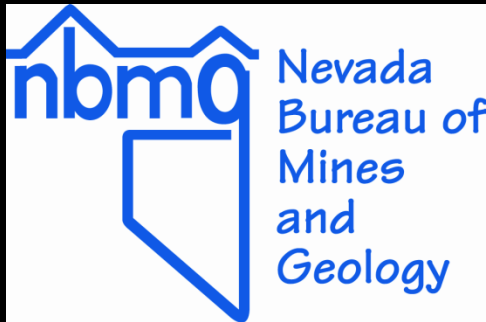
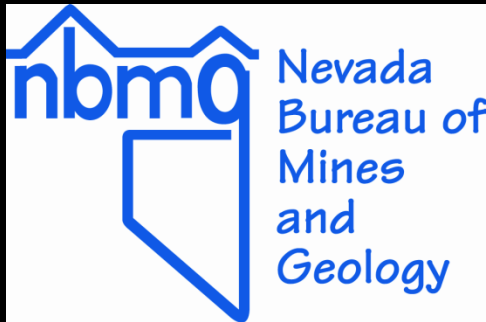


Earthquake Hazards in Lyon County

**Presentation to the Nevada Hazard Mitigation Planning Committee
10 February 2011
by Jonathan G. Price
Nevada Bureau of Mines and Geology**

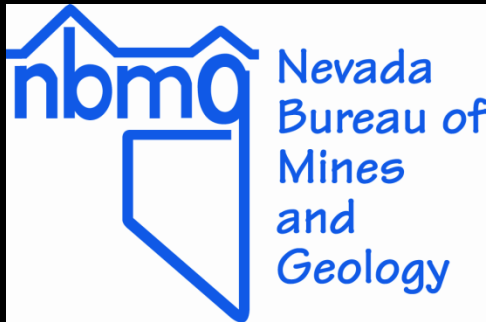


**Earthquake faults occur throughout Nevada,
and potential losses from earthquakes are high
for many communities.**



**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.nbm.unr.edu. You can use it to locate your home
or business.**



Age of Latest Fault Rupture

< 150 years (historical)

< 15,000 years

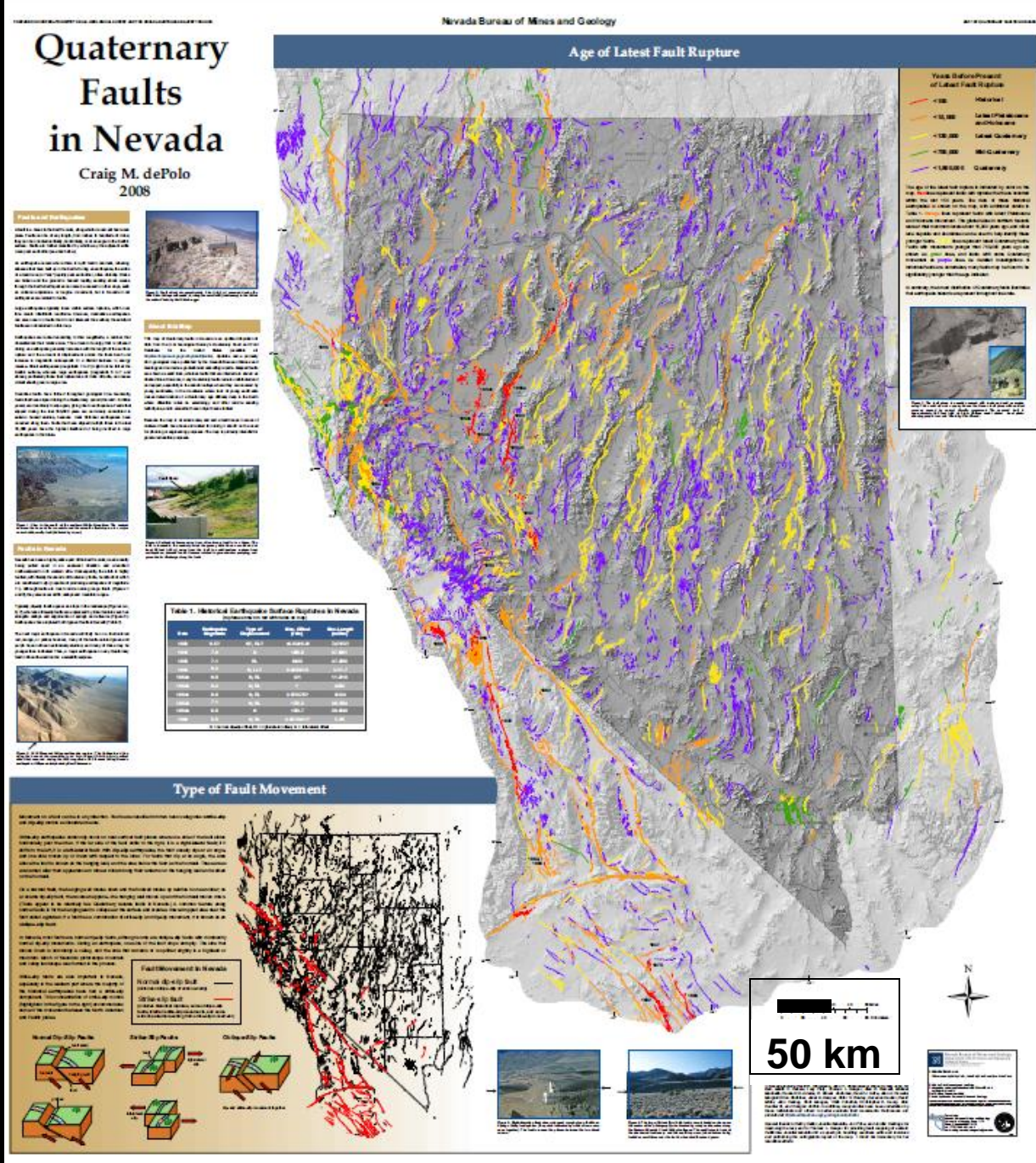
< 130,000 years

< 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.nbmng.unr.edu



Source: *Journal of the American Statistical Association*, 1997, 92, 1031-1042.

Craig M. dePolo
2008



Figure 10. Small village in the mountains. The village is composed of a few small wooden buildings.

[illegible]

Figure 1-2: Aerial view of a steep, eroded hillside. A road runs along the base of the slope, and a small structure is visible on the left. The hillside shows significant erosion and is covered with sparse vegetation.

Year	Intensity (MSK)	Depth (km)
1908	6.5	10
1914	7.0	10
1926	7.0	10

Control	2.7	100.0
Low-dose	2.3	85.2
High-dose	2.3	85.2

0.0001 (ANOVA)

Year	Population (millions)	Type of Government	Per Capita GDP (US\$)	Life Expectancy (years)
1950	2.5	Monarchy	100	45
1960	3.0	Monarchy	150	50
1970	3.5	Monarchy	200	55
1980	4.0	Monarchy	250	60
1990	4.5	Monarchy	300	65
2000	5.0	Monarchy	350	70
2010	5.5	Monarchy	400	75
2020	6.0	Monarchy	450	80
2030	6.5	Monarchy	500	85
2040	7.0	Monarchy	550	90
2050	7.5	Monarchy	600	95
2060	8.0	Monarchy	650	100
2070	8.5	Monarchy	700	105
2080	9.0	Monarchy	750	110
2090	9.5	Monarchy	800	115
2100	10.0	Monarchy	850	120

© 2000 Blackwell Science Ltd *Journal of Internal Medicine* 247: 361–367

Individuals participating in the study were not informed of their phone interviews about research ethics. Consequently, their participation in the last part of the study falls in line with the original idea of a deception research. It is considered a fair trade-off since participants may have otherwise decided not to agree and thus also make up or create false responses to the survey. For better than for evil, this study also collected better data in the long-term survey studies also during the last year of research. Nevertheless, researchers also have a responsibility toward participants that encompasses the long-term benefits of the research.

to identify other factors that may contribute to the development of the disease. The study will also look at the role of the immune system in the disease and the role of the environment in the disease. The study will also look at the role of the immune system in the disease and the role of the environment in the disease.

Product Information: The product is a...

© 2004 Blackwell Publishing Ltd, *Journal of Internal Medicine* 255: 105–112



Years Before Present of Latest Fault Rupture

< 100	Major I
< 10,000	Latest I and II events and Major II
< 100,000	Latest Quaternary
< 700,000	Old Quaternary
< 1,000,000	Quaternary

This type of blood vessel helps to transport oxygenated blood to the rest of the body. **Arteries** have a thick, muscular wall that contracts to pump blood out from the heart. Arteries branch out into smaller blood vessels called **capillaries**, which are the smallest blood vessels in the body. Capillaries are only one cell thick and allow for the exchange of oxygen and nutrients between the blood and the surrounding tissues. Blood flows from the heart through arteries, then through capillaries, and finally through **veins**, which return the blood to the heart. Veins have a thinner wall than arteries and rely on the contraction of the heart and the presence of valves to prevent backflow of blood.



Figure 1. The 1000 photos of a water body in a dry area, showing a large, dark, irregularly shaped area in a dry, hilly landscape. An inset image shows a smaller, more detailed view of the same area, showing a road and some vegetation.



50 km

These authors also found that the use of a single, unidimensional measure of self-esteem was insufficient to capture the complexity of the construct. They argued that self-esteem is a multidimensional construct, and that different measures of self-esteem may capture different aspects of the construct. For example, they found that the use of a single, unidimensional measure of self-esteem was insufficient to capture the complexity of the construct. They argued that self-esteem is a multidimensional construct, and that different measures of self-esteem may capture different aspects of the construct.

[illegible]

Quaternary Faults in Nevada - Online Interactive Map

Look for a fault



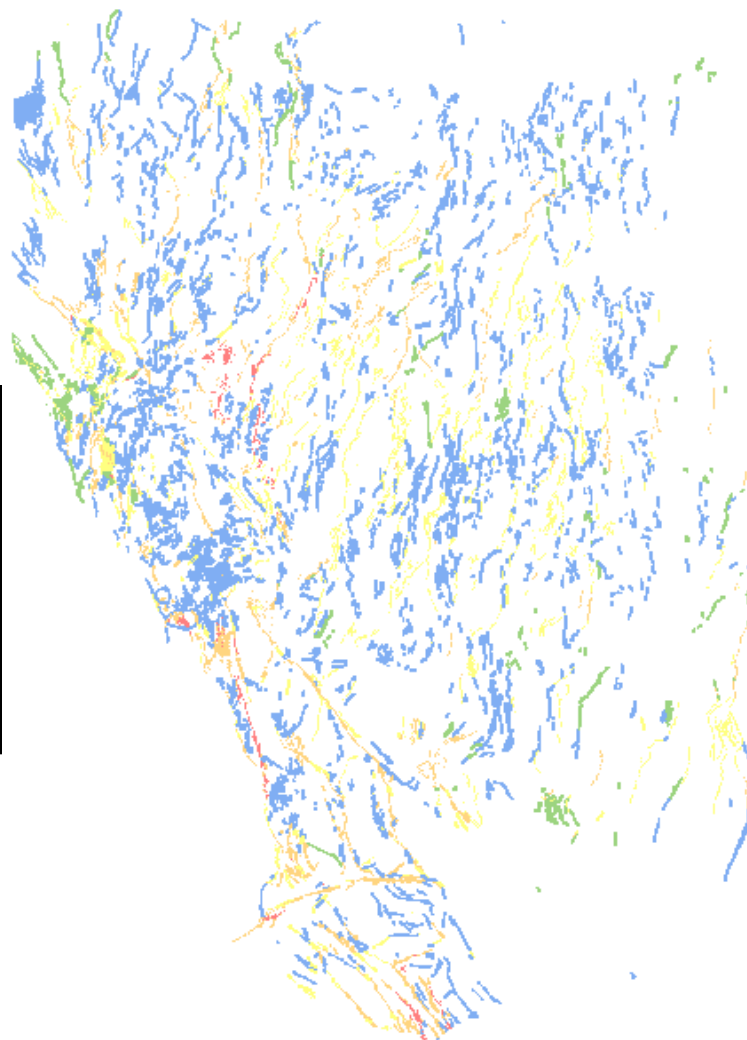
Results

Map Contents

- ☒ 9i10glj_Q_Faults
 - ☒ 500 Meter Fault Buffer
 - ☒ Base Data
- ☐ 9i10glj_TOPO_data
 - ☒ Base Data
- ☐ 9i10glj_NAPS_data
 - ☒ Base Data



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.nbmng.unr.edu.



0 19 38 76 114 152 Miles

Look for a fault **Find an Address** Print a Map

Results

Map Contents

Find an Address

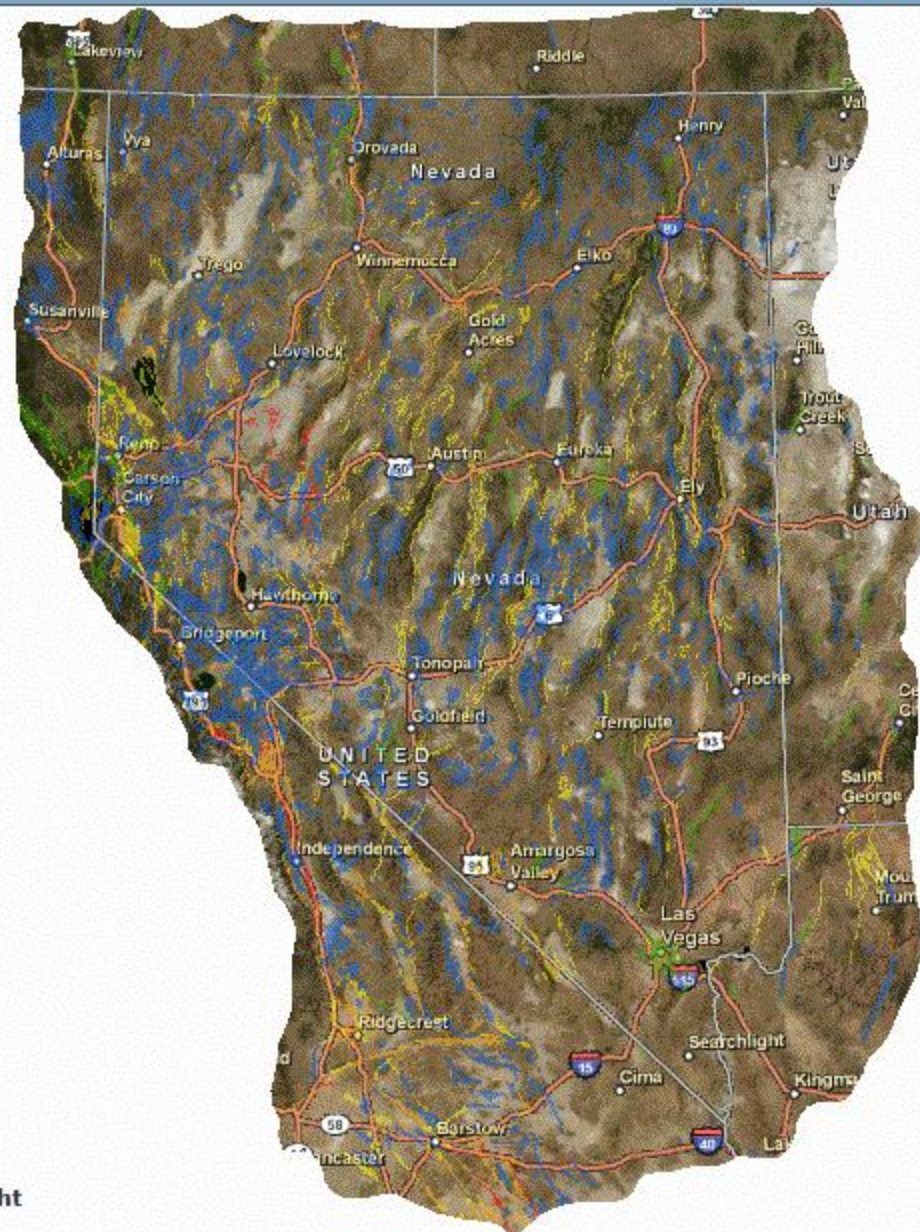
☒ Quaternary
☒ Quaternary
☒ USGS
☒ USGS

Street or Intersection: 27 South Main Street
City: Yerington
State: Nevada
ZIP:

Find

0 18 36 72 108 144 Miles

Copyright



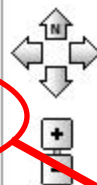
Look for a fault | Find an Address | Print a Map

Results

- ☒ 27 South Main Street, Yerington, Ne
- ☒ 27 S Main St, Yerington, NV, 89447

Map Contents

- ☒ Quaternary_Faults2
 - ☒ Quaternary Faults
 - ☐ USGS Topo Maps
 - ☒ USGS Aerial Imagery



0 18 36 72 108 144 Miles
Copyright



Look for a fault | Find an Address | Print a Map

Results

☒ 27 South Main Street, Yerington, Ne

☒ 27 S Main St, Yerington, NV, 89447

☒ Yerington, NV, 89447

☒ Remove

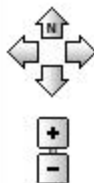
Map Contents

☒ Quaternary_Faults2

☒ Quaternary Faults

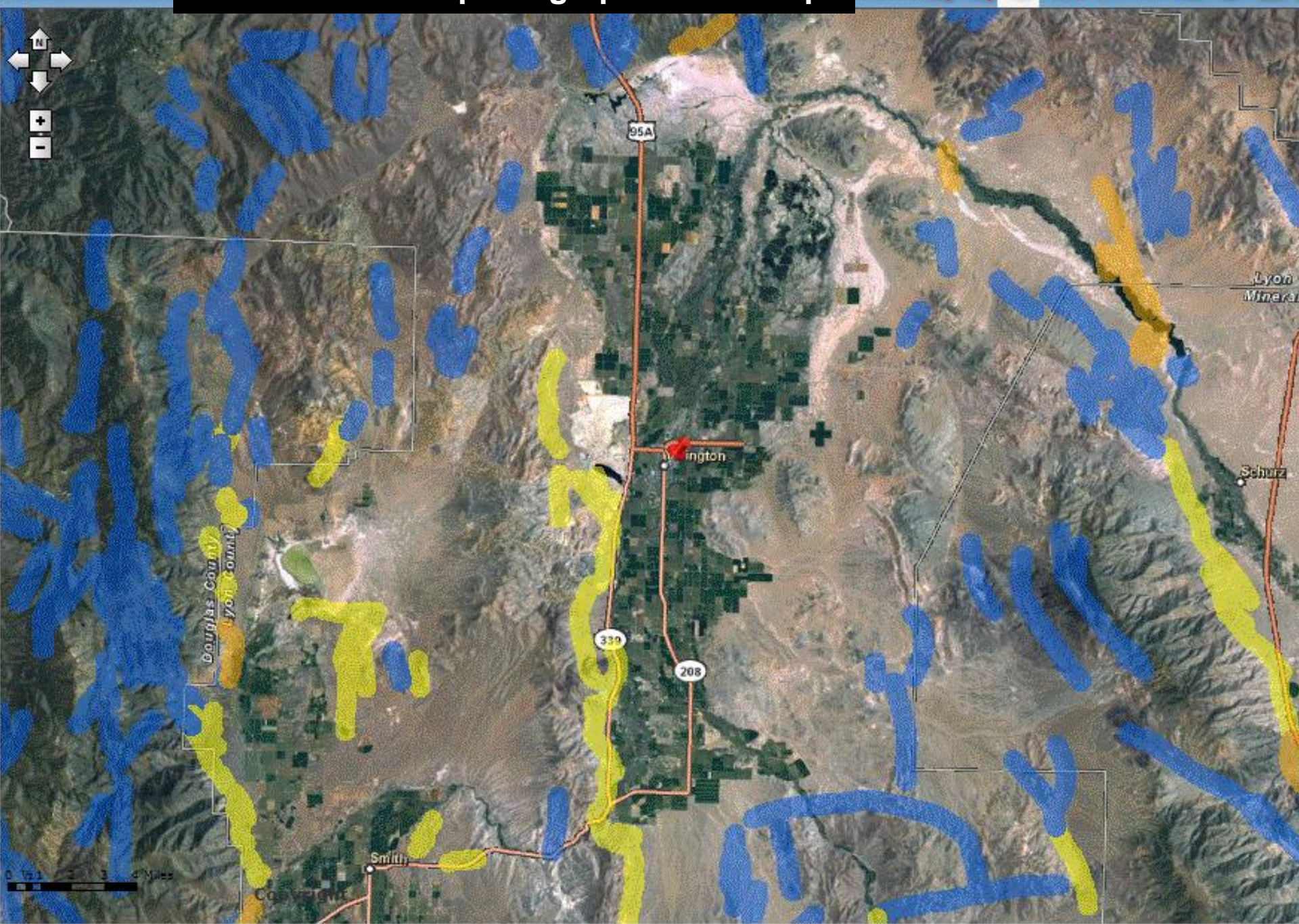
☒ USGS Topo Maps

☒ USGS Aerial Imagery

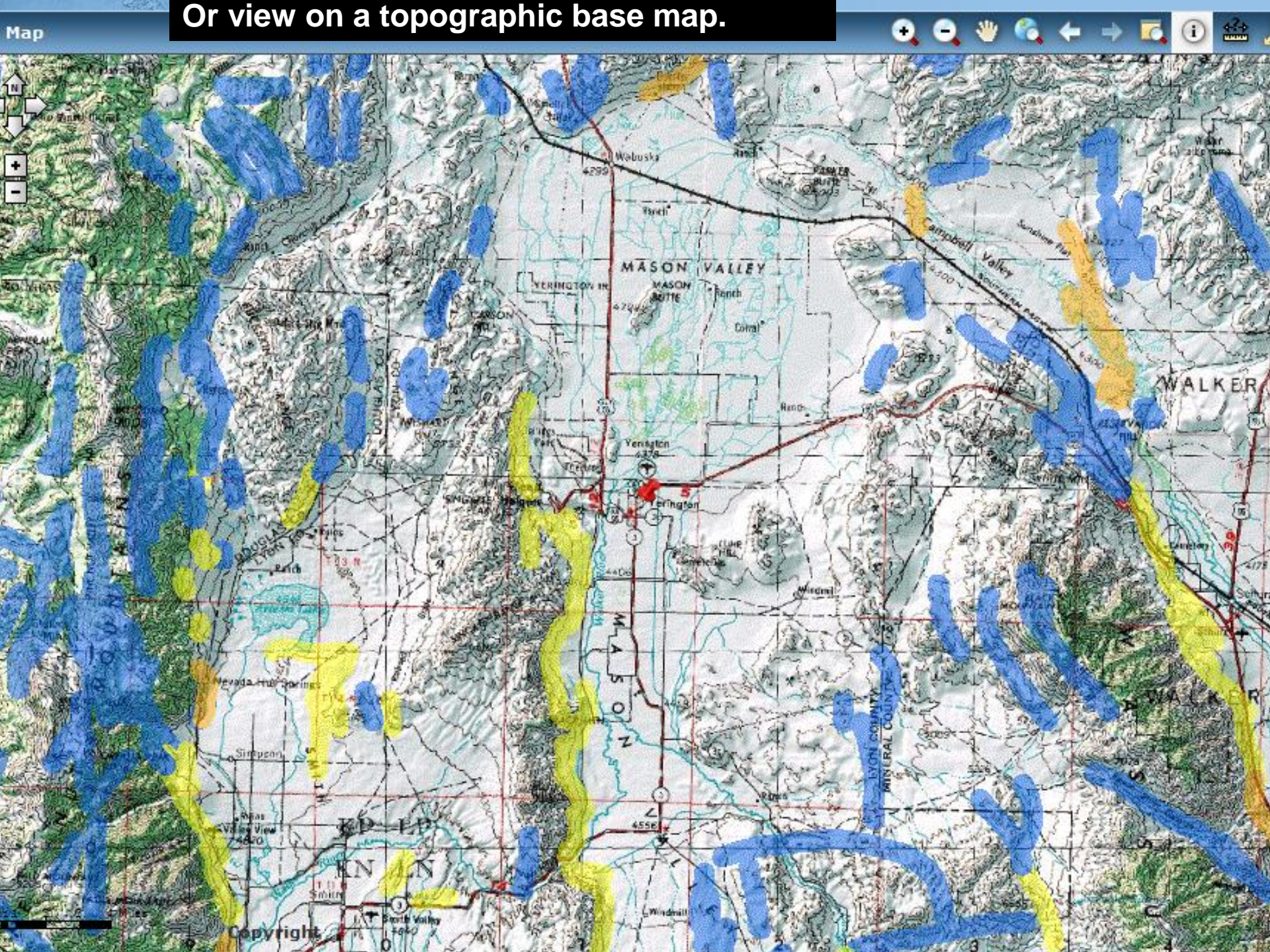


0 18 36 72 108 144 Miles
Copyright

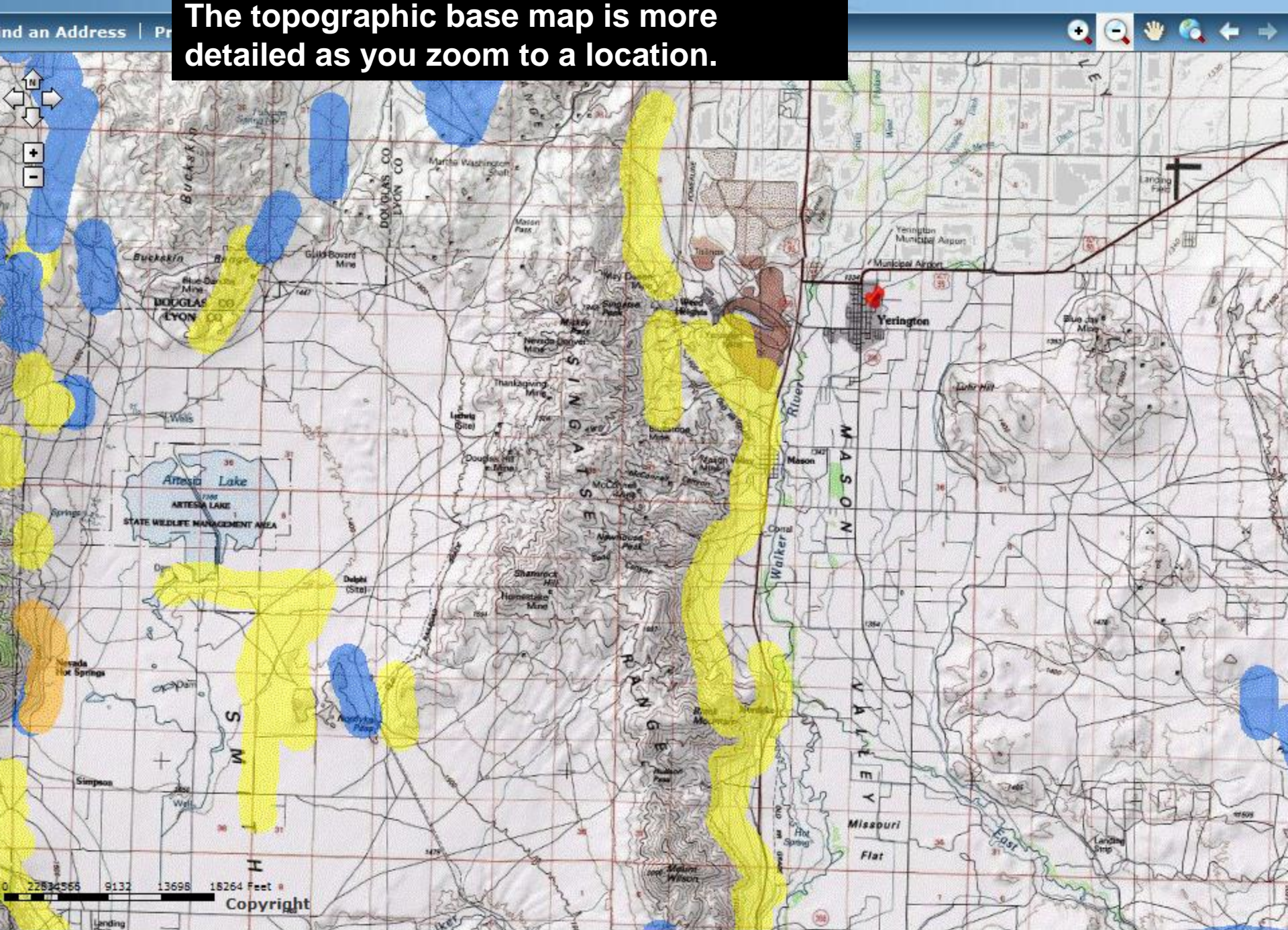




Or view on a topographic base map.



The topographic base map is more detailed as you zoom to a location.



Quaternary Faults in Nevada - Online Interactive Map

Look for a fault | Find an Address | Print a Map

Results

Map Contents

☒ Quaternary_Faults2

☒ Quaternary Faults

☒ Historic - within the

☒ Historic - within the

☒ latest Pleistocene &

☒ latest Pleistocene &

☒ late Quaternary - v

☒ late Quaternary - v

☒ middle Quaternary

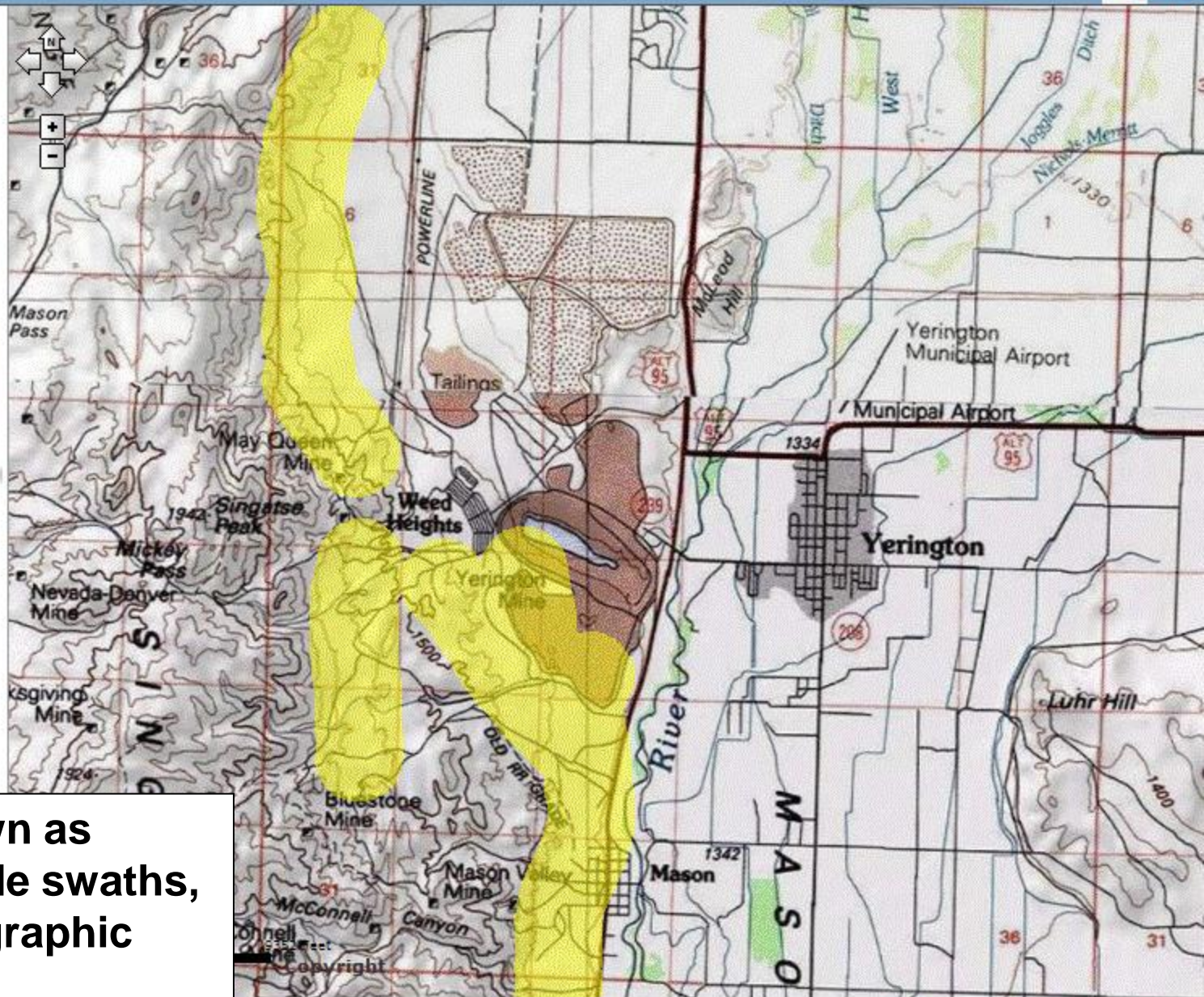
☒ middle Quaternary

☒ Quaternary - withi

☒ Quaternary - withi

☒ USGS Topo Maps

☒ USGS Aerial Imagery

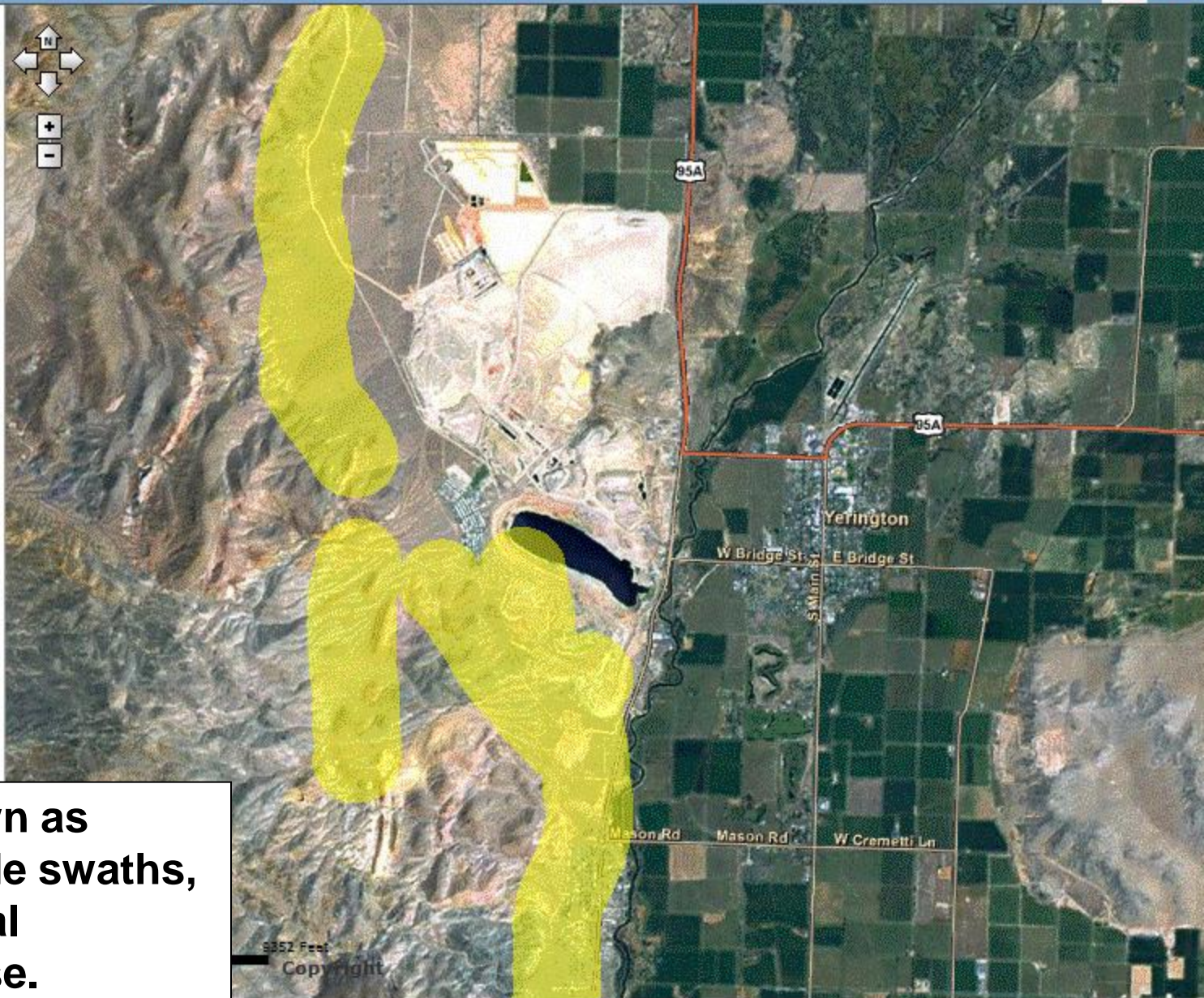


Faults are shown as
1,000-meter-wide swaths,
here on a topographic
map base.

Quaternary Faults in Nevada - Online Interactive Map

Look for a fault | Find an Address | Print a Map

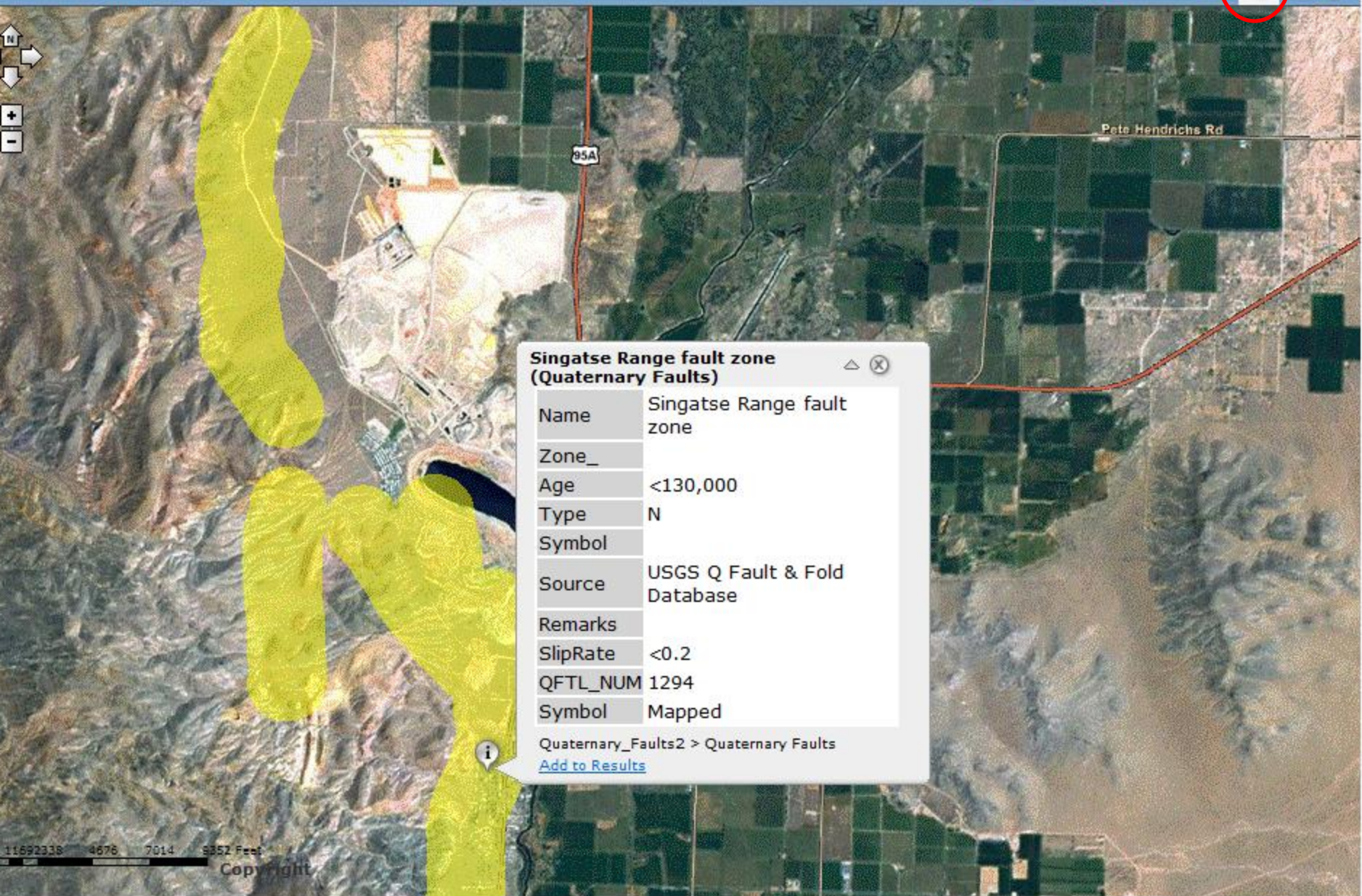
- Results ▾
- Map Contents ▴
- ☒ Quaternary_Faults2
 - ☒ Quaternary Faults
 - Historic - within the
 - Historic - within the
 - latest Pleistocene &
 - latest Pleistocene &
 - late Quaternary - v
 - late Quaternary - v
 - middle Quaternary
 - middle Quaternary
 - Quaternary - withir
 - Quaternary - withir
 - ☐ USGS Topo Maps
 - ☒ USGS Aerial Imagery



Faults are shown as
1,000-meter-wide swaths,
here on an aerial
photograph base.

Easy to get information about faults

Print a Map



Singatse Range fault zone (Quaternary Faults)

Name	Singatse Range fault zone
Zone_	
Age	<130,000
Type	N
Symbol	
Source	USGS Q Fault & Fold Database
Remarks	
SlipRate	<0.2
QFTL_NUM	1294
Symbol	Mapped

Quaternary_Faults2 > Quaternary Faults
[Add to Results](#)

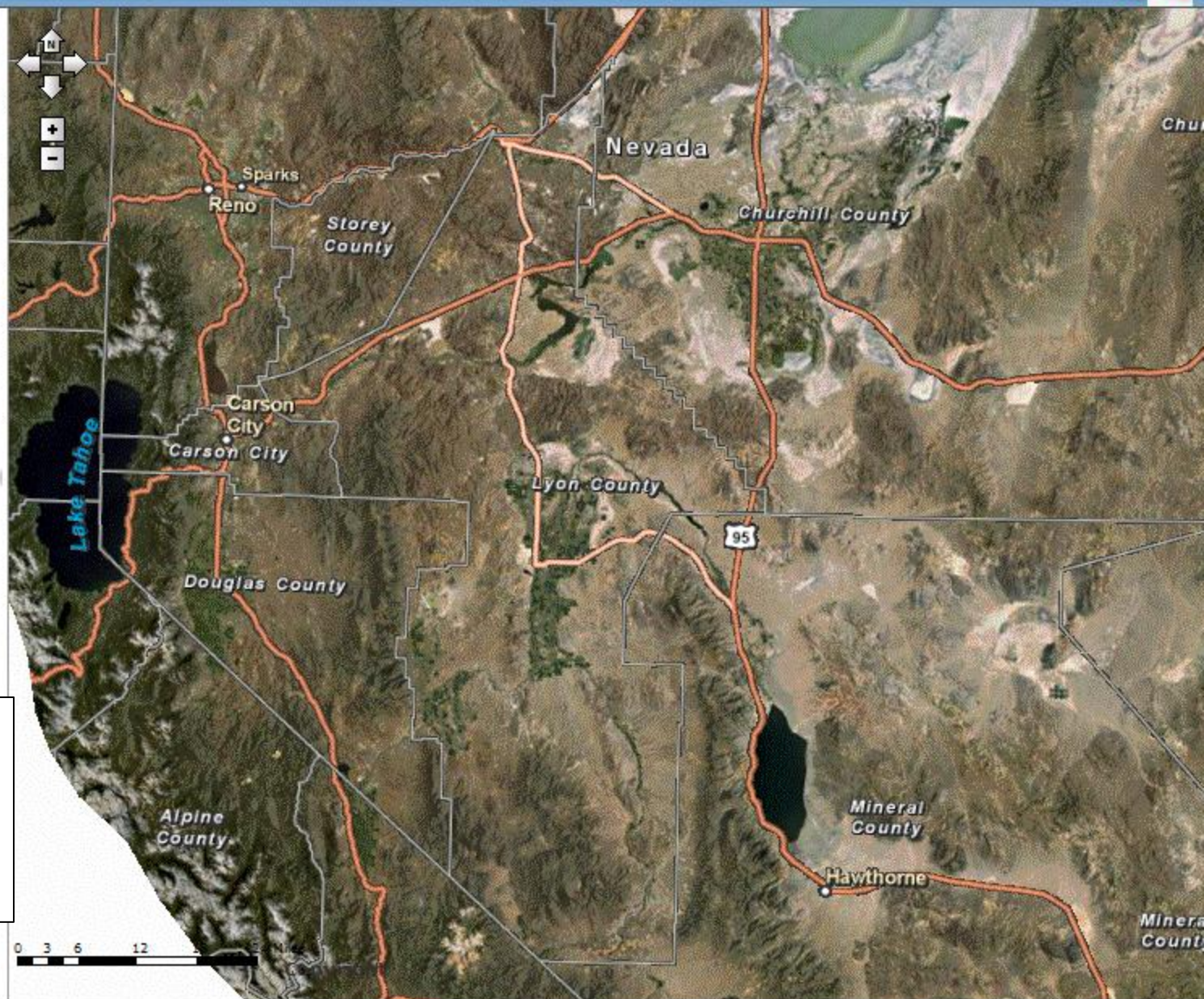
Quaternary Faults in Nevada - Online Interactive Map

Look for a fault | Find an Address | Print a Map

Results

Map Contents

- ☒ Quaternary_Faults2
 - ☐ Quaternary Faults
 - ☐ USGS Topo Maps
 - ☒ USGS Aerial Imagery



(1) Active faults occur nearly everywhere in Nevada, including Lyon County.

Quaternary Faults in Nevada - Online Interactive Map

Look for a fault | Find an Address | Print a Map

Results

Map Contents

☒ Quaternary_Faults2

☒ Quaternary Faults

☒ Historic - within the

☒ Historic - within the

☒ latest Pleistocene &

☒ latest Pleistocene &

☒ late Quaternary - v

☒ late Quaternary - v

☒ middle Quaternary

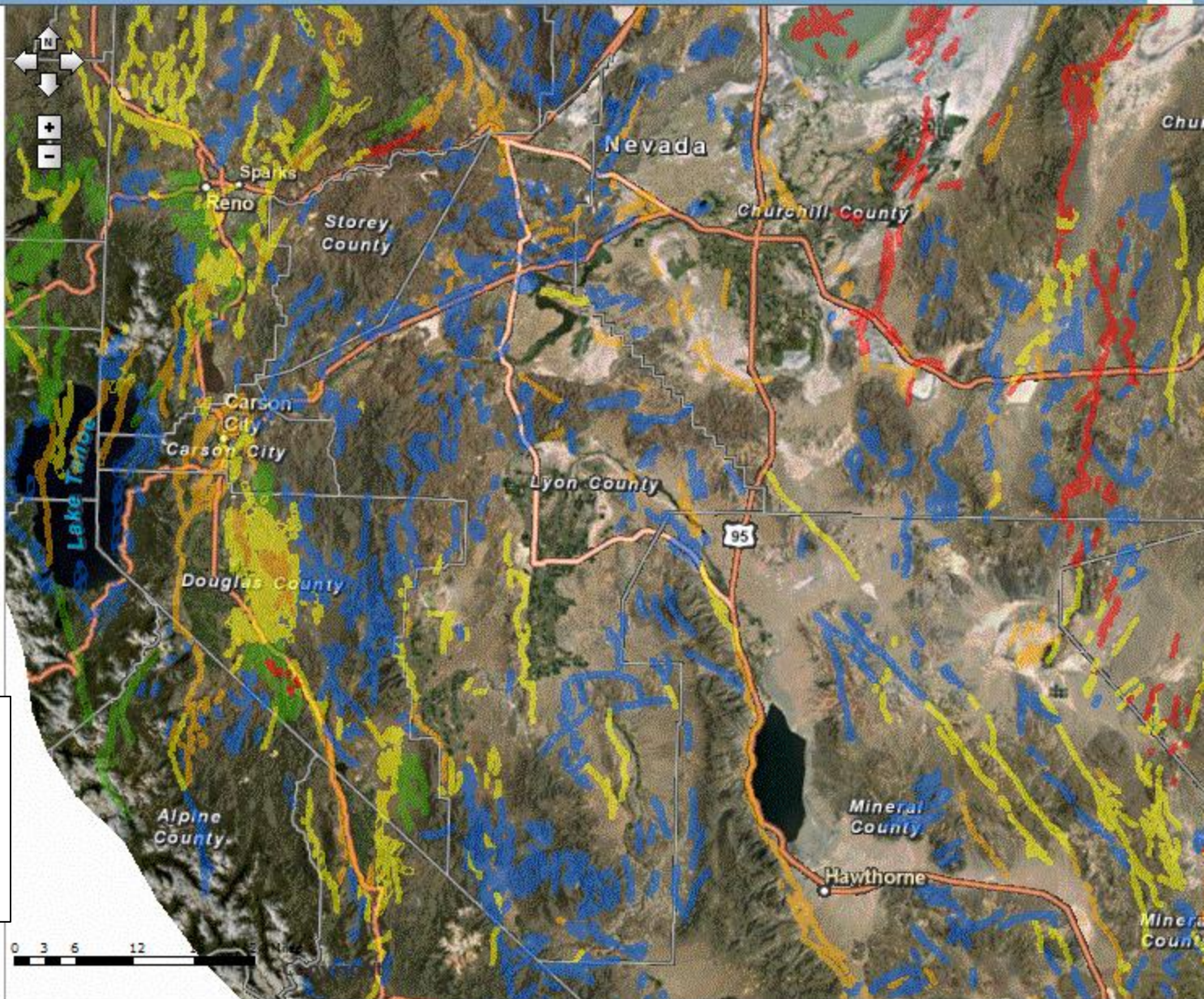
☒ middle Quaternary

☒ Quaternary - withir

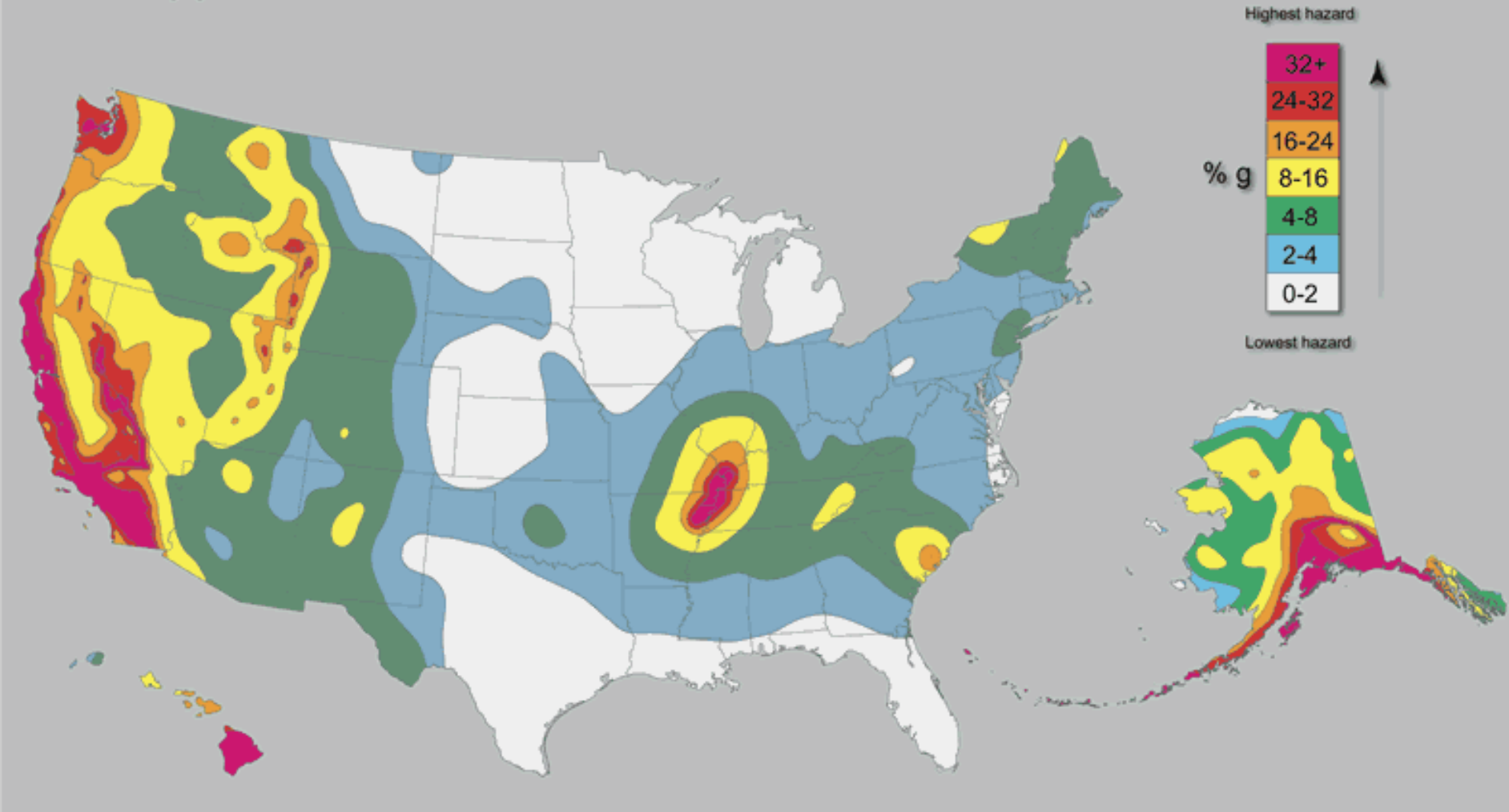
☒ Quaternary - withir

☒ USGS Topo Maps

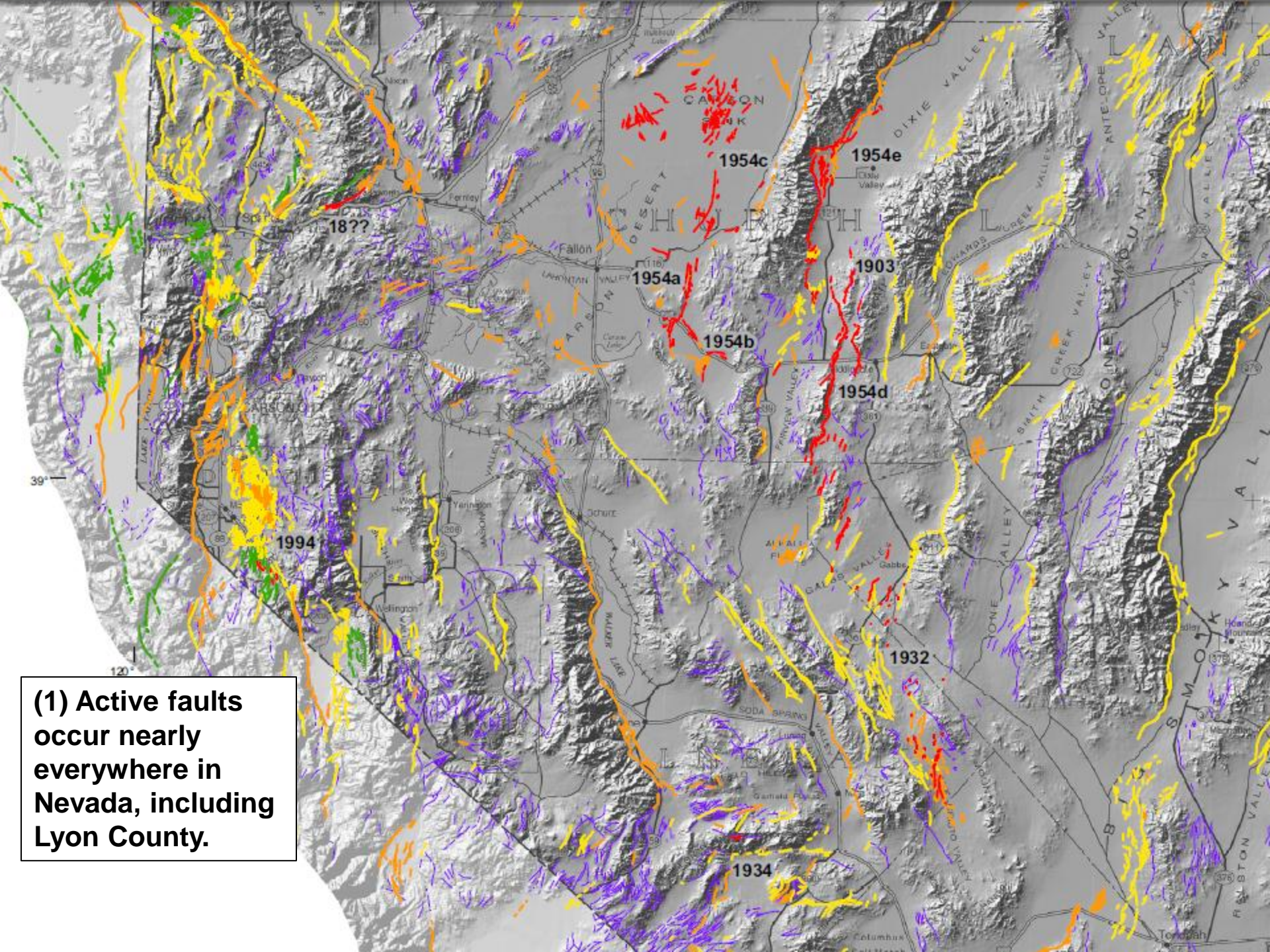
☒ USGS Aerial Imagery



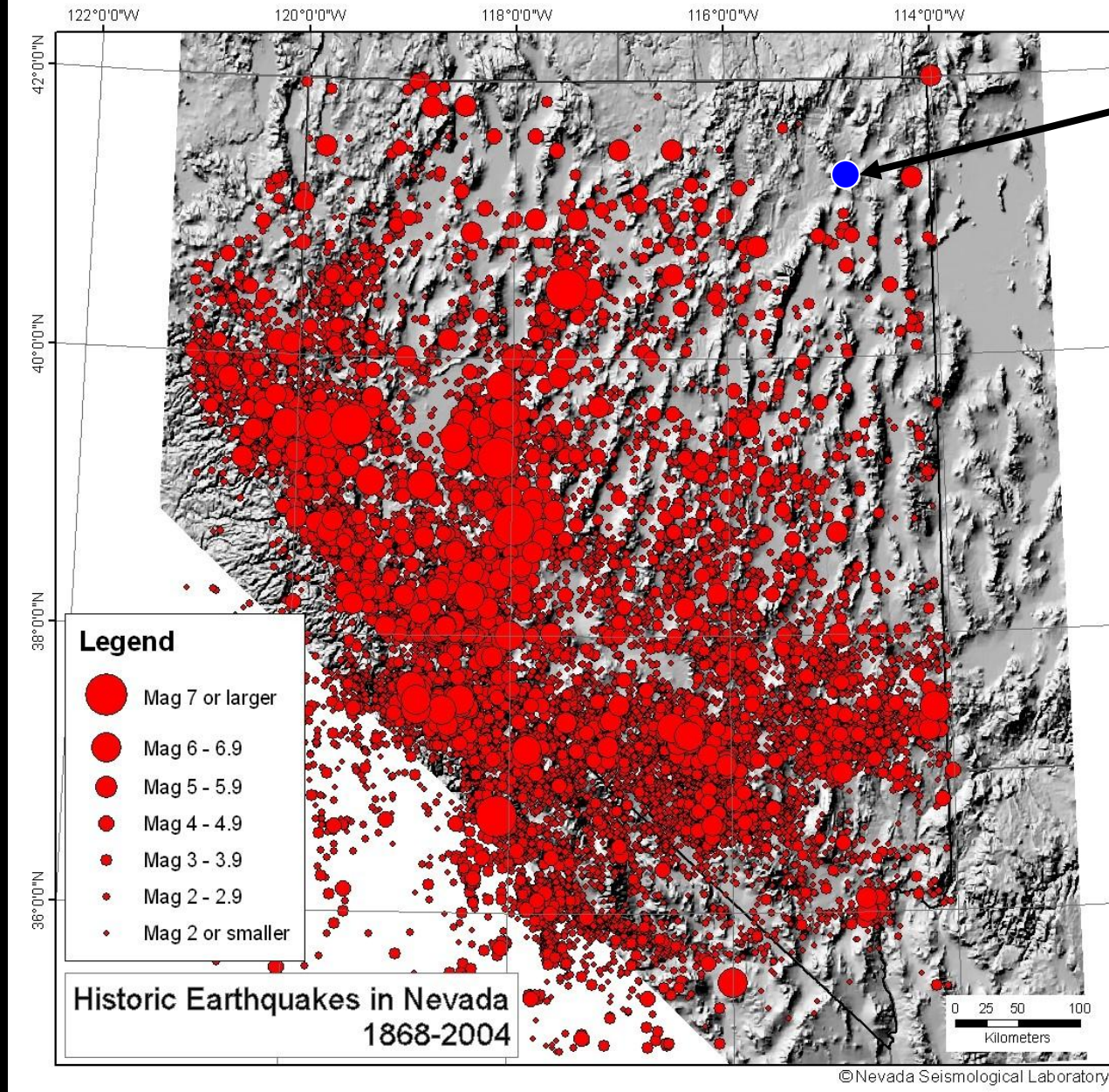
(1) Active faults occur nearly everywhere in Nevada, including Lyon County.



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 Lyon County.



Wells
21 Feb 08
M = 6.0

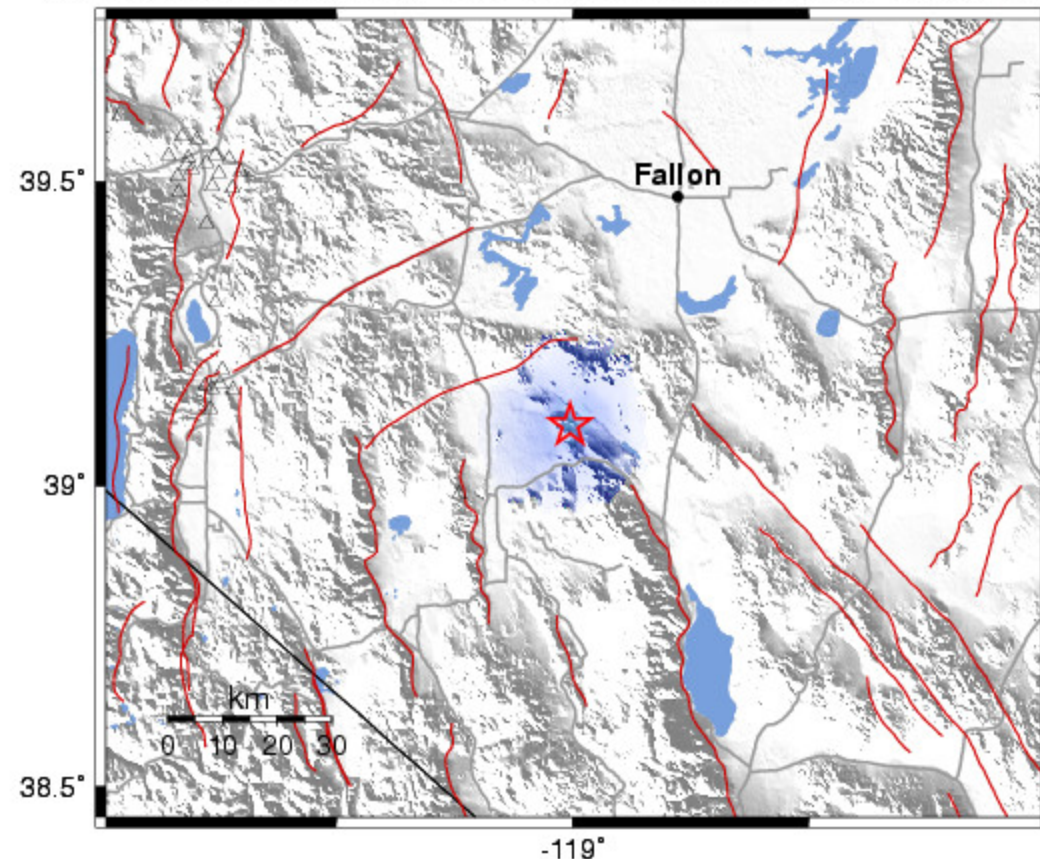
(2) Earthquakes have occurred throughout Nevada.

Large Historical Earthquakes near Lyon County

<u>Date</u>	<u>Magnitude</u>	<u>Near</u>
1852?	7.3	Fallon
1932	7.1	Cedar Mtn.
July 6, 1954 (a)	6.6	Rainbow Mtn.
11 hours later (b)	6.0	Fourmile Flat
August 24, 1954 (c)	6.8	Stillwater
December 16, 1954 (d)	7.1	Fairview Peak
4 minutes later (e)	6.8	Dixie Valley
March 23, 1959	6.3	Dixie Valley
1994	5.8	Double Spring Flat

NSL ShakeMap : 11.8 miles NE of YERINGTON-NV

Thu Apr 28, 2005 01:27:15 PM PDT M 3.2 N39.10 W119.01 Depth: 5.2km ID:2005118_137502

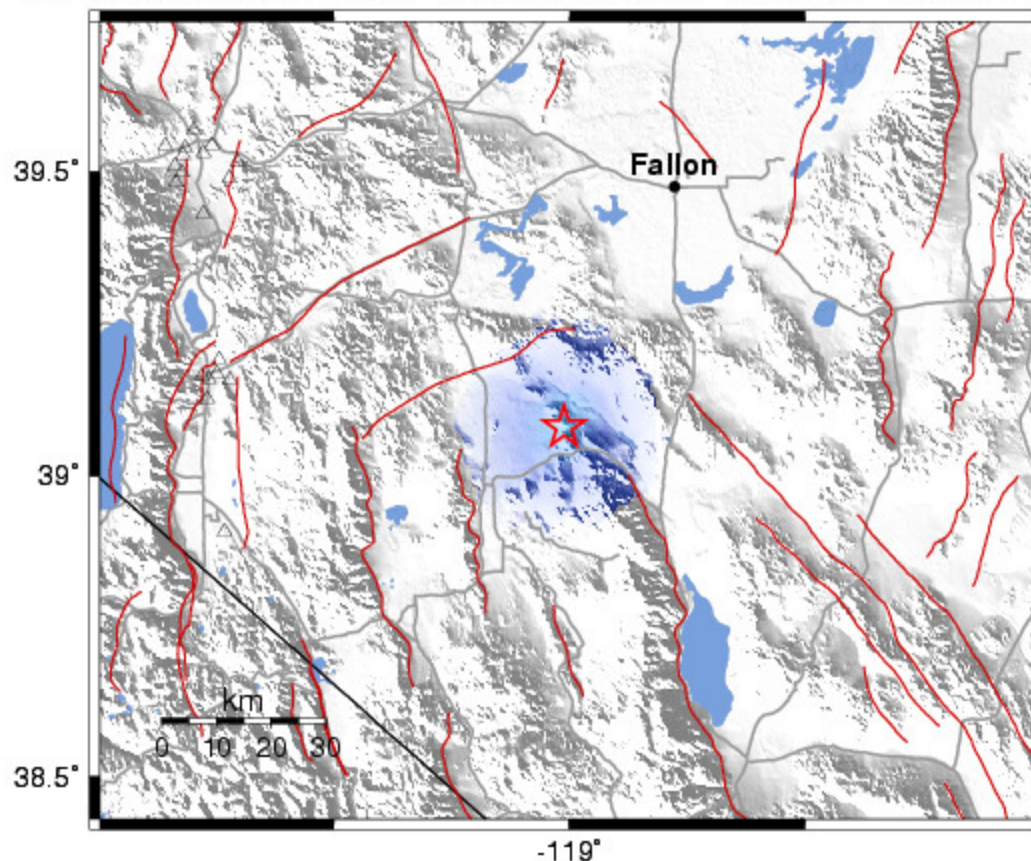


Map Version 6 Processed Tue Dec 12, 2006 08:51:22 PM PST.

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 : 10.6 miles NE of YERINGTON-NV

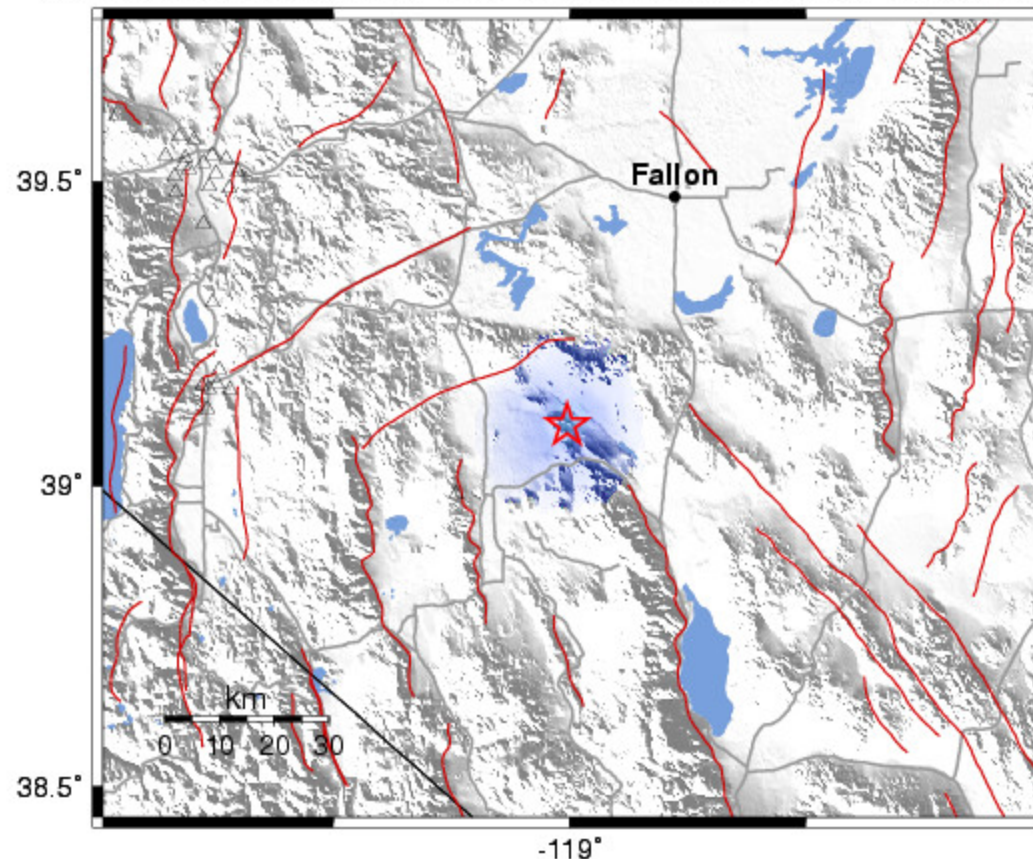
Mon Nov 28, 2005 08:45:41 PM PST M 3.6 N39.08 W119.01 Depth: 6.1km ID:2005333_169321



Map Version 8 Processed Tue Dec 12, 2006 09:05:42 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 : 11.8 miles NE of YERINGTON-NV
Thu Apr 28, 2005 01:27:15 PM PDT M 3.2 N39.10 W119.01 Depth: 5.2km ID:2005118_137502

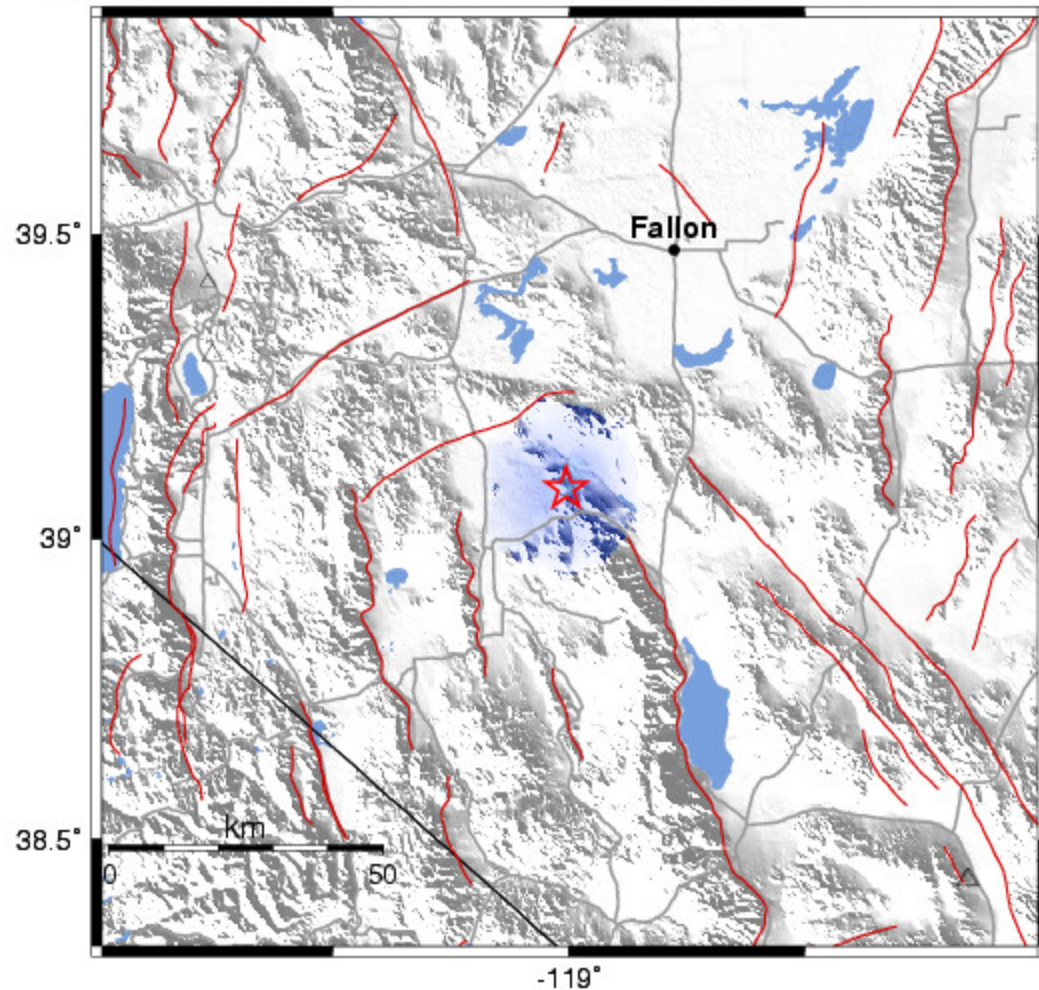


Map Version 6 Processed Tue Dec 12, 2006 08:51:22 PM PST.

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+

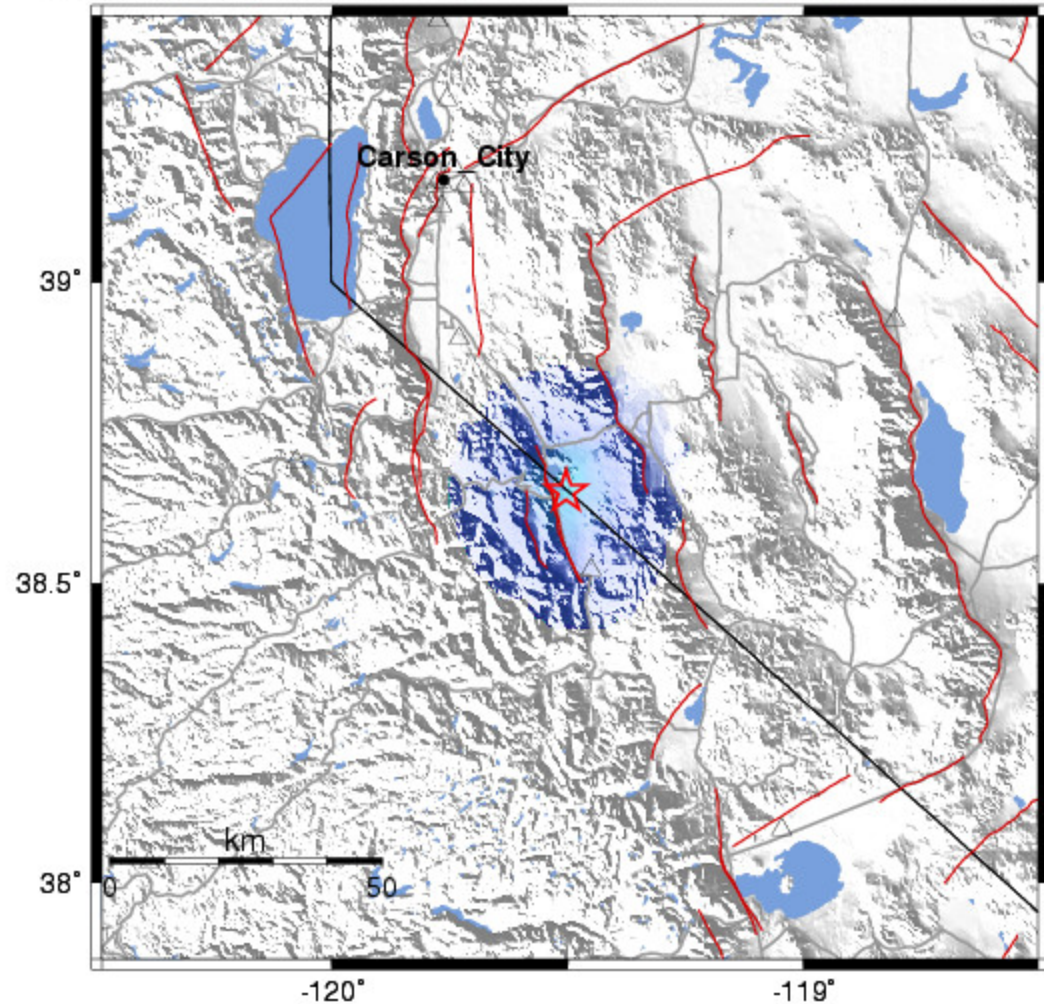
NSL ShakeMap : 10.9 miles NE of YERINGTON-NV

Wed Apr 5, 2006 05:03:16 AM PDT M 3.4 N39.08 W119.01 Depth: 4.9km ID:2006095_178608



Map Version 7 Processed Wed Mar 7, 2007 01:17:51 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+

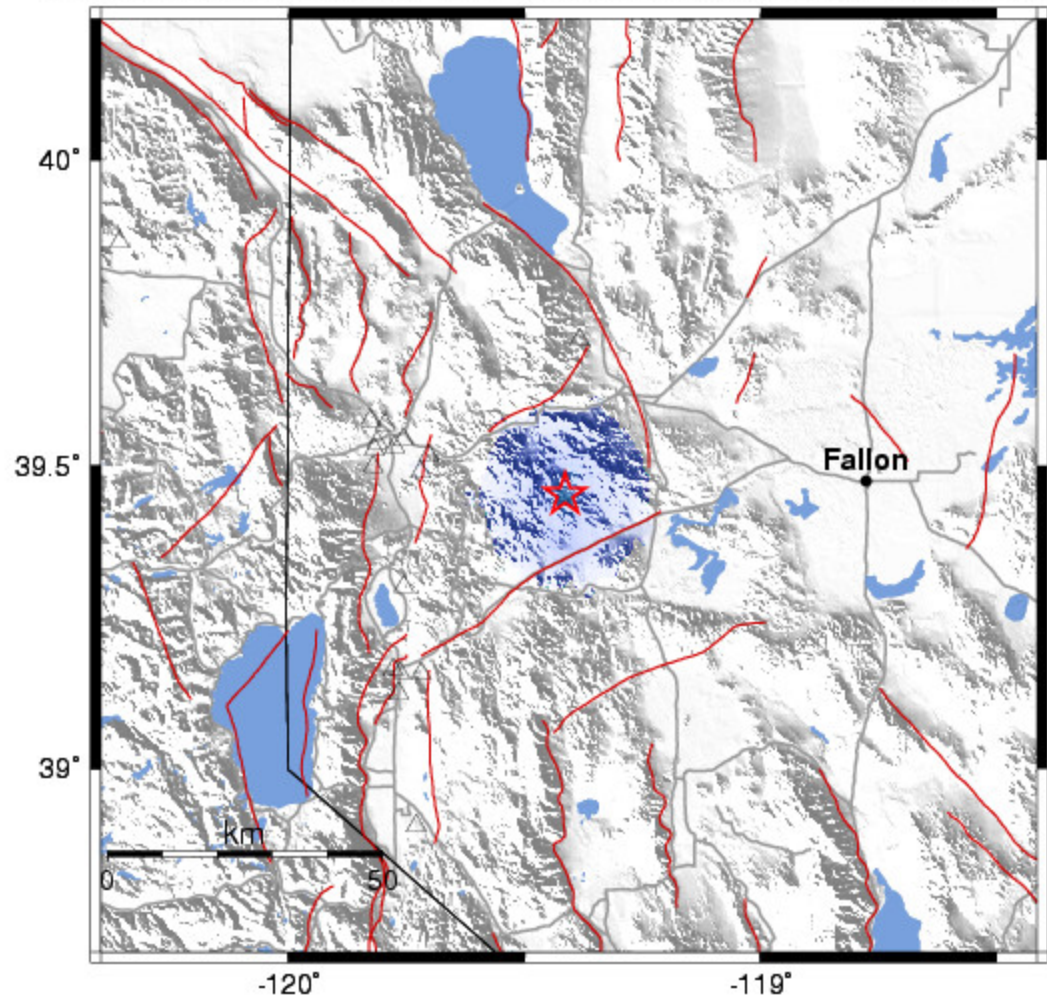


Map Version 1 Processed Thu Apr 19, 2007 08:44:48 PM PDT, - NOT REVIEWED BY HUMAN

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+

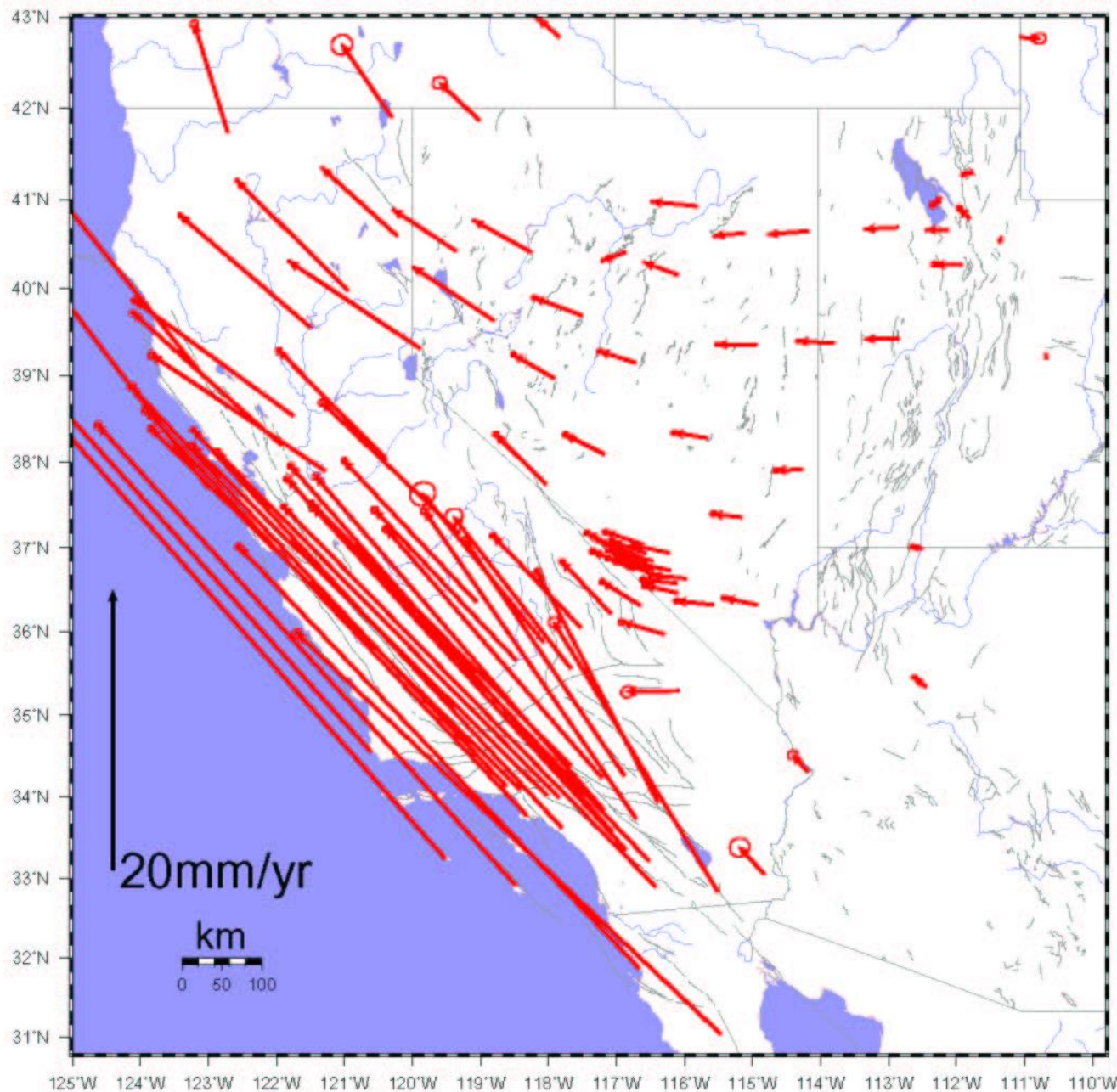
NSL ShakeMap : 13.7 miles SW of FERNLEY-NV

Sun Oct 26, 2008 09:41:46 PM PST M 3.5 N39.45 W119.41 Depth: 8.6km ID:2008301_263795



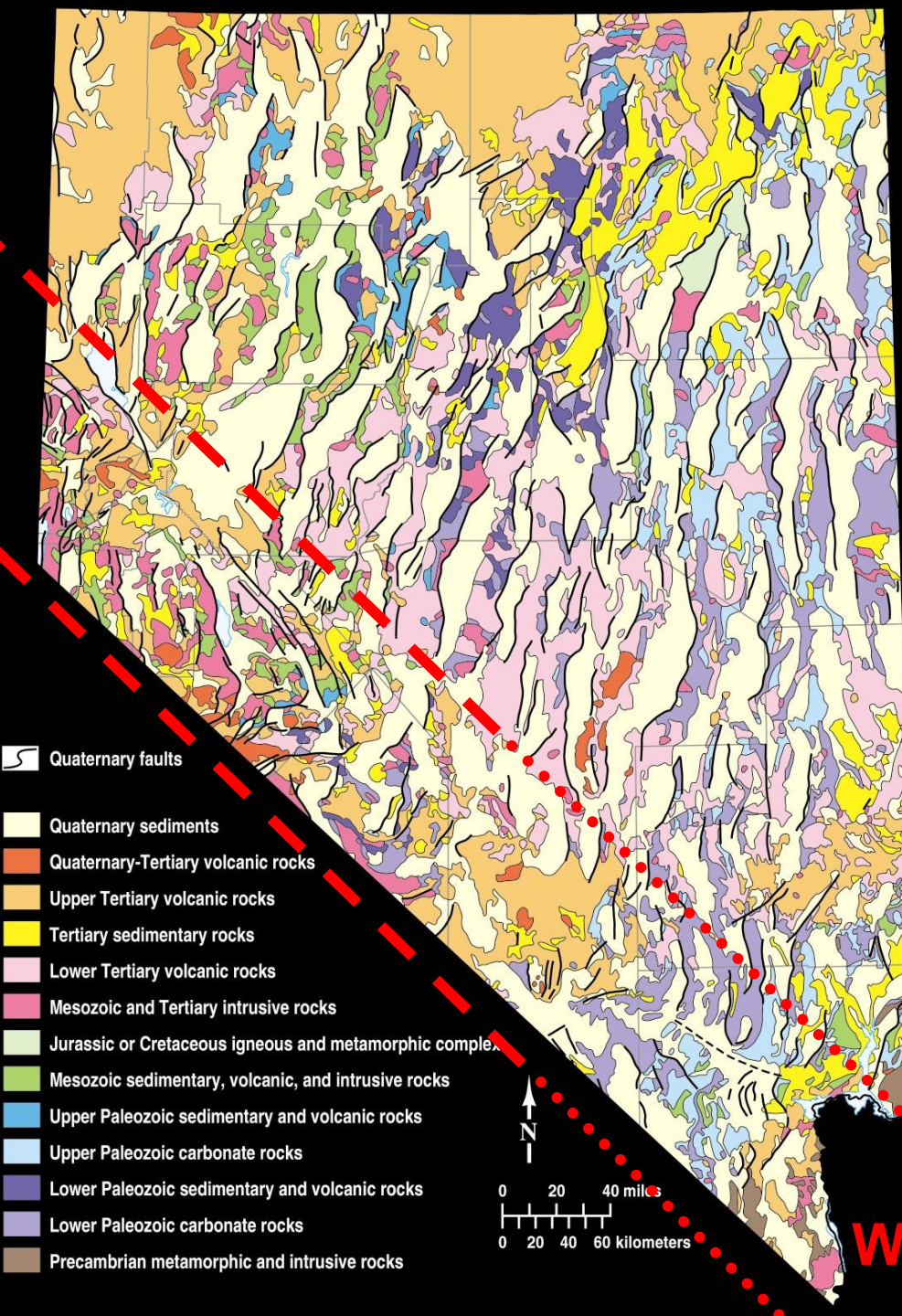
Map Version 1 Processed Mon Oct 27, 2008 10:51:01 AM PST, - NOT REVIEWED BY HUMAN

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)

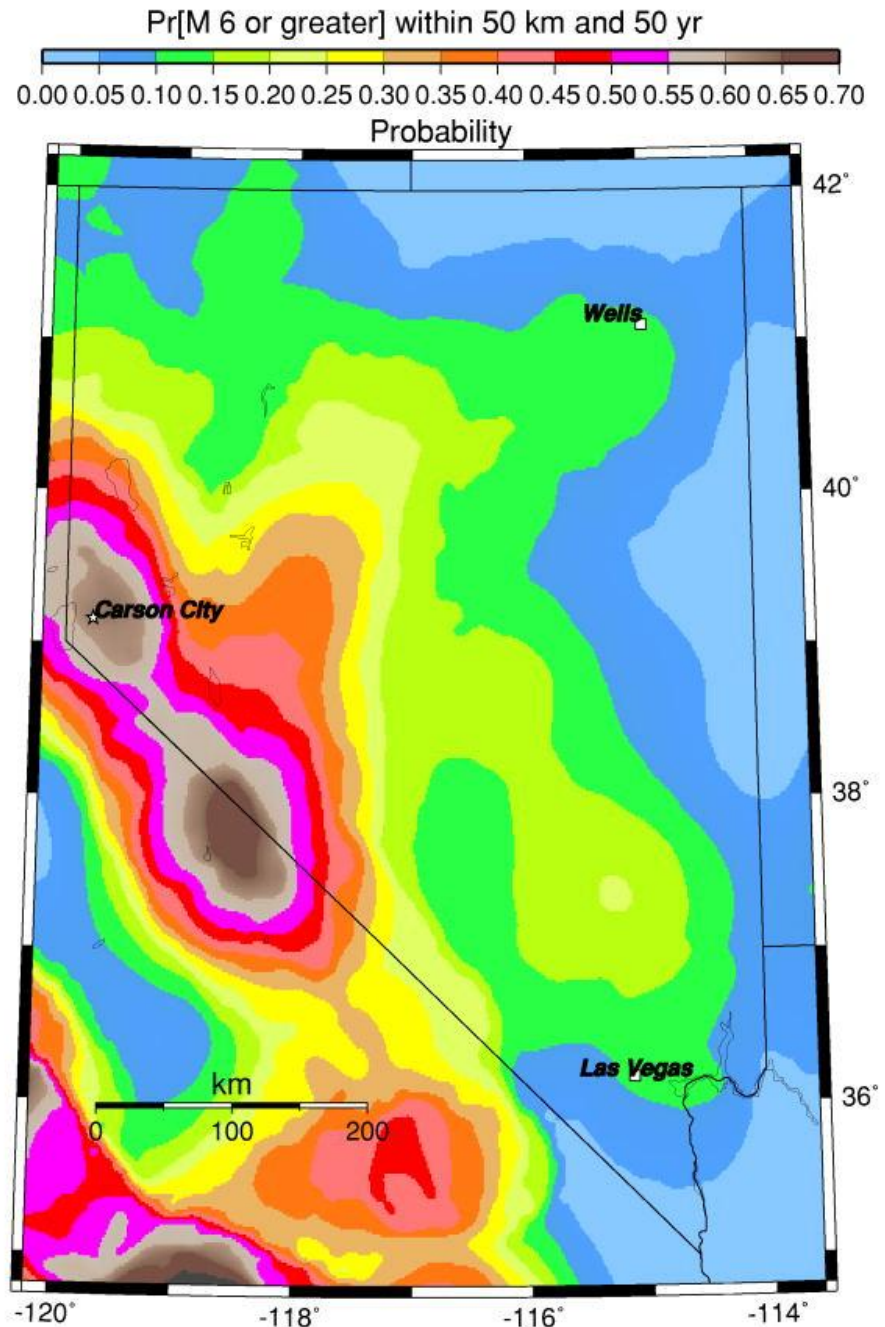


In Nevada, much of the right-lateral shear between the North American and Pacific plates occurs along northwest-striking strike-slip faults of the Walker Lane.

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

Walker Lane

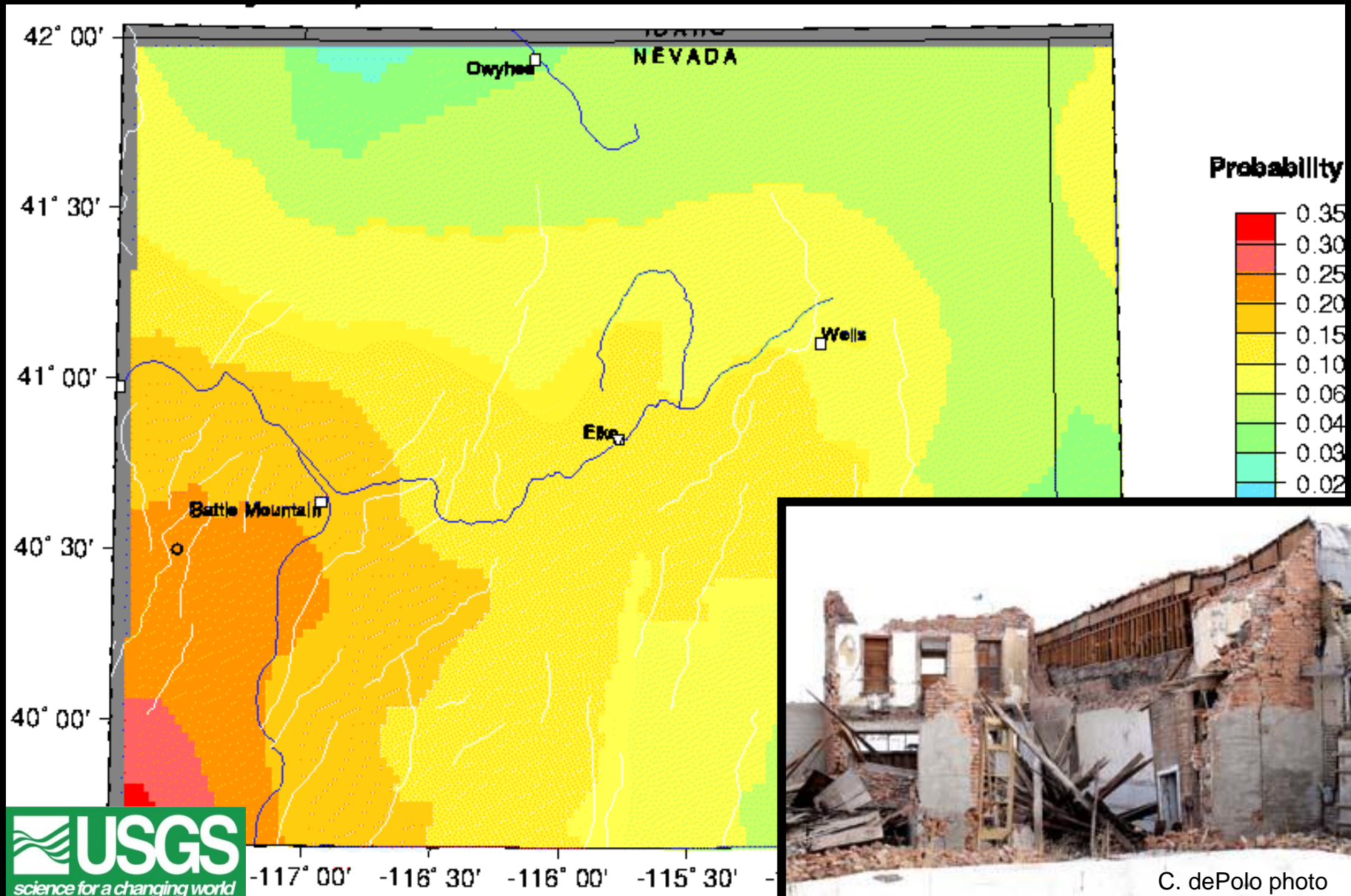
The U.S. Geological Survey integrates our geologic, seismic, and geodetic observations to create a probabilistic seismic hazard analysis, which is used in the International Building Code.



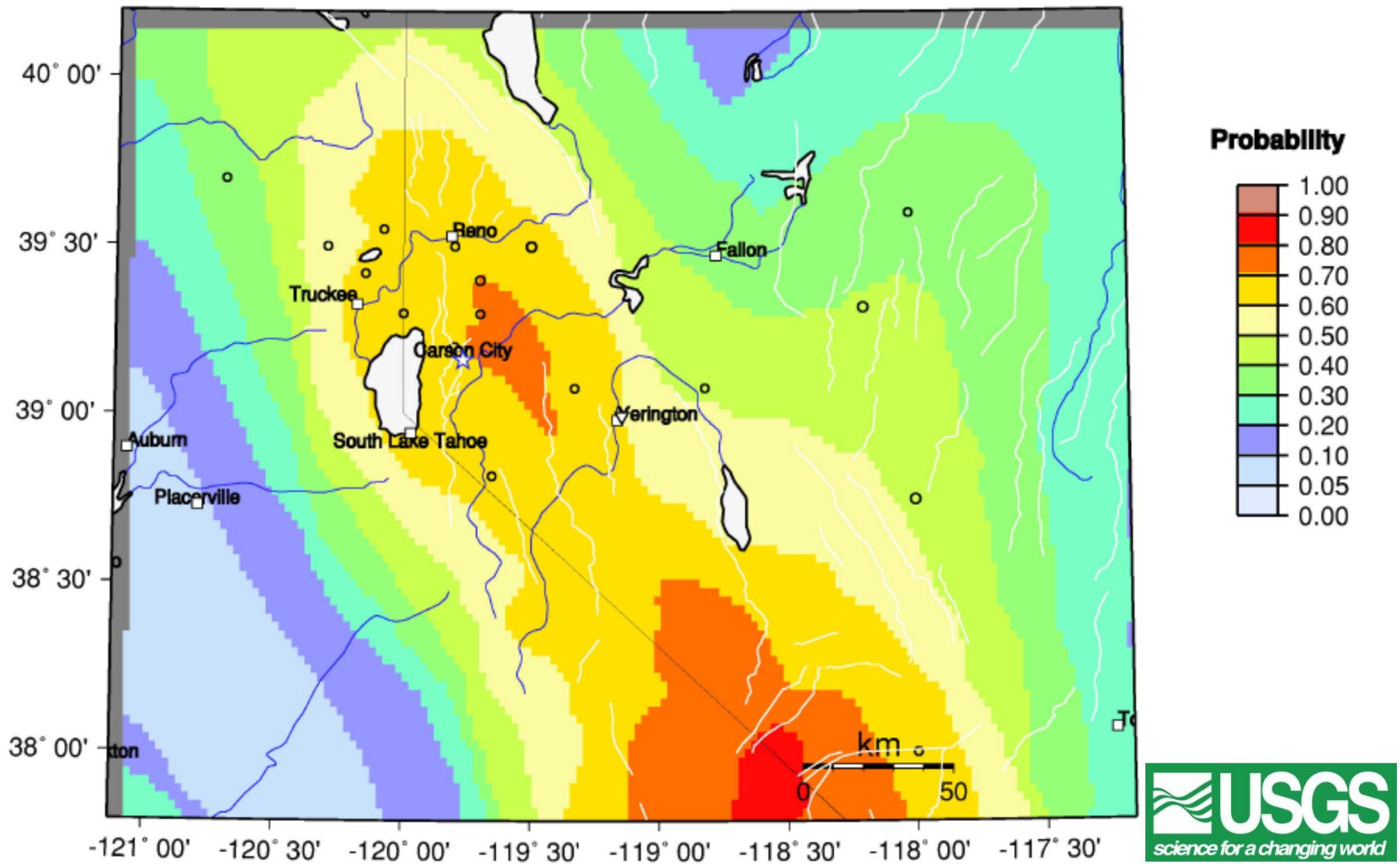
University of Nevada, Reno
Statewide • Worldwide



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.



The probability of a magnitude 6.0 earthquake occurring within 50 km of Yerington within the next 50 years is approximately 60%, considerably higher than for Wells.



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.

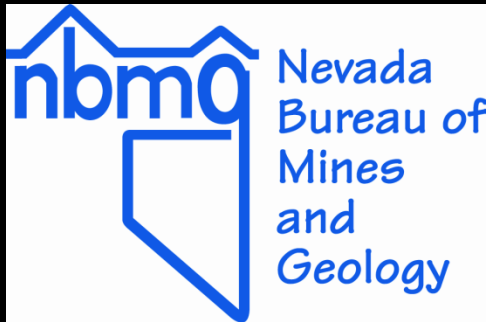
Community	% Probability of magnitude greater than or equal to magnitude				
	5.0	5.5	6.0	6.5	7.0
Dayton	>90	~80	70-75	50-55	15-18
Carson City	>90	~80	70	50-55	12-15
Reno	>90	~80	67	50	12-15
Yerington	>90	~75	60	40-45	12
Silver Springs	>90	~70	50-60	30-40	10-12
Fernley	90	~70	48	35	8
Las Vegas	40-50	~30	12	4-5	<0.5
Elko	30-40	~25	10-15	6-8	0.5-1
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 extrapolated between 5.0 and 6.0.

So what?

Who cares?

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.

INCIDENT NAME - VIGILANT GUARD ^{TIME} 0600
7.1 MAGNITUDE EARTHQUAKE
INITIAL DAMAGE REPORT -
COLLEGE DORMITORY COLLAPSE w/ VICTIMS
LABORATORY / CHEMICAL FACILITY COLLAPSE w/ VICTIMS
INCIDENT COMMAND - RENO FIRE DEPT.
RESOURCES - RENO FD USE, ^{ON SCENE}
NEVADA TASK FORCE 1 - LAS VEGAS
REMSA, SPARKS PD,
REQUESTED - 92ND CIVIL SUPPORT TEAM - NATIONAL GUARD
LAS VEGAS
NATIONAL GUARD BATTALIONS + RESOURCES
FROM CALIFORNIA, HAWAII, ARIZONA,
UTAH, IDAHO, WASHINGTON STATE
INITIAL REPORT -
DAMAGE ALSO REPORTED - CARSON CITY, CHURCHILL CO.
LYON COUNTY, DOUGLAS COUNTY
STONEY SE - VIRGINIA CITY +
INDUSTRIAL DISTRICT
AFTERSHOCKS POSSIBLE -



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.

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).

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%
Dayton	\$340 million	70-75%
Elko	\$160 million	10 to 15%
Fernley	\$62 million	48%
Silver Springs	\$60 million	50-60%
Yerington	\$56 million	60%
Wells	\$30 million	9%

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

A topographic map of the Great Salt Lake region, showing various valleys and mountain ranges. The map is overlaid with numerous colored lines representing seismic hazard zones. These lines are primarily yellow, orange, and red, indicating areas of higher seismic risk. Some areas are marked with purple lines. The map includes labels for various locations such as Nixon, Dayton, Silver Springs, Yerington, and Fallon. It also shows major roads and geographical features like Lake Tahoe and Lake Mead. The map is oriented with North at the top.

Fernley, \$62 million

Dayton, \$340 million

Silver Springs, \$60 million

Yerington, \$56 million

**Estimated losses
from a magnitude
6.0 earthquake on
the fault closest to
the town.**

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

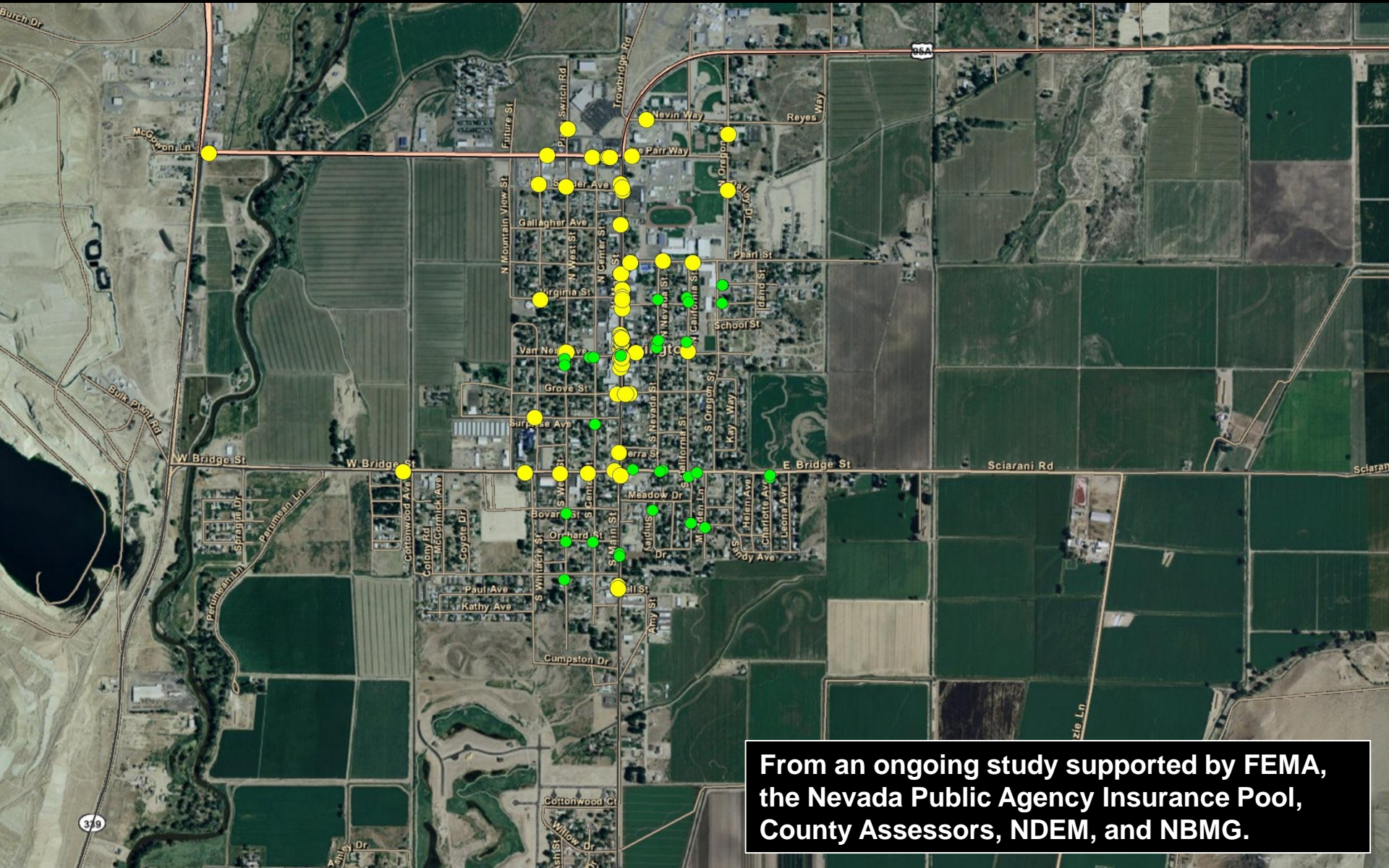


View from front, 20 May 2009

Some possible URM's in Yerington

● Commercial

● Residential

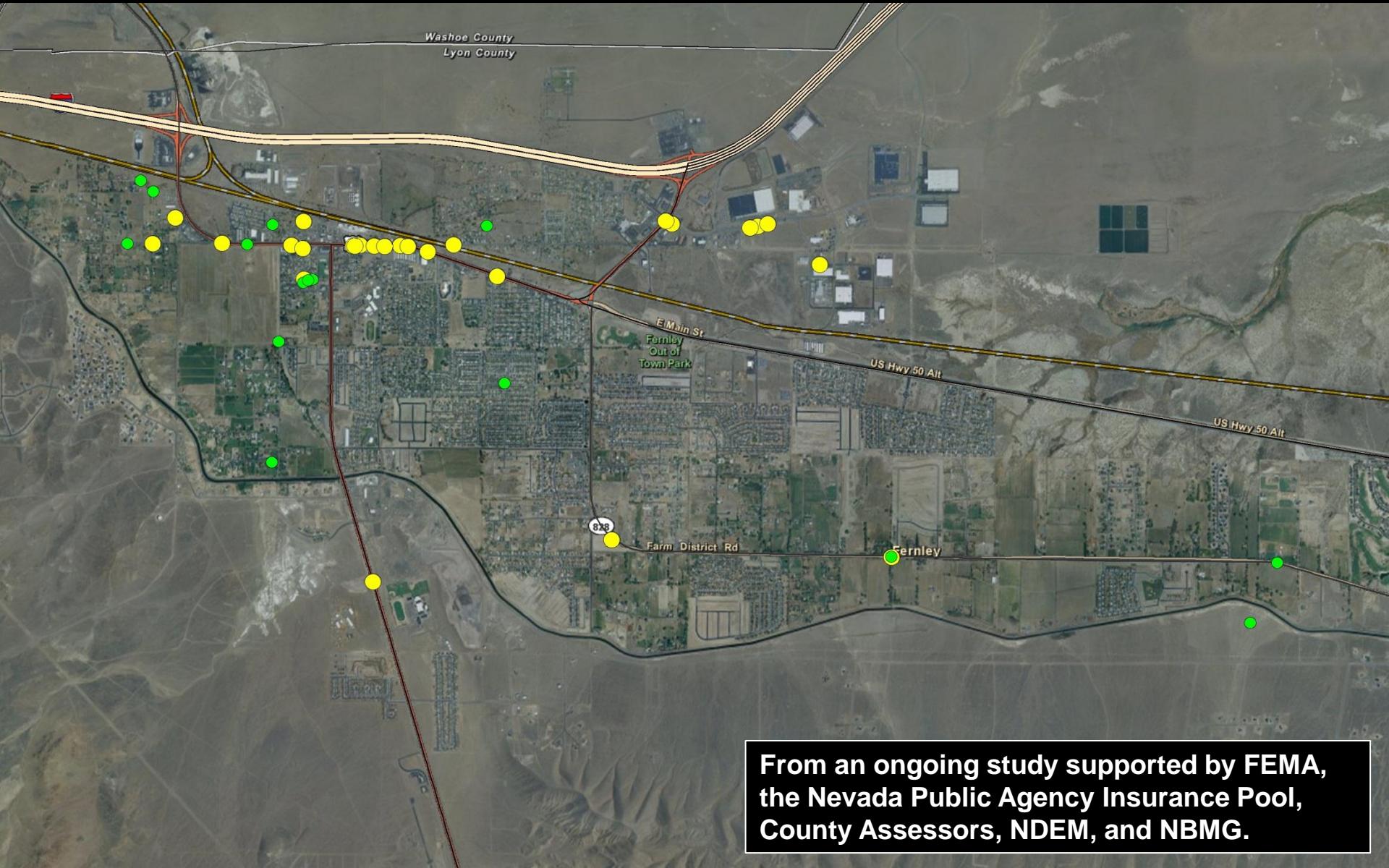


From an ongoing study supported by FEMA, the Nevada Public Agency Insurance Pool, County Assessors, NDEM, and NBMG.

Some possible URM's in Fernley

● Commercial

● Residential

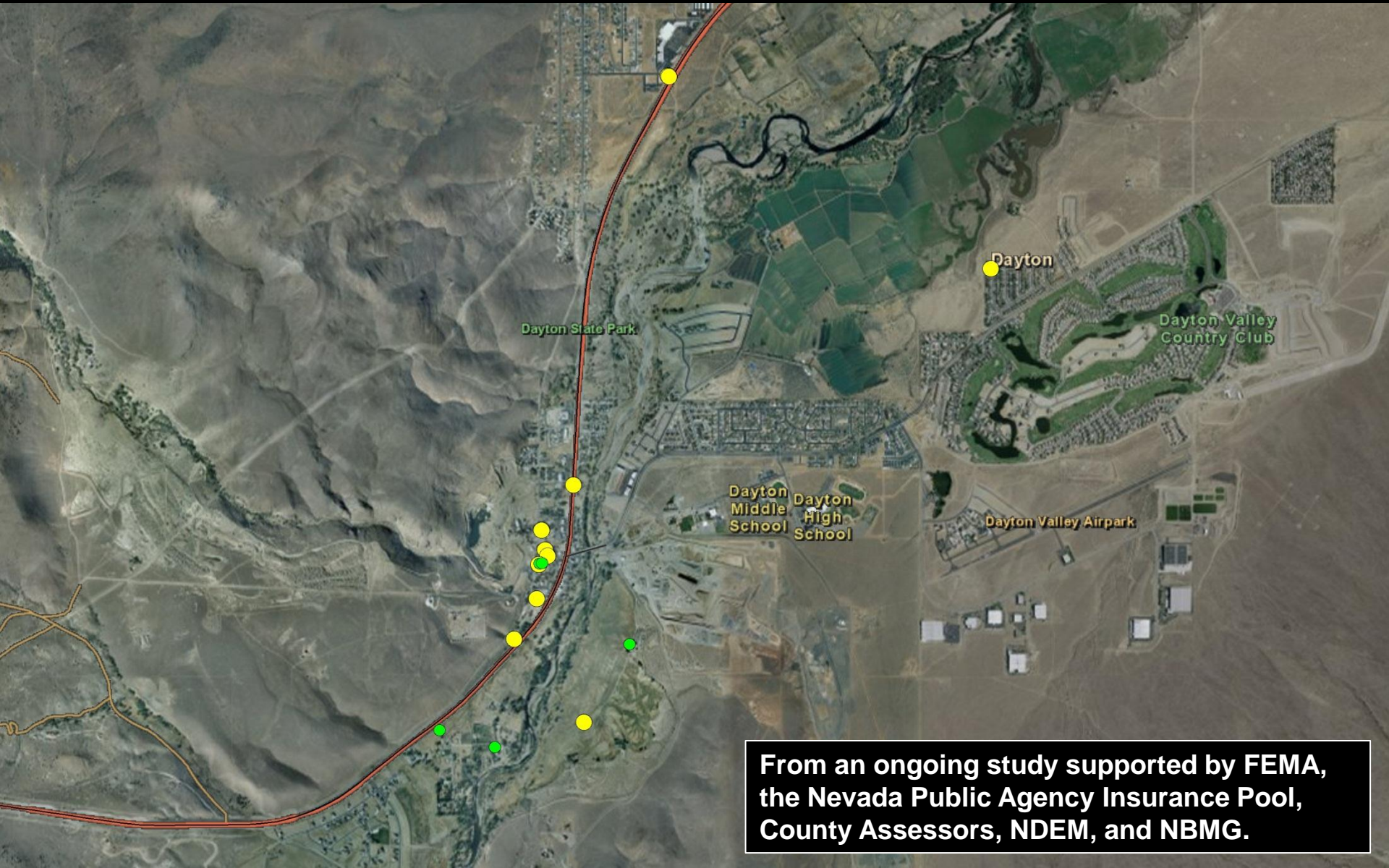


From an ongoing study supported by FEMA, the Nevada Public Agency Insurance Pool, County Assessors, NDEM, and NBMG.

Some possible URM's in Dayton

● Commercial

● Residential

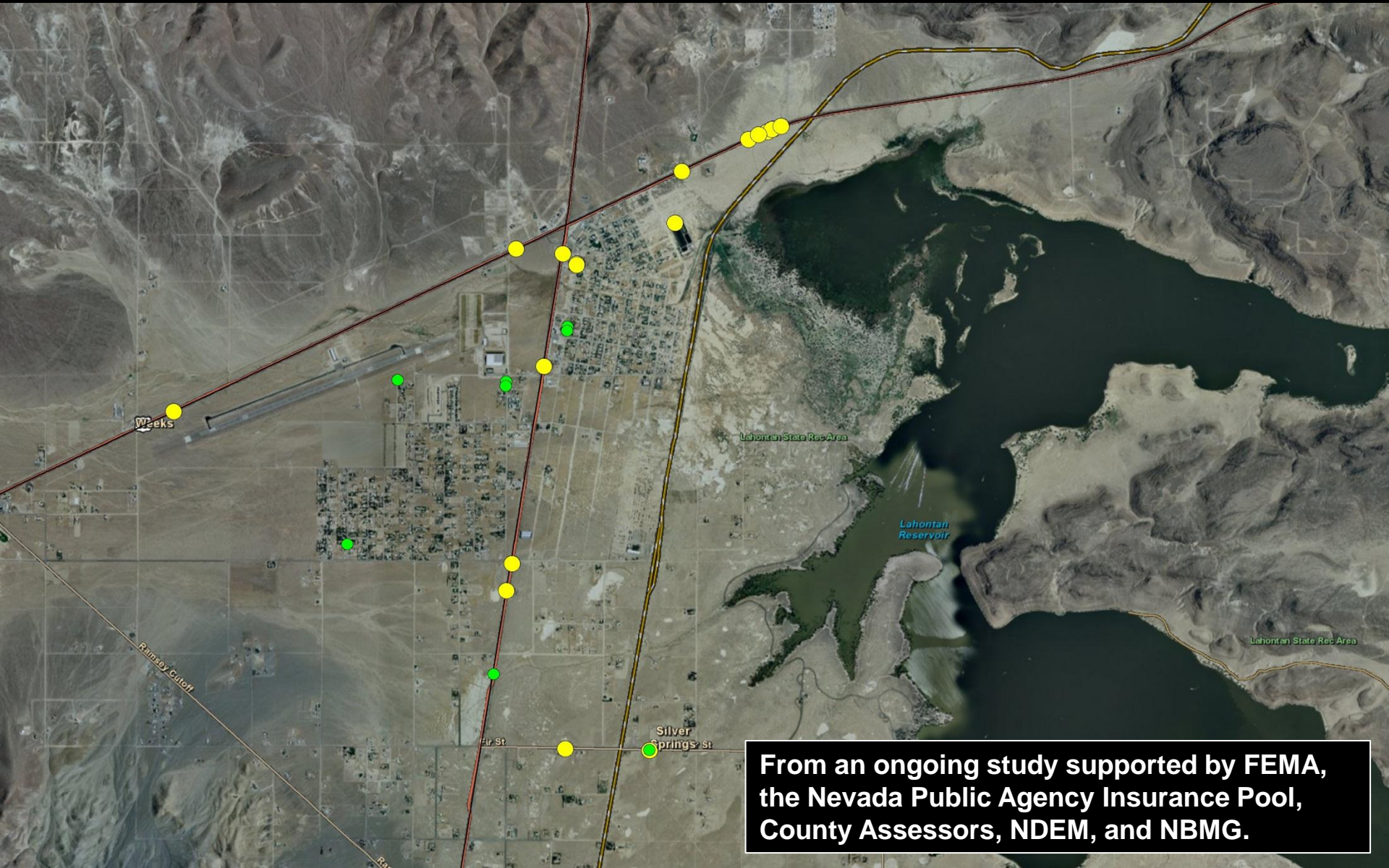


From an ongoing study supported by FEMA, the Nevada Public Agency Insurance Pool, County Assessors, NDEM, and NBMG.

Some possible URM's in Silver Springs

● Commercial

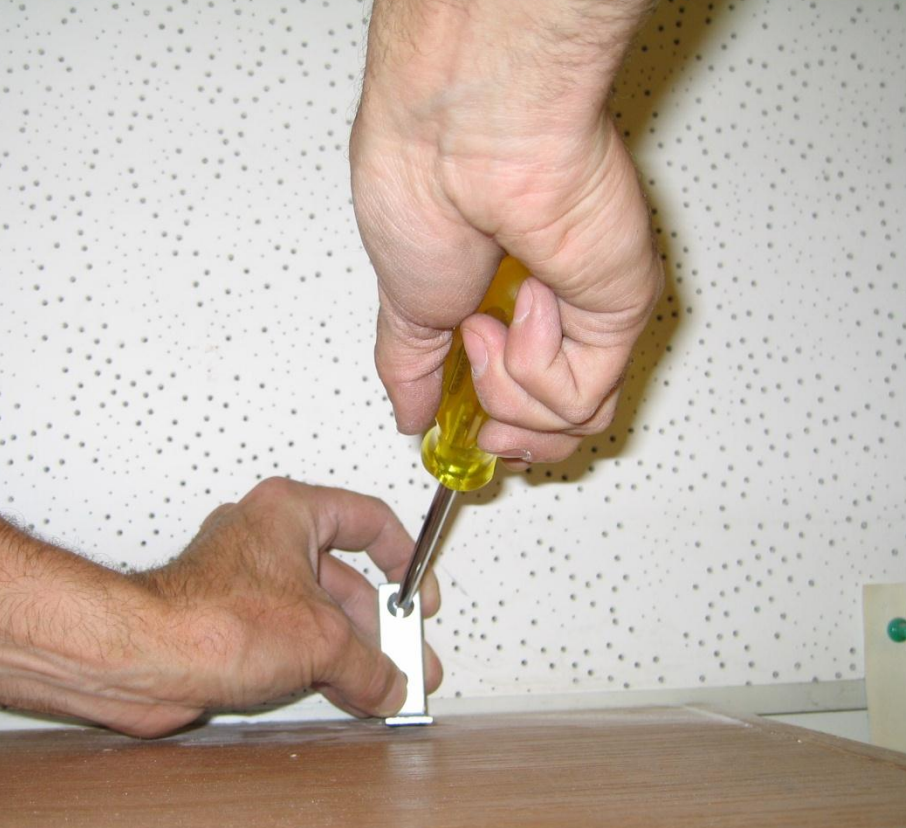
● Residential



From an ongoing study supported by FEMA, the Nevada Public Agency Insurance Pool, County Assessors, NDEM, and NBMG.



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 as online documents at www.nbmng.unr.edu.

From there, go to online documents at <http://www.nbmng.unr.edu/dox/dox.htm>, then scroll down to OF 09-8 or 09-9. Link to the fault map from OF 09-9.

