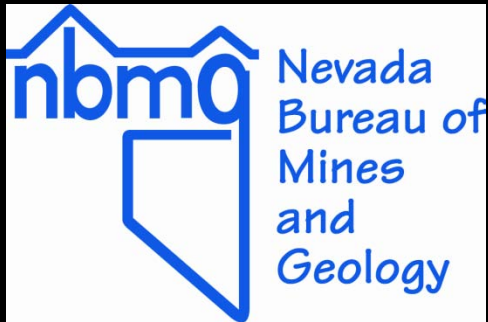
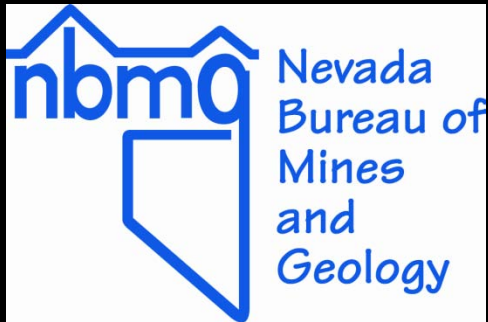


Earthquake Hazards in Elko County

Presentation to the Nevada Hazard Mitigation Planning Committee
26 April 2011
by Jonathan G. Price
Nevada Bureau of Mines and Geology

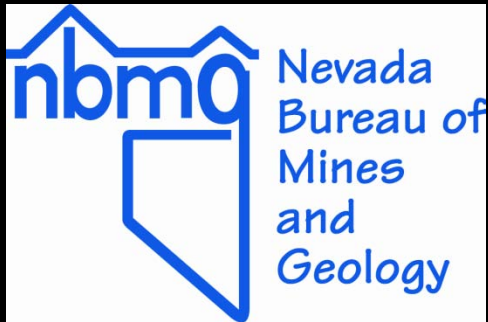


**Earthquake faults occur throughout Nevada,
and potential losses from earthquakes are high
for many communities.**



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



Age of Latest Fault Rupture

< 150 years (historical)

< 15,000 years

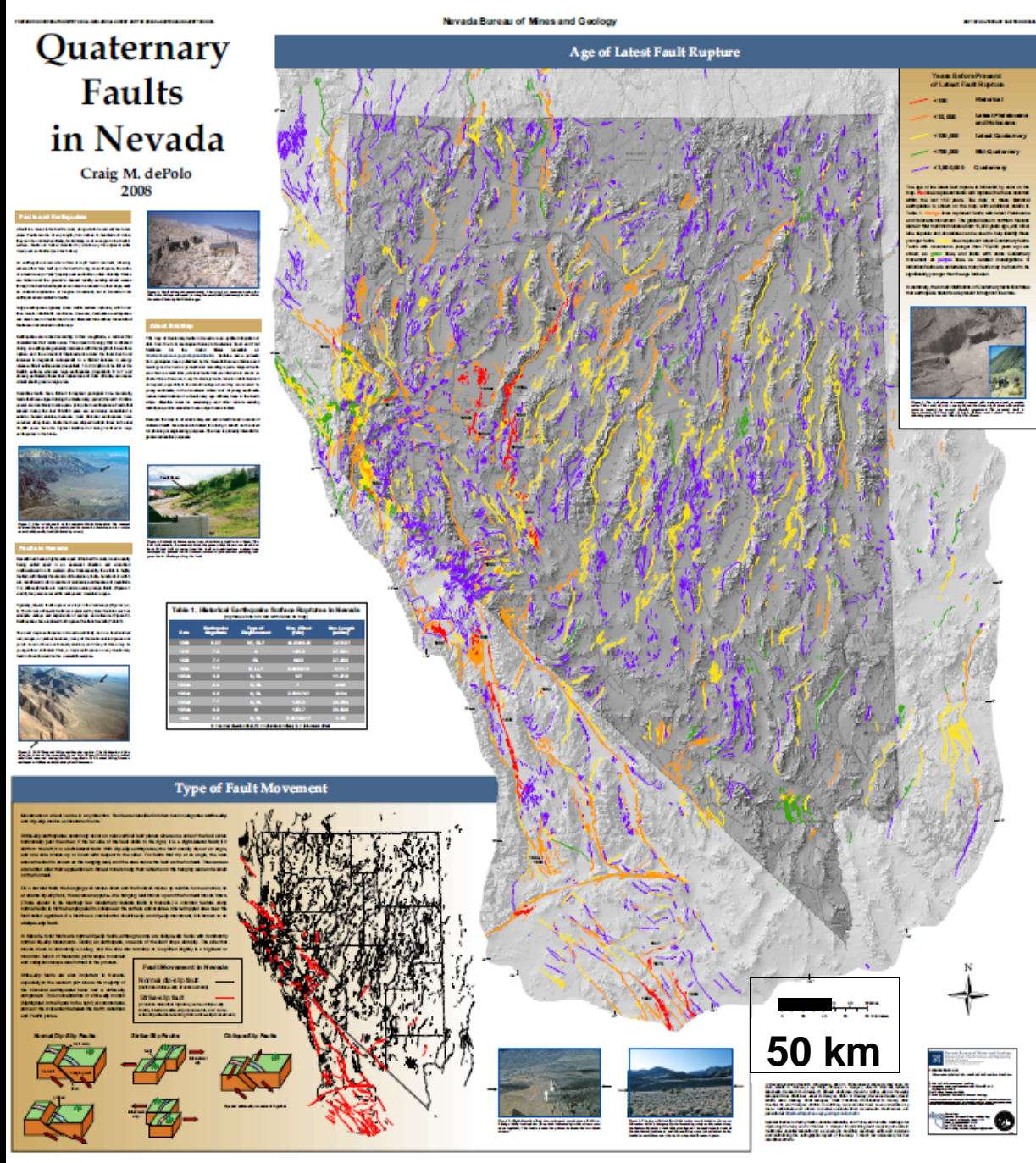
< 130,000 years

< 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.nbmgs.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.

Quaternary Faults in Nevada

Craig M. dePolo
2008

Faults in the Basin and Range
The Basin and Range province is a tectonic province in the western United States, extending from the Sierra Nevada in the north to the Colorado Plateau in the south, and from the Rocky Mountains in the west to the Appalachian Mountains in the east. It is characterized by a series of parallel mountain ranges and valleys, separated by normal faults.



About This Map
This map shows the locations of Quaternary faults in Nevada. The faults are color-coded according to their age of latest rupture. The map is based on data from the Nevada Bureau of Mines and Geology's Quaternary Fault Database.

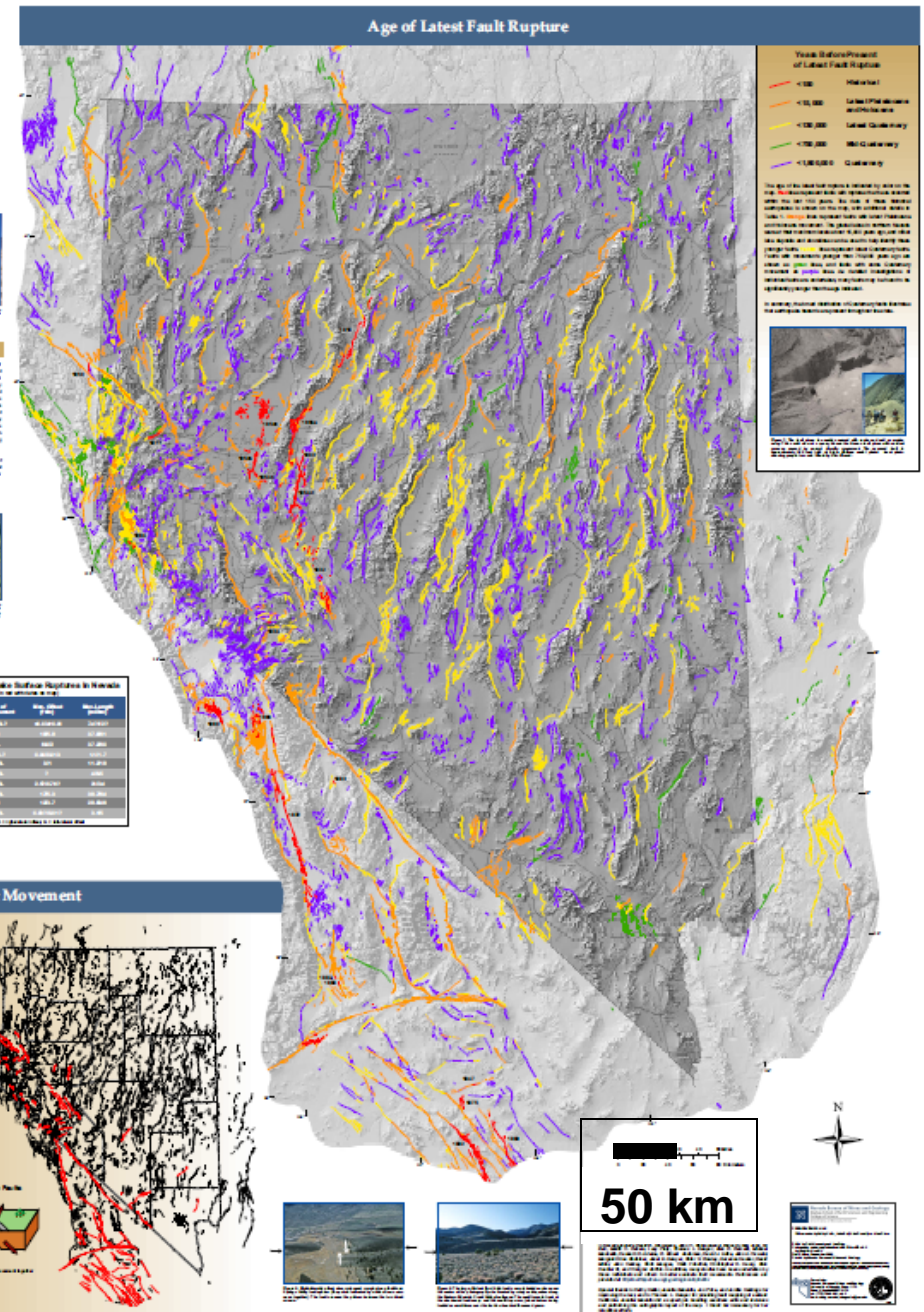
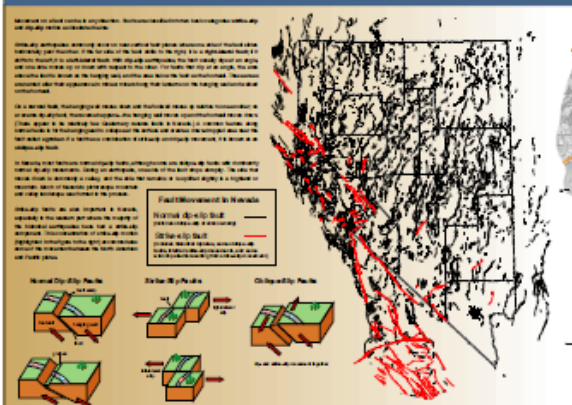


How to Use This Map
This map is intended for use as a reference tool. It is not intended to be used for engineering or other purposes. The map is based on data from the Nevada Bureau of Mines and Geology's Quaternary Fault Database.

Table 1. Historical Earthquake Surface Ruptures in Nevada, 1800-1950

Date	Location	Type of Fault	Length (km)	Magnitude
1800	1800	1800	1800	1800
1850	1850	1850	1850	1850
1900	1900	1900	1900	1900
1950	1950	1950	1950	1950

Type of Fault Movement



50 km

Scale
0 10 20 30 40 50 km

North Arrow

Legend
 <100: Holocene
 <10,000: Late Pleistocene
 <100,000: Late Quaternary
 <1,000,000: Mid-Quaternary
 >1,000,000: Quaternary

Earthquake-active faults in Elko County

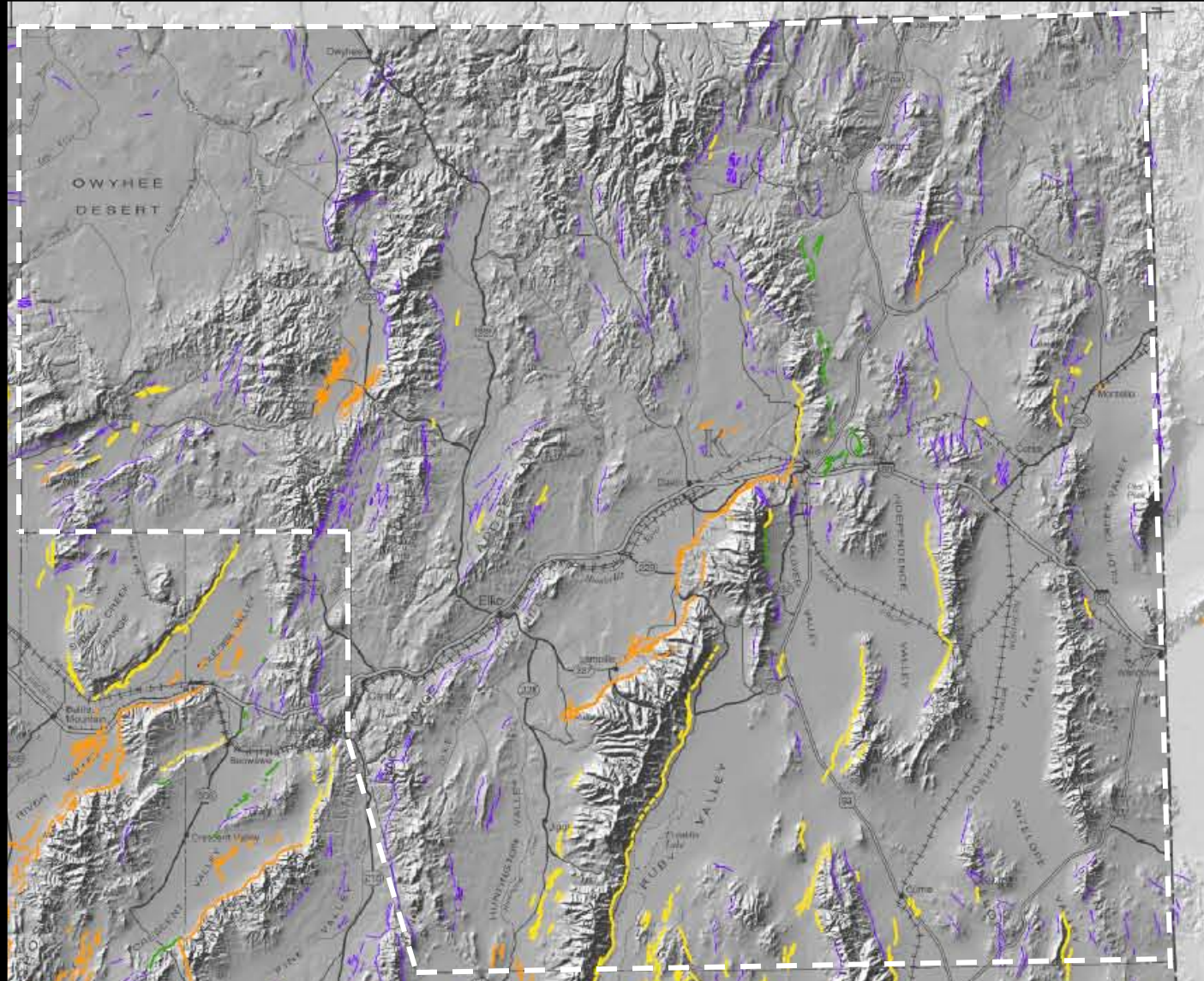
Age of Latest Fault Rupture

< 15,000 years

< 130,000 years

< 750,000 years

< 1,800,000 years
(Quaternary)



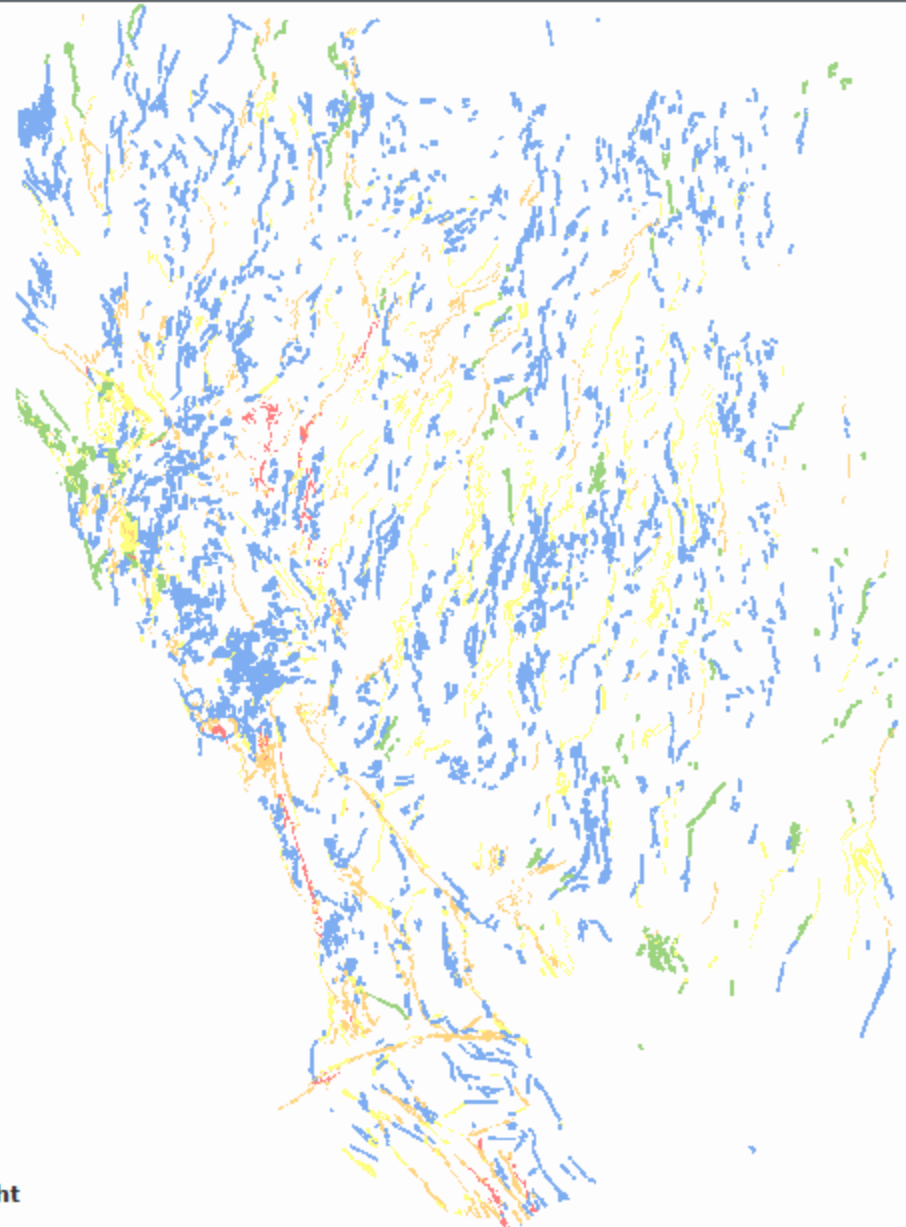
Quaternary Faults in Nevada - Online Interactive Map

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

Results

Map Contents

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



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.

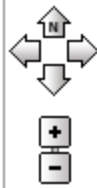
0 18 36 72 108 144 Miles

Copyright

Easy to pinpoint an address

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

- Results
- Map Contents
 - Quaternary_Faults2
 - Quaternary Faults
 - USGS Topo Maps
 - USGS Aerial Imagery



0 18 36 72 108 144 Miles
Copyright



Easy to pinpoint an address

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

Results

Map Contents

- Quaternary
- Quaternary
- USGS
- USGS

Find an Address

Street or Intersection:

City:

State:

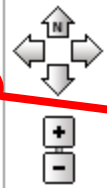
ZIP:

0 18 36 72 108 144 Miles
Copyright

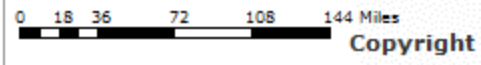


Look for a fault | Find an Address | Print a Map

- Results**
- 540 Court Street, Elko, Nevada,**
 - 540 Court St, Elko, NV, 89801



- Map Contents**
- Quaternary_Faults2
 - Quaternary Faults
 - USGS Topo Maps
 - USGS Aerial Imagery



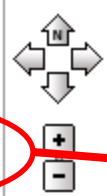
Look for a fault | Find an Address | Print a Map

Results

- 540 Court Street, Elko, Nevada, NV
- 540 Court St, Elko, NV
- Zoom to**
- Pan to
- Remove

Map Contents

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



0 18 36 72 108 144 Miles
Copyright



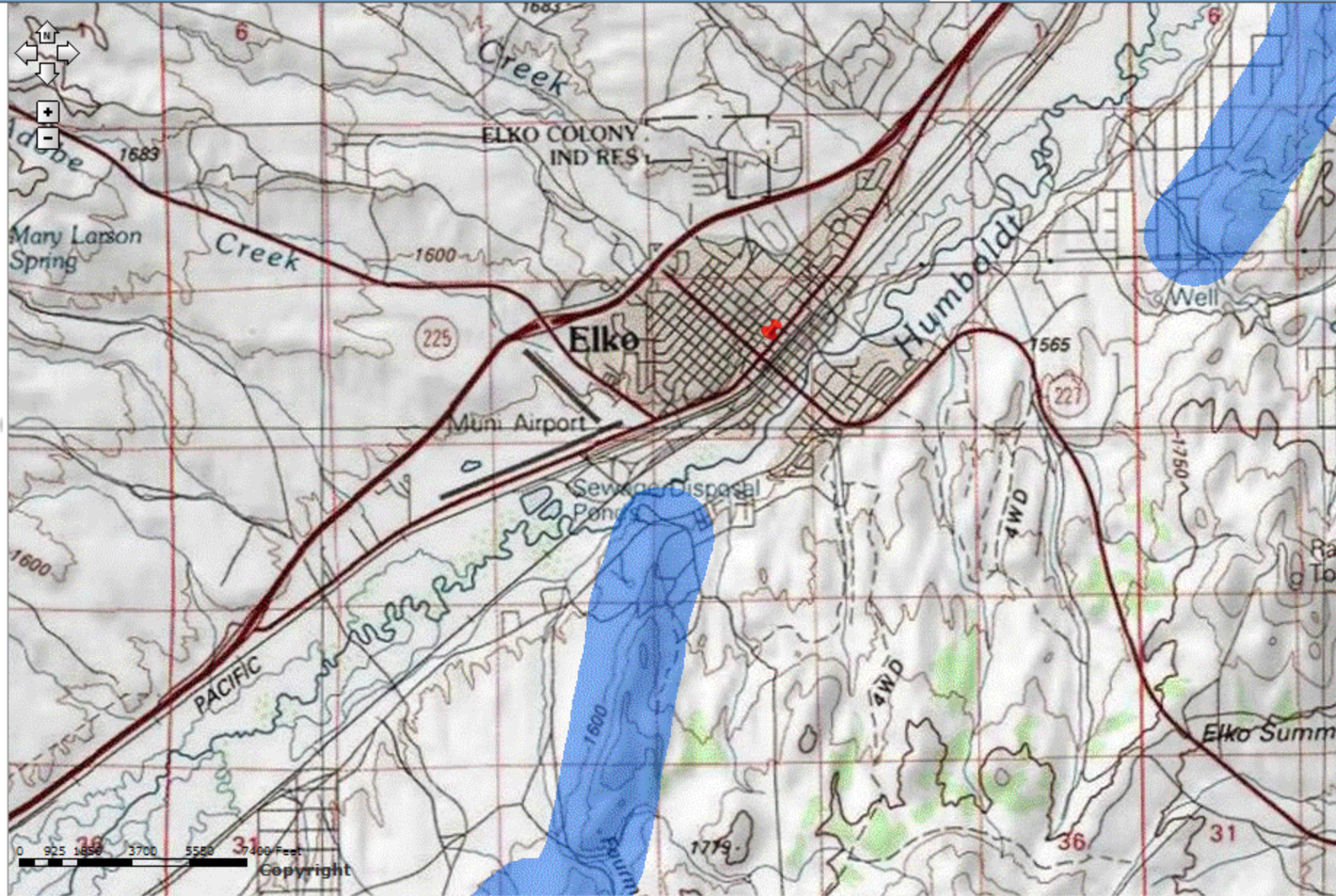
View on an aerial photographic base map.

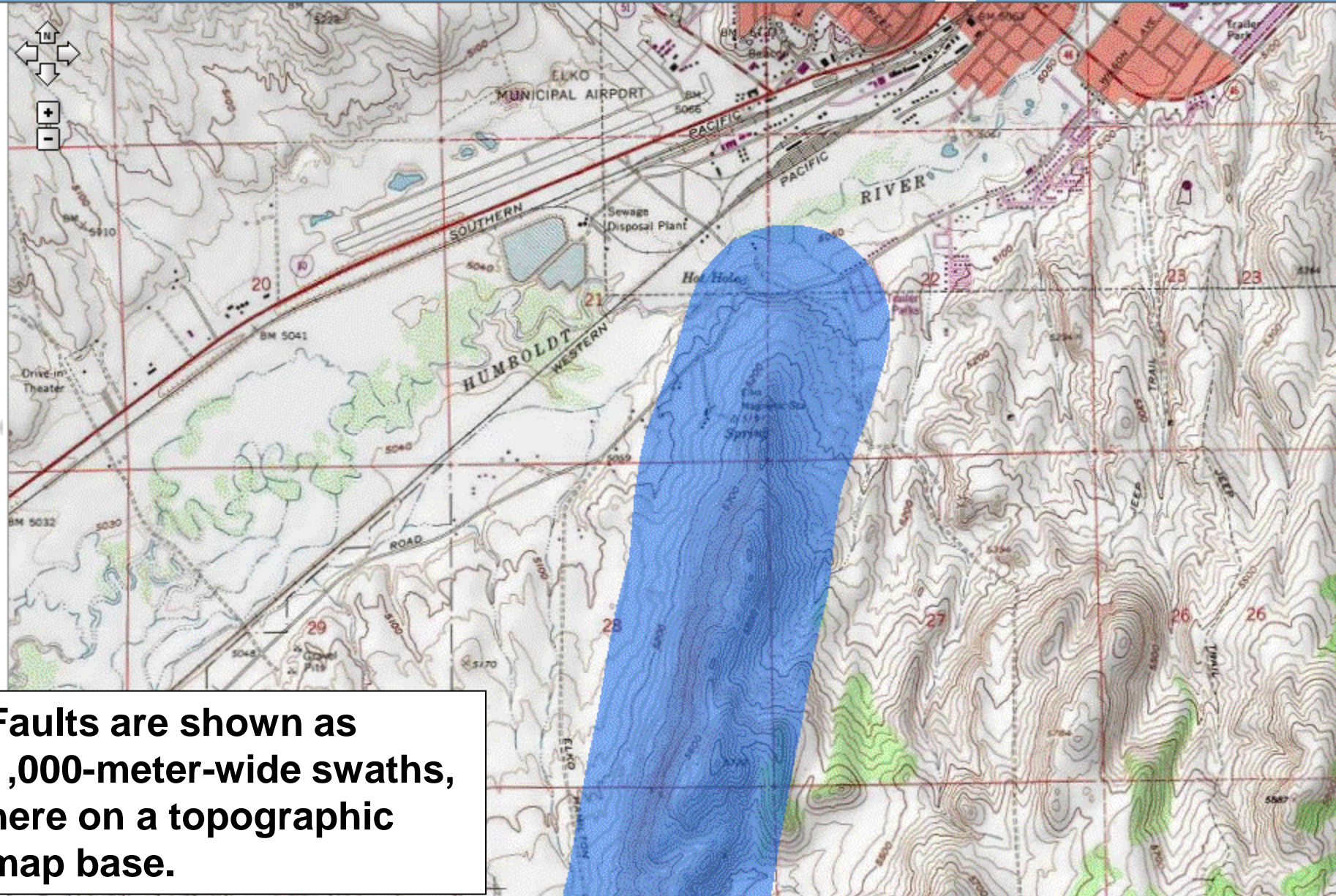


0 925 1850 3700 5550 7400 Feet
Copyright

Or view on a topographic base map.

Print a Map

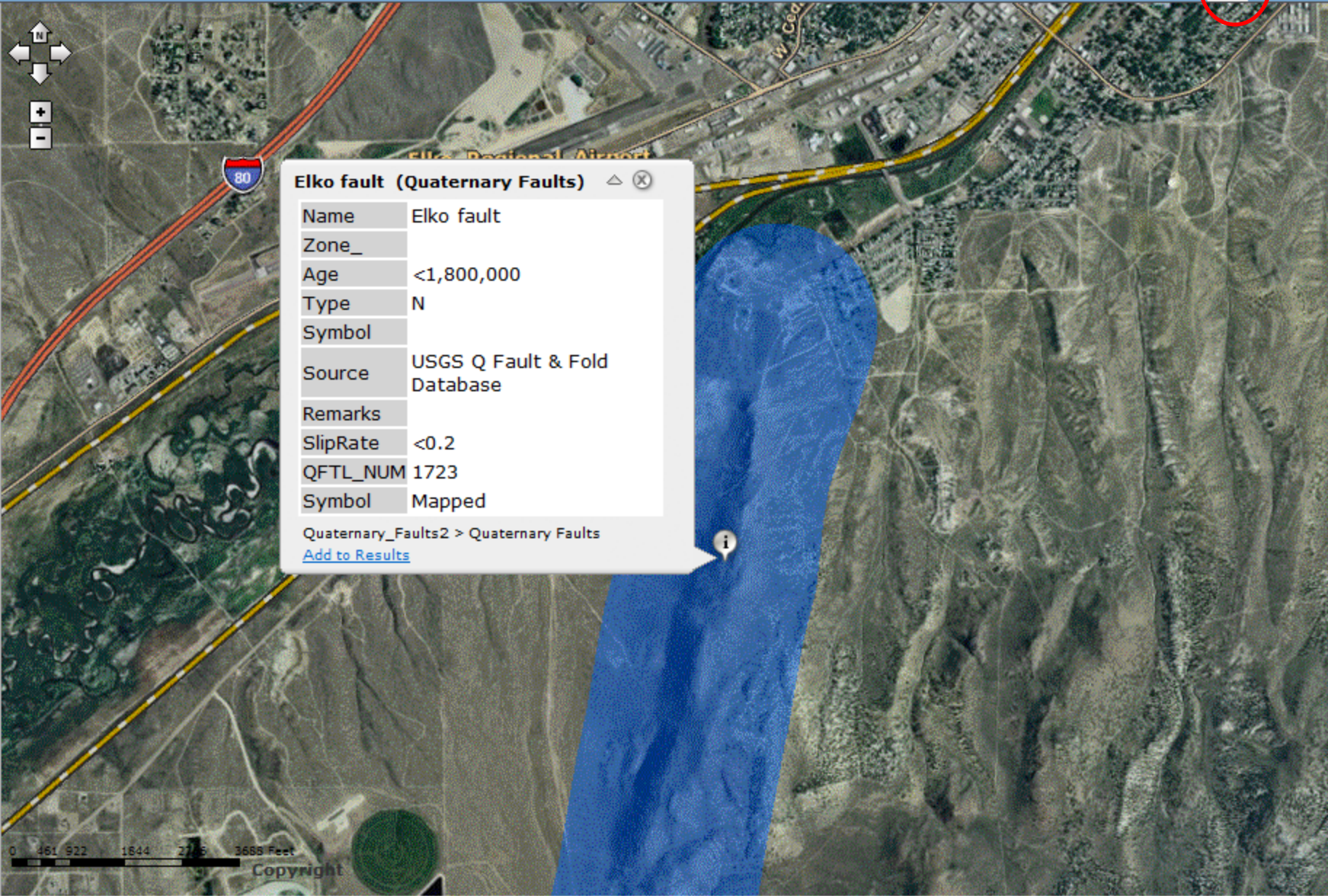




Faults are shown as 1,000-meter-wide swaths, here on a topographic map base.



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



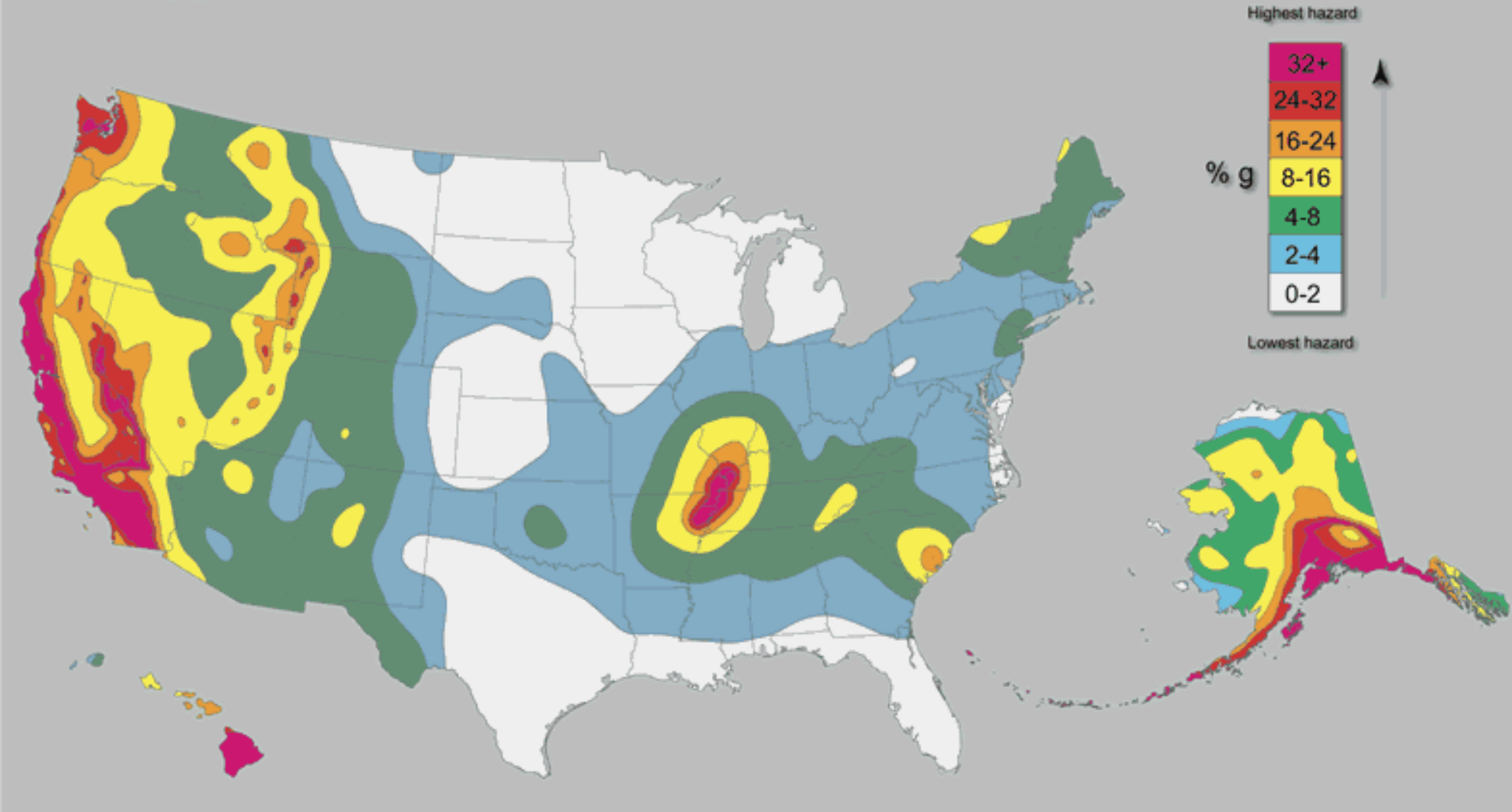
Elko fault (Quaternary Faults) [Close] [Maximize]

Name	Elko fault
Zone_	
Age	<1,800,000
Type	N
Symbol	
Source	USGS Q Fault & Fold Database
Remarks	
SlipRate	<0.2
QFTL_NUM	1723
Symbol	Mapped

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

0 461 922 1844 2766 3688 Feet

Copyright



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

Earthquake-active faults in Elko County

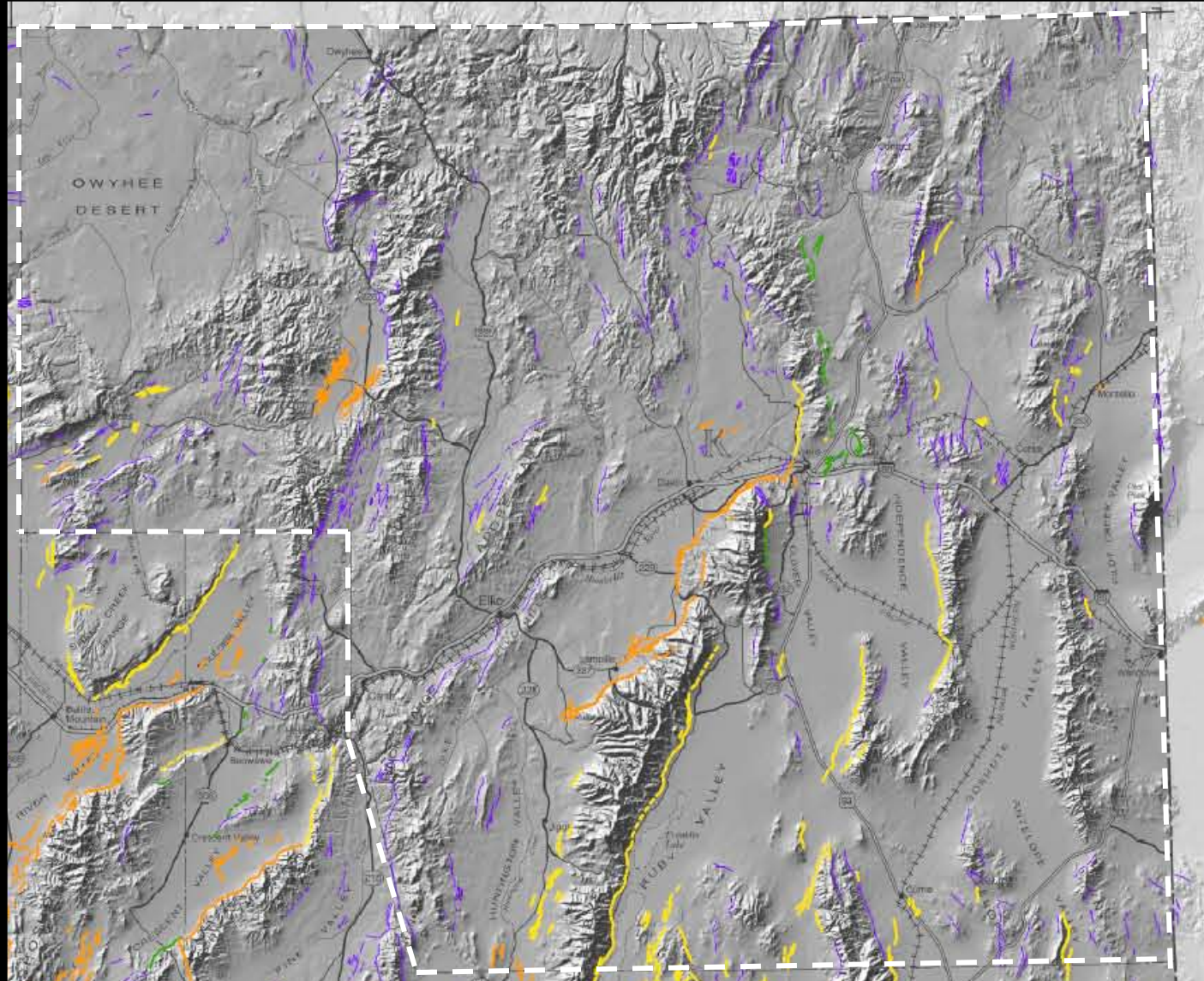
Age of Latest Fault Rupture

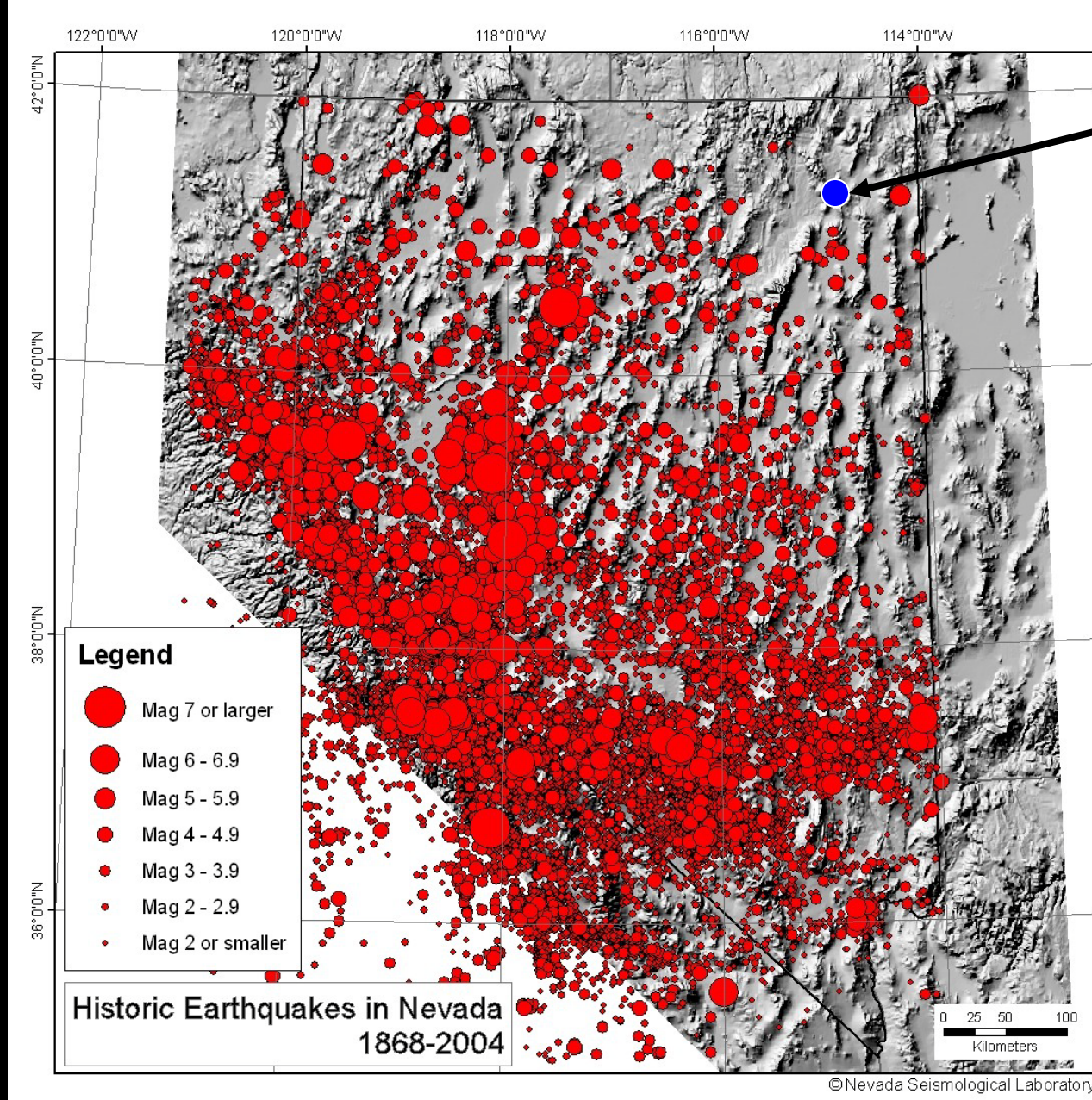
< 15,000 years

< 130,000 years

< 750,000 years

< 1,800,000 years
(Quaternary)





Wells
21 Feb 08
M = 6.0

(2) Earthquakes have occurred throughout Nevada.

Large Historical Earthquakes in Elko County

Date

2008

Magnitude

6.0

Near

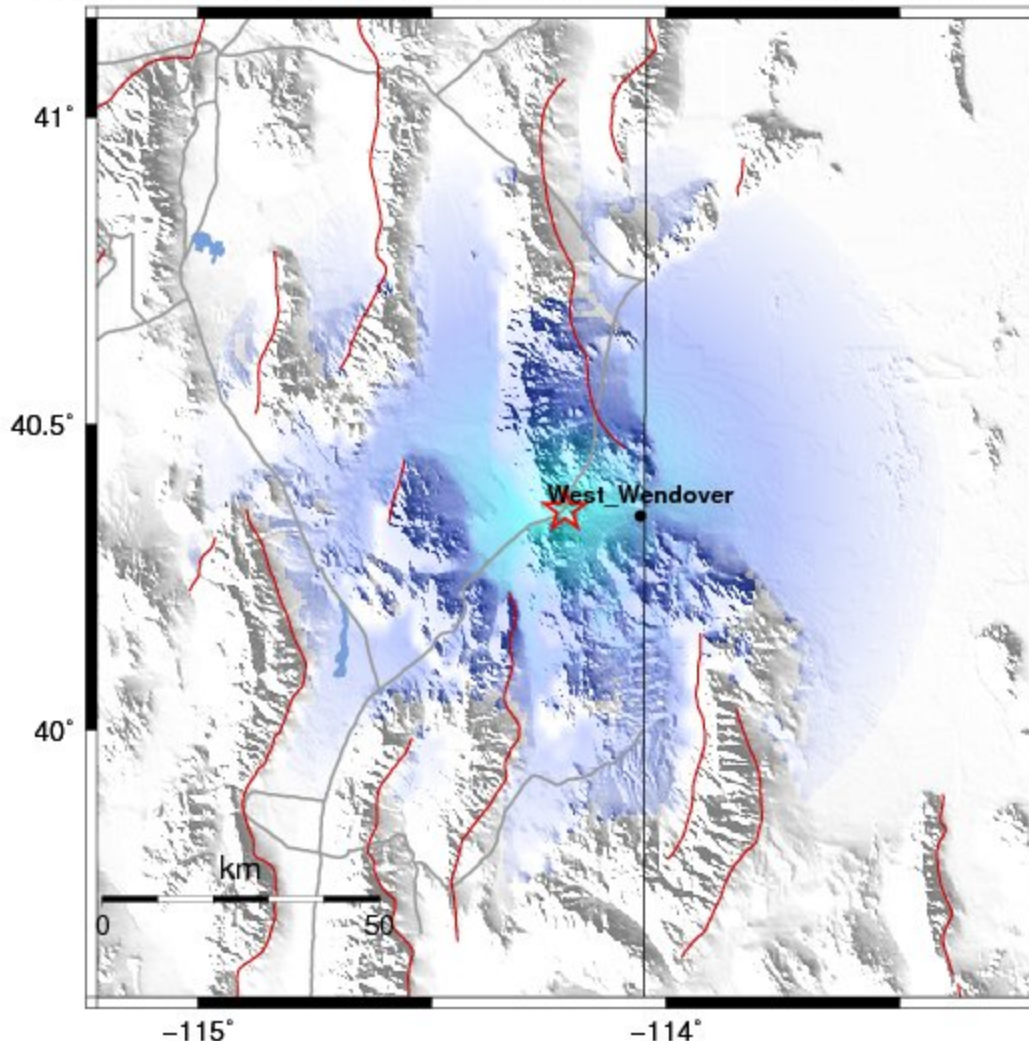
Wells



NSL Reno ShakeMap : 65.1 miles SE of WELLS-NV

Sat Jan 1, 2011 11:34:55 PM PST M 3.7 N40.36 W114.22 Depth: 0.0km ID:2011002_323965

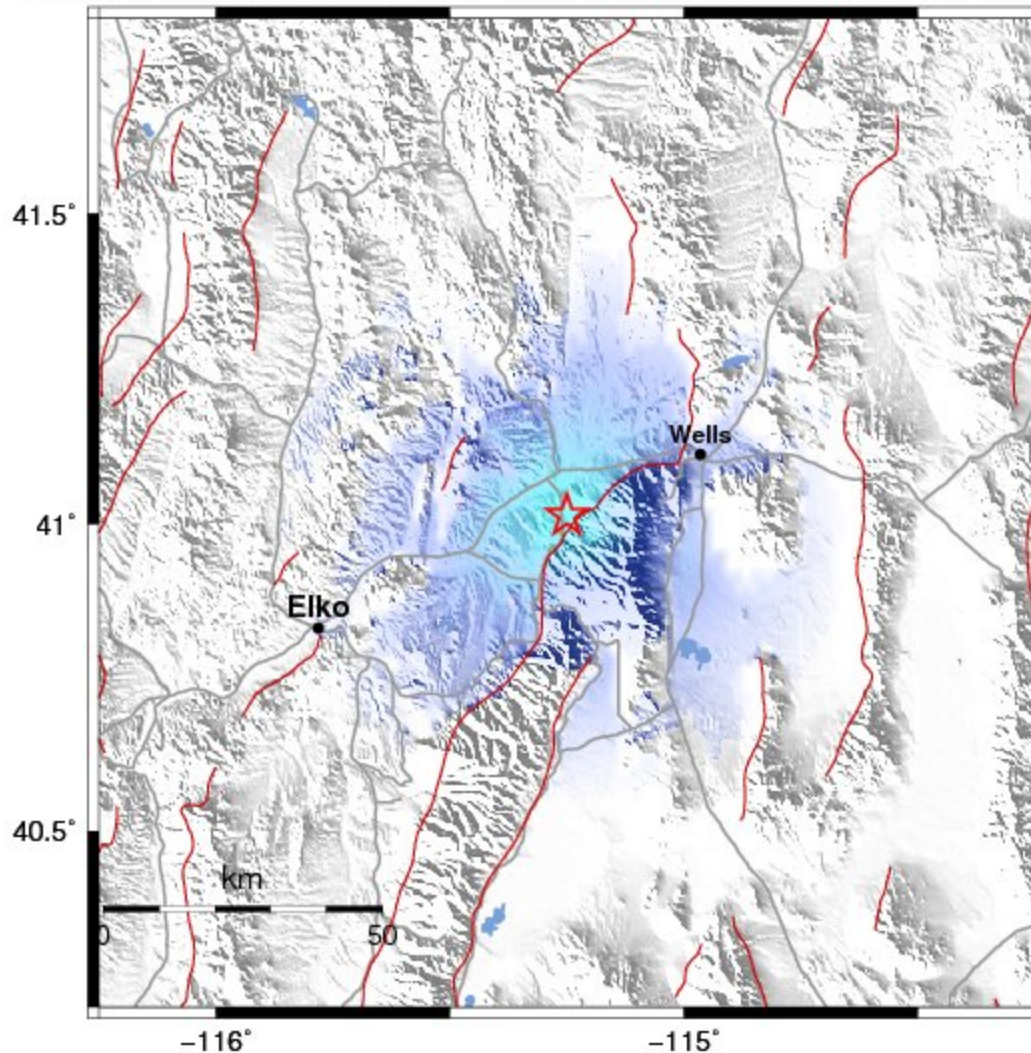
**January 1, 2011
Magnitude 3.7
near
West Wendover**



Map Version 1 Processed Sun Jan 2, 2011 01:01:01 PM PST - 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+

**September 2, 2010
 Magnitude 3.3
 near
 Deeth**



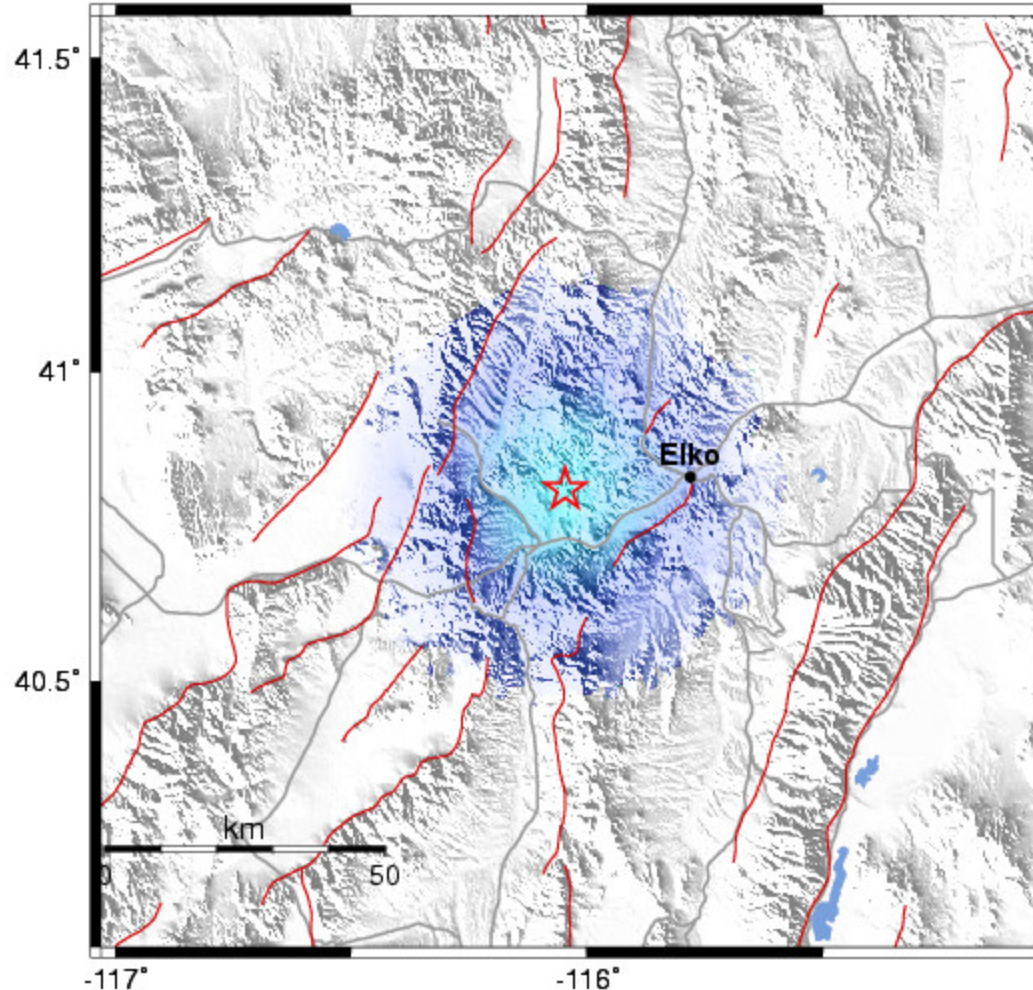
Map Version 1 Processed Mon Sep 20, 2010 09:29:21 AM PDT - ShakeMap v3.5

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 : 7.2 miles NNE of CARLIN-NV

Tue Mar 17, 2009 01:59:05 AM PST M 3.5 N40.81 W116.05 Depth: 12.0km ID:2009076_278656

**March 17, 2009
Magnitude 3.5
near
Carlin**



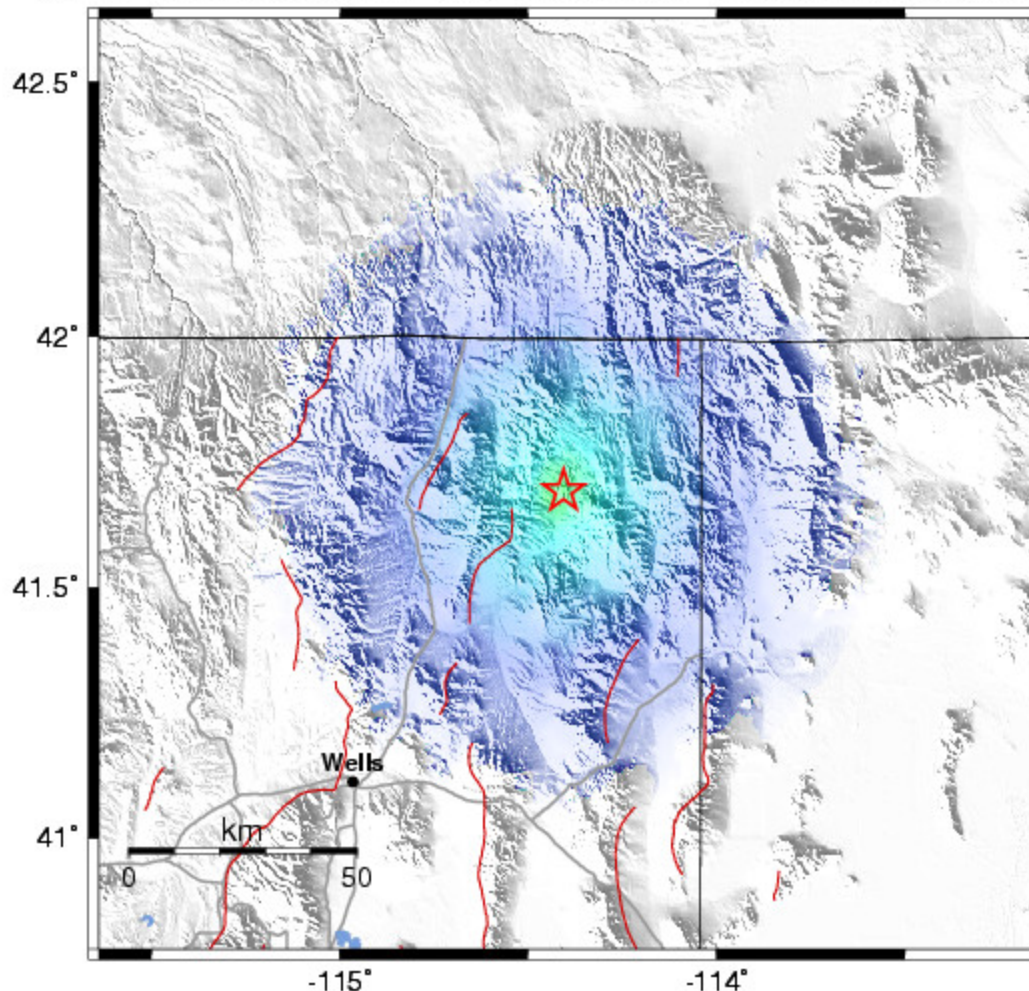
Map Version 1 Processed Tue Mar 17, 2009 02:16:47 AM PST, -- NOT REVIEWED BY HUMAN

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+

NSL ShakeMap : 49.6 miles NE of WELLS-NV

Sun Jan 4, 2009 07:29:20 AM PST M 4.3 N41.69 W114.41 Depth: 0.0km ID:2009004_270790

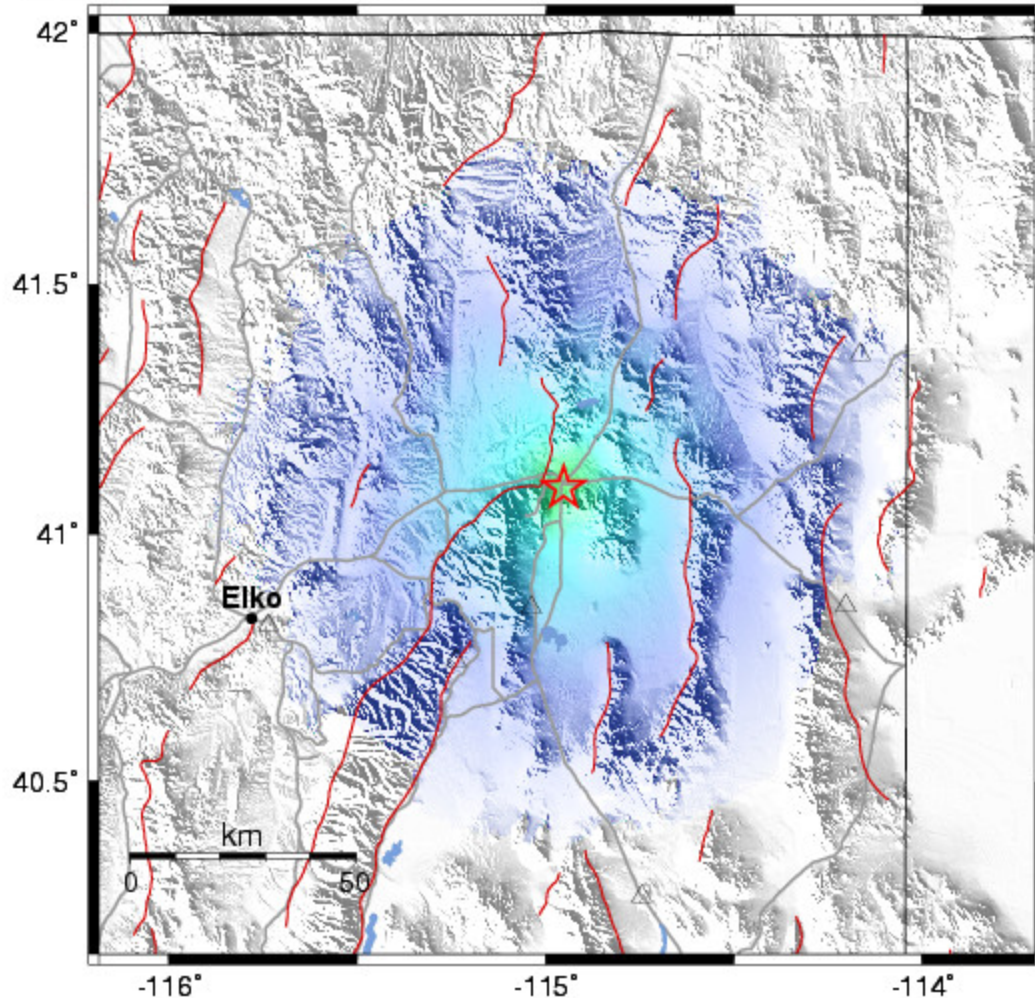
January 4, 2009
Magnitude 4.3
near
Jackpot



Map Version 1 Processed Sun Jan 4, 2009 07:46:25 AM PST, -- NOT REVIEWED BY HUMAN

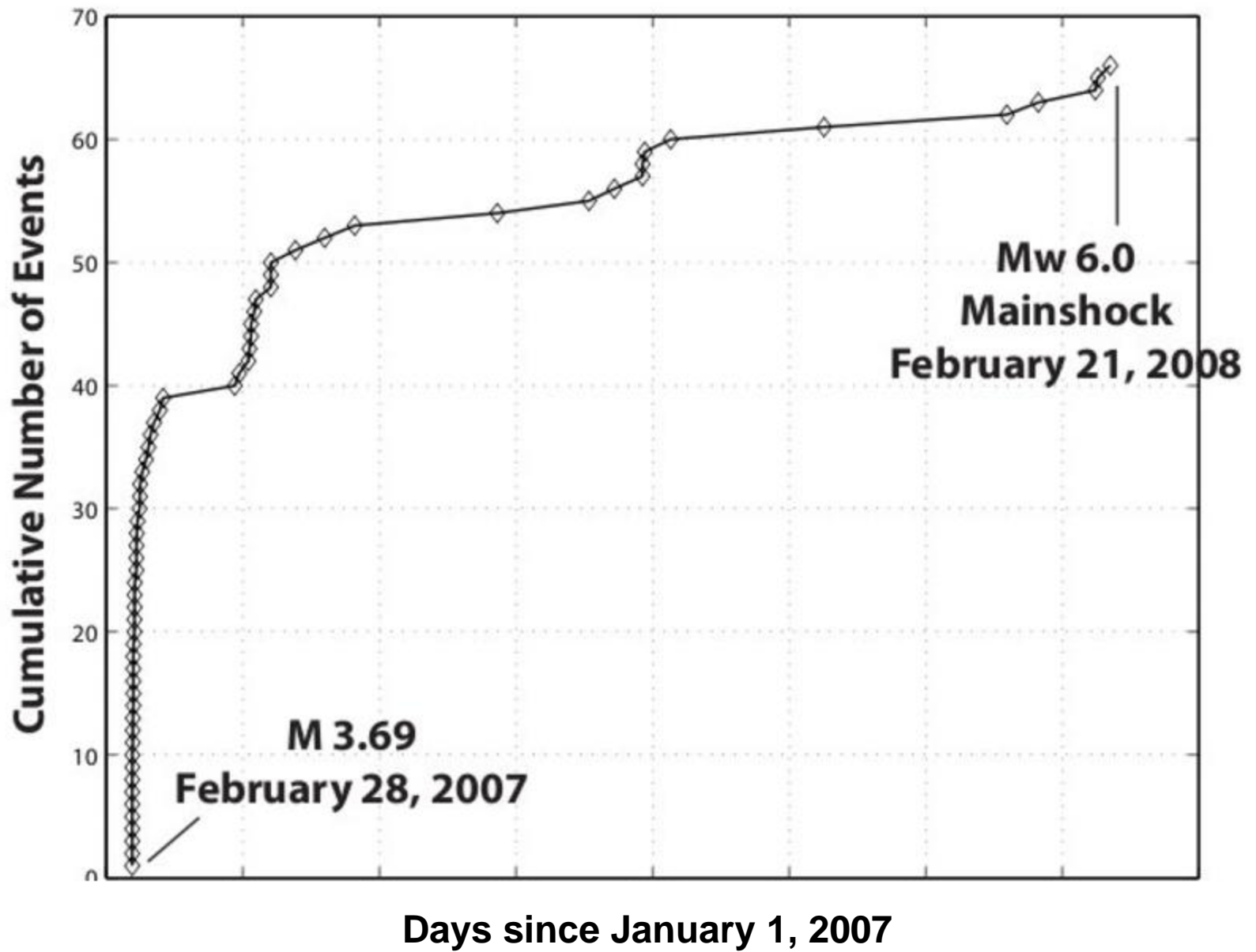
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16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

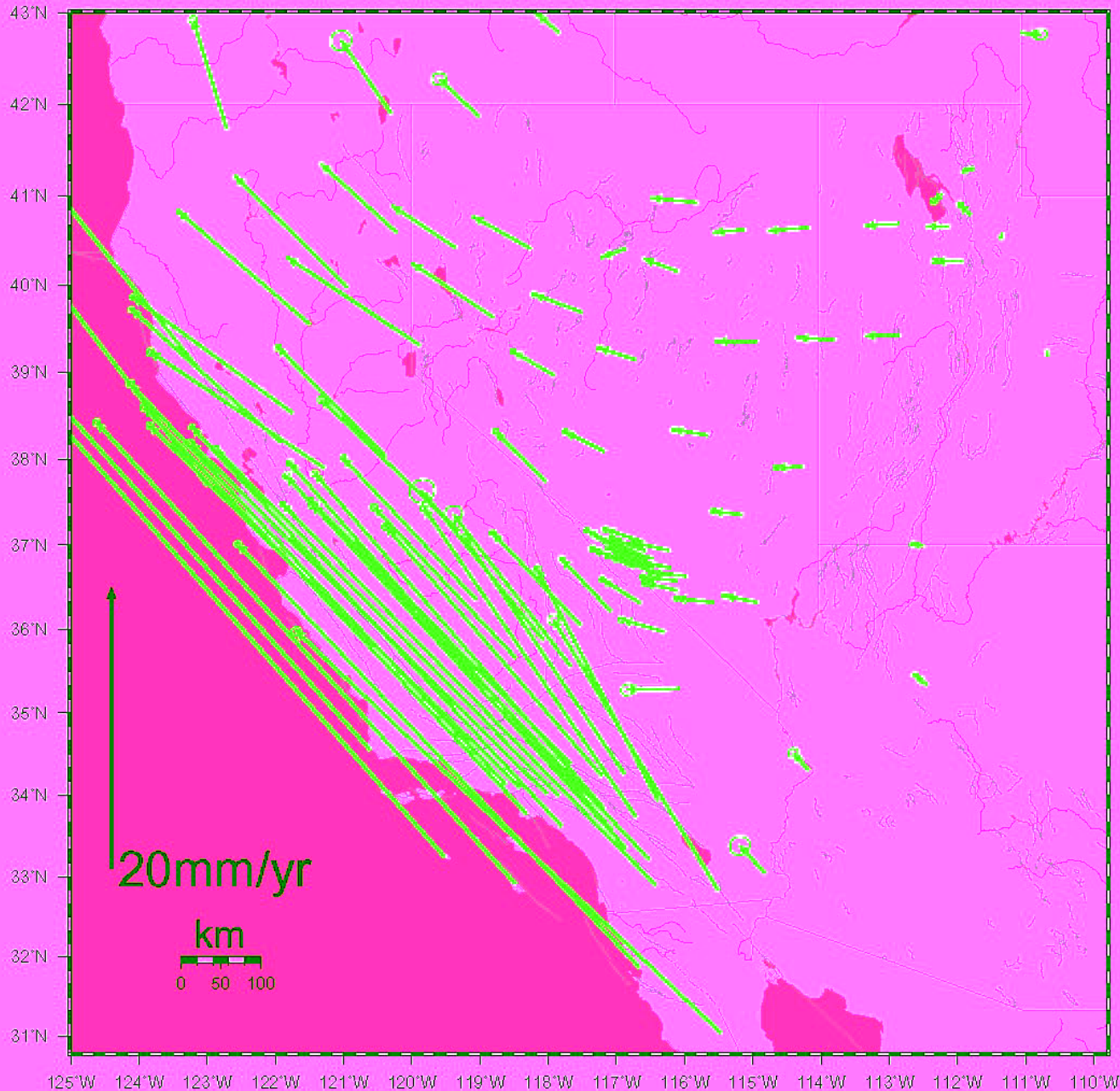
February 21, 2008 Magnitude 5.1 aftershock at Wells



Map Version 1 Processed Thu Feb 21, 2008 09:16:10 AM PST, -- NOT REVIEWED BY HUMAN

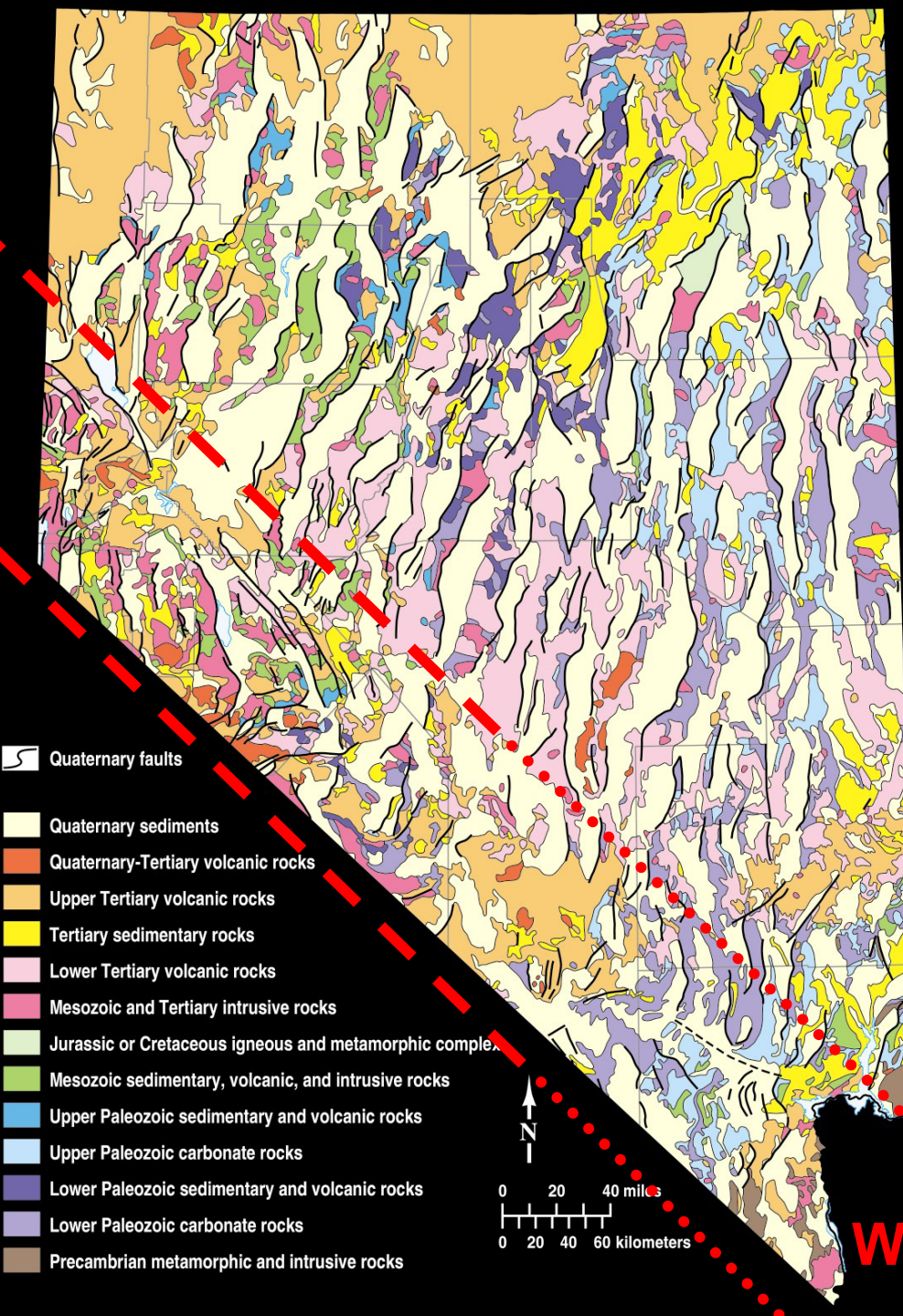
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC (%g)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL (cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	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.

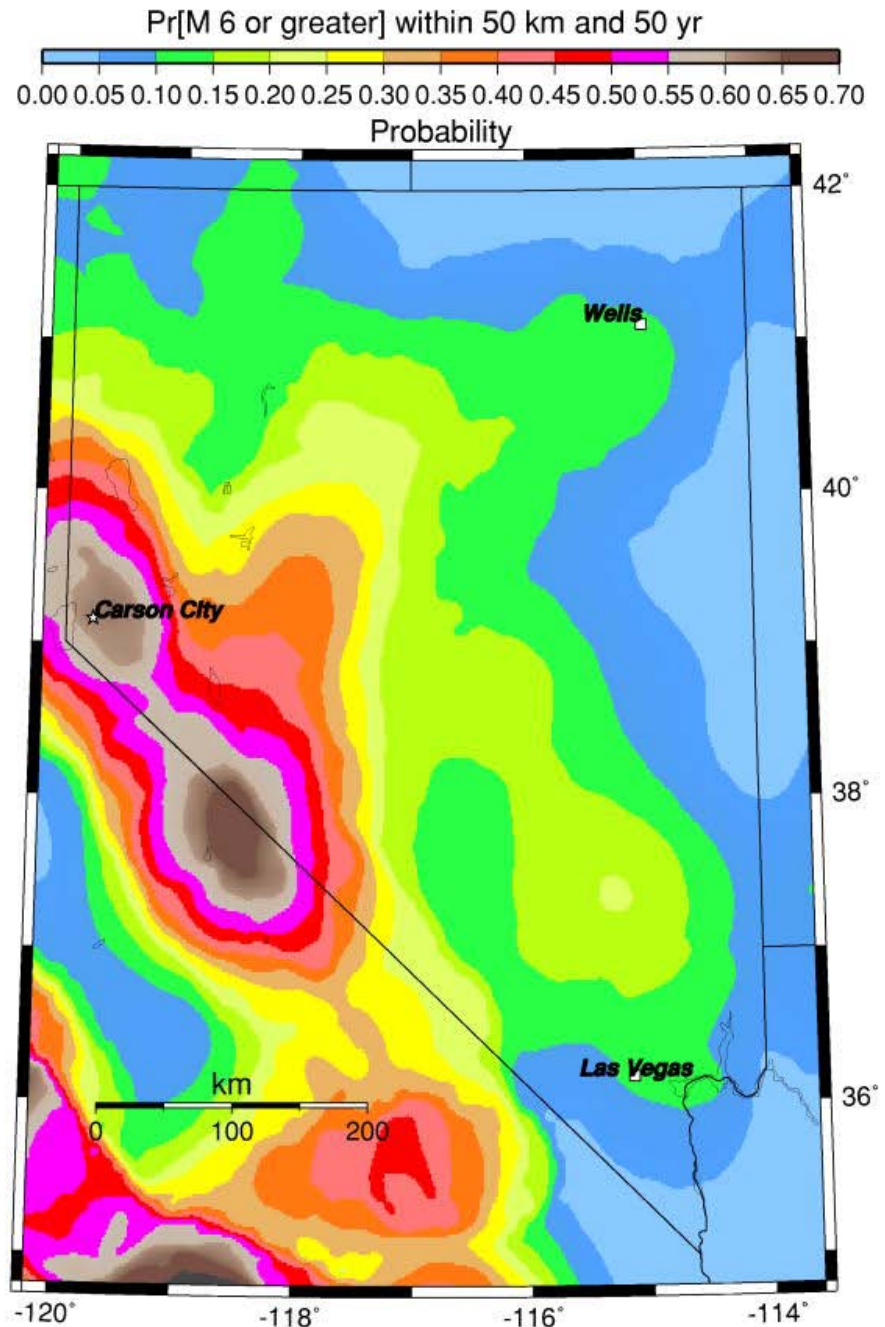
Kreemer and Hammond (2007)



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.

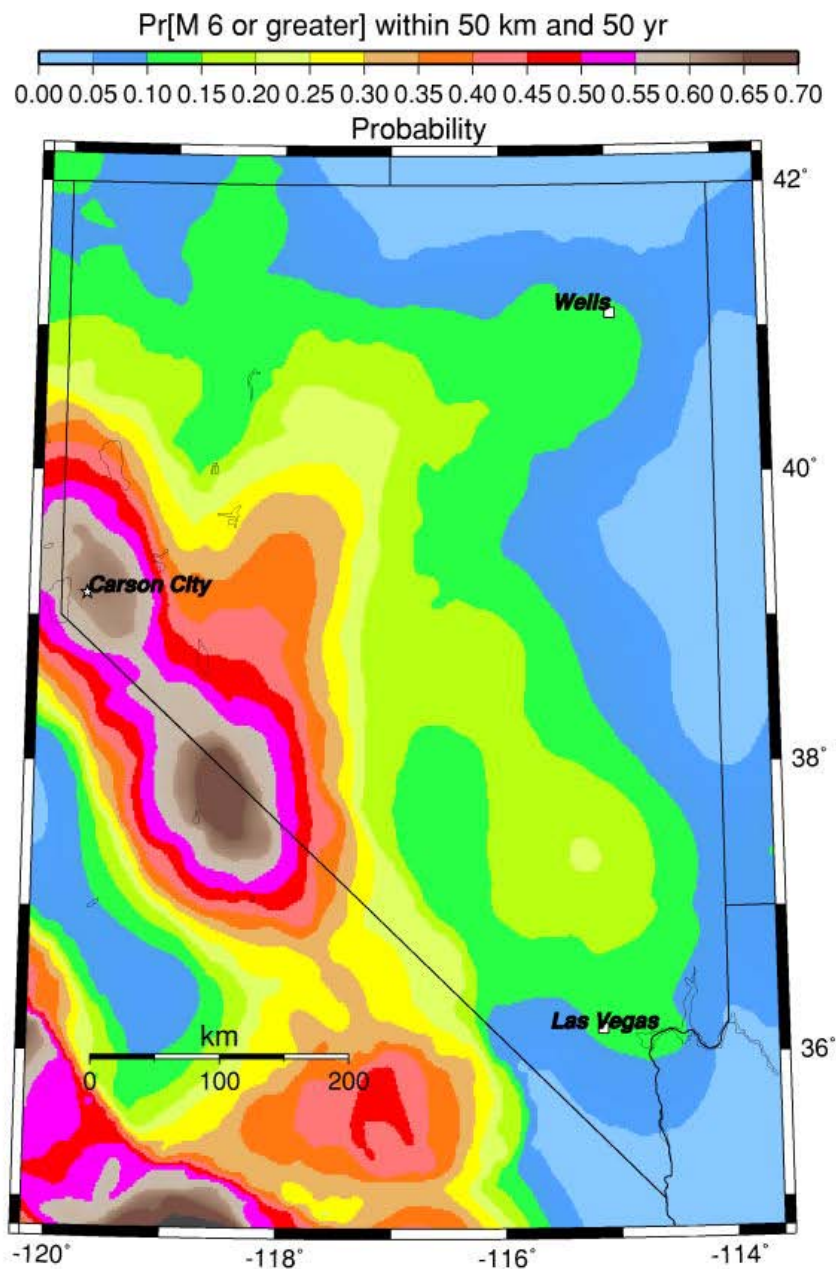
Extension largely is accommodated along N- to NE-striking, basin-bounding normal faults.

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





Source: USGS

The probability of a magnitude 6.0 earthquake occurring within 50 km of Las Vegas within the next 50 years is about the same as that for Wells, and it happened there.

The probability for the Reno-Carson City urban corridor is about 6 times 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.

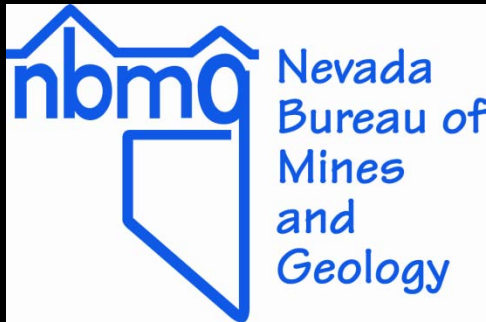
Community	% Probability of magnitude greater than or equal to magnitude				
	5.0	5.5	6.0	6.5	7.0
Dayton	>90	~80	70-75	50-55	15-18
Carson City	>90	~80	70	50-55	12-15
Reno	>90	~80	67	50	12-15
Las Vegas	40-50	~30	12	4-5	<0.5
Elko	30-40	~25	10-15	6-8	0.5-1
Wells	30-40	~20	9	6	0.5-1
Laughlin	10-20	~5	2-3	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 USAF,
ON SCENE NEVADA TASK FORCE 1 - CAS VEGAS
RENSA SPARKS PD,
REQUESTED - 92ND Civil Support Team - NATIONAL GUARD
LAS VEGAS
NATIONAL GUARD OST'S + 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%
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> .

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



San Marin Hotel, Wells, Nevada
before the 21 February 2008
 M_w 6.0 earthquake

**Lesson learned (again):
Unreinforced masonry
buildings tend to collapse
during large earthquakes.**

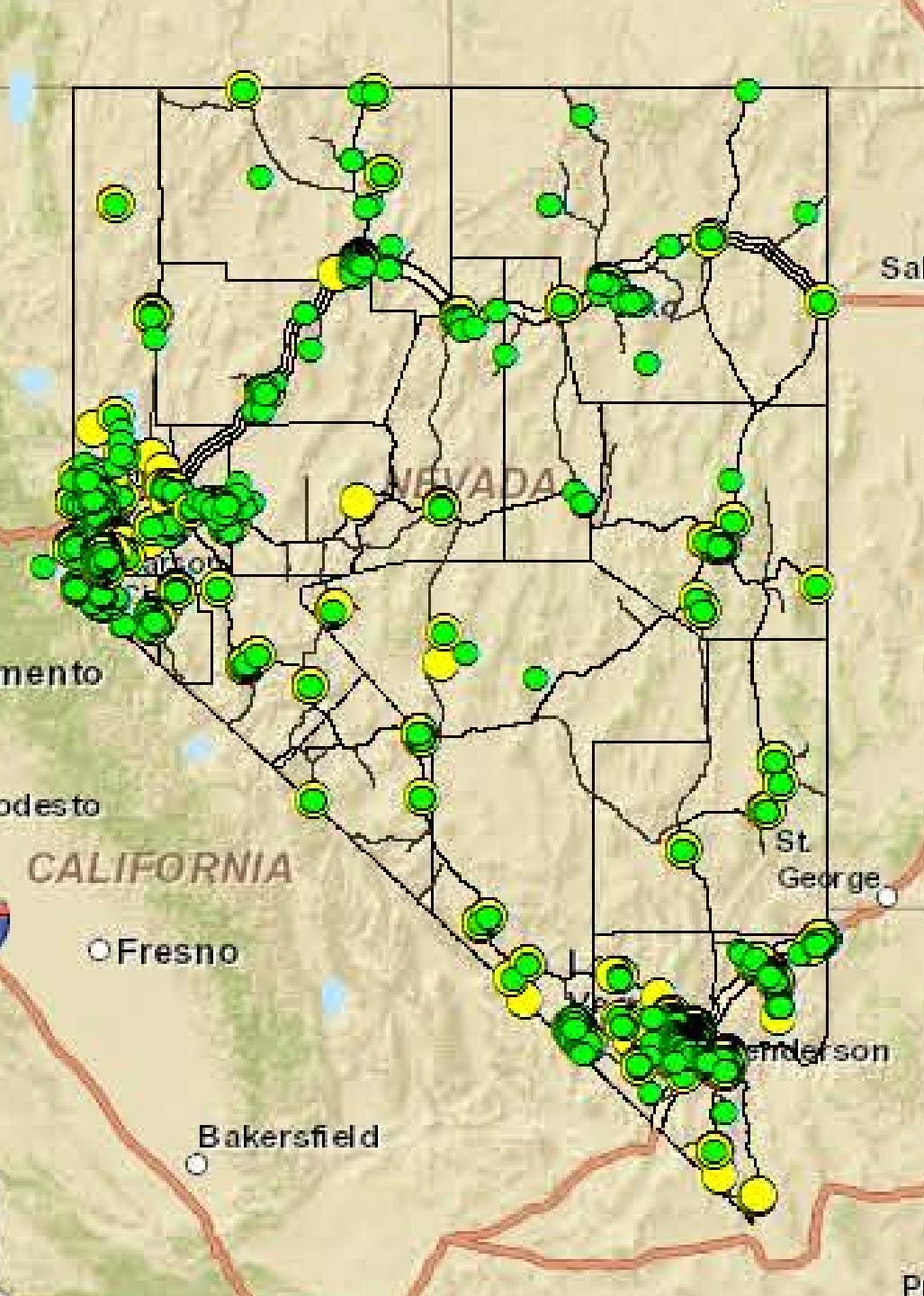


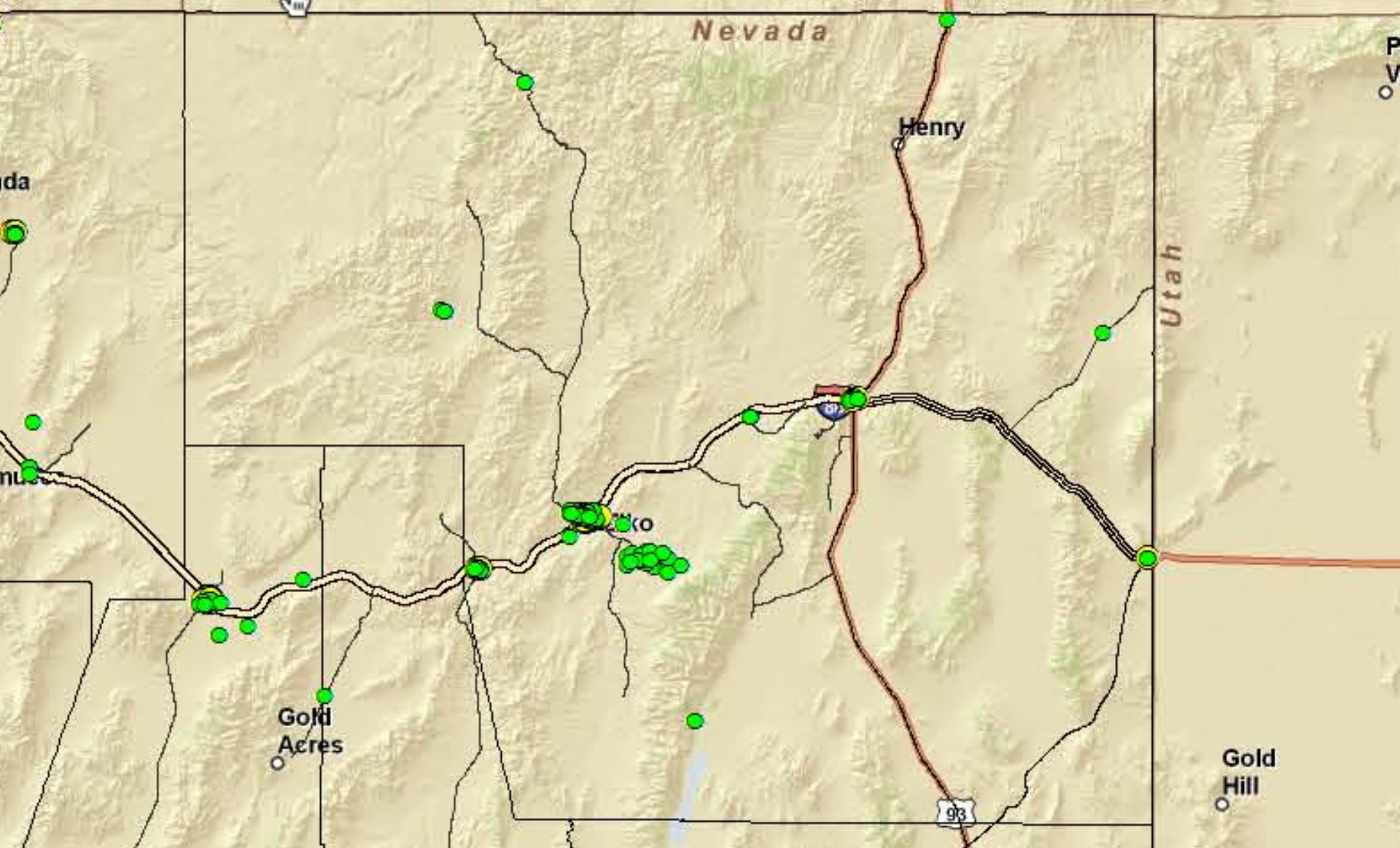
Front and back of the hotel after
the earthquake



Some possible URMs in Nevada

- Commercial
- Residential





Some possible URMs in Elko County

● Commercial

● Residential

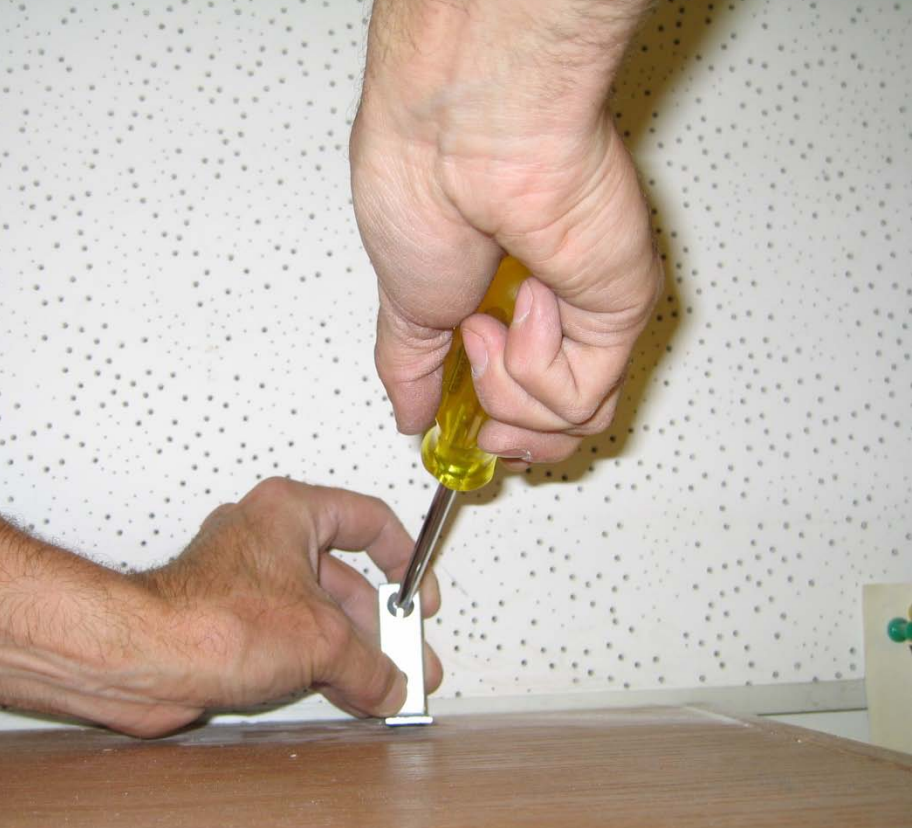
Some possible URM's in Elko

● Commercial

● Residential



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.

