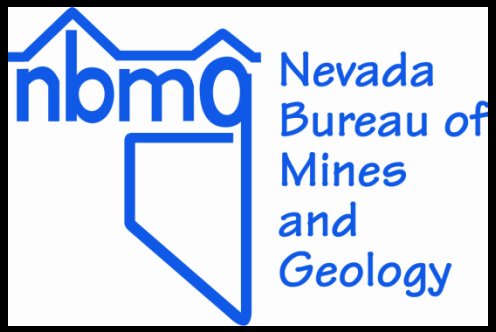
Earthquake Hazards in Nye County

Presentation to the Nevada Hazard Mitigation Planning Committee
18 November 2010
by Jonathan G. Price
Nevada Bureau of Mines and Geology

Earthquake faults occur throughout Nevada, and potential losses from earthquakes are high for many communities.



Earthquake faults occur throughout Nevada, and potential losses from earthquakes are high for many communities.

NBMG Map 167, *Quaternary Faults in Nevada*, is now available not only as a poster but also as an interactive map (Open-File Report 09-9) on line at www.nbmg.unr.edu. You can use it to locate your home or business.

Nevada Bureau of Mines and Geology

University of Nevada, Reno
Statewide • Worldwide

FEMA

Nevada Department of Public Safety
Division of Emergency Management

Nevada Earthquake Safety Council

USGS
science for a changing world

Nevada Seismological Laboratory

The Great Seal of the State of Nevada
All for our Country

Age of Latest Fault Rupture

< 150 years (historical)

< 15,000 years

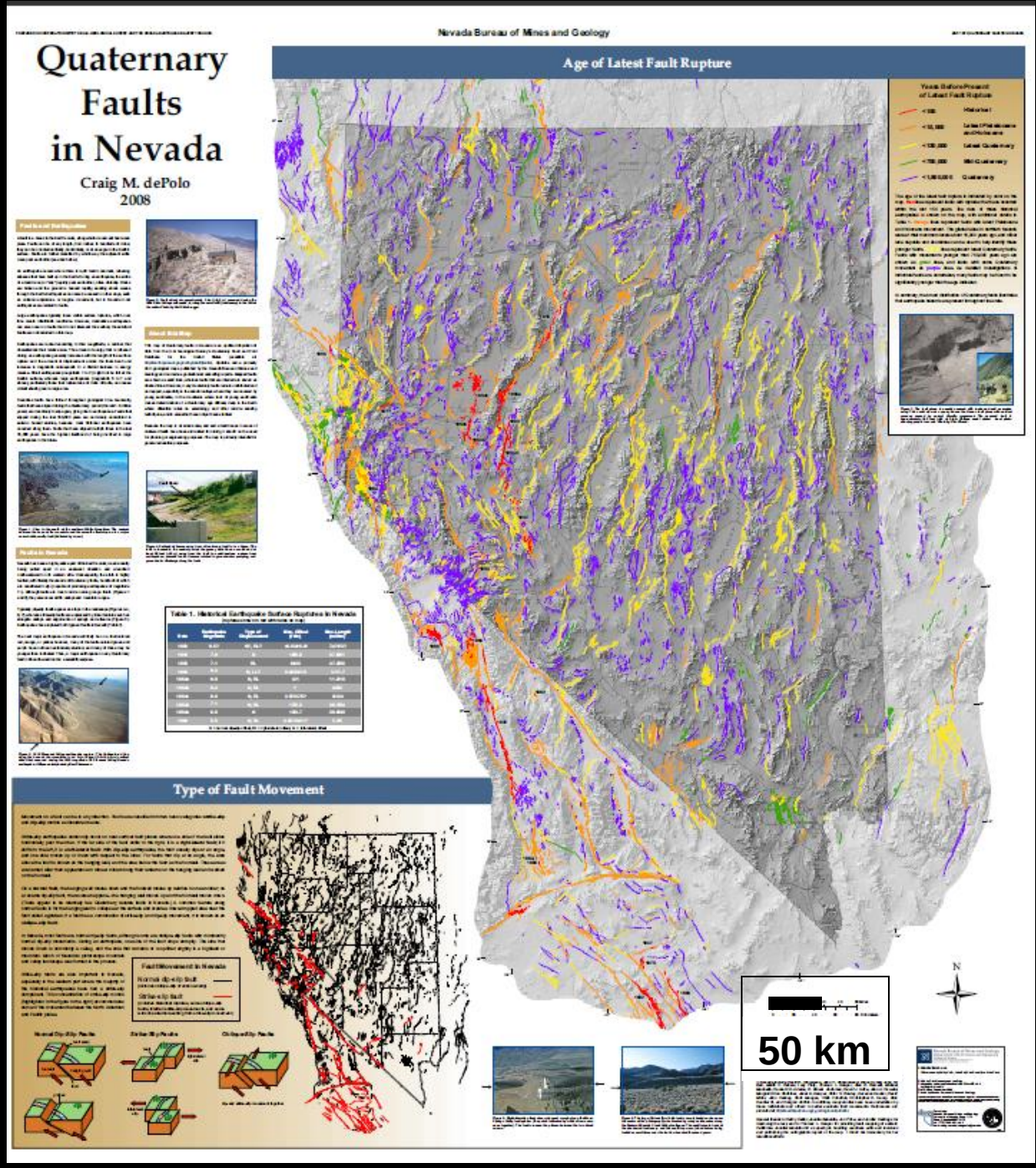
< 130,000 years

< 750,000 years

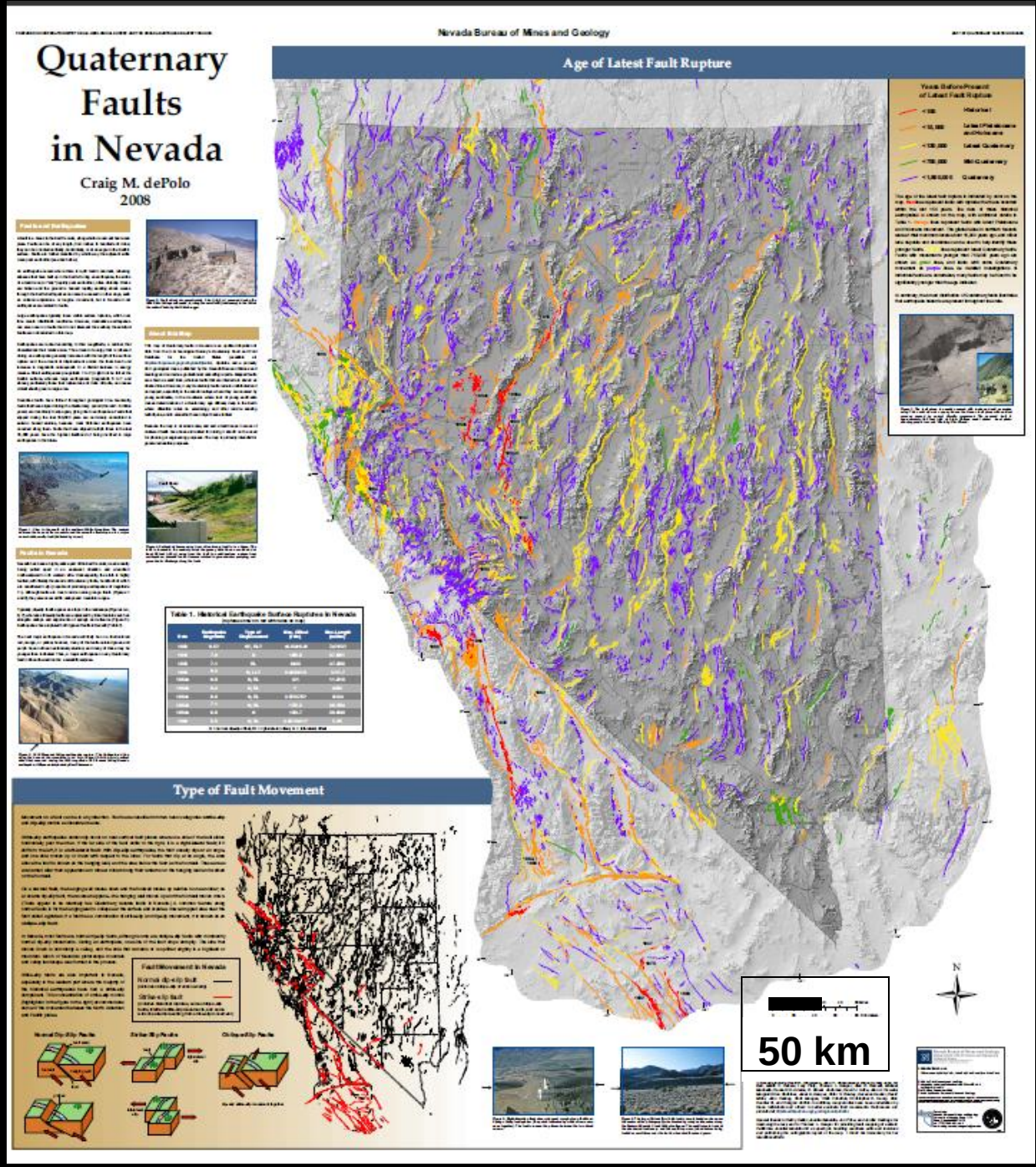
< 1,800,000 years (Quaternary)

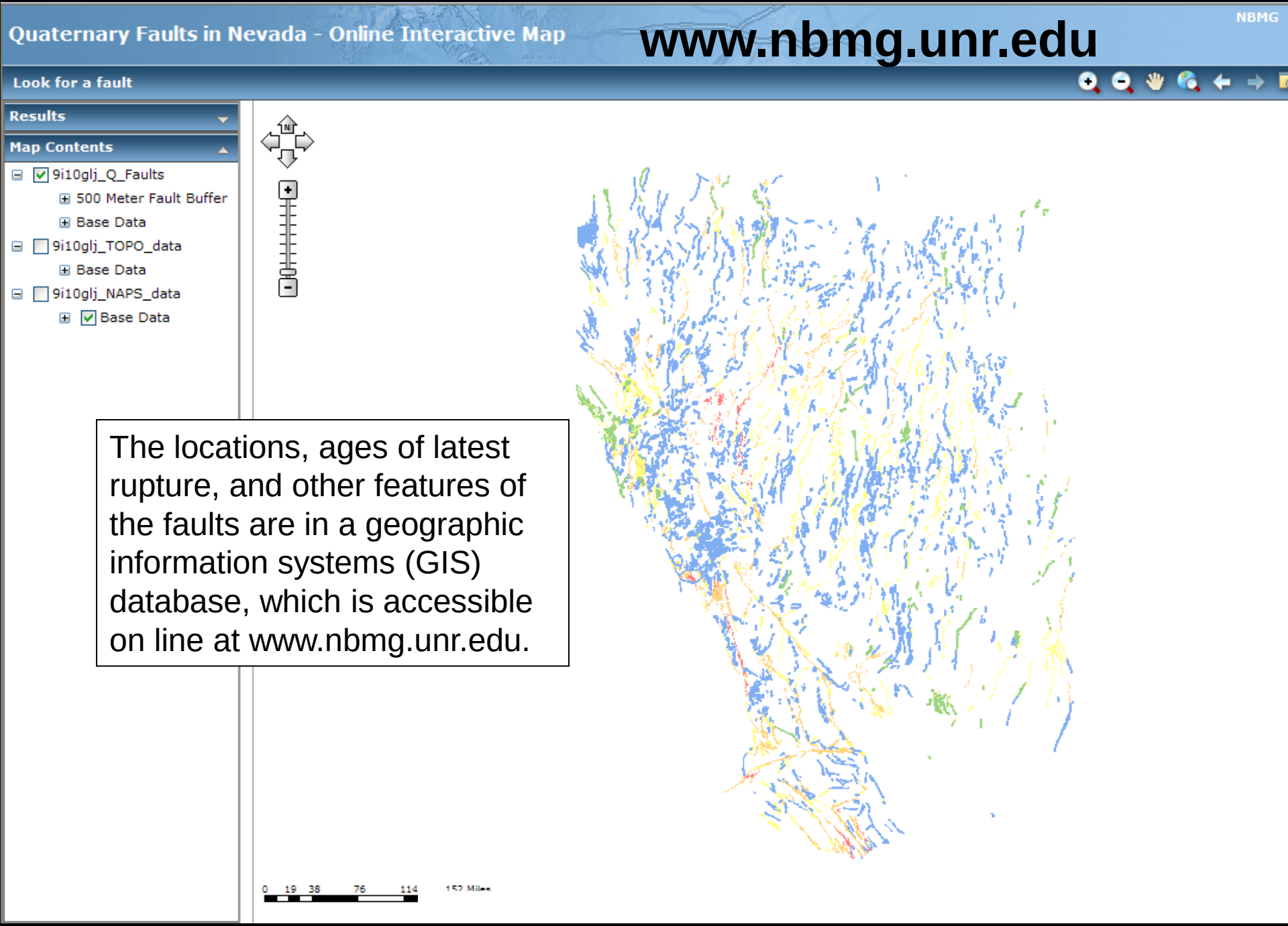
There are active faults nearly everywhere in Nevada. A magnitude 6.0 earthquake can occur anywhere in Nevada.

www.nbmg.unr.edu



The map has ~130 major faults (with lengths >19 miles or 30 km), ~300 intermediate faults with lengths of 6-19 miles (10-30 km), and >1,150 smaller faults. Surface breakage typically occurs when an earthquake is greater than or equal to magnitude 6.5.





The locations, ages of latest rupture, and other features of the faults are in a geographic information systems (GIS) database, which is accessible on line at www.nbmg.unr.edu.

Quaternary Faults in Nevada - Online Interactive Map

Look for a fault | Find Address

Easy to pinpoint an address

Results

Map Contents

- Quaternar
  - Legend
  - Base D
- 9i10glj_TC
  - Base D
- USGS_aer
  - Bas

Find Address

Street or Intersection	1520 East Basin Road
City	Pahrump
State	Nevada
ZIP	89049

Find Your Address

Quaternary Faults in Nevada - Online Interactive Map

Look for a fault | Find Address

Easy to pinpoint an address

Results

- **1520 East Basin Road, F**
  - 1520 E Basin Ave, Pahr

Map Contents

- Quaternary_Faults
  - Legend
    - Historic - within the
    - Historic - within the
    - latest Pliestocene &
    - latest Pliestocene &
    - late Quaternary - wi
    - late Quaternary - wi
    - middle Quaternary -
    - middle Quaternary -
    - Quaternary - within
    - Quaternary - within
  - Base Data
- 9i10glj_TOPO_data
  - Base Data
- USGS_aerial_photographs
  - Base Data

Quaternary Faults in Nevada - Online Interactive Map

Look for a fault | Find Address

Easy to zoom in on an address

Results

- **1520 East Basin Road, Pahrump,**
  - 1520 E Basin Ave, Pahrump, NV,

Zoom to
Pan to
Remove

Map Contents

- Quaternary_Faults
  - Legend
  - Base Data
- 9i10glj_TOPO_data
  - Base Data
- USGS_aerial_photographs
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- 1520 East Basin Road, P
  - 1520 E Basin Ave, Pah

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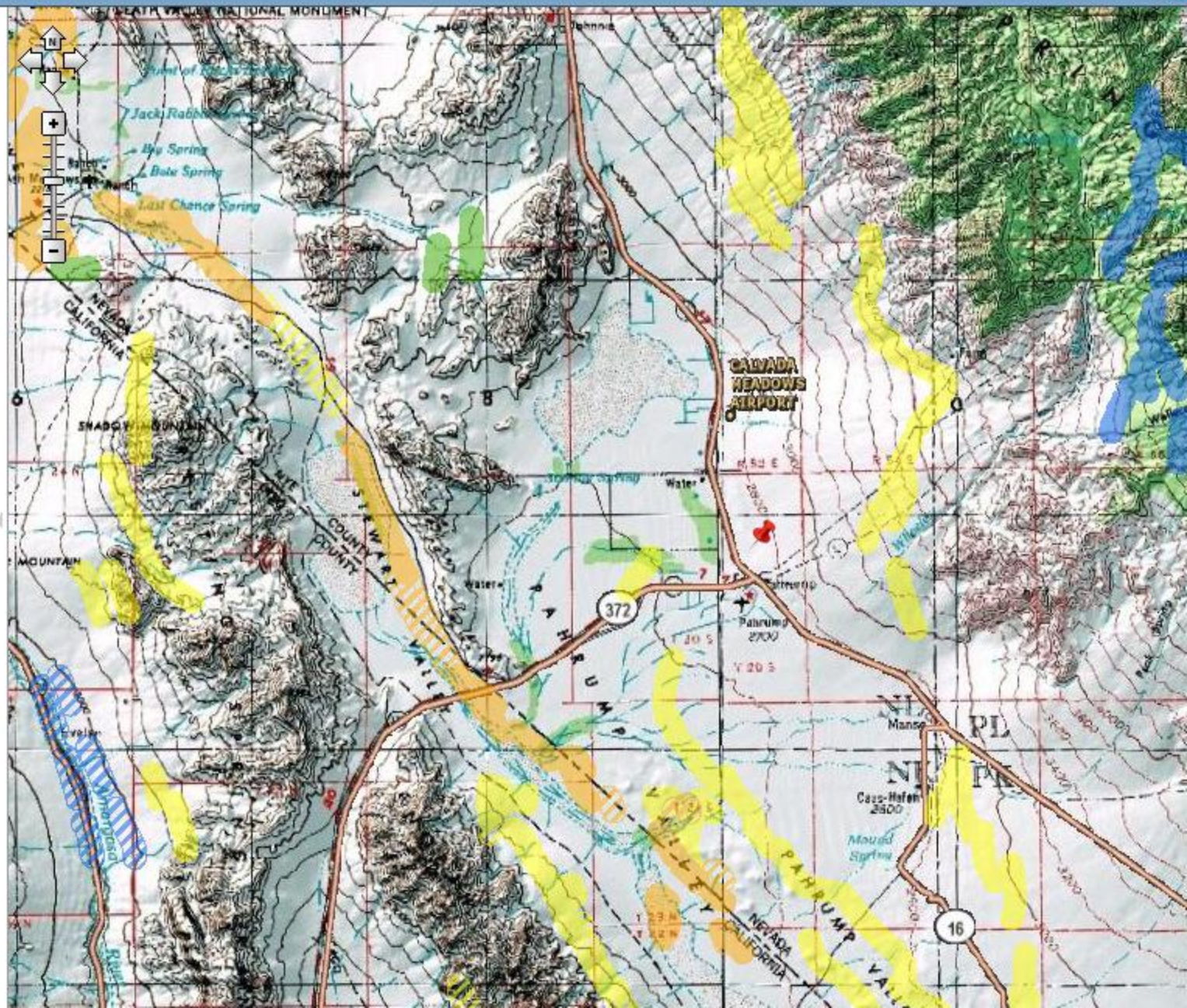

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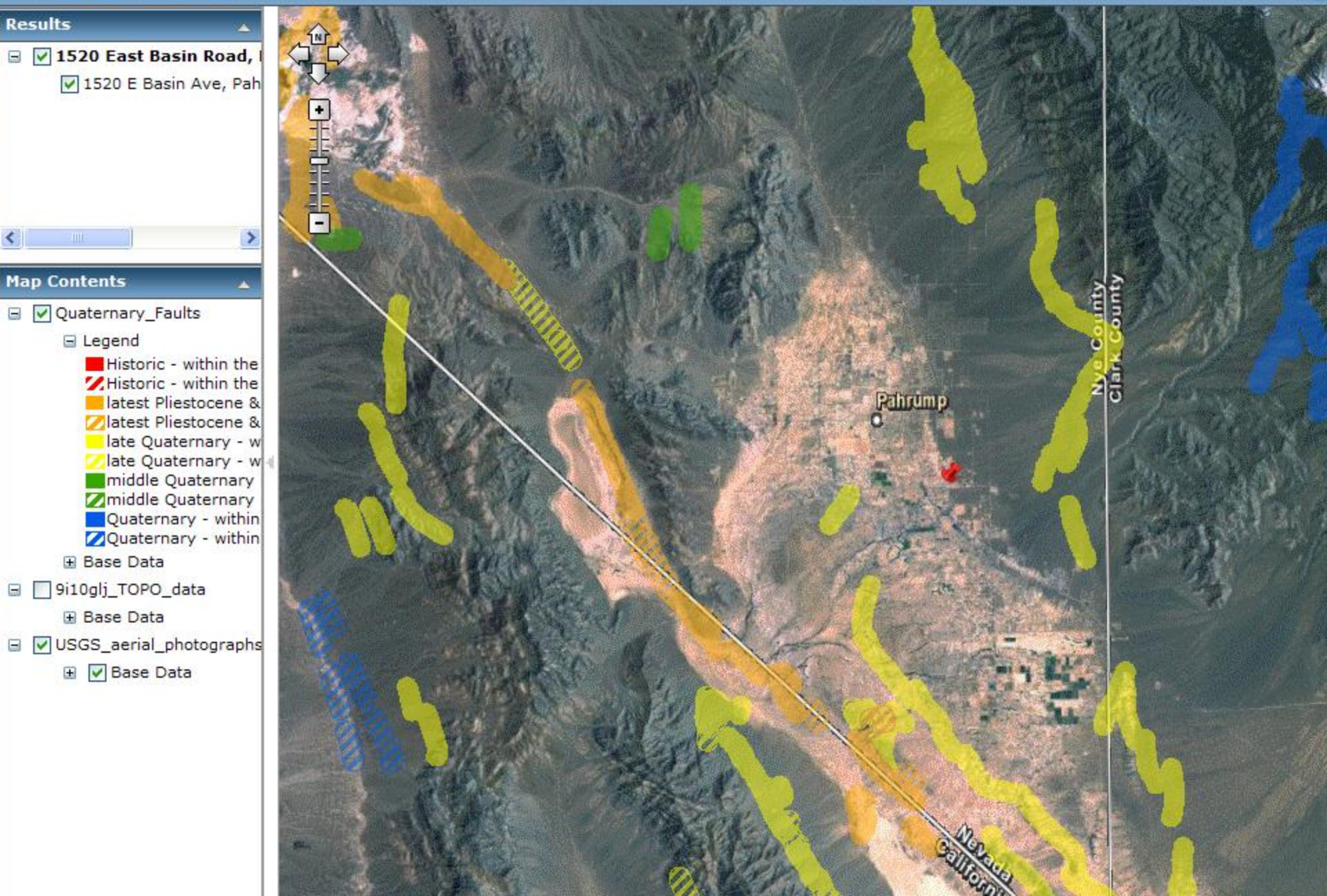

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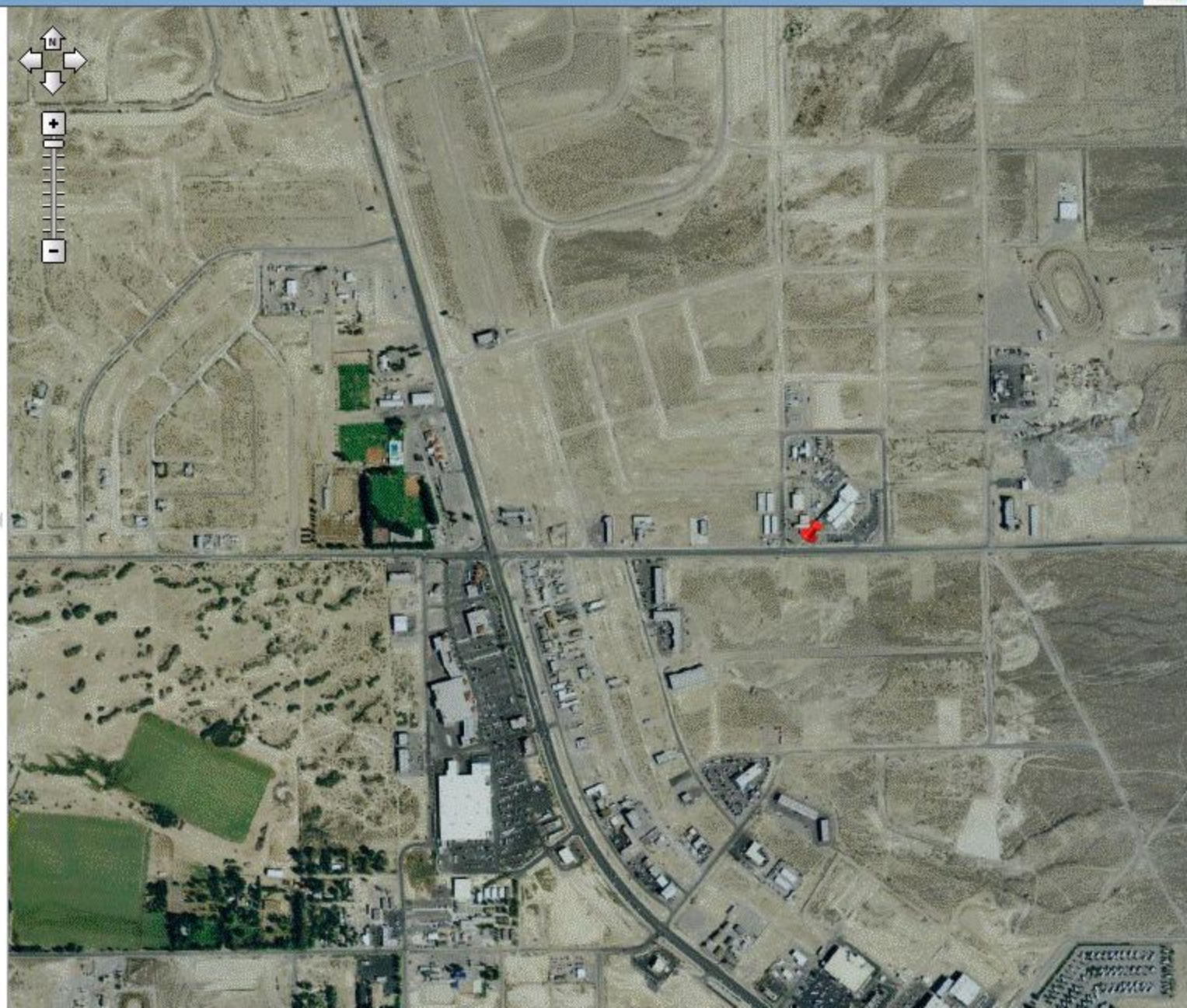
Look for a fault | Find Address



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- 1520 East Basin Road, I
  - 1520 E Basin Ave, Pah

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    - Historic - within the
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    - latest Pliestocene &
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    - late Quaternary - w
    - middle Quaternary
    - middle Quaternary
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  - Base Data
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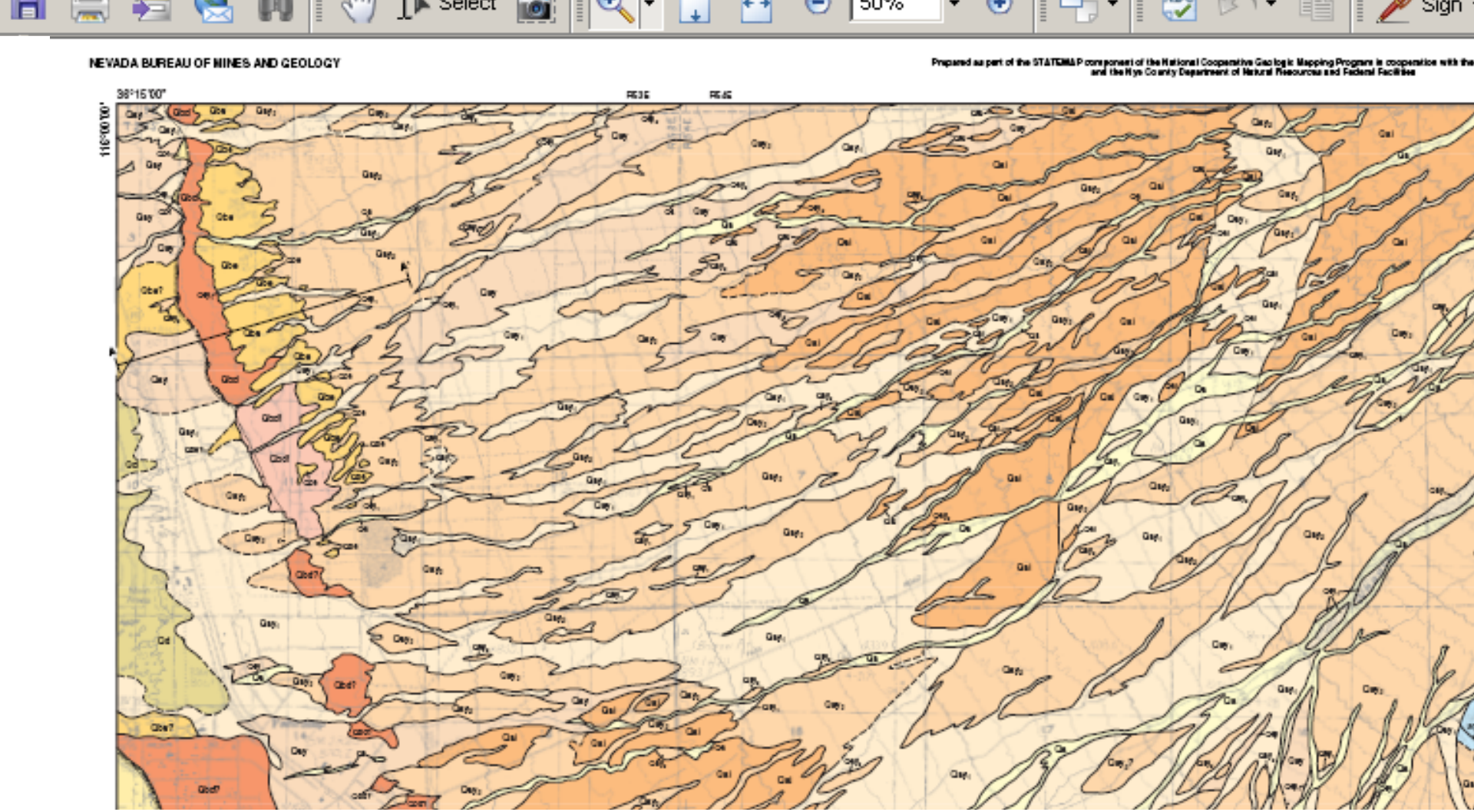
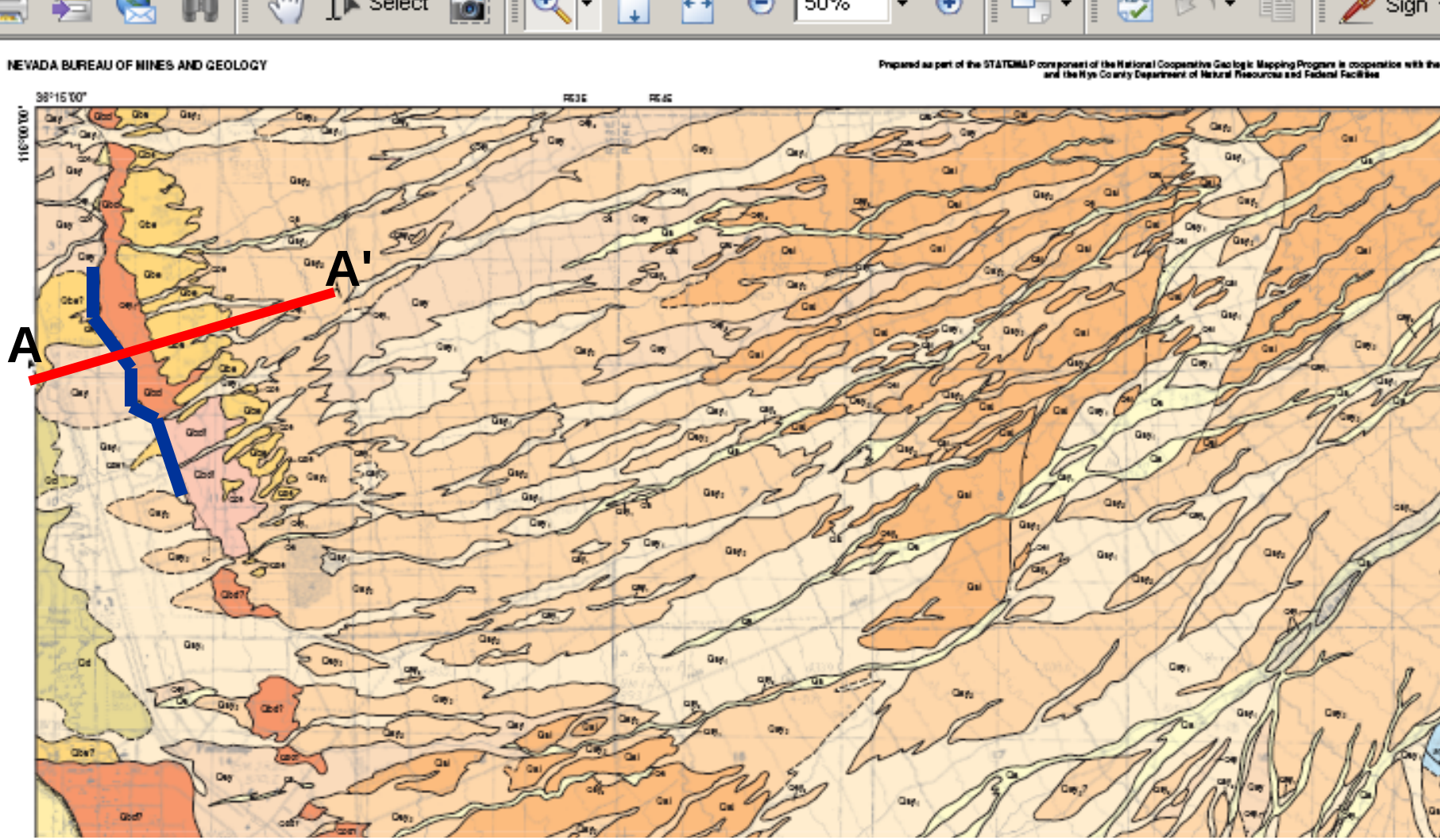


Northwest corner of the geologic map of the Pahrump Quadrangle (7.5-minute – Nevada Bureau of Mines and Geology Open-File Report 99-14), showing the location of the cross section illustrating displacement across a normal fault



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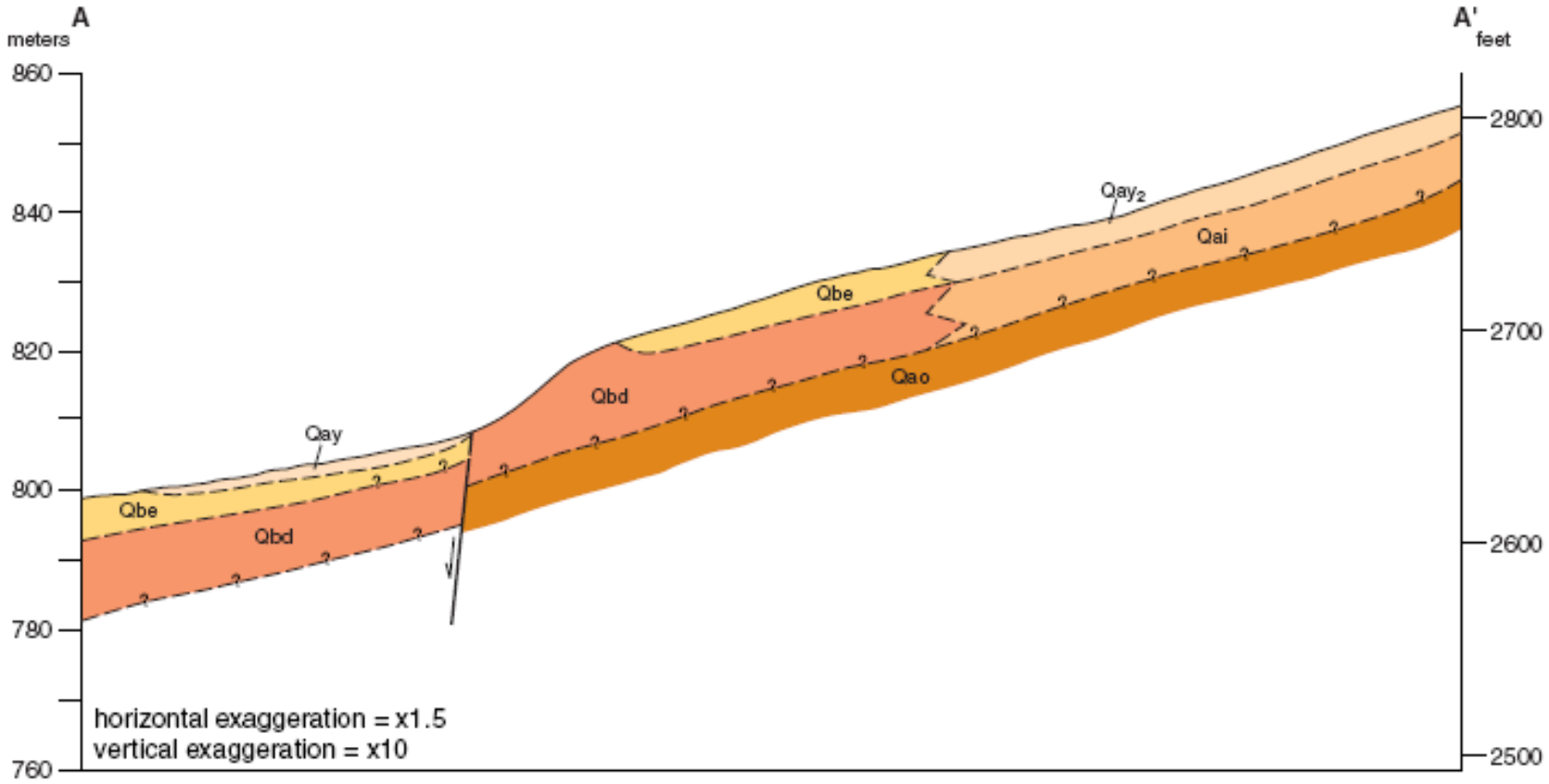
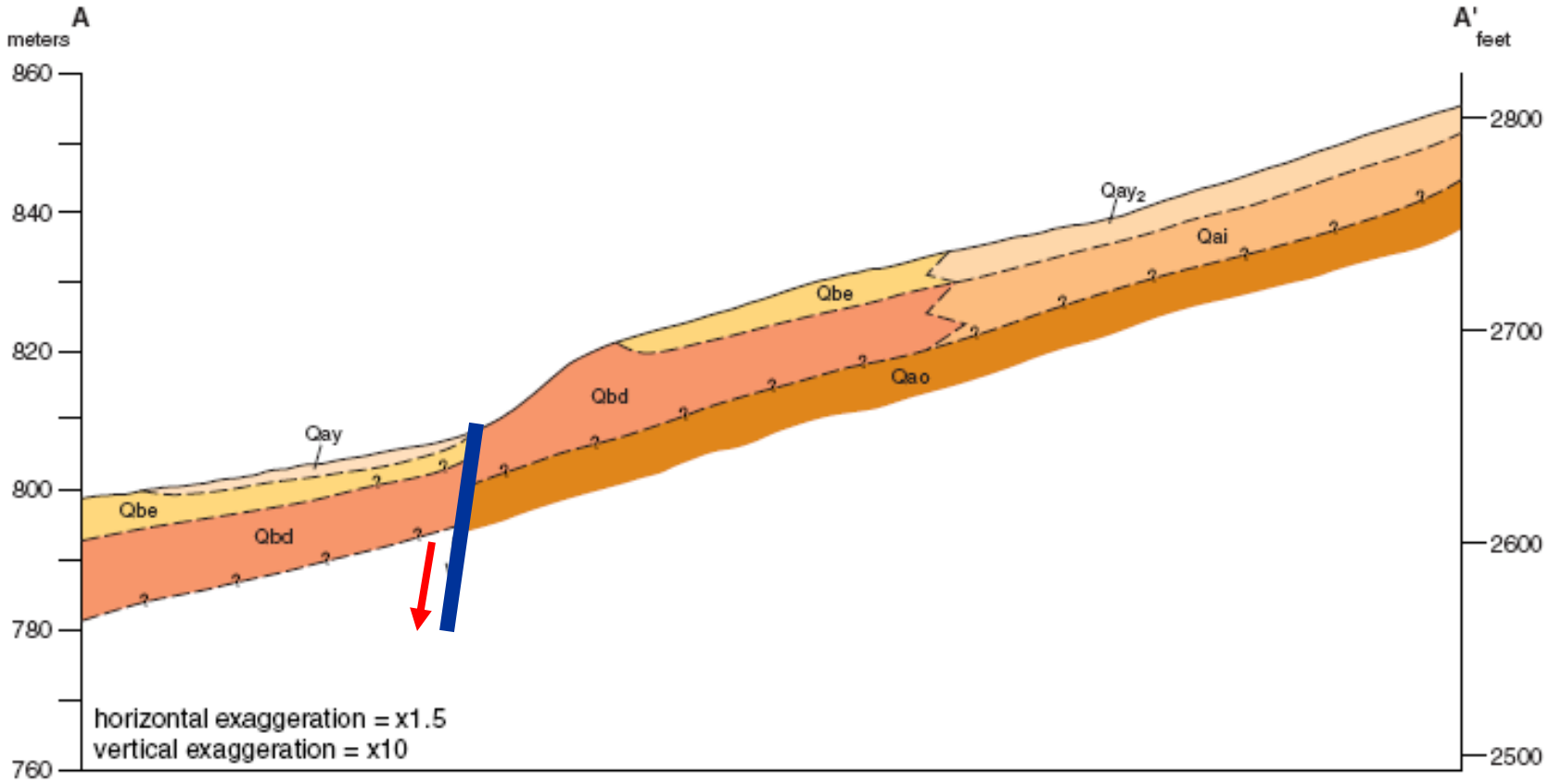


Vertical cross section showing a part of a fault that cuts Quaternary alluvial sediments on the north side of Pahrump



Vertical cross section showing a part of a fault that cuts Quaternary alluvial sediments on the north side of Pahrump

Quaternary Faults in Nevada - Online Interactive Map

Look for a fault | Find Address

Results

- 101 Radar Road, Tonop
  - 101 Radar Rd, Tonopa
  - 101 Radar Rd, Goldfie

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- Quaternary_Faults
  - Legend
    - Historic - within the
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    - latest Pliestocene &
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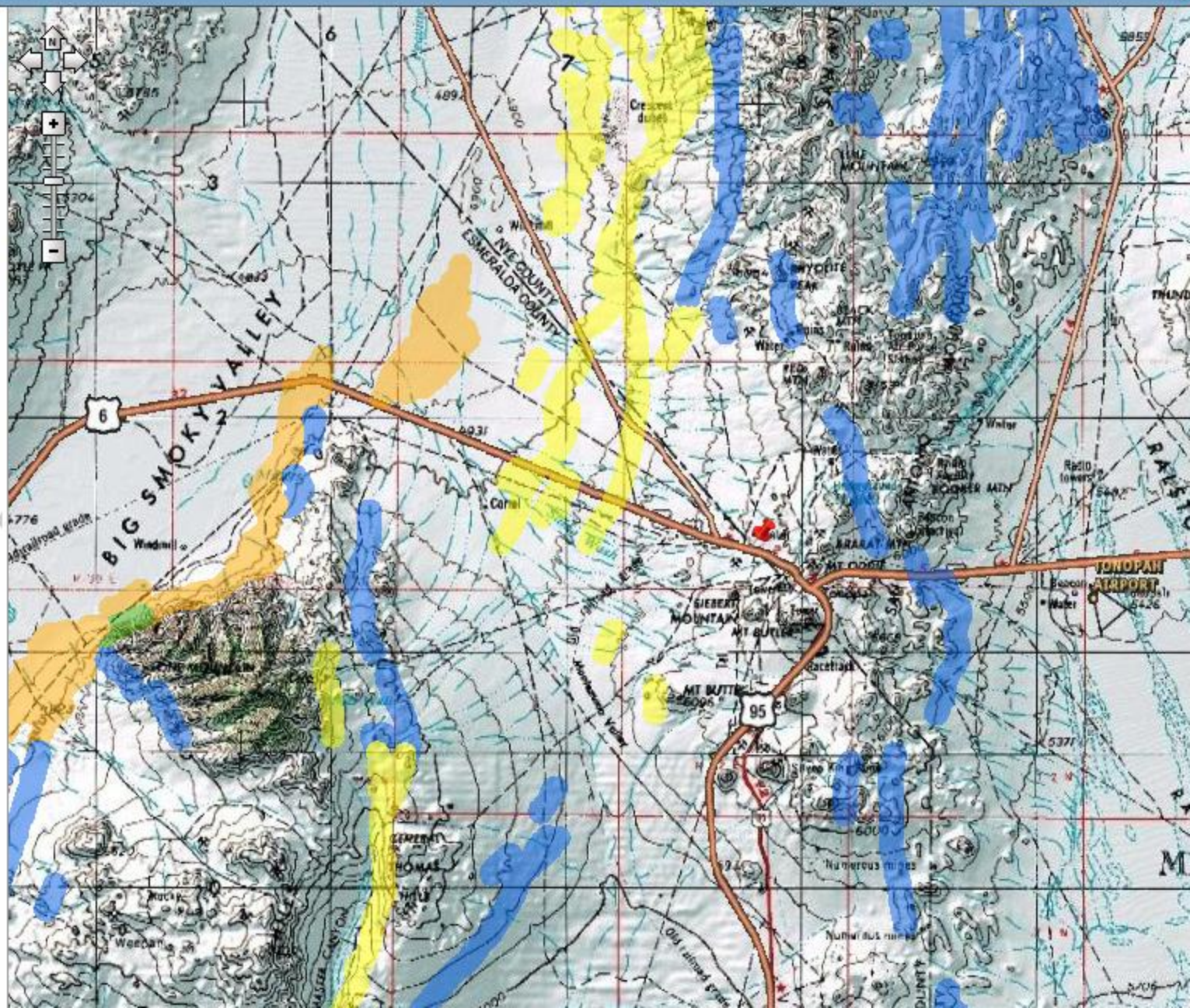

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    - Historic - within the
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    - middle Quaternary
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Quaternary Faults in Nevada - Online Interactive Map

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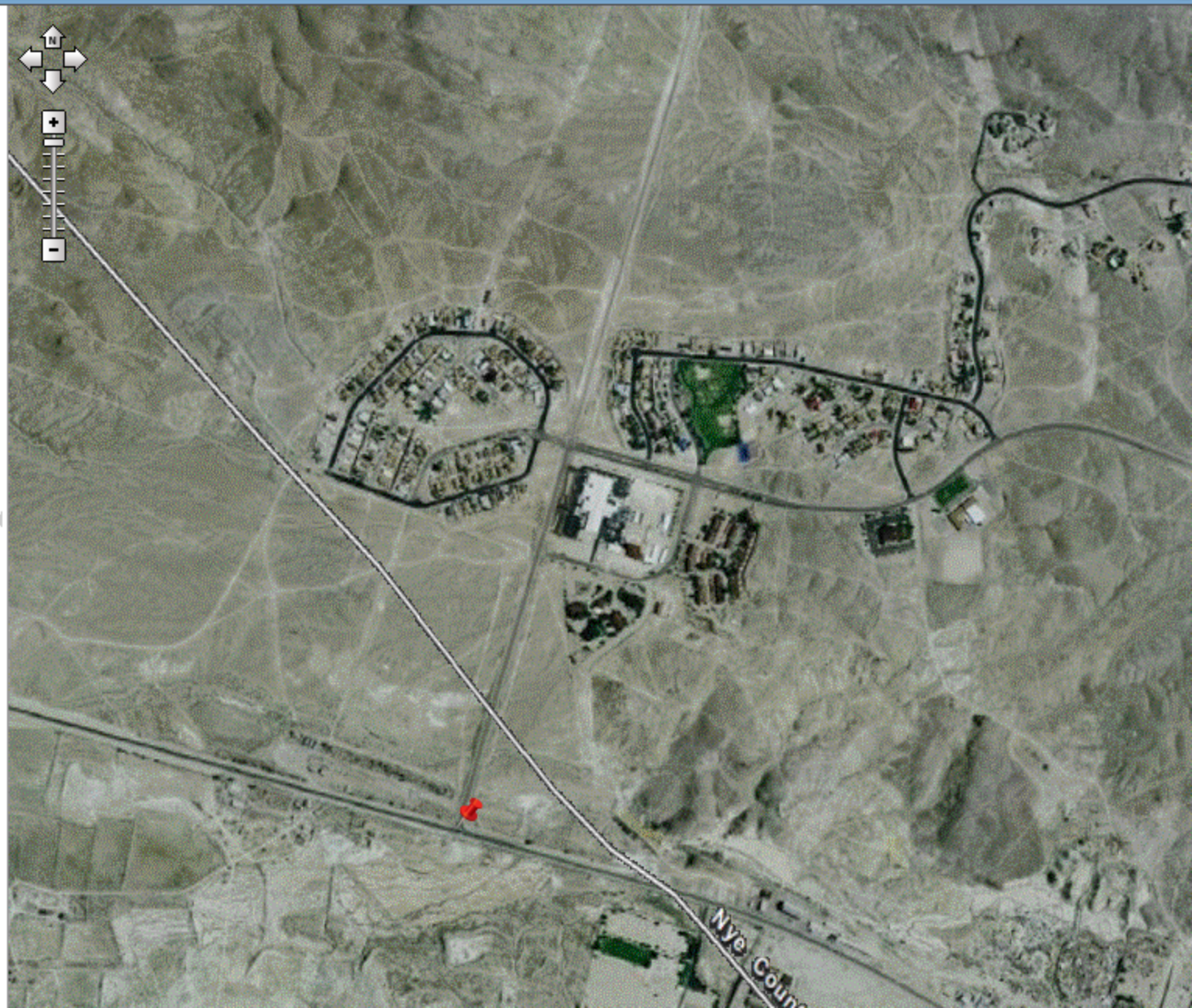

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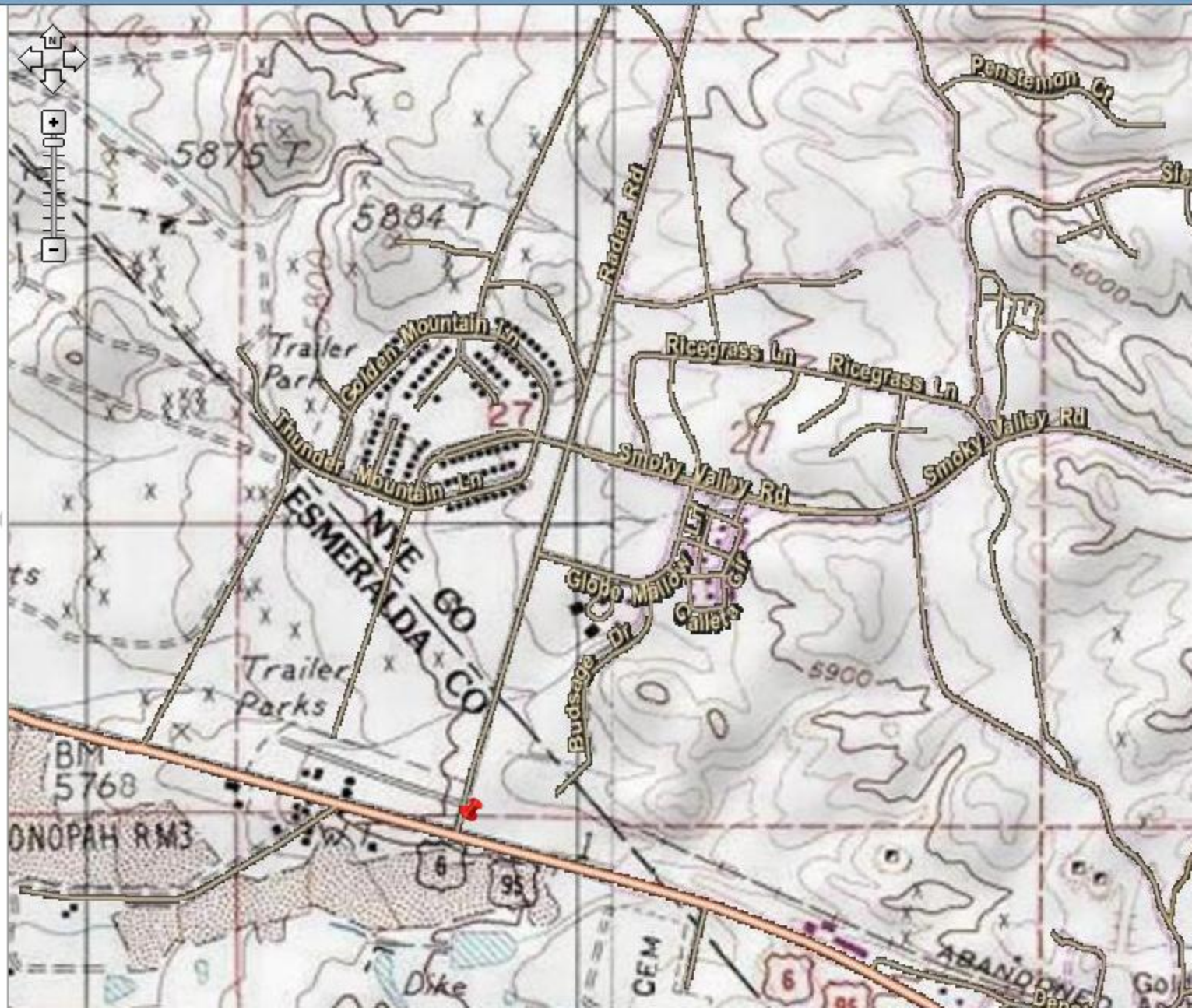
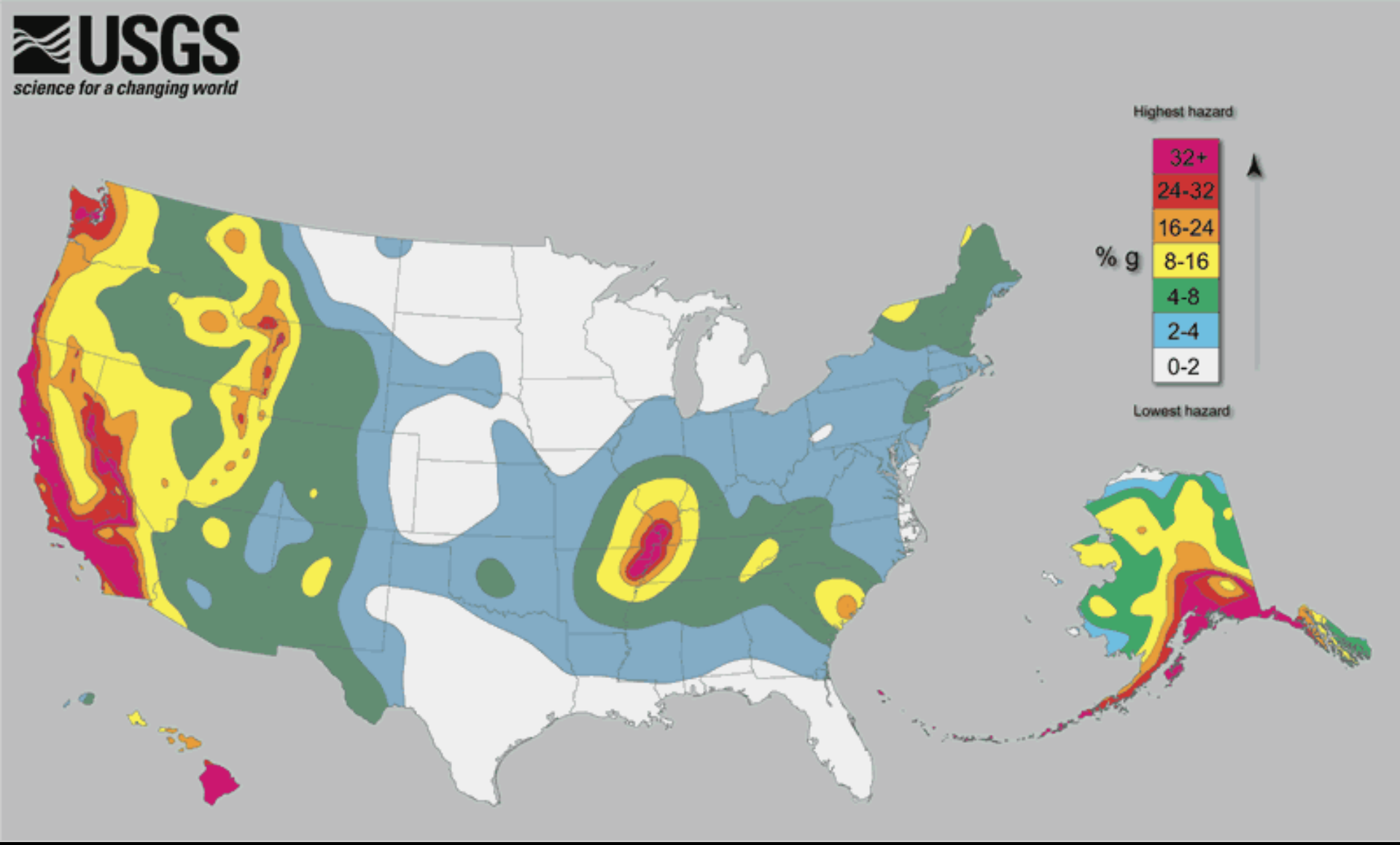
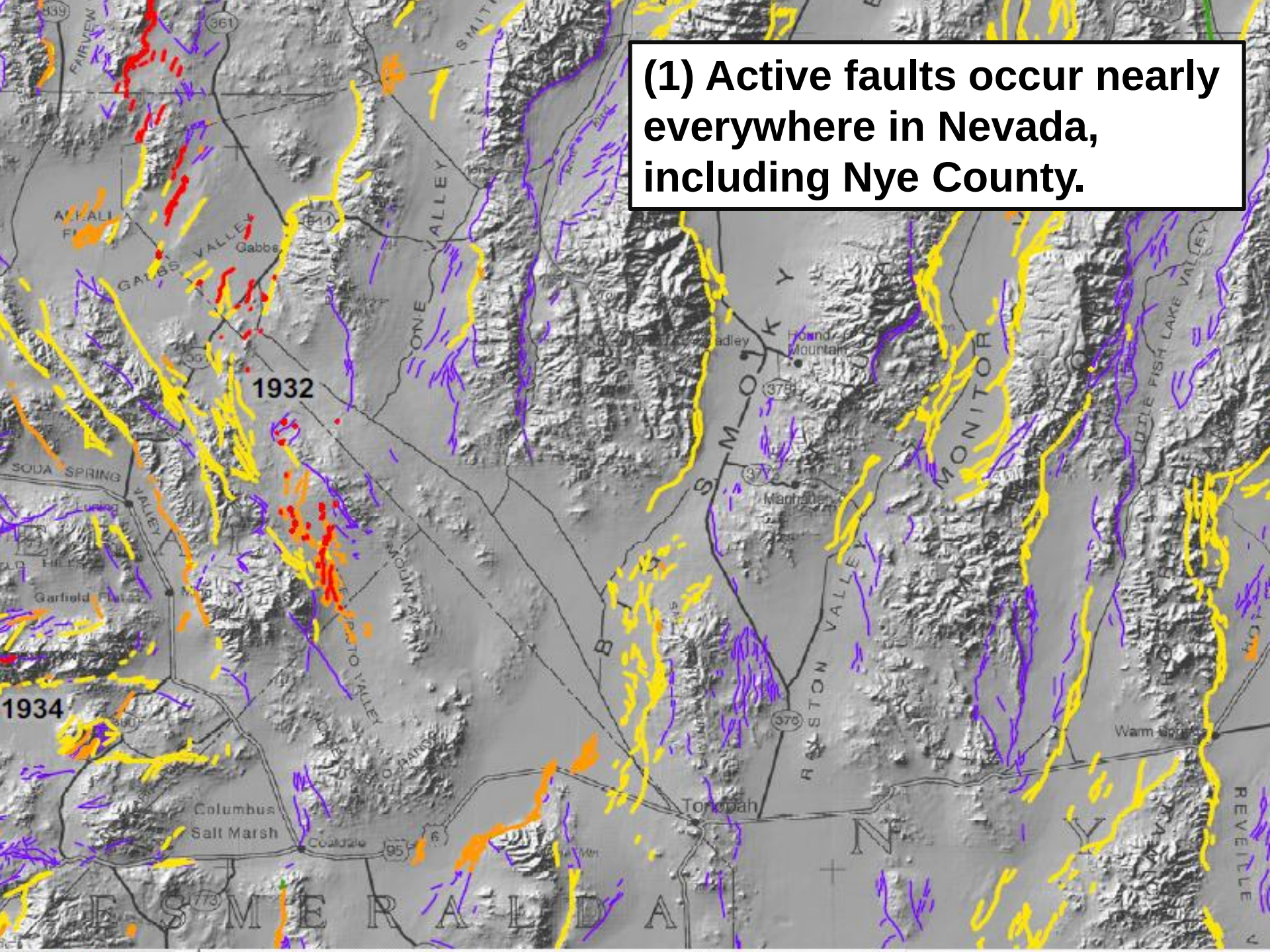
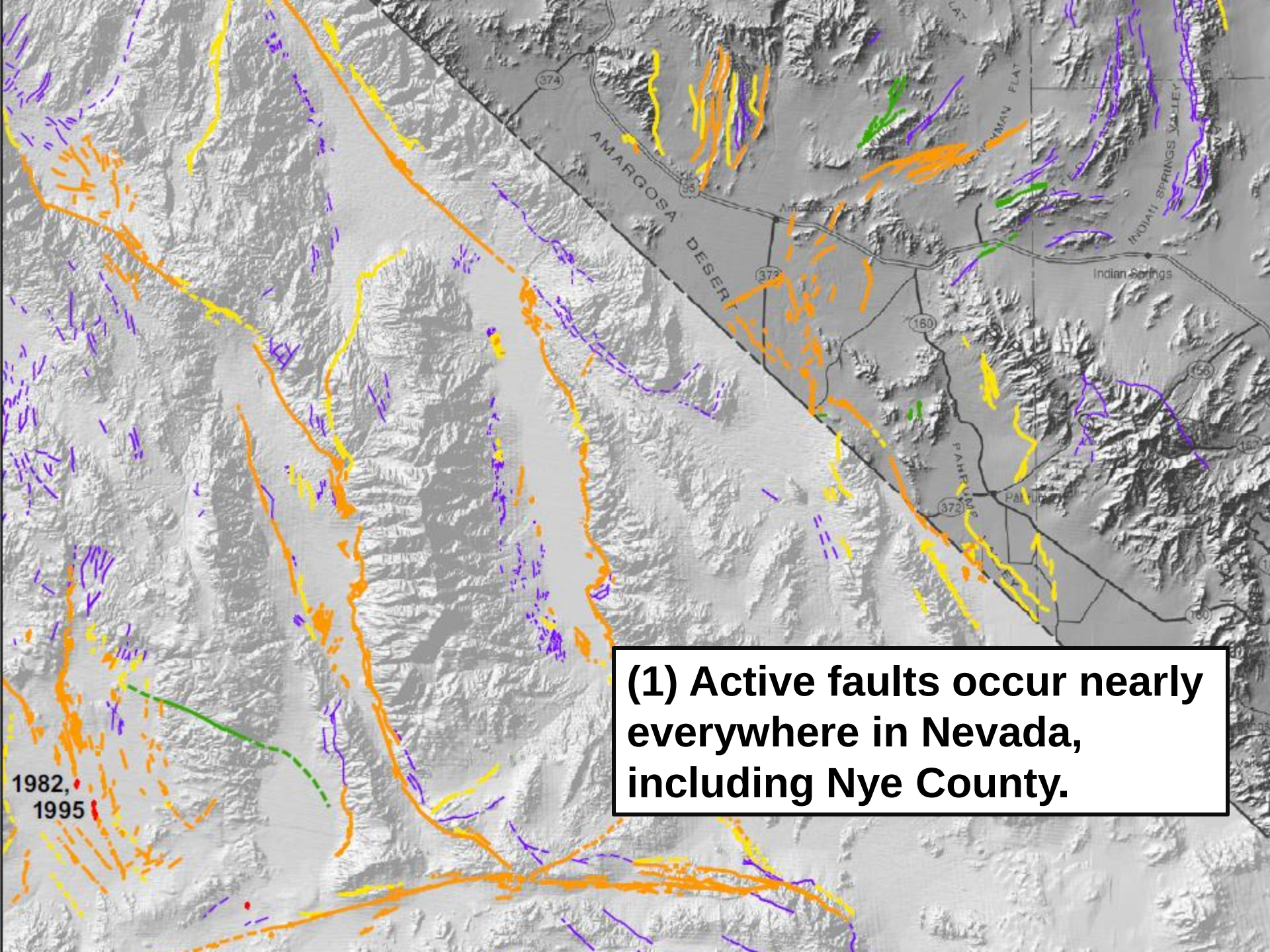




The USGS integrates (1) fault, (2) earthquake, and (3) geodetic data into its probabilistic seismic hazard analysis.


(1) Active faults occur nearly everywhere in Nevada, including Nye County.
1932
1934
FAIRVIEW
SMITH
DIXIE VALLEY
GABBS VALLEY
Gabbs
SODA SPRING VALLEY
Garfield Flat
Columbus Salt Marsh
Coaldale
Tonopah
Manhattan
Round Mountain
BIG SMOKY VALLEY
RAILROAD VALLEY
MONITOR
DIXIE FISH LAKE VALLEY
Warm Springs
REVEILLE
E S M E R A L D A
N Y



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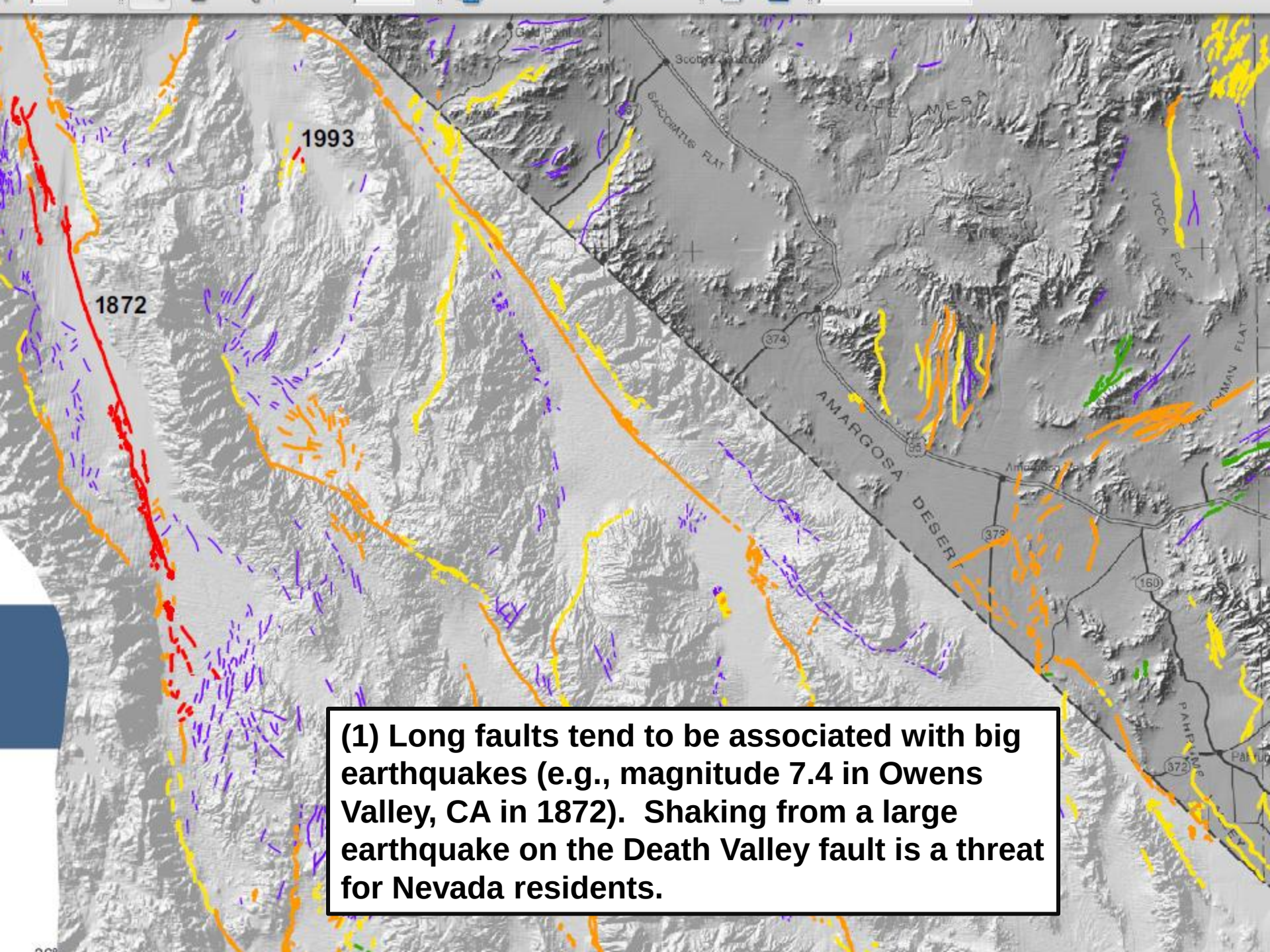
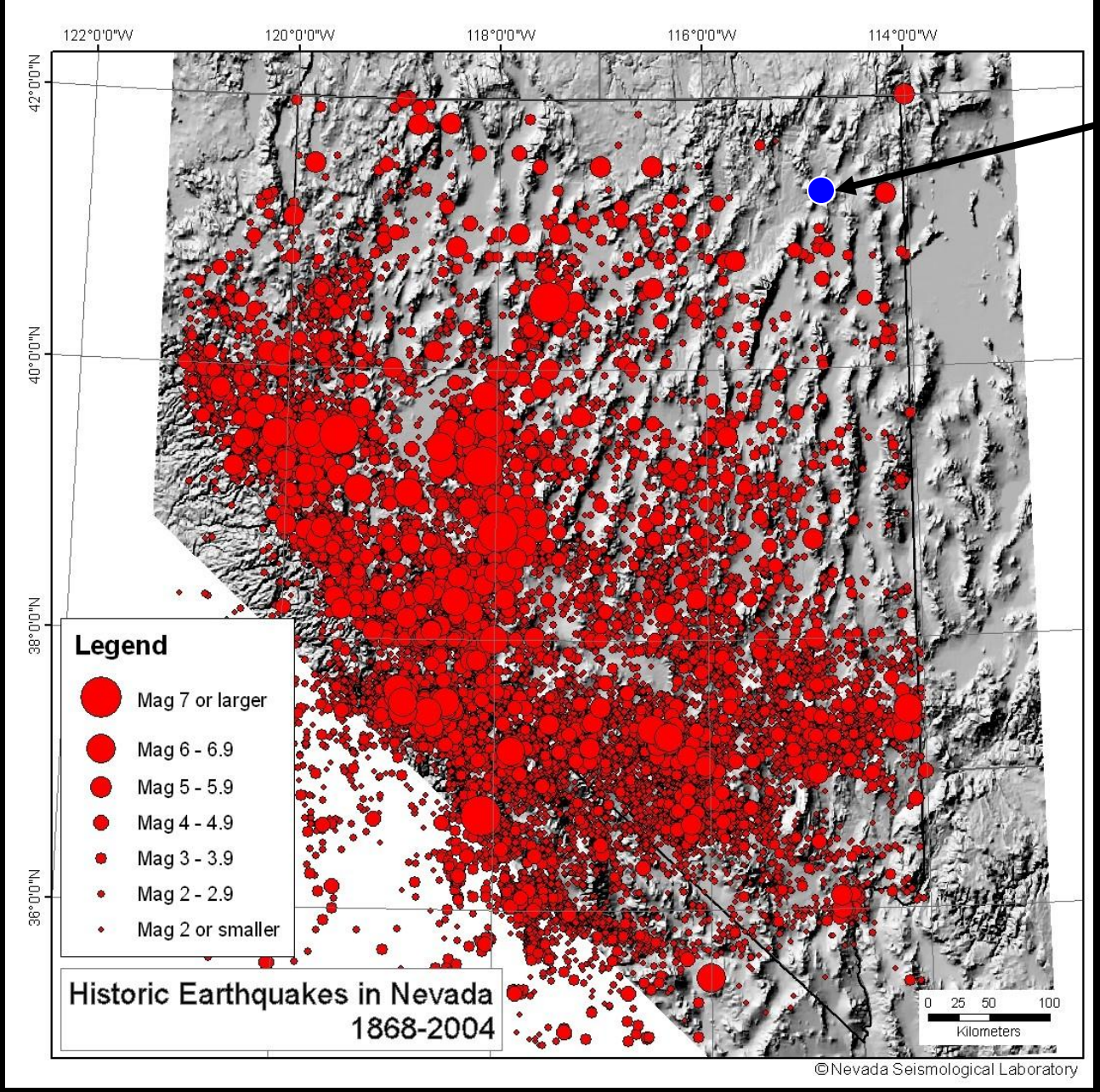


(1) Long faults tend to be associated with big earthquakes (e.g., magnitude 7.4 in Owens Valley, CA in 1872). Shaking from a large earthquake on the Death Valley fault is a threat for Nevada residents.

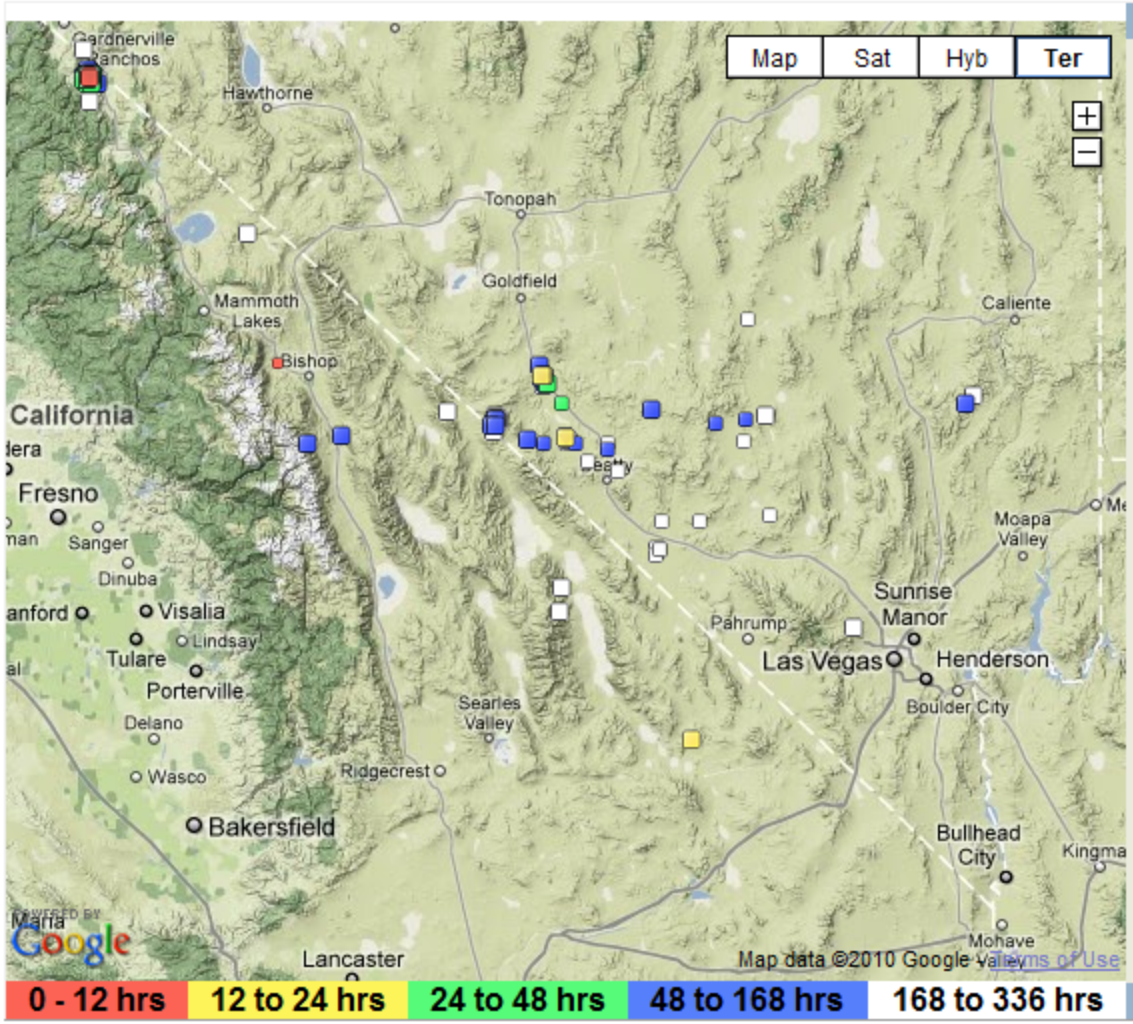


(2) Earthquakes have occurred throughout Nevada.

Large Historical Earthquakes in and near Nye County

Date	Magnitude	Near
1872	7.4	Owens Valley, CA
1932	7.1	Cedar Mtn. (near Gabbs)
1954	7.1	Fairview Peak (northwest of Gabbs)

NEVADA REGIONAL EARTHQUAKES IN THE LAST 14 DAYS 16 November 2010

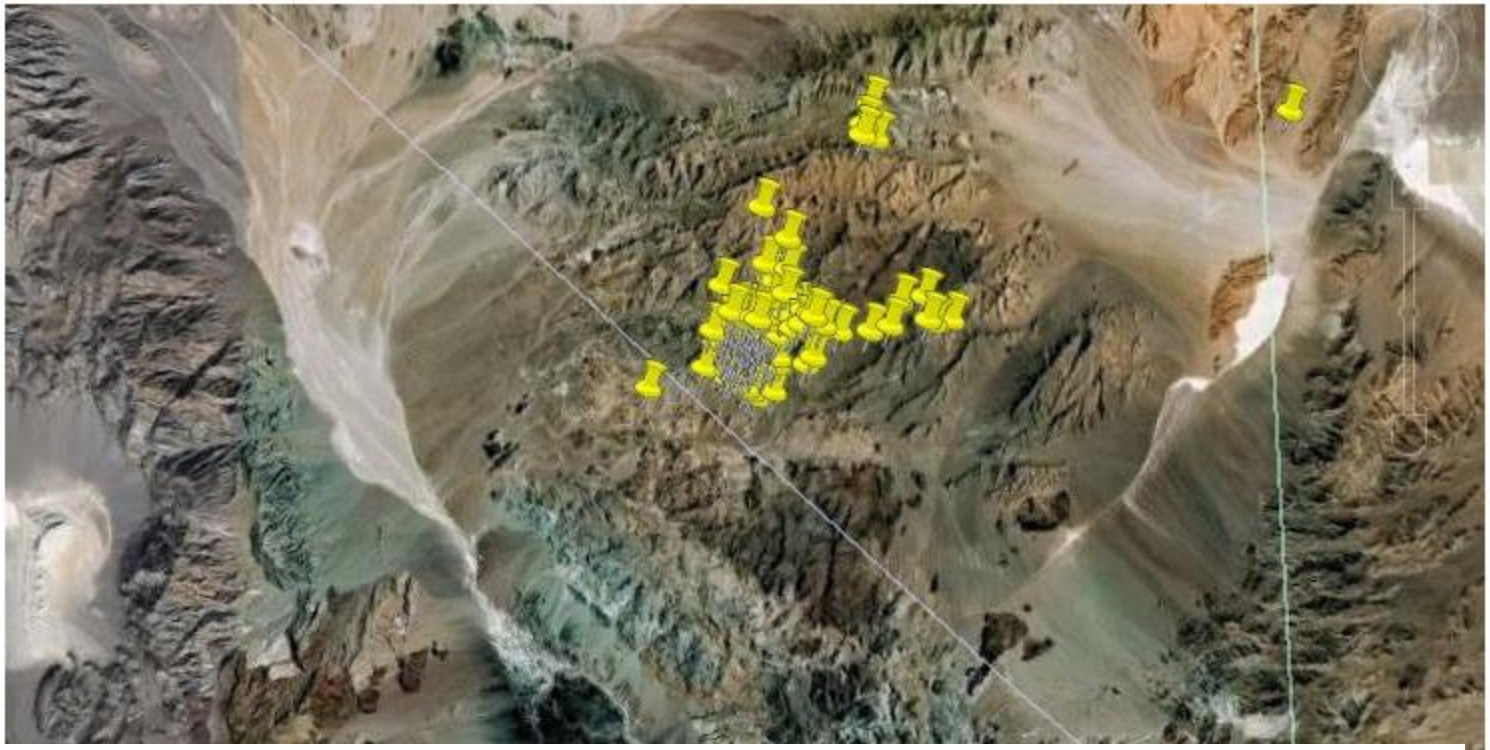


- 24.3 miles SSE of GOLDFIELD-NV
- 24.1 miles SSE of GOLDFIELD-NV
- 14.2 miles WSW of WELLINGTON-NV
- 13.5 miles WSW of WELLINGTON-NV
- 12.8 miles WSW of WELLINGTON-NV
- 24.2 miles SSE of GOLDFIELD-NV
- 24.2 miles SSE of GOLDFIELD-NV
- 27.3 miles SSE of GOLDFIELD-NV
- 13.5 miles WSW of WELLINGTON-NV
- 14.2 miles WSW of WELLINGTON-NV
- 13.8 miles SW of WELLINGTON-NV
- 13.5 miles WSW of WELLINGTON-NV
- 15.4 miles WSW of WELLINGTON-NV
- 13.9 miles WSW of WELLINGTON-NV
- 12.9 miles WSW of WELLINGTON-NV
- 14.9 miles SW of WELLINGTON-NV
- 14.2 miles WSW of WELLINGTON-NV
- 13.0 miles WSW of WELLINGTON-NV
- 13.7 miles WSW of WELLINGTON-NV
- 13.5 miles WSW of WELLINGTON-NV
- 13.0 miles WSW of WELLINGTON-NV
- 27.3 miles NNW of BEATTY-NV
- 24.5 miles SSE of GOLDFIELD-NV
- 27.1 miles WNW of BEATTY-NV
- 8.6 miles SW of BIG_PINE-CA
- 26.8 miles SSE of GOLDFIELD-NV

DID YOU FEEL AN EARTHQUAKE?

USGS LATEST EARTHQUAKE MAPS

WHERE DOES OUR DATA COME FROM?

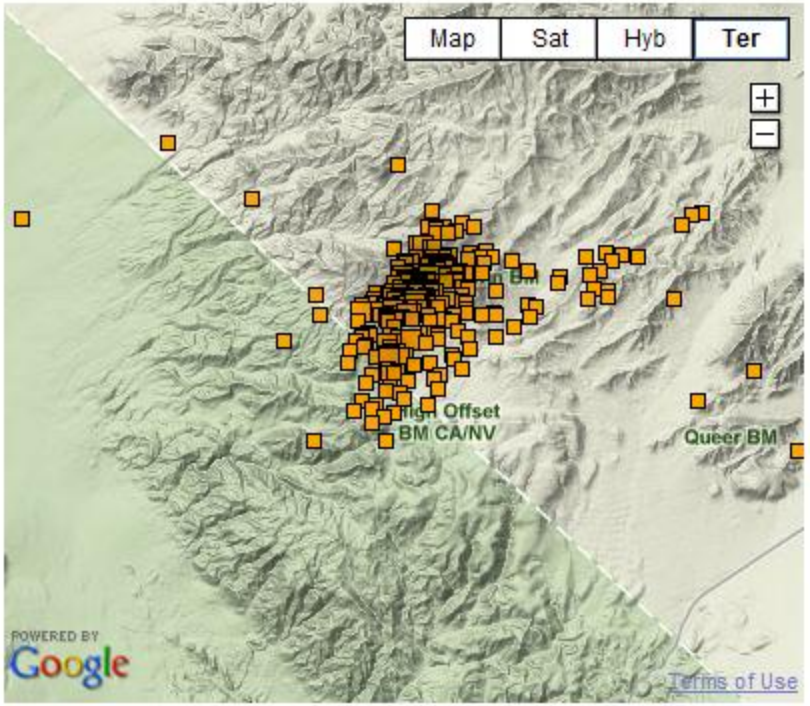


UPDATE: Earthquake sequence about 10 km NNW of Scotty's Castle, CA, Northern Death Valley. (Updated information is through October 17th, 10AM PST) Image from Google Earth.
Small magnitude earthquakes continue in the ongoing sequence NNW of Scotty's Castle. The earthquake sequence defines a NE striking strike-slip fault dipping approximately 80 degrees to the NW. The sequence has included two Magnitude 4+ earthquakes.

Event 317359 | Waveforms | Moment Tensor

Summary:

Magnitude (ML)	4.42
Region	37.7 miles WNW of BEATTY-NV
Date time	2010-09-30 at 08:37:35.927 UTC 2010-09-30 at 01:37:35.927 PDT
Location	37.1385 ; -117.3803
Depth	8.4561 km
RMS	0.2259
Gap	145
Stations	24
Defining Phases	24
Associated Phases	55
Type	Local
Status	Reviewed



Map includes seismicity in the last 60 days within 55 Km of this event.

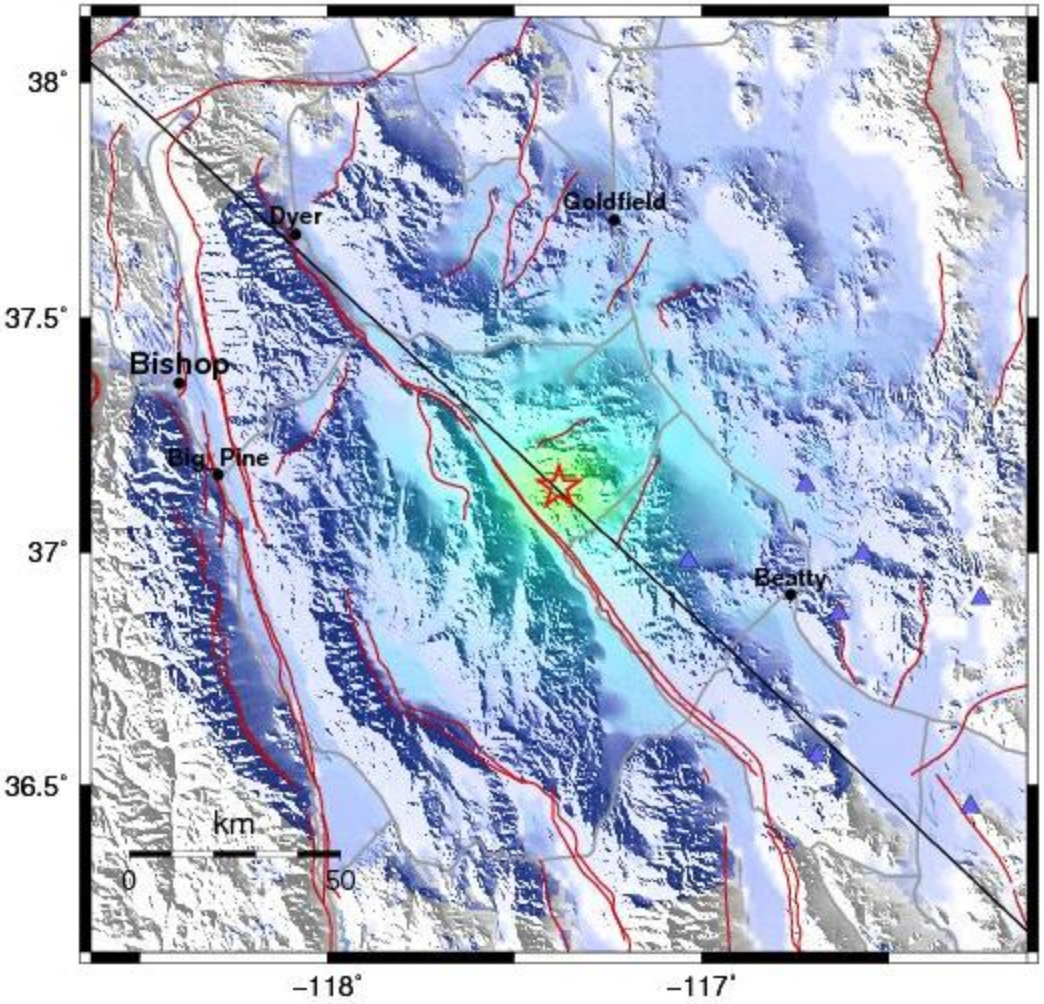
Magnitude 4.3 Earthquake near Scotty's Castle, Northern Death Valley Area

A magnitude 4.3 earthquake occurred east of Scotty's Castle, northern Death Valley, in Nevada at 1:37 AM PST. Additional information on the earthquake can be found on the NSL web site at:

http://www.seismo.unr.edu/Events/main.php?evid=317359

NSL Reno ShakeMap : 37.7 miles WNW of BEATTY–NV

Thu Sep 30, 2010 01:37:35 AM PDT M 4.4 N37.14 W117.38 Depth: 8.5km ID:2010273_317359

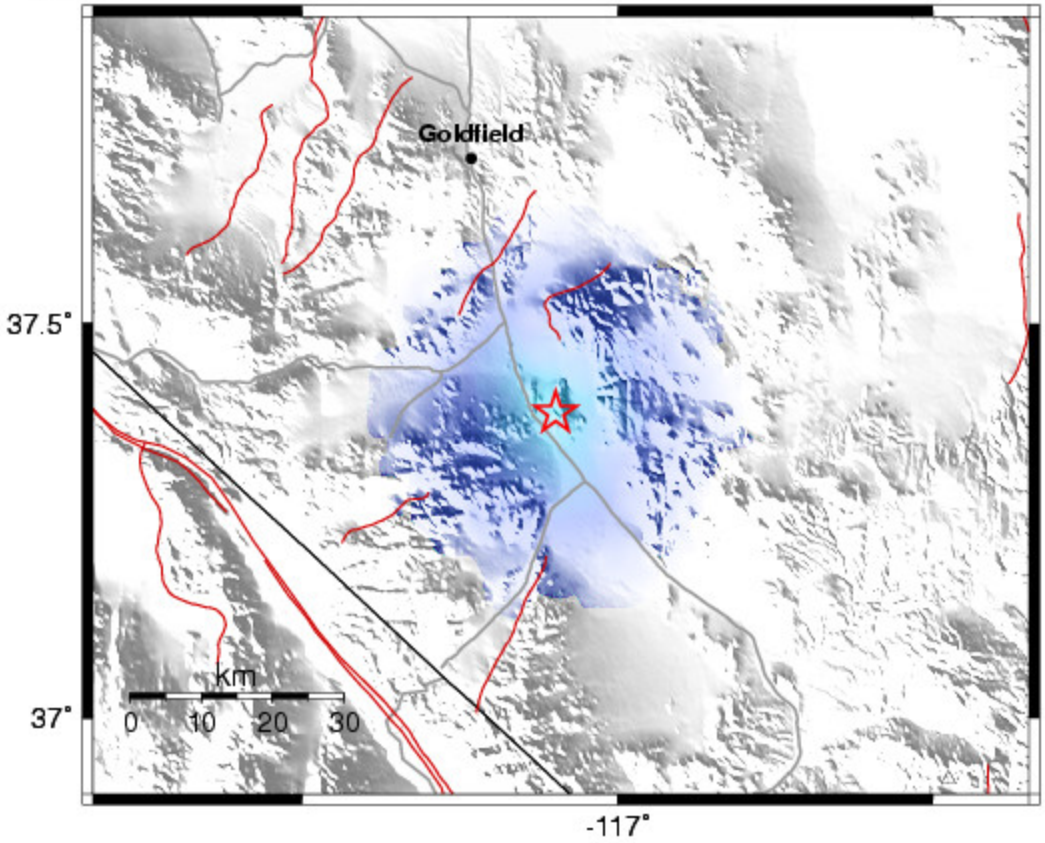


Map Version 8 Processed Tue Oct 26, 2010 09:50:37 AM PDT – ShakeMap v3.5

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17–1.4*	*1.4–3.9*	*3.9–9.2*	*9.2–18*	18–34	34–65	65–124	>124
PEAK VEL.(cm/s)	<0.1	0.1–1.1	1.1–3.4	3.4–8.1	*8.1–16*	*16–31*	*31–60*	*60–116*	*>116*
INSTRUMENTAL INTENSITY	I	II–III	IV	V	VI	VII	VIII	IX	X+

NSL ShakeMap : 23.4 miles SSE of GOLDFIELD-NV

Tue Nov 1, 2005 12:04:32 PM PST M 3.1 N37.39 W117.10 Depth: 8.1km ID:2005305_167076

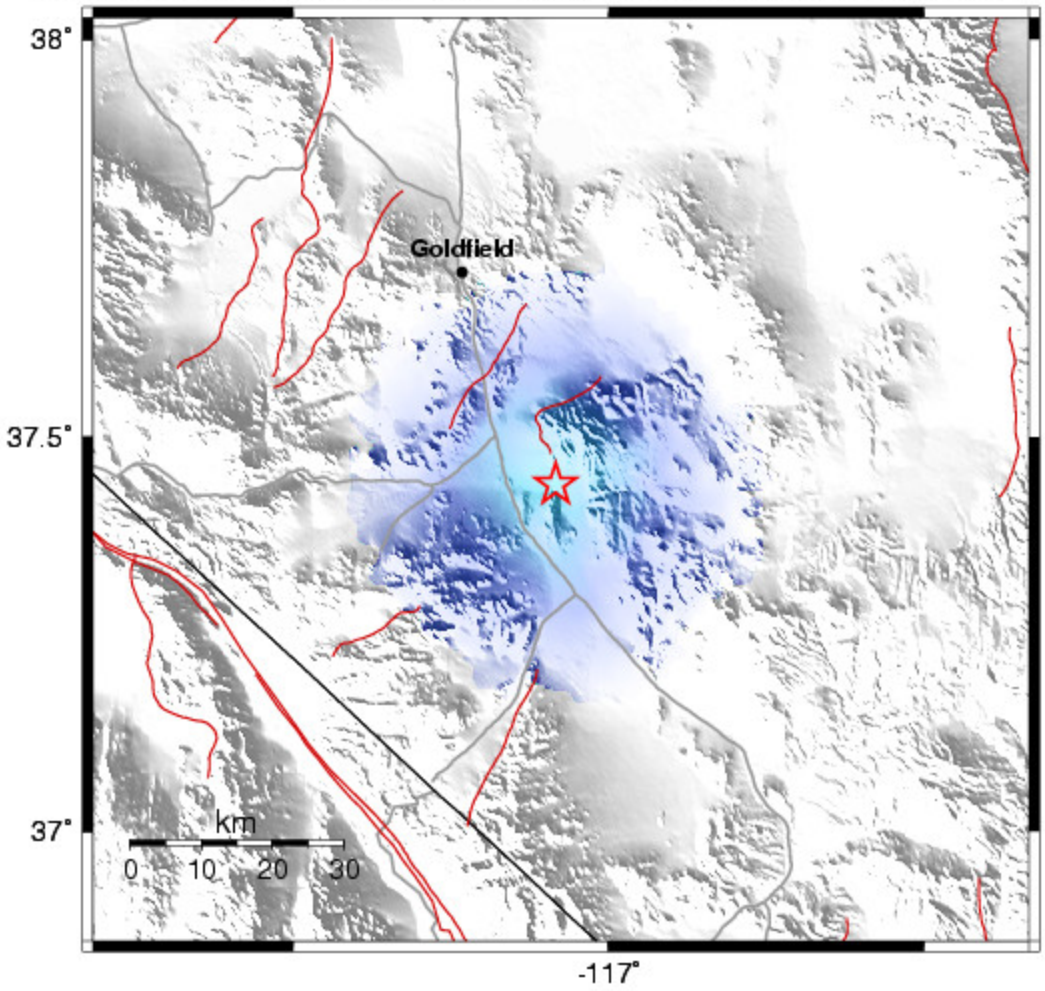


Map Version 8 Processed Tue Dec 12, 2006 09:02:25 PM PST,

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

NSL ShakeMap : 20.3 miles SSE of GOLDFIELD-NV

Tue Jan 3, 2006 10:21:09 AM PST M 3.1 N37.44 W117.08 Depth: 5.5km ID:2006003_172198

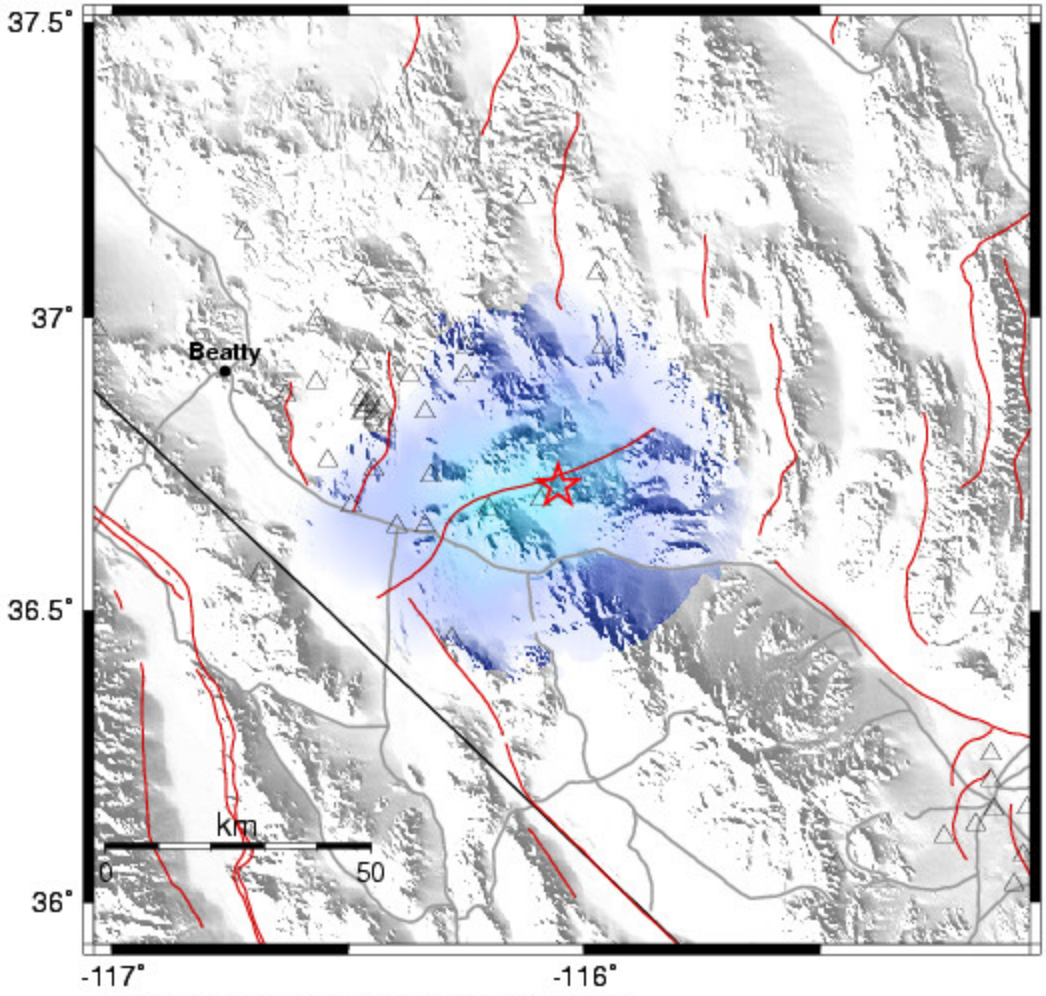


Map Version 13 Processed Wed Mar 7, 2007 01:01:06 PM PST,

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

NSL ShakeMap : 13.6 miles E of Little_Skull_Mtn.-NV

Mon Apr 17, 2006 01:14:51 PM PDT M 3.3 N36.71 W116.06 Depth: 5.6km ID:2006107_179405

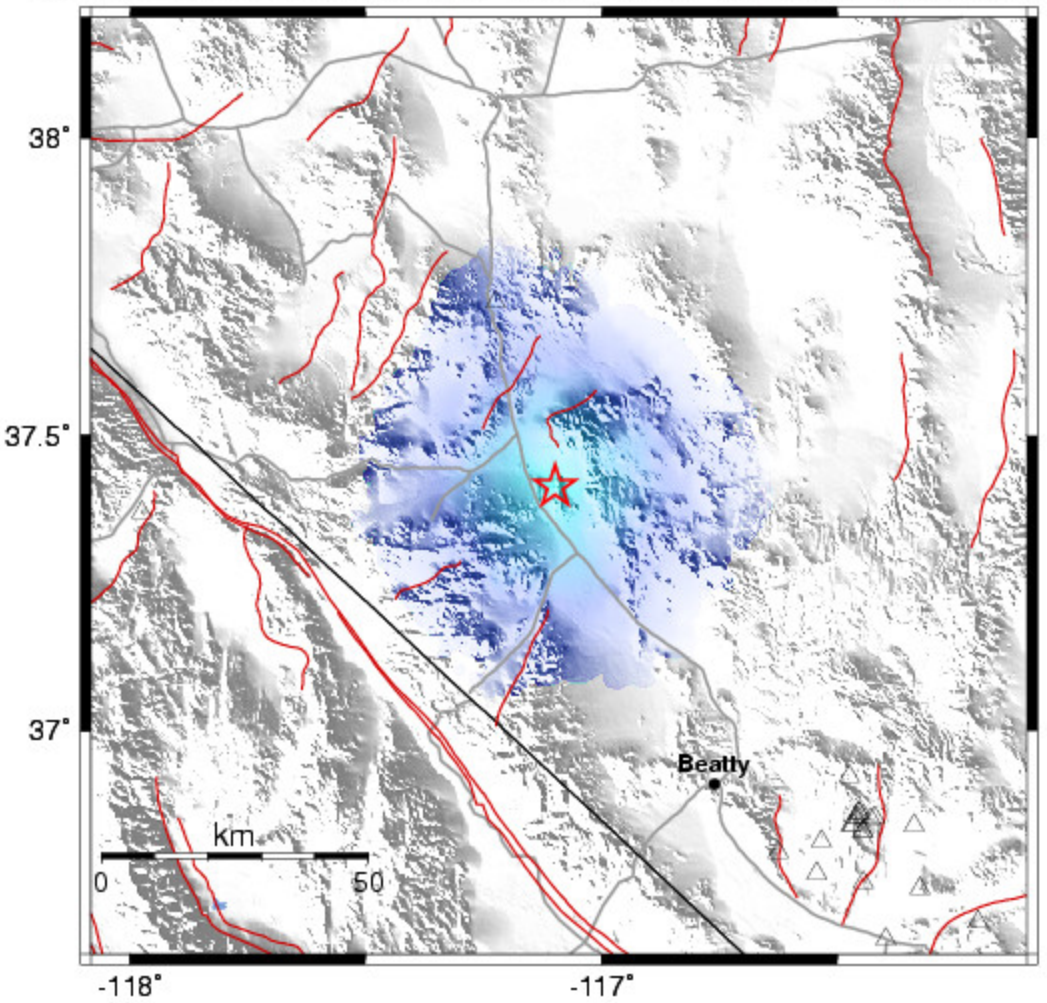


Map Version 16 Processed Wed Mar 7, 2007 01:23:20 PM PST.

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

NSL ShakeMap : 21.7 miles SSE of GOLDFIELD-NV

Wed Jan 24, 2007 03:30:16 AM PST M 4.1 N37.41 W117.10 Depth: 6.1km ID:2007024_197036

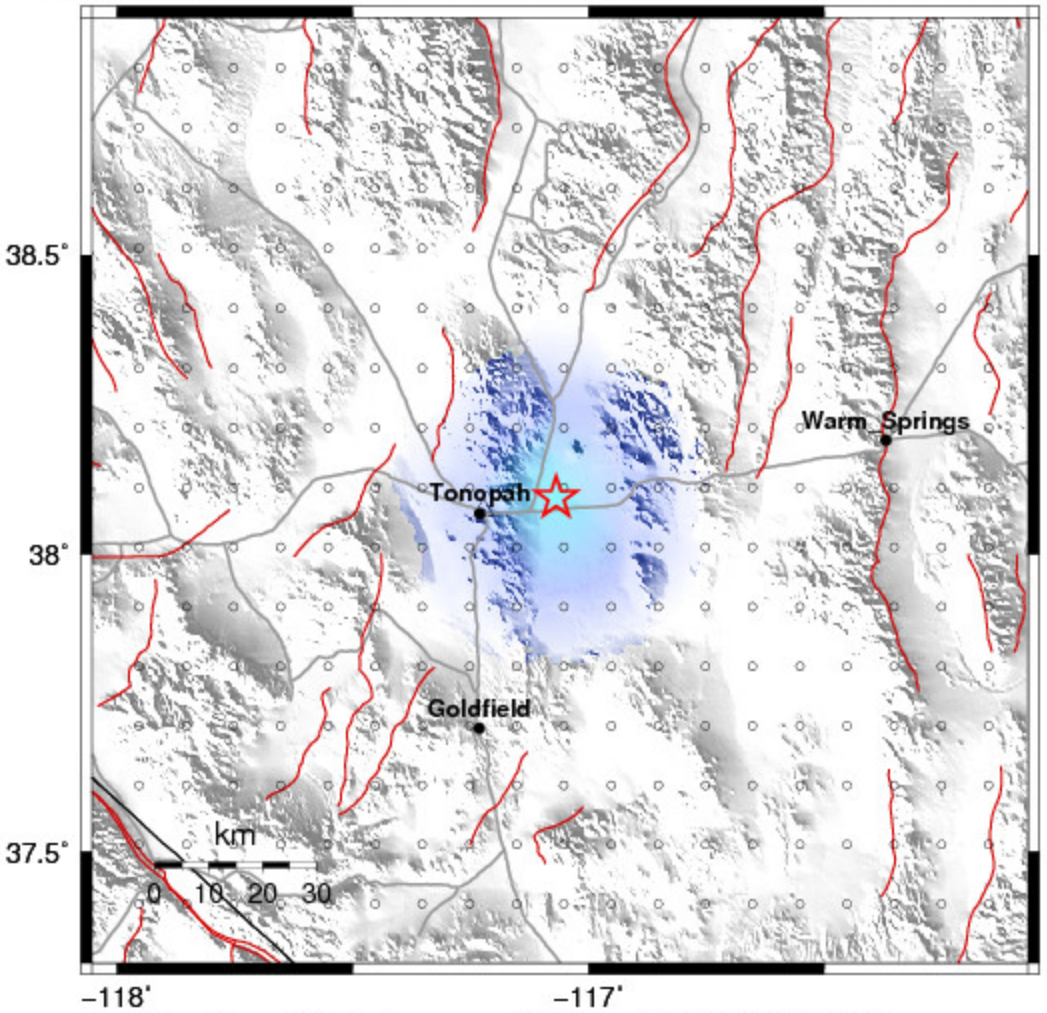


Map Version 22 Processed Fri Mar 9, 2007 09:58:02 AM PST.

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	*8.1-16*	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

NSL ShakeMap : 9.0 miles ENE of TONOPAH–NV

Sat Jan 24, 2009 10:15:50 AM PST M 3.1 N38.10 W117.07 Depth: 2.0km ID:2009024_273275

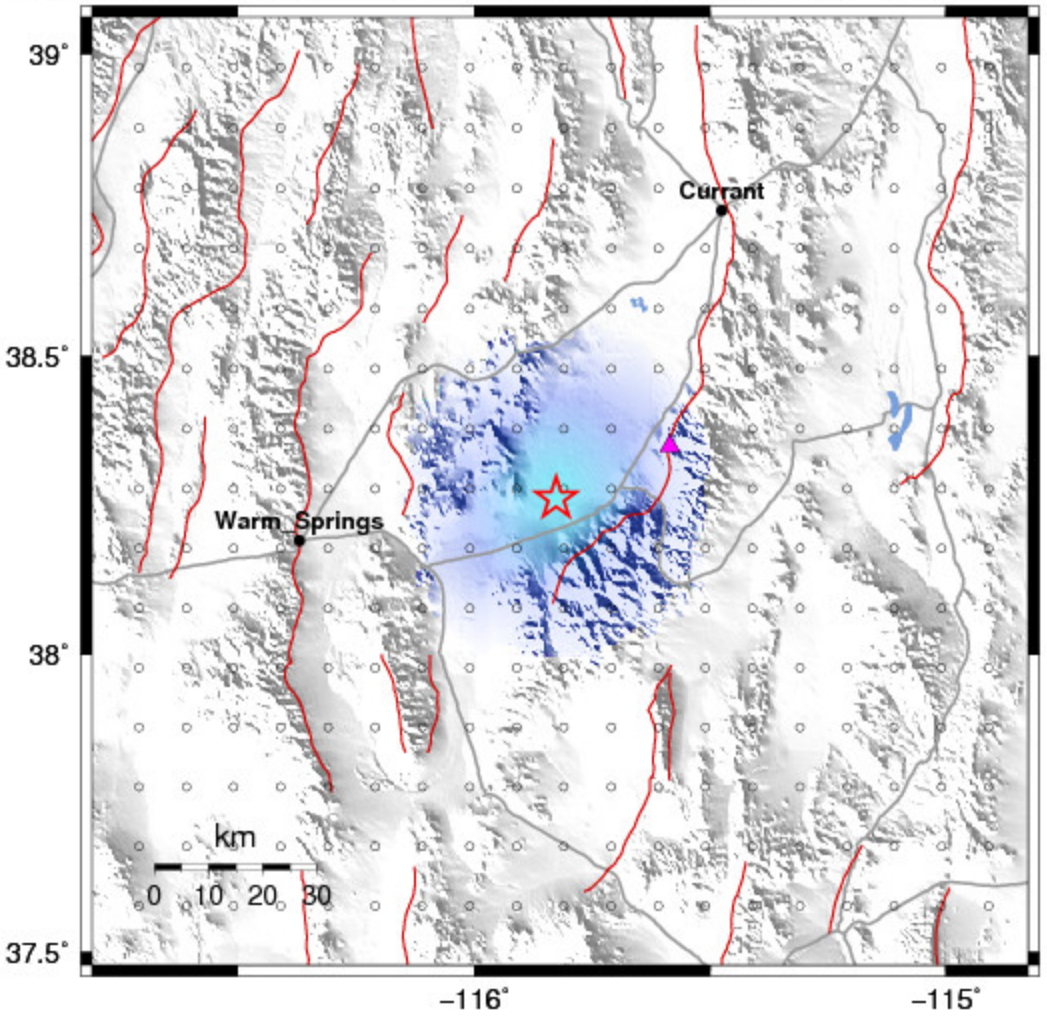


Map Version 1 Processed Mon Oct 12, 2009 05:02:51 PM PDT, -- NOT REVIEWED BY HUMAN

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17–1.4*	*1.4–3.9*	*3.9–9.2*	*9.2–18*	18–34	34–65	65–124	>124
PEAK VEL.(cm/s)	<0.1	0.1–1.1	1.1–3.4	3.4–8.1	*8.1–16*	*16–31*	*31–60*	*60–116*	*>116*
INSTRUMENTAL INTENSITY	I	II–III	IV	V	VI	VII	VIII	IX	X+

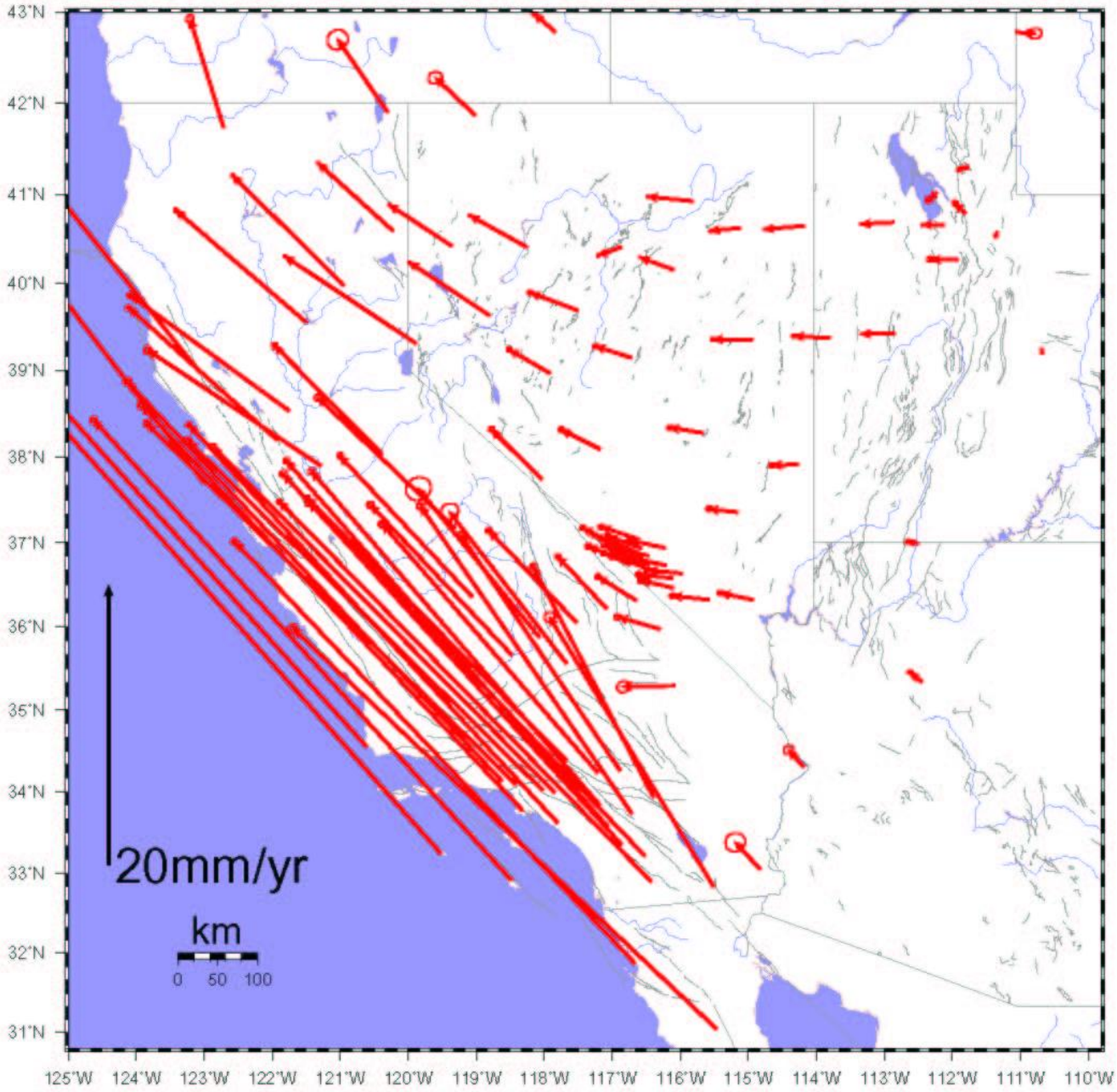
NSL ShakeMap : 29.9 miles E of WARM SPRINGS–NV

Sun Sep 13, 2009 12:28:53 PM PDT M 3.2 N38.26 W115.83 Depth: 8.2km ID:2009256_292390



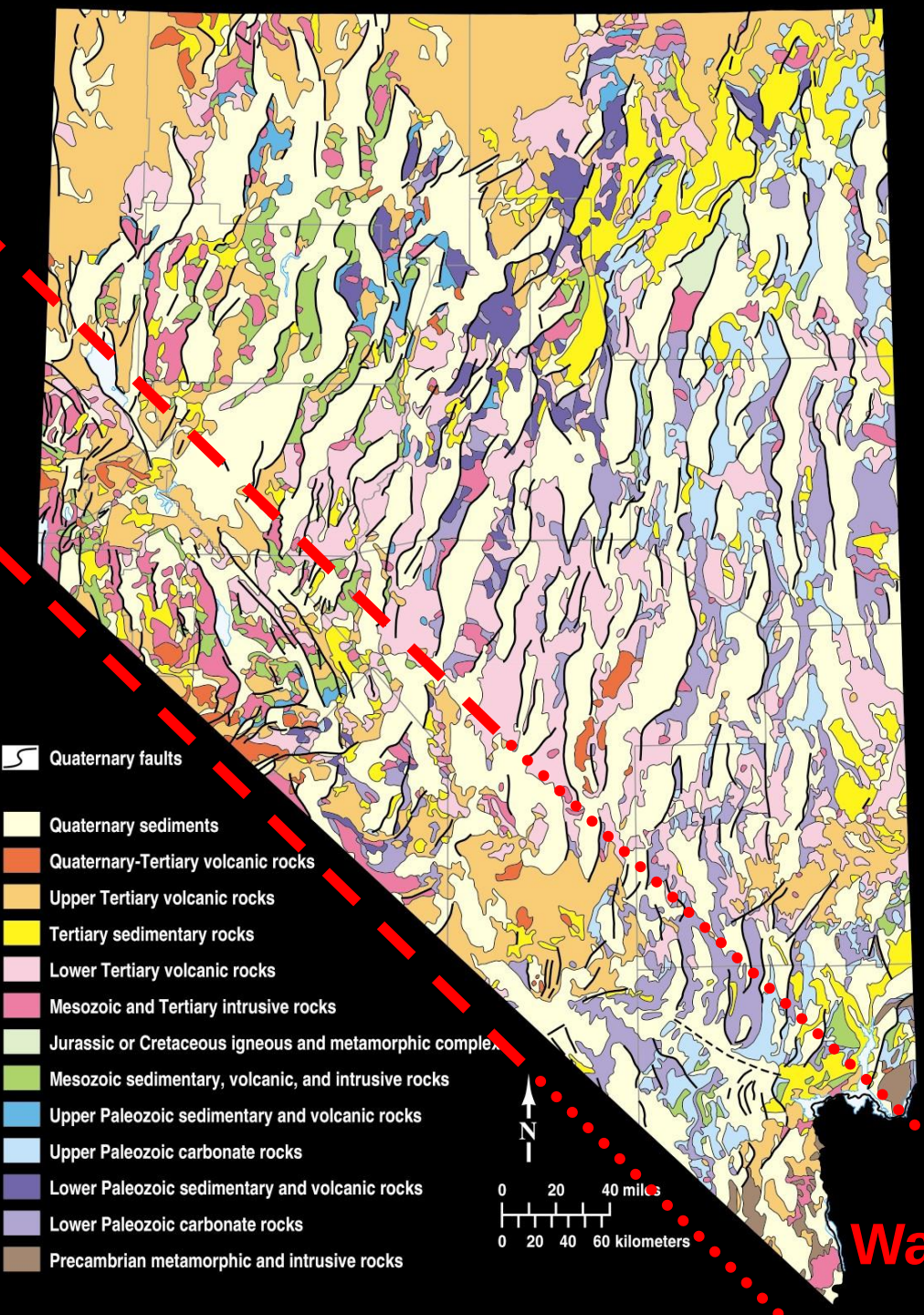
Map Version 2 Processed Tue Sep 15, 2009 11:32:59 AM PDT, -- NOT REVIEWED BY HUMAN

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17–1.4*	*1.4–3.9*	*3.9–9.2*	*9.2–18*	18–34	34–65	65–124	>124
PEAK VEL.(cm/s)	<0.1	0.1–1.1	1.1–3.4	3.4–8.1	*8.1–16*	*16–31*	*31–60*	*60–116*	*>116*
INSTRUMENTAL INTENSITY	I	II–III	IV	V	VI	VII	VIII	IX	X+



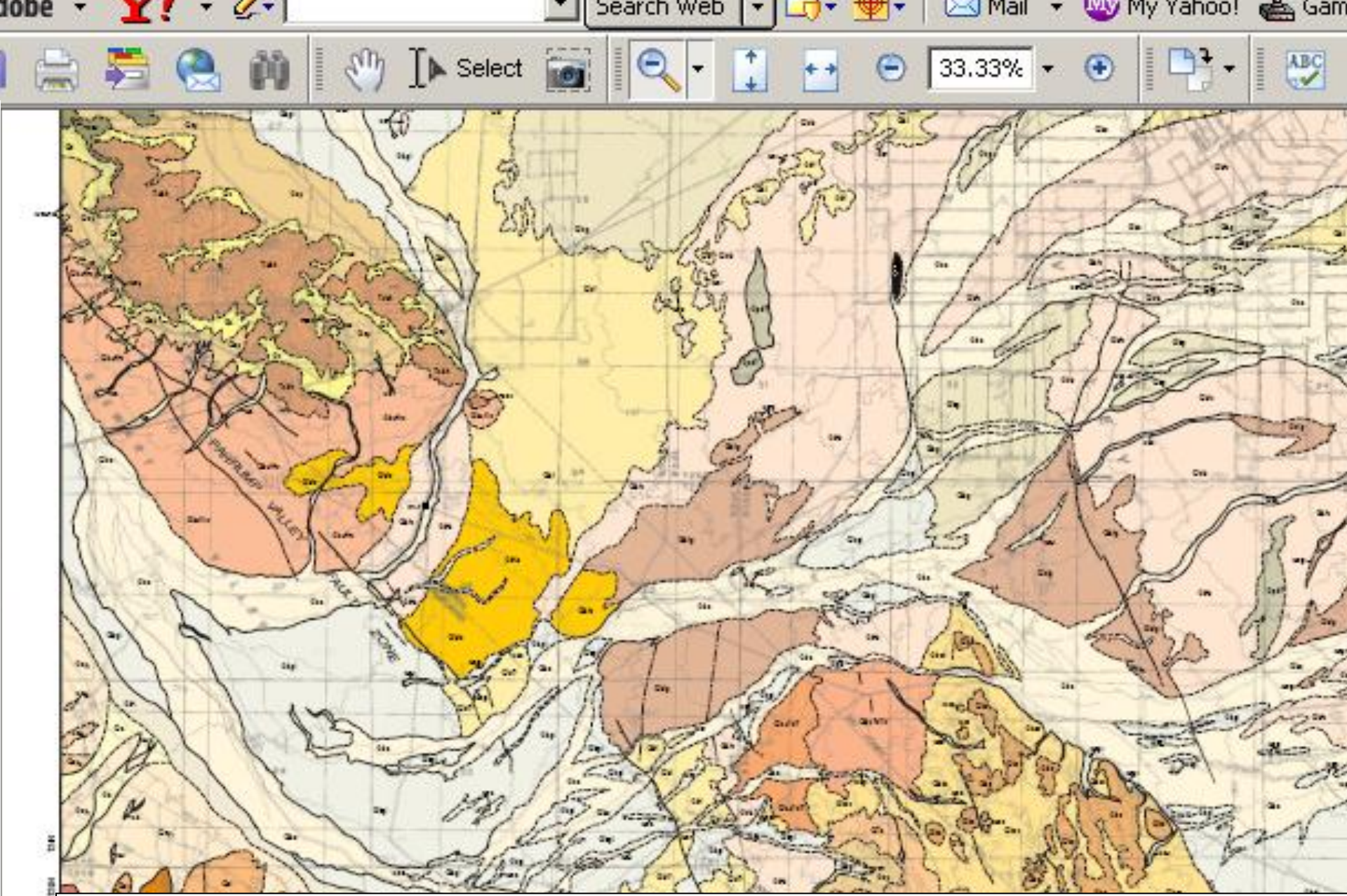
(3) Geodetic data indicate that the Basin and Range province is gaining about 1.3 acres of area per year through crustal extension, and that western Nevada is accommodating ~20% of the North American-Pacific plate interaction.

Kreemer and Hammond (2007)

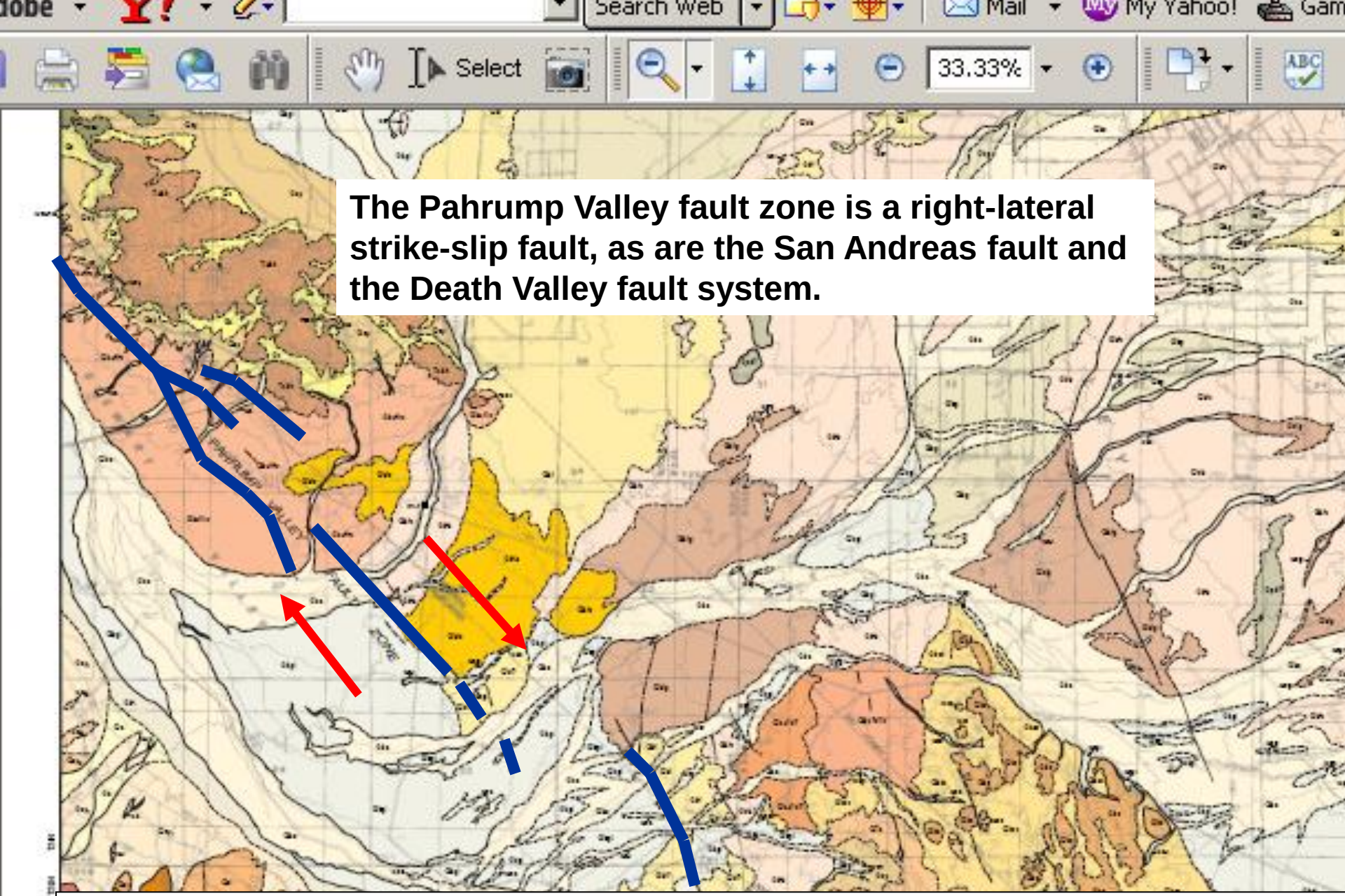


In Nevada, much of the right-lateral shear between the North American and Pacific plates occurs along northwest-striking strike-slip faults of the Walker Lane.

Extension largely is accommodated along N- to NE-striking, basin-bounding normal faults.



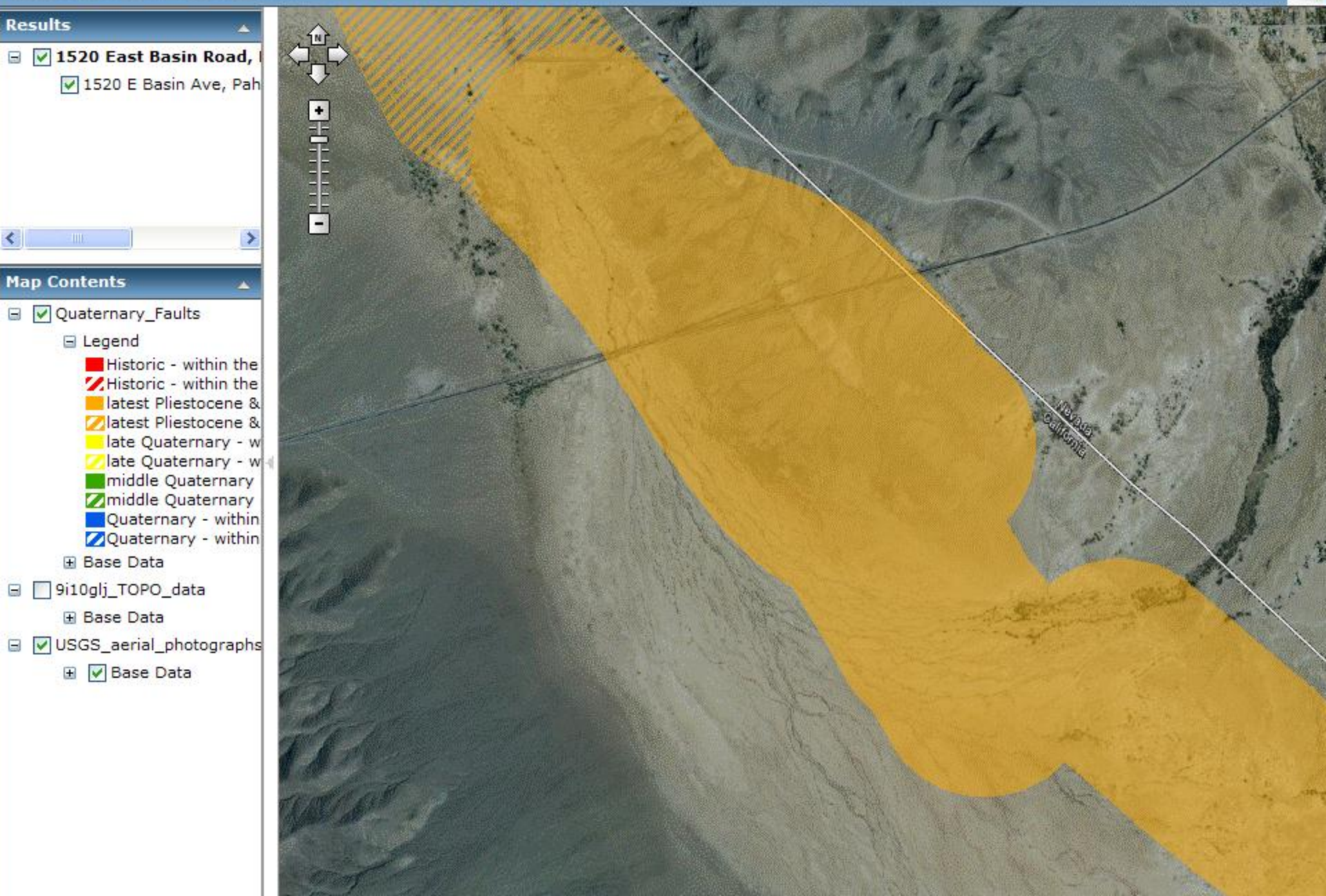
Pahrump Valley fault zone, mapped on the southeast corner of the Sixmile Spring Quadrangle (Nevada Bureau of Mines and Geology Open-File Report 03-11)



Pahrump Valley fault zone, mapped on the southeast corner of the Sixmile Spring Quadrangle (Nevada Bureau of Mines and Geology Open-File Report 03-11)

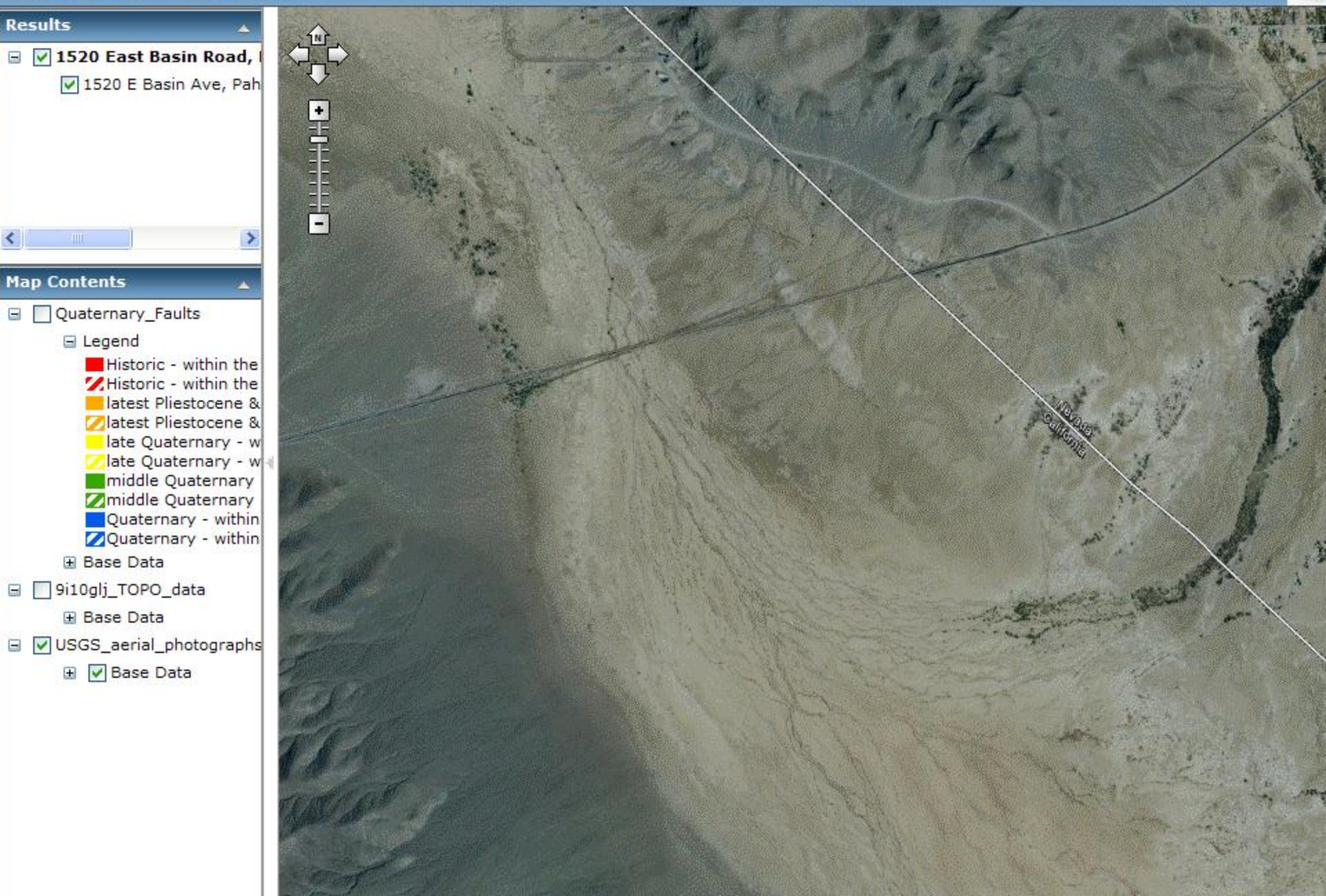
Quaternary Faults in Nevada - Online Interactive Map

Look for a fault | Find Address



Quaternary Faults in Nevada - Online Interactive Map

Look for a fault | Find Address



Quaternary Faults in Nevada - Online Interactive Map

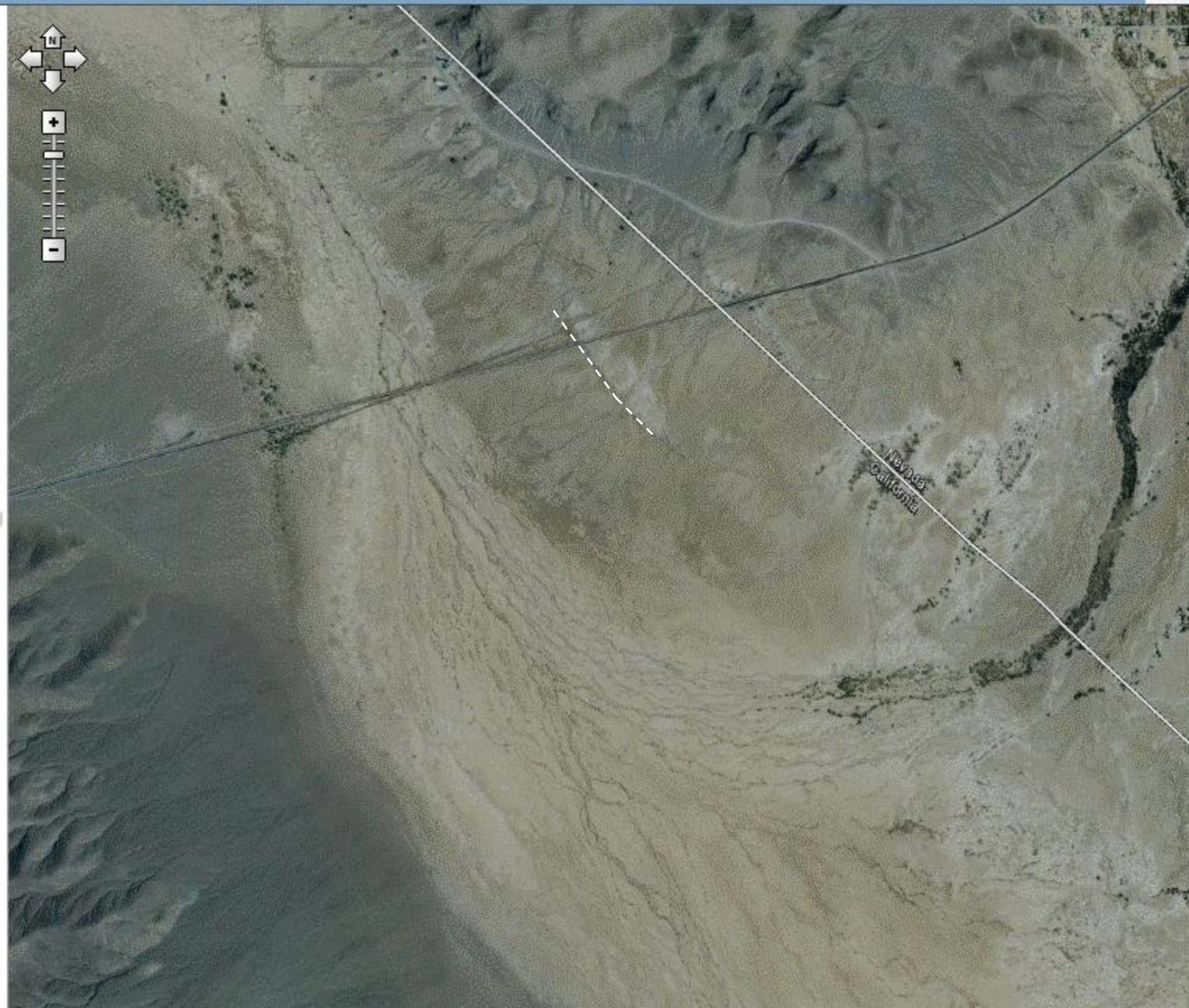
Look for a fault | Find Address

Results

- 1520 East Basin Road, I
  - 1520 E Basin Ave, Pah

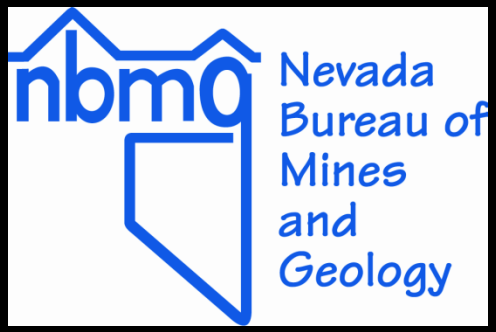
Map Contents

- Quaternary_Faults
  - Legend
    - Historic - within the
    - Historic - within the
    - latest Pliestocene &
    - latest Pliestocene &
    - late Quaternary - w
    - late Quaternary - w
    - middle Quaternary
    - middle Quaternary
    - Quaternary - within
    - Quaternary - within
  - Base Data
- 9i10glj_TOPO_data
  - Base Data
- USGS_aerial_photographs
  - Base Data



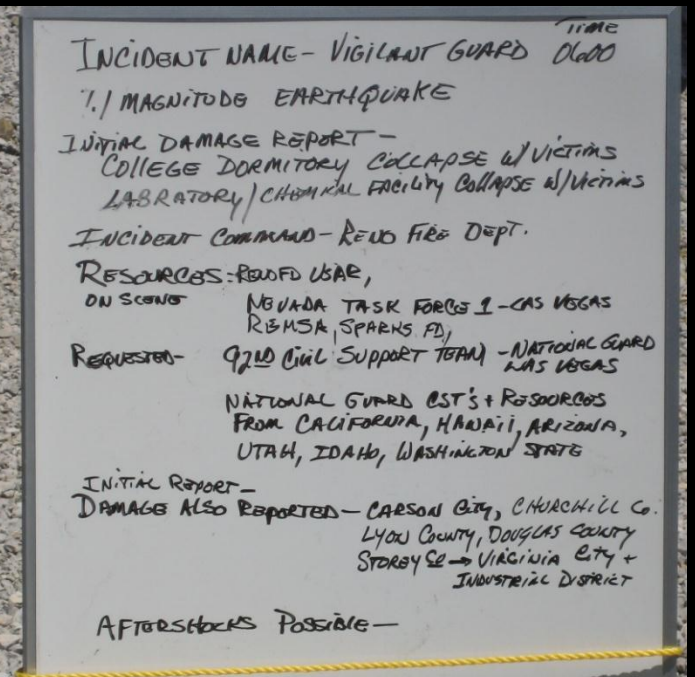
Earthquake faults occur throughout Nevada, and potential losses from earthquakes are high for many communities.

NBMG Open-File Report 09-8, *Estimated Losses from Earthquakes near Nevada Communities*, demonstrates that the consequences of earthquakes can be huge in Nevada, particularly if individuals are not prepared.



Earthquake risks in Nevada are assessed by the Nevada Bureau of Mines and Geology using the Federal Emergency Management Agency's loss-estimation model, HAZUS-MH, and the U.S. Geological Survey's probabilistic seismic hazard analysis.

These loss estimates are useful in hazard-mitigation planning, in building scenarios for emergency response and recovery exercises, and in helping emergency managers and the Governor make decisions on official disaster declarations after an actual earthquake.



Earthquake risks in Nevada are assessed by the Nevada Bureau of Mines and Geology using the Federal Emergency Management Agency's loss-estimation model, HAZUS-MH, and the U.S. Geological Survey's probabilistic seismic hazard analysis.

NBMG Open-File Report 09-8, *Estimated Losses from Earthquakes near Nevada Communities*, contains HAZUS scenarios for magnitude 5.0, 5.5, 6.0, 6.5, and 7.0 earthquakes near 38 communities in Nevada.

The hazard: expressed in terms of probability of an earthquake of a given magnitude occurring within 50 years and within 50 km of the community.

	% Probability of magnitude greater than or equal to magnitude				
Community	**5.0**	**5.5**	**6.0**	**6.5**	**7.0**
Dayton	>90	~80	70-75	50-55	12-15
Carson City	>90	~80	70	50-55	12-15
Reno	>90	~80	67	50	12-15
Gabbs	**90**	**~65**	**40-50**	**20-25**	**6-8**
Beatty	**70-80**	**~55**	**30-40**	**20-30**	**10-12**
Tonopah	**70-80**	**~50**	**20-30**	**5-10**	**<1**
Las Vegas	40-50	~30	12	4-5	<0.5
Elko	30-40	~25	10-15	6-8	0.5-1
Pahrump	**30-40**	**~25**	**5-10**	**3**	**<1**
Wells	30-40	~20	9	6	0.5-1
Laughlin	10-20	~5	2-3	0.5-1	<0.5

Data are from the USGS at http://eqint.cr.usgs.gov/eqprob/2002/index.php .
Values for magnitude 5.5 are interpolated between 5.0 and 6.0.

Uncertainties in the location of epicenters, depths, and magnitude, when combined with changing population and uncertainties in local effects (soil and rock types, assumptions about attenuation, basin geometry, liquefaction potential, and directivity), make loss estimates generally consistent within one order of magnitude (a factor of 10).

The risks are huge.

For a magnitude 7.0 earthquake near, HAZUS estimated:

$550 million in economic loss ($190 million for Nye County alone)

major damage to approximately 2,700 buildings

27 people needing public shelter

7 fatalities.

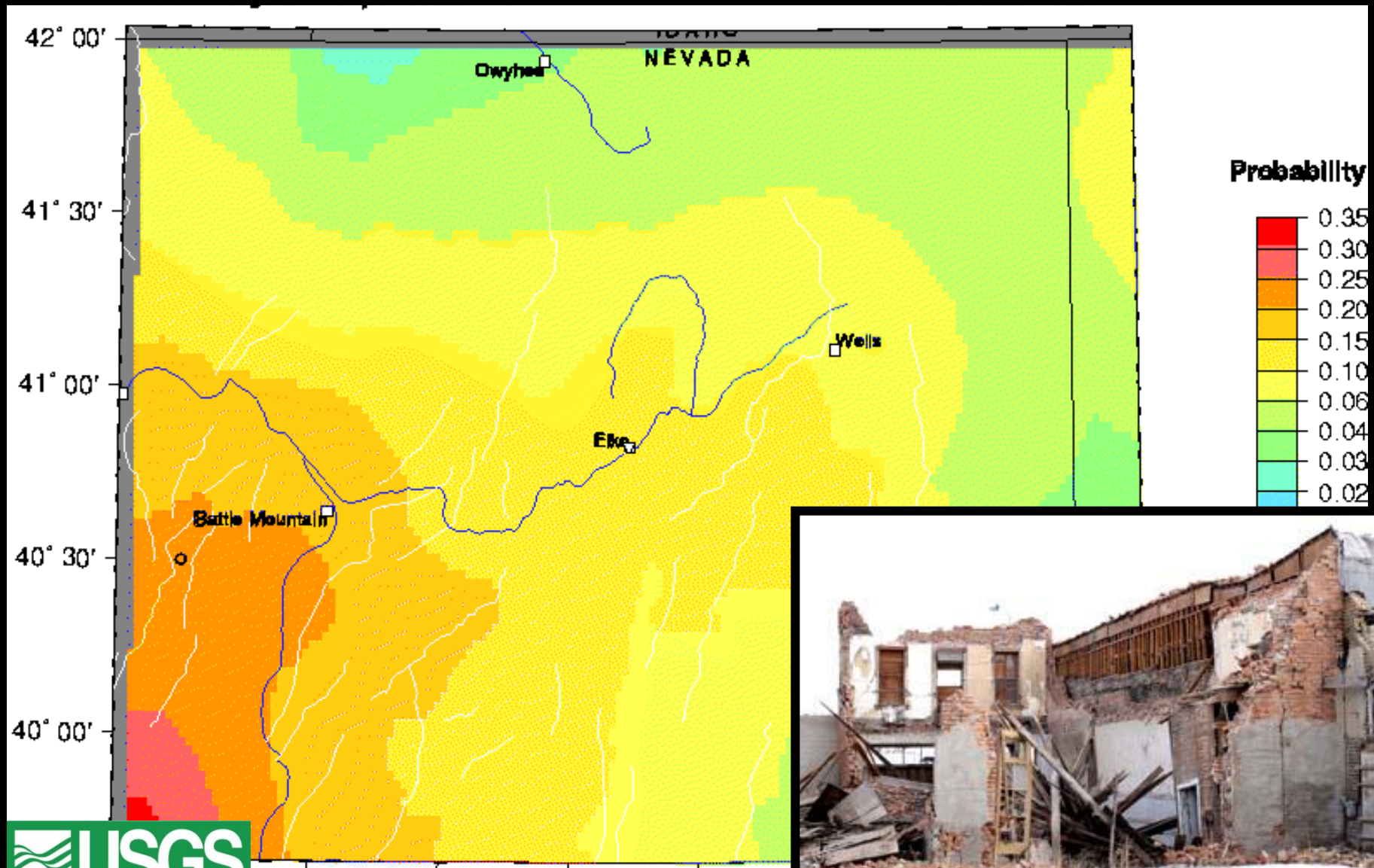
*** Figures could be higher; populations in Nye and Clark Counties has increased by more than 30% since the 2000 census.**

HAZUS estimates for total economic loss from a magnitude 6.0 earthquake and probability of an earthquake of this magnitude or greater occurring within 50 years and within 50 km of the community.

Community	Total Economic Loss	Probability in 50 years within 50 km
Las Vegas	$7.2 billion	12%
Reno	$1.9 billion	67%
Stateline	$590 million	60 to 70%
Elko	$160 million	10 to 15%
Wells	$30 million	9%
Pahrump	$84 million	5 to 10%
Tonopah	$18 million	20 to 30%
Beatty	$6.5 million	30 to 40%
Gabbs	$2.6 million	40 to 50%

Total economic loss is from HAZUS. Probabilities are from the USGS at http://eqint.cr.usgs.gov/eqprob/2002/index.php .

The probability of a magnitude 6.0 earthquake occurring within 50 km of Wells, Nevada within the next 50 years is approximately 9%.
It happened on 21 February 2008.

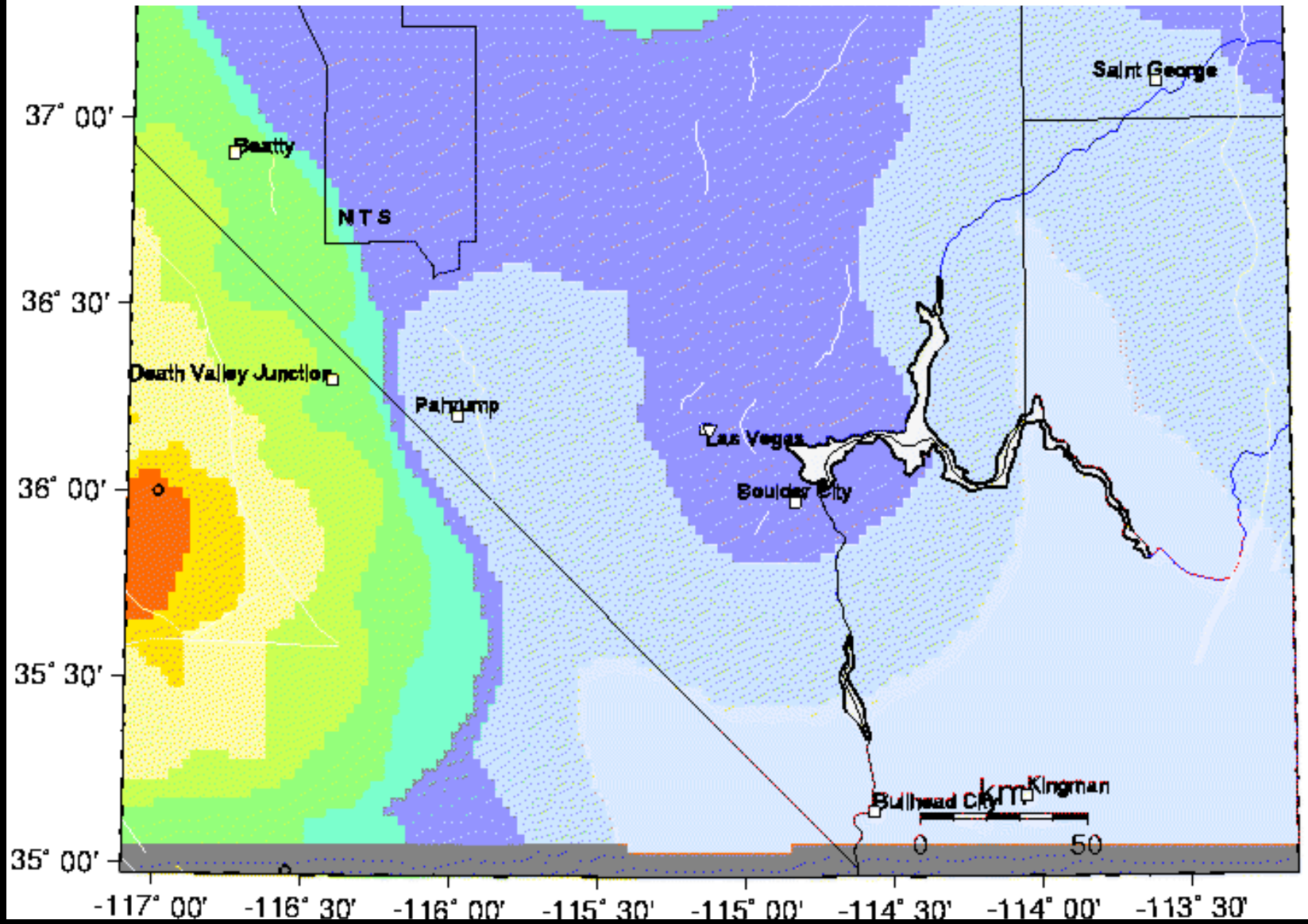


C. dePolo photo

USGS science for a changing world

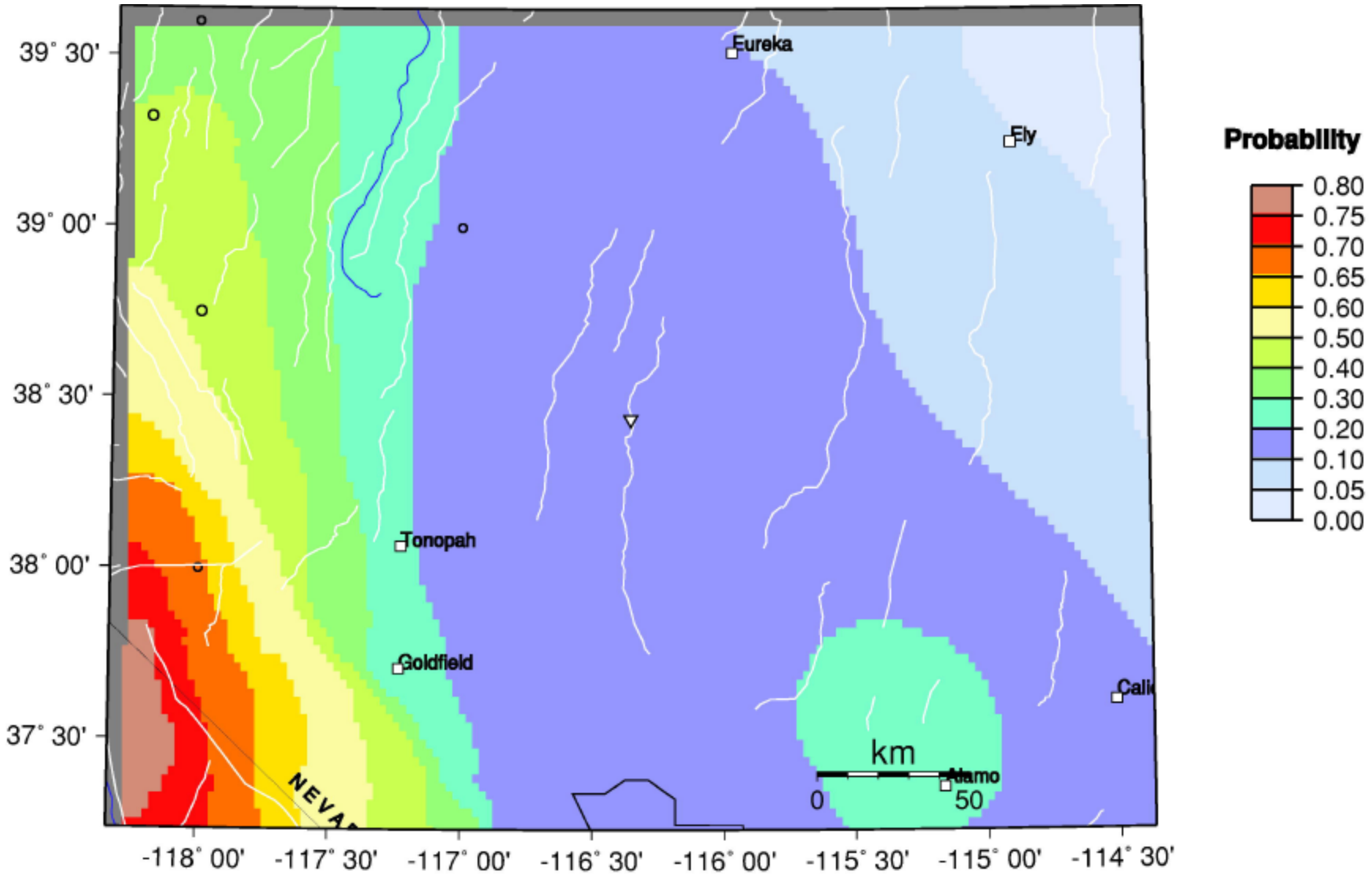
Probability of an earthquake of magnitude 6.0 or greater occurring within 50 km in 50 years (from USGS probabilistic seismic hazard analysis)

5-10% chance for Pahrump, magnitude 6



Probability of an earthquake of magnitude 6.0 or greater occurring within 50 km in 50 years (from USGS probabilistic seismic hazard analysis)

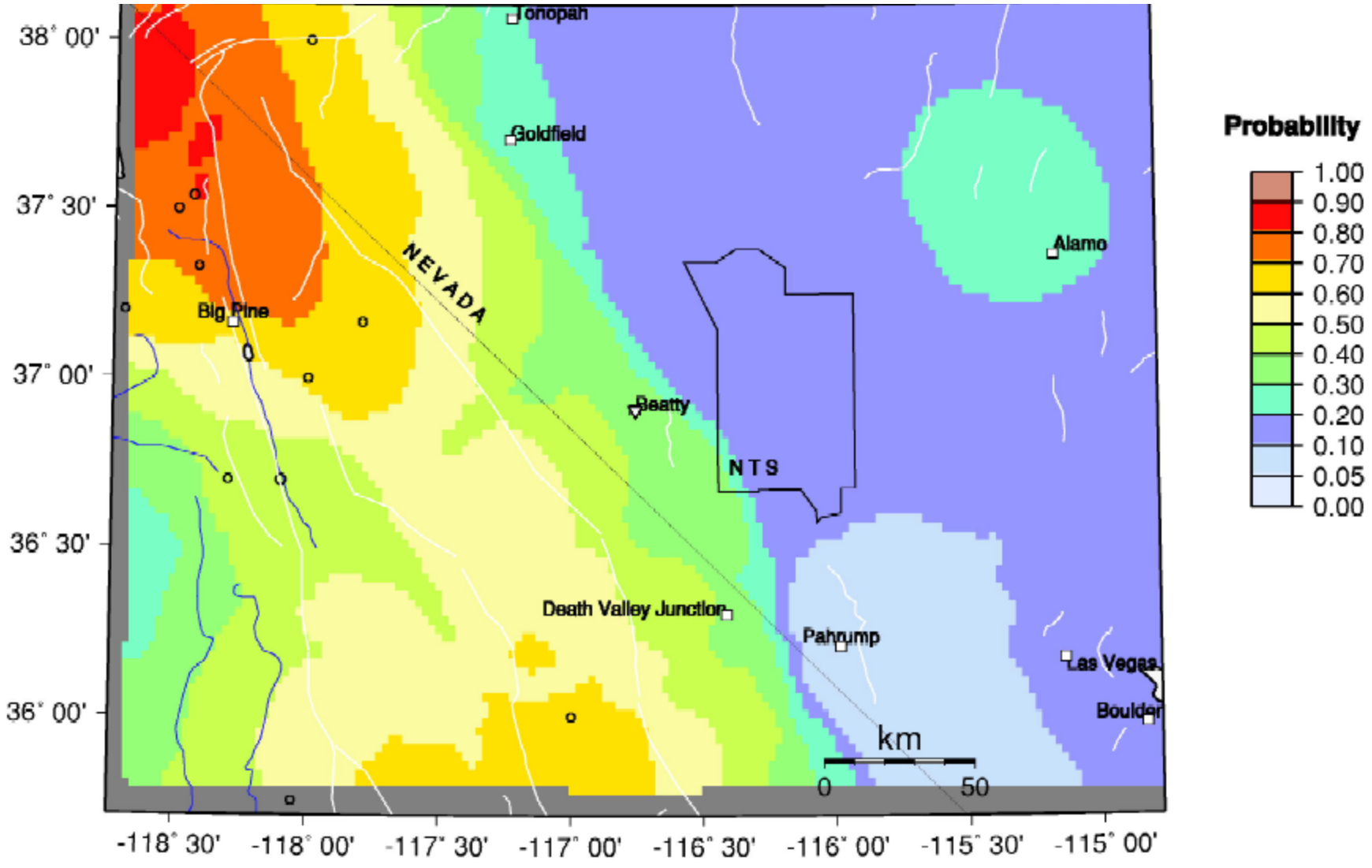
20-30% chance for Tonopah, magnitude 6



GMT May 3 18:23 Earthquake probabilities from USGS 2002 PSHA. 50 km maximum horizontal distance. Site of interest: triangle. Fault traces are white; rivers blue. Epicenters M>=6.0 circles.

Probability of an earthquake of magnitude 6.0 or greater occurring within 50 km in 50 years (from USGS probabilistic seismic hazard analysis)

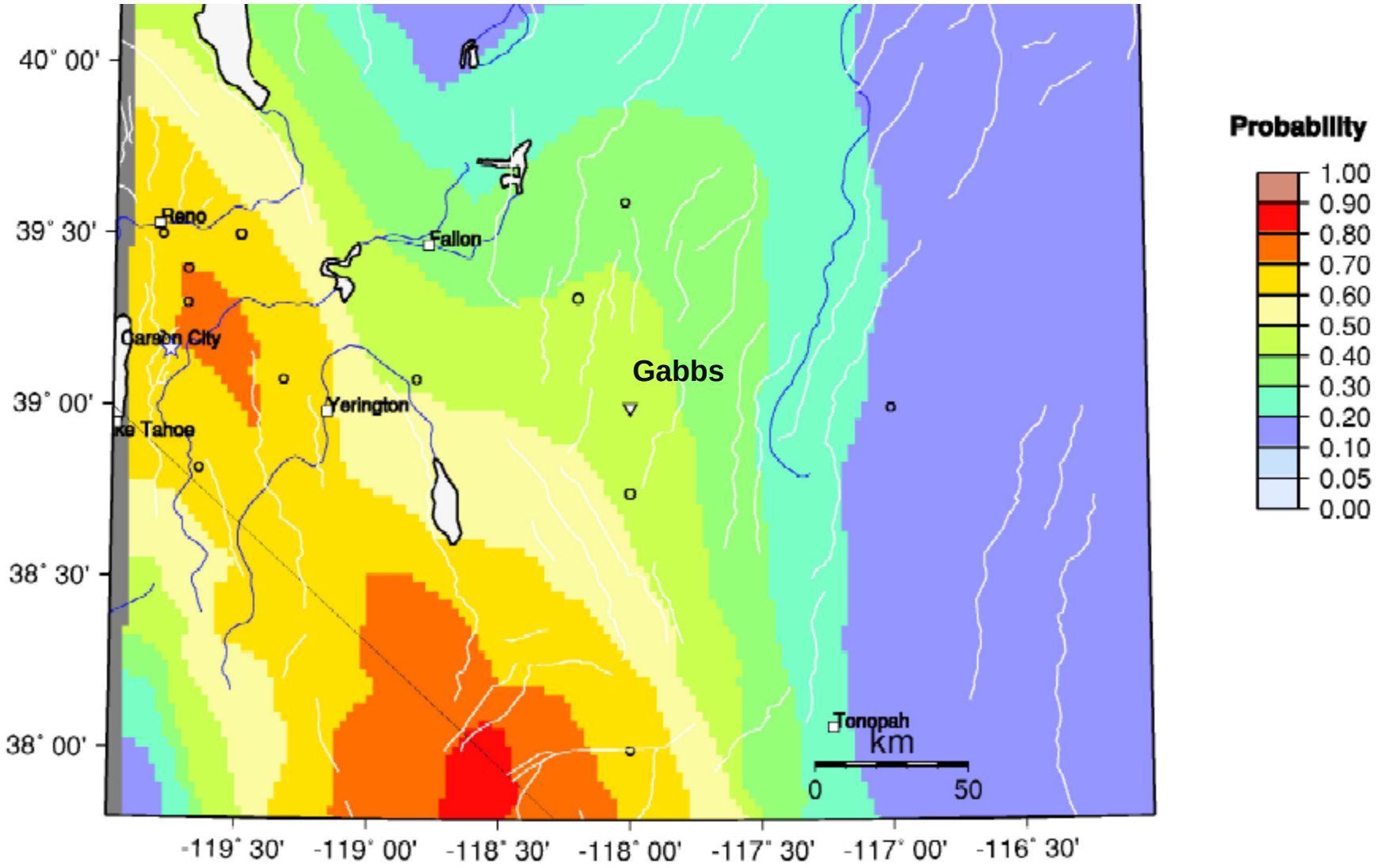
30-40% chance for Beatty, magnitude 6



GMT May 3 18:44 | Earthquake probabilities from USGS 2002 PSHA. 50 km maximum horizontal distance. Site of interest: triangle. Fault traces are white; rivers blue. Epicenters M>=6.0 circles.

Probability of an earthquake of magnitude 6.0 or greater occurring within 50 km in 50 years (from USGS probabilistic seismic hazard analysis)

40-50% chance for Gabbs, magnitude 6



GMT May 4 09:41 | Earthquake probabilities from USGS 2002 PSHA. 50 km maximum horizontal distance. Site of interest: triangle. Fault traces are white; rivers blue. Epicenters M>=6.0 circles.

Earthquake faults occur throughout Nevada, and potential losses from earthquakes are high for many communities.

The consequences of earthquakes can be huge in Nevada, particularly if individuals are not prepared.

A. Be prepared to respond.

B. Mitigate structural risks, largely through building codes and avoiding faults and areas of liquefaction.

C. Mitigate nonstructural risks.

Unreinforced masonry building (URM) that collapsed during the Wells earthquake on 21 February 2008

View from back, 20 May 2009

View from front, 20 May 2009

Nonstructural damage often can be easily prevented.

Earthquake-secure bookshelves in the office of the State Geologist

Secured computers at the Clark County Building Department

Thank you!

And thanks to Gary Johnson, Christine Ballard, Heather Armeno, Irene Seeley, Linda D. Goar, and Jordan T. Hastings for their work on the open-file reports (OF 09-8 and 09-9), which are available at **www.nbmg.unr.edu**.

From there, go to NBMG products on earthquakes, then scroll down to OF 09-8, OF 09-9, Map 167, and ***Living with Earthquakes in Nevada.***