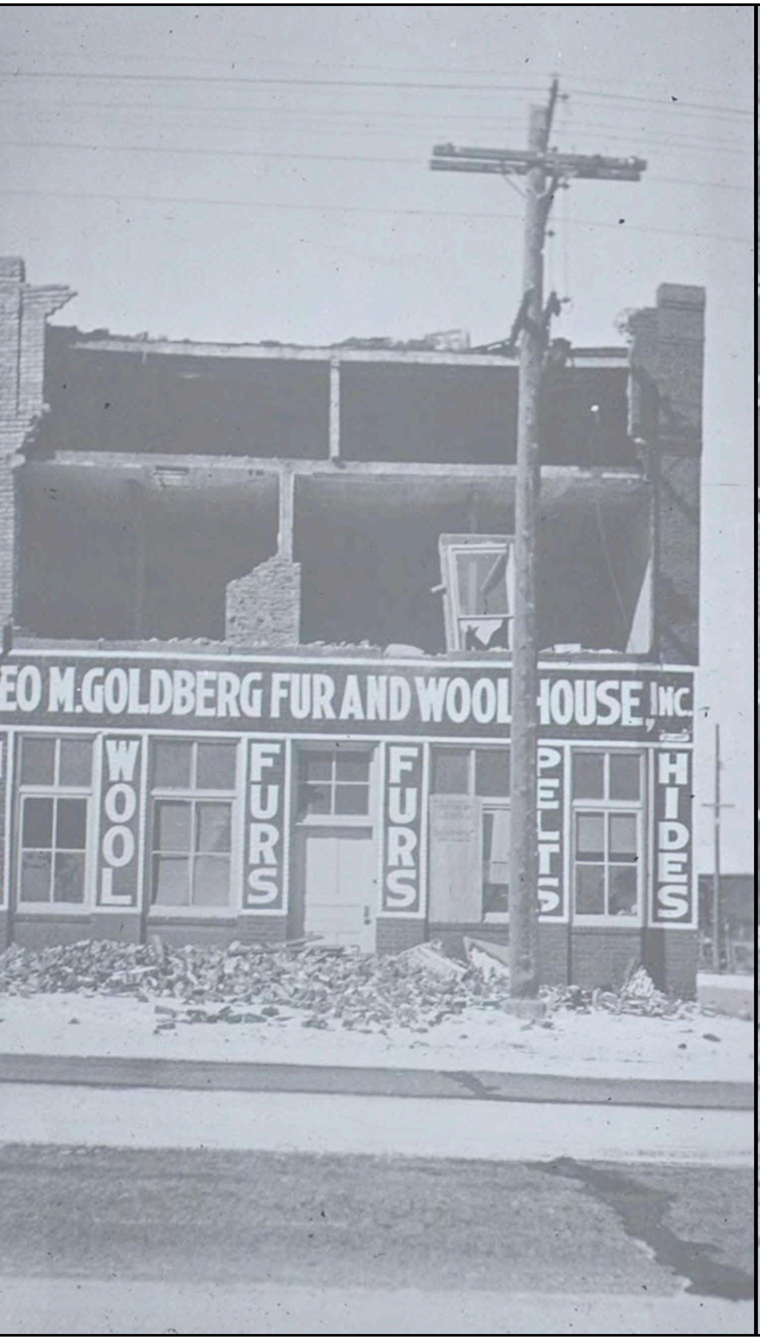
M 6.3 Oct. 18, 1935 Damage

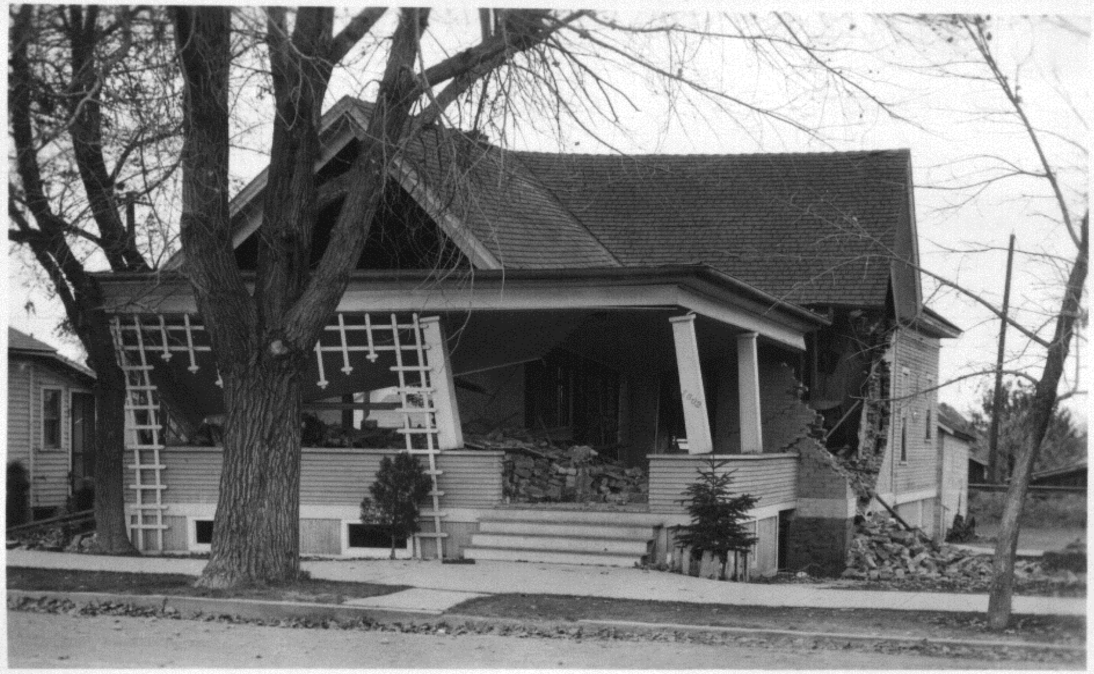
M 6.0 Oct. 31, 1935 Damage






BRYANT SCHOOL
HELENA QUAKES
248


EO M.GOLDBERG FUR AND WOOL HOUSE, INC.
WOOL
FURS
FURS
PELTS
HIDES




WILLARD


I MAN KILLED HERE.
HELENA FAIRGROUNDS.
QUAKE OCT. 18, 1935.
JORUD PHOTO 205


LODGING
I MAN KILLED HERE DURING HELENA
EARTHQUAKE OCT. 18, 1935. 9:50 P.M.
JORUD PHOTO
173

from Anderson and Martinson 1936

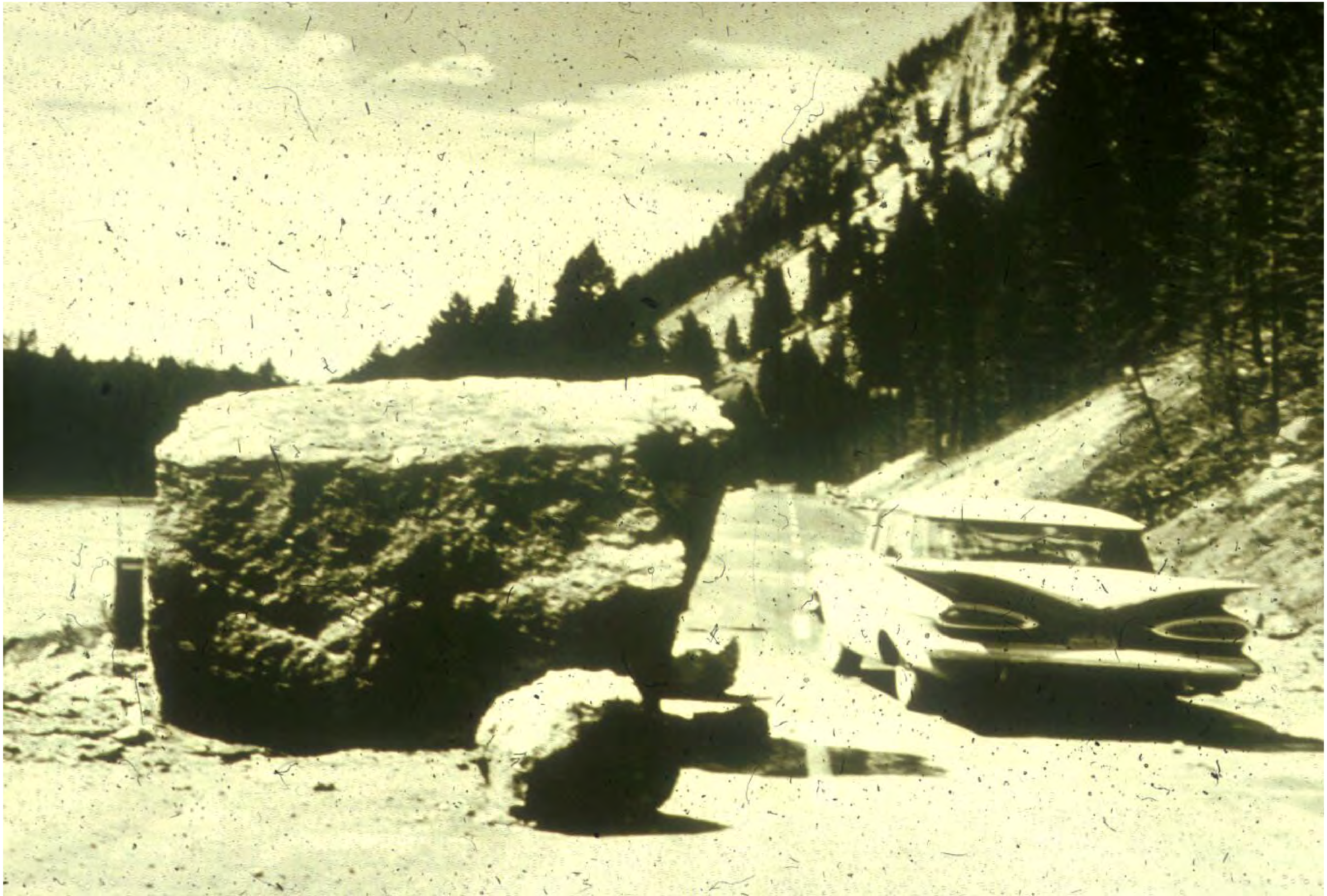


Photo courtesy of U.S. Forest Service

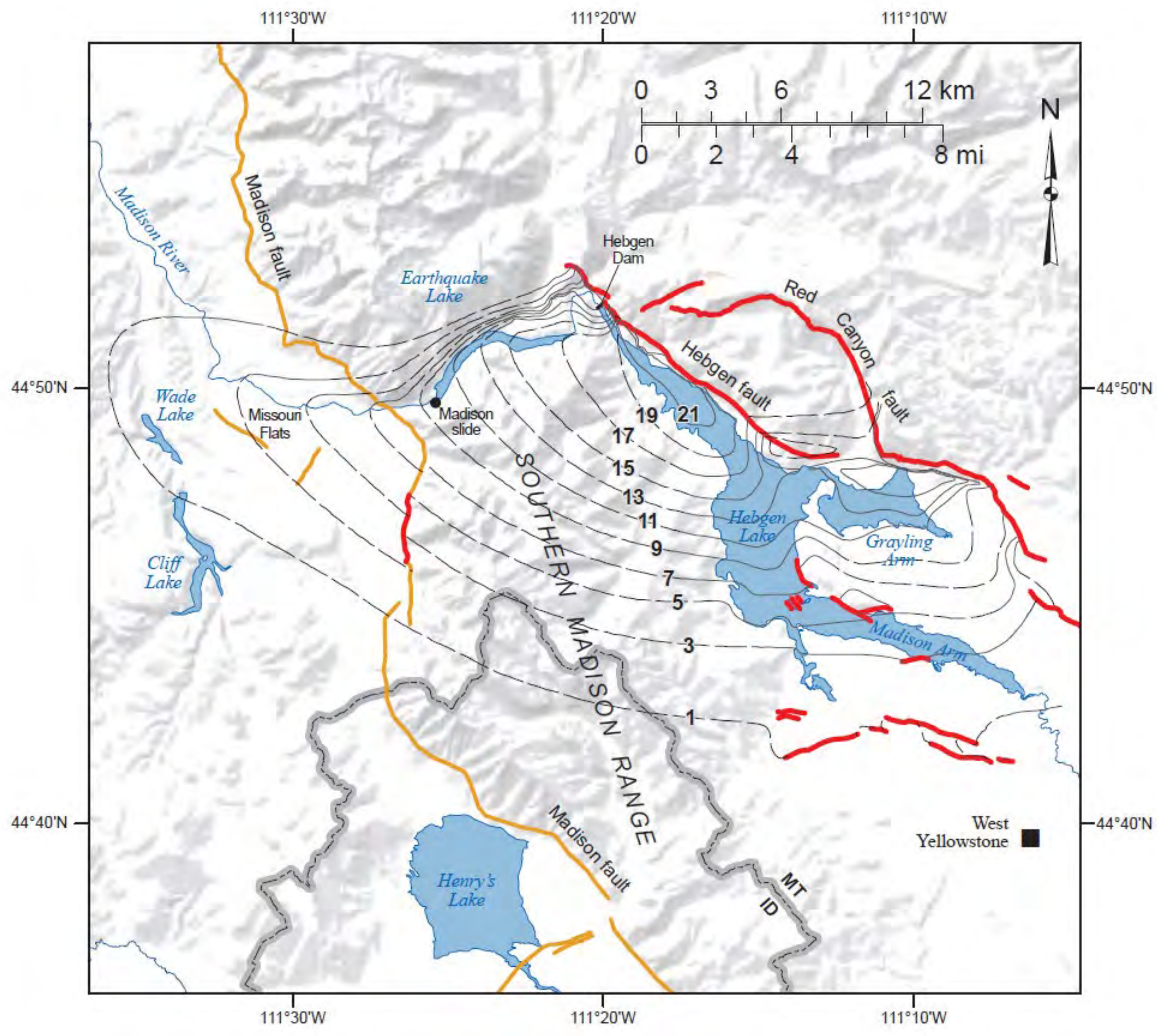
One of several cracks in core of Hebgen Dam ranging from 1-6 inches wide.

Photo courtesy of MT Historical Society

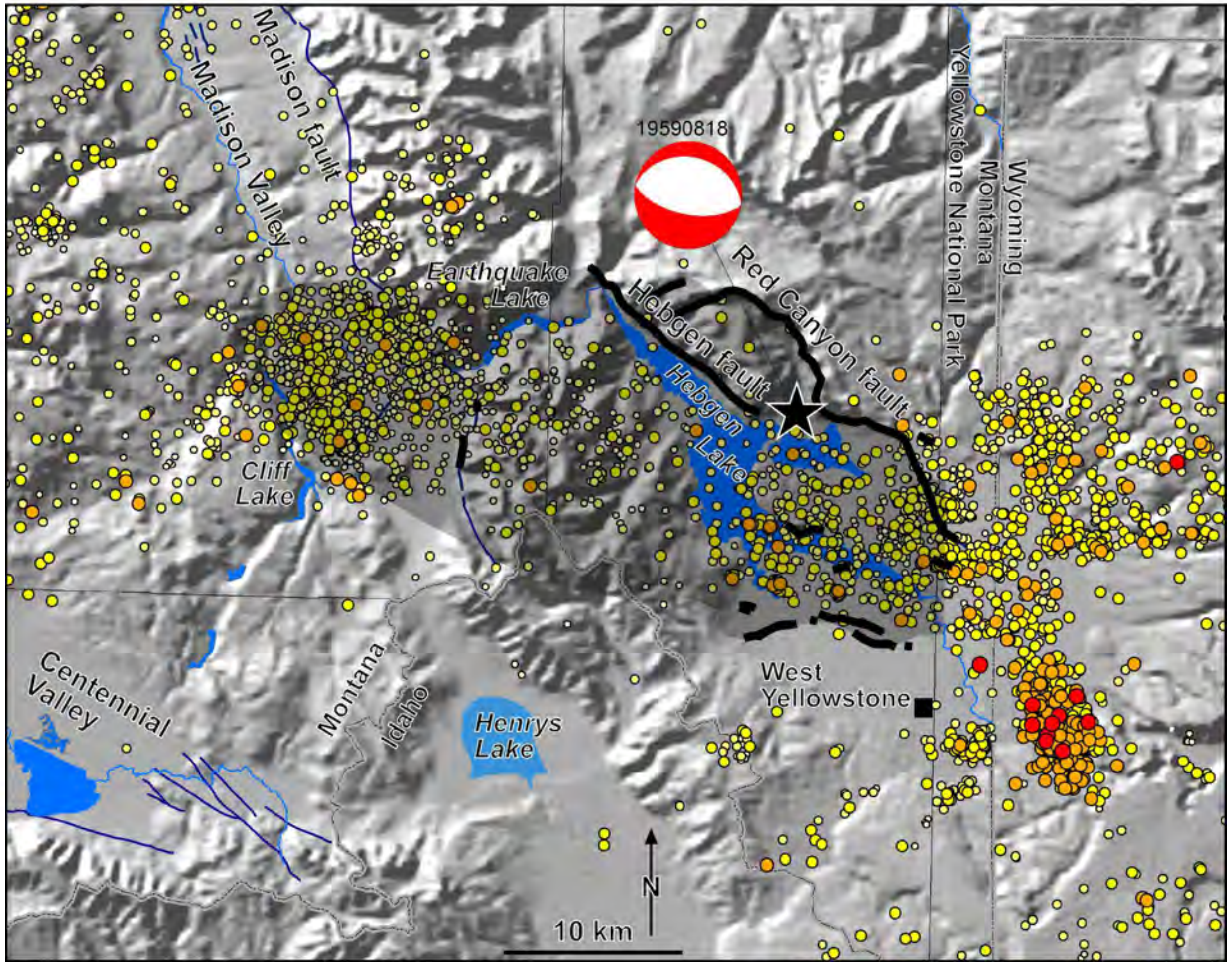

40


U.S. AIR FORCE


S. AIR FORCE



111°30'W
111°20'W
111°10'W
44°50'N
44°40'N
0 3 6 12 km
0 2 4 8 mi
N
Madison River
Madison fault
Earthquake Lake
Hebgen Dam
Red Canyon fault
Hebgen fault
Wade Lake
Missouri Flats
Madison slide
19 21
17
15
13
11
9
7
5
3
1
SOUTHERN MADISON RANGE
Hebgen Lake
Grayling Arm
Madison Arm
Cliff Lake
West Yellowstone
Henry's Lake
MT
ID



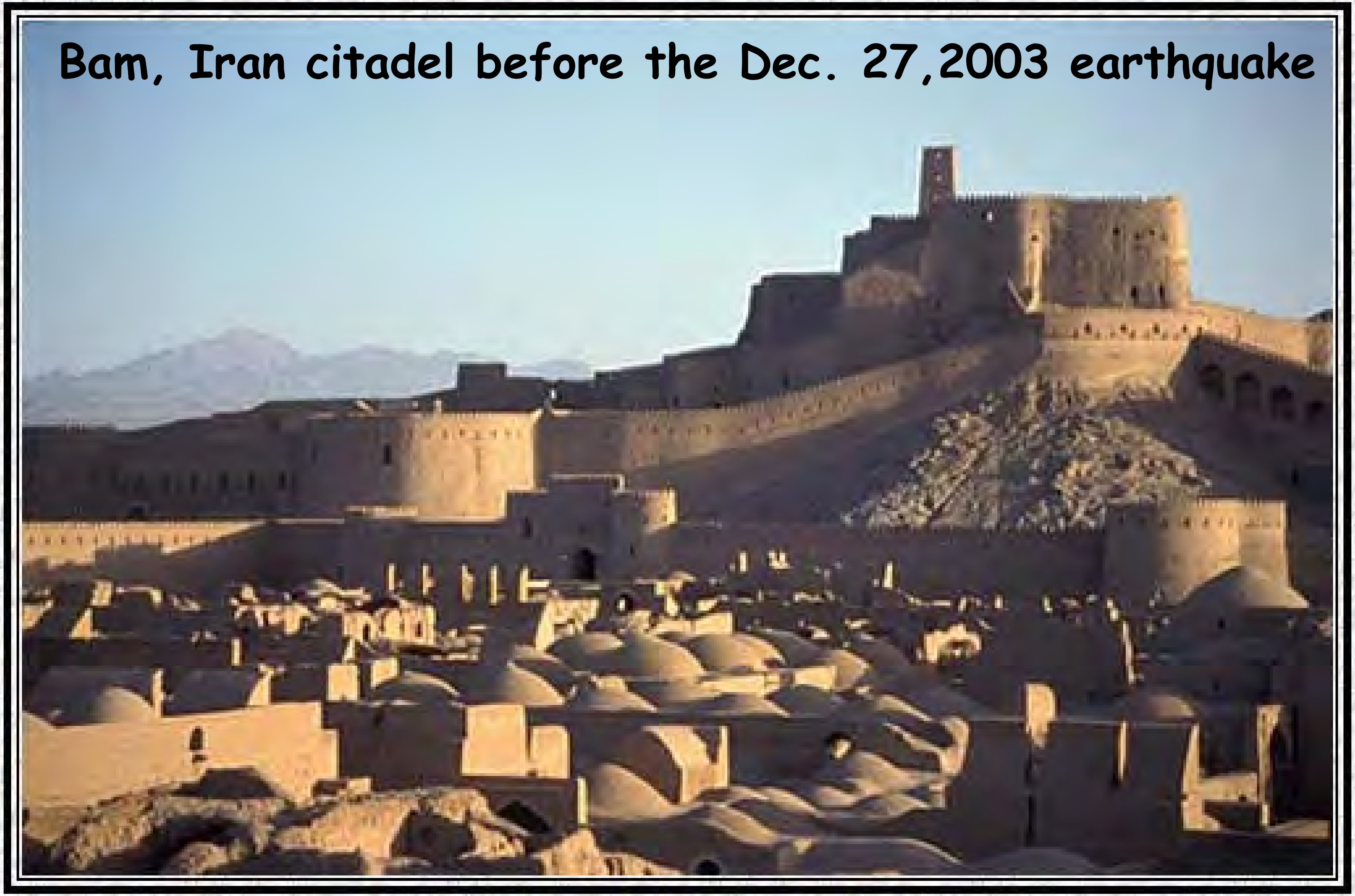
Madison fault
Madison Valley
19590818
Earthquake Lake
Red Canyon fault
Hebgen fault
Hebgen Lake
Yellowstone National Park
Montana
Wyoming
Cliff Lake
Centennial Valley
Montana
Idaho
Henrys Lake
West Yellowstone
N
10 km

Clock tower in Paso Robles, CA

http://community.webshots.com/photo/

Paso Robles clock tower after the Dec. 22, 2003 quake

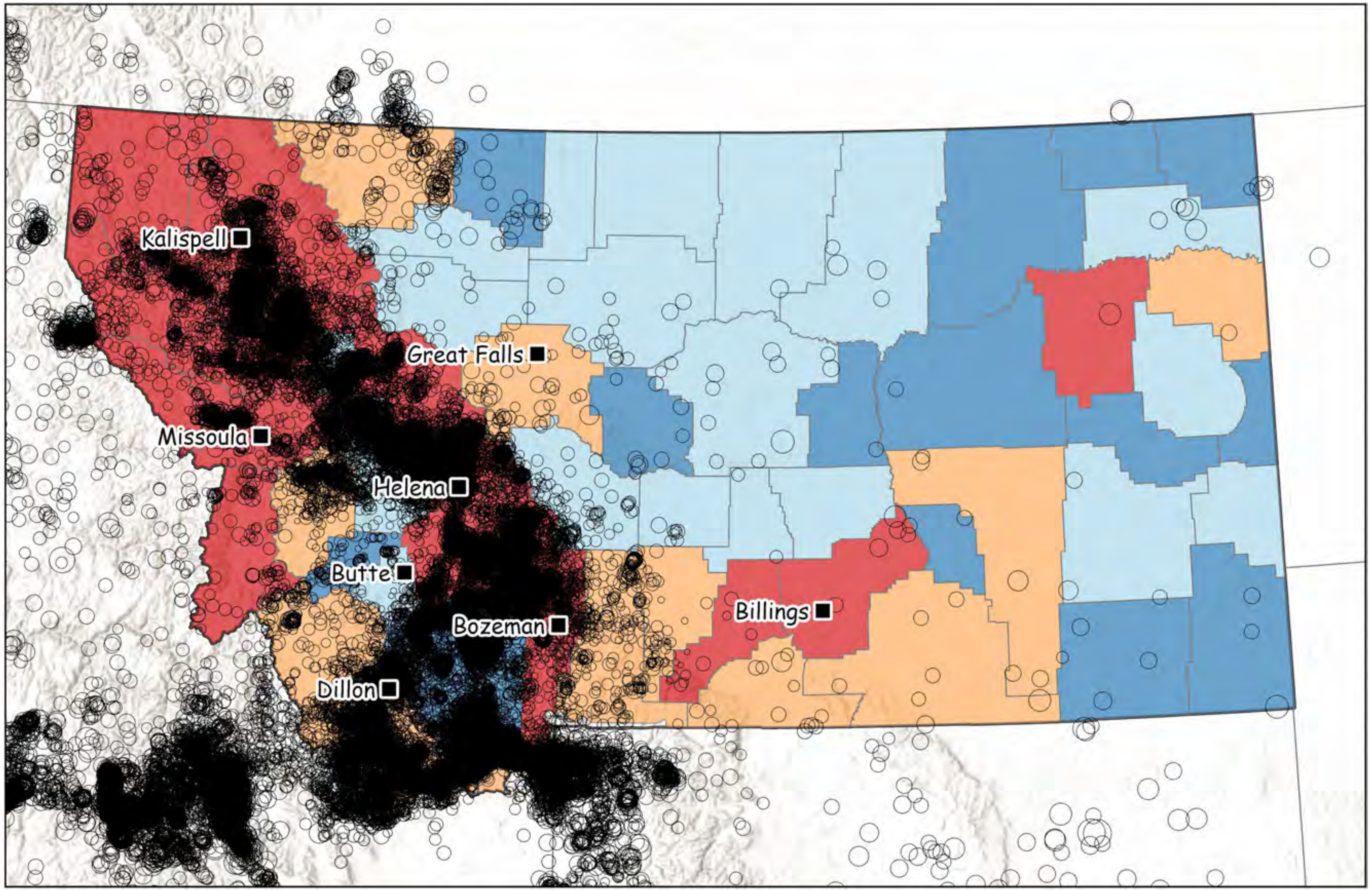
http://community.webshots.com/photo/



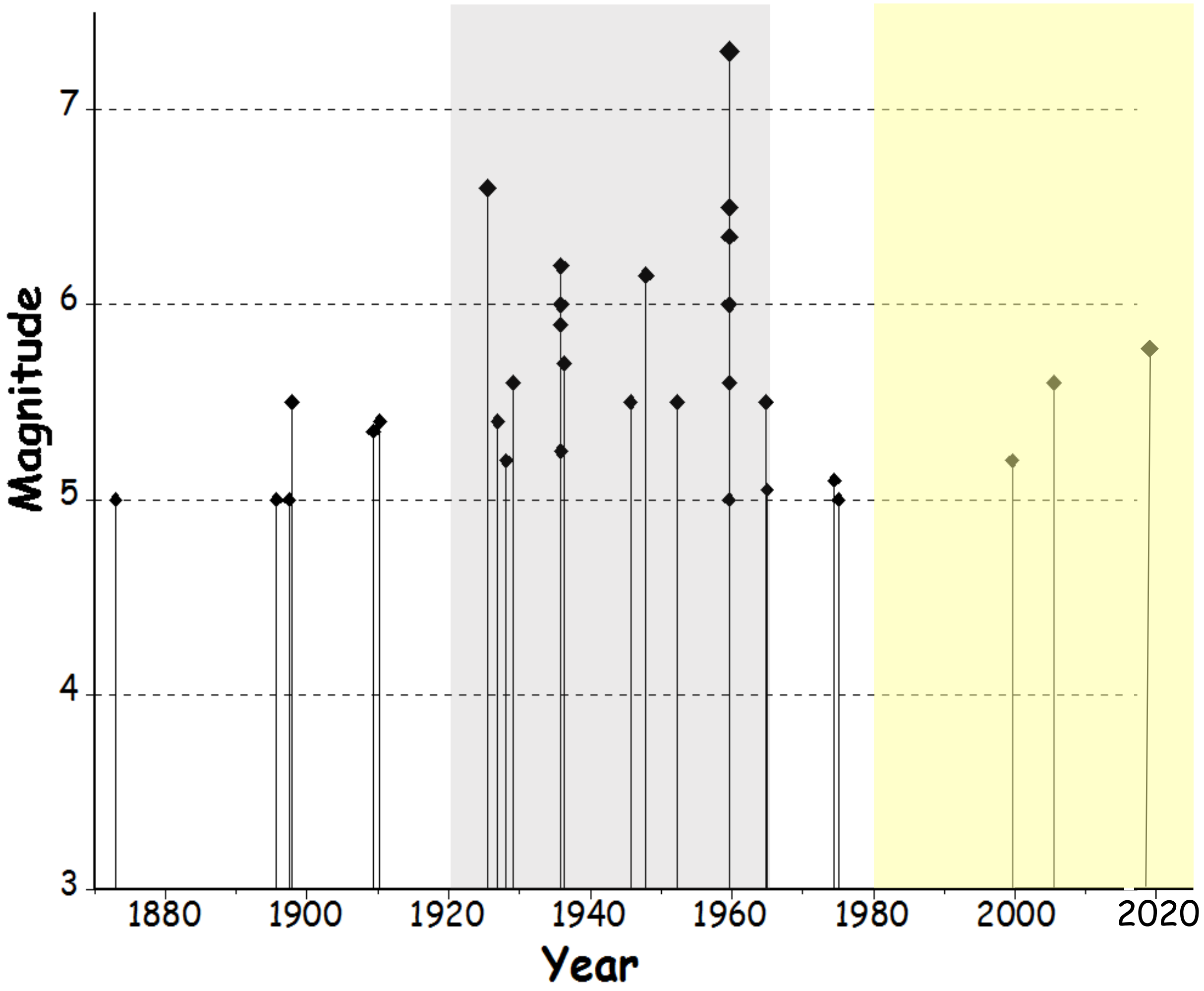
Citadel and mud city of Bam

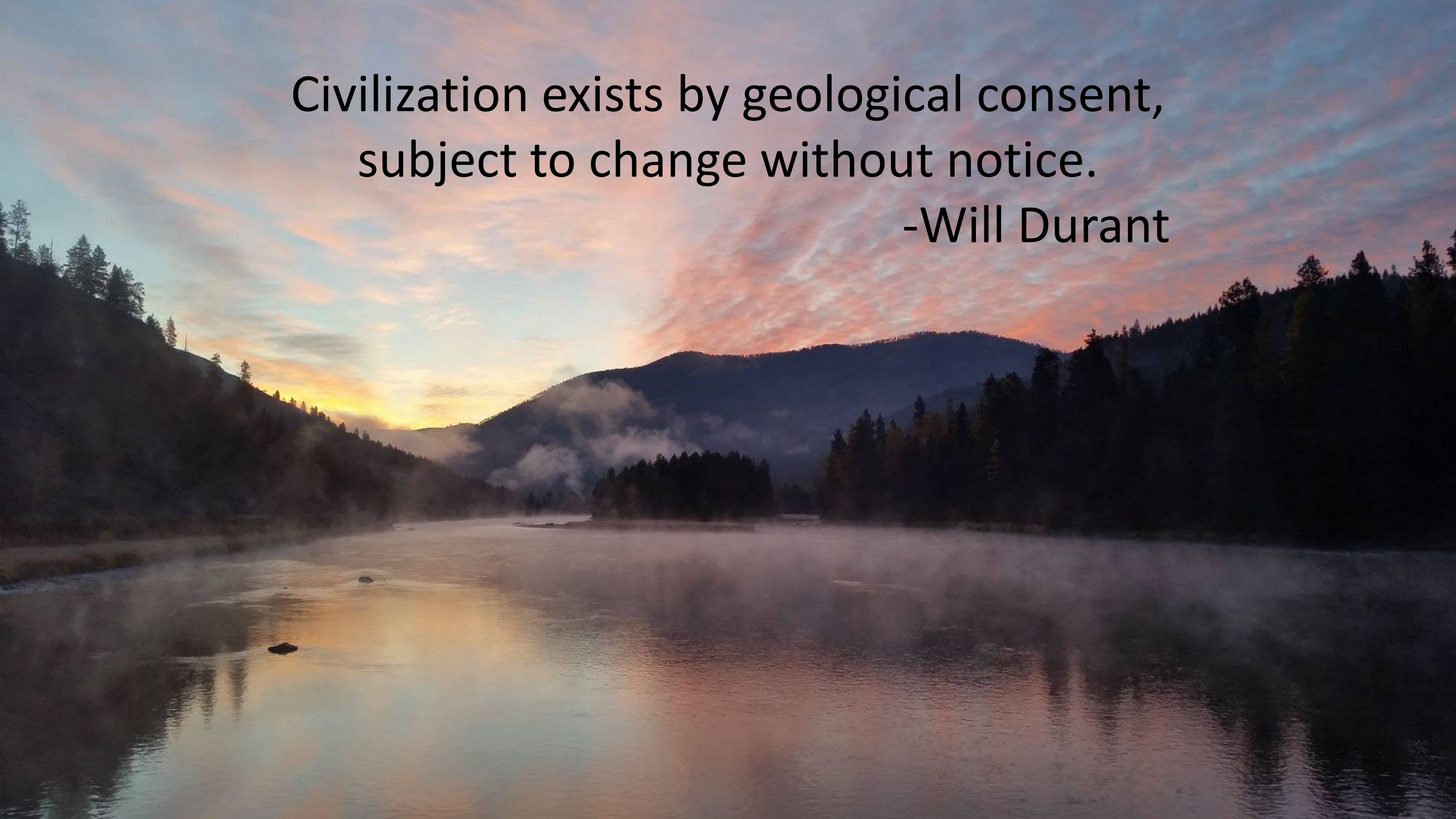

ISNA
ISNA/PHOTO:MEHDI GHASEMI

Change in County Population 1960-2020



Montana Earthquakes M ≥ 5




Civilization exists by geological consent,
subject to change without notice.
-Will Durant

Earthquake Effects and Hazards

Robb Eric S. Moss, Ph.D., P.E., F.ASCE

Prof. of Geotechnical, Earthquake, and Risk Engineering

Civil and Environmental Engineering

The purpose of this presentation:

- Demonstrate earthquake effects the hazards they pose to the built environment using prior earthquakes around the world.

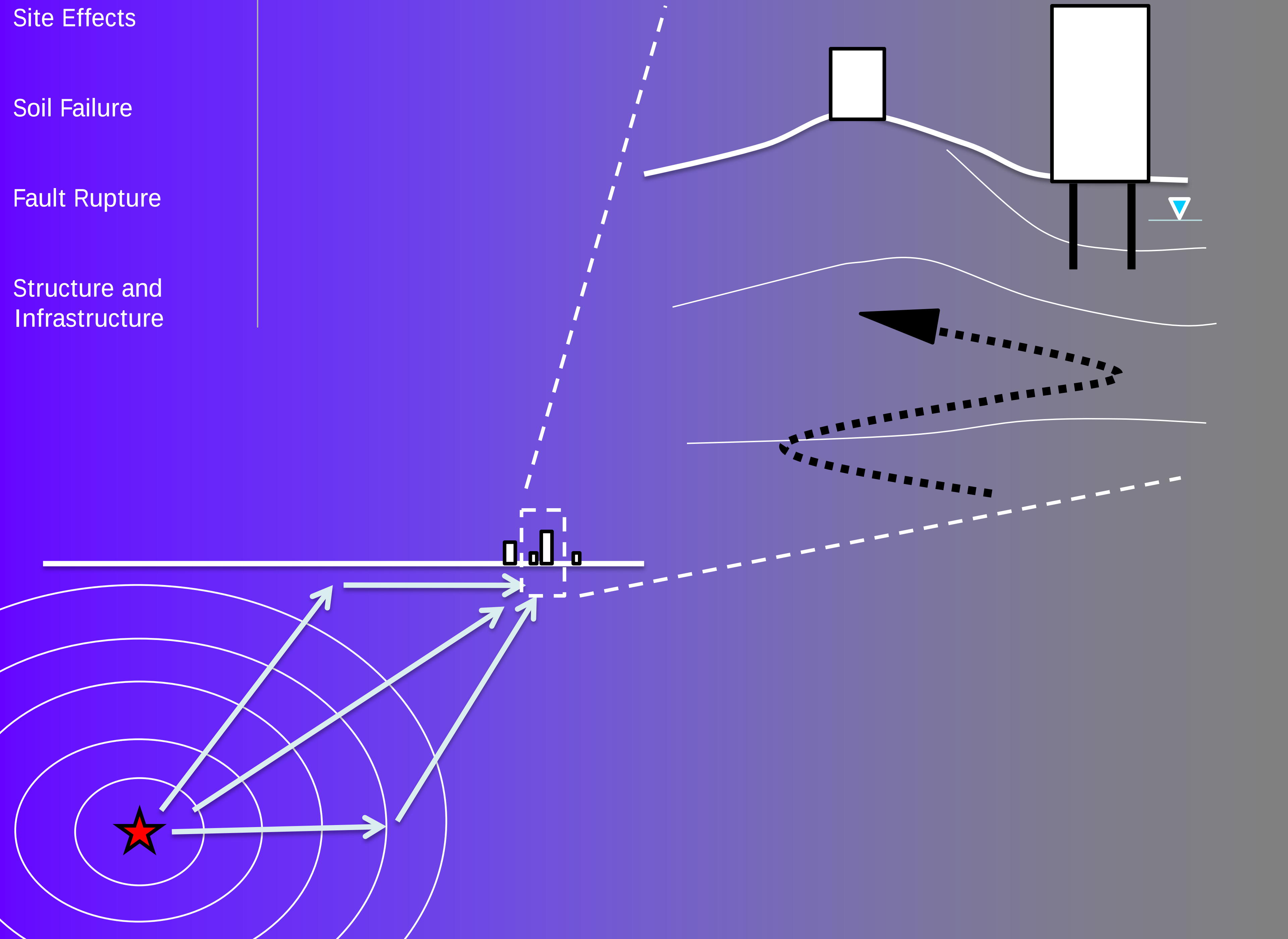
- Highlight: site effects, soil failure, surface fault rupture, and the related structural/infrastructure damage.

Site Effects

Soil Failure

Fault Rupture

Structure and Infrastructure

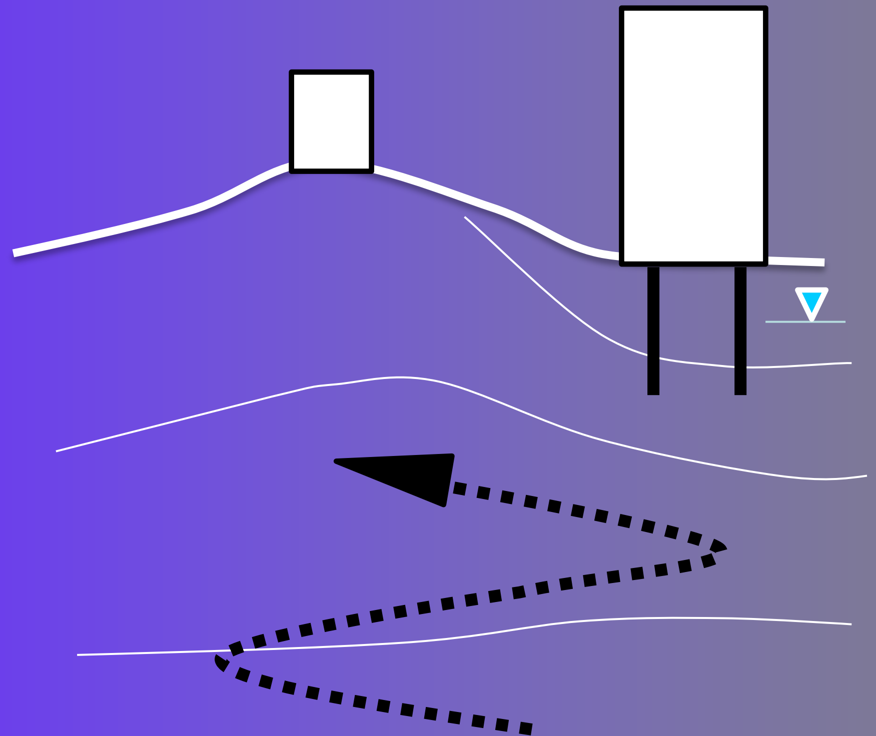


Site Effects

Soil Failure

Fault Rupture

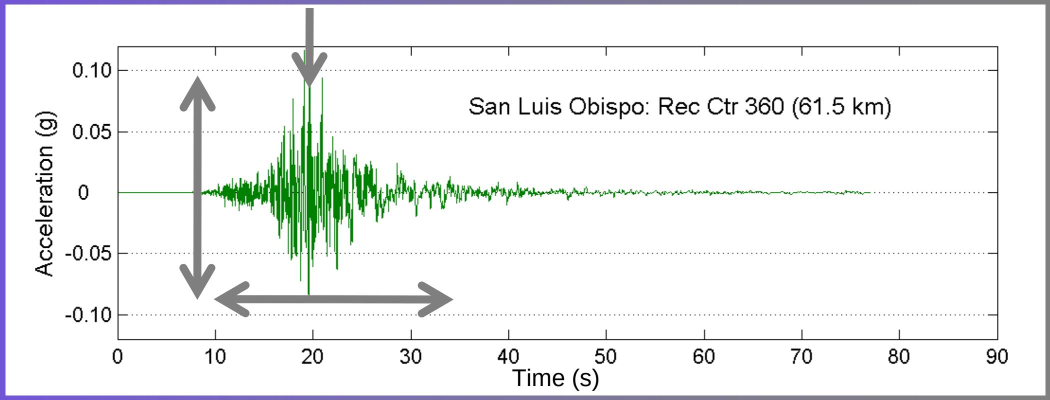
Structure and Infrastructure



Near Surface Soil Response

Topographic Effects

Basin and Basin Edge Effects



amplitude duration frequency content

Site Effects

Soil Failure

Fault Rupture

Structure and Infrastructure

Site Effects - 1999 Mexico

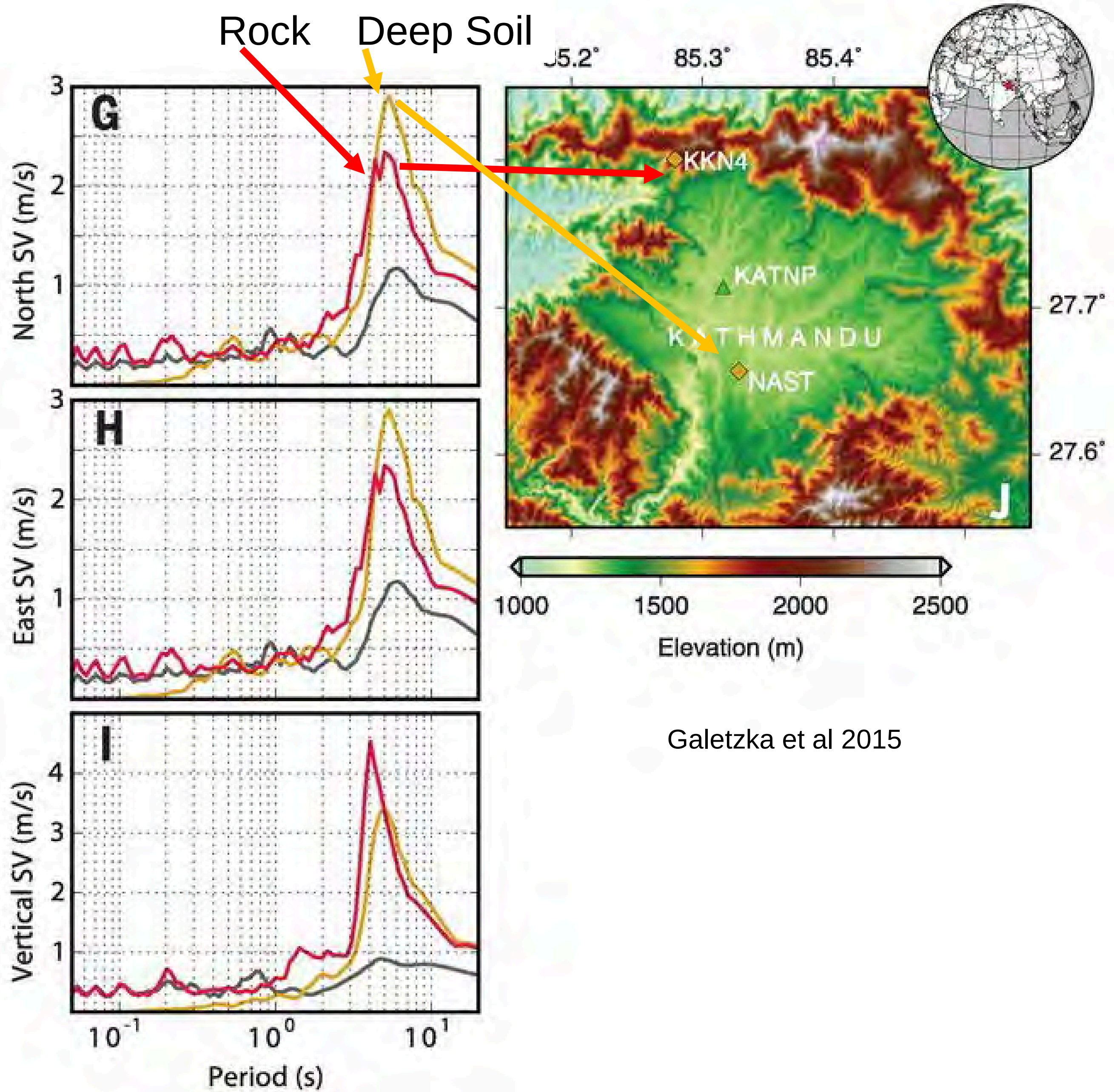
Site Effects

Soil Failure

Fault Rupture

Structure and Infrastructure

Basin Effects – 2015 Nepal



Galetzka et al 2015

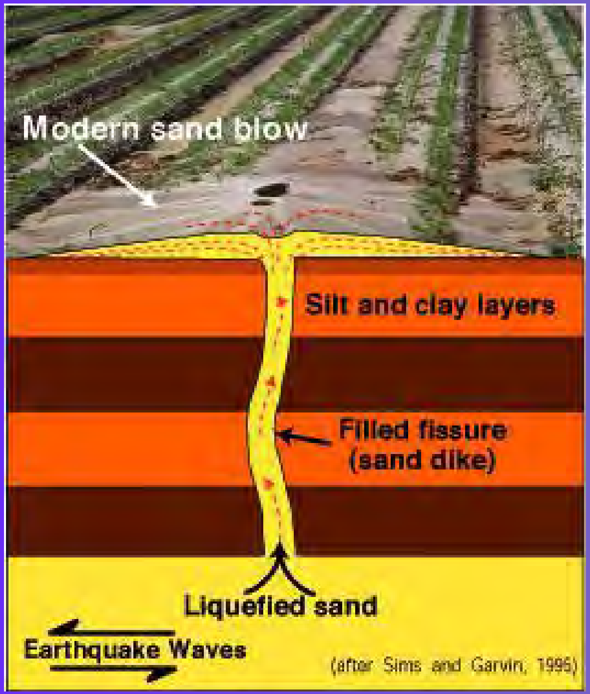
Site Effects

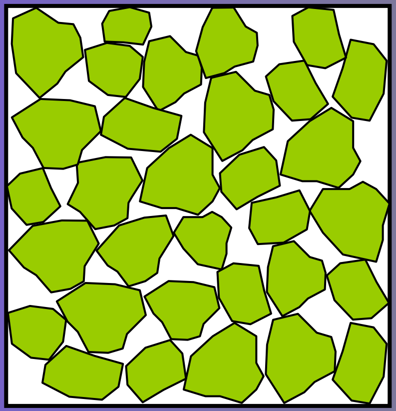
Soil Failure

Fault Rupture

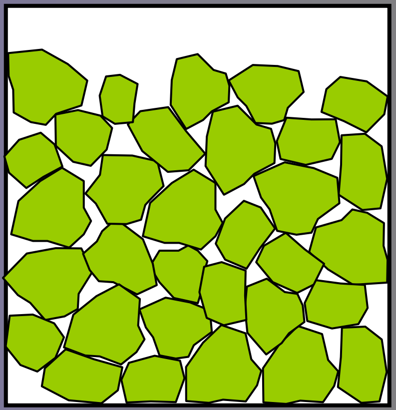
Structure and Infrastructure

Liquefaction

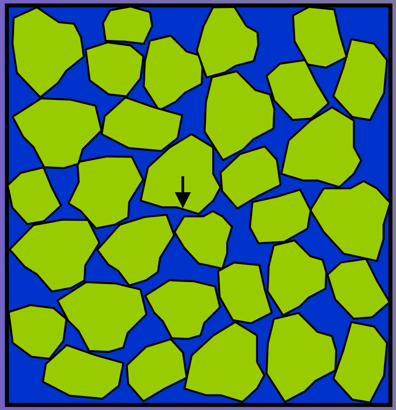




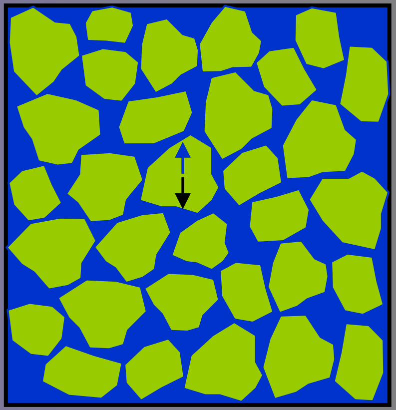
Dry Loose Sand



after Shaking



Saturated Loose Sand



after Shaking

Site Effects

Soil Failure

Fault Rupture

Structure and Infrastructure

Liquefaction – 2001 Bhuj India

Site Effects

Soil Failure

Fault Rupture

Structure and Infrastructure

Liquefaction – 2003 San Simeon

Photo Keith Knudsen

Photo Keith Knudsen

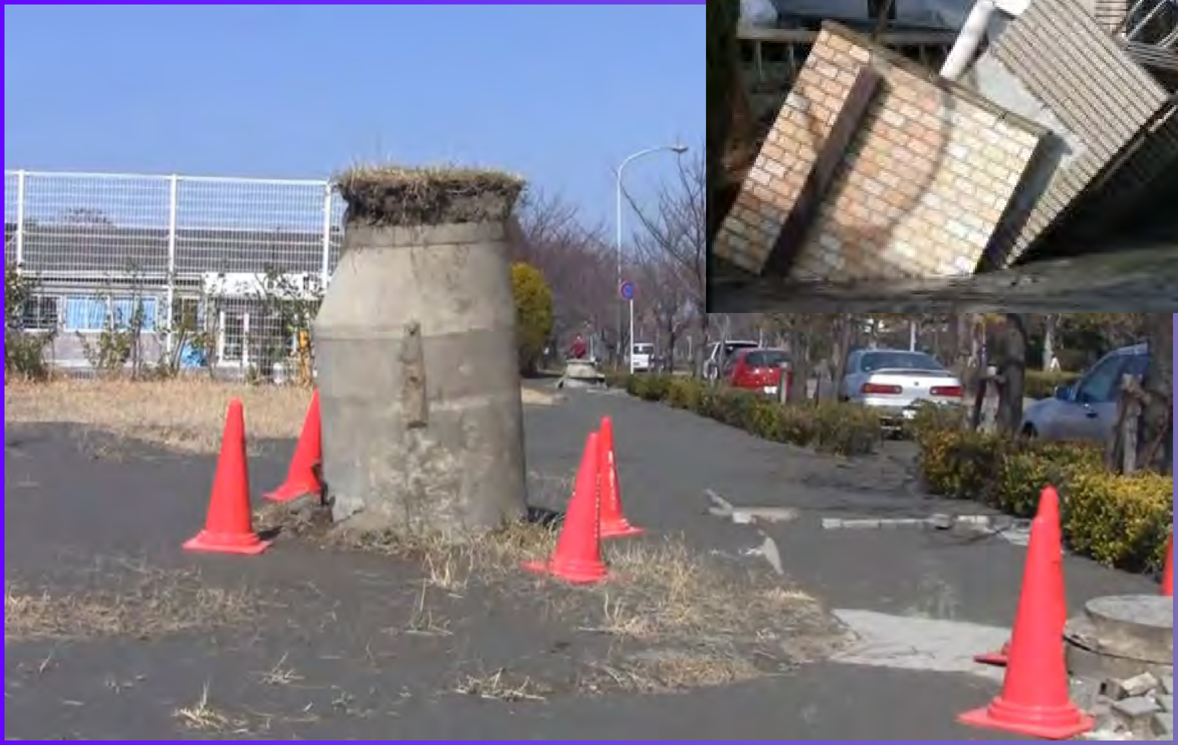
(Oceano)

Liquefaction – 2010 Maule Chile


Photo Gonzalo Montalva

Photo Tara Hutchison

Liquefaction – 2011 Tohoku Japan



Site Effects

Soil Failure

Fault Rupture

Structure and Infrastructure

Liquefaction – 2023 Turkiye

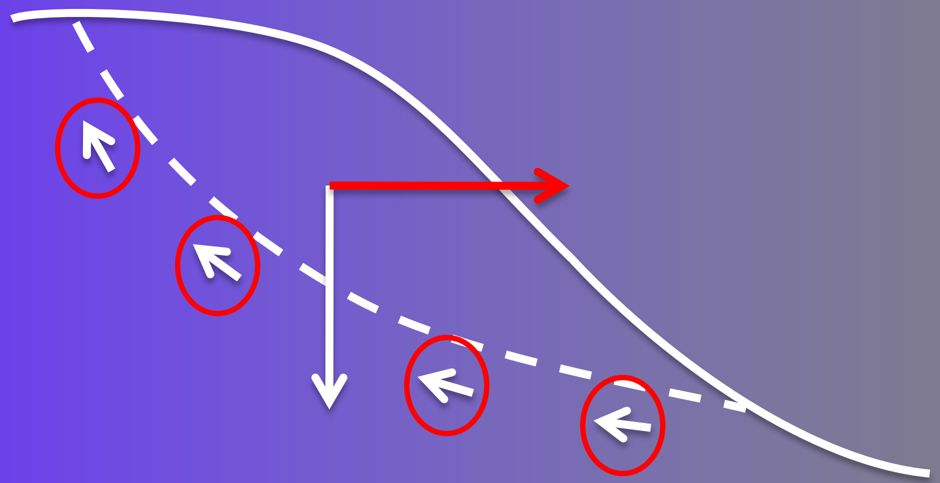
Site Effects

Soil Failure

Fault Rupture

Structure and Infrastructure

Seismic Induced Landslides



Primary Variables:

a) Period of slide mass
b) Period of earthquake
c) Earthquake Duration

resonance

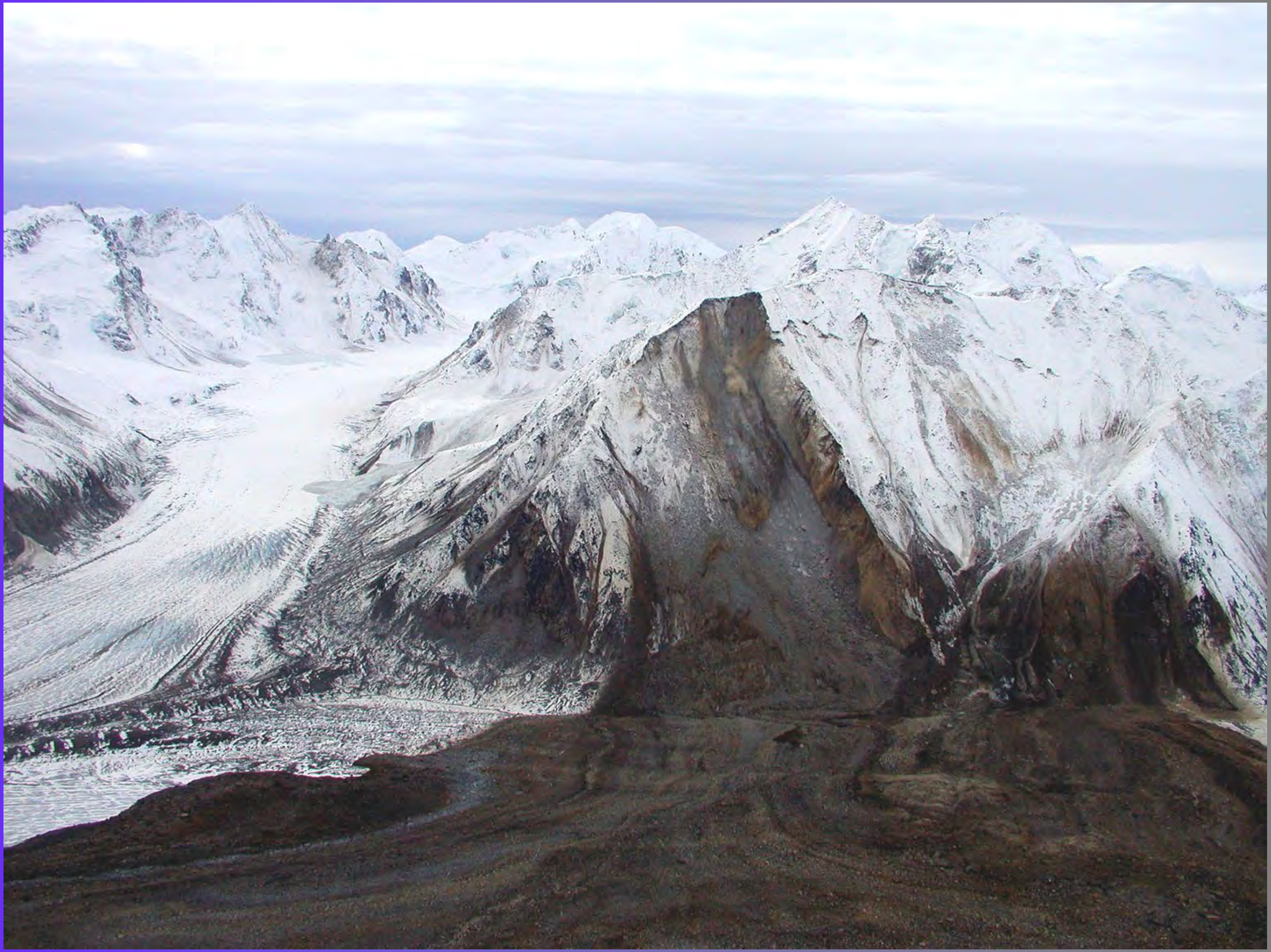
Site Effects

Soil Failure

Fault Rupture

Structure and Infrastructure

Seismic Induced Landslides – 2002 Alaska



Site Effects

Soil Failure

Fault Rupture

Structure and Infrastructure

Seismic Induced Landslides - 2003 San Simeon

(Paso Robles)

Photo Lew Rosenberg

Photo Robb Moss

Seismic Induced Landslides – 2010 Maule Chile

Photo Robb Moss

Seismic Induced Landslides – 2011 Tohoku Japan

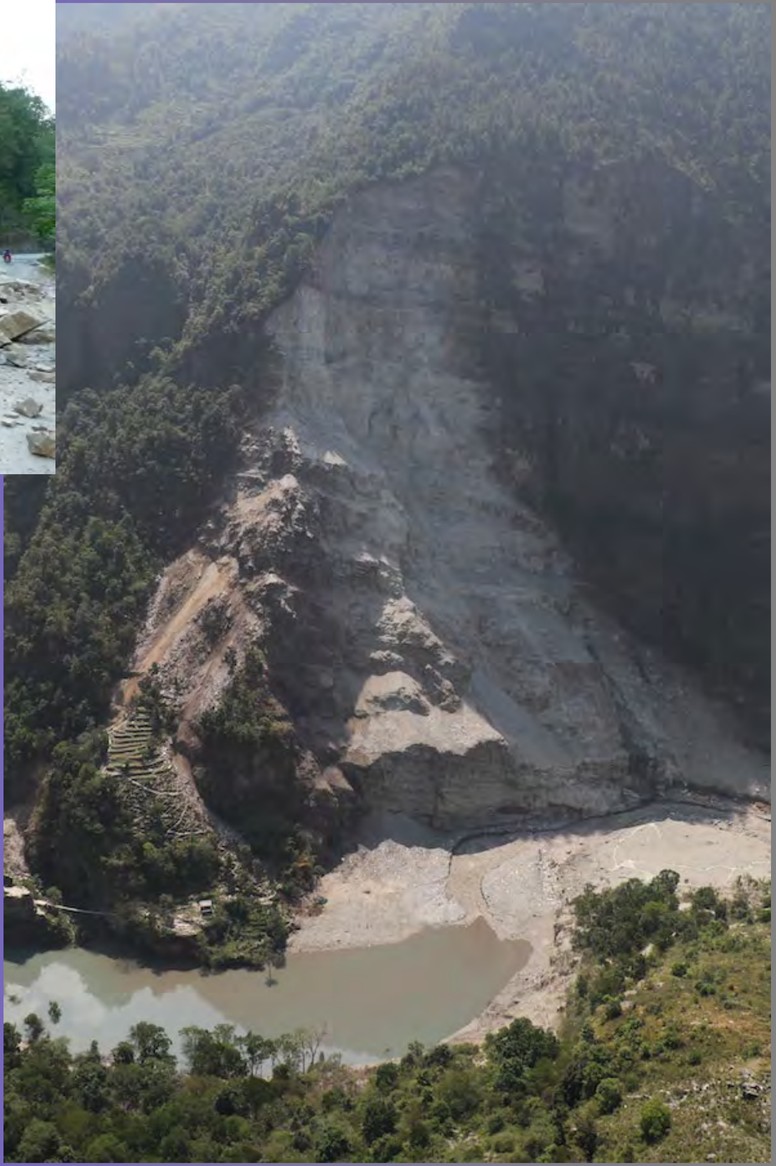
Site Effects

Soil Failure

Fault Rupture

Structure and Infrastructure

Seismic Induced Landslides – 2015 Nepal



Site Effects

Soil Failure

Fault Rupture

Structure and Infrastructure

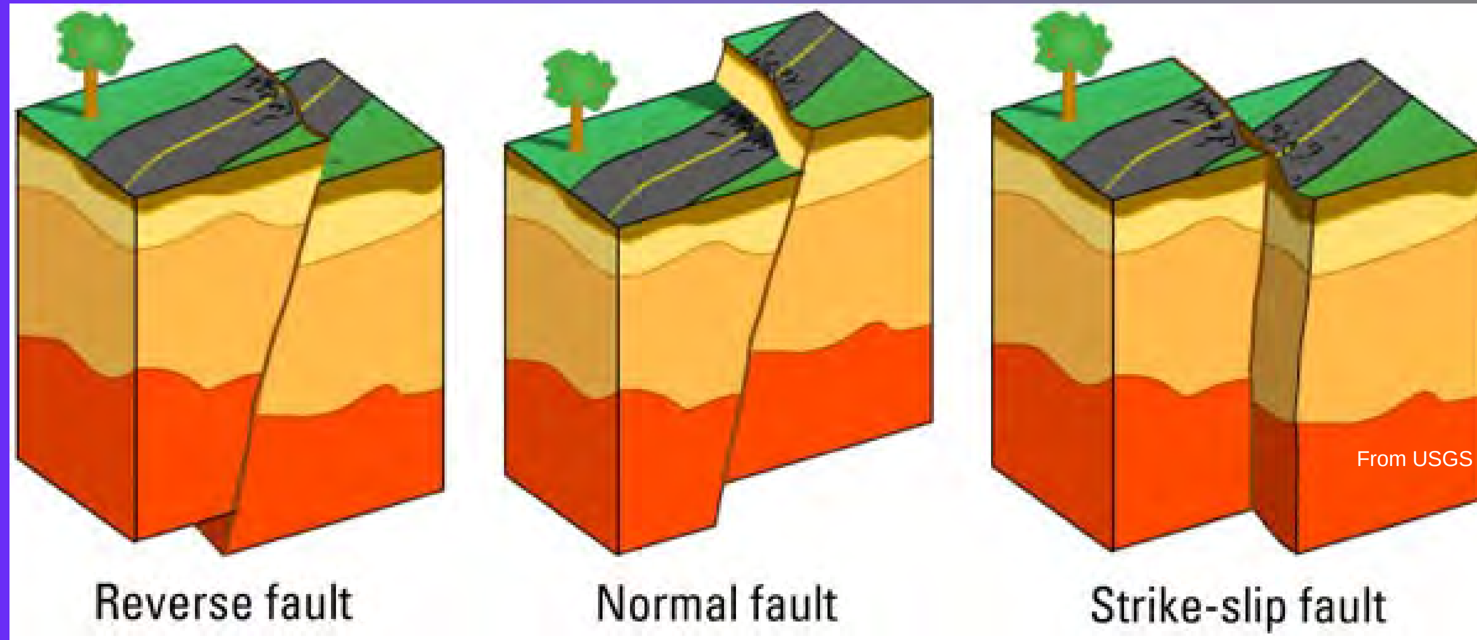
Seismic Induced Landslides – 2023 Turkiye

Site Effects

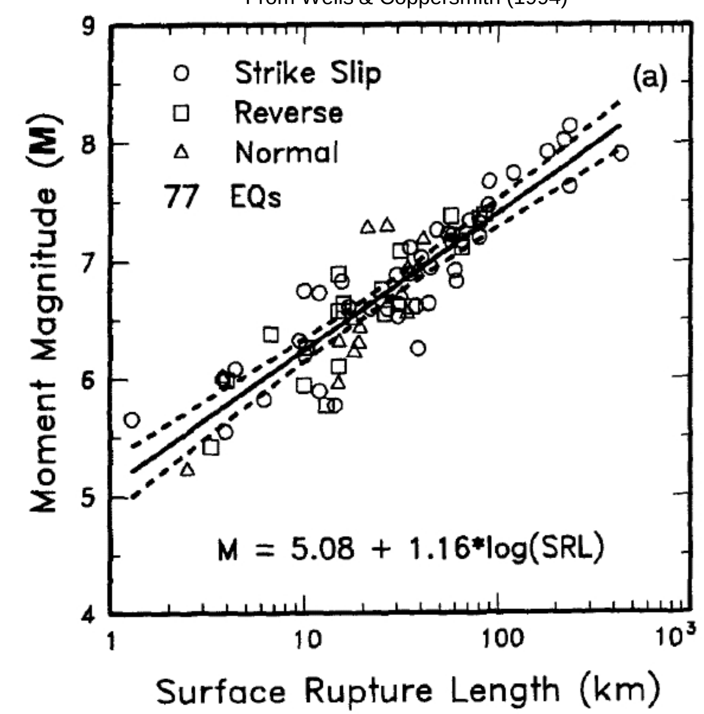
Soil Failure

Fault Rupture

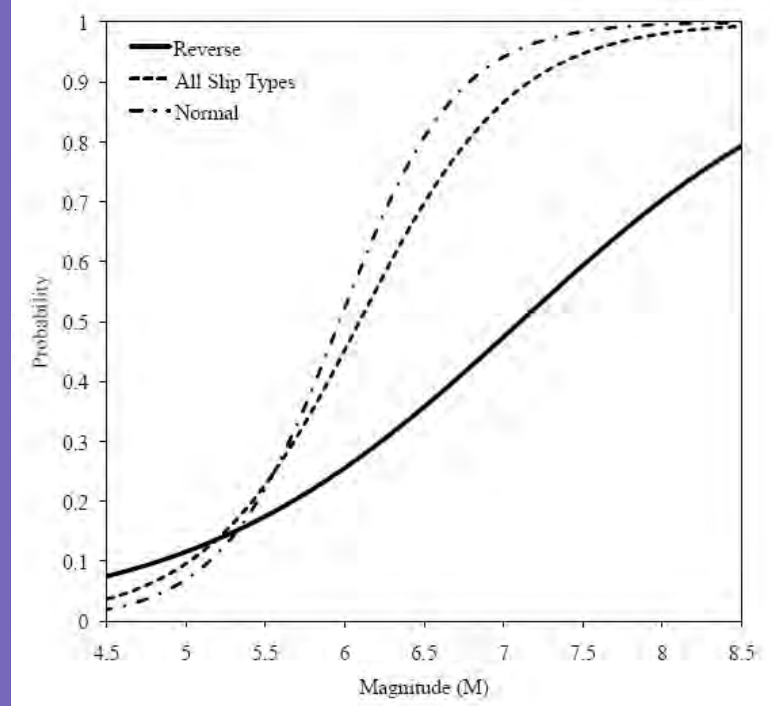
Structure and Infrastructure



From Wells & Coppersmith (1994)



From Moss & Ross (2010)



Site Effects

Soil Failure

Fault Rupture

Structure and Infrastructure

2001 Bhuj India

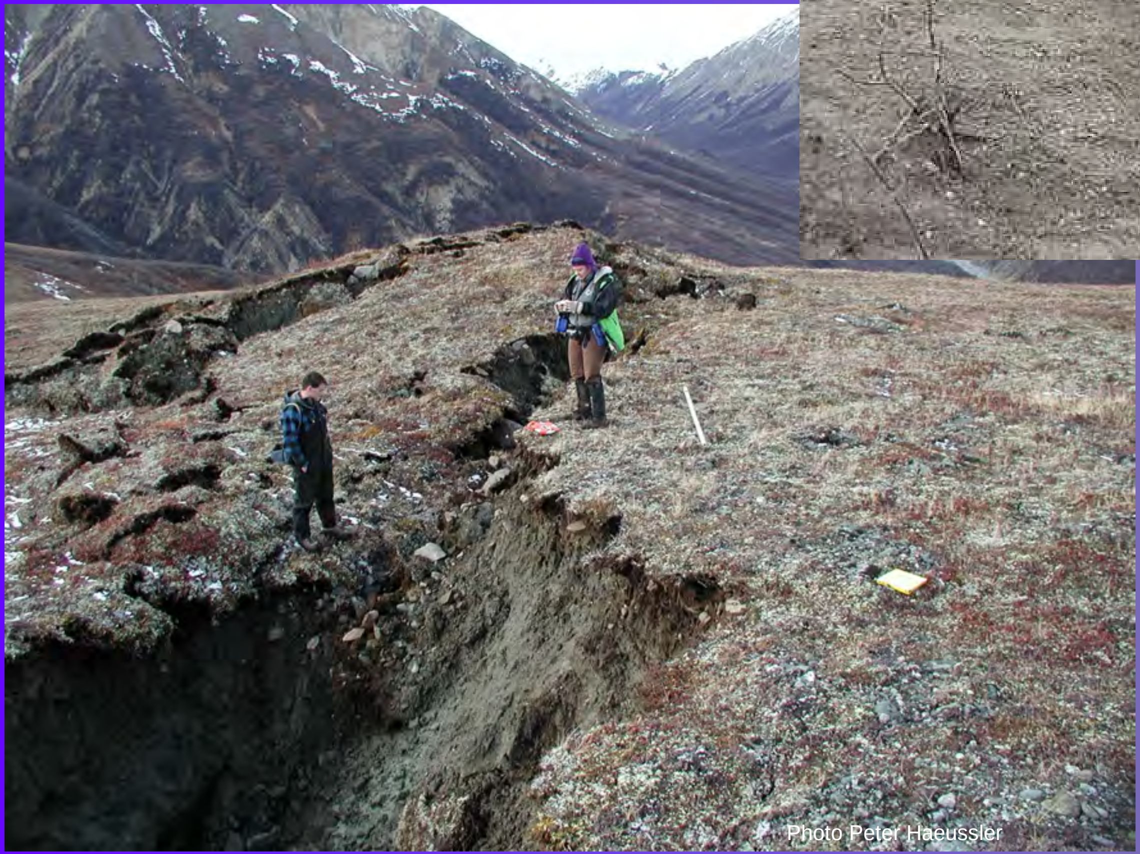
Site Effects

Soil Failure

Fault Rupture

Structure and Infrastructure

2002 Alaska



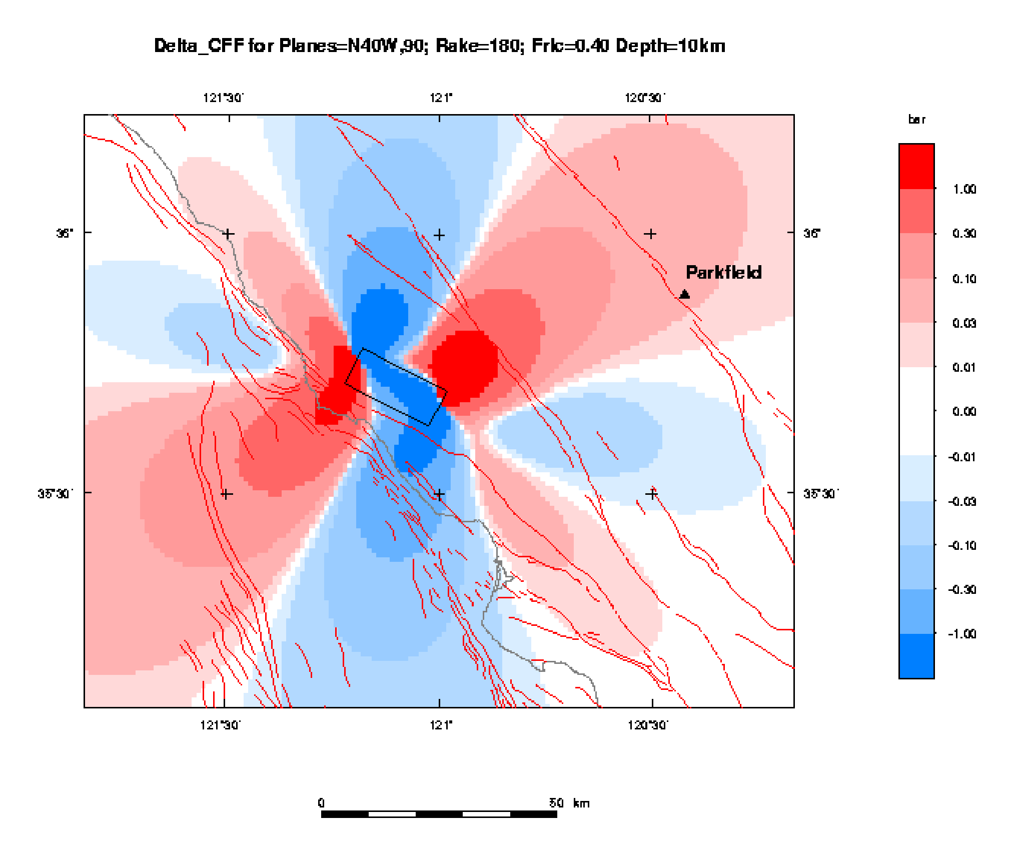
Site Effects

Soil Failure

Fault Rupture

Structure and Infrastructure

2004 Parkfield CA



Site Effects

Soil Failure

Fault Rupture

Structure and Infrastructure

2023 Turkiye

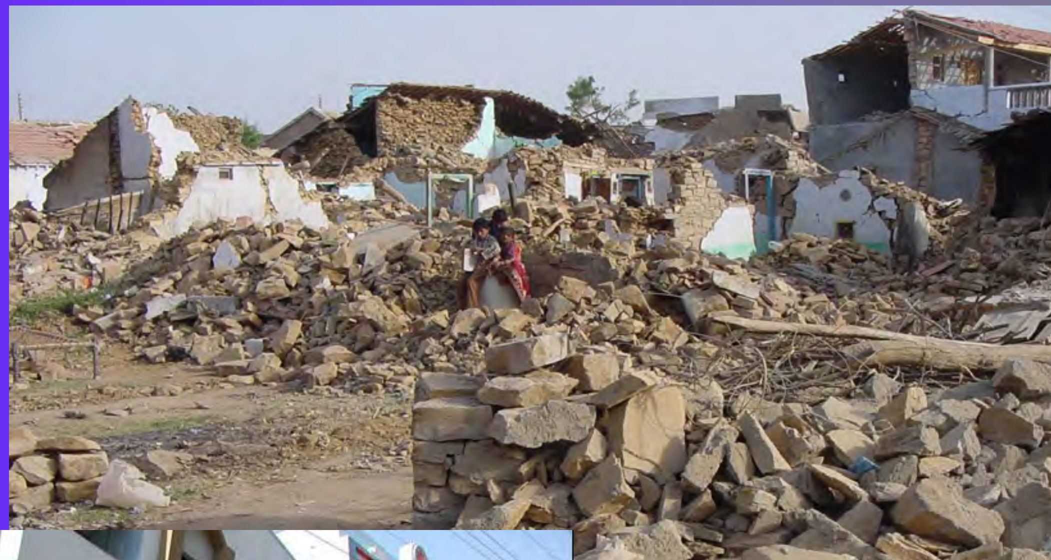
Site Effects

Soil Failure

Fault Rupture

Structure and Infrastructure

Structural Failure– 2001 Bhuj India



Site Effects

Soil Failure

Fault Rupture

Structure and Infrastructure

Structural Failure – 2003 San Simeon

Site Effects

Soil Failure

Fault Rupture

Structure and Infrastructure

Structural Failure – 2010 Chile

Photo Robb Moss

Photo Robb Moss

Infrastructure – 2010 Chile

Photo Robb Moss

Photo Christian Ledezma

Photo Christian Ledezma

Photo Christian Ledezma

Site Effects

Soil Failure

Fault Rupture

Structure and Infrastructure

Infrastructure – 2010 Chile


Photo Robb Moss


Photo Robb Moss

Site Effects

Soil Failure

Fault Rupture

Structure and Infrastructure

Infrastructure – 2010 Chile

Photo Robb Moss

Photo Christian Ledezma

Structural Failure – 2015 Nepal

Site Effects

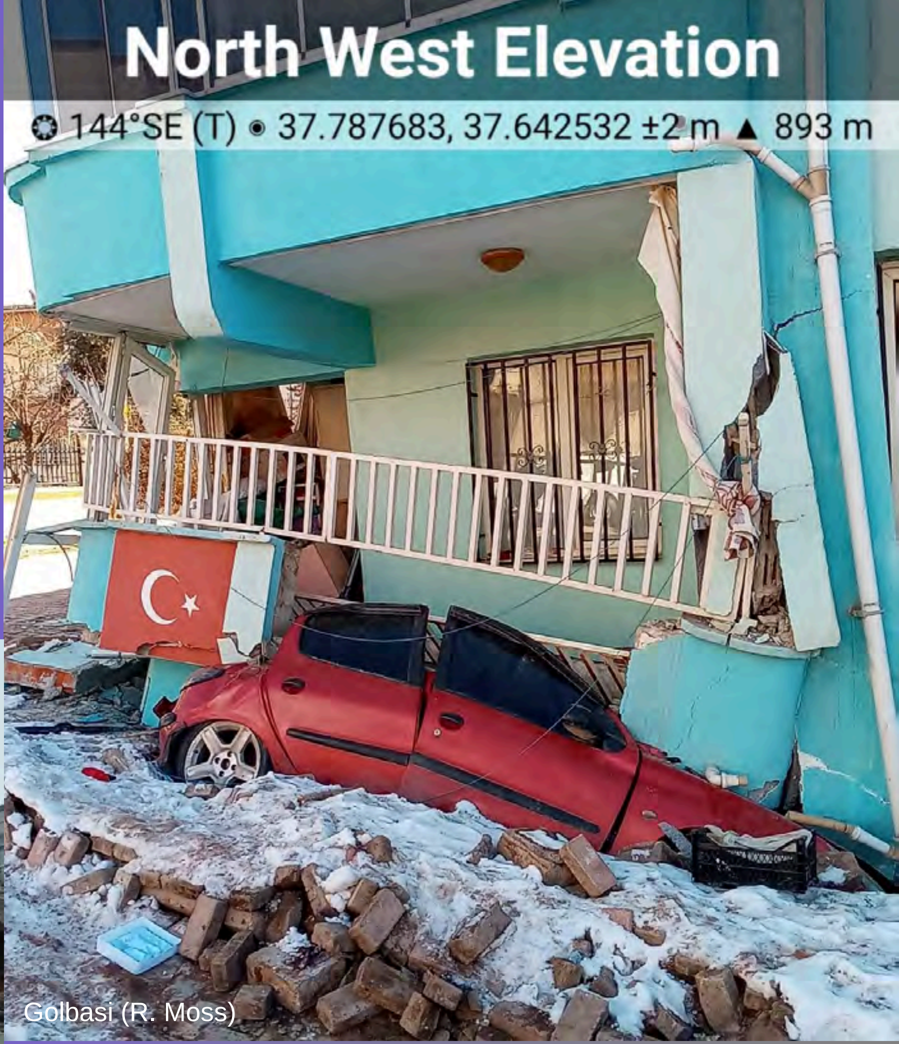
Soil Failure

Fault Rupture

Structure and Infrastructure

Structural Failure - 2023 Turkiye

Elbistan (R. Moss)



Golbasi (R. Moss)

Site Effects

Soil Failure

Fault Rupture

Structure and Infrastructure

Infrastructure - 2023 Turkiye

Sultansuyau (R. Moss)

Summary -
Earthquakes Effects and Hazards

+hazards:
ground shaking, soil failure, fault rupture, structural failure…

+implemented seismic design codes proven to work well

+infrastructure issues remain: highways, power, water, telecom

+hazard mitigation and emergency response critical

2025 Montana Geohazards Workshop

Kalispell – May 7-8, 2025

Past Montana Geohazards Workshops

April 28, 2022
Montana Tech – Butte

April 26-28, 2023
Fort Harrison – Helena

May 1-2, 2024
Univ. of Montana – Missoula

MBMG, DES, FEMA, EERI, UM, MDT, MSL, DNRC, DEQ, Missoula County, Lewis and Clark County, Beaverhead County, NOAA, National Security Emergency Preparedness, Rocky Mountain Lab, Bitterroot Irrigation District, Missoula Public Schools, Helena Public Schools, CalPoly, EarthScope, Cascade Region Earthquake Working Group, Resilience Action Partners, Representatives from Tester, Zinke, and Daines offices.

- Present updates from the MBMG Geohazards Program, various state agencies, and research programs.
- Information sessions on regional/local seismic hazards and risks.
- Earthquake Working Group and Seismic Safety Commission
- Synergies for collaborative projects and funding opportunities
- Earthquake tabletop exercises, training courses, and field trips.

Montana Earthquake Working Group (MEWG)

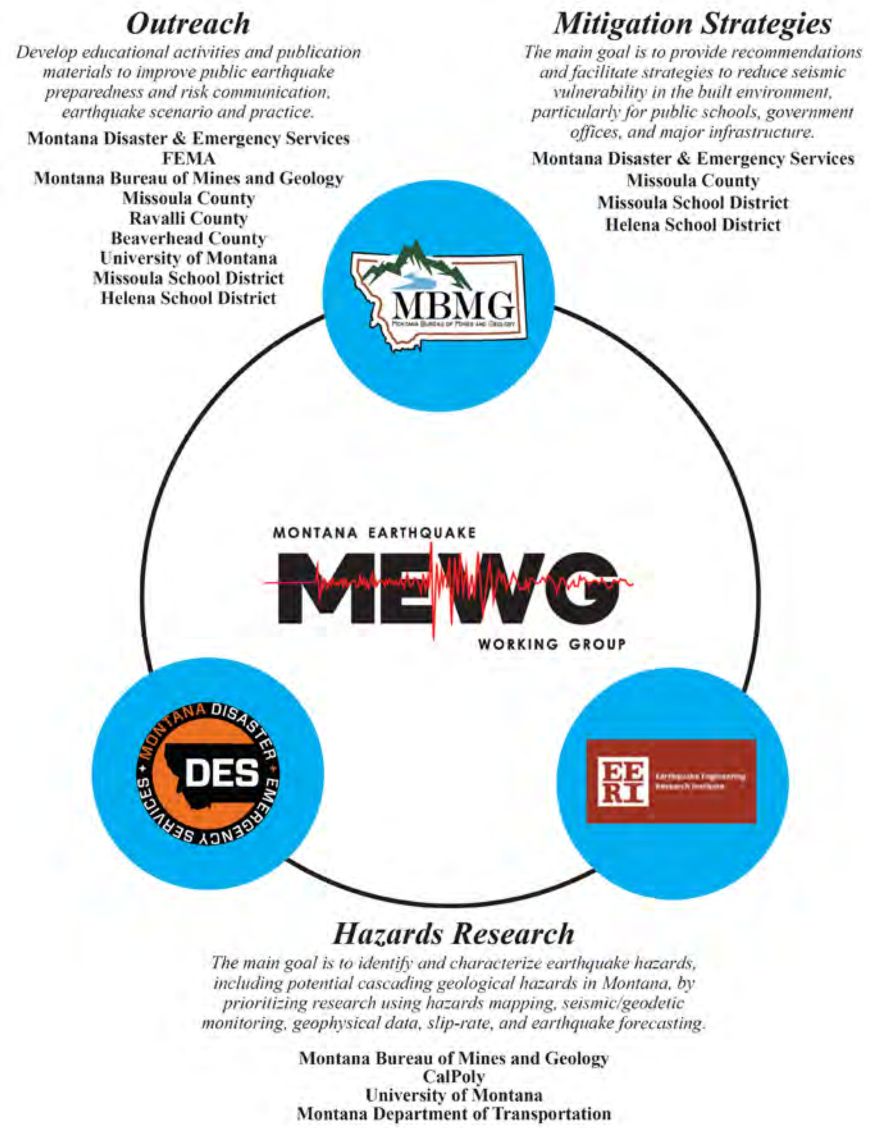
Mission Statement

The MEWG is a non-regulatory partnership of state and federal government agencies, universities, private-sector partners, and the people of Montana. Together, the MEWG will become Montana's go-to source of information for anyone concerned with earthquake safety in our state.

The group will research, advocate for, and promote mitigation actions to help reduce risk from earthquakes. It will offer information that people living in Montana can freely access and understand to help make sure everyone in Montana knows how to help save lives, protect property, and reduce the social and economic disruption caused by earthquakes and cascading natural hazards, such as landslides.

Interest Groups

•Hazards Research •Mitigation Strategies •Outreach



Montana Earthquake Working Group (MEWG)

Helena Public Schools
A great place to learn

HAGERTY

FEMA

School inventory for seismic retrofit

Bitterroot Mtns Virtual Reality Video

Public Information session on Bitterroot fault and earthquake hazards in the Bitterroot Valley.

Ravalli County
Bitterroot Valley

Resilience Action Partners
A JOINT VENTURE OF OGILVY & MICHAEL BAKER INTERNATIONAL

FEMA

County-wide earthquake preparedness campaign, support MEWG and annual Montana Geohazards Workshops

MBMG Geohazards Program

Yann Gavillot
Montana Bureau of Mines and Geology

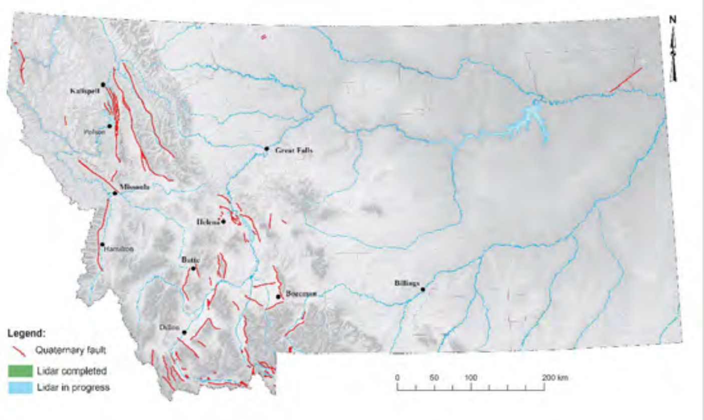
2025 Montana Geohazards Workshop: Kalispell May 8-9, 2025

MBMG Geohazards Program

Geohazards

The MBMG Geohazards Program has a mission to catalog, assess, and monitor geologic hazards across the state of Montana. The Geohazards Program strives to provide information on active faults, earthquakes, and landslides and makes these data available to scientific community, policy makers and the public.

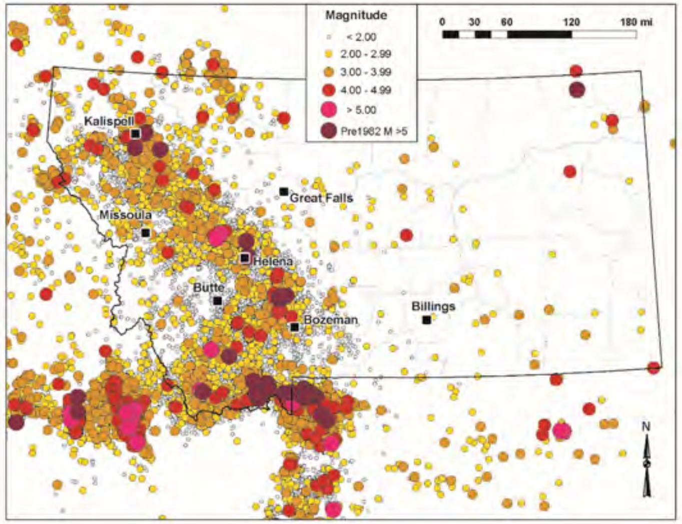
Active Faults



Active Fault Hazards Program

Active faults: The Active Fault Hazards Program provide research and information of Montana's active faults that demonstrate fault activity during the recent geologic time (Quaternary faults) and have the potential to generate damaging earthquakes.

Earthquakes



Earthquake Studies Program

Earthquakes: The Earthquake Studies Office monitors, analyses, and report on Montana earthquakes to and makes these data available to the scientific community and the public.

Landslides

Landslides Hazards Program

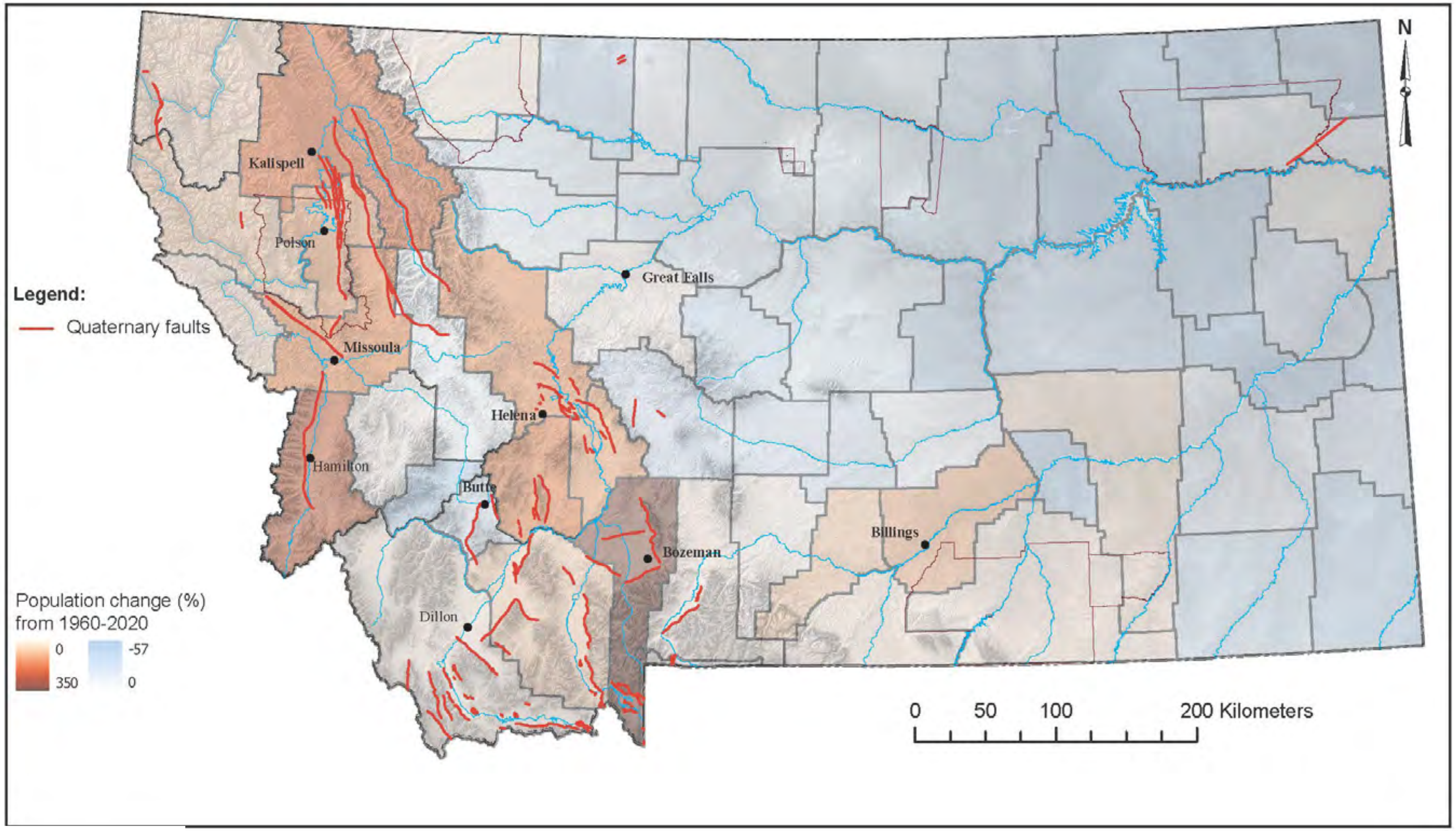
Landslides: The Landslide Hazards Program aims to identify, map, and categorize landslide areas across the state of Montana.

<u>Program information</u>: Yann Gavillot, Mike Stickney

Geohazards Support Team: Colleen Elliott, Mandy Willingham, Ray Salazar, John Sanford, Henry Stahl, Yiwen Li, Trish Ekberg

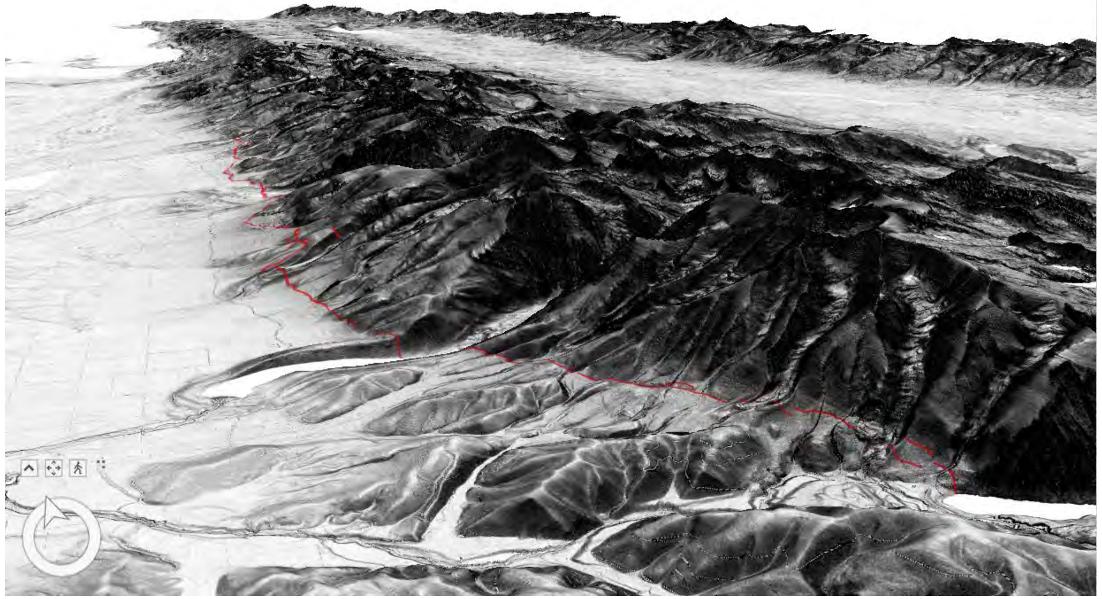
Geological Hazards studies in Montana

(FEMA-NEHRP, MTDES, USGS-NEHRP, USGS-STATEMAP)

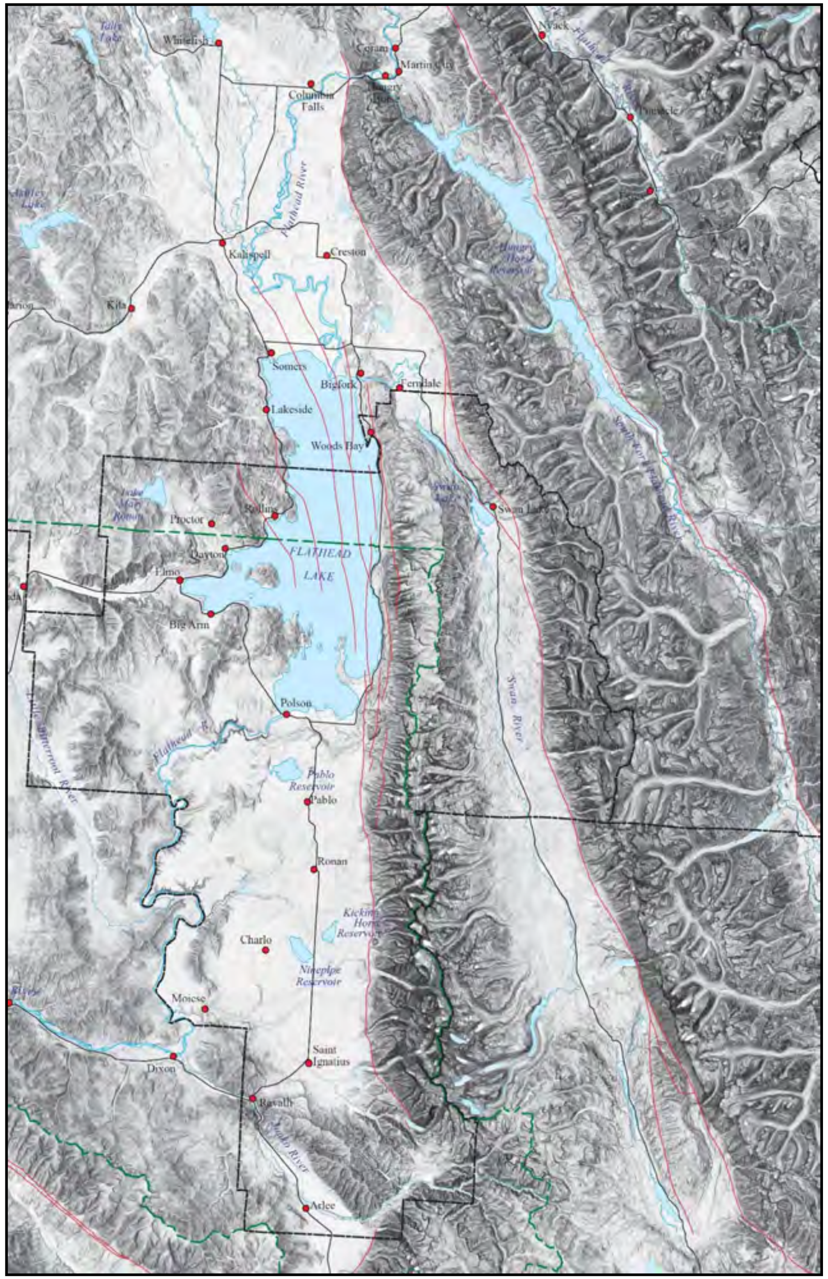



Bitterroot fault scarp


Hebgen Lake fault scarp
1959 M7.3 Earthquake

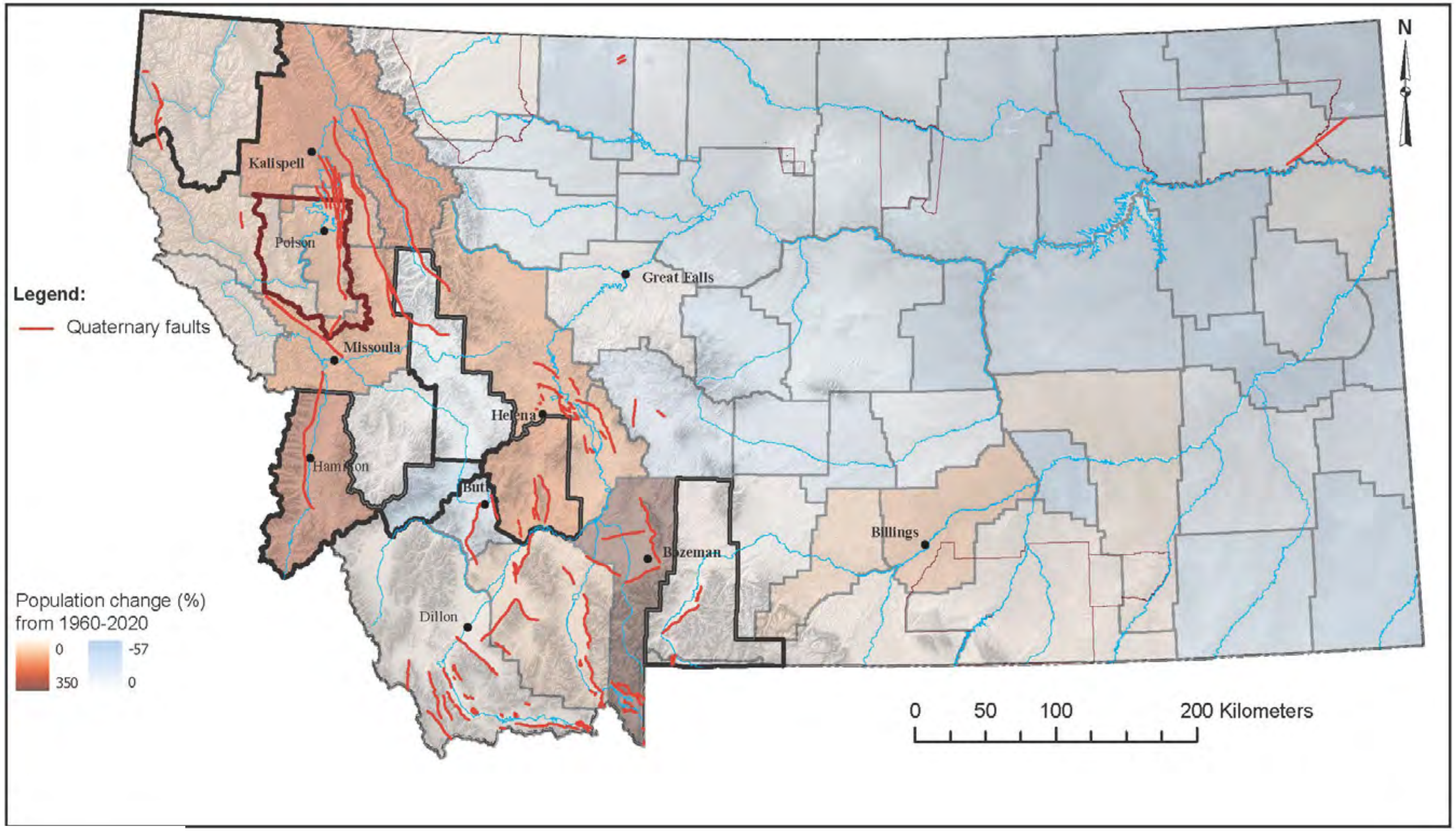



Mission fault scarp

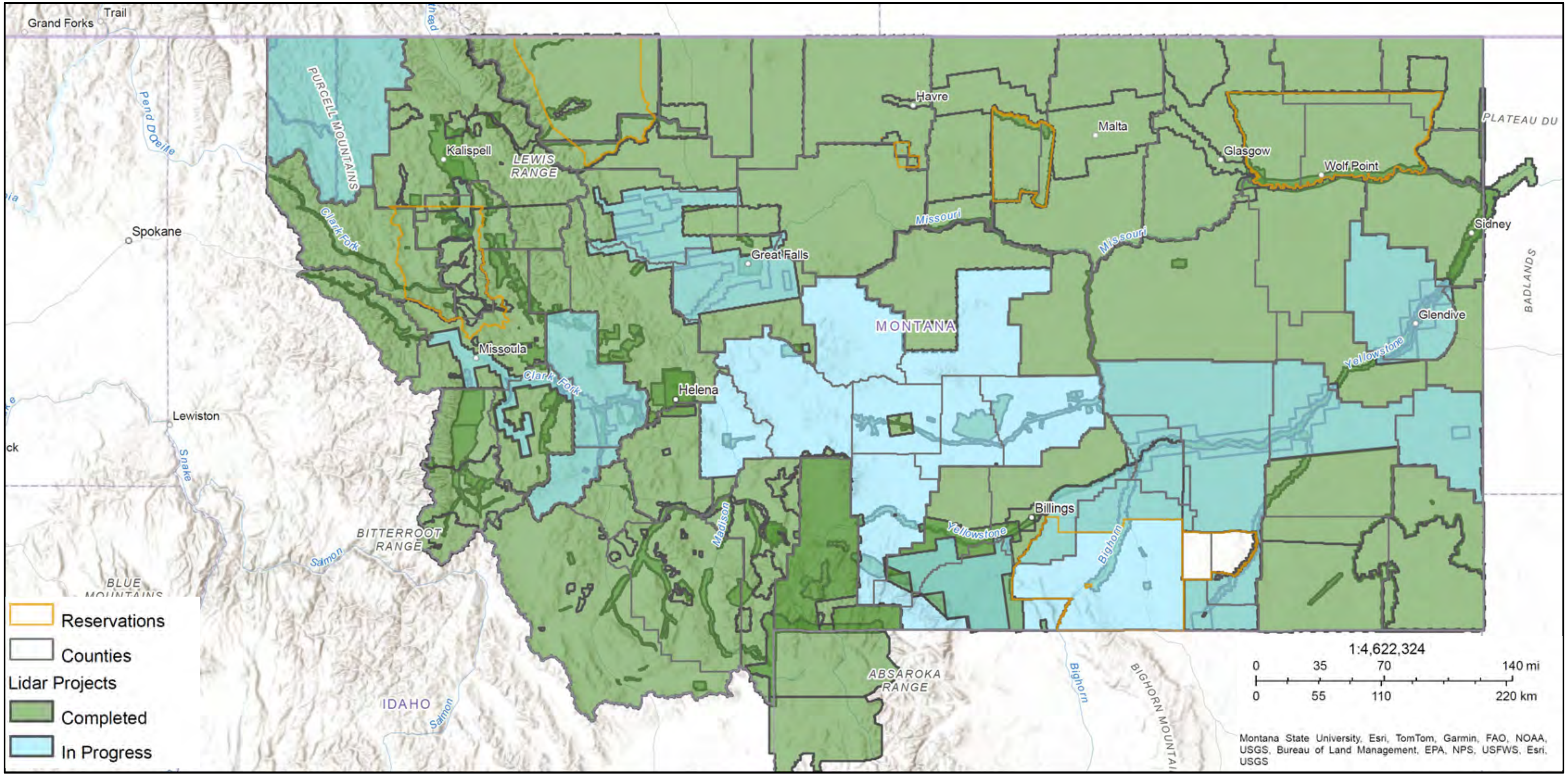

Whitefish
Columbia Falls
Flathead River
Kalispell
Creston
Kila
Somers
Bigfork
Ferndale
Lakeside
Woods Bay
Proctor
Rollins
Dayton
Elmo
FLATHEAD
LAKE
Big Arm
Swan Lake
Polson
Swan River
Pablo Reservoir
Pablo
Ronan
Charlo
Ninepipe Reservoir
Moiese
Saint Ignatius
Dixon
Ravalli
Arlee

Geological Hazards studies in Montana

(FEMA-NEHRP, MTDES, USGS-NEHRP, USGS-STATEMAP)

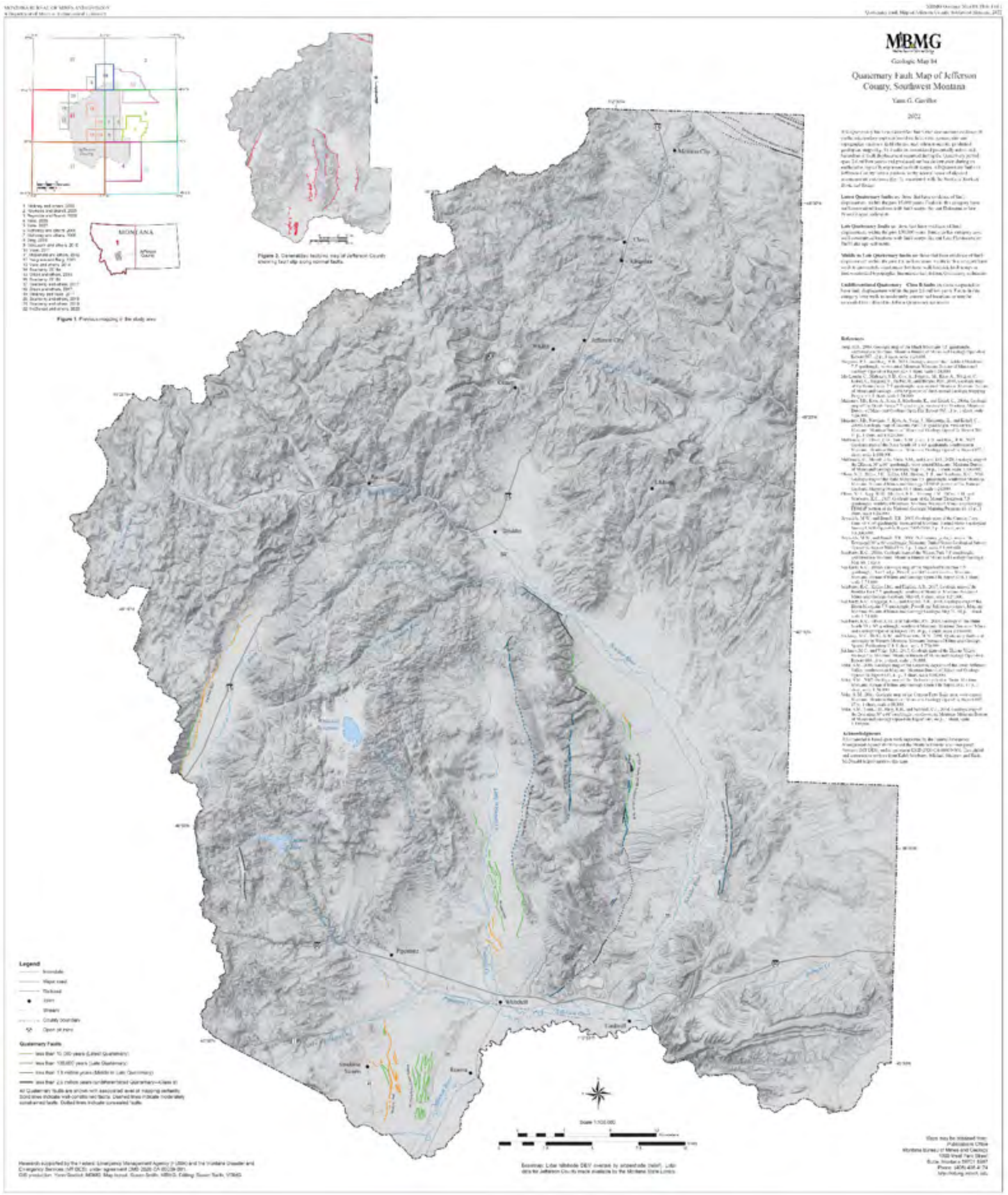


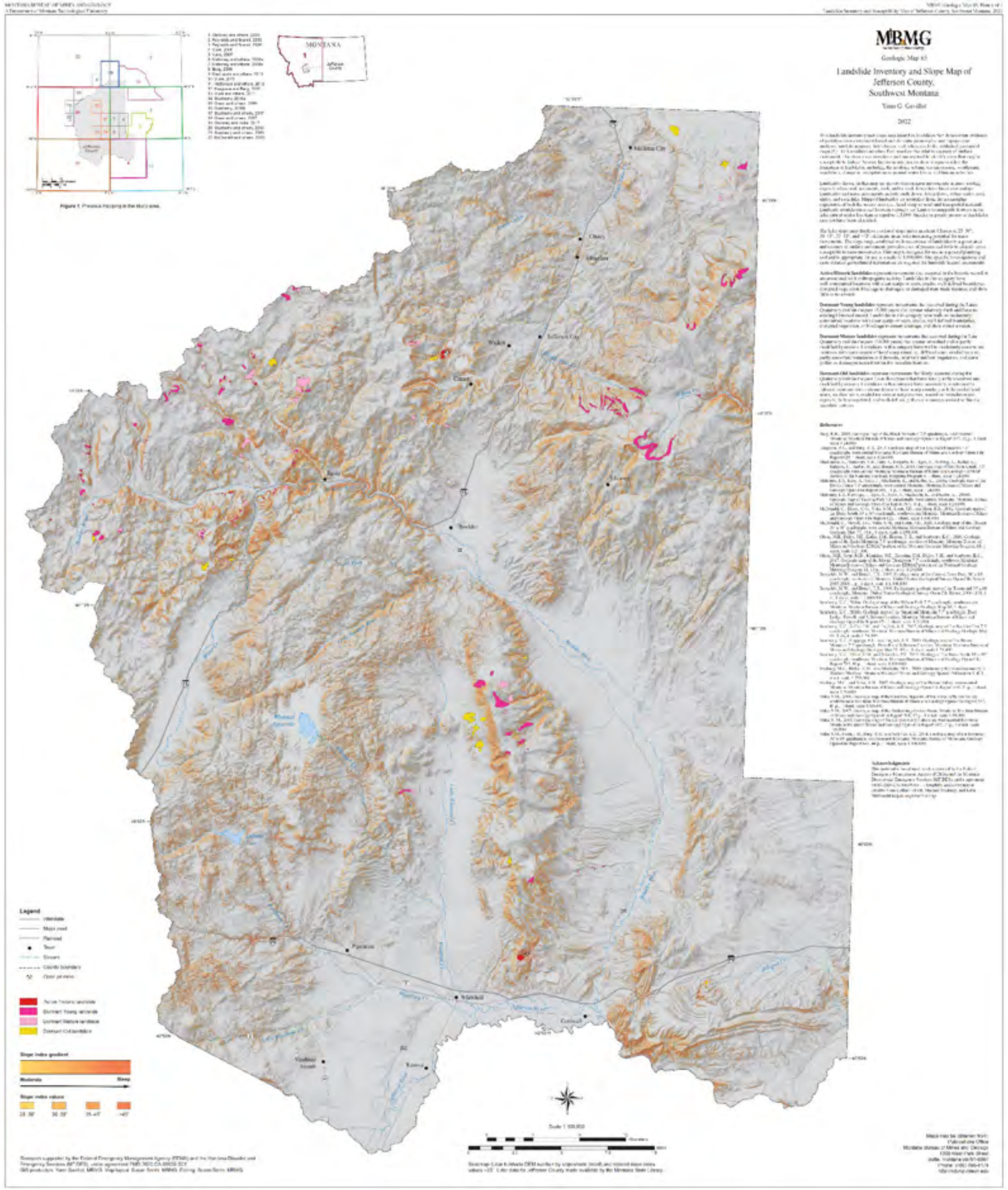
Lidar 2025 update



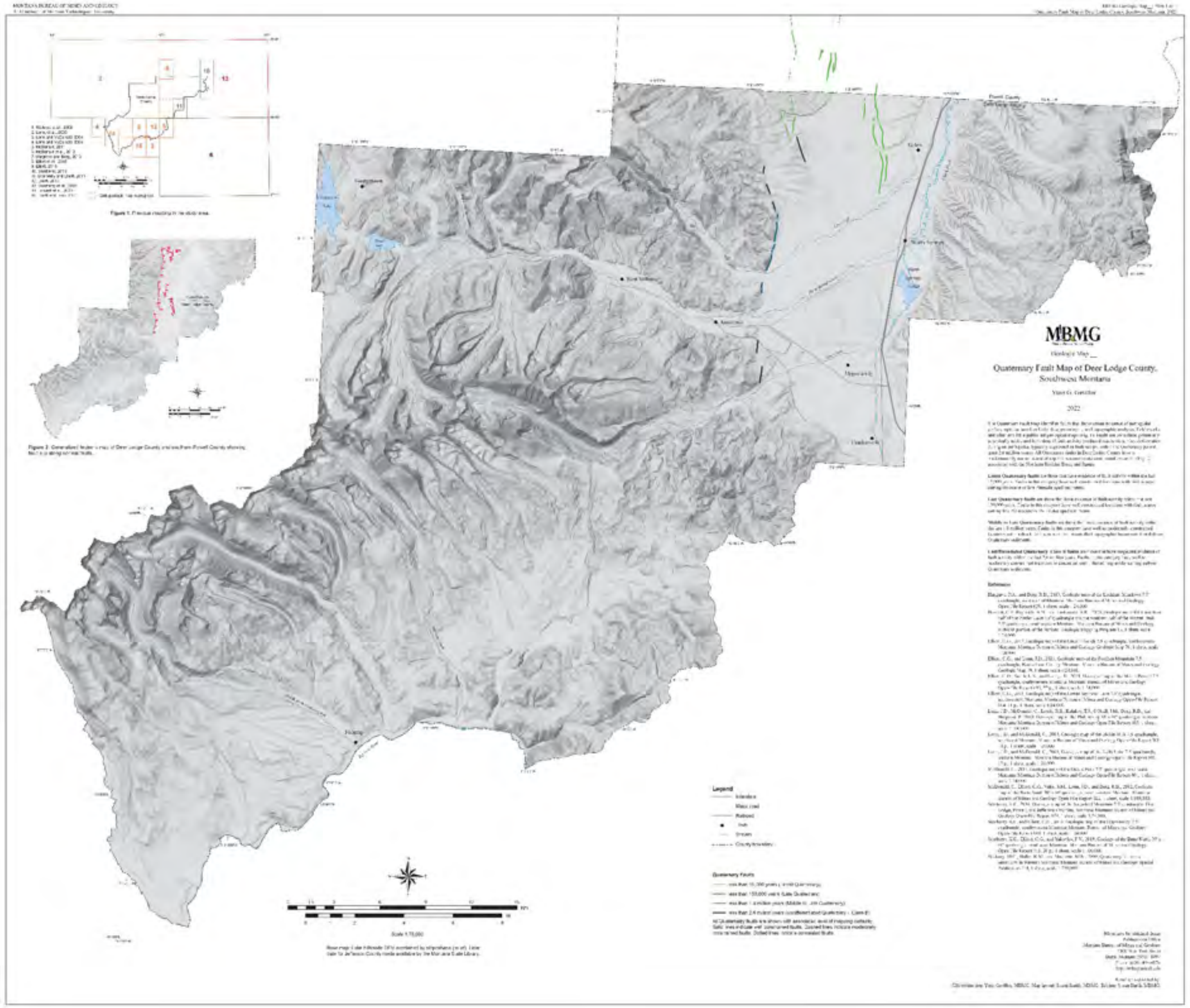
Montana State Library (USGS 3DEP, various partners)

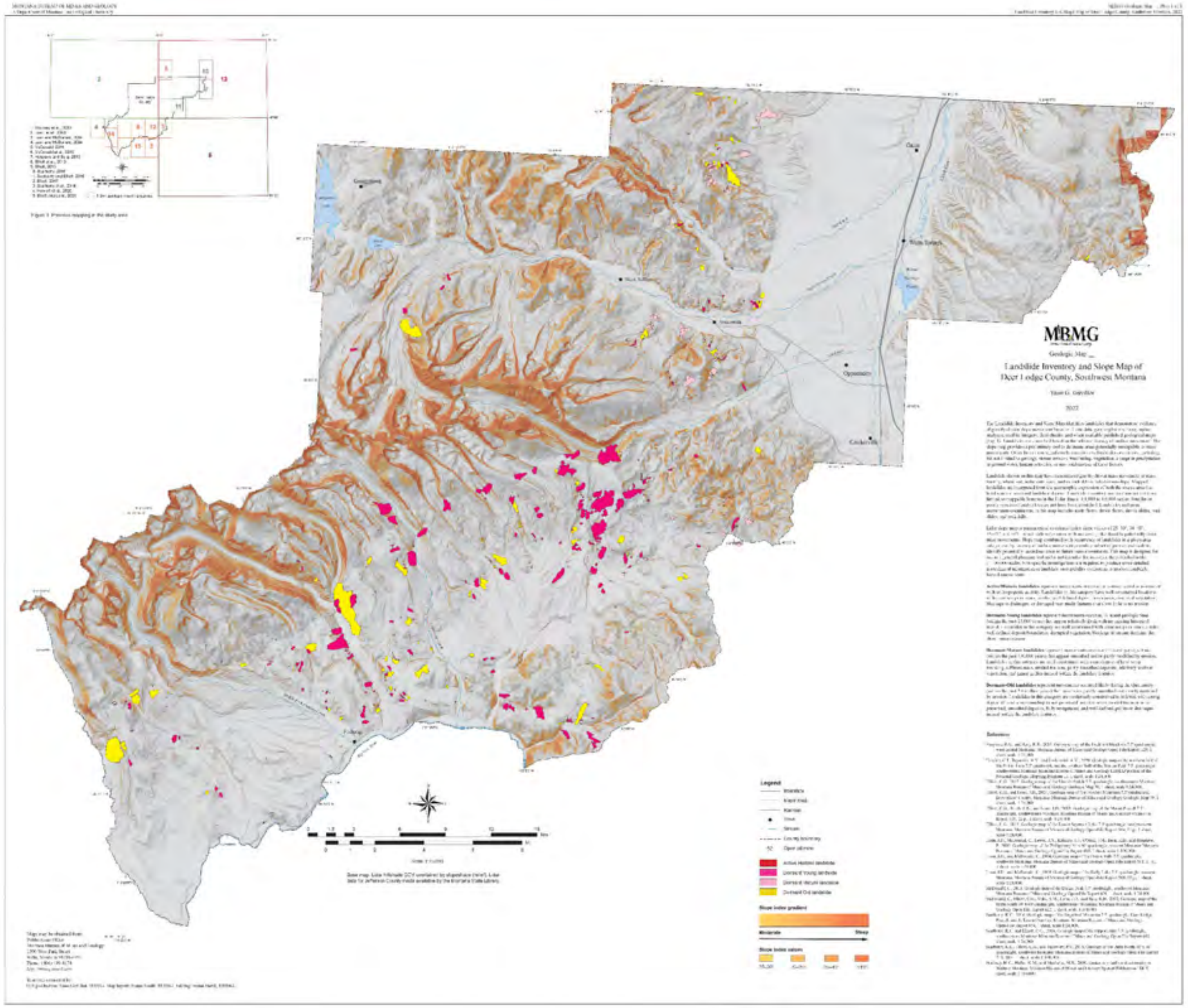
Quaternary Fault and Landslide Hazard Maps – Jefferson County



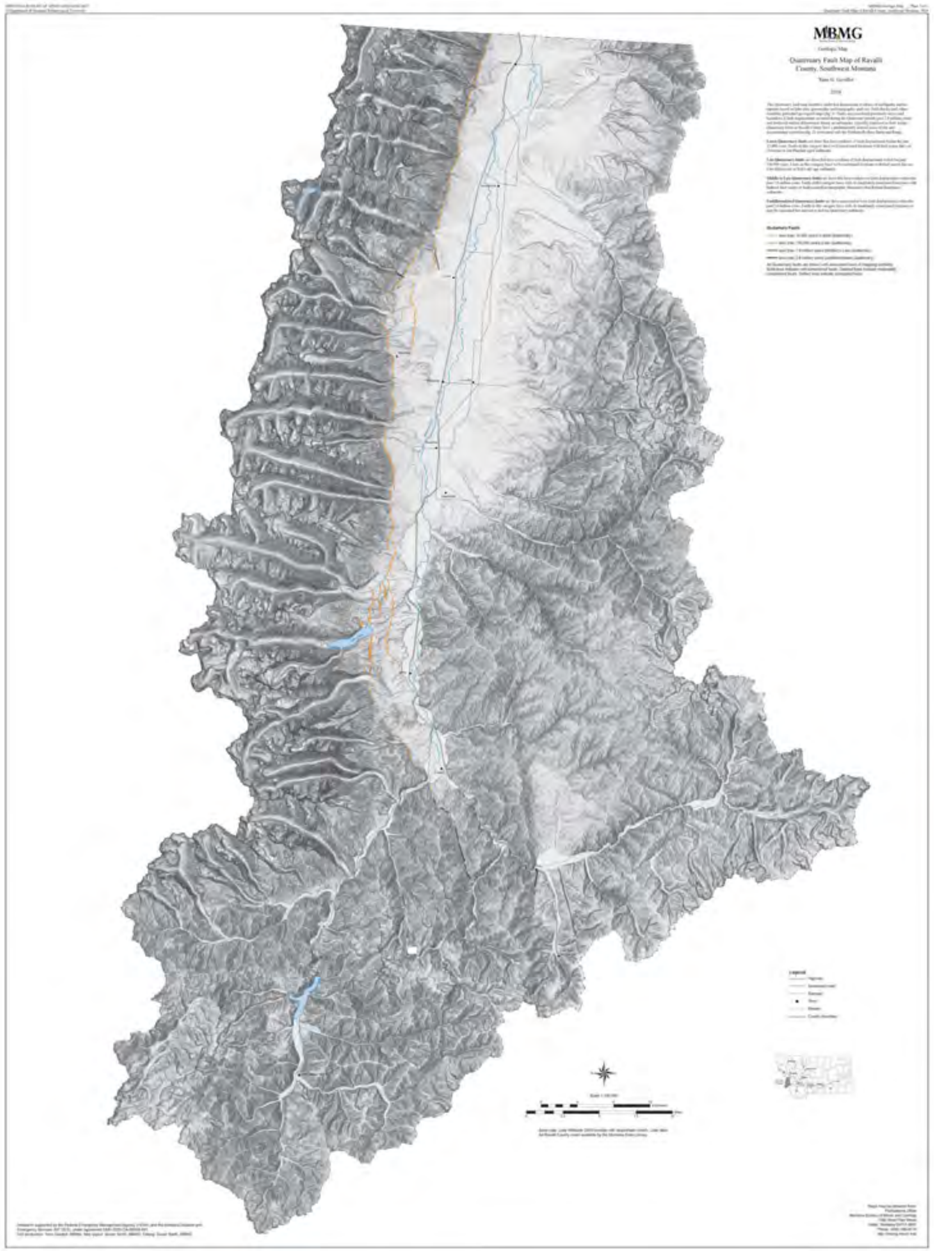


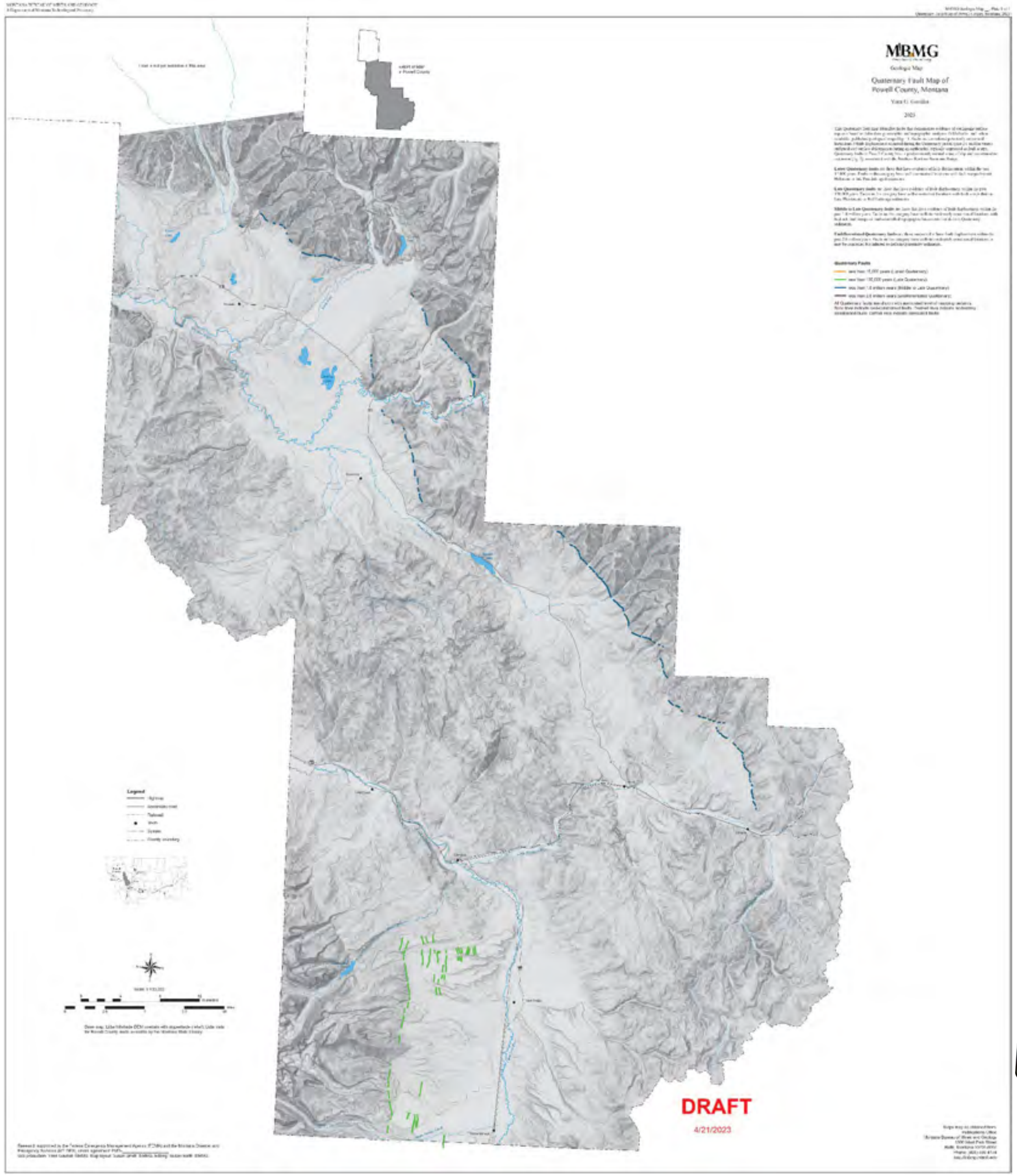
Quaternary Fault and Landslide Hazard Maps – Deer Lodge County



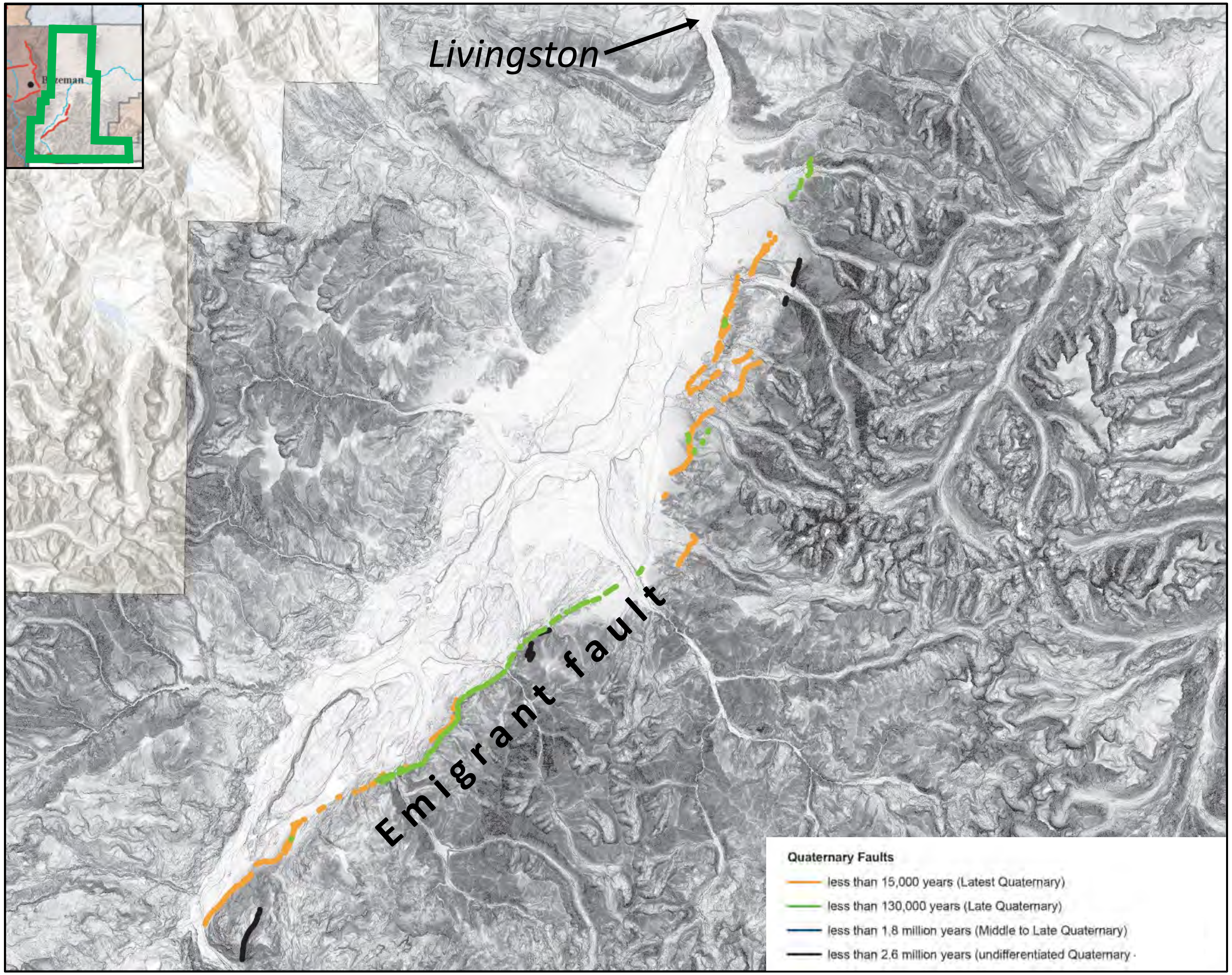


Quaternary Fault and Landslide Hazard Maps
Ravalli and Powell Counties





Quaternary Fault and Landslide Hazard Maps – Park County



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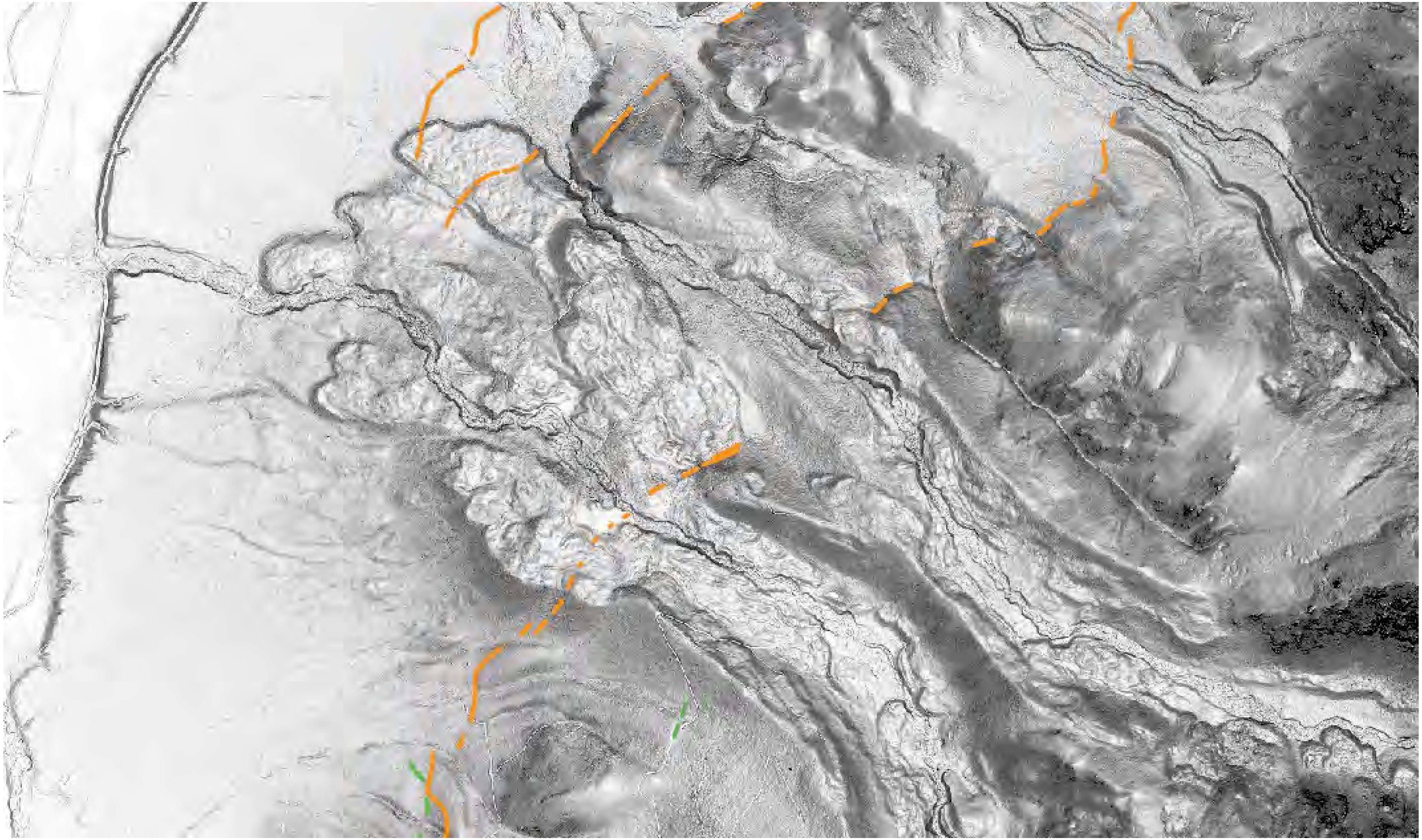
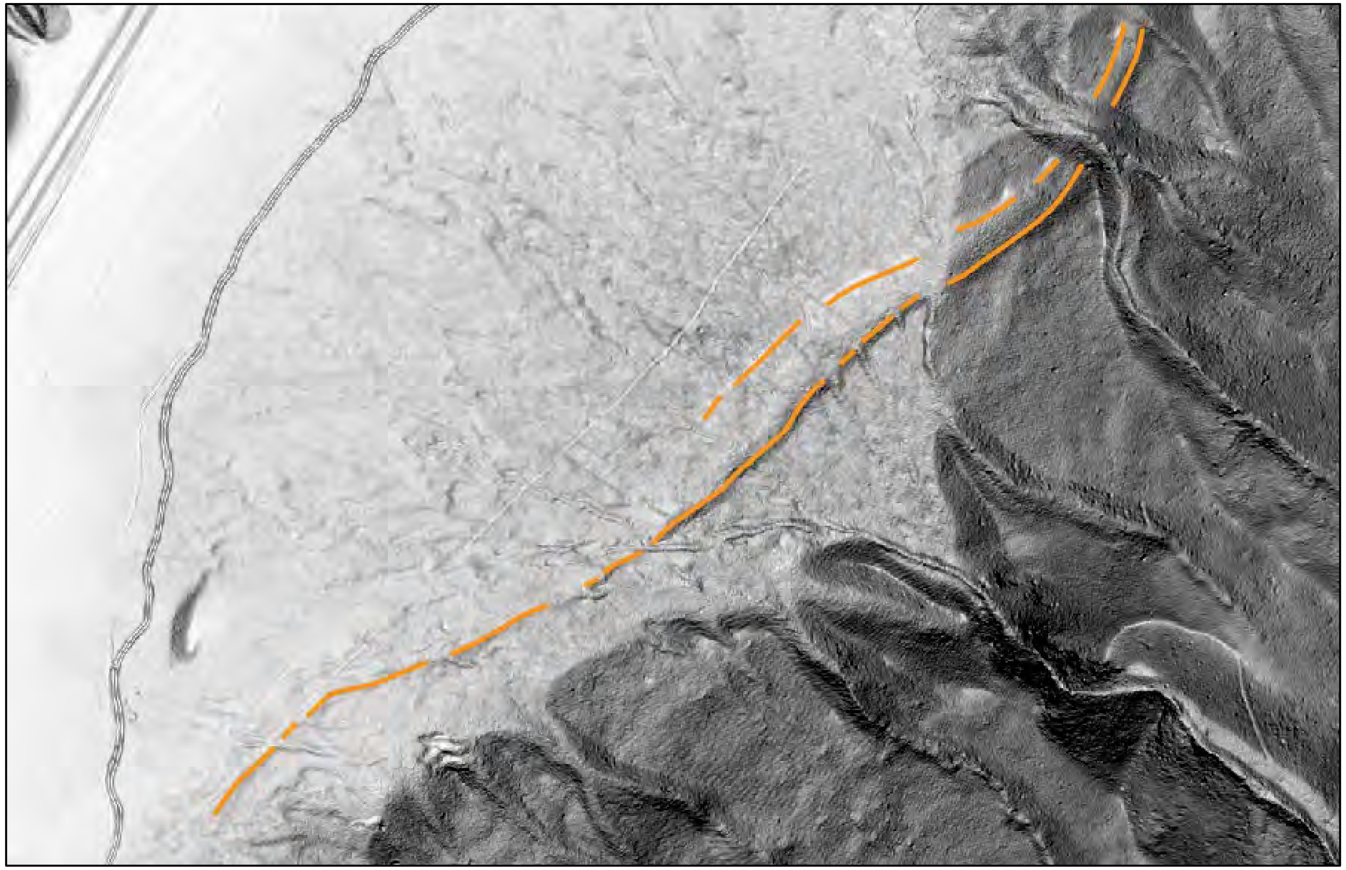
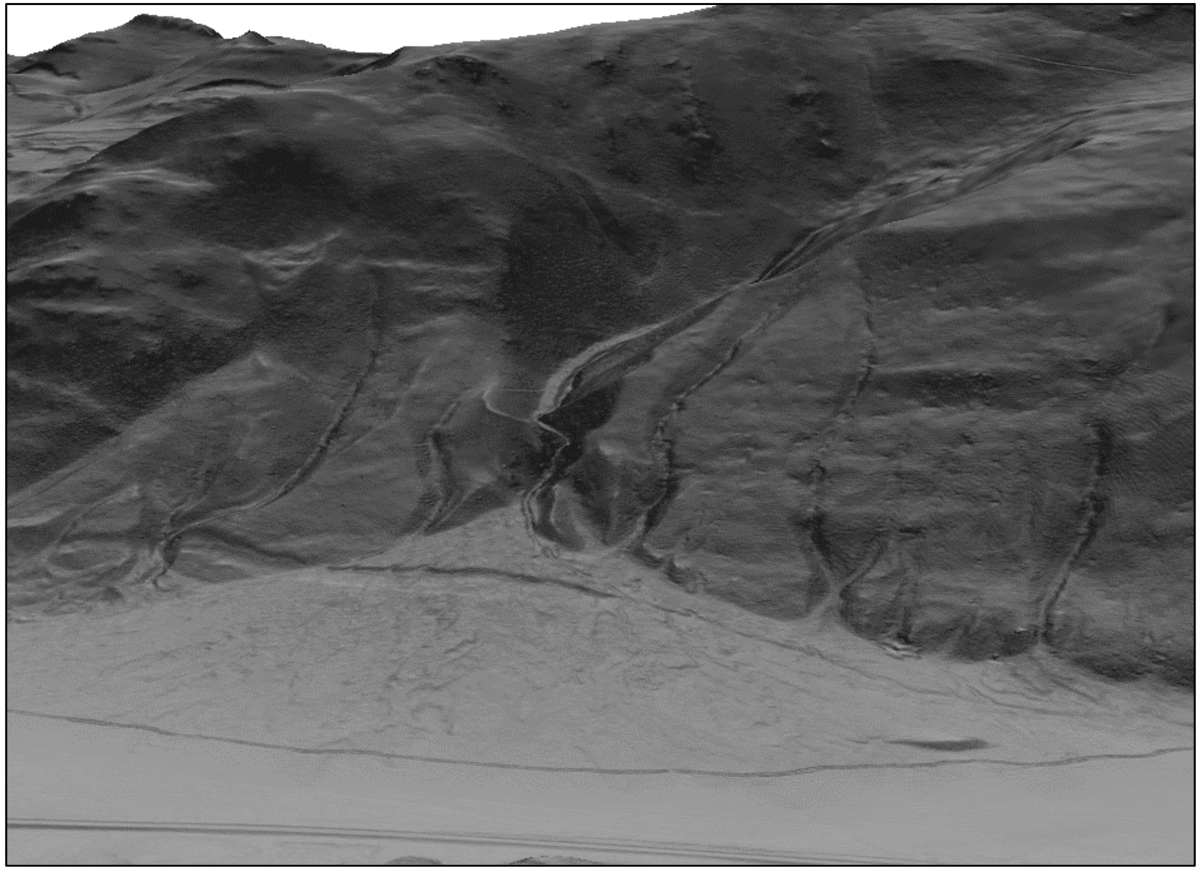
Quaternary Fault Mapping

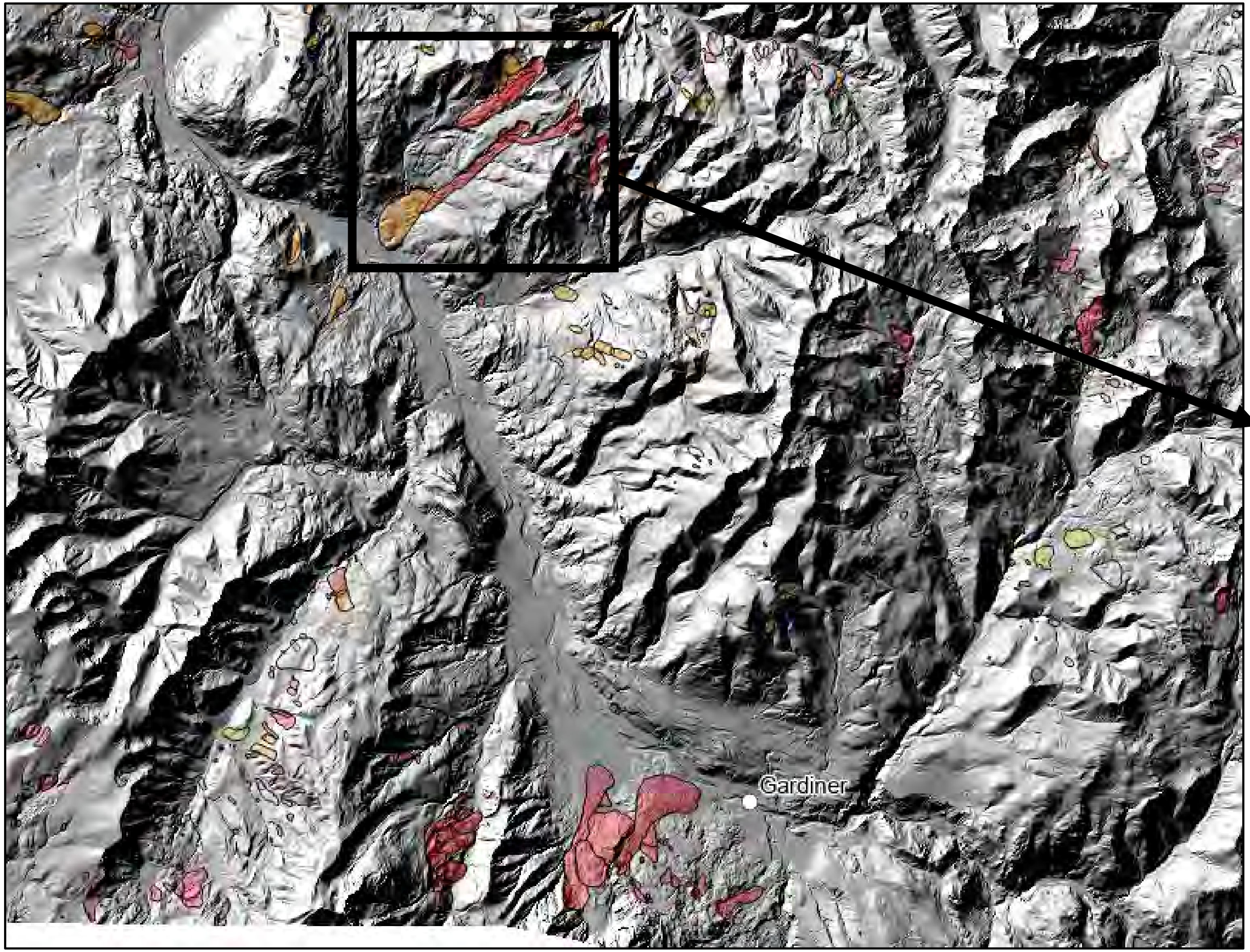


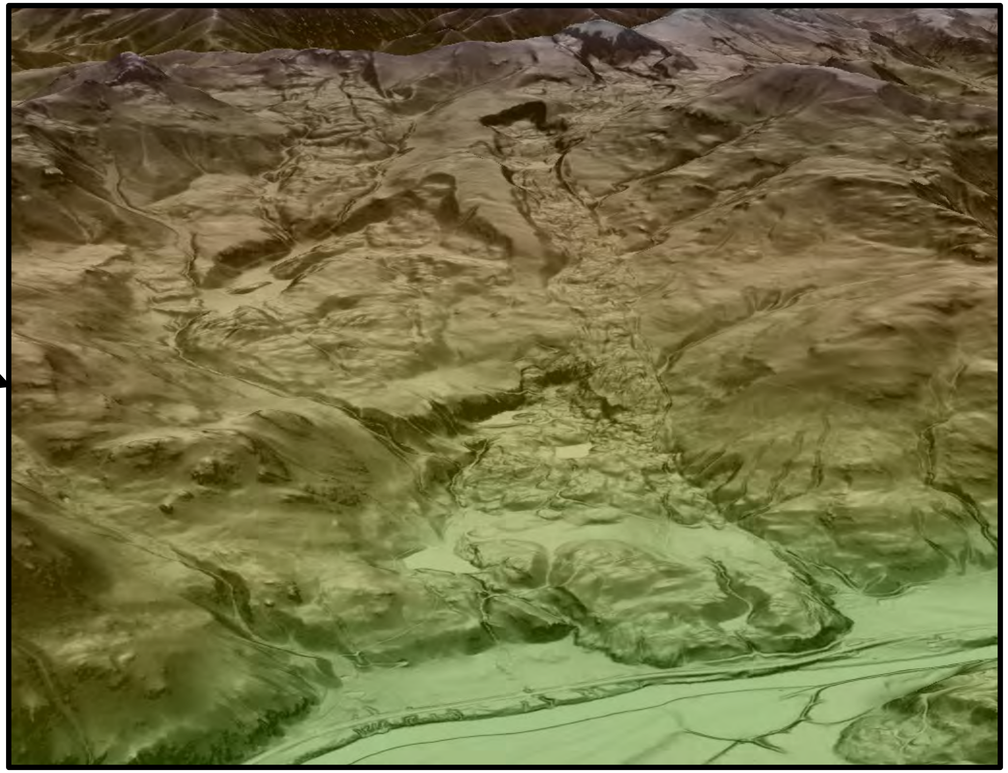
Quaternary Fault Mapping



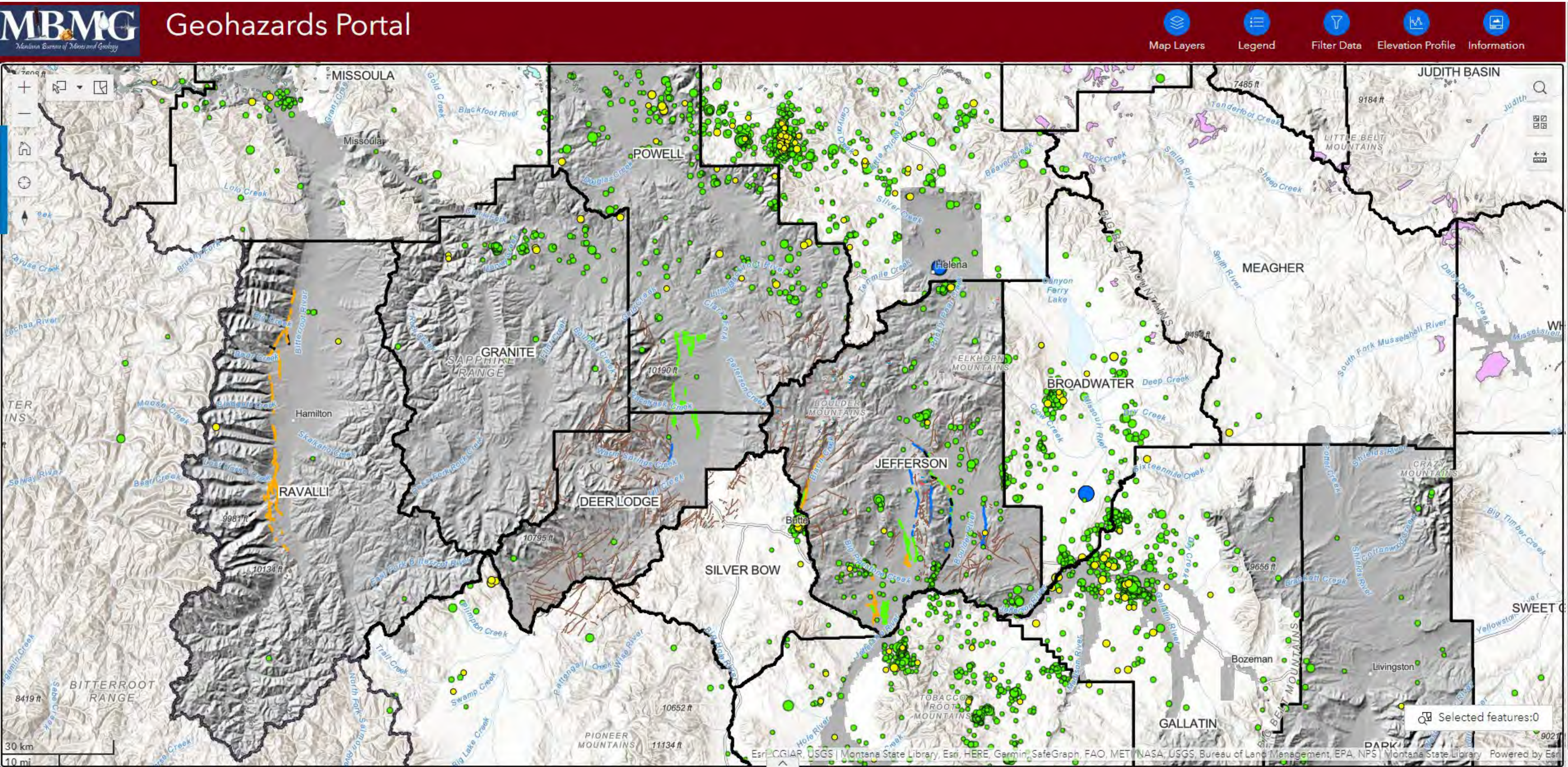


Landslide Mapping

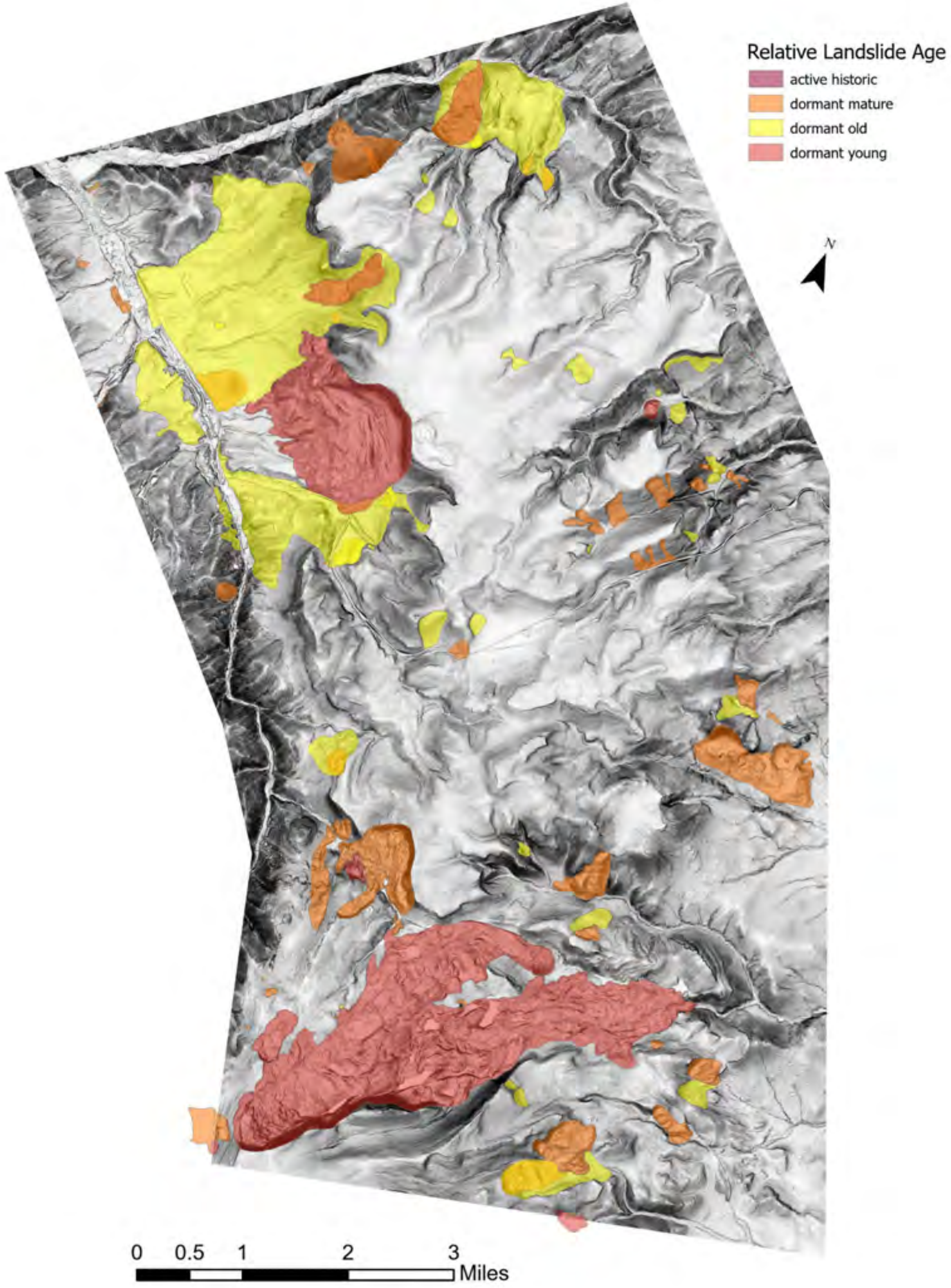


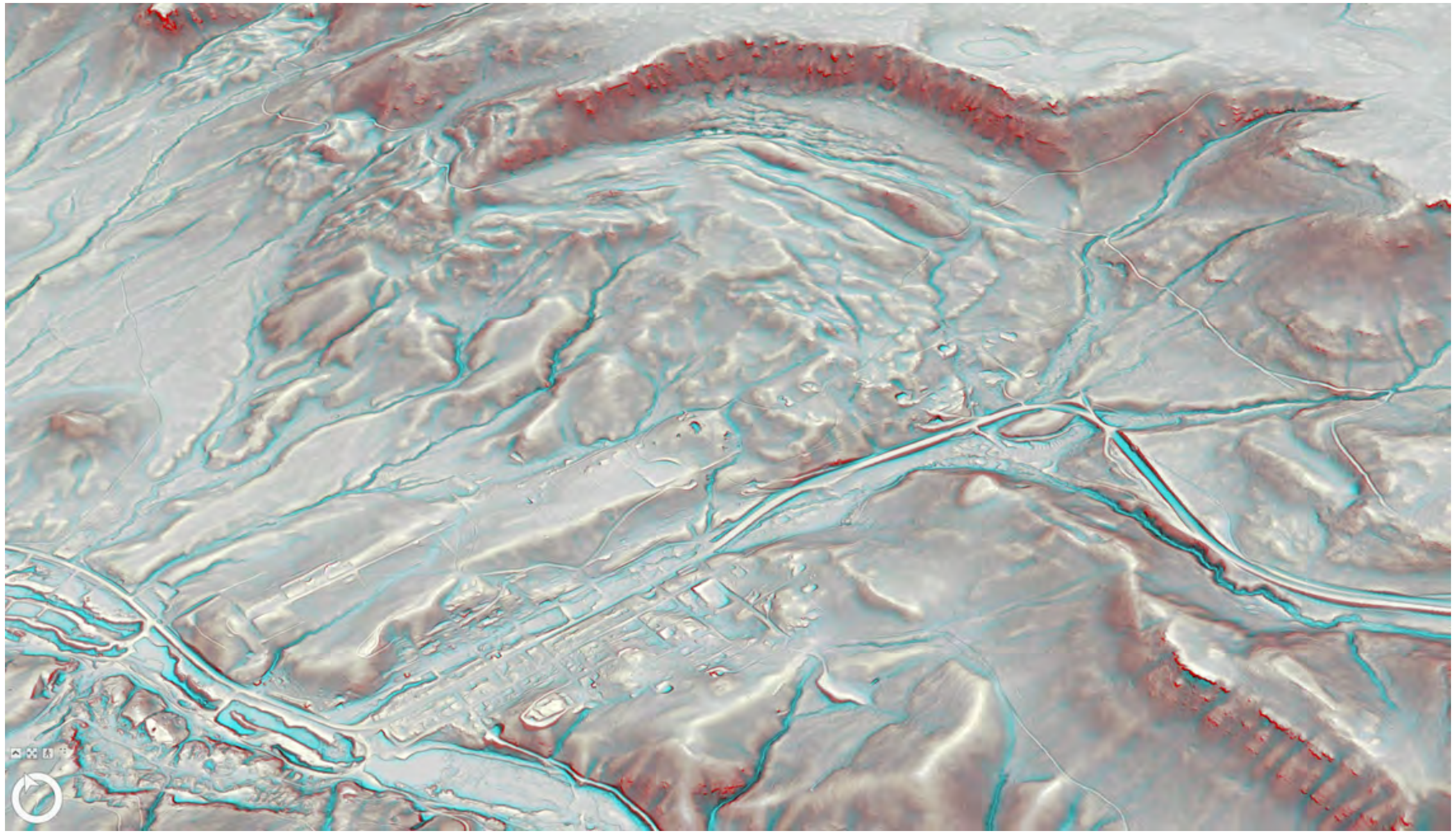


GIS Hub Site - Geohazards Portal

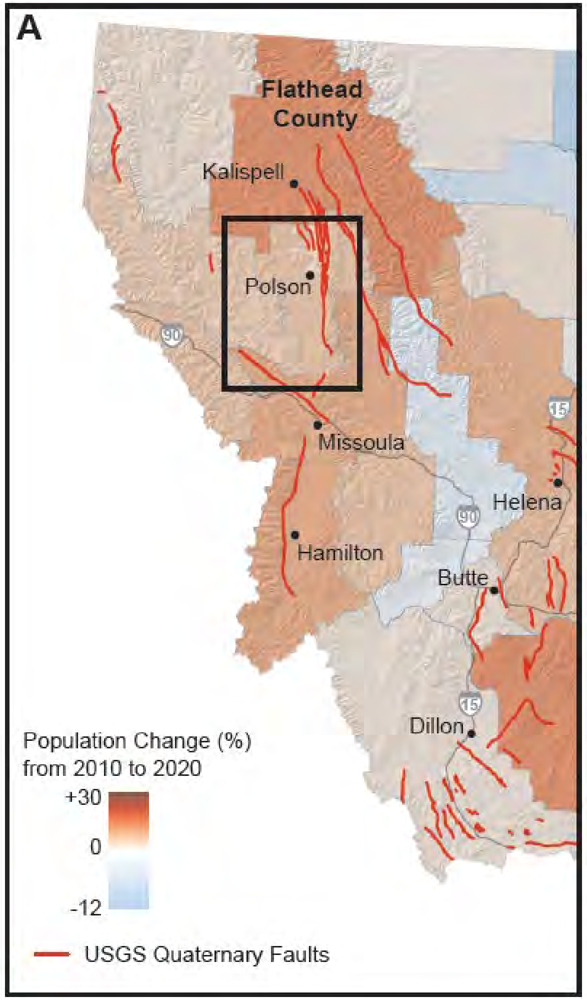


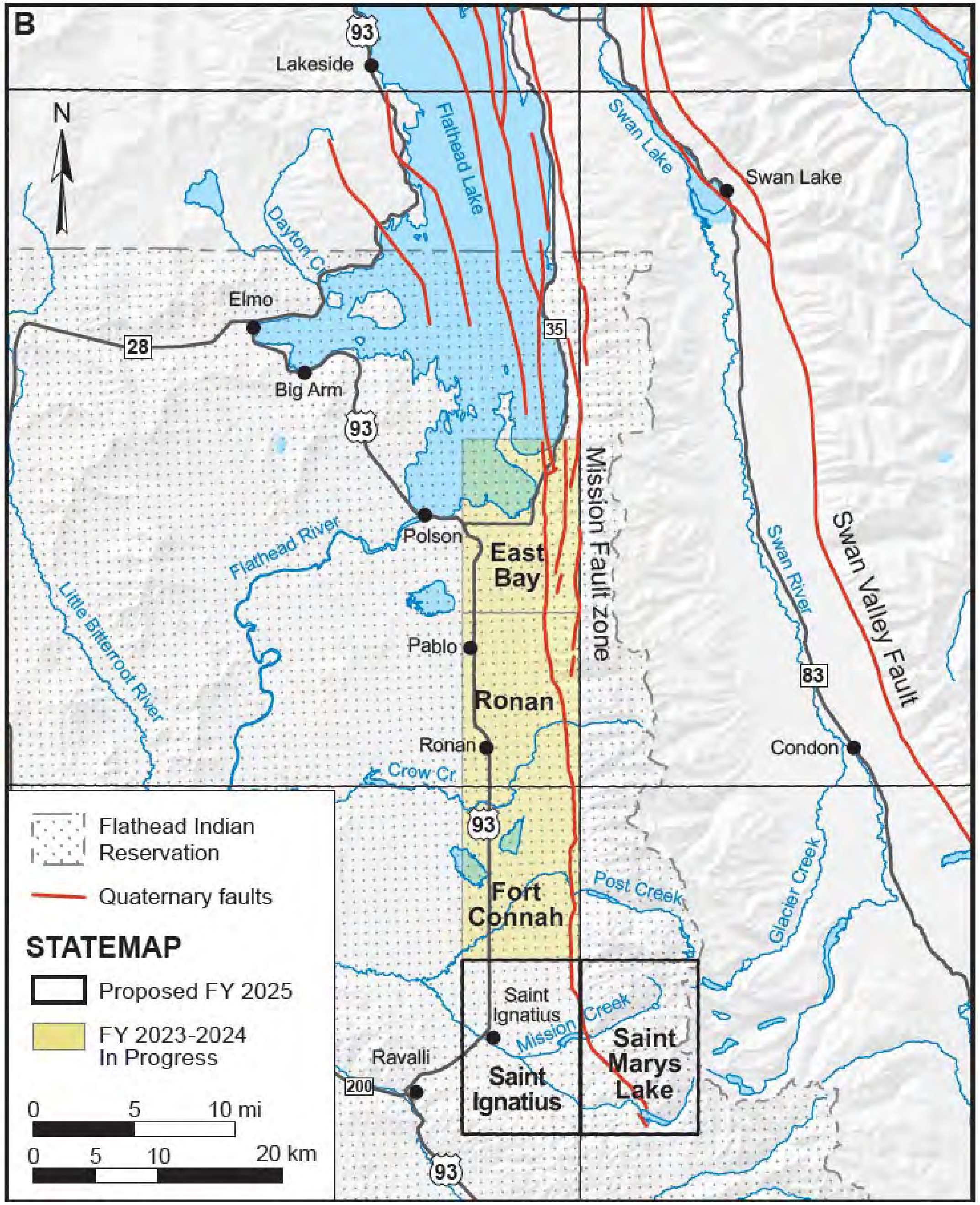
STATEMAP - Virginia City Landslide Mapping





STATEMAP - Geological Mapping of the Mission fault

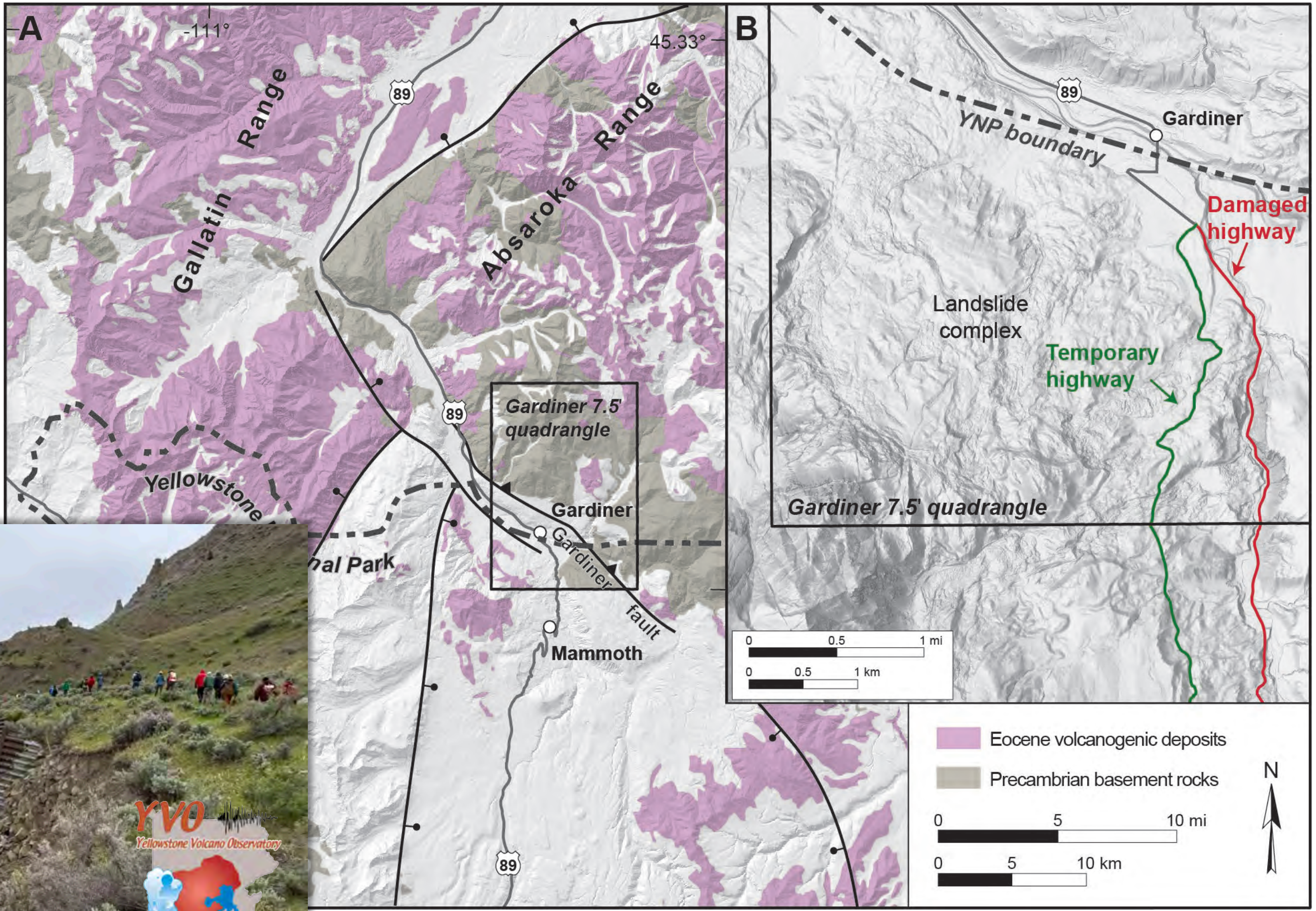




STATEMAP FY25

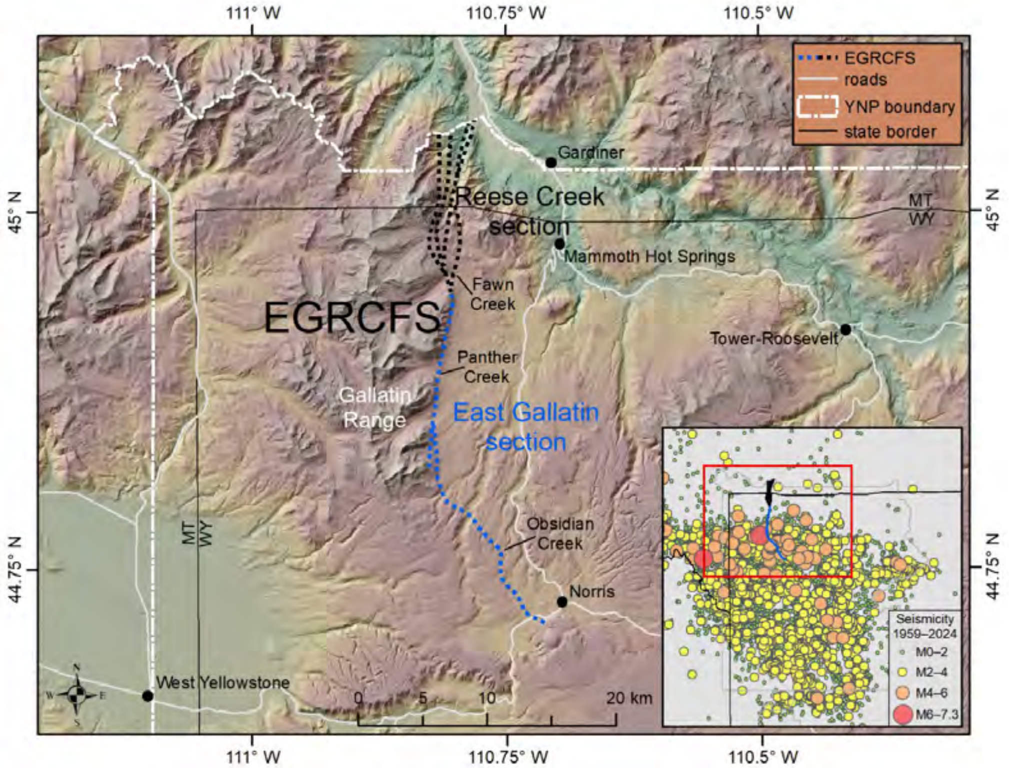
Gardiner project

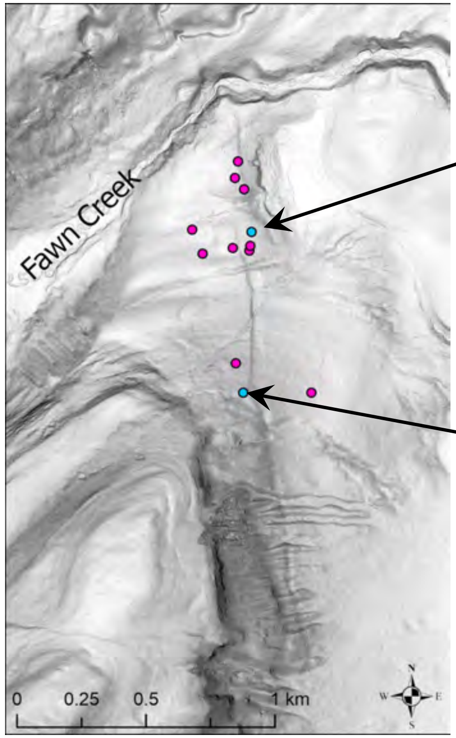
- 24k scale mapping
- Geohazards (mass wasting)
- Volcano-sedimentary stratigraphy
- Geochronology and geochemistry



MBMG-WSGS Collaboration in North Yellowstone NP (USGS NEHRP)

East Gallatin-Reese Creek fault system project

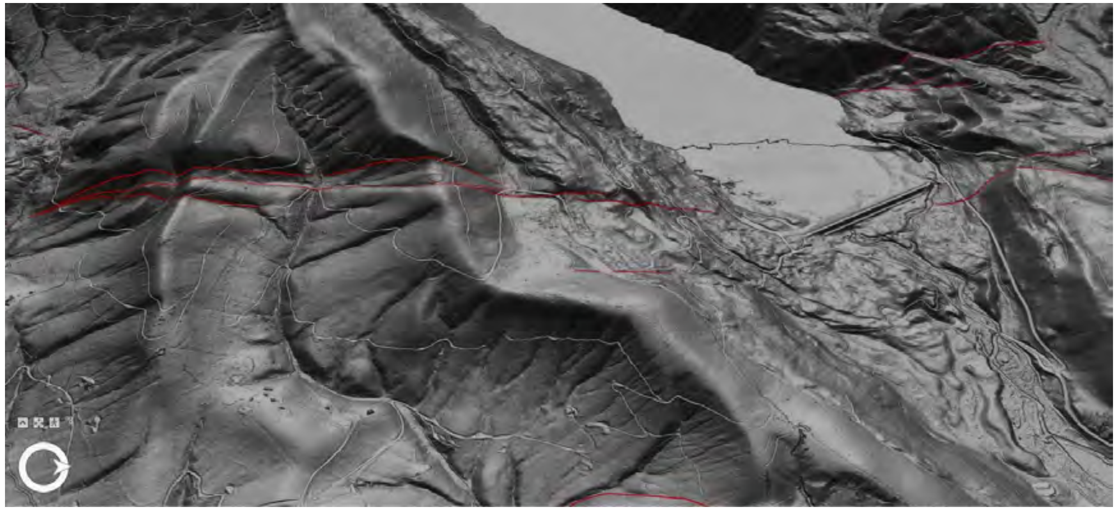


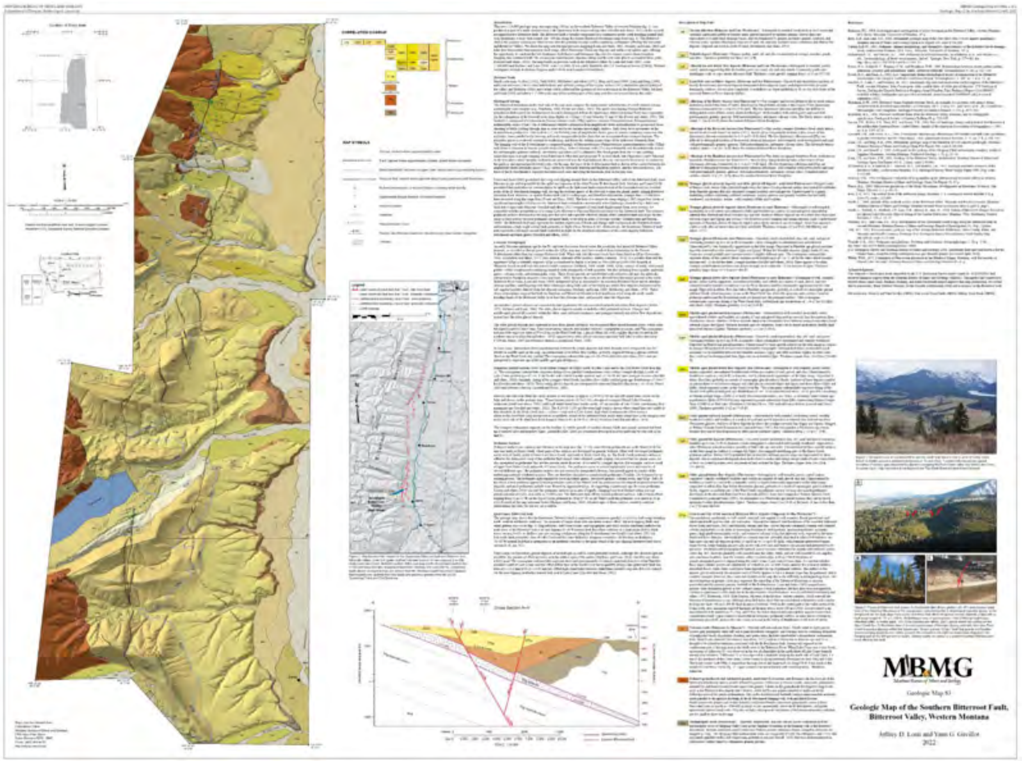


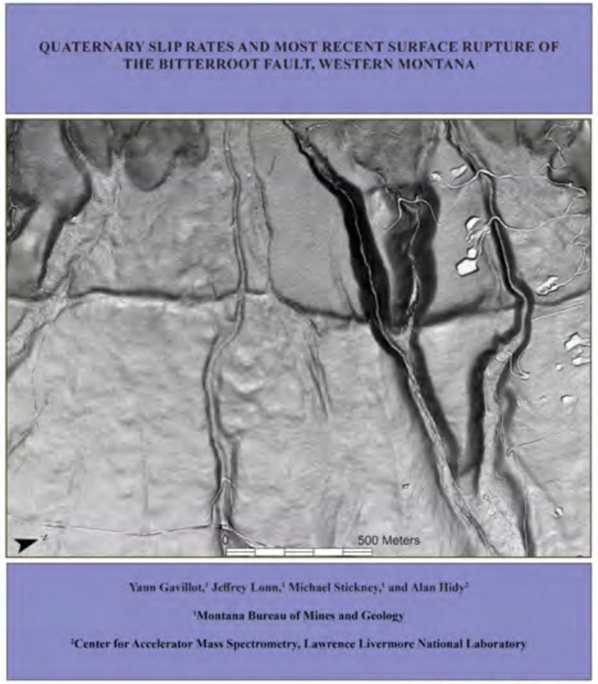
YG23YELL-FC02
14.1 ± 0.6 ka

YG23YELL-FC01
14.2 ± 0.6 ka

Earthquake Hazards of the Bitterroot Valley (NEHRP, BoR, USGS)






February 2023

Montana Bureau of Mines and Geology Bulletin 142

QUATERNARY SLIP RATES AND MOST RECENT SURFACE RUPTURE OF THE BITTERROOT FAULT, WESTERN MONTANA

500 Meters

Yann Gavillot,[1] Jeffrey Lonn,[1] Michael Stickney,[1] and Alan Hidy[2]

[1]Montana Bureau of Mines and Geology

[2]Center for Accelerator Mass Spectrometry, Lawrence Livermore National Laboratory

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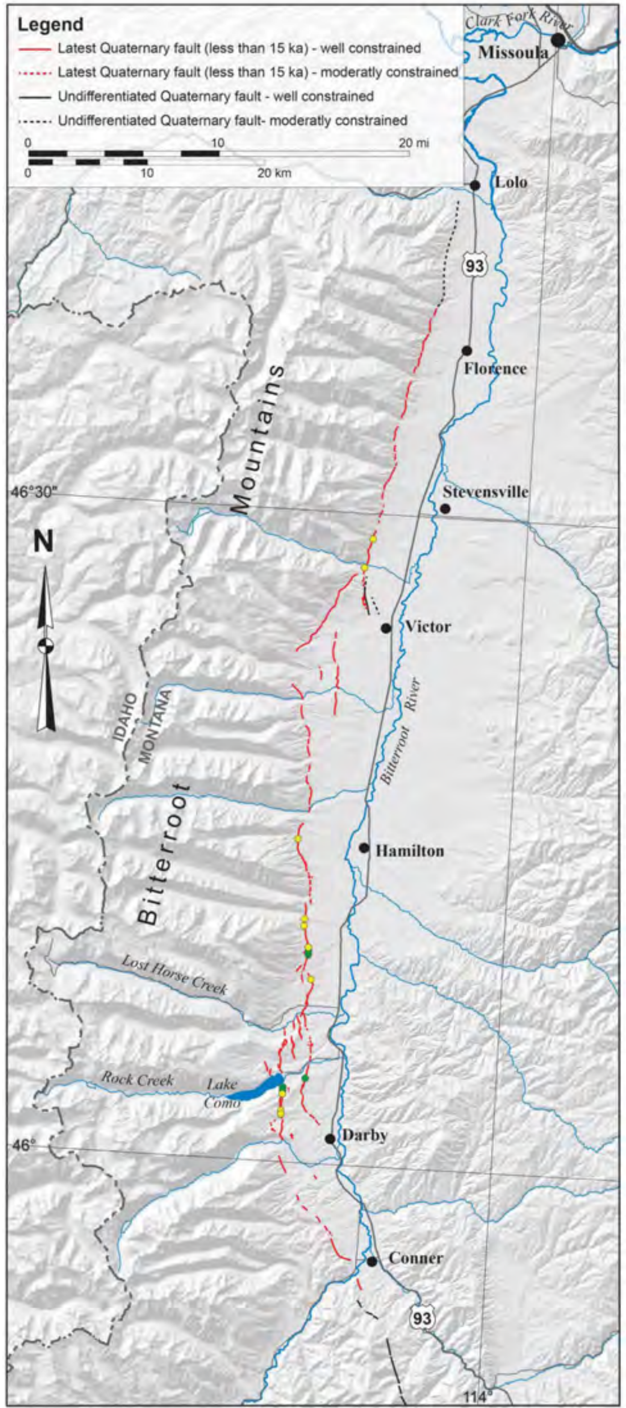
Bitterroot Fault Slip Rate – New updates



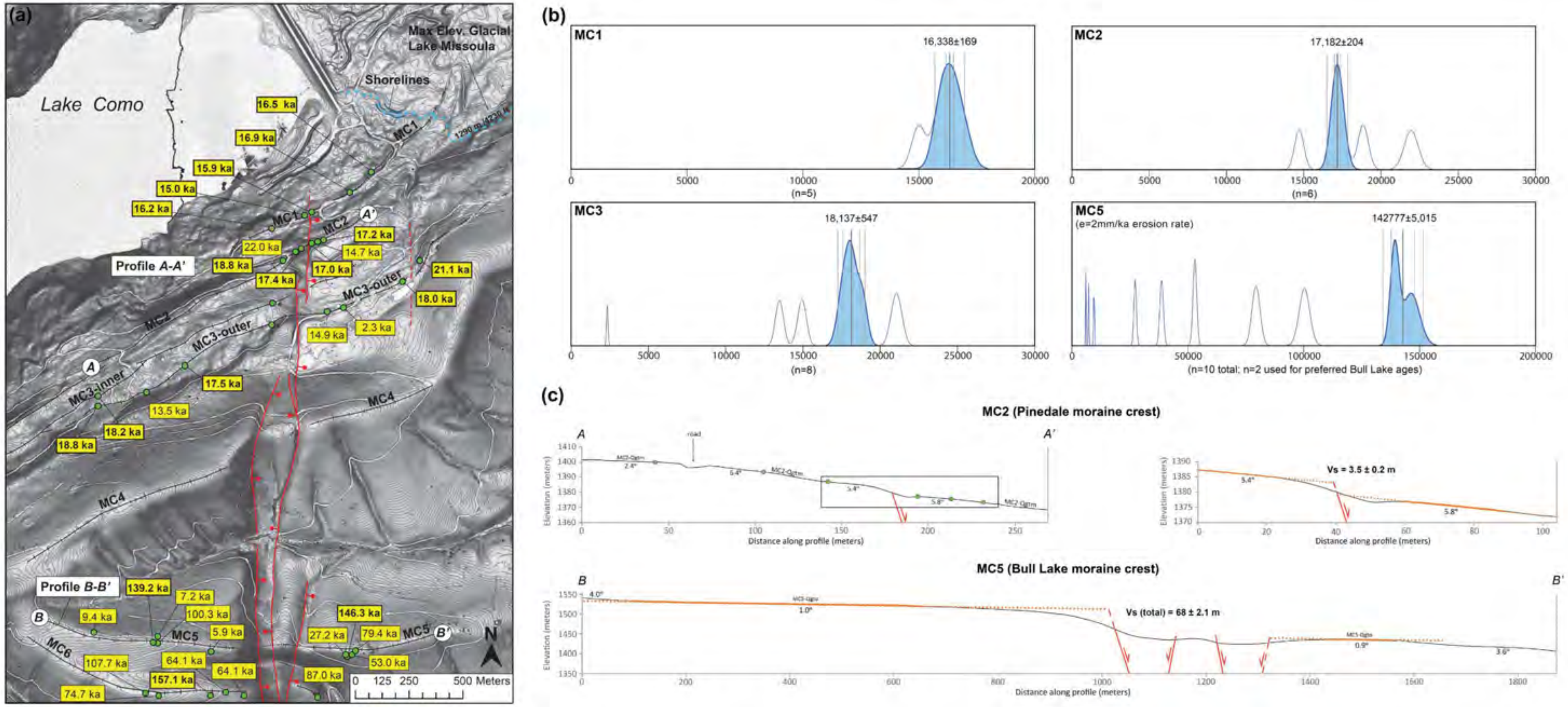


Table 2. Vertical separation and fault slip rates for the Bitterroot fault.

	Vertical separation (m)	Surface age (ka)	Fault dip (degrees)	Vert. separation	Fault slip rate (mm/yr)
Lake Como					
MC2 - Pinedale moraine	3.5 ± 0.1	17.2 ± 0.2	62.5 ± 7.5	0.20–0.21	**0.21–0.26**
MC5 - Bull Lake moraine	68 ± 2	142.8 ± 5.0	62.5 ± 7.5	0.45–0.51	**0.48–0.62**
*Rock Creek**					
Glacial Lake Missoula shorelines	4.6 ± 1.5	16.4 ± 0.2	75 ± 5	0.18–0.38	**0.19–0.40**
*Ward Creek Fan**					
S1 - Pinedale debris fan	2.4 ± 0.2	16.8 ± 0.7	52.5 ± 7.5	0.13–0.16	**0.15–0.23**
S2 - Medium-aged debris fan	4.5 ± 0.1	66.6 ± 5.5	52.5 ± 7.5	0.06–0.08	**0.07–0.11**

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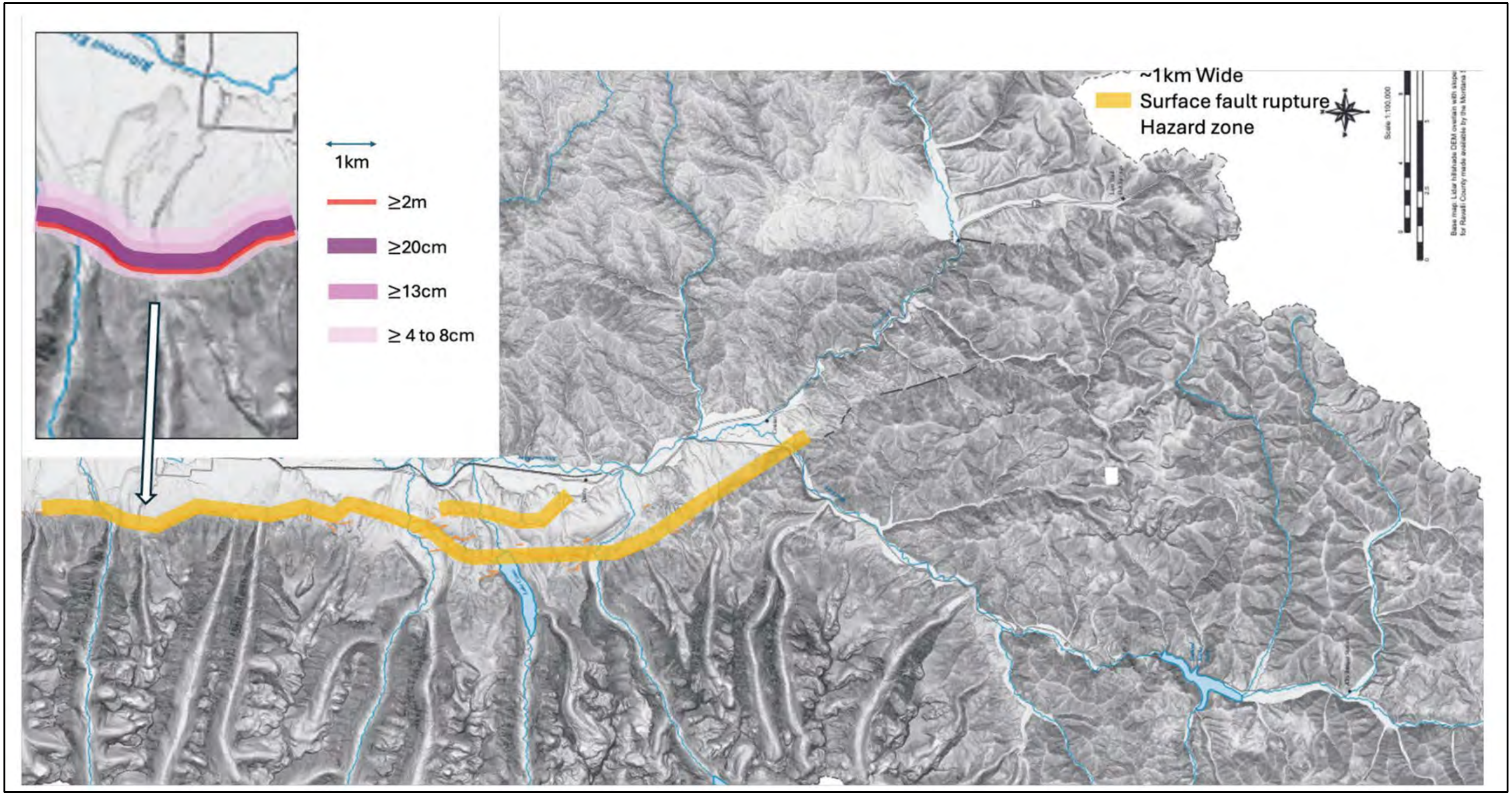
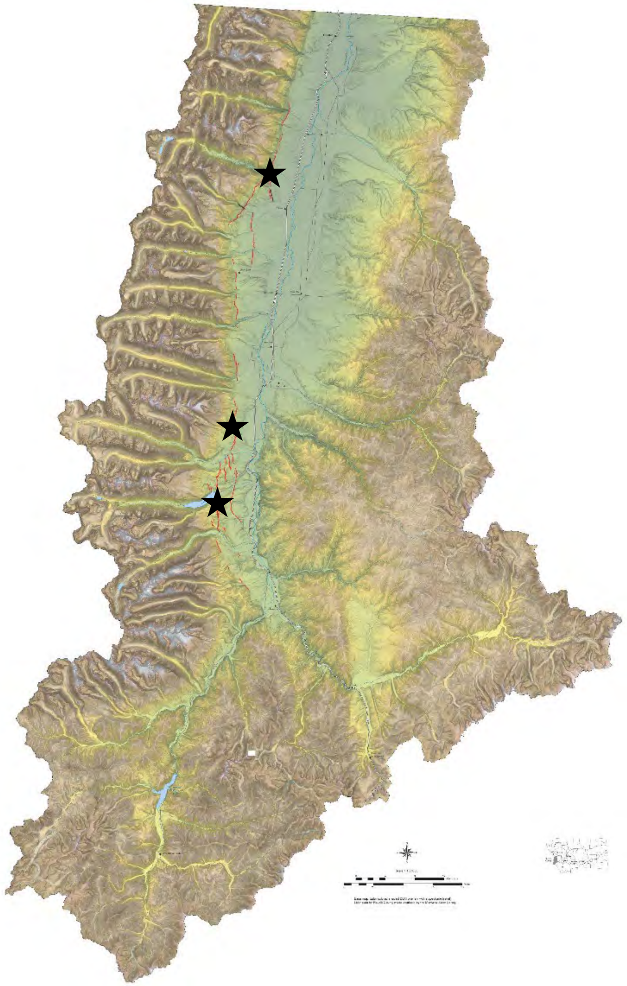
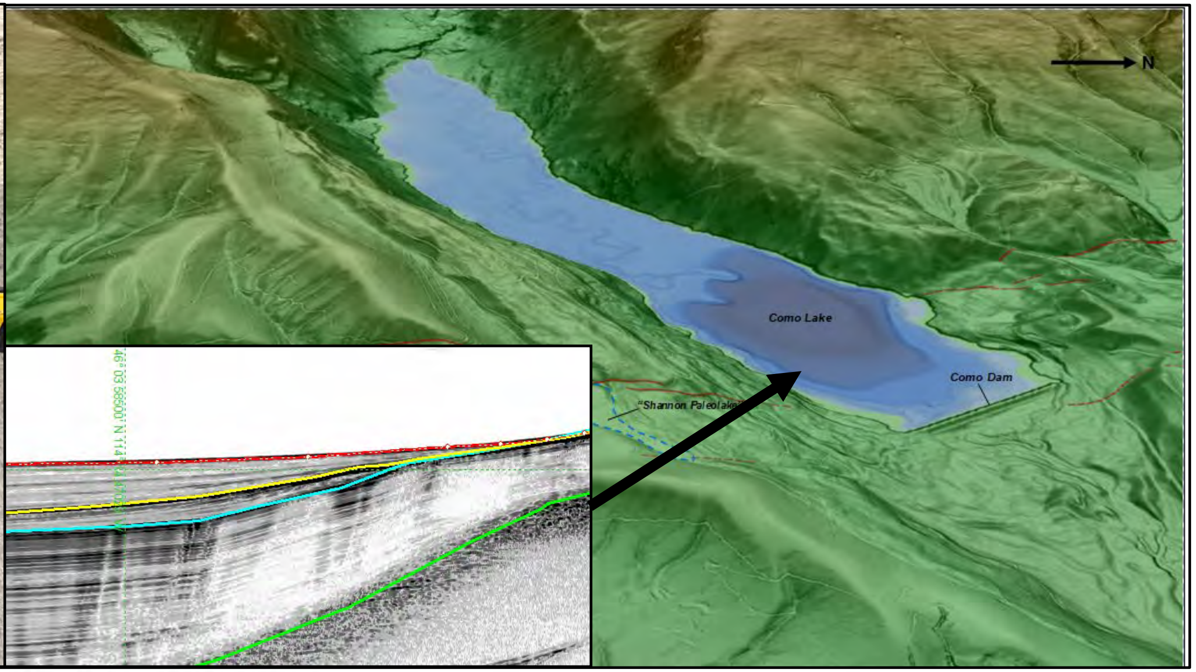
Forecast Fault Displacement Hazards Mapping along the Bitterroot fault



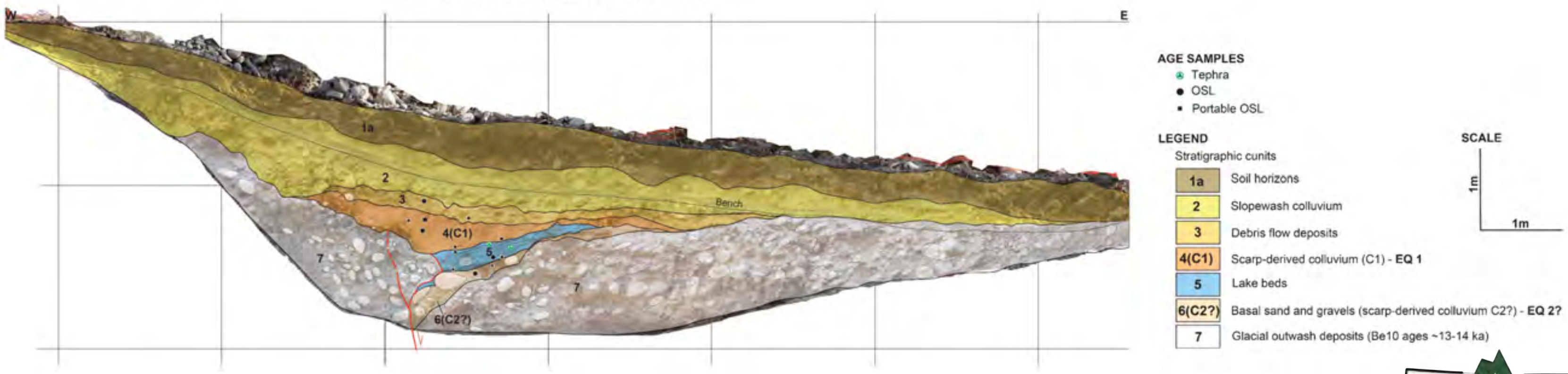
USGS NEHRP Final Technical Report – Moss and Gavillot, 2024

Prehistoric Earthquakes of the Bitterroot fault: Upcoming Publications





Camas Creek Trench 2 - South Wall



EQ1?: 1,500-11,000 years **EQ2: ~11,000 years ago** **EQ3: ~16,000 years ago**

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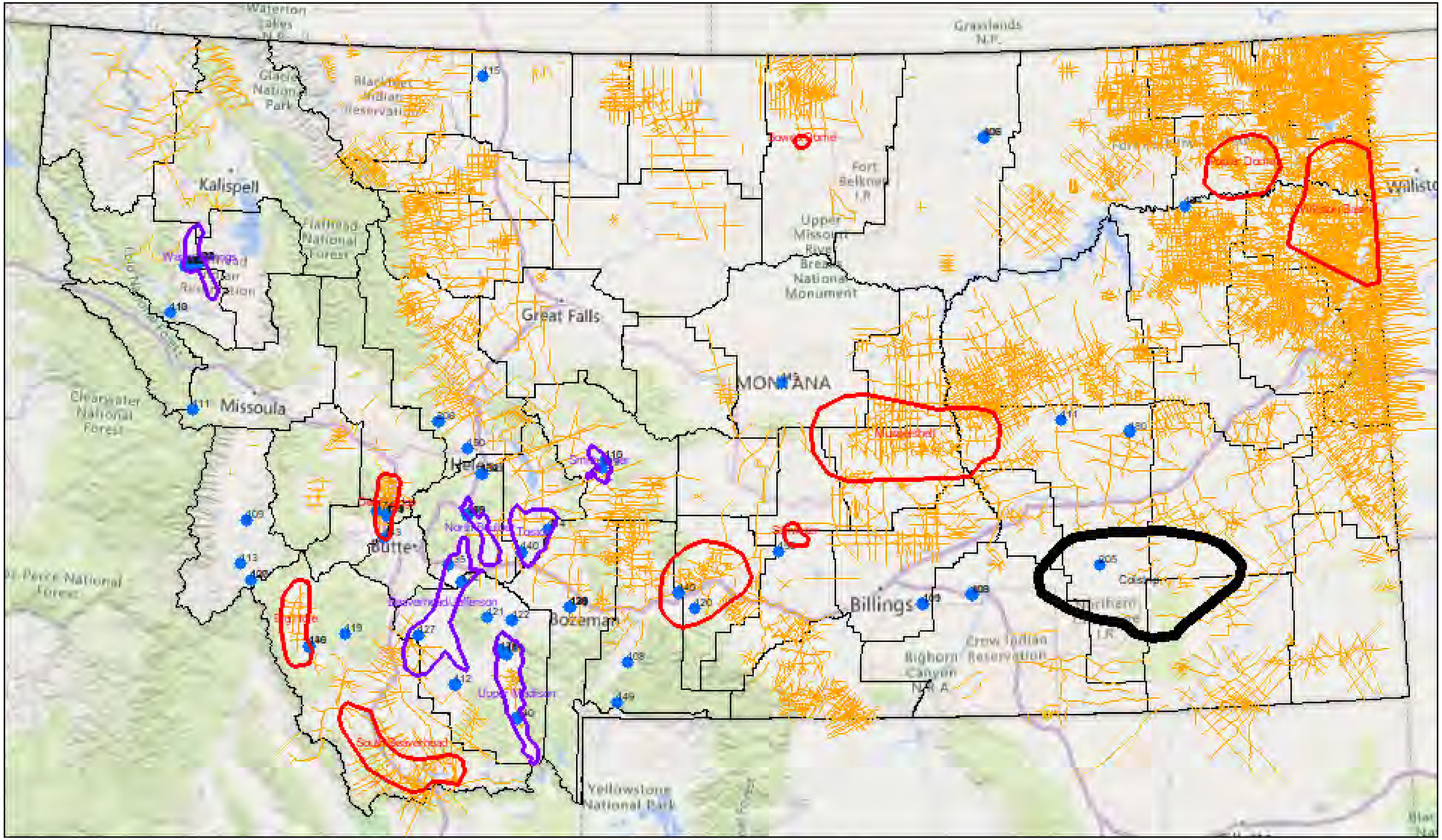
Application of Seismic Data - Active faults



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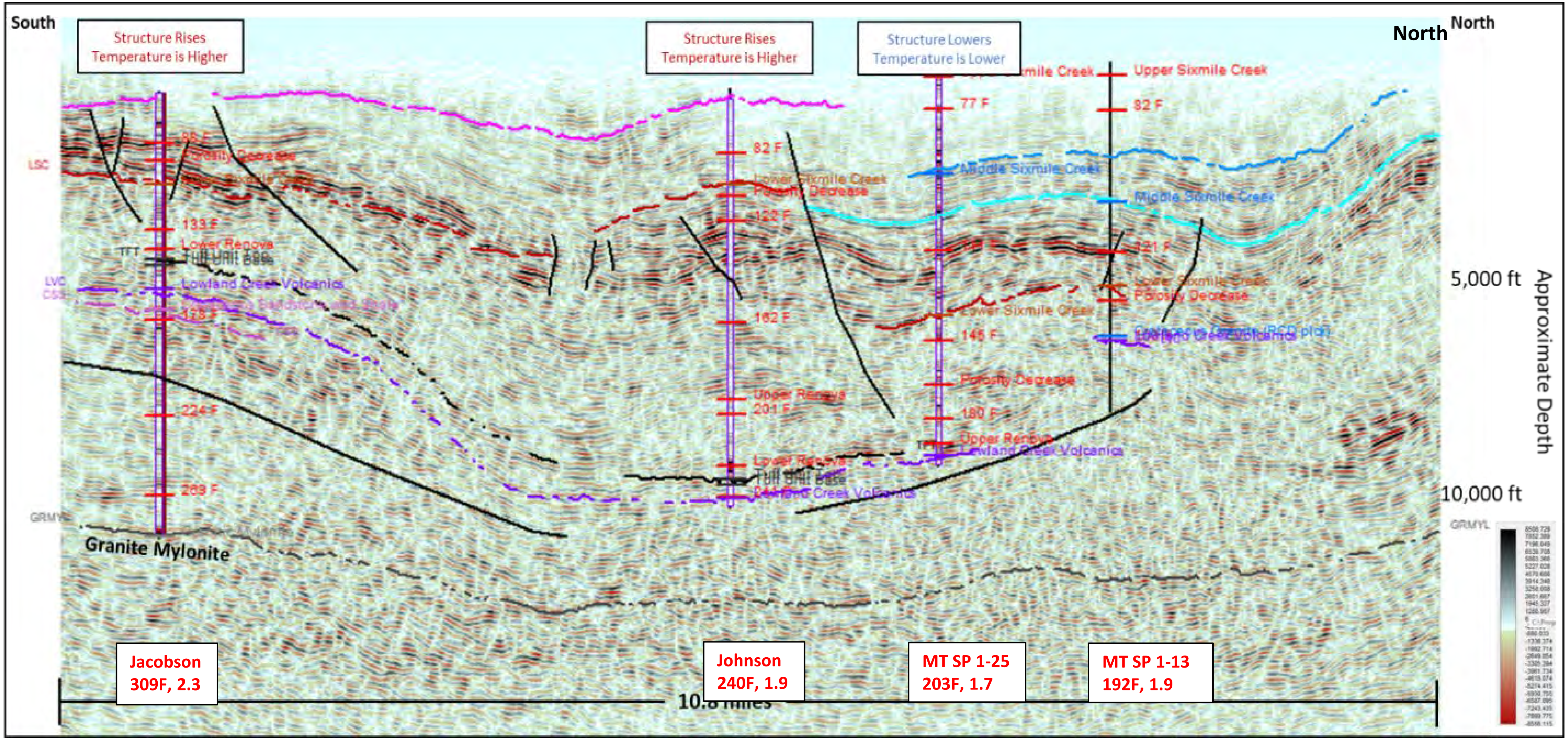
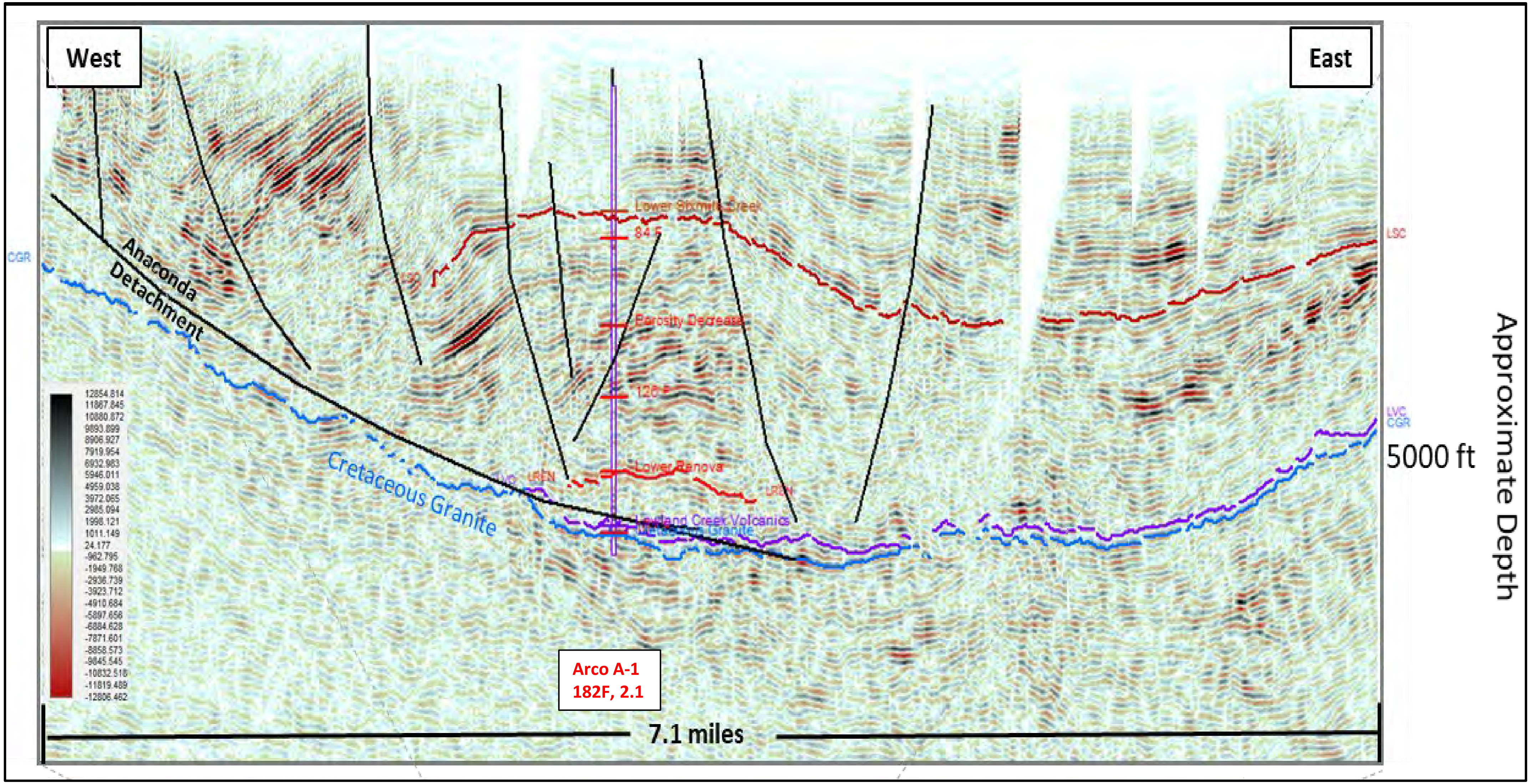
Deer Lodge Basin: Seismic, N-S line



Seismic data owned or controlled by Seismic Exchange, Inc.

Deer Lodge Basin: Seismic, W-E Line



Seismic data owned or controlled by Seismic Exchange, Inc.

Montana Earthquake Working Group (MEWG)

Outreach

Develop educational activities and publication materials to improve public earthquake preparedness and risk communication, earthquake scenario and practice.

Montana Disaster & Emergency Services
FEMA
Montana Bureau of Mines and Geology
Missoula County
Ravalli County
Beaverhead County
University of Montana
Missoula School District
Helena School District

Mitigation Strategies

The main goal is to provide recommendations and facilitate strategies to reduce seismic vulnerability in the built environment, particularly for public schools, government offices, and major infrastructure.

Montana Disaster & Emergency Services
Missoula County
Missoula School District
Helena School District

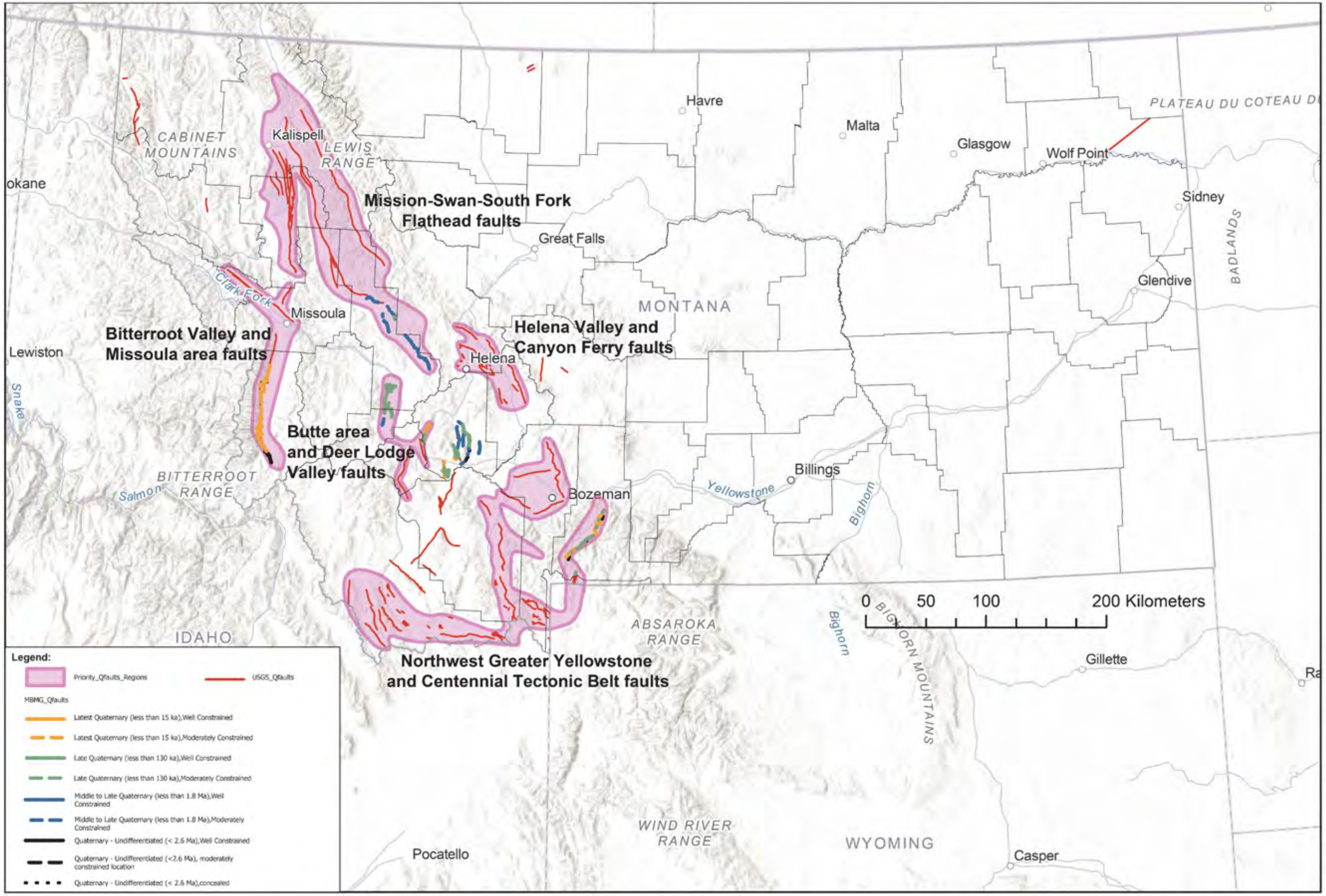
MONTANA EARTHQUAKE
MEWG
WORKING GROUP

Hazards Research

The main goal is to identify and characterize earthquake hazards, including potential cascading geological hazards in Montana, by prioritizing research using hazards mapping, seismic/geodetic monitoring, geophysical data, slip-rate, and earthquake forecasting.

Montana Bureau of Mines and Geology
CalPoly
University of Montana
Montana Department of Transportation

Montana Priority Regions – Earthquake Hazards Research



- **Mission-Swan-South Fork Flathead faults.**
- **Bitterroot Valley and Missoula area faults** (Bitterroot, Ninemile, Jocko)
- **Helena Valley and Canyon Ferry faults.**
- **Greater Yellowstone and Centennial Tectonic Belt regions** (Madison, Bridger, Gallatin Range, Emigrant, East Gallatin-Reese Creek faults, Centennial, Red Rock, Hebgen-Red Canyon).
- **Butte and Deer Lodge Valley faults** (Continental-Klepper-Elk Park, Deer Lodge Valley, Racetrack)

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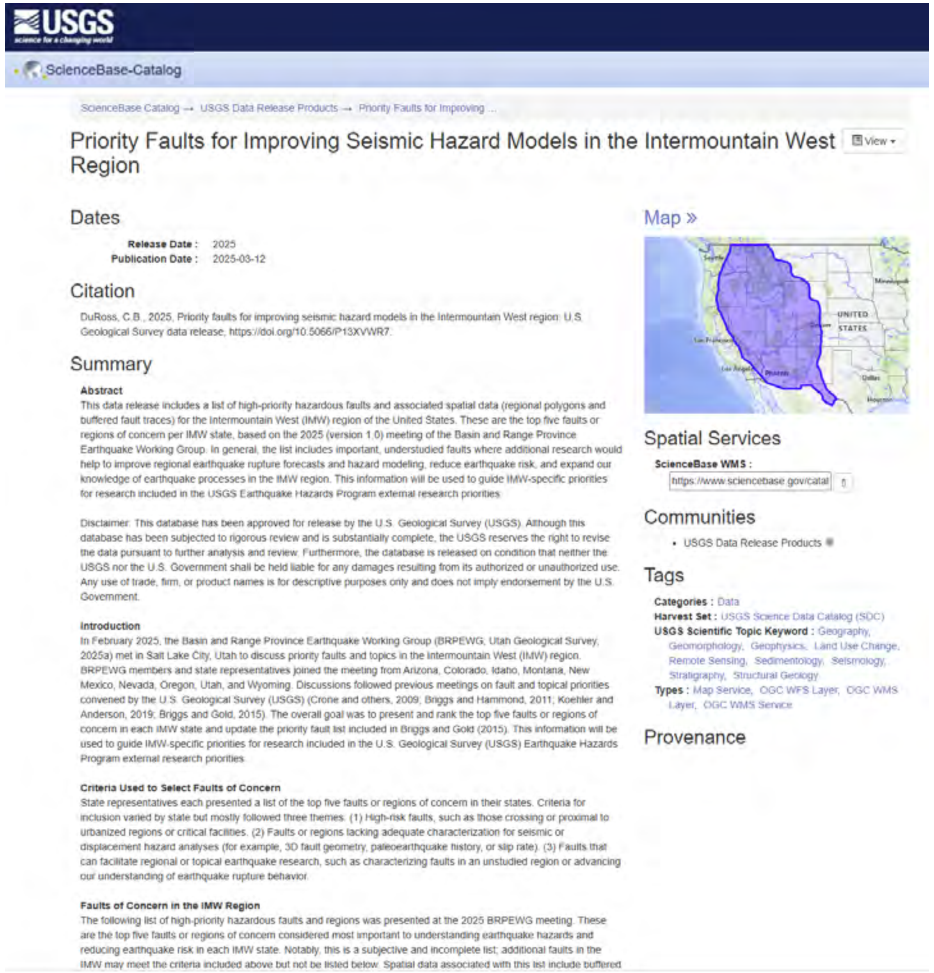
Montana Bureau of Mines and Geology

Intermountain West Priority Faults :
Basin and Range Province Earthquake Working Group (BRPEWG)



USGS science for a changing world

ScienceBase-Catalog

ScienceBase Catalog → USGS Data Release Products → Priority Faults for Improving ...

Priority Faults for Improving Seismic Hazard Models in the Intermountain West Region

View

Dates

Release Date : 2025
Publication Date : 2025-03-12

Citation

DuRoss, C.B., 2025, Priority faults for improving seismic hazard models in the Intermountain West region: U.S. Geological Survey data release, https://doi.org/10.5066/P13XVWR7.

Summary

Abstract

This data release includes a list of high-priority hazardous faults and associated spatial data (regional polygons and buffered fault traces) for the Intermountain West (IMW) region of the United States. These are the top five faults or regions of concern per IMW state, based on the 2025 (version 1.0) meeting of the Basin and Range Province Earthquake Working Group. In general, the list includes important, understudied faults where additional research would help to improve regional earthquake rupture forecasts and hazard modeling, reduce earthquake risk, and expand our knowledge of earthquake processes in the IMW region. This information will be used to guide IMW-specific priorities for research included in the USGS Earthquake Hazards Program external research priorities.

Disclaimer: This database has been approved for release by the U.S. Geological Survey (USGS). Although this database has been subjected to rigorous review and is substantially complete, the USGS reserves the right to revise the data pursuant to further analysis and review. Furthermore, the database is released on condition that neither the USGS nor the U.S. Government shall be held liable for any damages resulting from its authorized or unauthorized use. Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Introduction

In February 2025, the Basin and Range Province Earthquake Working Group (BRPEWG; Utah Geological Survey, 2025a) met in Salt Lake City, Utah to discuss priority faults and topics in the Intermountain West (IMW) region. BRPEWG members and state representatives joined the meeting from Arizona, Colorado, Idaho, Montana, New Mexico, Nevada, Oregon, Utah, and Wyoming. Discussions followed previous meetings on fault and topical priorities convened by the U.S. Geological Survey (USGS) (Crone and others, 2009; Briggs and Hammond, 2011; Koehler and Anderson, 2019; Briggs and Gold, 2015). The overall goal was to present and rank the top five faults or regions of concern in each IMW state and update the priority fault list included in Briggs and Gold (2015). This information will be used to guide IMW-specific priorities for research included in the U.S. Geological Survey (USGS) Earthquake Hazards Program external research priorities.

Criteria Used to Select Faults of Concern

State representatives each presented a list of the top five faults or regions of concern in their states. Criteria for inclusion varied by state but mostly followed three themes: (1) High-risk faults, such as those crossing or proximal to urbanized regions or critical facilities. (2) Faults or regions lacking adequate characterization for seismic or displacement hazard analyses (for example, 3D fault geometry, paleoearthquake history, or slip rate). (3) Faults that can facilitate regional or topical earthquake research, such as characterizing faults in an unstudied region or advancing our understanding of earthquake rupture behavior.

Faults of Concern in the IMW Region

The following list of high-priority hazardous faults and regions was presented at the 2025 BRPEWG meeting. These are the top five faults or regions of concern considered most important to understanding earthquake hazards and reducing earthquake risk in each IMW state. Notably, this is a subjective and incomplete list; additional faults in the IMW may meet the criteria included above but not be listed below. Spatial data associated with this list include buffered

Map »

UNITED
STATES

Spatial Services

ScienceBase WMS : https://www.sciencebase.gov/catal

Communities

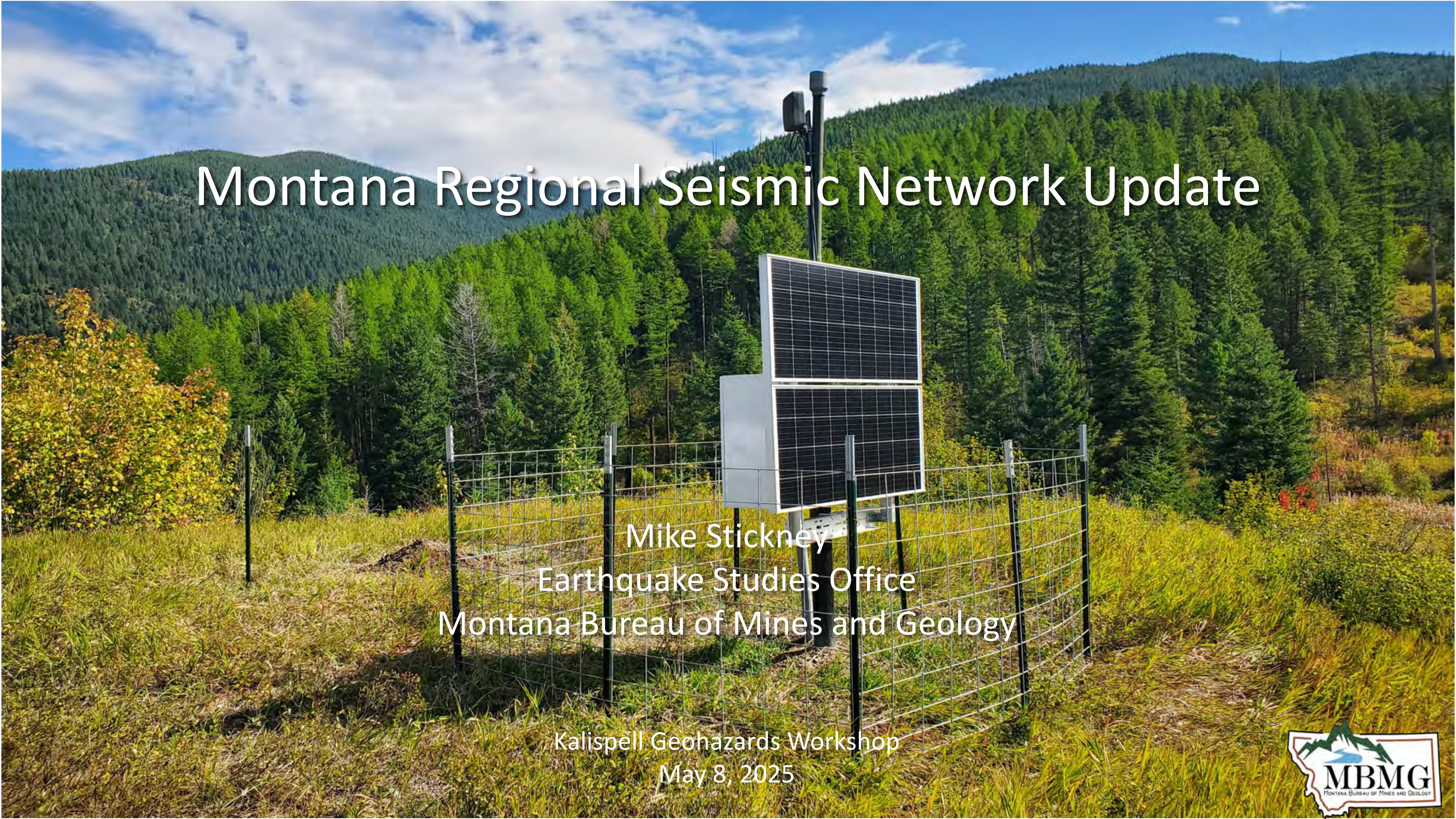
- USGS Data Release Products

Tags

Categories : Data
Harvest Set : USGS Science Data Catalog (SDC)
USGS Scientific Topic Keyword : Geography, Geomorphology, Geophysics, Land Use Change, Remote Sensing, Sedimentology, Seismology, Stratigraphy, Structural Geology
Types : Map Service, OGC WFS Layer, OGC WMS Layer, OGC WMS Service

Provenance

MBMG
Montana Bureau of Mines and Geology



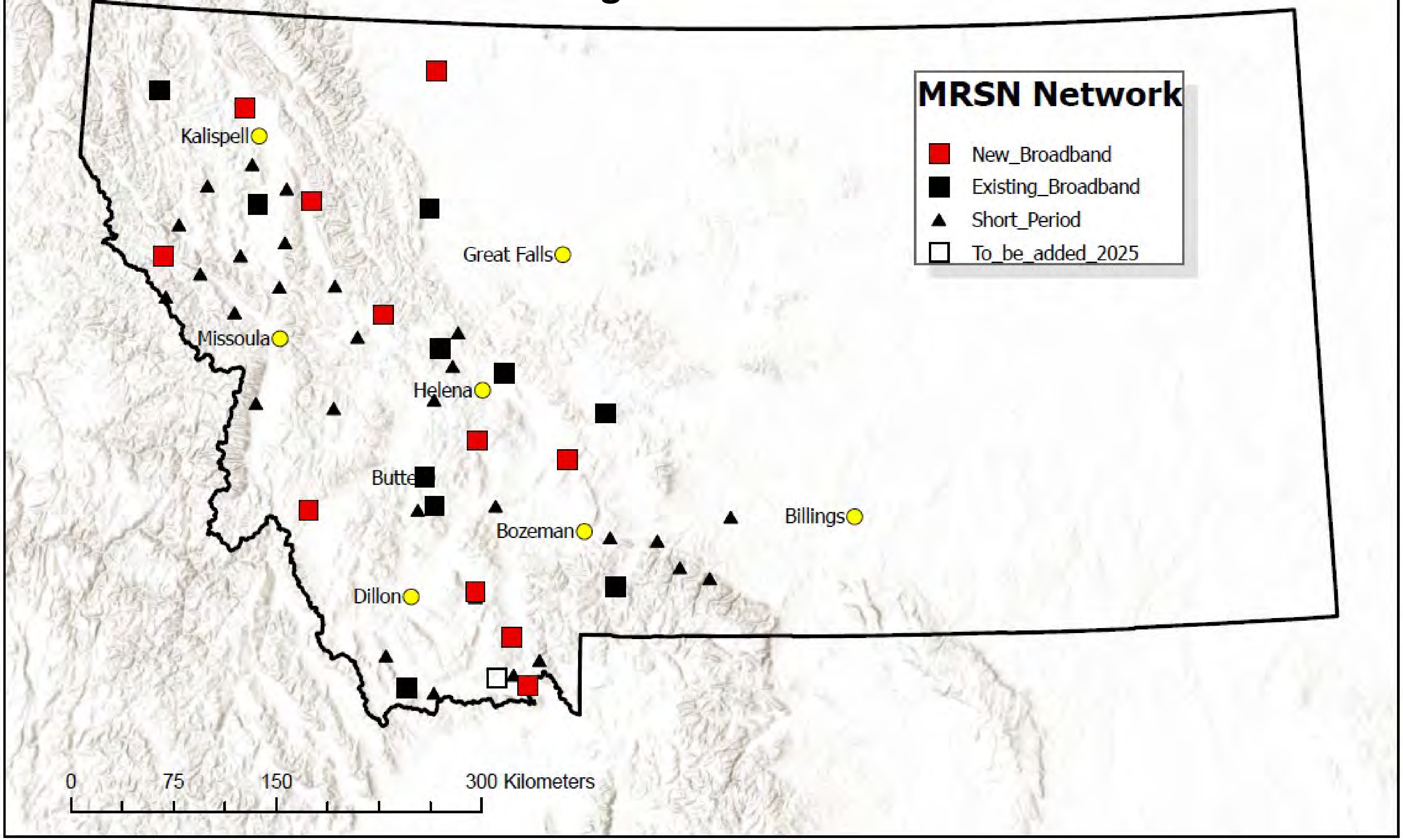
Montana Regional Seismic Network Update

Mike Stickney
Earthquake Studies Office
Montana Bureau of Mines and Geology

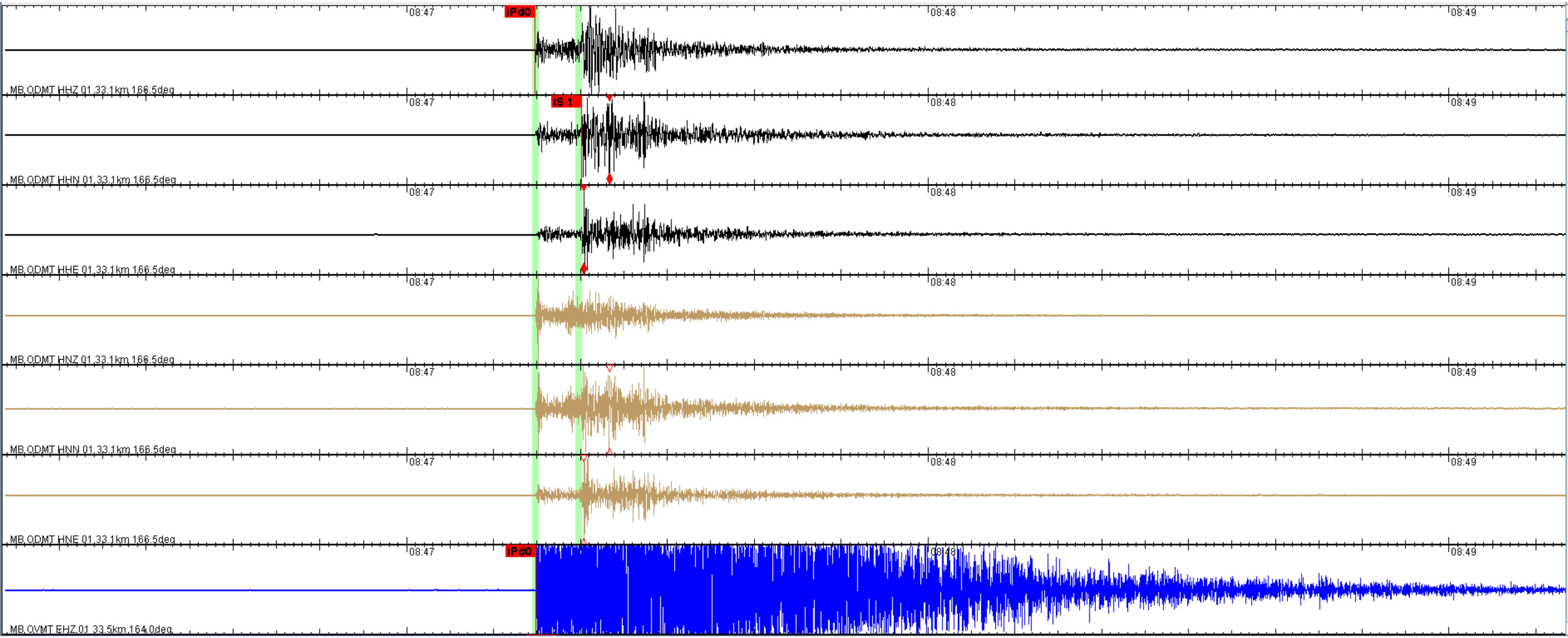
Kalispell Geohazards Workshop
May 8, 2025


F150
0004413

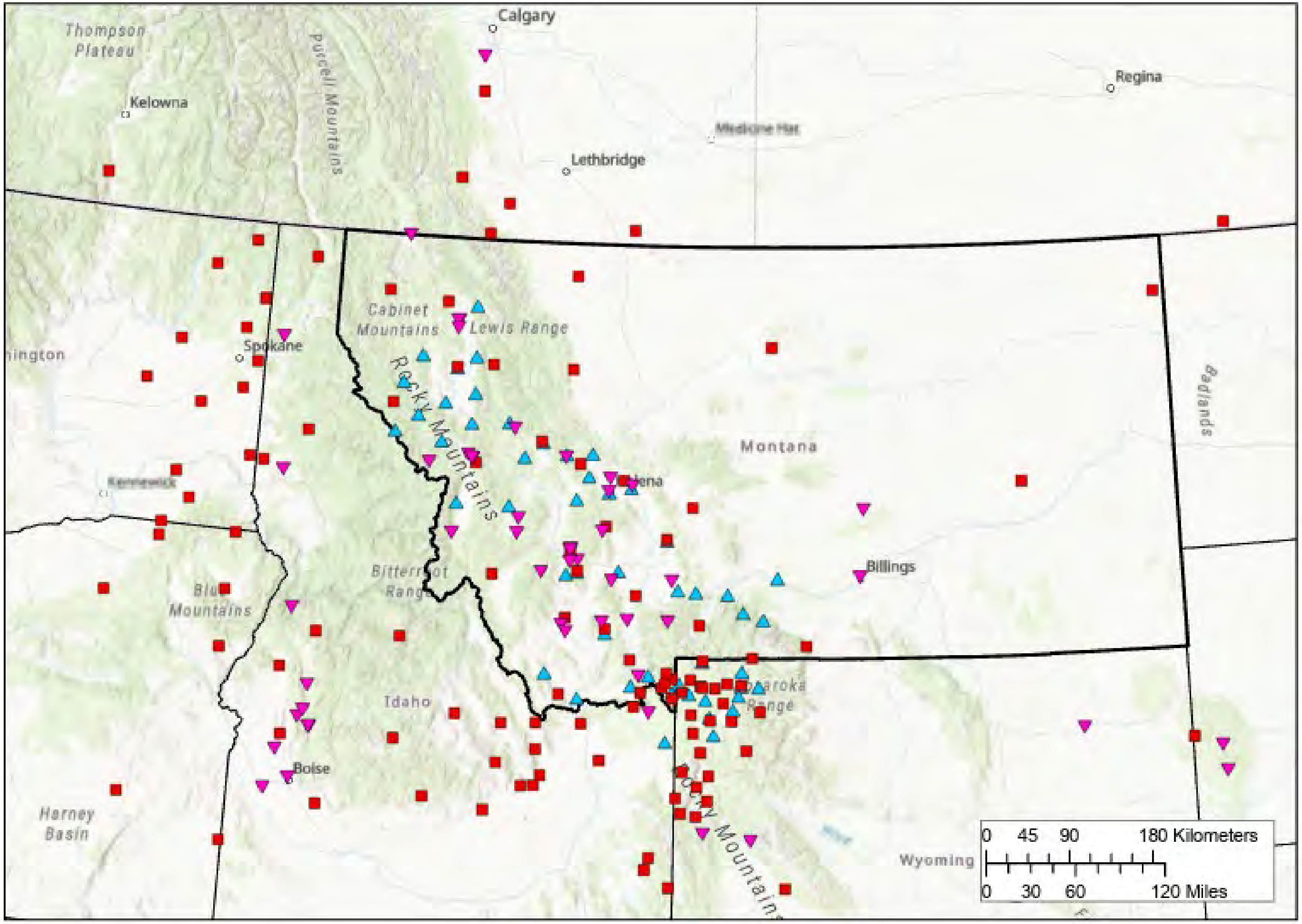
Montana Regional Seismic Network



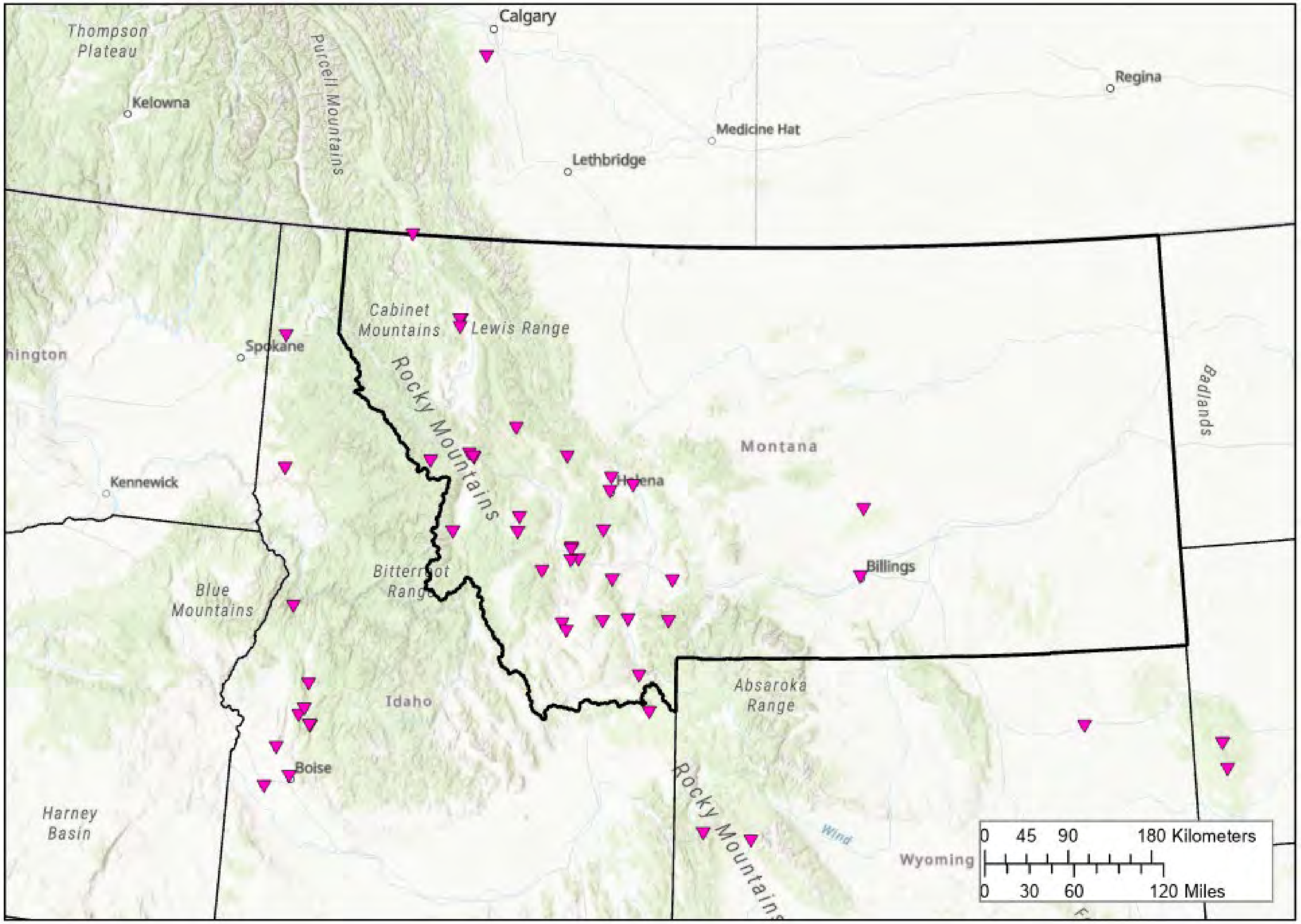
Ovando seismic station recordings of a M 3.7 earthquake on Sept, 1, 2024 centered 20 miles NE of Seeley Lake



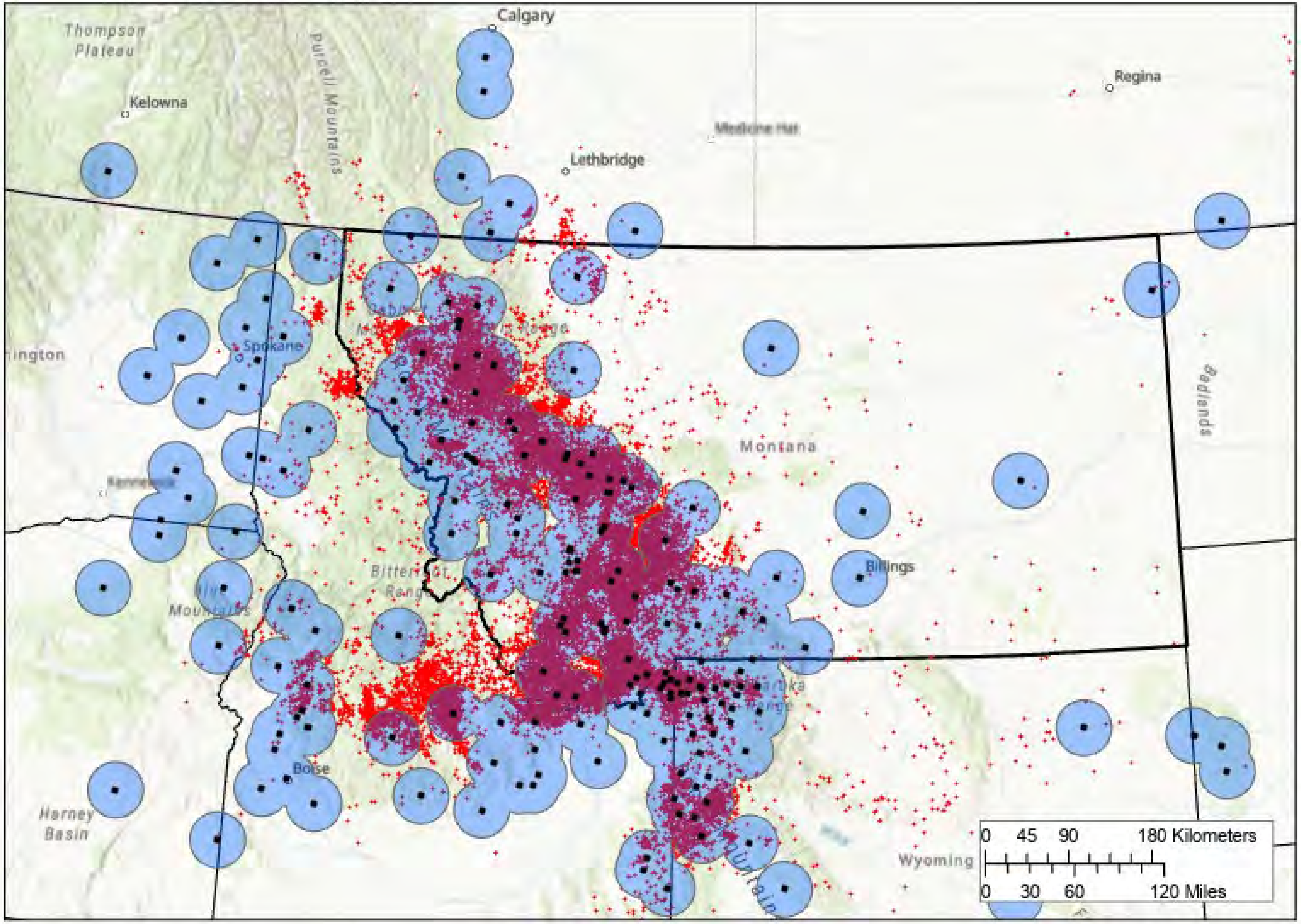
221 stations



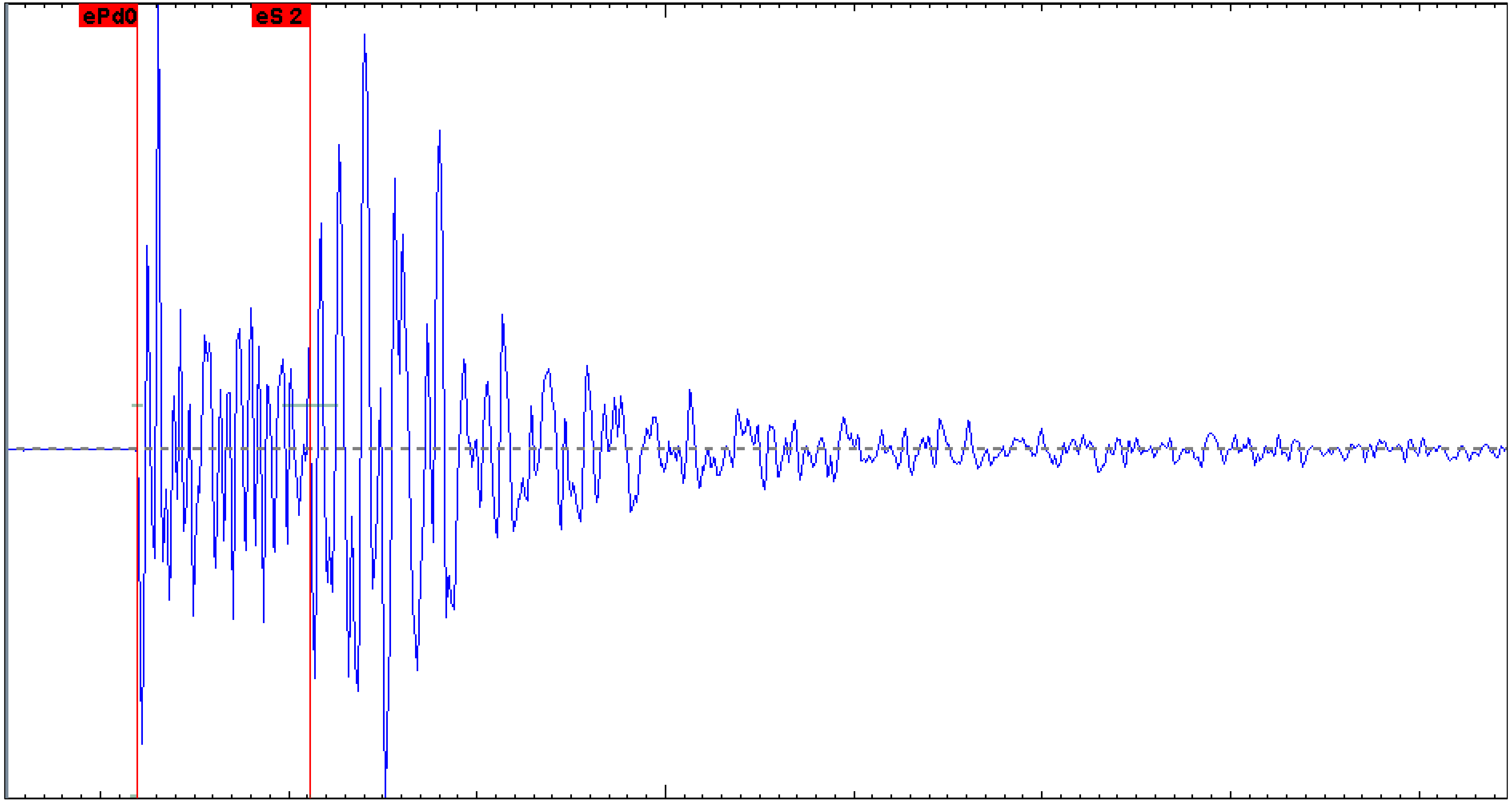
51 Raspberry Shake seismograph stations



All stations with 30-km buffer

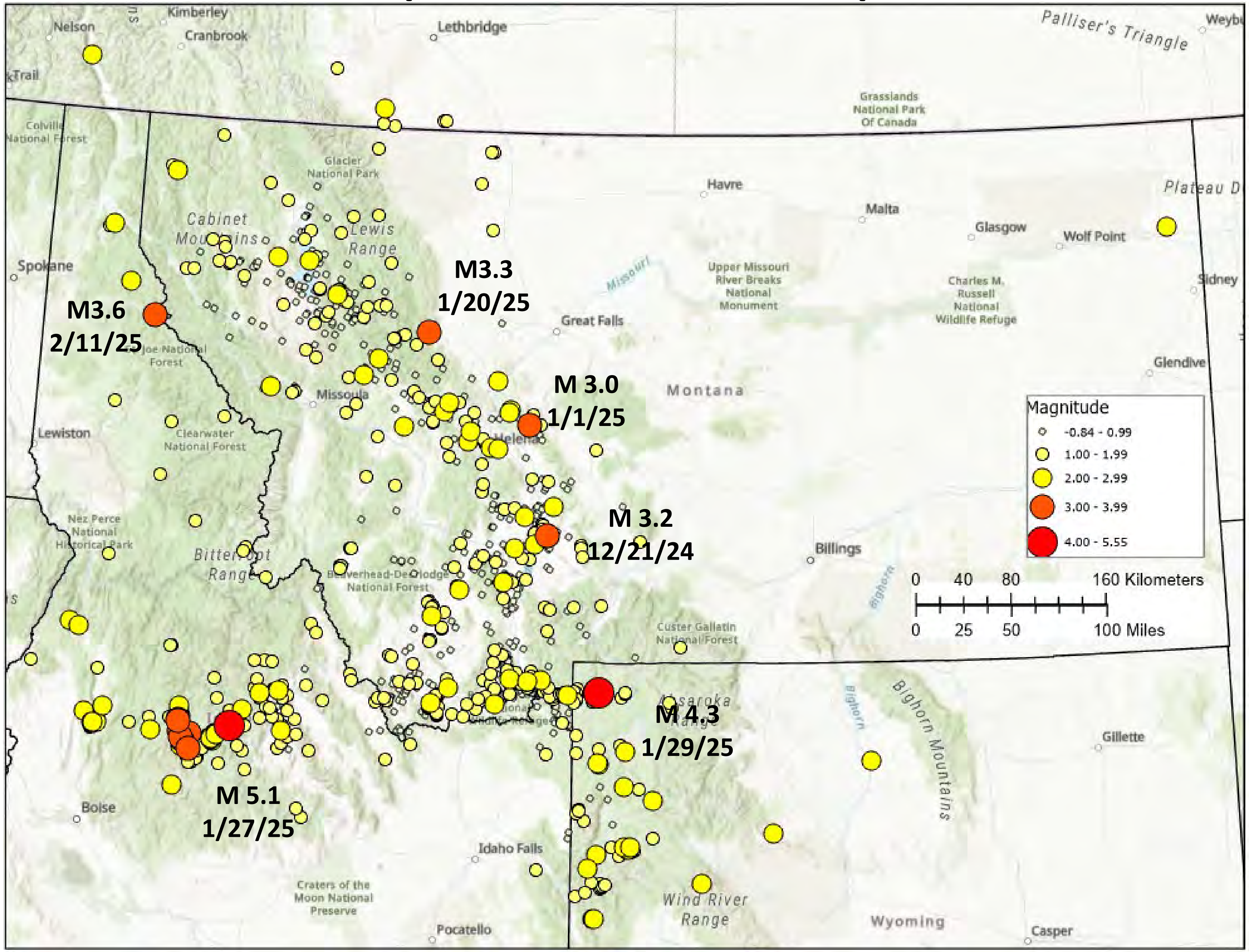


Raspberry Shake seismograph operating in the basement of a Butte residence.

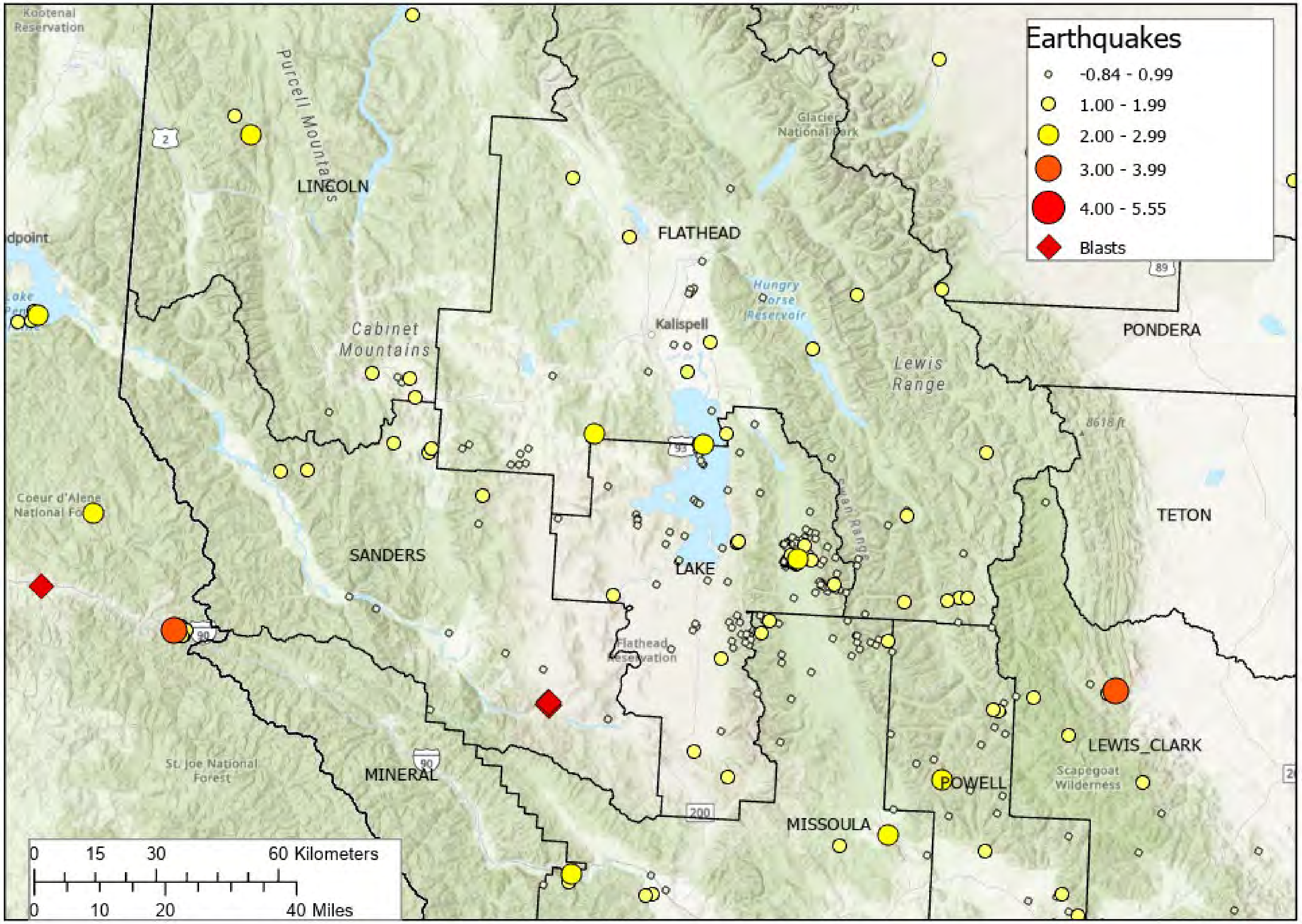


Seismogram showing the P- and S-wave arrivals recorded on Raspberry Shake station R714F, located 2.2 miles southwest of the epicenter.

1,925 Earthquakes Oct 15, 2024 – Apr 15, 2025



1,925 Earthquakes Oct 15, 2024 – Apr 15, 2025

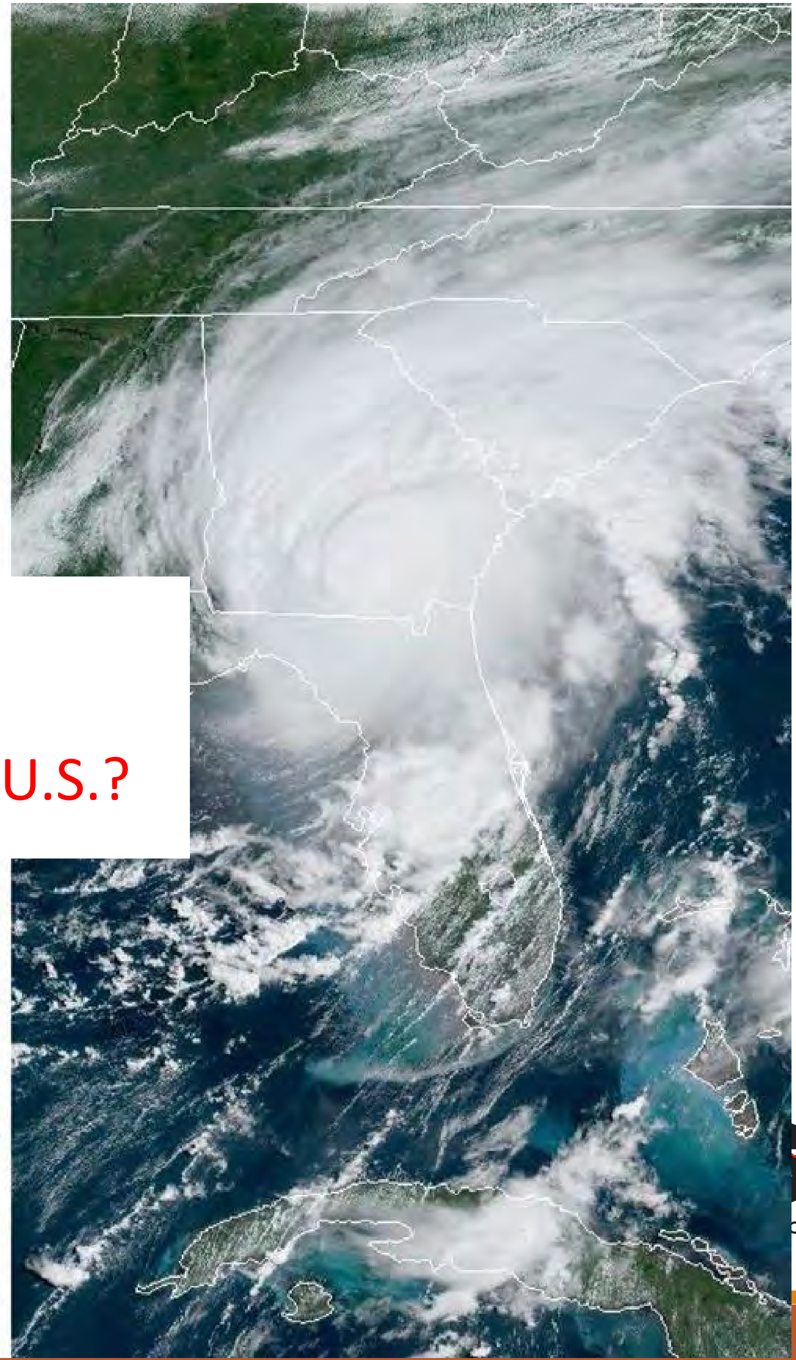


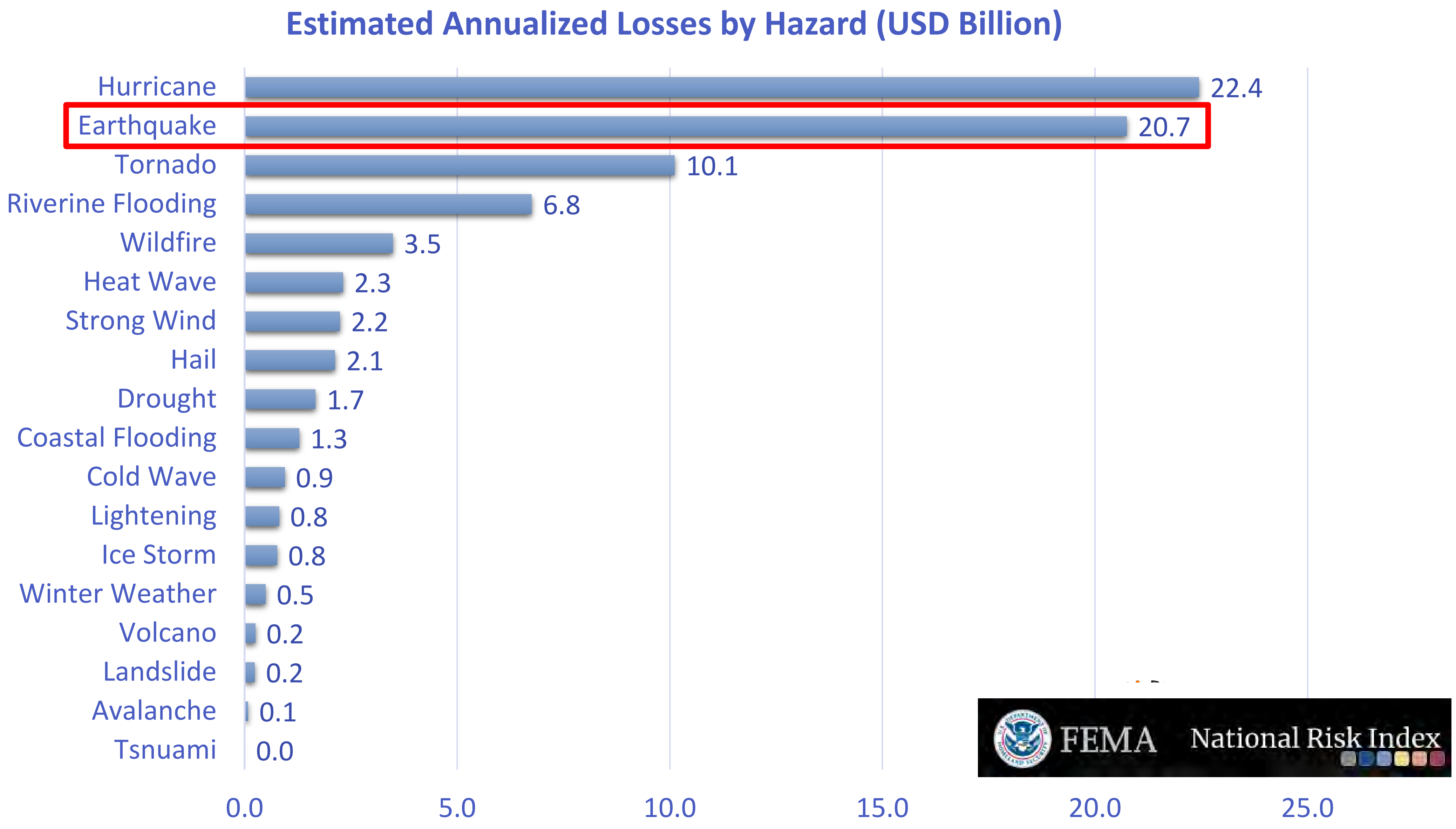
Understanding and Mitigating Risk through Hazard Mitigation Planning

ANDREW LONG AND ANNA LANG

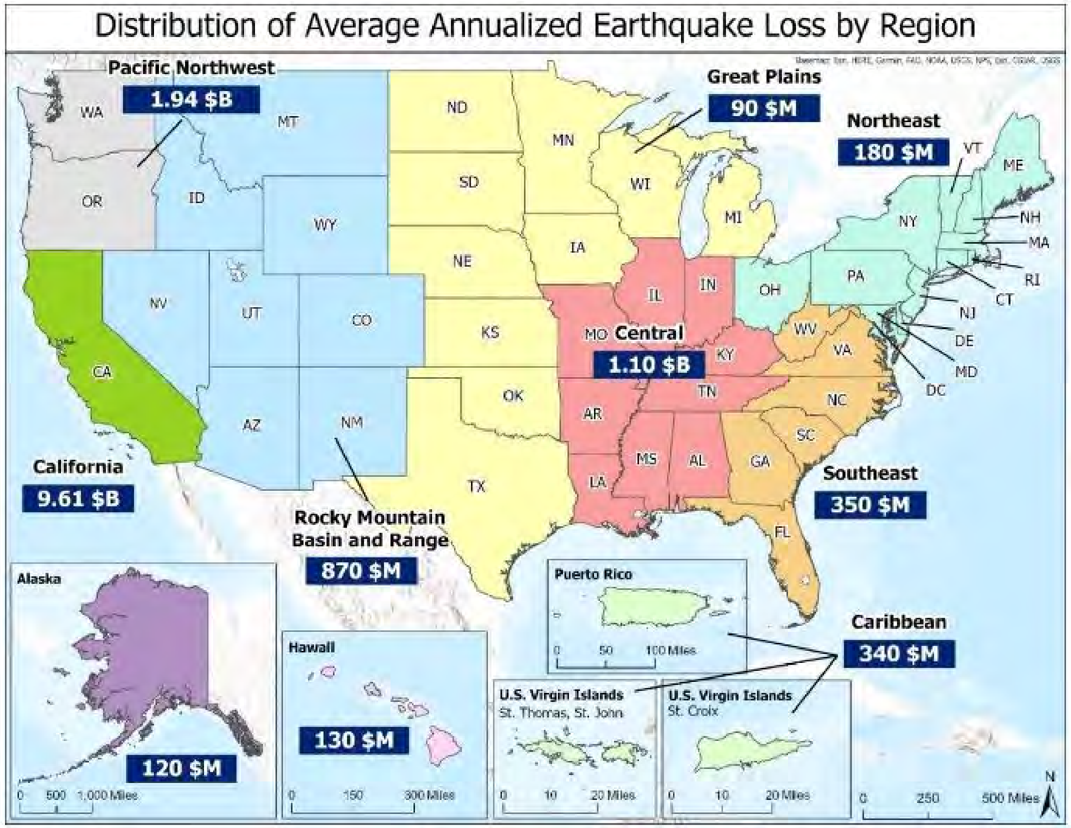
Quiz time!

What's the biggest disaster threat to the U.S.?



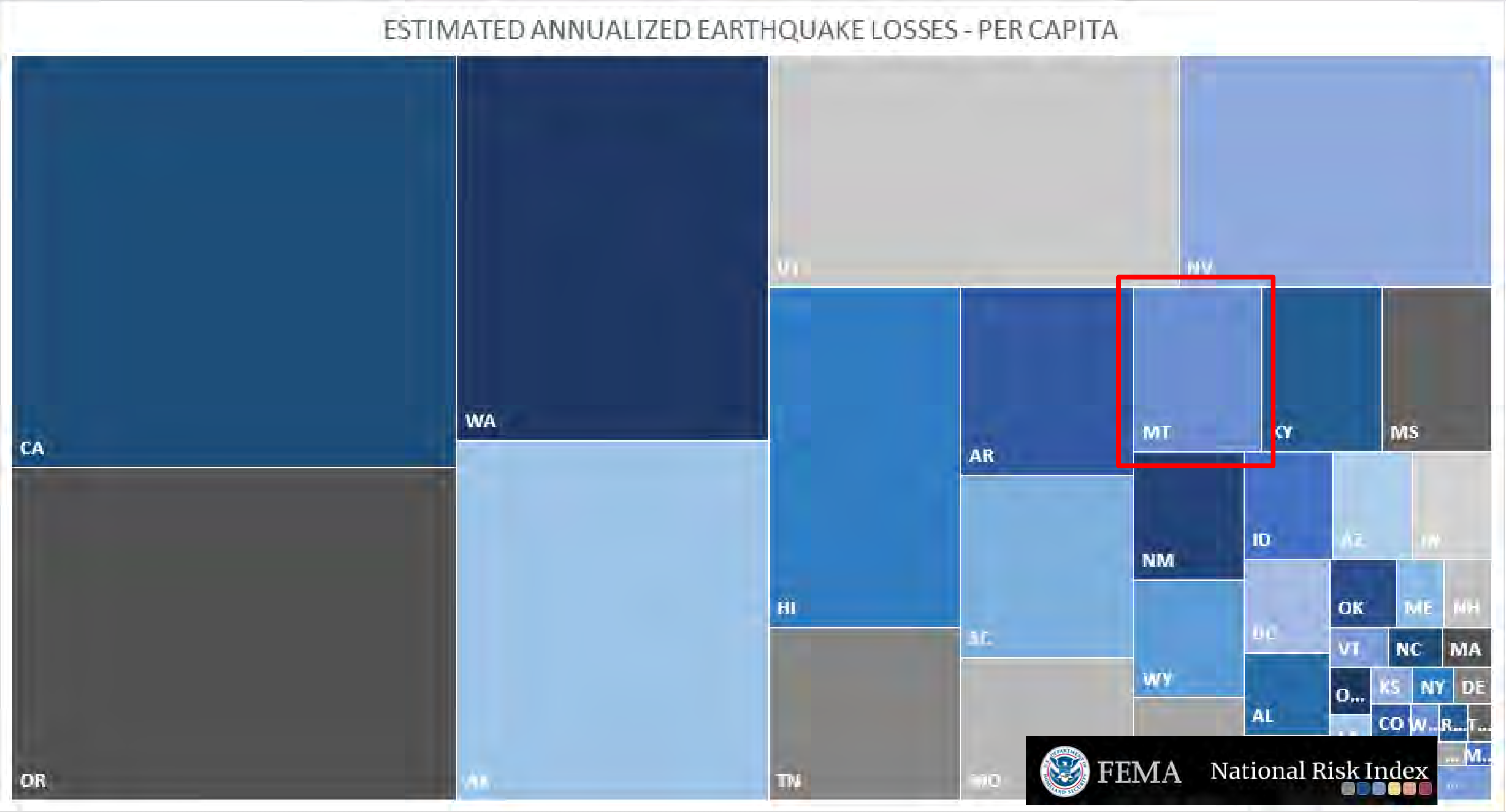

Estimated Annualized Losses by Hazard (USD Billion)
Hurricane 22.4
Earthquake 20.7
Tornado 10.1
Riverine Flooding 6.8
Wildfire 3.5
Heat Wave 2.3
Strong Wind 2.2
Hail 2.1
Drought 1.7
Coastal Flooding 1.3
Cold Wave 0.9
Lightening 0.8
Ice Storm 0.8
Winter Weather 0.5
Volcano 0.2
Landslide 0.2
Avalanche 0.1
Tsnuami 0.0
0.0
5.0
10.0
15.0
20.0
25.0
FEMA
National Risk Index

Annualized Earthquake Loss

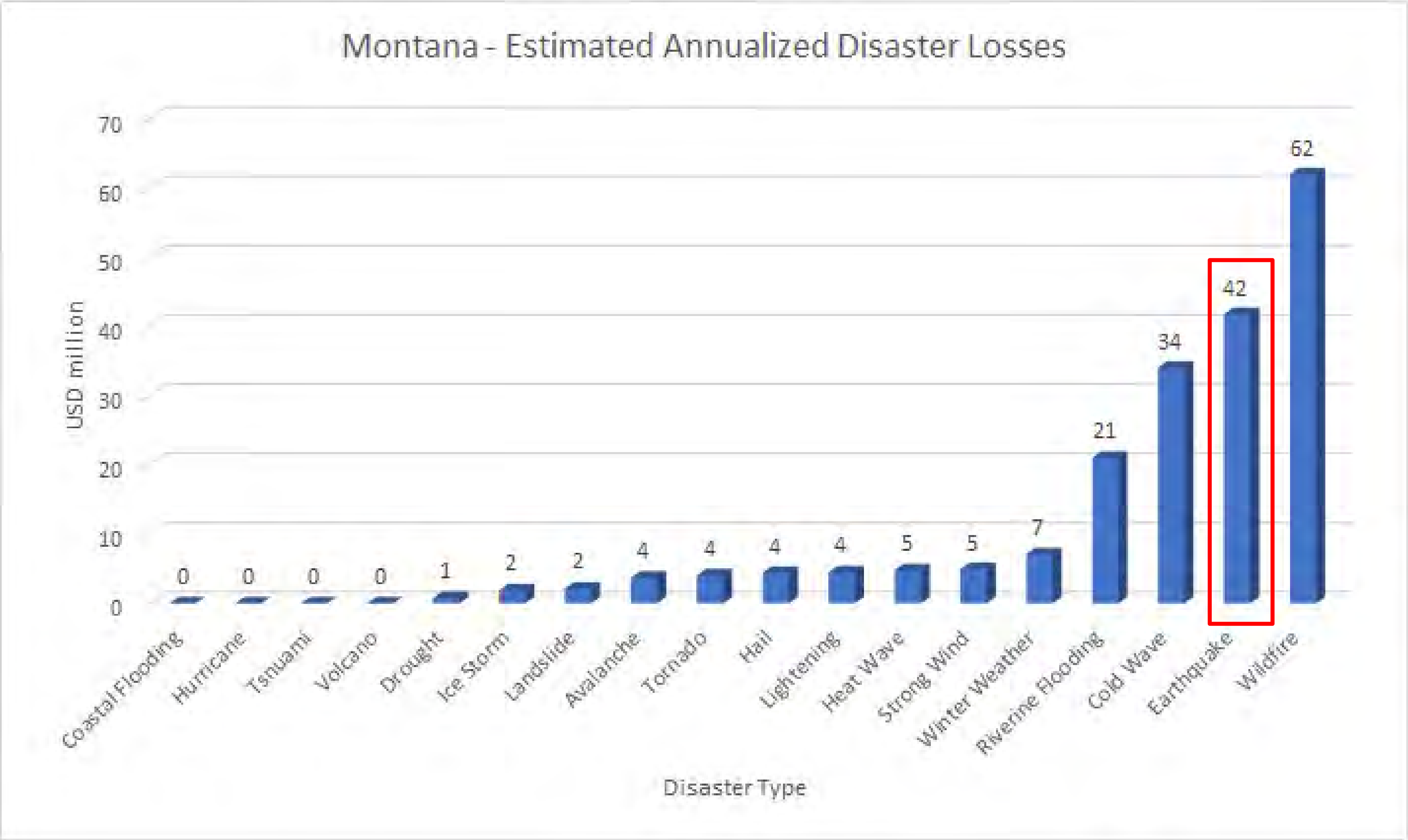


Recent USGS/FEMA study estimates that earthquakes cost the nation **$14.7 billion** annually in building damage and associated losses.

- These are long-term estimates
- A single large event can make up the difference
- 65% of the loss in CA
- 78% in Western states

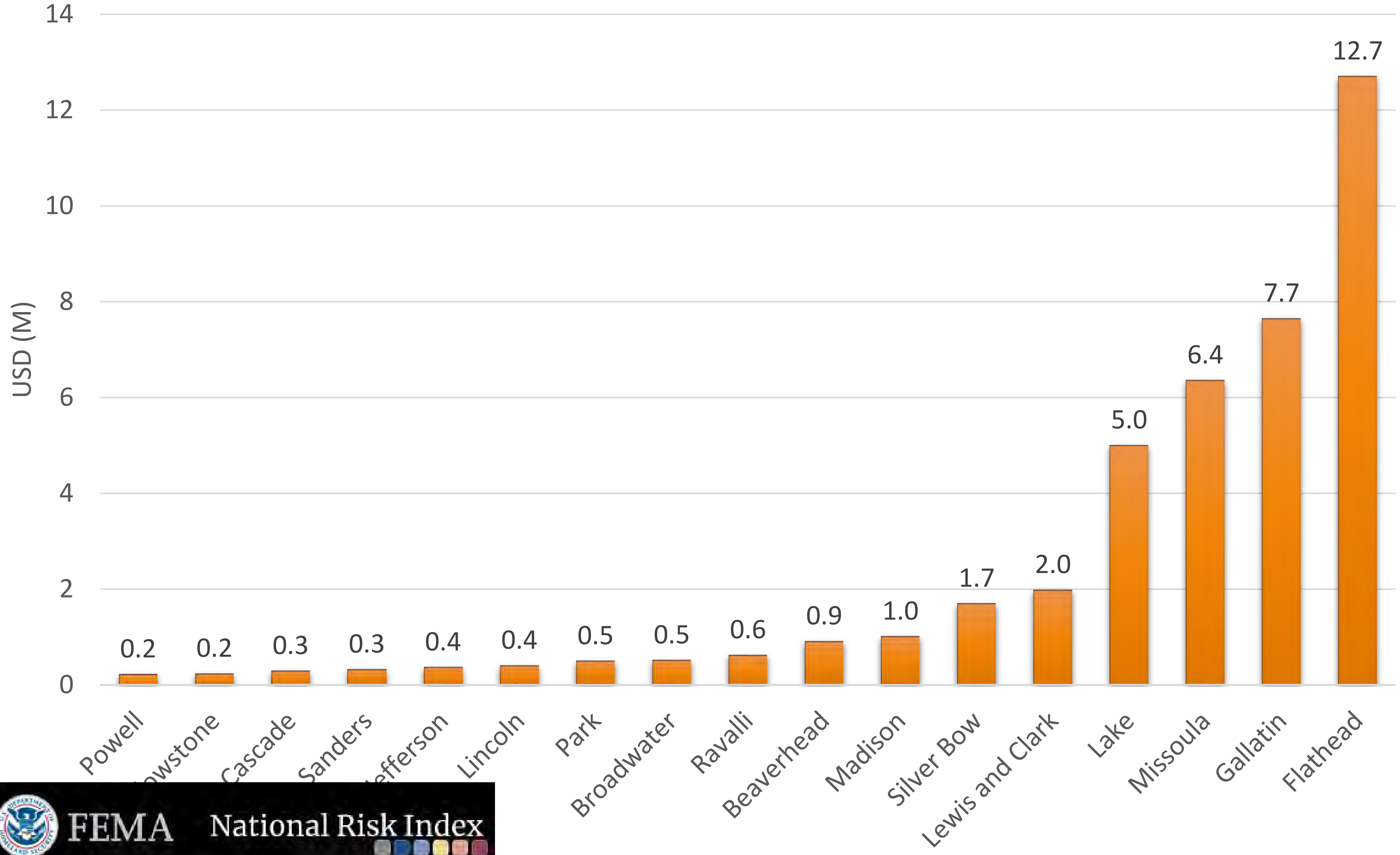


ESTIMATED ANNUALIZED EARTHQUAKE LOSSES - PER CAPITA
CA
WA
OR
NV
HI
AR
MT
MS
NM
ID
OK
ME
VT
NC
MA
WY
KS
NY
DE
AL
CO
TN
FEMA
National Risk Index

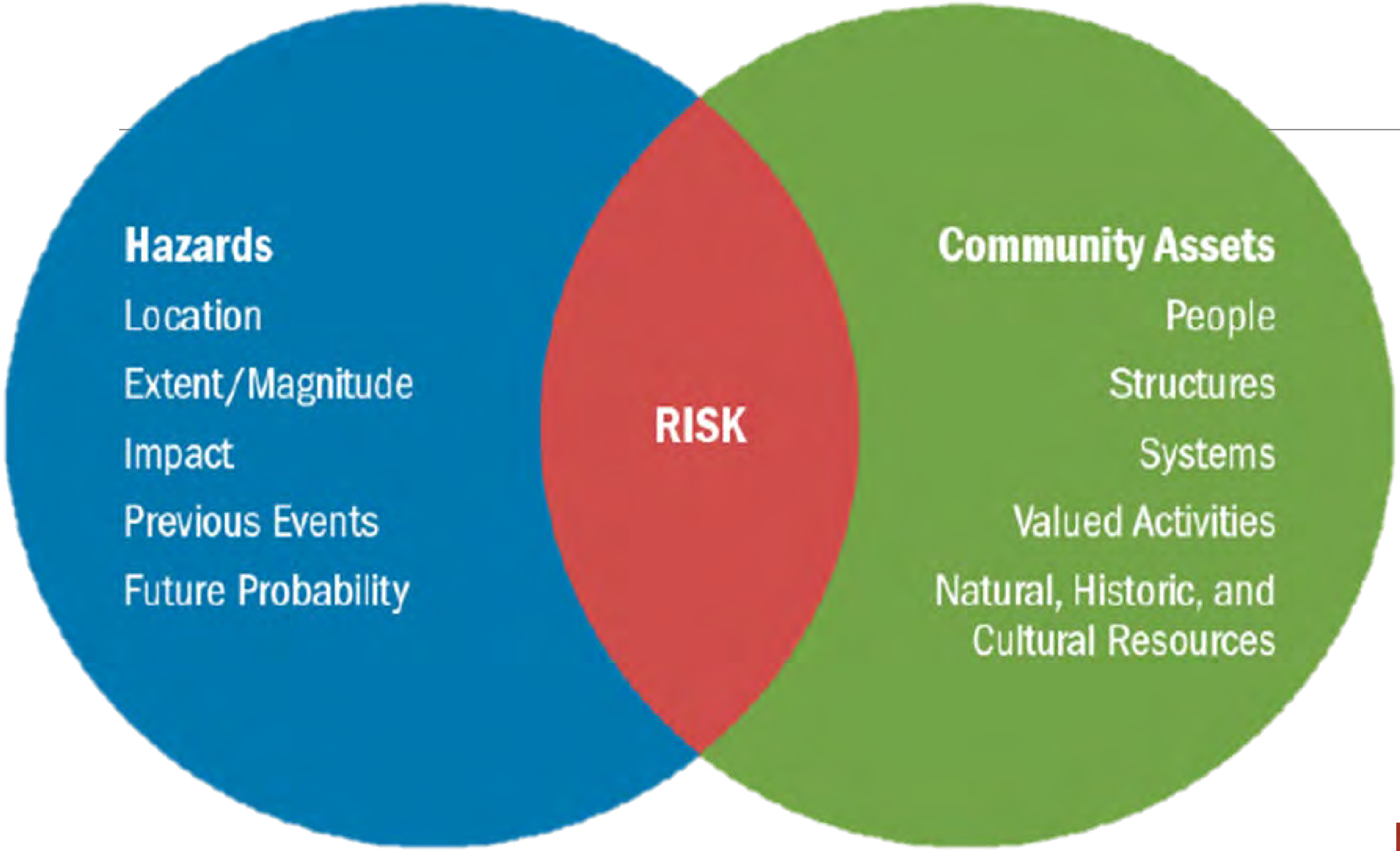


Montana - Estimated Annualized Disaster Losses
USD million
0
10
20
30
40
50
60
70
0
0
0
0
1
2
2
4
4
4
4
5
5
7
21
34
42
62
Coastal Flooding
Hurricane
Tsunami
Volcano
Drought
Ice Storm
Landslide
Avalanche
Tornado
Hail
Lightening
Heat Wave
Strong Wind
Winter Weather
Riverine Flooding
Cold Wave
Earthquake
Wildfire
Disaster Type

Estimated Annualized Earthquake Losses across Montana Counties



FEMA National Risk Index



Hazards, Assets, and Risk

Challenges

1. **Existing vulnerable buildings:** Adopting the latest building codes does not apply retroactively to existing buildings.
2. **Capacity:** While Montana has adopted the latest building code, code enforcement is locally governed and inconsistent. Builders lack capacity and proper oversight.
3. **"Built to code" ≠ "Built to last":** Modern building codes provide minimum safety requirements for new buildings, i.e., "life-safety." Current codes and standards do not prevent damage, explicitly protect against economic losses, or ensure the return of function for most buildings.

Existing Vulnerable Buildings

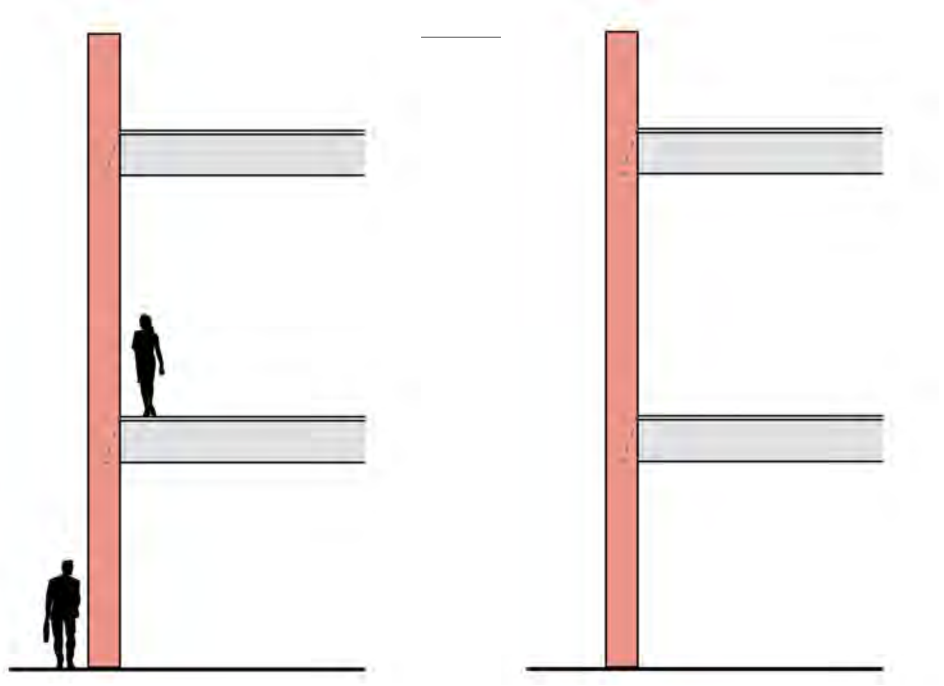
Unreinforced Masonry Buildings

1933 Long Beach, CA

2001 Seattle, Nisqually Earthquake

Christchurch, NZ 2011

2023 Kahramanmaras, Turkey



"URMs failed in predictable fashion"
-David Sommer
Degenkolb Engineers

Slide courtesy
Amanda Hertzfeld


Butte, Montana
ONLY


Sandstone masonry
Columbus, Montana
Historic Preservation Soc


Helena, Montana


Kalispell, Montana
HOTEL

Residential Vulnerabilities

Living space over a Garage

Cripple Wall & Stern Wall

Manufactured and Mobile Homes

Capacity

Damage Is Widespread in City But Far Less on Slopes on West Side

THE WEATHER

The Helena Independent

DAILY SUNDAY

Full Associated Press Service

Member N. E. A.

N. Y. Stock and Bond List

Helena Is Almost Deserted After Series of Quakes Rock the City

FRIDAY, JANUARY 10, 1936

COSTLY FEDERAL AID.

While many communities are congratulating

technical men who are competent to point out the faults and the weaknesses.

Writing in "Building Standards," a technical magazine for December, R. M. Beanfield of Los Angeles, a structural engineer of standing on the Pacific coast, has this to say about the failure of the Helena High School to stand the earthquake strain, after he had made a personal investigation and spent much time going over the structure:

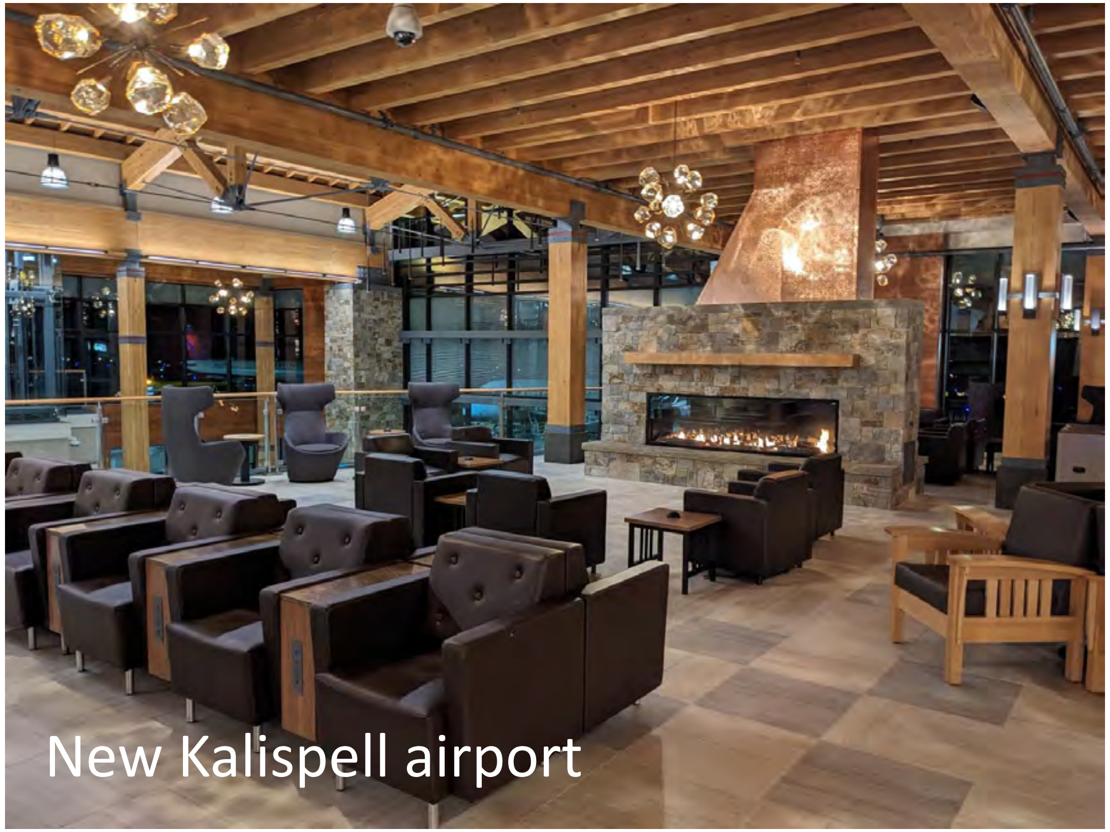
"Materials failed, not because of their inheritant weakness, but by reason of their unintelligent use and combination, improper designs, together with poor workmanship and construction."

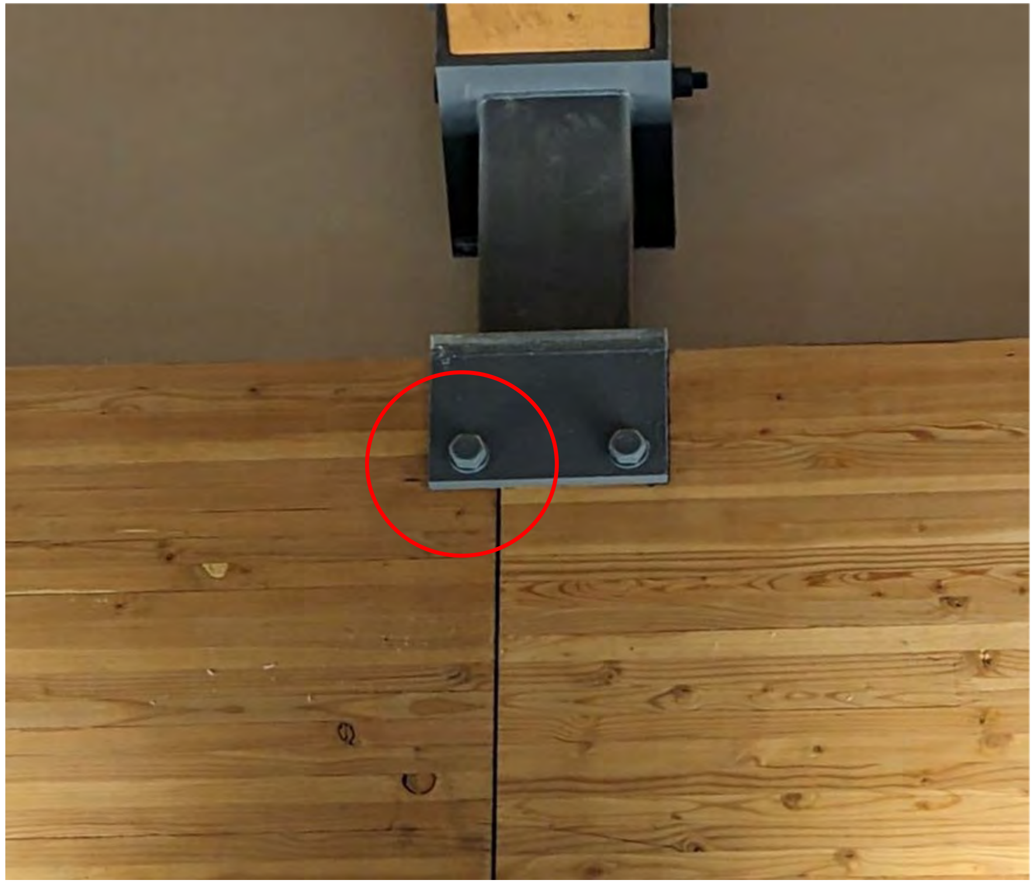
It seems to The Independent that in a few words Mr. Beanfield has told the whole story. The architects are to blame for improper designs; the contractor is to blame for the unintelligent use of materials; the PWA is to blame for the "poor workmanship and construction."

It is gratifying to know that some one had the courage to come right out and name the third party contributing to the faulty construction of the High School.

http://www.helenahistory.org/helena_high_school_2.htm

Capacity Challenges - Building Industry & Bldg Departments



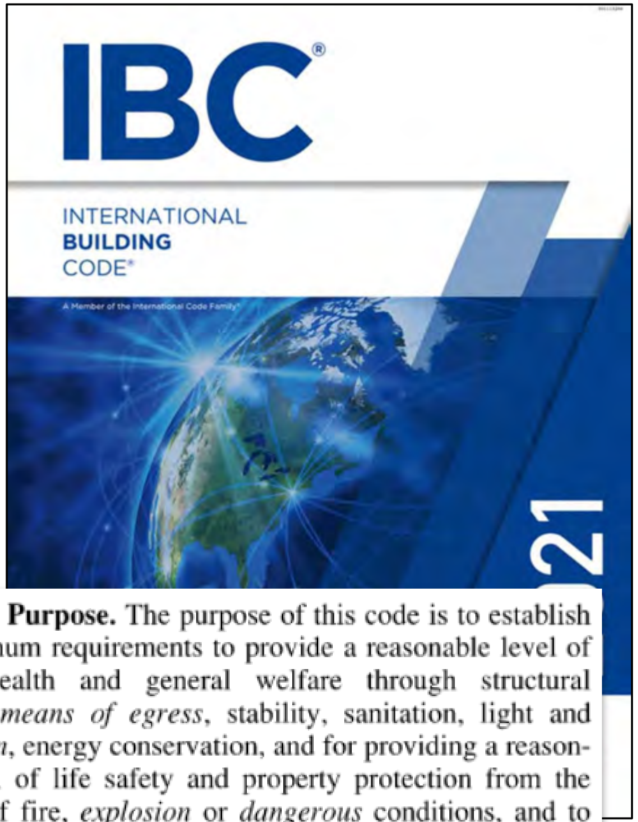


“Built to code” ≠ “Built to last”

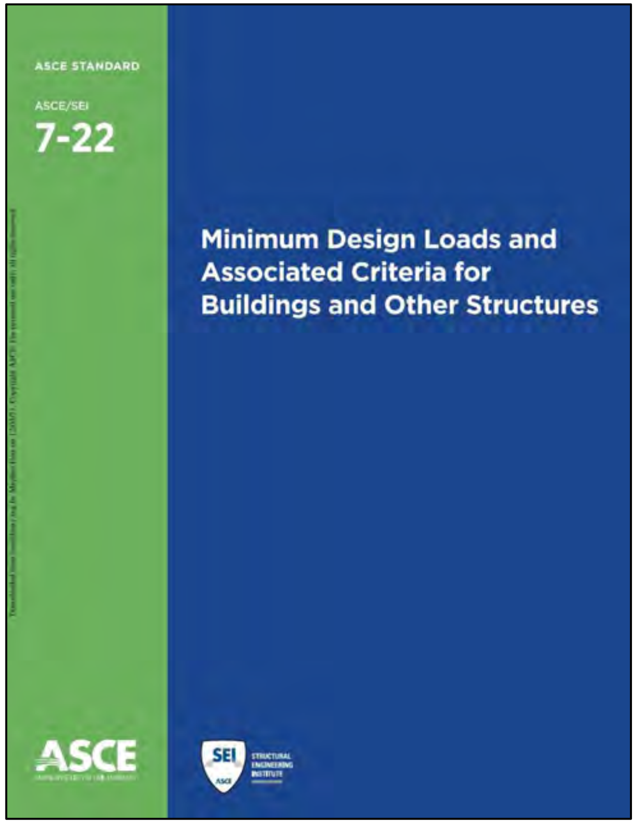
Life Safety Building Codes

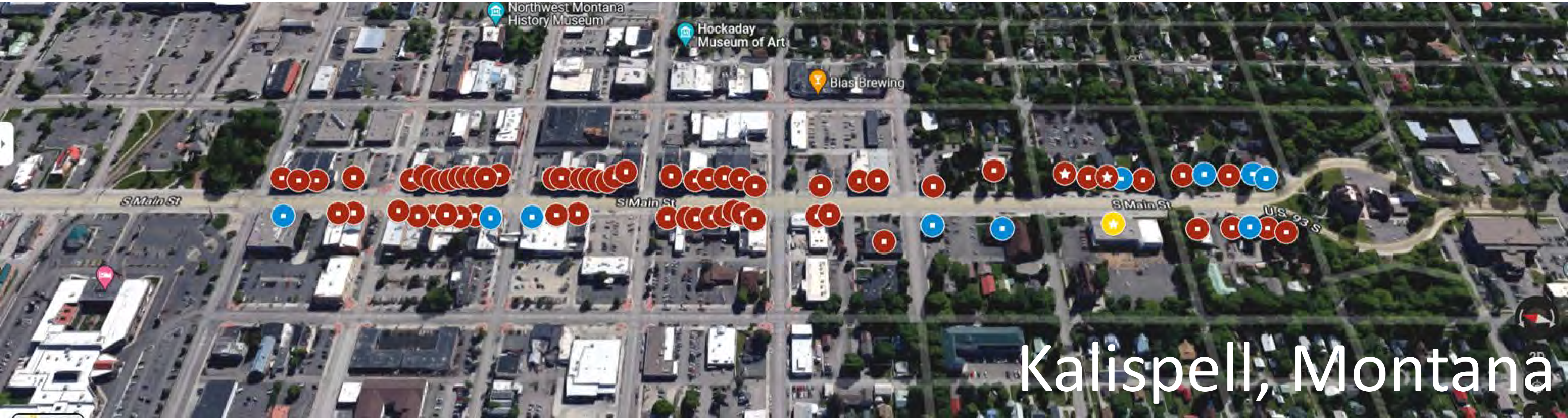
Modern building codes provide minimum requirements for earthquake safety for new buildings:

- Maintain “life safety”
- 10% probability of collapse
- Better performance for emergency services & response

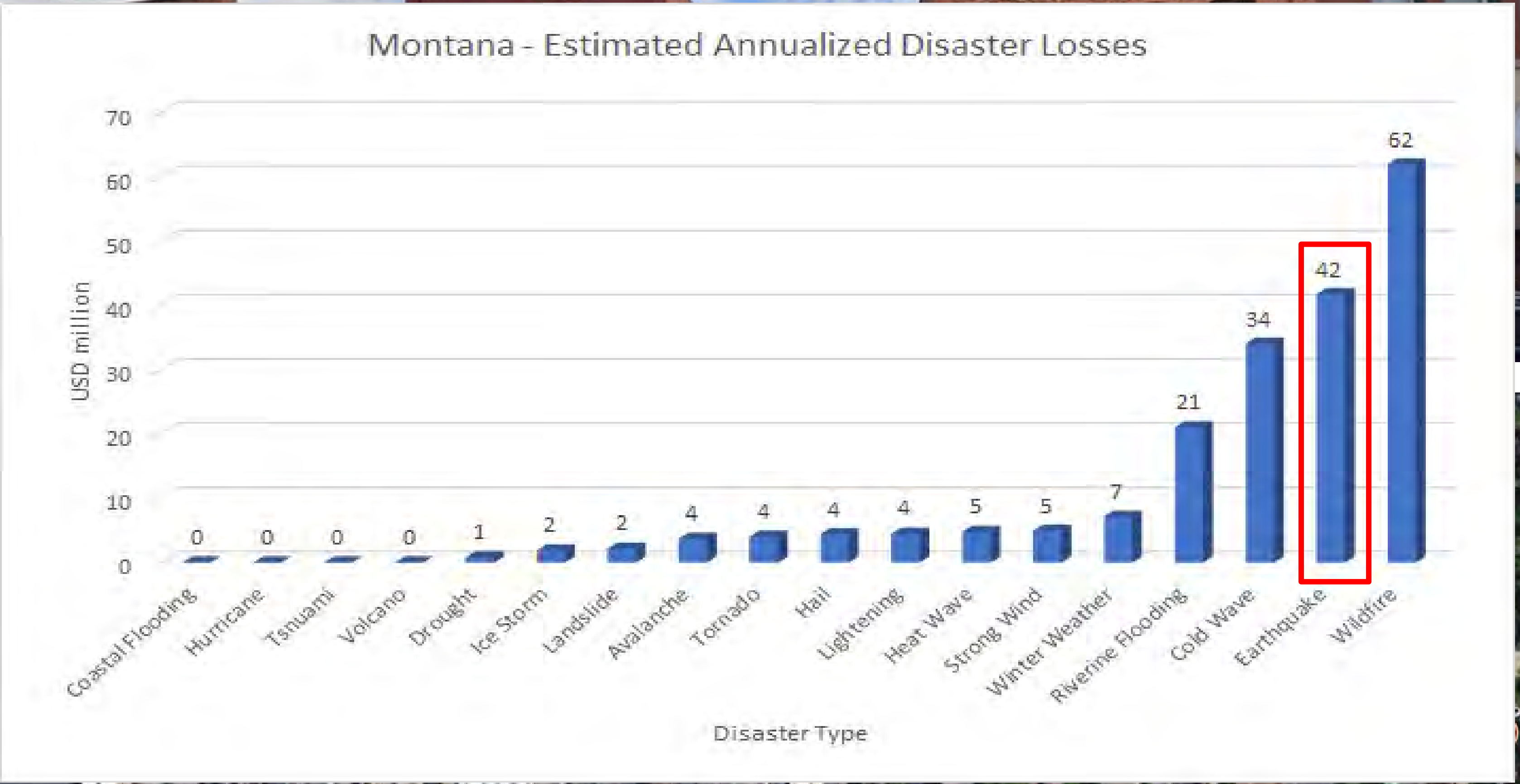


[A] 101.3 Purpose. The purpose of this code is to establish the minimum requirements to provide a reasonable level of safety, health and general welfare through structural strength, *means of egress*, stability, sanitation, light and *ventilation*, energy conservation, and for providing a reasonable level of life safety and property protection from the hazards of fire, *explosion* or *dangerous* conditions, and to provide a reasonable level of safety to fire fighters and emergency responders during emergency operations.





Kalispell, Montana



Kalispell, Montana

Mitigating Risk through Proactive Planning

What is Hazard Mitigation?

Hazard mitigation is any <u>sustained</u> action taken to reduce or eliminate <u>long-term</u> risk to people and properties from natural hazards and their effects.

Phases of Emergency Management

- Preparedness is a state of readiness to respond to a disaster, crisis or other emergency situation.
- Preparedness actions include those used to plan, organize, equip, and train. These build and sustain the capabilities you need to prevent and protect against threats.

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MONTANA EARTHQUAKE MEWG WORKING GROUP

Mitigation vs. Preparedness

	ACTIONS		OUTCOMES
PREPAREDNESS	Acquire the knowledge and resources to protect or maintain functionality *in anticipation of a disaster.*	**HAZARD EVENT**	• A better response to disaster. • Knowledge of how to react. • This does not typically reduce hazard impacts on structures.
MITIGATION	Affecting the built or natural environment in a way that reduces the impact of hazards to prevent disaster.		• Helps avoid disasters. • Reduced hazard impacts, including life safety and recovery costs.

Examples of Mitigation vs. Preparedness

Mitigation: Elevating a home by a flood source.

Mitigation: Acquiring a property to create open land in a high-risk area.

Mitigation: Adopting a Building code

Preparedness and Response: Purchasing a Police Command Vehicle

Investing in Resilience

Mitigation is an investment to:

- Prevent injury and loss of life.
- Protect community assets (structural, historic and cultural).
- Reduce the costs of disaster response and recovery.
- Support what matters to your community.

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MEWG
WORKING GROUP

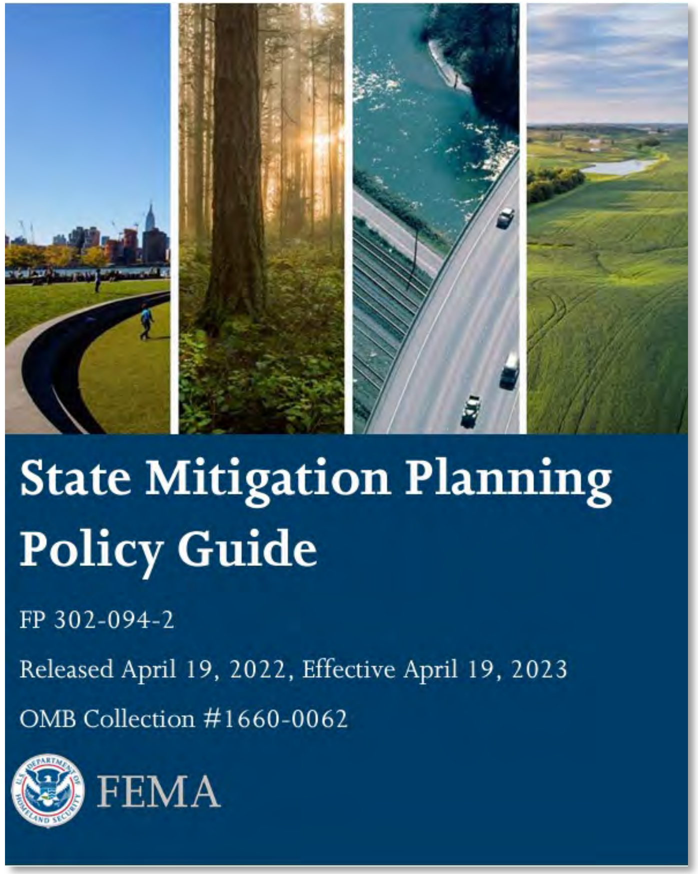
Mitigation Saves Study

National Institute of BUILDING SCIENCES	ADOPT CODE	ABOVE CODE	BUILDING RETROFIT	LIFELINE RETROFIT	FEDERAL GRANTS
Overall Benefit-Cost Ratio	11:1	4:1	4:1	4:1	6:1
Cost ($ billion)	$1/year	$4/year	$520	$0.6	$27
Benefit ($ billion)	$13/year	$16/year	$2200	$2.5	$160
Riverine Flood	6:1	5:1	6:1	8:1	7:1
Hurricane Surge	not applicable	7:1	not applicable	not applicable	not applicable
Wind	10:1	5:1	6:1	7:1	5:1
Earthquake	12:1	4:1	13:1	3:1	3:1
Wildland-Urban Interface Fire	not applicable	4:1	2:1	not applicable	3:1

What is Hazard Mitigation Planning?

A coordinated process used by state, local, tribal and territorial governments to identify their risks and vulnerabilities associated with natural disasters and to develop and implement strategies to reduce or eliminate long-term risk.

FEMA's Mitigation Planning Policies



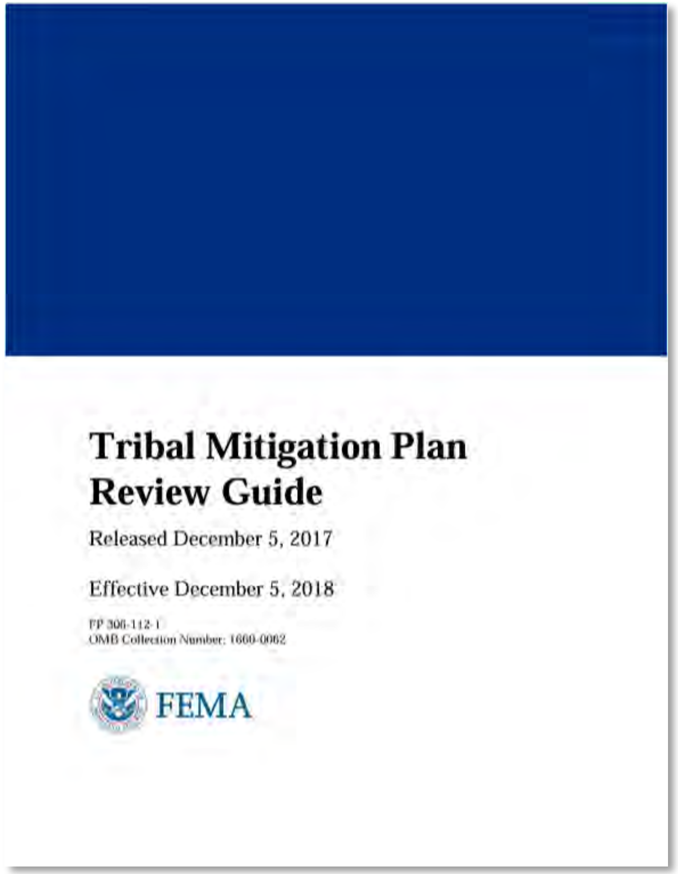
State Mitigation Planning Policy Guide

FP 302-094-2

Released April 19, 2022, Effective April 19, 2023

OMB Collection #1660-0062

FEMA



Tribal Mitigation Plan Review Guide

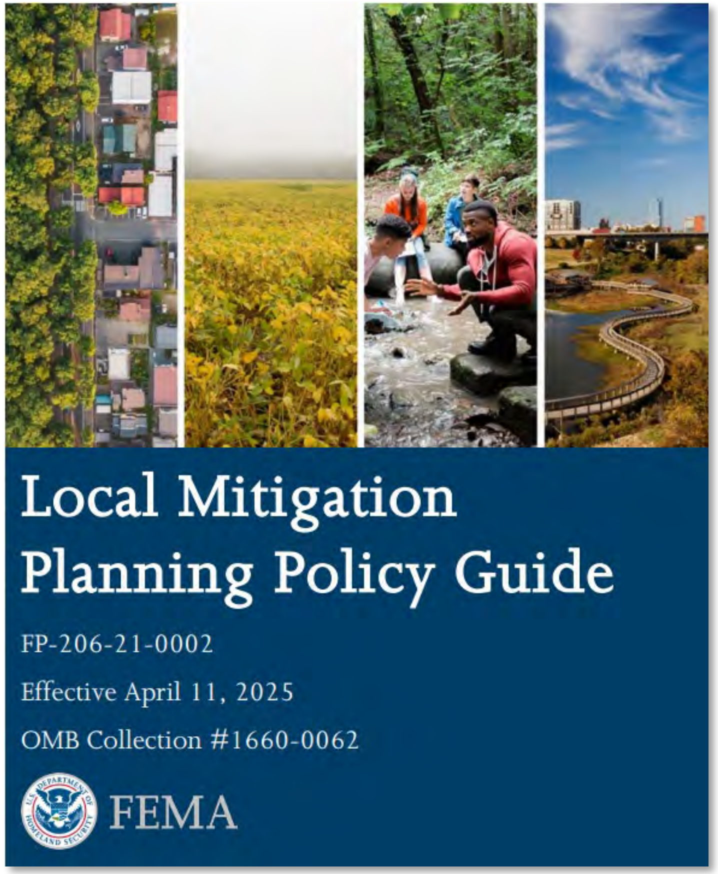
Released December 5, 2017

Effective December 5, 2018

FP 306-112-1

OMB Collection Number: 1660-0062

FEMA



Local Mitigation Planning Policy Guide

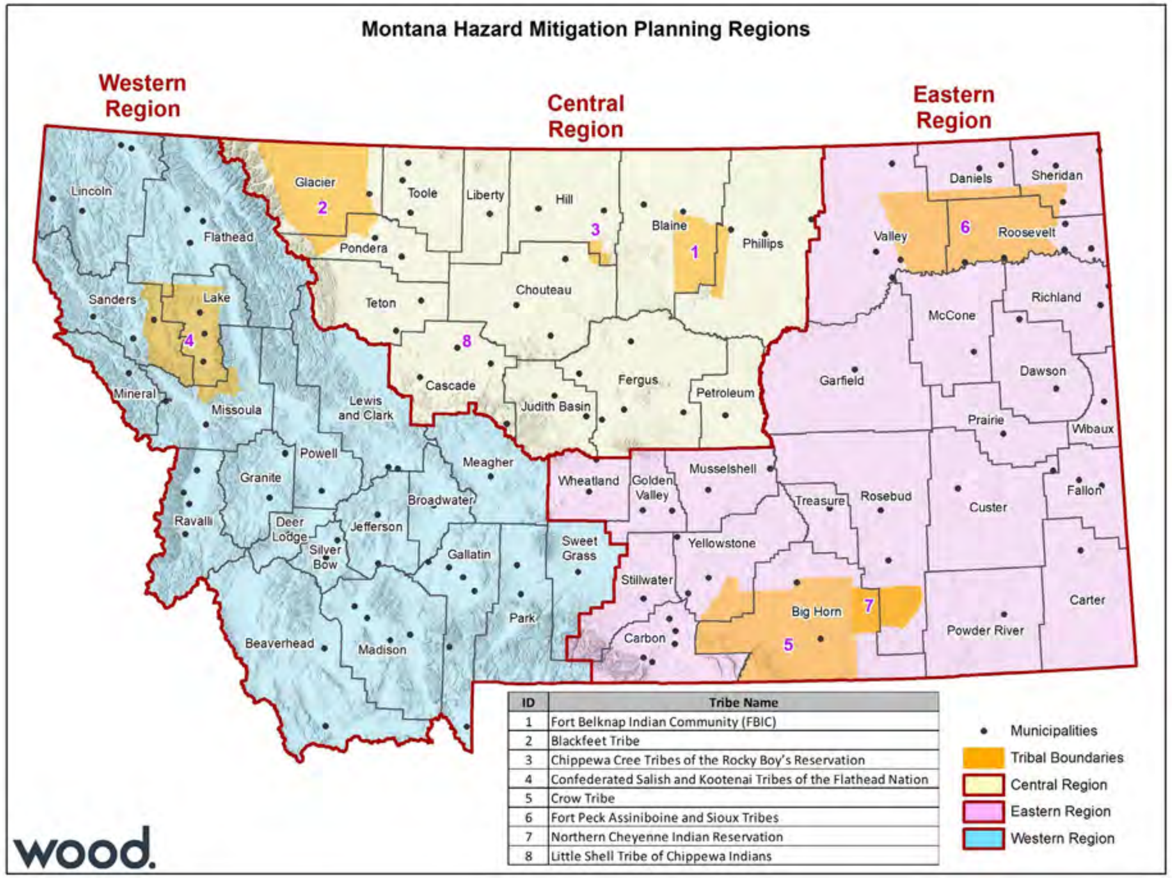
FP-206-21-0002

Effective April 11, 2025

OMB Collection #1660-0062

FEMA

State and Regional Plans in Montana



Plan Development Roadmap

Planning Process
- Introduce Mitigation
- Planning Team
- Participation
- Plan Incorporation

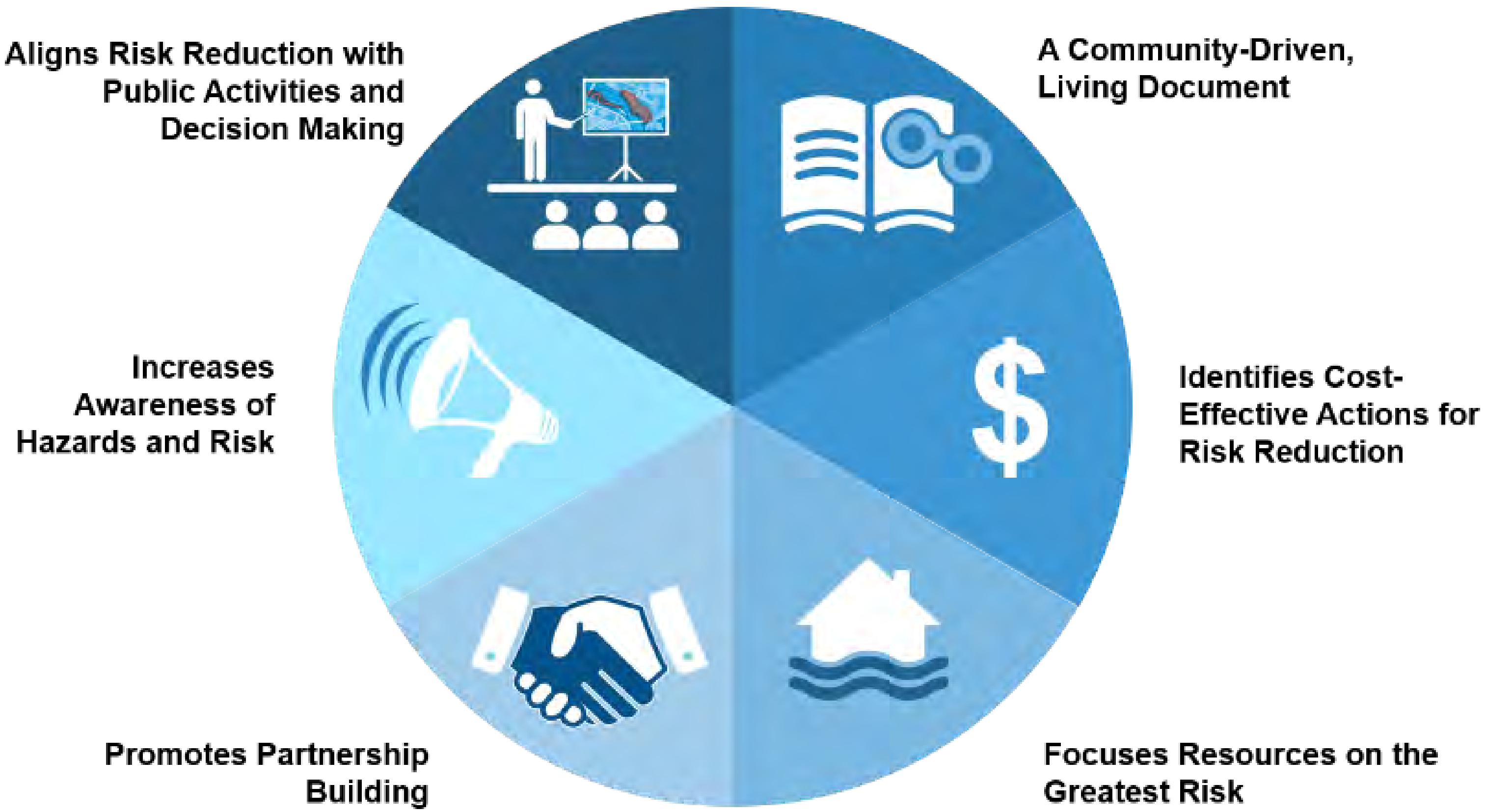
Conduct a Risk Assessment
- Identify & Profile Exposed Community Assets
- Identify & Profile Hazards
- Assess & Summarize Vulnerability & Impacts
- Prioritize Risks and Vulnerabilities

Develop a Mitigation Strategy
- Assess Capabilities
- Develop Mitigation Goals
- Identify & Evaluate Mitigation Actions
- Prepare the Action Plan

Plan Adoption and Maintenance
- Maintain the Plan
- Continue Public Involvement
- Consider Plan Updates

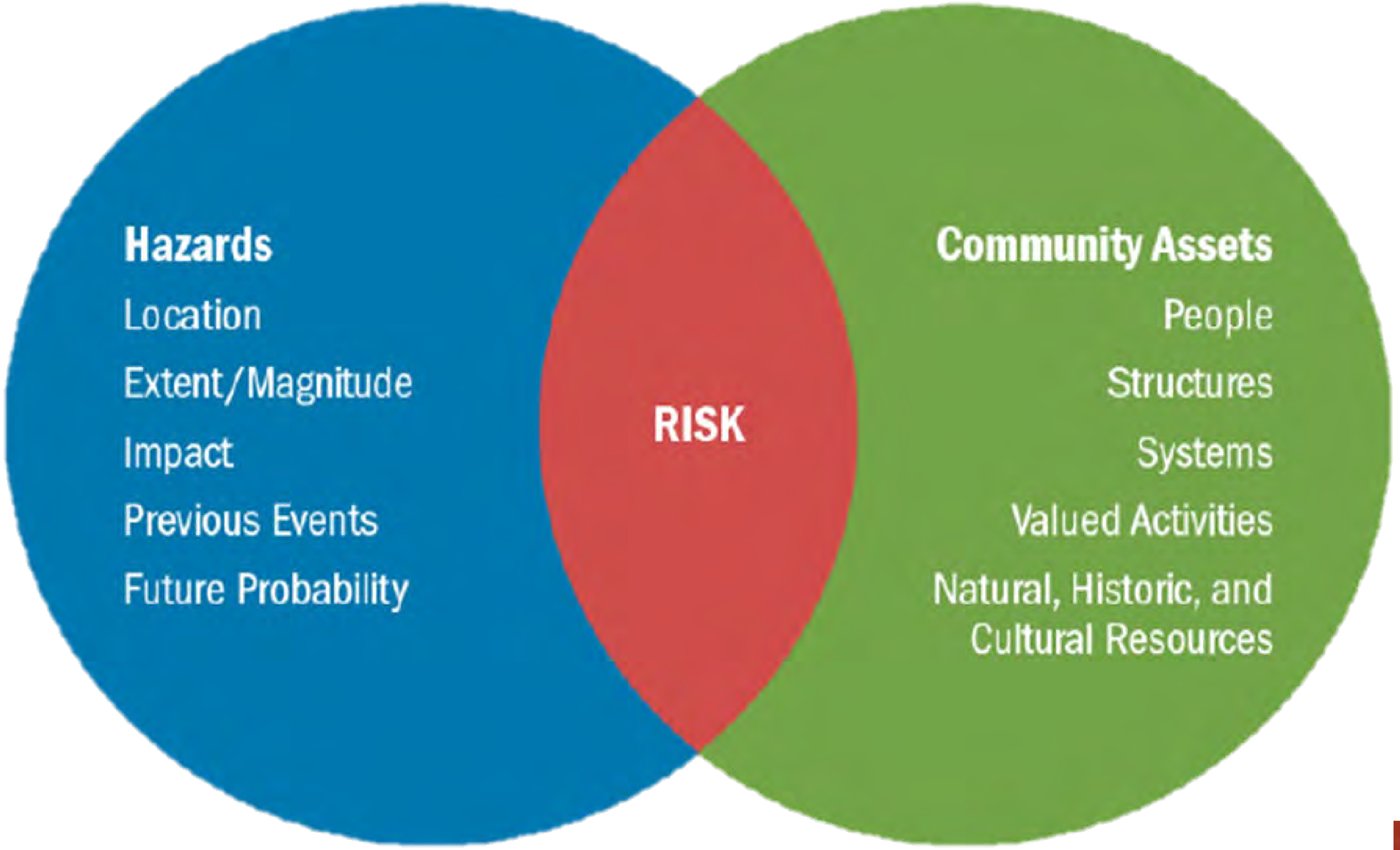
Plan Implementation
- Review, Adopt, and Approve the Plan
- Implement the Plan
- Move Mitigation Forward
- Use Mitigation Funds and Assistance

Planning Is the Foundation for Mitigation Investments



HMPs Are Tools to Assess Risk

- Mitigation works best when it is based on a long-term plan. The plan must be developed before a disaster.
- Mitigation planning assesses the risk and vulnerability to hazards. This identifies long-term local policies and actions that can increase resilience.



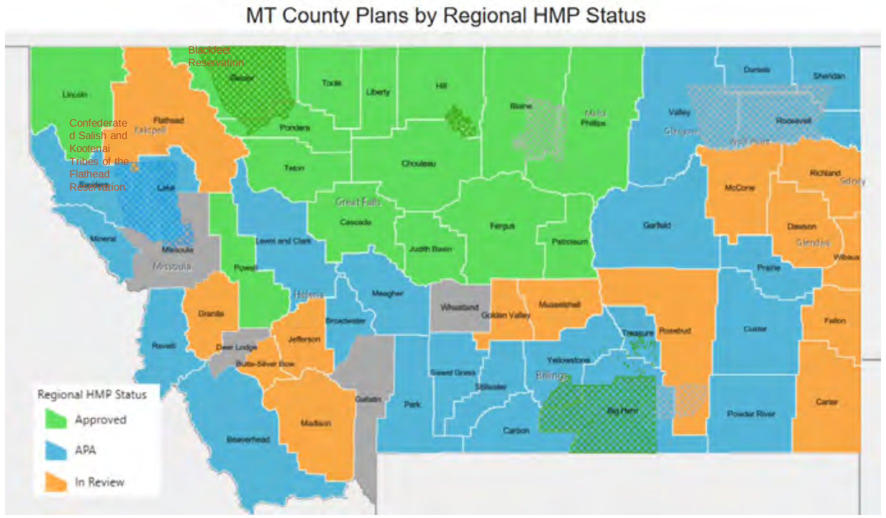
Hazards, Assets, and Risk

Benefits of Mitigation Planning

- Saves lives and reduces the risk from future disasters.
- Aids in making risk-informed decisions for the whole community.
- Prepares your community to adapt to a changing climate.
- Helps direct mitigation resources to where they are most needed.
- Increases the capacity to support faster disaster recovery.

Plan Updates to Advance Mitigation

- HMPs are required to be updated every 5 years.
- Each plan update is a chance for continuous improvement.



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Resources Affected if an HMP Expires

Assistance/Funding Description	Not Impacted	Impacted
Ability to receive an **Emergency Declaration** or **Major Disaster Declaration**.	X	
Ability to receive **FMAG** assistance.		X
IA: *Existing declarations*	X	
IA: *Future declarations*	X	
PA Categories A-B: *Existing declarations*	X	
PA Categories A-B: *Future declarations**	X	
PA Categories C-G: *Existing declarations, projects that are obligated.*	X	
PA Categories C-G: *Existing declarations, unobligated projects.*		X
PA Categories C-G: *Future declarations*		X
HMGP 15% set-aside after a declaration.*		X
HMGP: *Existing funds that are obligated.*	X	
HMGP: *Existing funds that are pending award.*		X

Making Mitigation Plans Actionable

Planning Process	→	Planning partners and the public participate actively.	→	Gain community buy-in and find local champions.
Hazard Identification and Risk and Capability Assessments	→	Identify the risks specific to the community and assess its capability.	→	Plan feasible, high-impact projects.
Mitigation Strategy	→	Connect your strategy to the priorities of the grant program.	→	Be eligible and competitive for grant funds.

Types of Hazard Mitigation

Local Plans and Regulations (LPR)

Government authorities, policies, or codes that influence the way land and buildings are developed and maintained

Structure and Infrastructure Projects (SIP)

Modifying existing infrastructure to remove it from a hazard area or construction of new structures to reduce impacts of hazards

Natural Systems Protection (NSP)

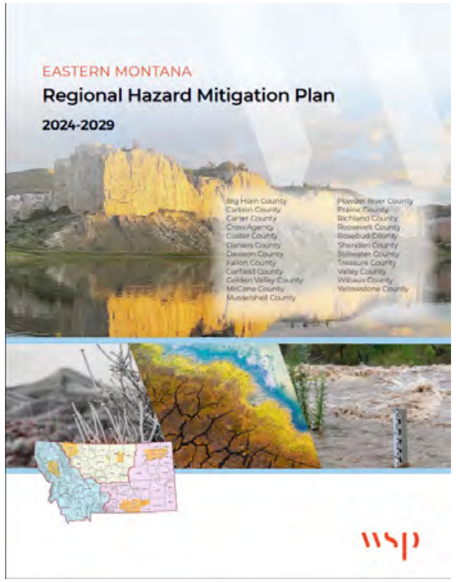
Actions that minimize damage and losses and also preserve or restore the functions of natural systems

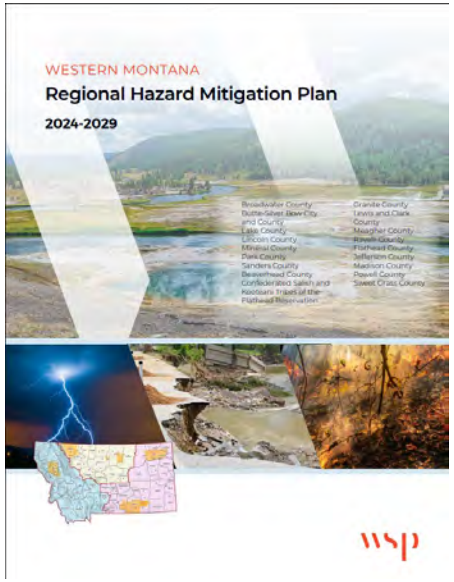
Education and Awareness Programs (EAP)

Sustained programs to educate the public and decision makers about hazard risks and community mitigation programs

Local Plans and Regulations

- Hazard Mitigation Plans
  Climate Adaptation Plans
- Building Codes
- Activities such as:
  - Plan Integration





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Structure and Infrastructure Projects

- Structurally retrofit buildings
- Brace/Anchor critical utilities
- Acquire/elevate homes
- Improve stormwater drainage capacity
- Elevating critical utilities
- Harden infrastructure

Natural Systems Protection

Watershed or landscape-scale practices

- Conserve land; greenways; create greenways, walking trails and parks; restore and protect wetlands.

Neighborhood or site-scale practices

- Add permeable pavement, tree trenches, green roofs, rain gardens, and/or tree canopies.

Coastal practices

- Protect and restore sand dunes; build living shorelines; restore coral reefs; protect and restore coastal wetlands; build waterfront parks and trails.

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Education and Awareness Programs

- Mitigation-focused outreach programs.
  - Educating homeowners and local businesses on mitigation techniques they can use.
- Train users on permitting and enforcement.
- Offer outreach and education on insurance.

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Plan Implementation

Implementation is a critical part of the plan lifecycle. It brings your plan to life by carrying out the actions in its mitigation strategy, to reduce risk in your community. This step is critical to:

- Protect members of your community.
- Prevent damage to assets.
- Reduce the costs of disaster response and recovery.
- Develop more safely and sustainably.

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Grant Funding – Many federal, state, local, or private grants are available to support various mitigation actions

Other Funding – Your community may consider unique ways to fund mitigation, such as Capital Improvement Funds, taxes, or fees.

Plan Integration – Integration means to include data and strategies from your mitigation plan into other existing community plans. by doing so you can leverage activities that have co-benefits, increase buy-in for mitigation, and reduce potential for development that conflicts with the principals of the mitigation plan.

How to Implement your Plan

What Mitigation Planning means for YOU

- Mitigation planning is the foundation for reducing risk in Montana and how each of you understands risk.
- Your data and research can inform future mitigation planning.
- You can use the mitigation plan to advocate for mitigation action in your community.
- You can be involved in future mitigation planning updates.
- Learn from your neighbors and build a network to advance mitigation.
- DES is here to help – ask us questions!

Our communities across Montana are changing. Mitigation planning can inform how those changes are managed. It is a blueprint and foundation to reduce future risk.

Our remaining sessions will help you understand how to connect your individual work to mitigation.

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THE JUXTAPOSITION OF ENERGY AND GEO-HAZARDS IN MONTANA

MONTANA ENERGY OFFICE

DEPARTMENT OF ENVIRONMENTAL QUALITY

JEFF BLEND, MAY 8, 2025

PURPOSE AND SCOPE

- ESF-12 coordinates the state's efforts in the restoration and protection of Montana's critical electricity, natural gas, and liquid fuels infrastructure
- Statutory authority: Title 90, Chapter 4, Part 3, MCA (Energy Supply Emergency Powers) and ARM Chapter 14.8.xx (Energy Shortages)
- Energy Emergency is a shortage or price of energy that will result in "curtailment of essential services or production of essential goods or the disruption of significant sectors of the economy," (90-4-302(4), MCA).

INTRODUCTION TO ESF-12

- The Montana Energy Office within DEQ is the primary agency
- Energy emergencies may involve:
  - Damage to infrastructure
  - Cascading effects from regional or national events (include quickly rising prices)
- Energy includes all major sectors
  - Electricity
  - Refined fuels
  - Crude oil
  - Natural gas
- There are a number of causes of energy outages including from natural events (storms), earthquakes, sabotage, cyber hacks, and international incidents
- Energy incidents dealing with transmission infrastructure are usually more serious than those involving one particular facility or plant
  - Yellowstone pipeline disrupted is more serious than any one refinery going down

OPERATIONAL FUNCTION

- The Montana Energy Office provides direct coordination and action with all relevant state, local, federal, and private entities
- Meets the planning and situational awareness needs of the Governor, policy makers, private industry, the public and other ESF partners
- Maintains essential contacts and situational awareness of energy sector in non-emergency times

Stakeholders

- ESF12 may deal with the following Stakeholders
  - Private sector
    - Refineries
    - Generators
    - Utilities
  - Local, State and Federal Government
  - Public
  - NGOs
    - Montana Petroleum Association
    - The Montana Petroleum Marketers & Convenience Store Association (MPMCSA)
  - Montana Multi-Hazard Mitigation Plan & Statewide Hazard Assessment; p. 305: Goal-- Implement flexible piping when extending water, sewer, or natural gas service on new construction in predicted seismic zones.

ESF12 DURING AN EARTHQUAKE

- Stakeholders may ask ESF12 team for:
  - Fuel when fuel is in short supply
  - Duration of Power Outage, Natural Gas Outage
  - Status of the utility
  - Driver Hour Waivers
  - Gasoline Standards Waivers
  - Backup generators
  - Wood for heat

DEQ MONTANA ENERGY OFFICE

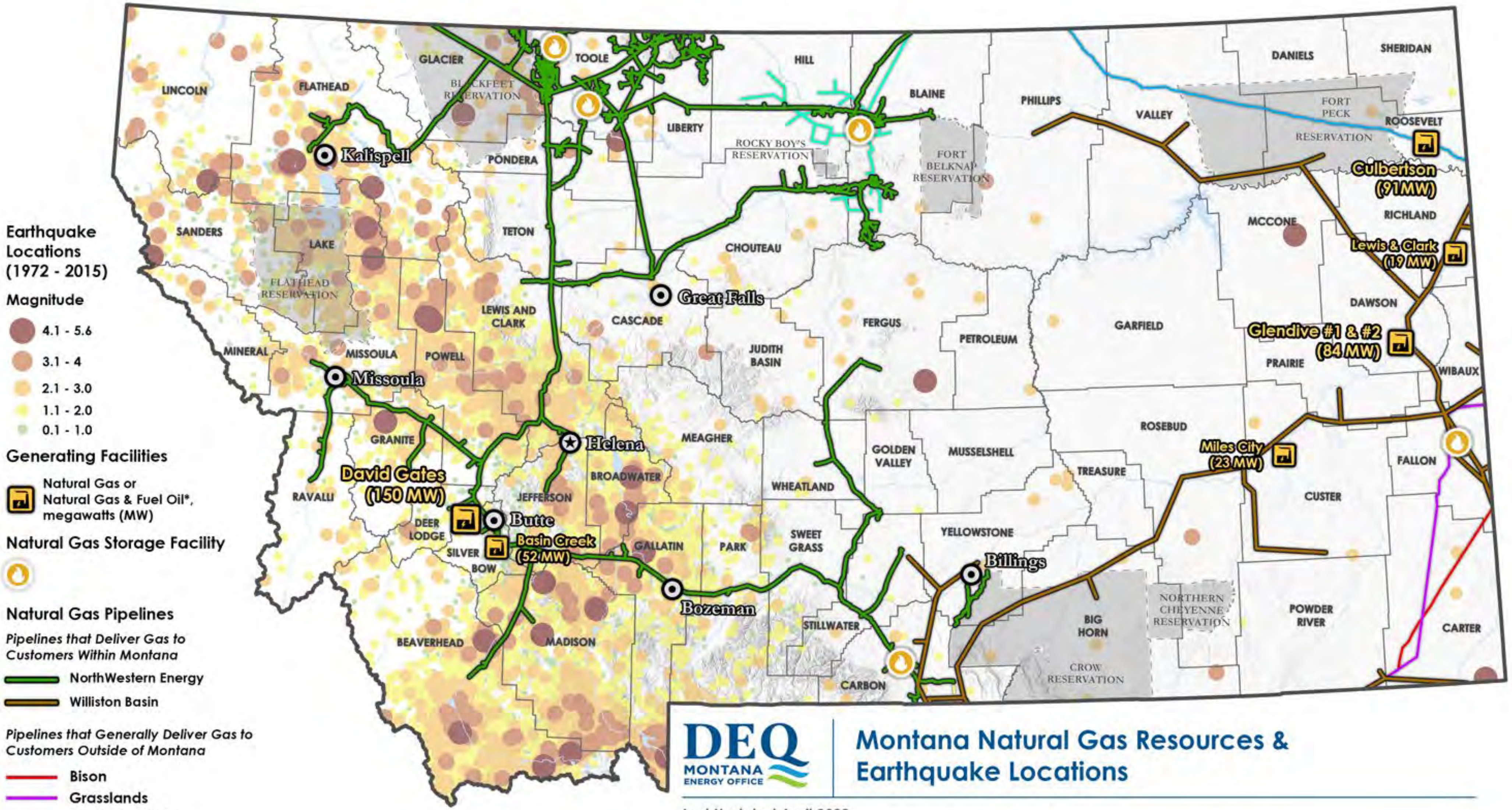
Montana Natural Gas Resources

Last Updated June 2022

Facility Data Source: U.S. Energy Information Administration (EIA), 2020

Pipeline Data Source: U.S. Energy Information Administration (EIA), 2020

Culbertson, Glendive 1 & 2, and Miles City are rated to operate with either natural gas or #2 fuel, but have been predominantly fueld by natural gas in recent years.



*Culbertson, Glendive 1 & 2, and Miles City are rated to operate with either natural gas or #2 fuel, but have been predominantly fueld by natural gas in recent years.

DEQ MONTANA ENERGY OFFICE

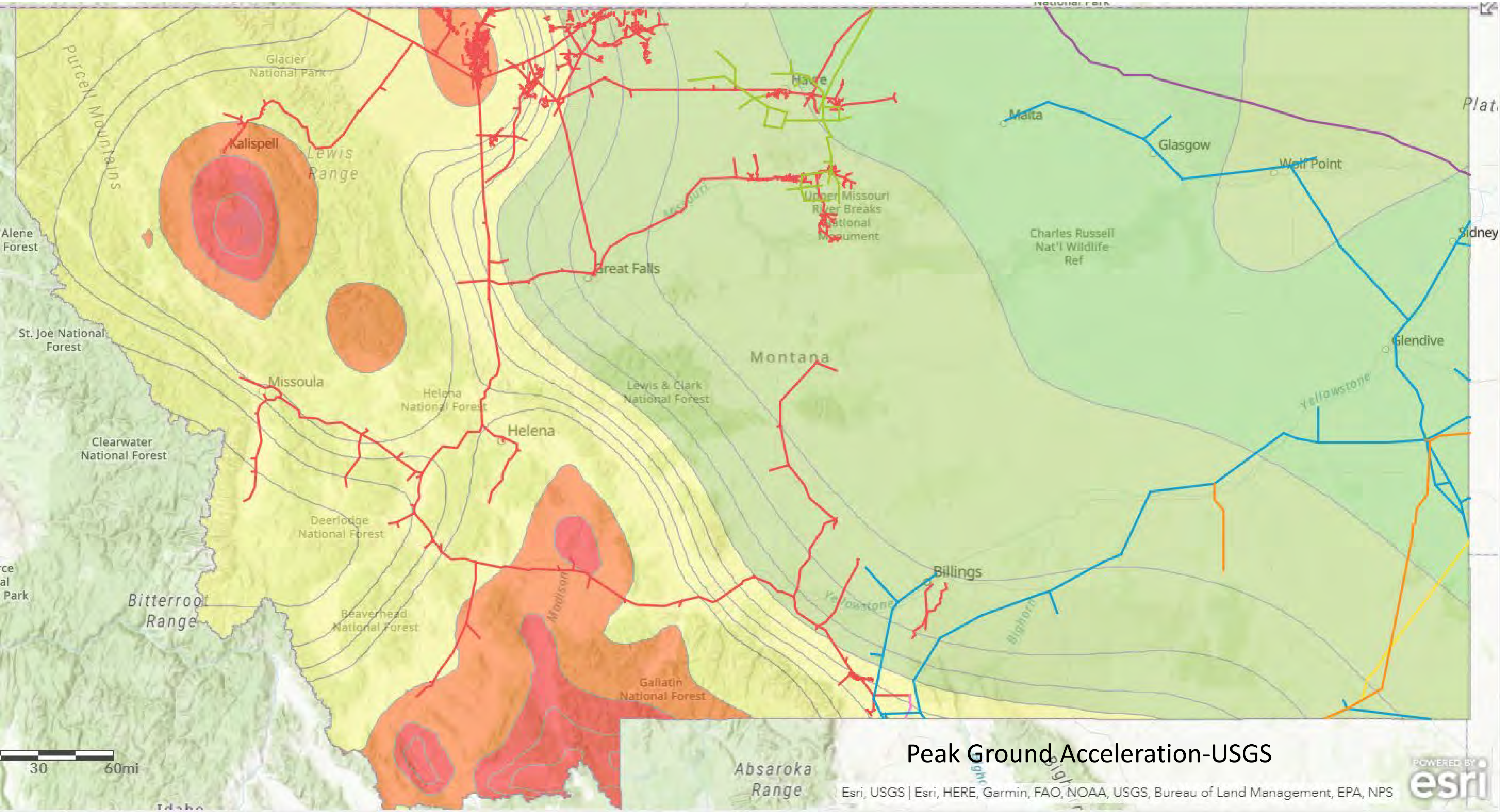
Montana Natural Gas Resources & Earthquake Locations

Last Updated April 2022

Facility Data Source: U.S. Energy Information Administration (EIA), 2020

Pipeline Data Source: U.S. Energy Information Administration (EIA), 2020

Earthquake Location Data Source: Montana Bureau of Mines & Geology (MBMG), 2022



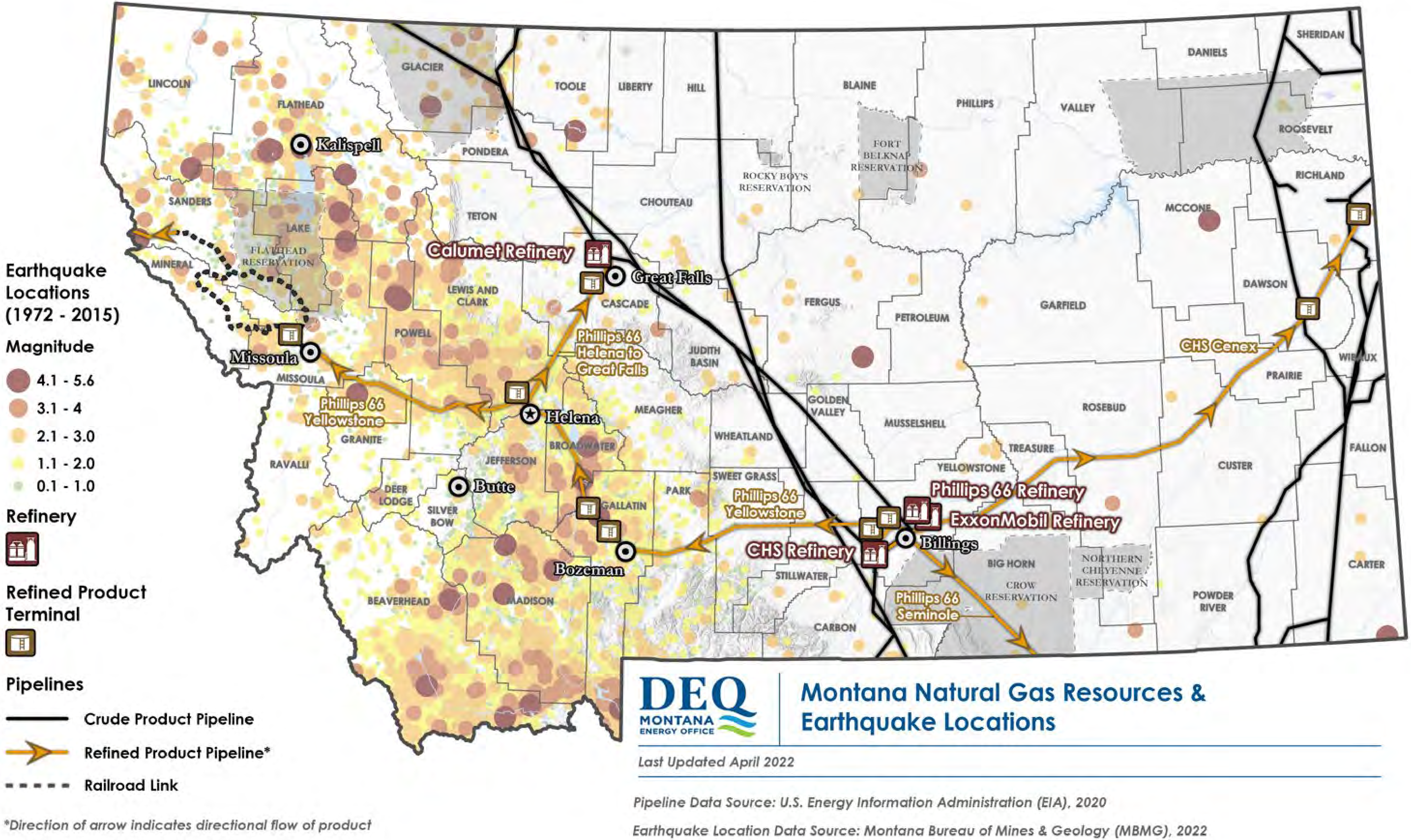
Peak Ground Acceleration-USGS

Montana Petroleum Resources

Last Updated April 2022

Direction of arrow indicates directional flow of product

Pipeline Data Source: U.S. Energy Information Administration (EIA), 2020



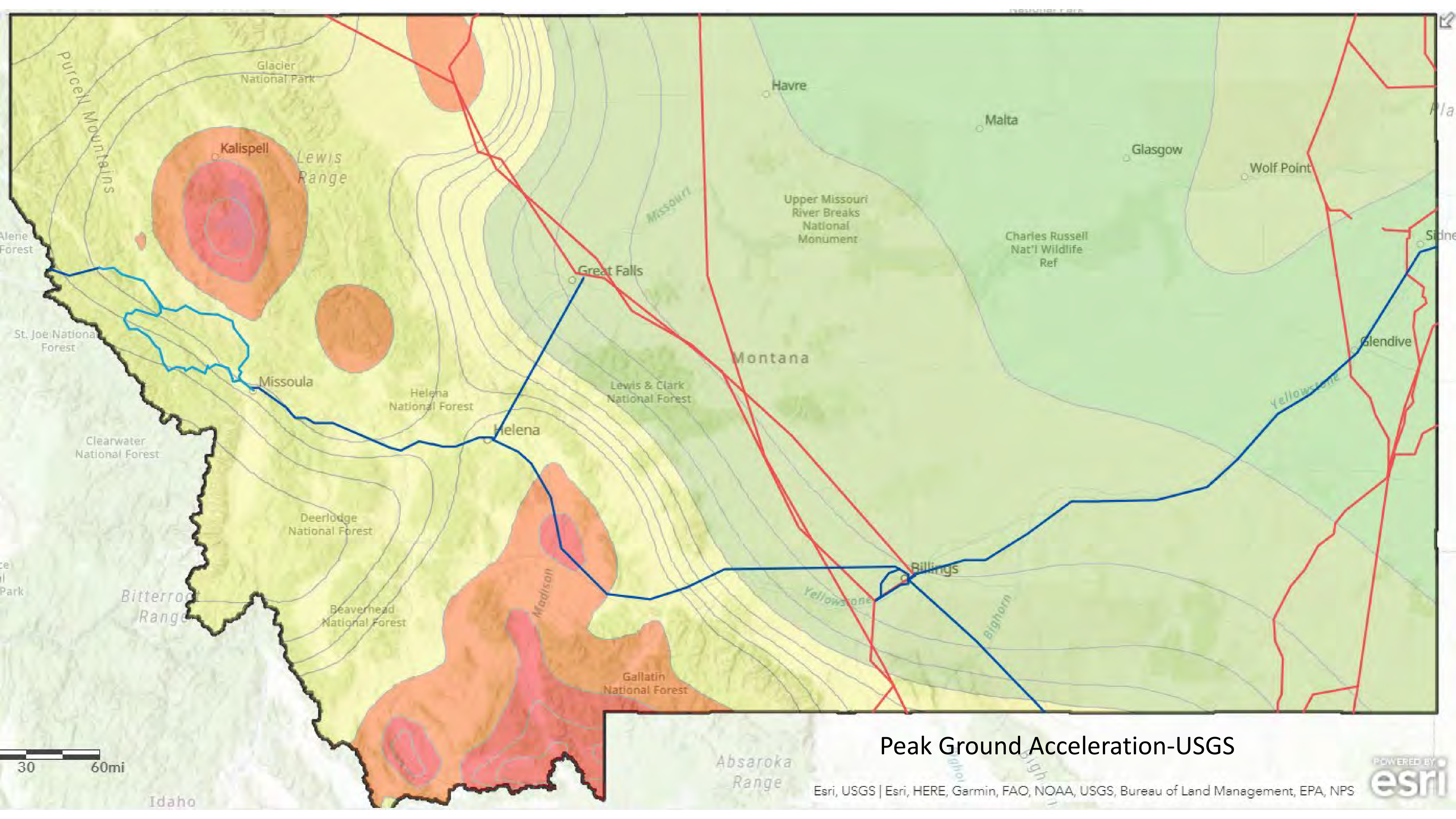
DEQ MONTANA ENERGY OFFICE

Montana Natural Gas Resources & Earthquake Locations

Last Updated April 2022

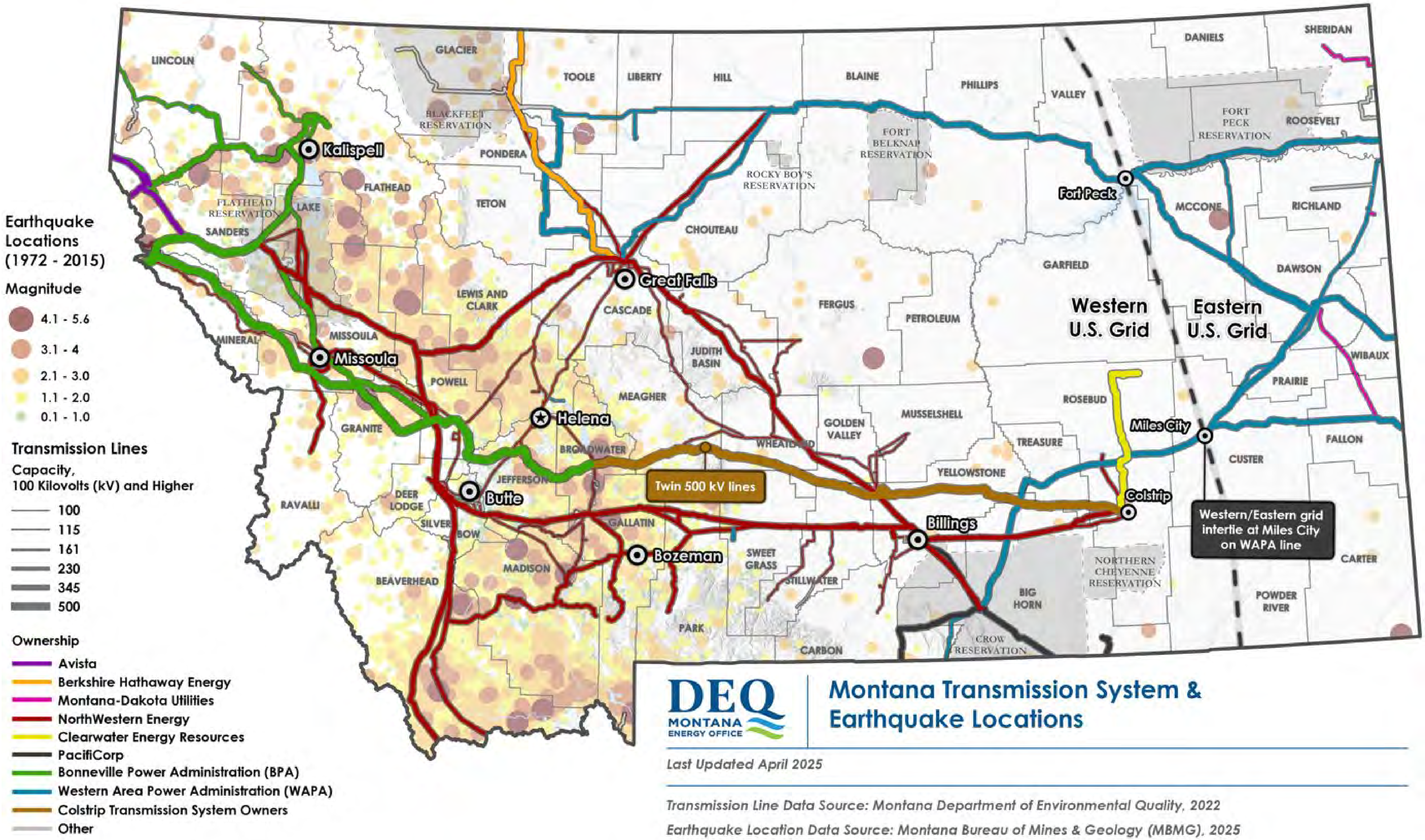
Pipeline Data Source: U.S. Energy Information Administration (EIA), 2020

Earthquake Location Data Source: Montana Bureau of Mines & Geology (MBMG), 2022



Peak Ground Acceleration-USGS


Transmission Lines
Capacity,
100 Kilovolts (kV) and Higher
100
115
161
230
345
500
Ownership
Avista
Berkshire Hathaway Energy
Montana-Dakota Utilities
NorthWestern Energy
Clearwater Energy Resources
PacifiCorp
Bonneville Power Administration (BPA)
Western Area Power Administration (WAPA)
Colstrip Transmission System Owners
Other
Kalispell
Missoula
Helena
Great Falls
Butte
Bozeman
Billings
Colstrip
Miles City
Fort Peck
Twin 500 kV lines
Western U.S. Grid
Eastern U.S. Grid
Western/Eastern grid intertie at Miles City on WAPA line
LINCOLN
GLACIER
BLACKFEET RESERVATION
TOOLE
LIBERTY
HILL
BLAINE
PHILLIPS
VALLEY
DANIELS
SHERIDAN
ROOSEVELT
FORT PECK RESERVATION
FORT BELKNAP RESERVATION
ROCKY BOY'S RESERVATION
PONDERA
FLATHEAD
TETON
CHOUTEAU
MCCONE
RICHLAND
SANDERS
LAKE
FLATHEAD RESERVATION
LEWIS AND CLARK
CASCADE
FERGUS
PETROLEUM
GARFIELD
DAWSON
MINERAL
MISSOULA
JUDITH BASIN
POWELL
MEAGHER
WIBAUX
PRAIRIE
ROSEBUD
GRANITE
BROADWATER
WHEATLAND
GOLDEN VALLEY
MUSSELSHELL
TREASURE
CUSTER
FALLON
YELLOWSTONE
JEFFERSON
DEER LODGE
RAVALLI
SILVER BOW
GALLATIN
SWEET GRASS
STILLWATER
MADISON
BEAVERHEAD
BIG HORN
NORTHERN CHEYENNE RESERVATION
POWDER RIVER
CARTER
PARK
CARBON
CROW RESERVATION
DEQ
MONTANA ENERGY OFFICE
Montana Transmission System
Last Updated November 2022
Transmission Line Data Source: Montana Department of Environmental Quality, 2022



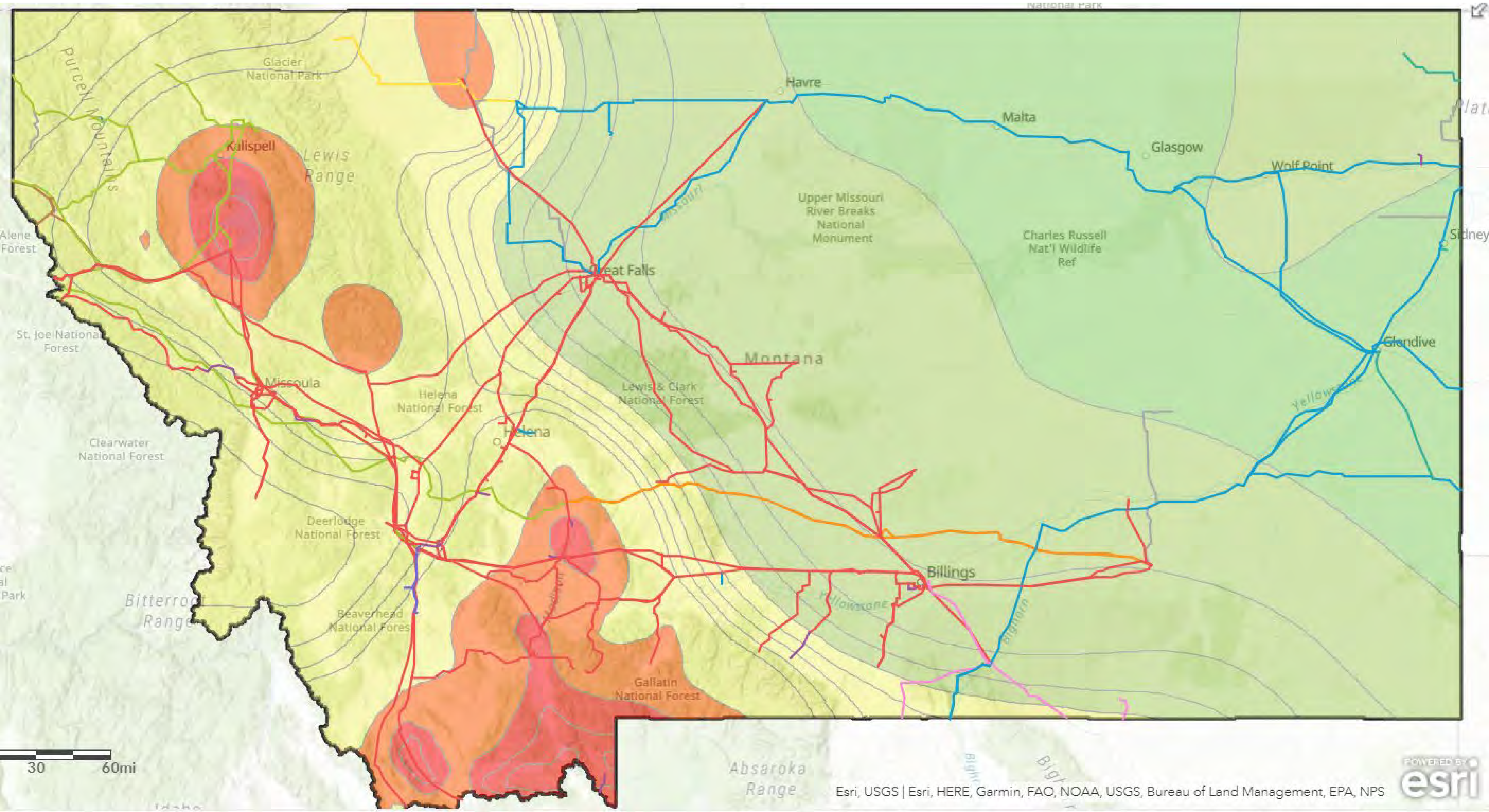
DEQ MONTANA ENERGY OFFICE

Montana Transmission System & Earthquake Locations

Last Updated April 2025

Transmission Line Data Source: Montana Department of Environmental Quality, 2022

Earthquake Location Data Source: Montana Bureau of Mines & Geology (MBMG), 2025



Glacier National Park
Purcell Mountains
Kalispell
Lewis Range
Havre
Malta
Glasgow
Wolf Point
Sidney
Upper Missouri River Breaks National Monument
Charles Russell Nat'l Wildlife Ref
Great Falls
Missouri
St. Joe National Forest
Montana
Glendive
Missoula
Helena National Forest
Lewis & Clark National Forest
Yellowstone
Helena
Clearwater National Forest
Deerlodge National Forest
Billings
Bitterroot Range
Beaverhead National Forest
Bighorn
Gallatin National Forest
Absaroka Range
Idaho
30
60mi
Esri, USGS | Esri, HERE, Garmin, FAO, NOAA, USGS, Bureau of Land Management, EPA, NPS

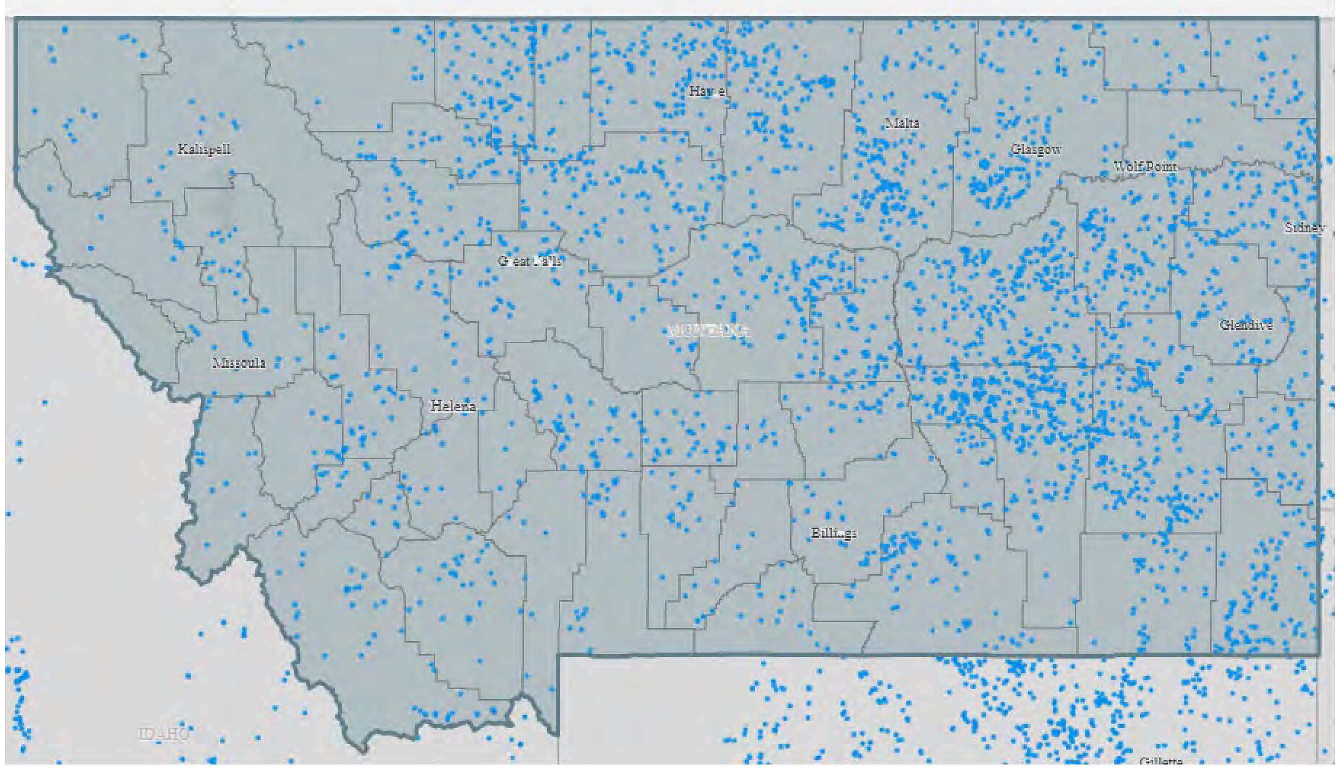
EARTHQUAKE RESPONSE PROCEDURE
DNRC DAM SAFETY PROGRAM

Doug Brugger, PE, CFM – Water Operations Bureau Chief
Brent Zundel, PE, CFM – Dam Safety Program Manager
Sam Johnson, PE, CFM – Dam Safety Construction Engineer
Chad Hill – Dam Safety Engineer
6 Regional Engineers, Part-Time Dam Safety

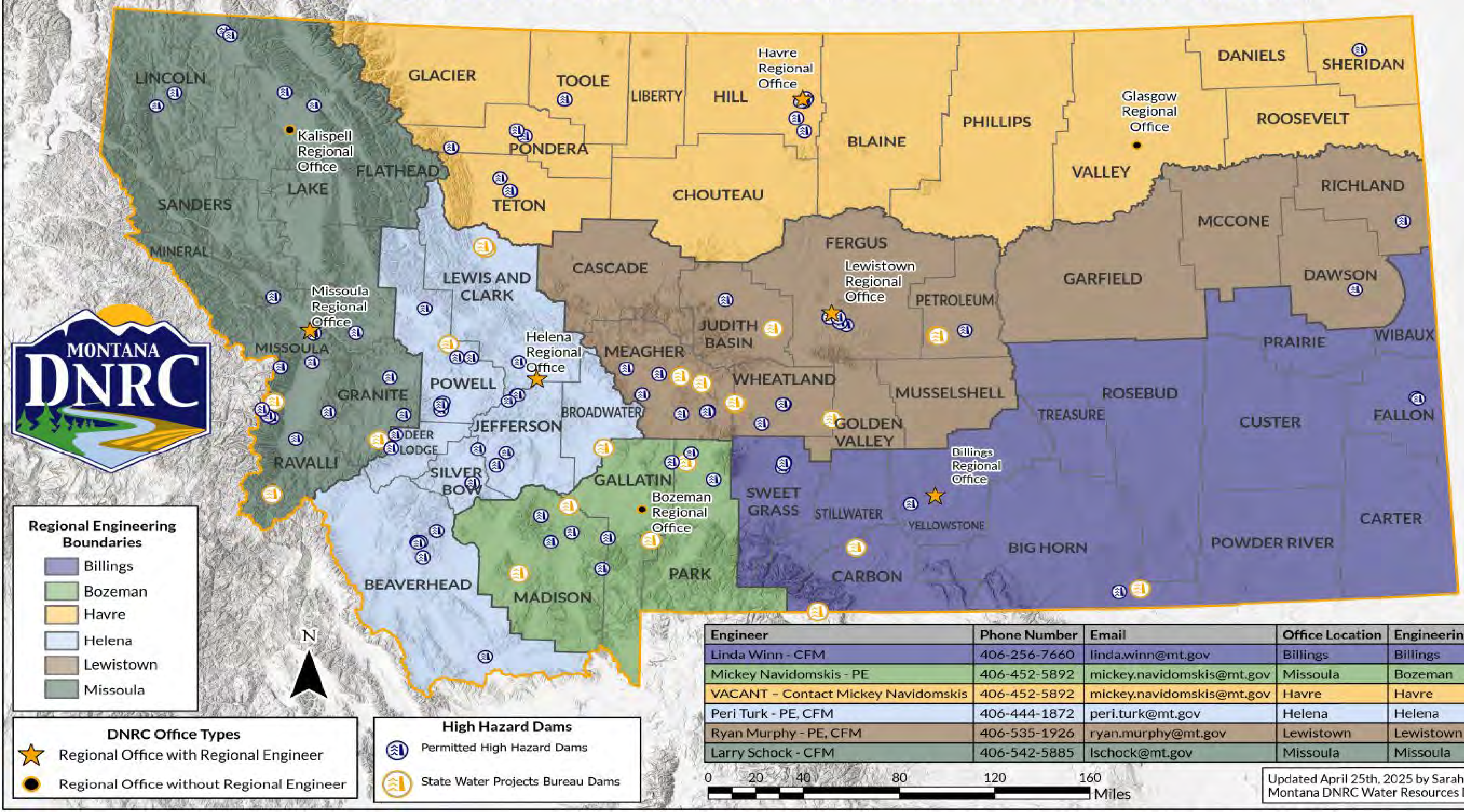
NID for MT

- 3,006 Jurisdictionally Sized Dams
- 72 years Average Dam Age
- 91% High Hazard Dams with EAPs
- 10% Federally Regulated Dams
- 89% State-Regulated Dams

50% more dams than peer states! (ID, WY, UT, CO, ND, SD)



MONTANA DNRC REGIONAL ENGINEERING BOUNDARIES



Engineer	Phone Number	Email	Office Location	Engineering Region
Linda Winn - CFM	406-256-7660	linda.winn@mt.gov	Billings	Billings
Mickey Navidomskis - PE	406-452-5892	mickey.navidomskis@mt.gov	Missoula	Bozeman
VACANT – Contact Mickey Navidomskis	406-452-5892	mickey.navidomskis@mt.gov	Havre	Havre
Peri Turk - PE, CFM	406-444-1872	peri.turk@mt.gov	Helena	Helena
Ryan Murphy - PE, CFM	406-535-1926	ryan.murphy@mt.gov	Lewistown	Lewistown
Larry Schock - CFM	406-542-5885	lschock@mt.gov	Missoula	Missoula

Updated April 25th, 2025 by Sarah Smolka
Montana DNRC Water Resources Division

Earthquake Incident Response Procedure

Updated [03-10-2025]

Version 5.20

CONTENTS

Earthquake Response Flowchart

START

Earthquake ≥ **4.0**

USGS automatically notifies DNRC Staff & DES calls until they get a live person on earthquakes with a magnitude ≥ 4.5

SWPB – Triage using EQ location and knowledge of their dams. If their dams are affected, they will contact dam tenders, then join zoom call.

All DNRC personnel will first enter ZOOM meeting then enter CONNECT meeting. Use phone # as a backup.

ZOOM Meeting Room
https://mt-gov.zoom.us/my/mtearthquakeresponse
Password: 258337

~~**DNRC EQ INCIDENT RESPONSE CENTER (CONNECT)**~~
~~https://dnrcwater.adobeconnect.com/earthquake~~

~~Admin Username: dnrdamsafety@mt.gov~~
~~Admin Password: damsafety~~

Phone # Backup

Audio: Telephone and Computer
Call-In: 1-646-558-8656 Meeting ID: 840 255 5446
Password: 258337

Communication lead opens Connect, used for displaying information and EQ results. DNRC personnel, Director, PIO, FEMA, DES, etc. will have access to this site.

IF YOU CAN'T MAKE MEETING

Try to get in touch with the team. Make sure to put safety first. **Do not take action alone.**

IF YOU CAN MAKE MEETING

Roll Call and Assignments

Prioritize potentially affected dams & take action according to the PGA Action Guidelines found on **Page 5**

Earthquake Response Flowchart

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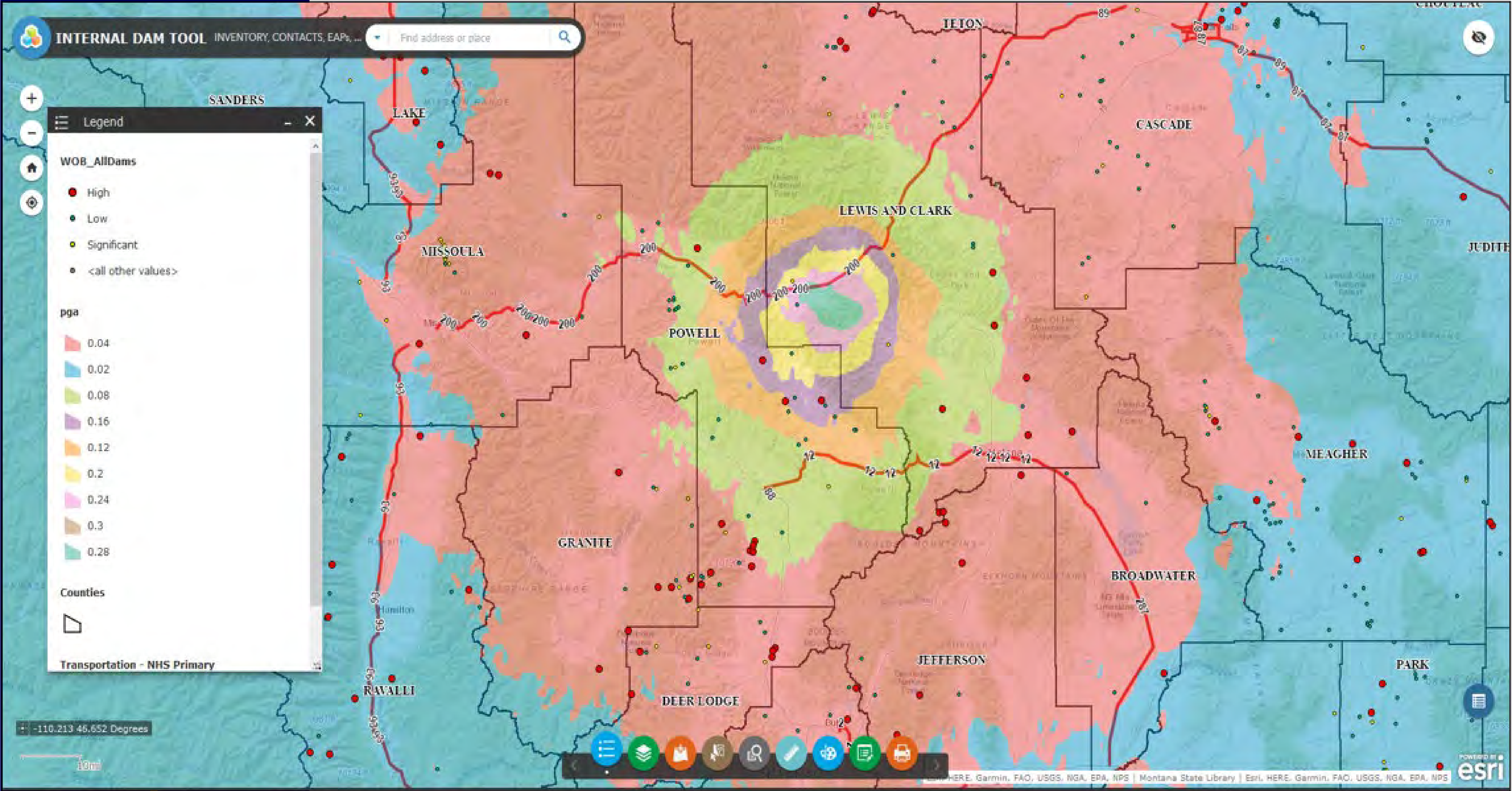
Intensity PGA PGV



INTERNAL DAM TOOL
INVENTORY, CONTACTS, EAPs, ...
Find address or place
Legend
WOB_AllDams
High
Low
Significant
<all other values>
pga
0.04
0.02
0.08
0.16
0.12
0.2
0.24
0.3
0.28
Counties
Transportation - NHS Primary
SANDERS
LAKE
MISSOULA
POWELL
LEWIS AND CLARK
TETON
CASCADE
JUDITH
MEAGHER
GRANITE
BROADWATER
JEFFERSON
DEER LODGE
RAVALLI
PARK
-110.213 46.652 Degrees
10mi
Esri, HERE, Garmin, FAO, USGS, NGA, EPA, NPS | Montana State Library | Esri, HERE, Garmin, FAO, USGS, NGA, EPA, NPS
esri

Affected Dams Inspection Priorities

Priority 1 – All high hazard dams with PGA > 0.2g
Priority 2 – All high hazard dams with PGA > 0.1g and ≤ 0.2g
Priority 3 – All high hazard dams with PGA > 0.05g and ≤ 0.1g
Priority 4 – All low and significant hazard dams with PGA > 0.2g
Priority 5 – All low and significant hazard dams with PGA > 0.1g and ≤ 0.2g

PGA Correlation

PGA Actions	Acceleration (g)	Perceived Shaking	Potential Damage
No Action	< 0.0017	Not felt	None
	0.0017 – 0.014	Weak	None
	0.014 – 0.039	Light	None
	0.039 – 0.050	Moderate	Very light
Immediate Owner Inspection	0.051 – 0.092	Moderate	Very light
	0.092 – 0.10	Strong	Light
Inspection by Owner's Engineer ASAP	0.11 – 0.18	Strong	Light
	0.18 – 0.20	Very Strong	Moderate
DNRC Immediate Inspection	0.21 – 0.34	Very Strong	Moderate
	0.34 – 0.65	Severe	Moderate to heavy
	0.65 – 1.24	Violent	Heavy
	> 1.24	Extreme	Very heavy

MONTANA DNRC

- Priority 1 – No dams
- Priority 2

PGA_Mean	National Id	Dam Name:	Owner Name
0.104	MT01222	MCKAY CREEK	PRICE TRUST

- Priority 3

PGA_Mean	National Id	Dam Name:	Owner Name
0.092	MT00017	NEVADA CREEK DAM	STATE OF MONTANA, D.N.R.C., W.R.D.
0.085	MT01378	DAVIS CREEK DAM	JOSEPH EVE & MELEANIE VANKOTEN-EVE

- Priority 4

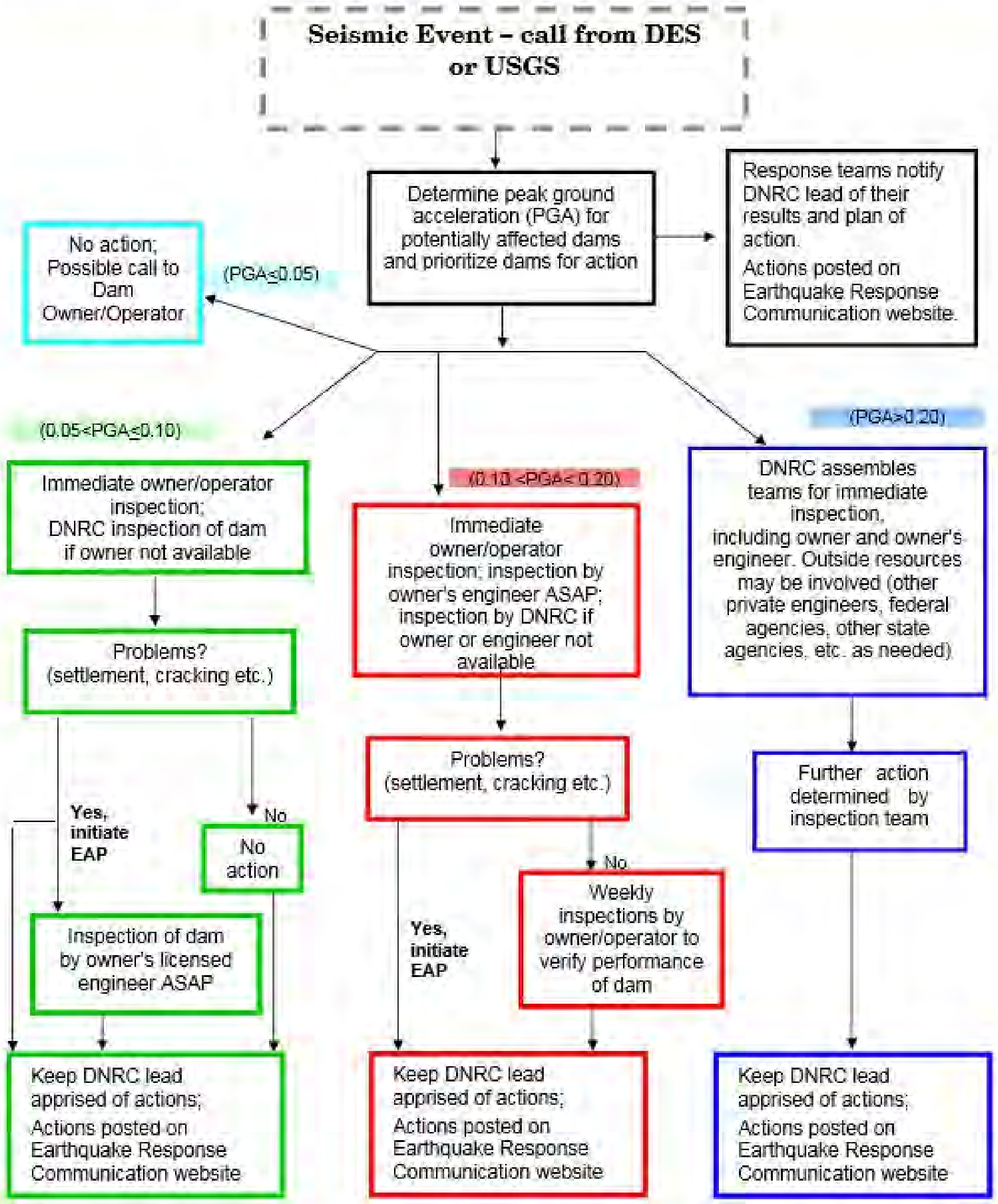
PGA_Mean	National Id	Dam Name:	Owner Name
0.215	MT03683	HERRIN LAKE	STATE OF MONTANA, D.N.R.C., T.L.M.D.
0.205	MT01388	MANNIX	F MANNIX

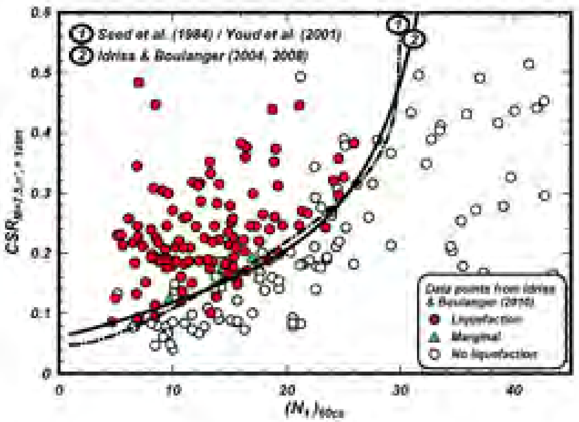
- Priority 5

PGA_Mean	National Id	Dam Name:	Owner Name
0.147	MT03684	SMITH LAKE	JAMES R HESS

Peak Ground Acceleration Action Guidelines

PEAK GROUND ACCELERATION (PGA) ACTION GUIDELINES





Technical Note 5 - Simplified Seismic Analysis Procedure for Montana Dams

Prepared for:

Montana Department of Natural Resources and Conservation

Water Resources Division

Water Operations Bureau

Dam Safety Program

November 30, 2020

Prepared by:

HDR Engineering

Available at:
https://dnrc.mt.gov/Water-Resources/Dam-Safety/Technical-Notes

Geohazards 2025

MONTANA
Department of Transportation

Geohazards- updates

- Have a position dedicated to geohazards and geotechnical asset management– he is on vacation this week
- MDT is currently doing some agency reorganization – will be an asset management group
- Use of New technologies – LIDAR, Drones (change detection), Remote sensing, machine learning and A.I. – prediction of rockfall? Possible upcoming research project for our rockslopes
- Last couple of weeks we took ownership of a new tracked Cone Penetration Test (CPT) rig. Able to perform shear wave velocity testing with it.
- What is priority of geohazards at MDT and by current state and federal administration?

Geohazards

- We do not have dedicated funding to solely address Geohazards (funding competes with other needs)

We currently do have a large landslide project under construction on Hwy 191 (Fred Robinson Bridge/CMR area)

  – This project is over $20M in cost and is intended to mitigate a large landslide impacting the roadway (slide plane is 120 feet deep, slide is over 1000 feet long)

Ongoing projects/maintenance for other minor roadway slides, rockfall, frost heaves, etc.

Seismic Design

All New/replacement structures (bridges and retaining walls) are designed for **Seismic** conditions. National LRFD specifications are used (general procedure)– 7% exceedance in 75 yrs ~ 1,000 yr earthquake. Occasional Site-Specific analysis in high pga areas or poor soils or where they coexist (e.g. Kalispell/Flathead area)

Slopes and embankments are evaluated for seismic, but may not be formally designed to resist seismic unless deemed critical.

We will be performing liquefaction mitigation at bridge approach embankments for Sportsman’s bridge on HWY 82 (bridge over Flathead river west of Bigfork).

Available funding <<< Transportation Infrastructure needs

- Geohazards are only one of many items that MDT addresses with our available funding.

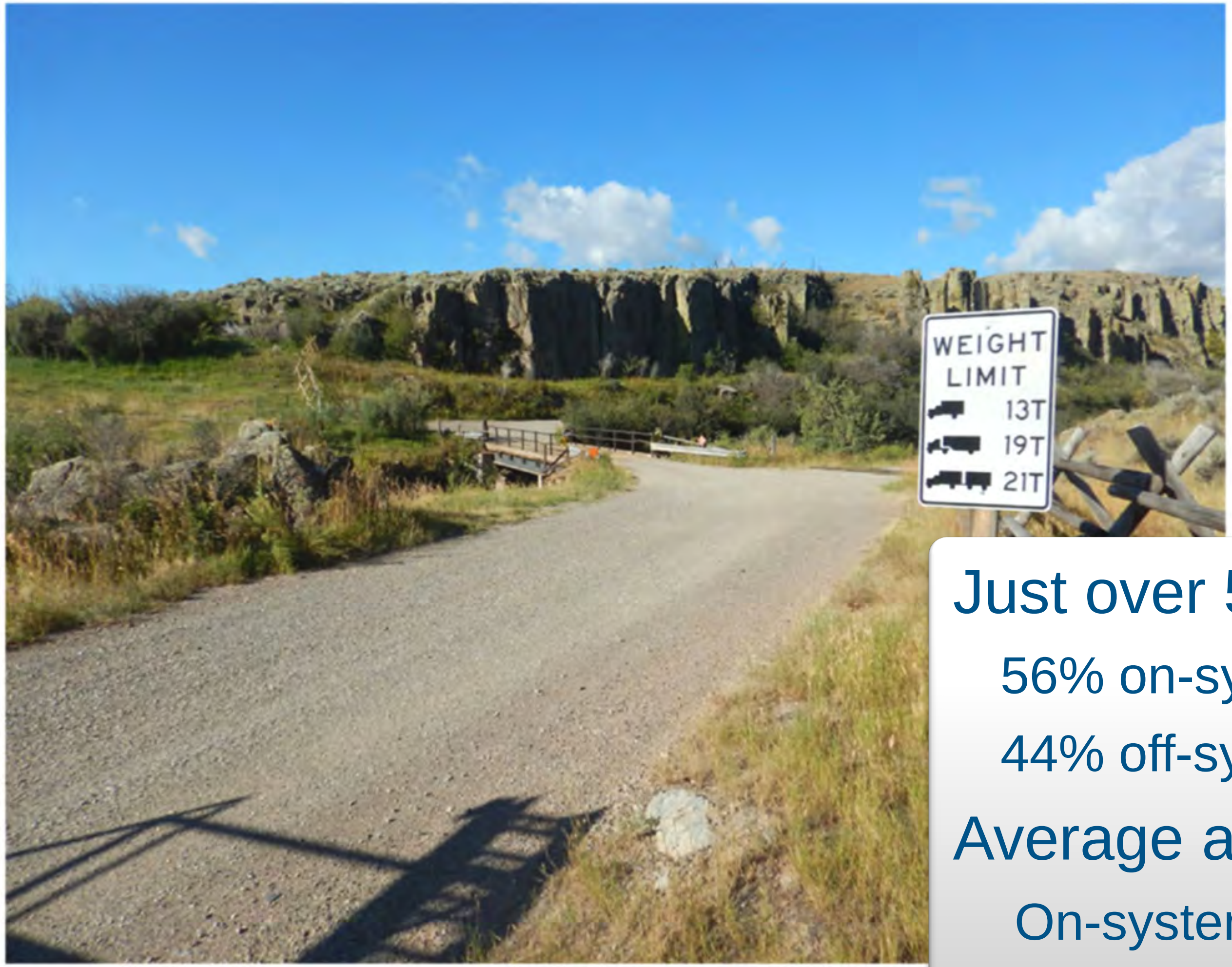
- We obligate about $450 million per year on construction projects (The funding is about 87% federal and 13% state)
  - These projects include pavement preservation projects (chip seals, mill/fill, etc.)
  - Safety projects – signing, guardrail, slope flattening, signals, roundabouts
  - Bridge projects – preservation or replacement
  - Rehabilitation --   more robust pavement work often with associated items such as culvert replacement, slope flattening, spot improvements, drainage, etc.
  - Reconstruction – reconstruction of roadways– add capacity, correct roadway geometrics, etc.
  - Pavement is designed or 20 yr design life (we usually get longer due to preservation)
  - Bridges and other structures – 75 yr design life

Current Bridge Challenge

A Little History, from Then…..

- 1,200 bridges built during New Deal
- Timber bridges built quickly
- 440 still in service
- 90 years old today

.....To Now



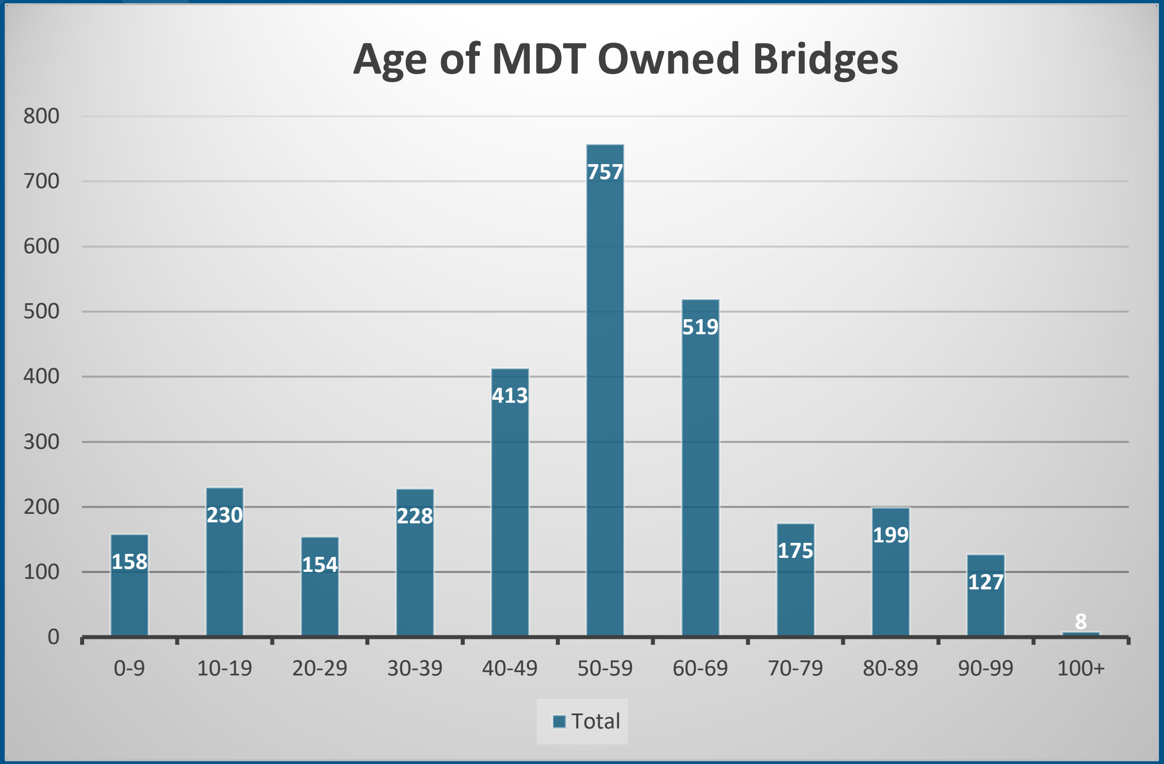
Just over 5,000 bridges in Montana

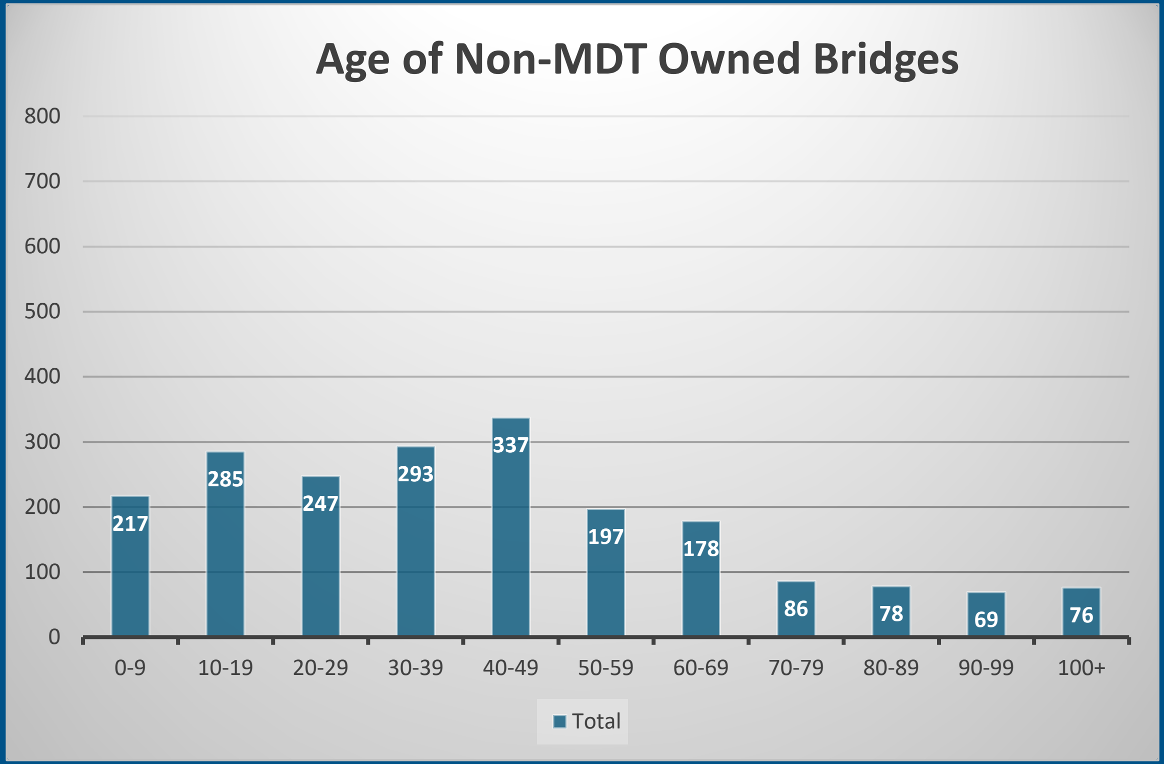
- 56% on-system
- 44% off-system

Average age

- On-system bridges = 50 years
- Off-system bridges = 45 years

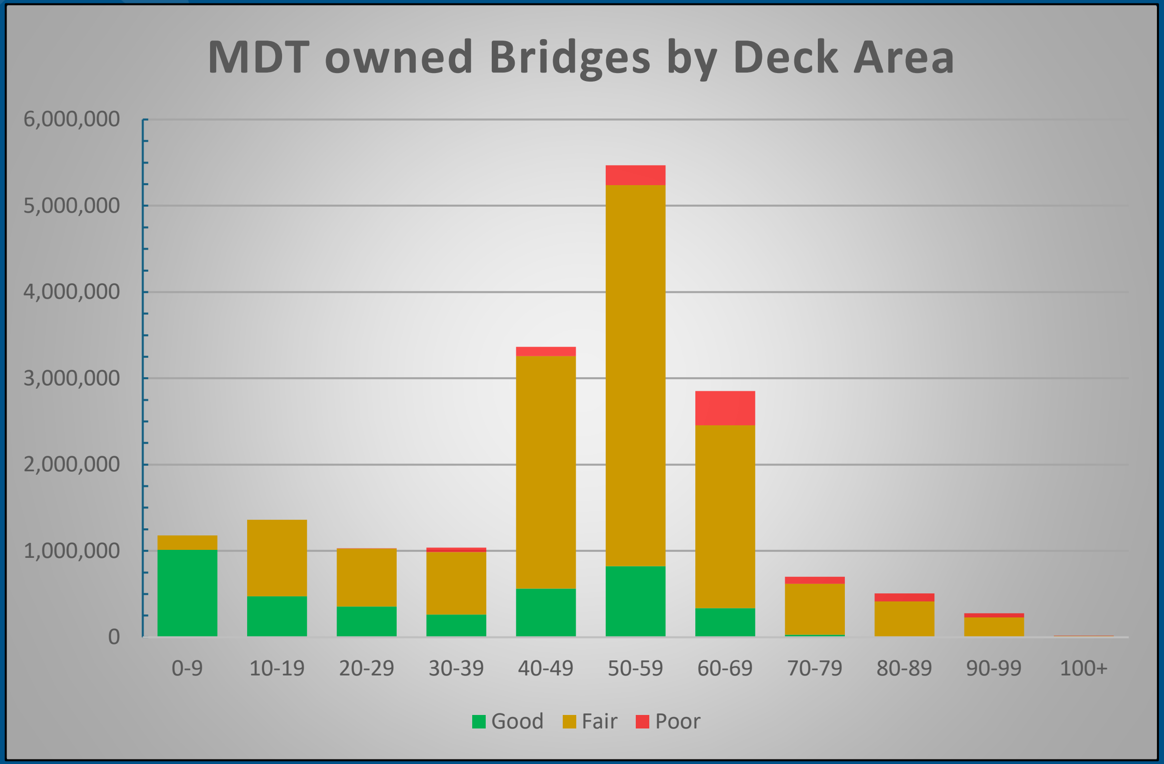
Current Condition of Bridges

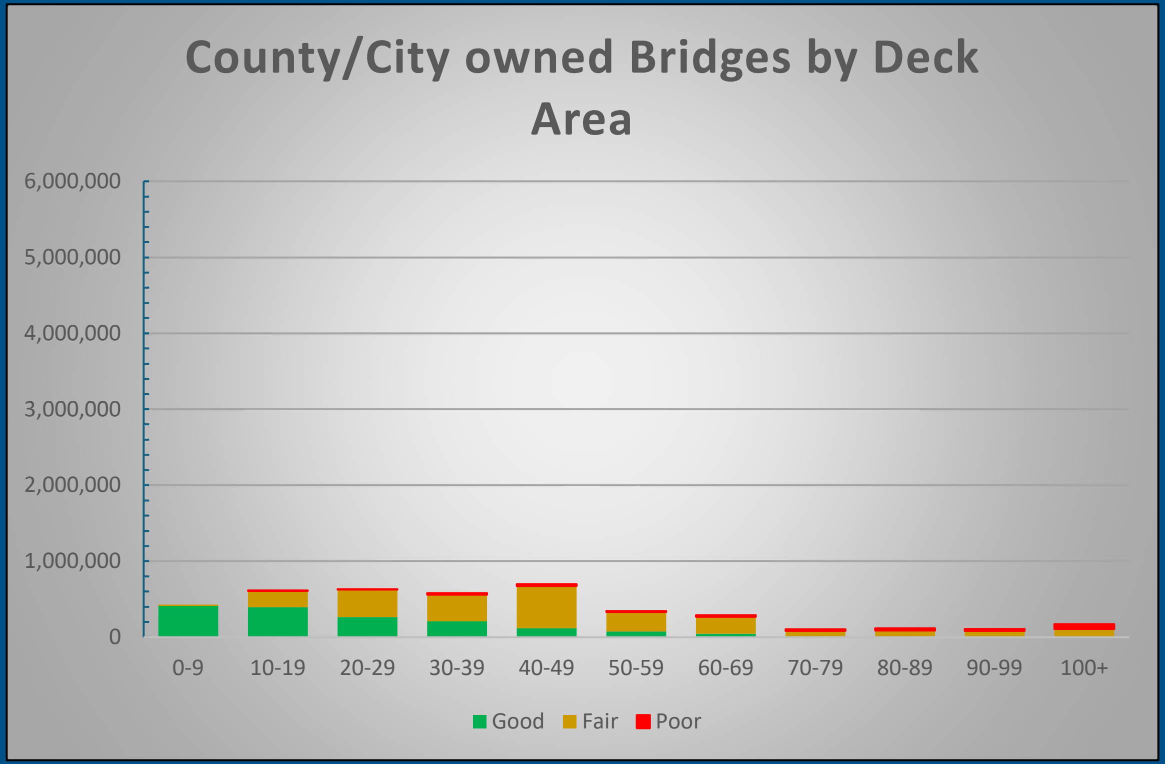




Average age when MDT owned bridge gets load-posted = 65 years
Average age when Non-MDT owned bridge gets load-posted = 55 years

Current Condition of Bridges





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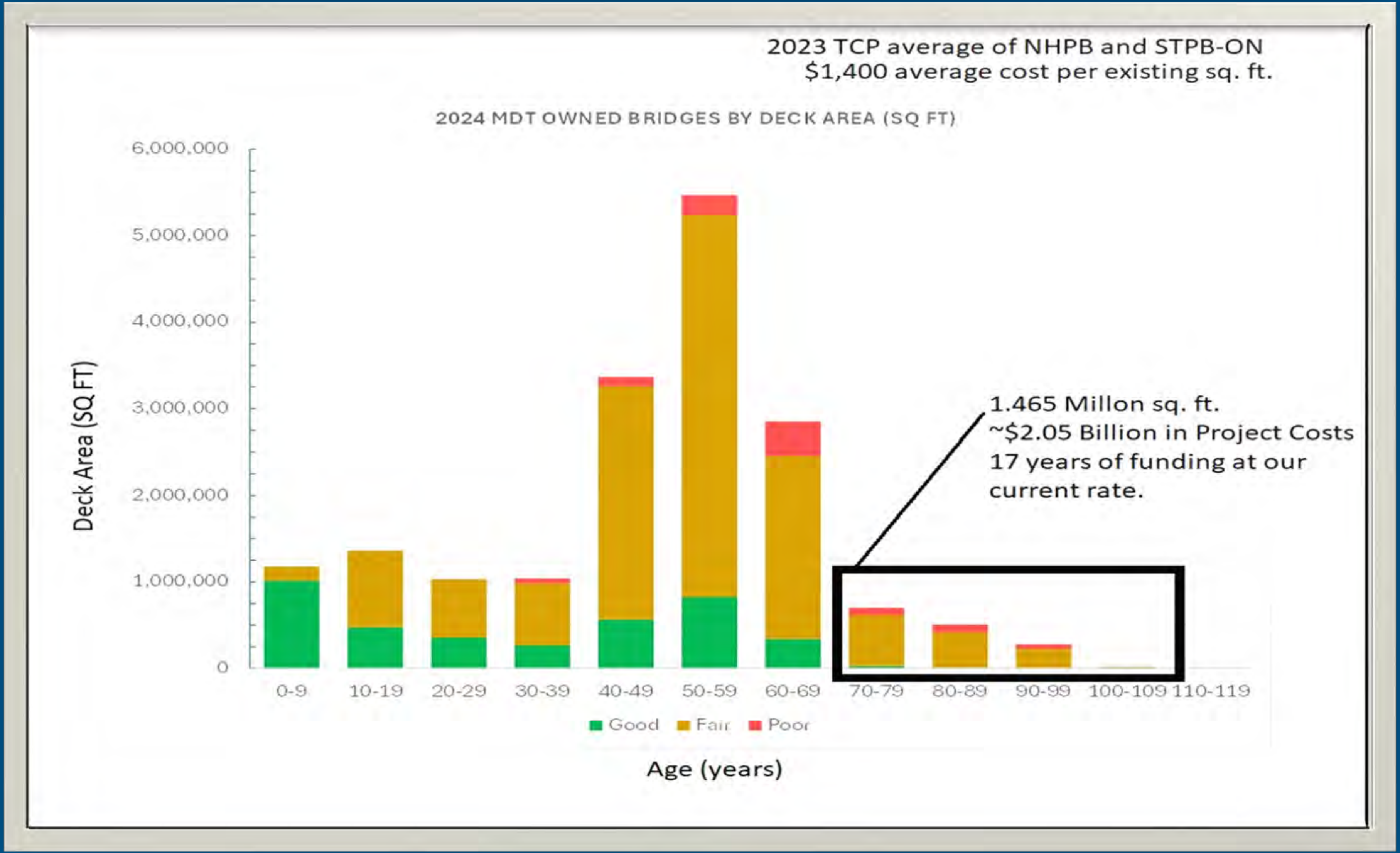
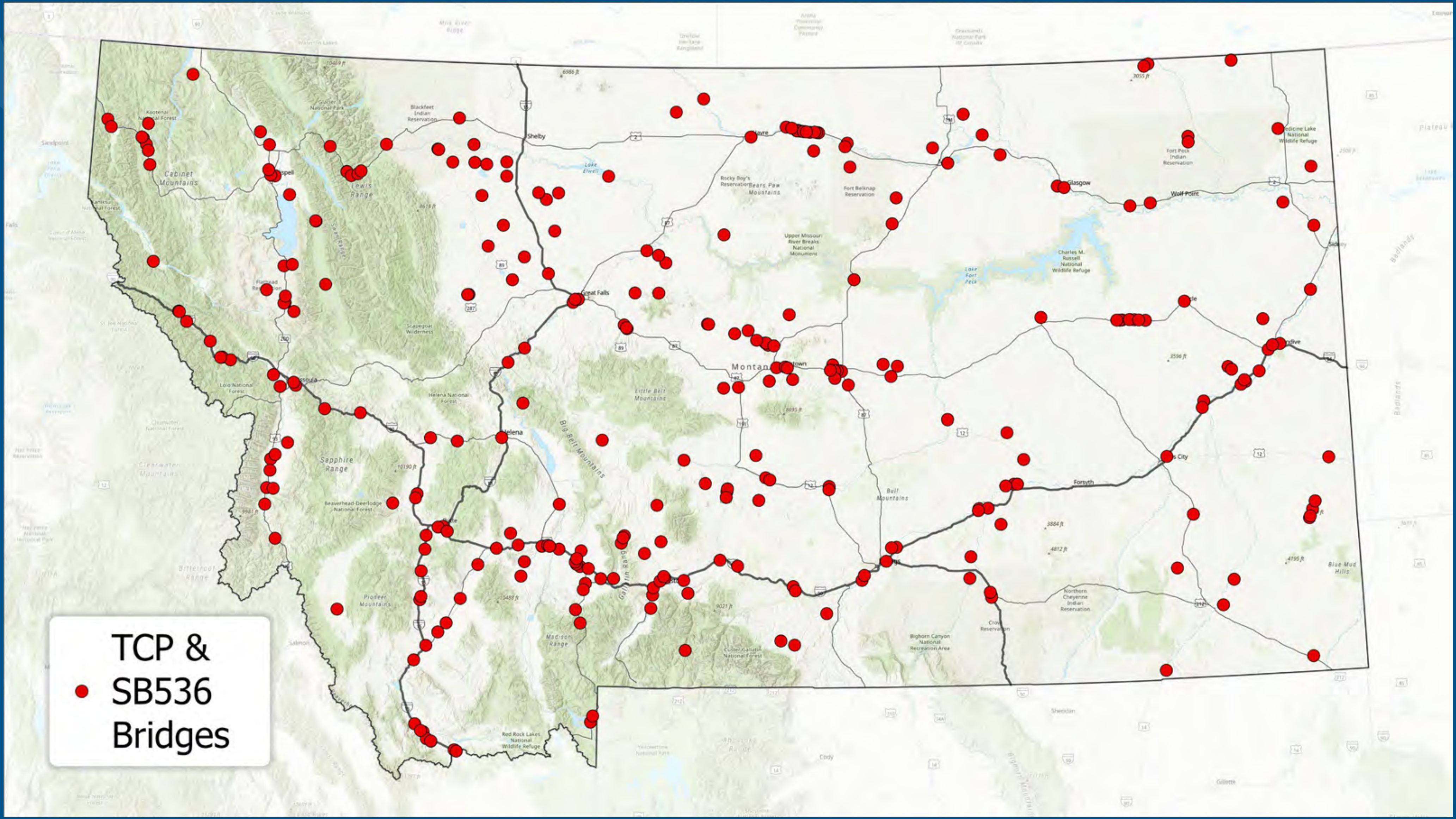
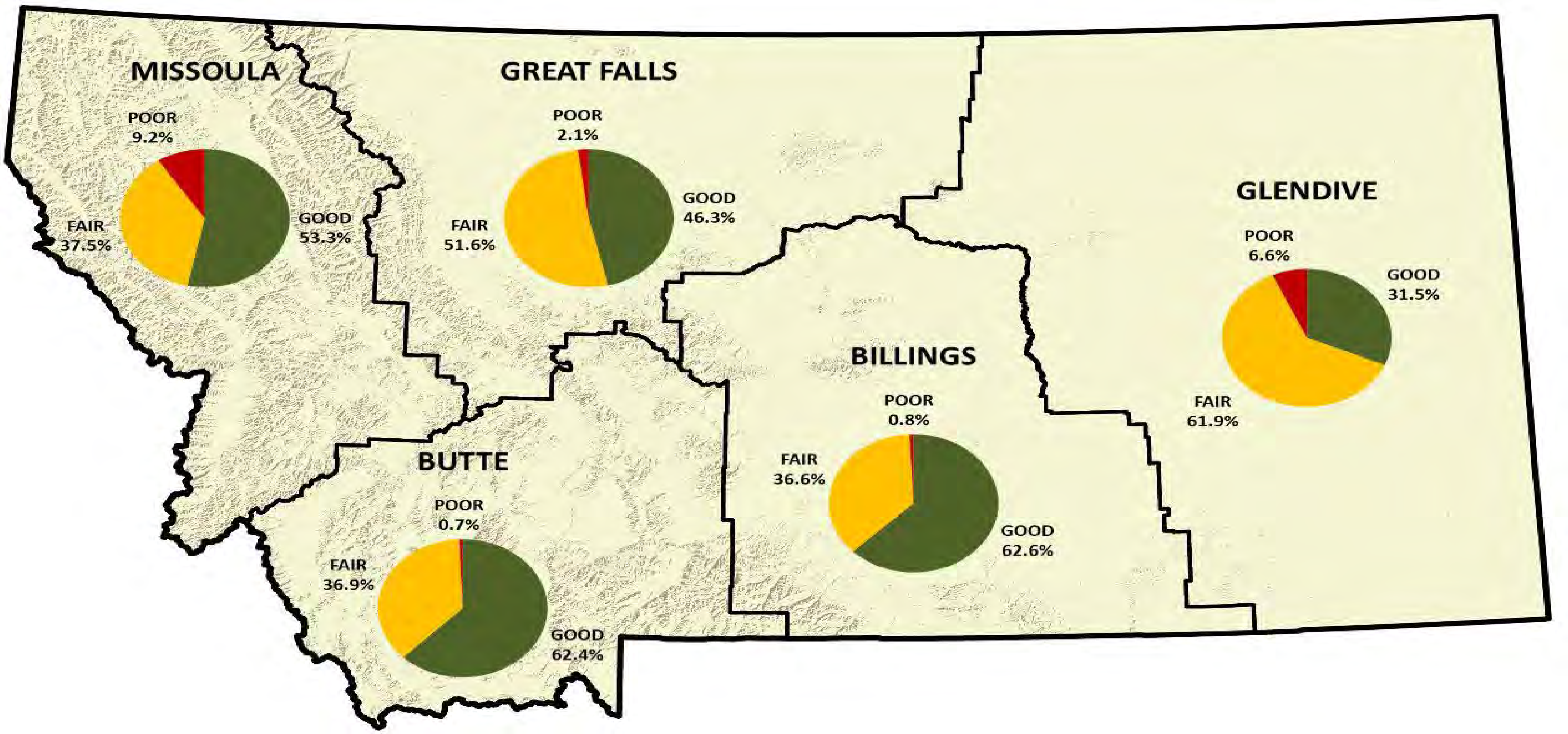


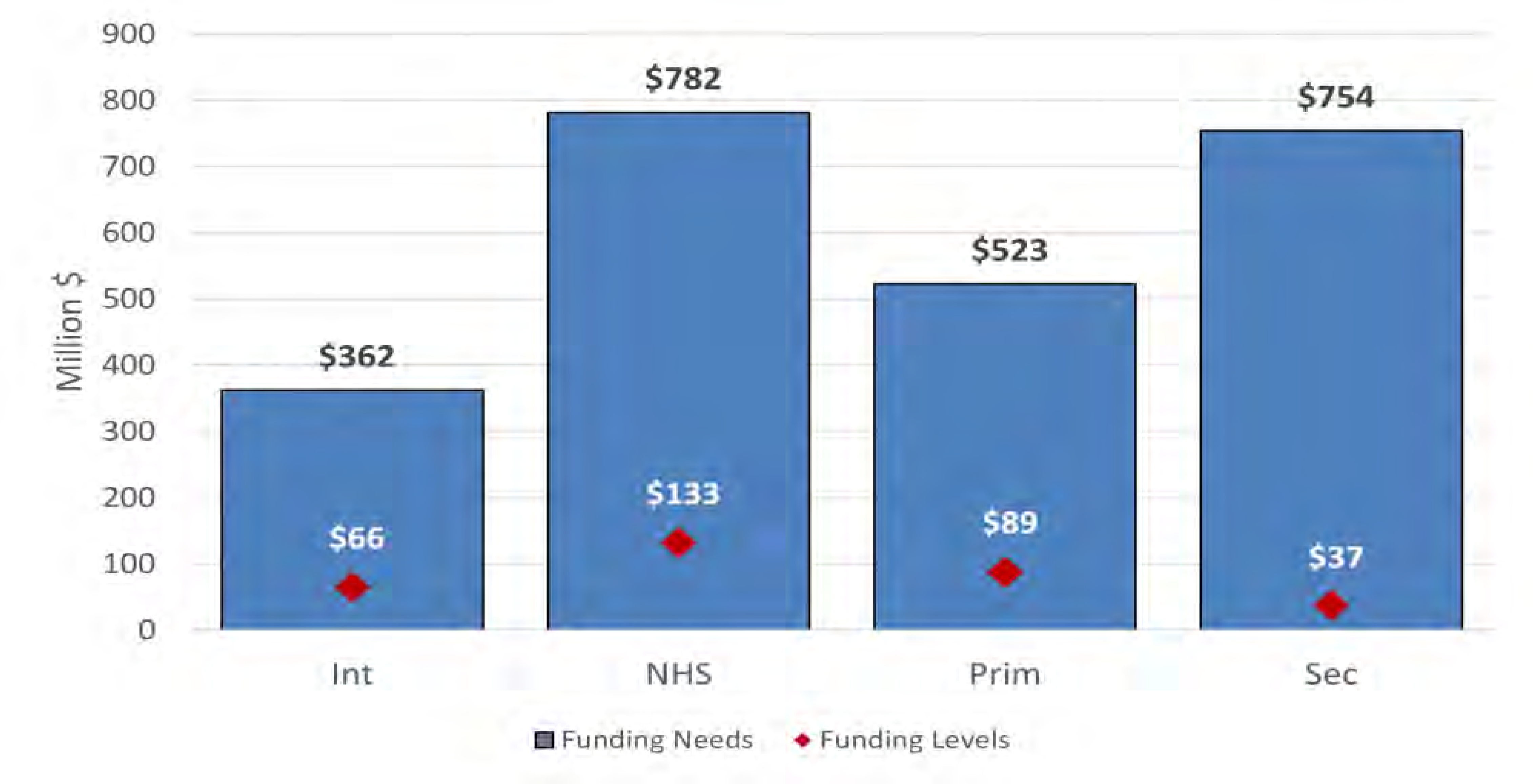
MDT’s 5 Year Bridge Plan



Pavement Condition by District



Current pavement needs by system



We are constantly looking at ways to stretch the dollar further such as innovations in design, construction, materials, etc.

This is a collaborative effort with numerous stakeholders…. Suppliers, contractors, other state agencies, local and state governments, amongst others.

Jeff Jackson, P.E.
Geotechnical and Pavement Bureau Chief
Montana Department of Transportation
406-444-3371 jejackson@mt.gov
mdt.mt.gov

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