

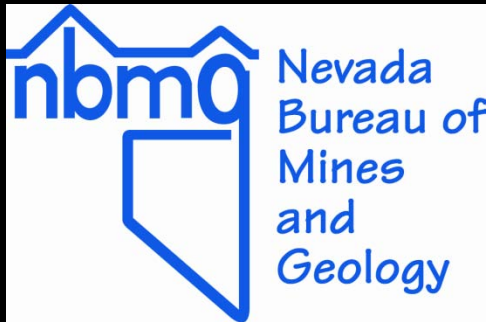
Earthquake Hazards in Pershing County

Presentation to the Nevada Hazard Mitigation Planning Committee

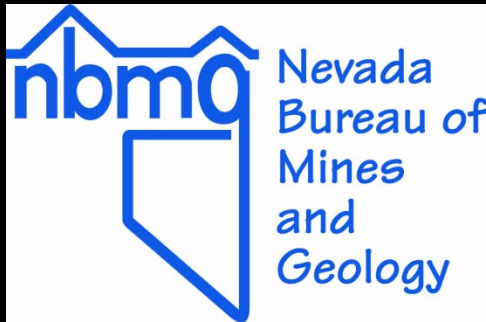
26 August 2010

by Jonathan G. Price

Nevada Bureau of Mines and Geology

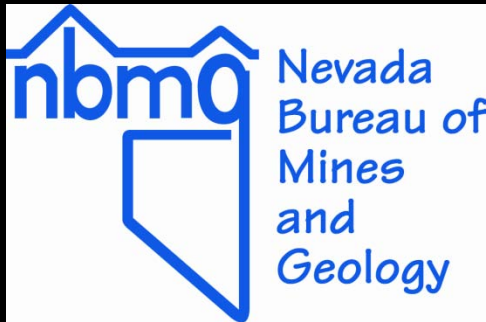


**Earthquake faults occur throughout Nevada,
and potential losses from earthquakes are high
for many communities.**



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



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

Find Us on all Your Devices

Effect of a 10-min pre-exercise meal, designed to contain all the essential amino acids, on myoelectric fatigue index. In subjects of both sexes, pre-exercise meal containing all the essential amino acids reduced the fatigue index by 20% after 10 min of exercise.



Allow all Write Merges

the 1990s, the number of people in the United States who are obese has increased by 50 percent. In 1990, 15 percent of the population was obese, and by 2000, 25 percent was obese. The increase in obesity is a major public health problem because it is a leading cause of heart disease, diabetes, and other chronic diseases. The increase in obesity is also a major public health problem because it is a leading cause of heart disease, diabetes, and other chronic diseases. The increase in obesity is also a major public health problem because it is a leading cause of heart disease, diabetes, and other chronic diseases.



Free will is free. Move out.

the ability to work with others. The results of the study suggest that the use of the model can be used to enhance the effectiveness of the team. The study also suggests that the model can be used to enhance the effectiveness of the team. The study also suggests that the model can be used to enhance the effectiveness of the team.

Figure 2 shows that the average number of correct responses for the 10 trials was 10.5 for the 10 trials, 10.5 for the 10 trials, and 10.5 for the 10 trials. The average number of correct responses for the 10 trials was 10.5 for the 10 trials, 10.5 for the 10 trials, and 10.5 for the 10 trials.

These results suggest that the use of a 10-min, 3-min, and 1-min sample for getting feedback, many of the teachers in the sample used with the instrument actually wanted a variety of time ranges. To provide this, the data from all three sample lengths is being made



Figure 1. 3D plot of the estimated mean response for the 1000 simulated datasets. The 3D plot shows the estimated mean response for the 1000 simulated datasets. The x-axis represents the treatment group (0, 1, 2), the y-axis represents the time point (0, 1, 2), and the z-axis represents the estimated mean response (0, 1, 2). The plot shows a clear trend of increasing response over time and treatment group.

Date	Earthquake Magnitude	Type of Displacement	Max. Offset (mm)	Max. Length (mm)
1906	6.5-7	SW, NE-S	40,000-100,000	1,000,000
1907	7.0-8	E	1,000-2,000	60,000
1908	7.5	SE	8,000-10,000	60,000
1909	7.0-8	SE, NE-S	2,000-10,000	100,000
1910-11	6.0-8	SE, NE-S	0	100,000
1912-13	6.0-8	SE, NE-S	0	100,000
1914	6.0-8	SE	0.5-1,000	80,000
1915	7.0-8	SE, NE-S	1,000-2,000	100,000
1916-18	6.0-8	SE	1,000-2,000	100,000
1919	7.0-8	SE, NE-S	0.5-1,000	50,000

Source: Smith (1980), Smith and Johnston (1983), Johnston (1988), Johnston and Smith (1990), Johnston et al. (1994).

Type of Fault Movement

Information on school status is available. The assessment instrument includes questions on the type and quality of the school environment.



consequently, just because it is the case that the fact itself is at an angle, it is a questionable move to infer from this that it is also the case that the fact itself corresponds to the fact exactly as if an angle will now also make up or stand with respect to the idea. For both the slip at an angle, the web connecting the two levels in the hanging early another also have the fact established. This cannot be understood after that appears to be more interesting than understand the hanging elements that

[illegible]

In January 1991, following a preliminary investigation, the following six books were identified as having been written by individuals who are members of the Ku Klux Klan. The sale of

Fund Movement in Nevada

Double-clip fault
A fault in which the hanging wall is displaced both vertically and horizontally.

Normal City-Edge Profile	Urban City Profile	City
		

[illegible]

Quaternary Faults in Nevada - Online Interactive Map

Look for a fault



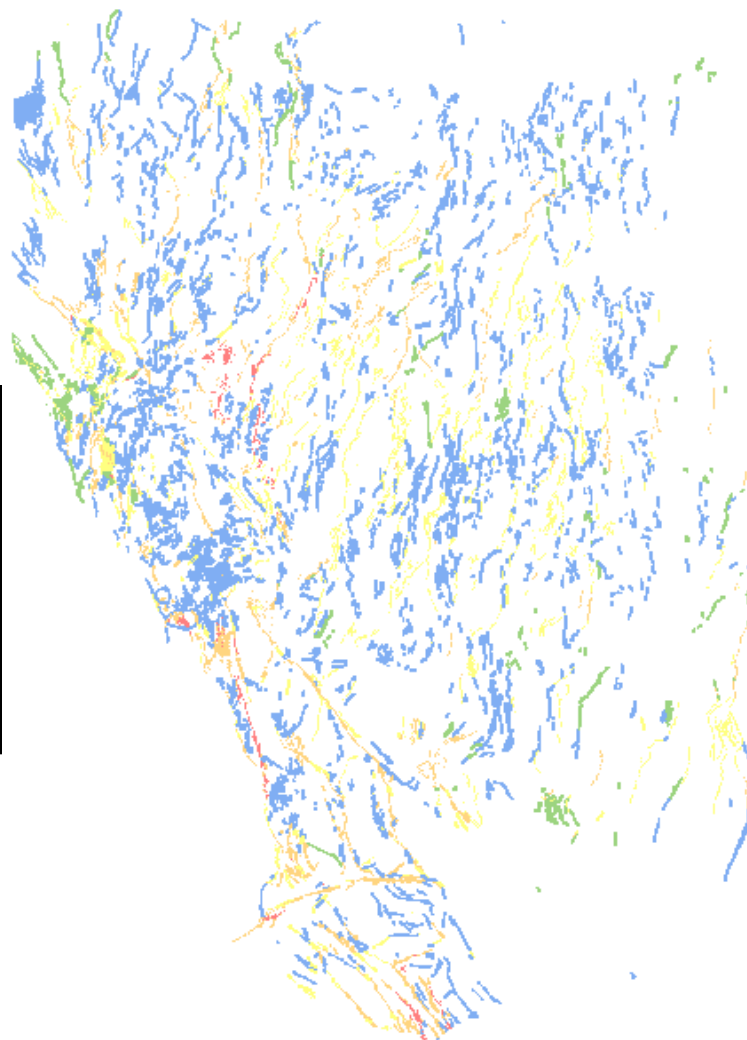
Results

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

Quaternary Faults in Nevada - Online Interactive Map

Easy to pinpoint an address

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

Results

Map Contents

Find an Address

☒ Quaternary

☒ Quaternary

☐ USGS

☒ USGS

Street or Intersection

City

State

ZIP

Find

0 19 38 76 114 152 Miles

Copyright



Quaternary Faluts in Nevada - Online Interactive Map

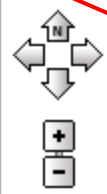
Look for a fault | **Find an Address** | Print a Map

Results

- ☒ **820 6th Street, Lovelock, Nevad**
- ☒ 820 6th St, Lovelock, NV, 89419

Map Contents

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



0 19 38 76 114 152 Miles
Copyright



Quaternary Faults in Nevada - Online Interactive Map

Easy to zoom in on an address

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

Results

☒ 820 6th Street, Lovelock, Nevad

☒ 820 6th St, Lovelock, NV, 89419

☒ Zoom to

☐ Pan to

☒ Remove

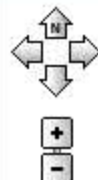
Map Contents

☒ Quaternary_Faults2

☒ Quaternary Faults

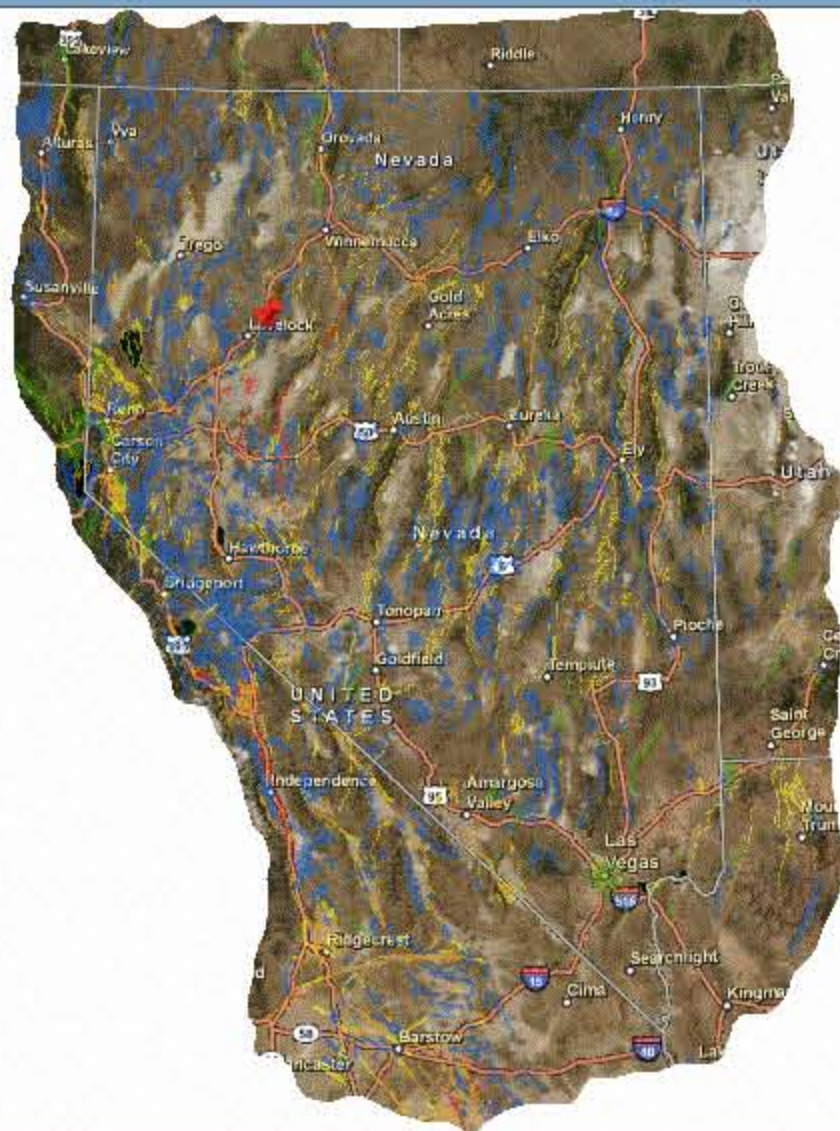
☐ USGS Topo Maps

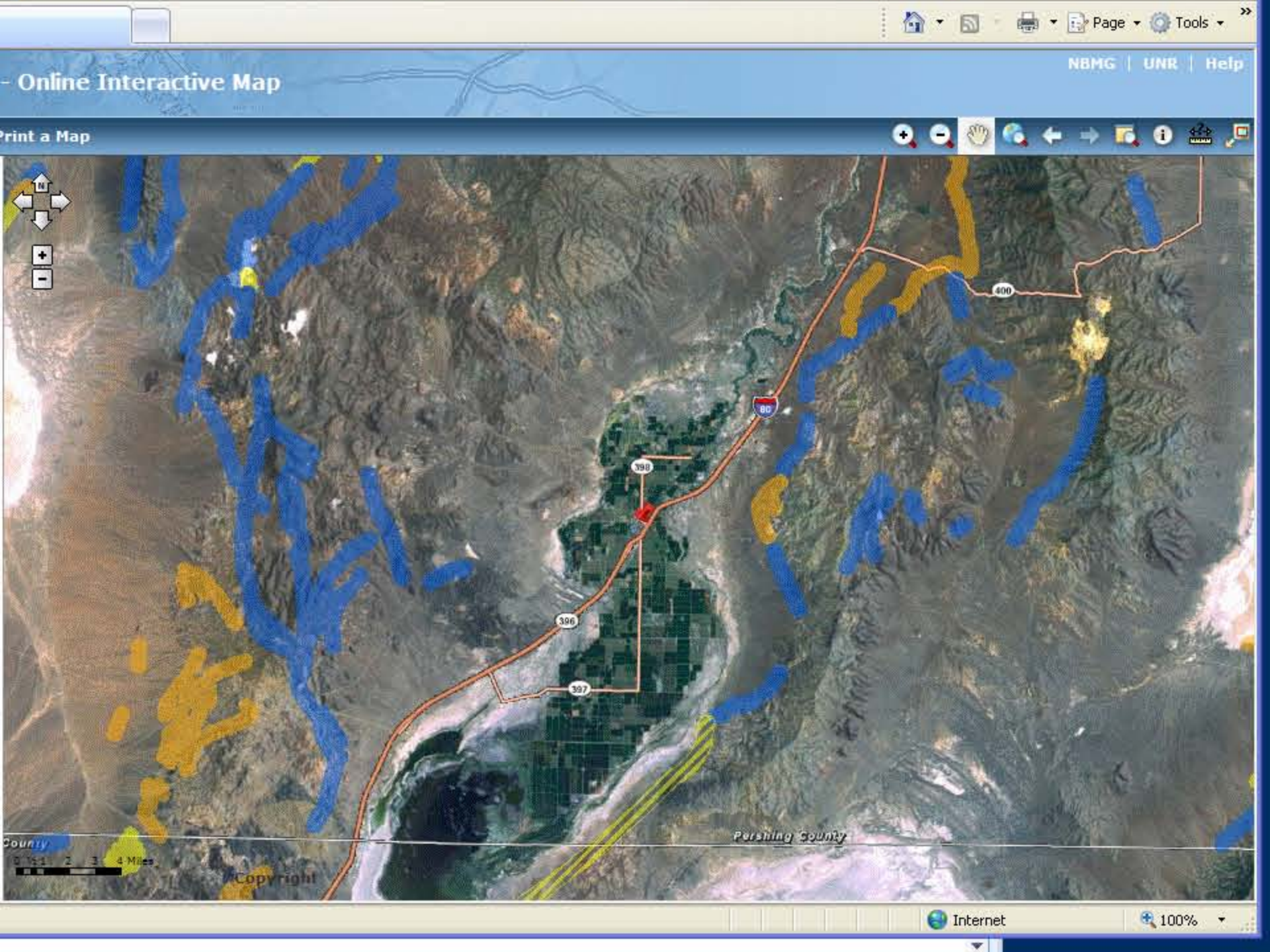
☒ USGS Aerial Imagery



0 19 38 76 114 152 Miles

Copyright





- Online Interactive Map

NBMG | UNR | Help

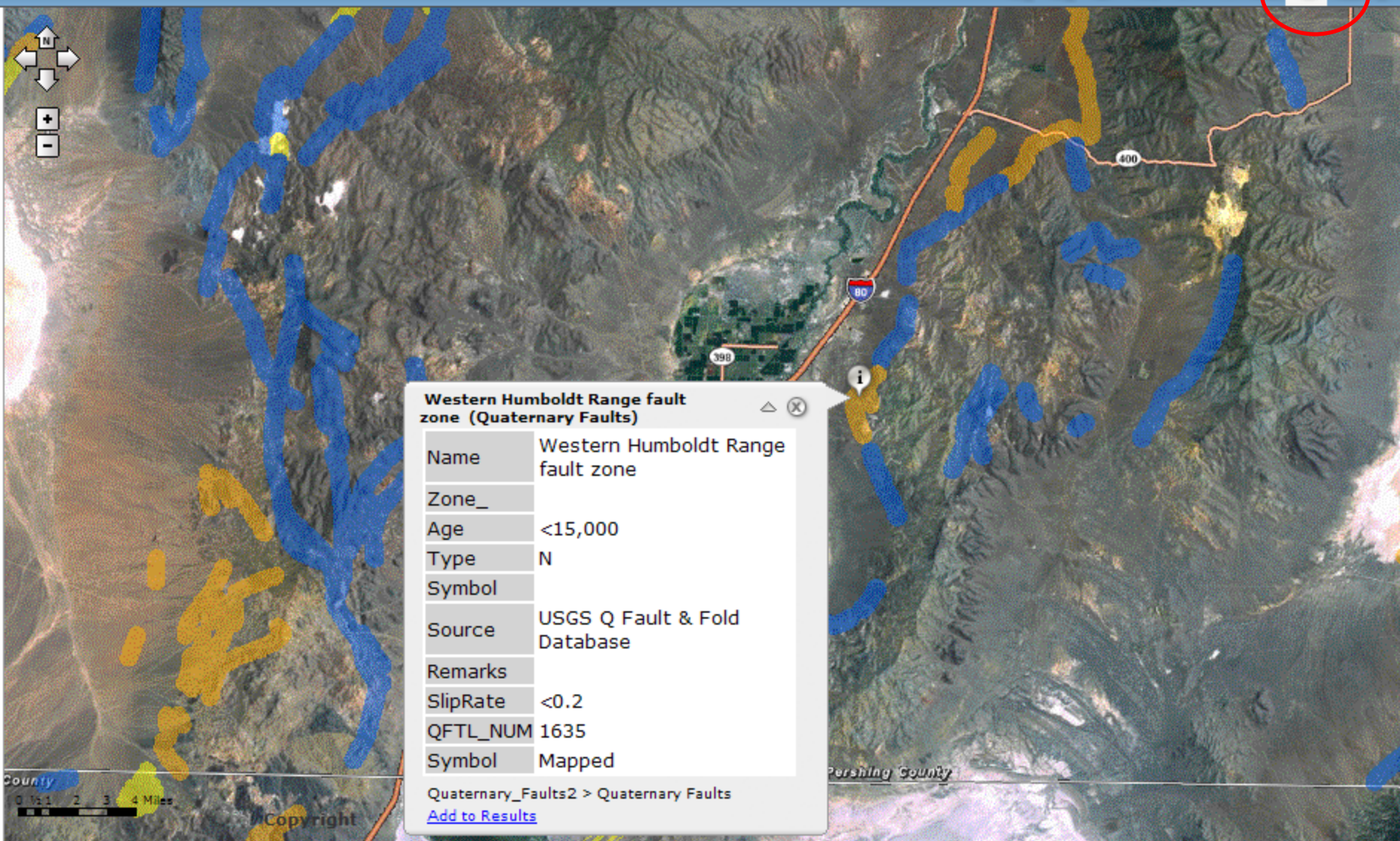
Print a Map



Internet

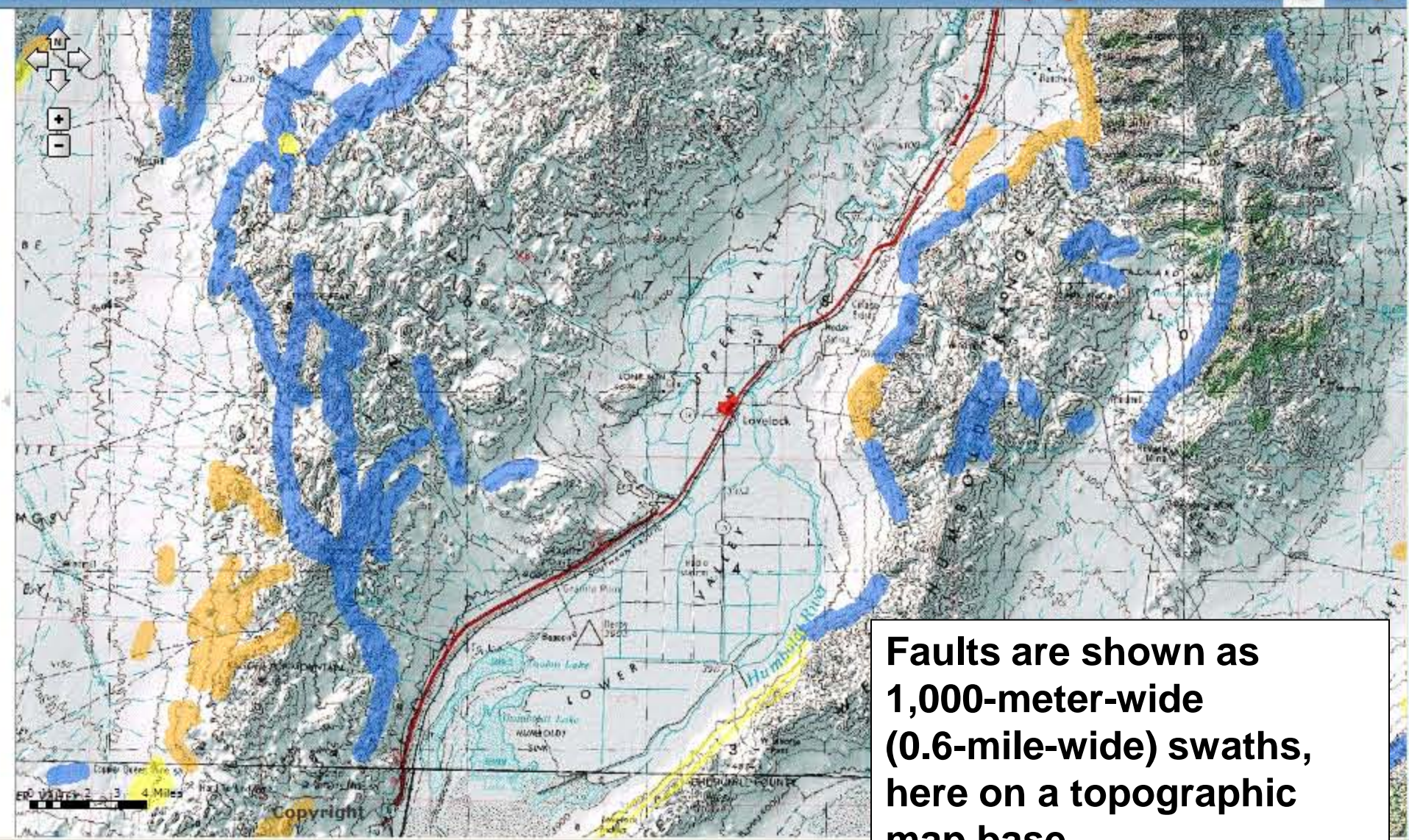
100%

Print a Map



Easy click to view the topographic map

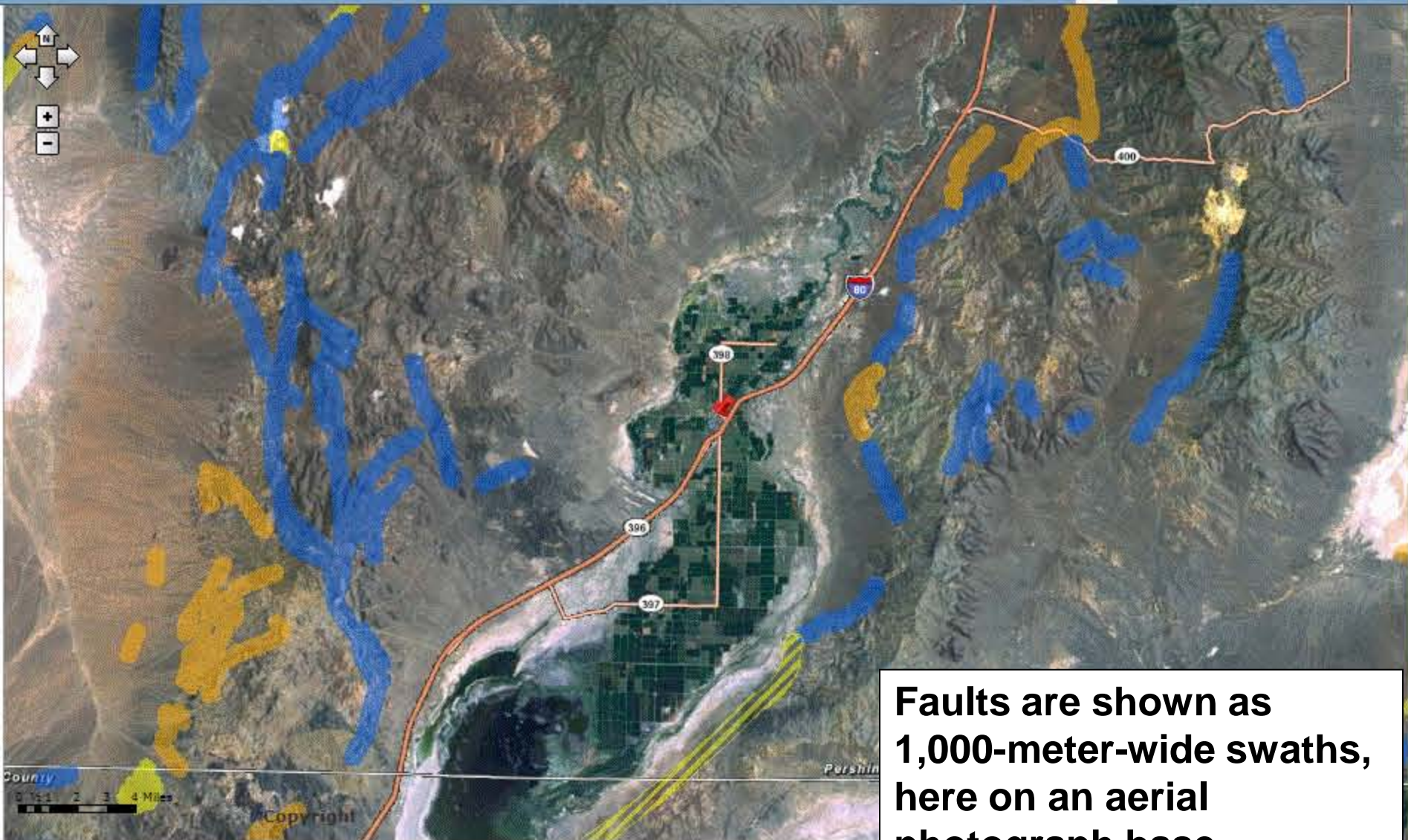
Print a Map



Faults are shown as 1,000-meter-wide (0.6-mile-wide) swaths, here on a topographic map base.

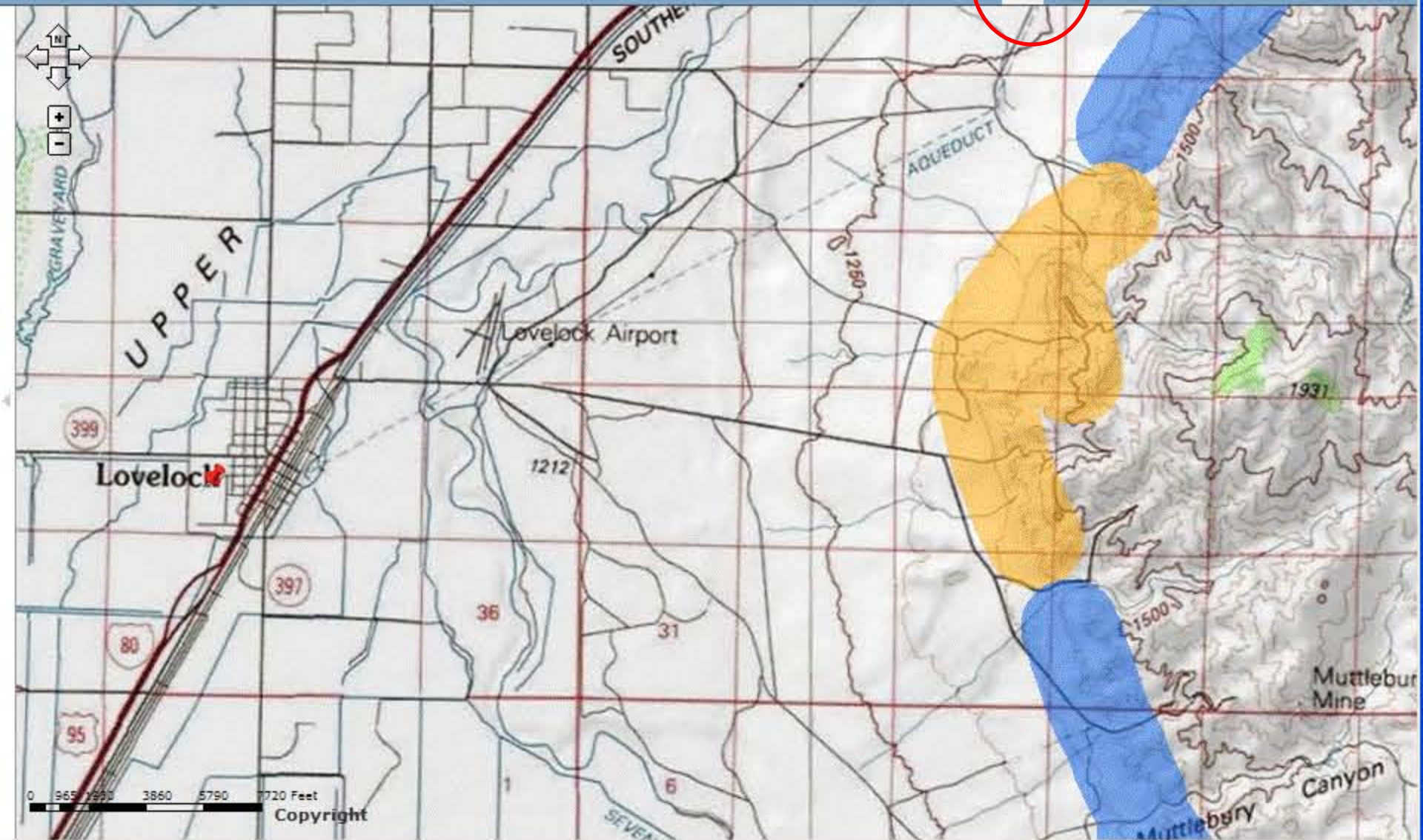
Easy click to return to the aerial photograph

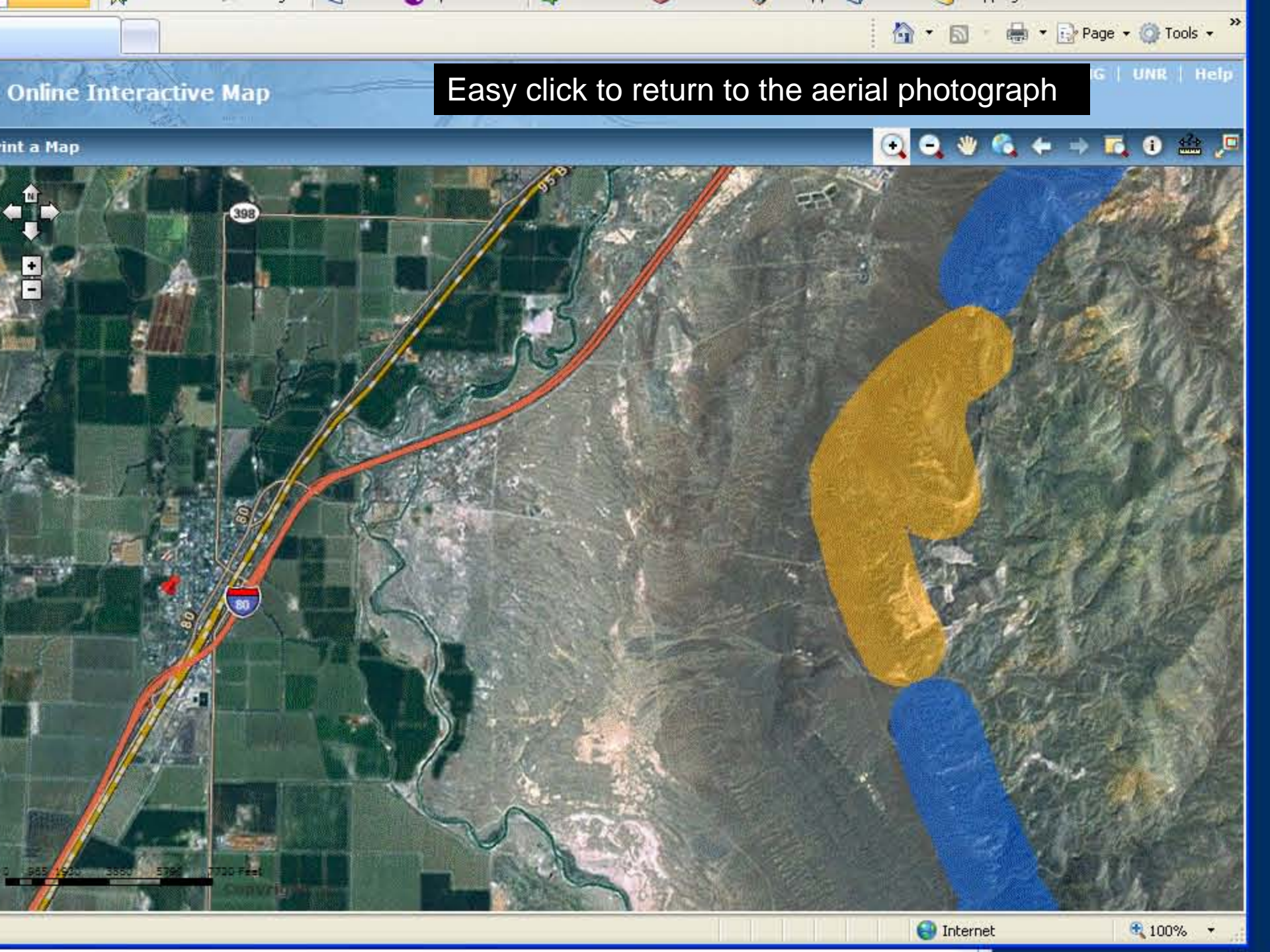
Print a Map



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

Print a Map





Online Interactive Map

Easy click to return to the aerial photograph

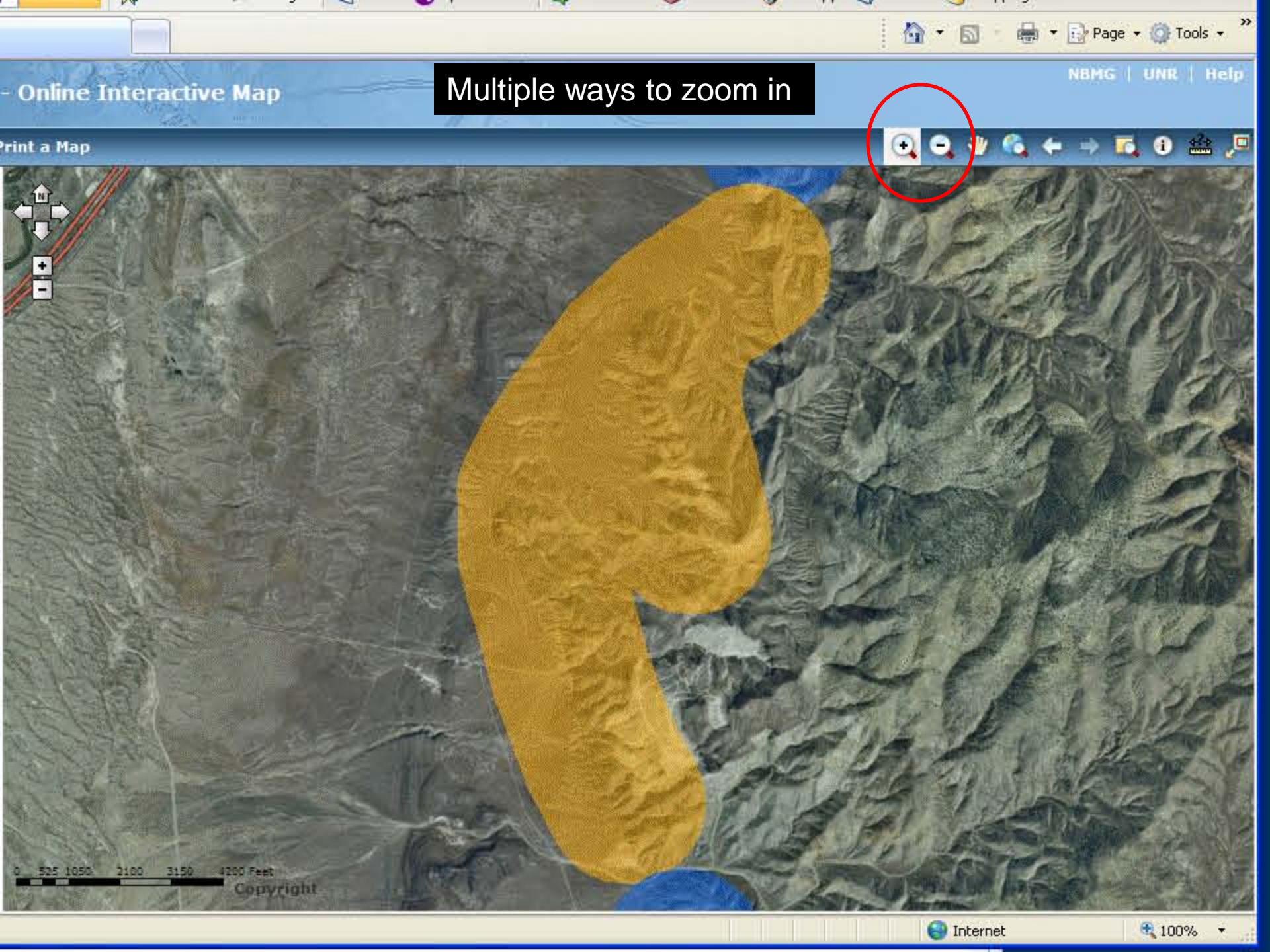
IG | UNR | Help

Print a Map



Internet

100%

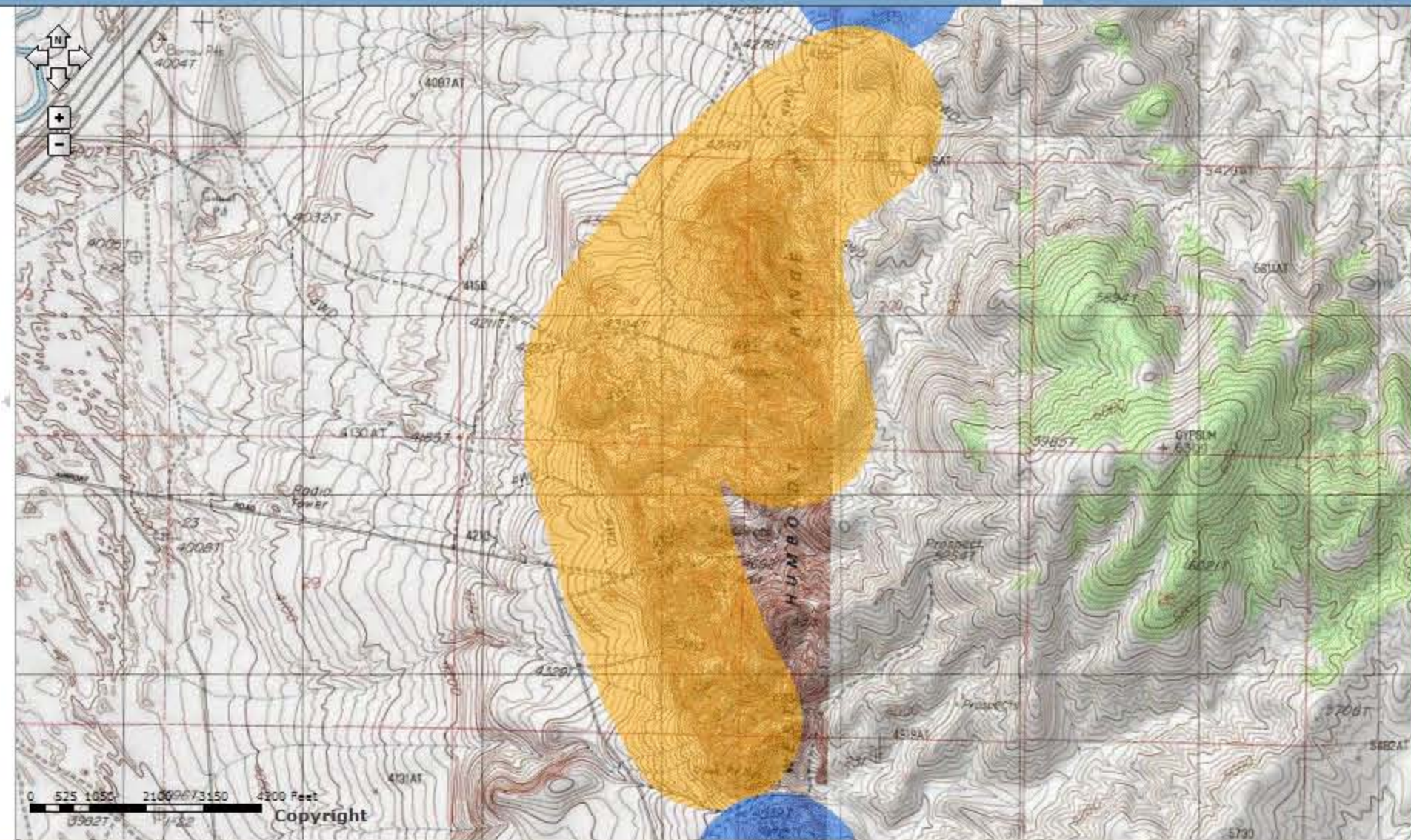


Multiple ways to zoom in

Print a Map



Print a Map



Quaternary faults are commonly visible on aerial photographs

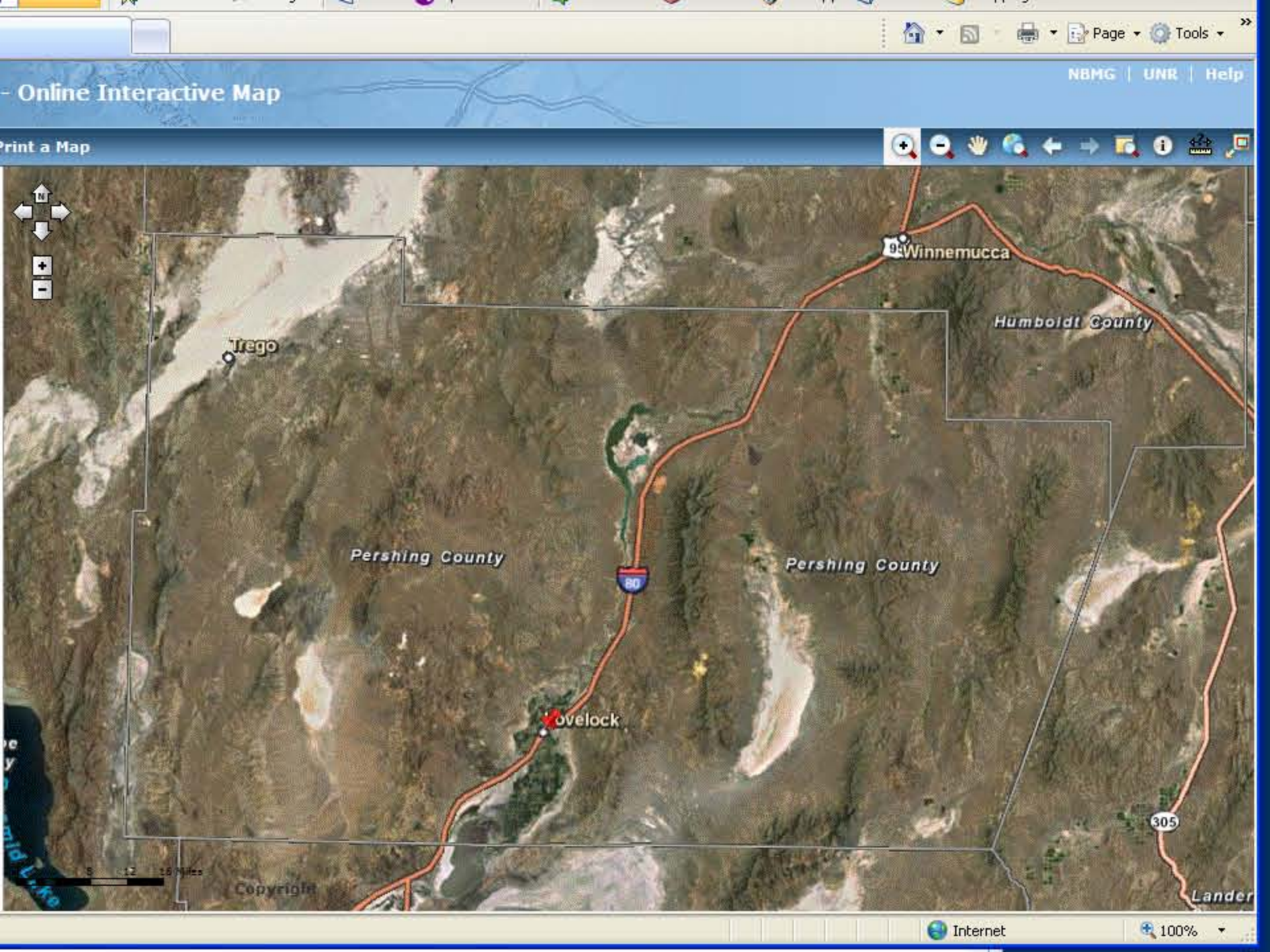
Print a Map



Quaternary faults are commonly visible on aerial photographs.

Print a Map





Online Interactive Map

NBMG | UNR | Help

Print a Map

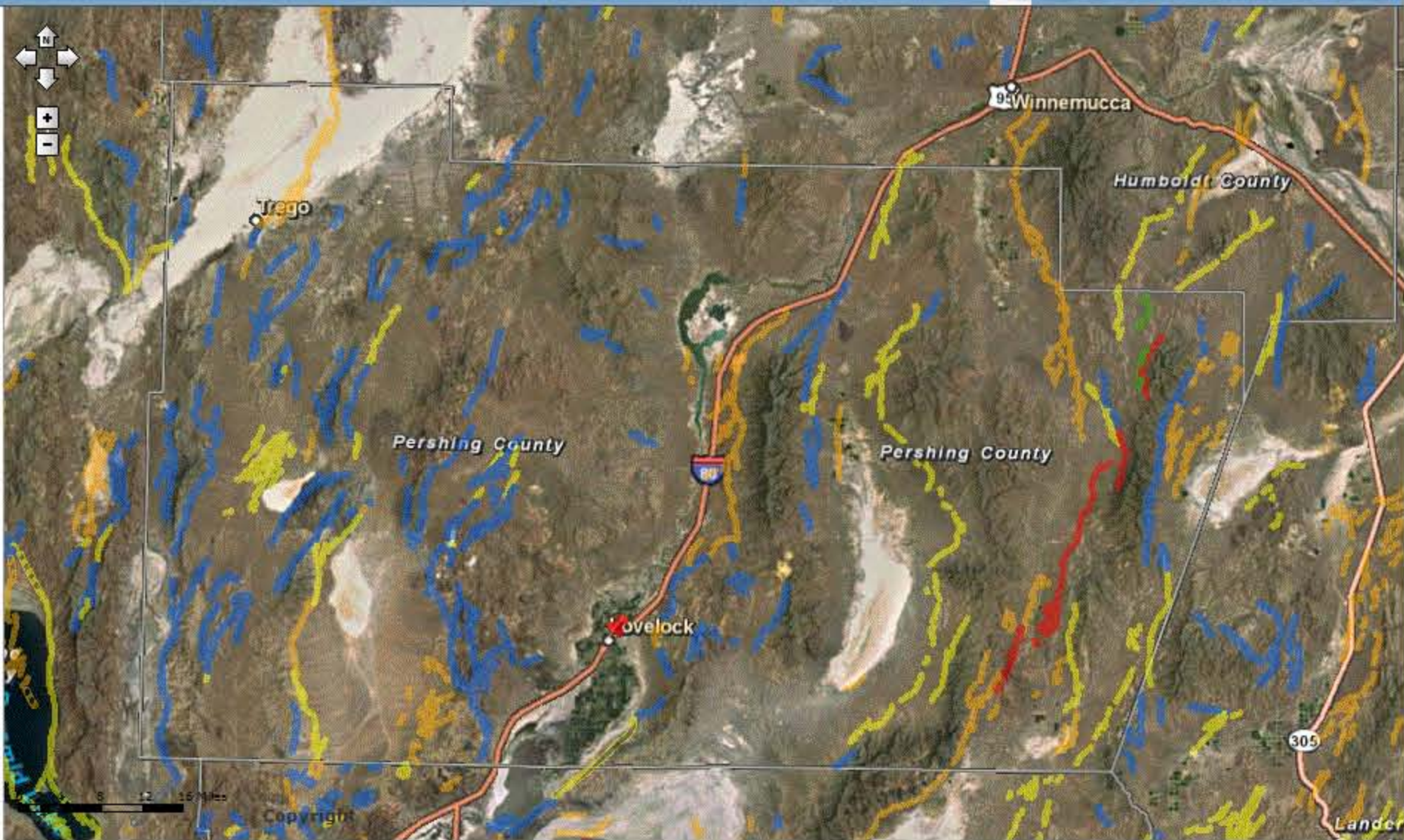


Internet

100%

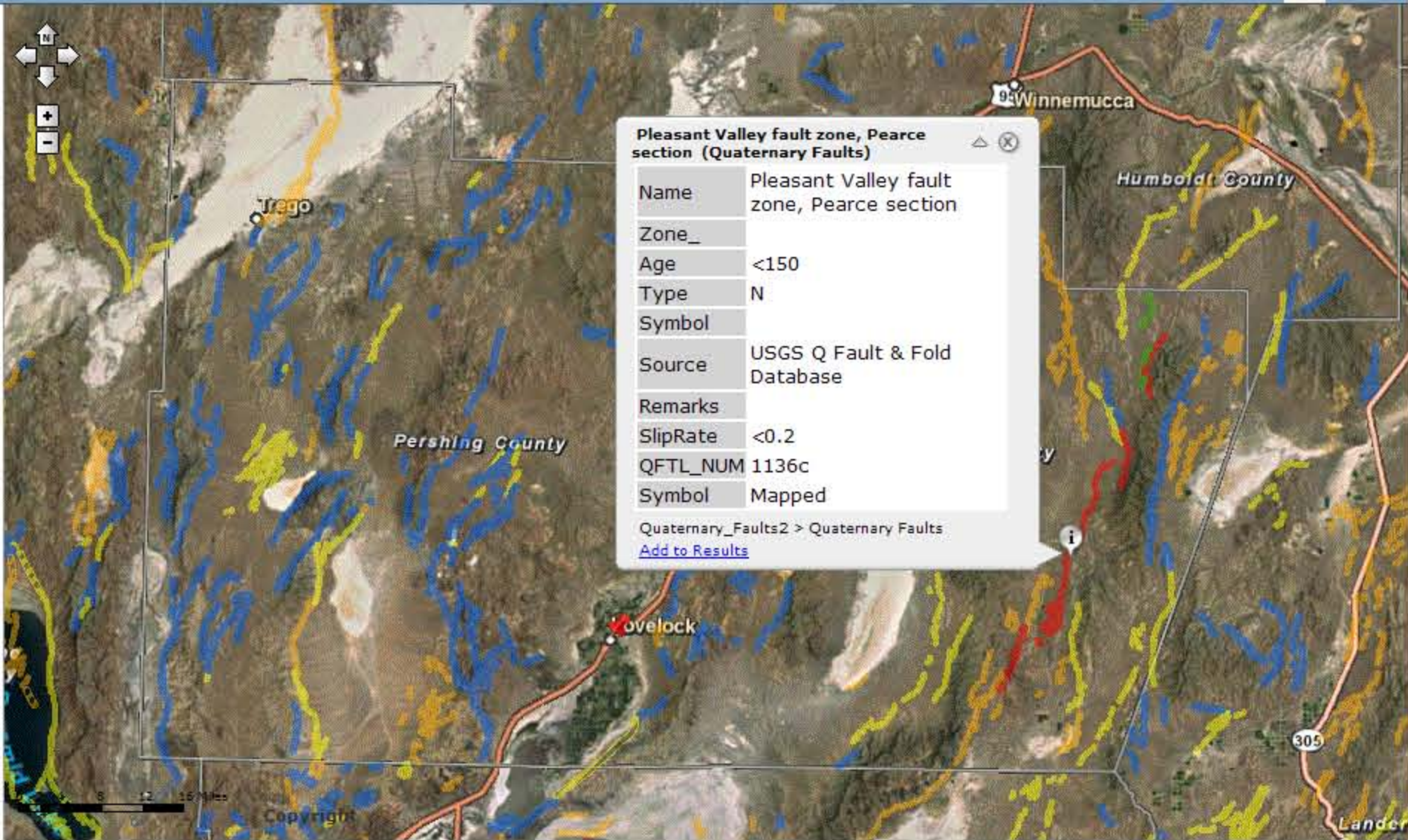
There are active faults nearly everywhere in Pershing County.

Print a Map



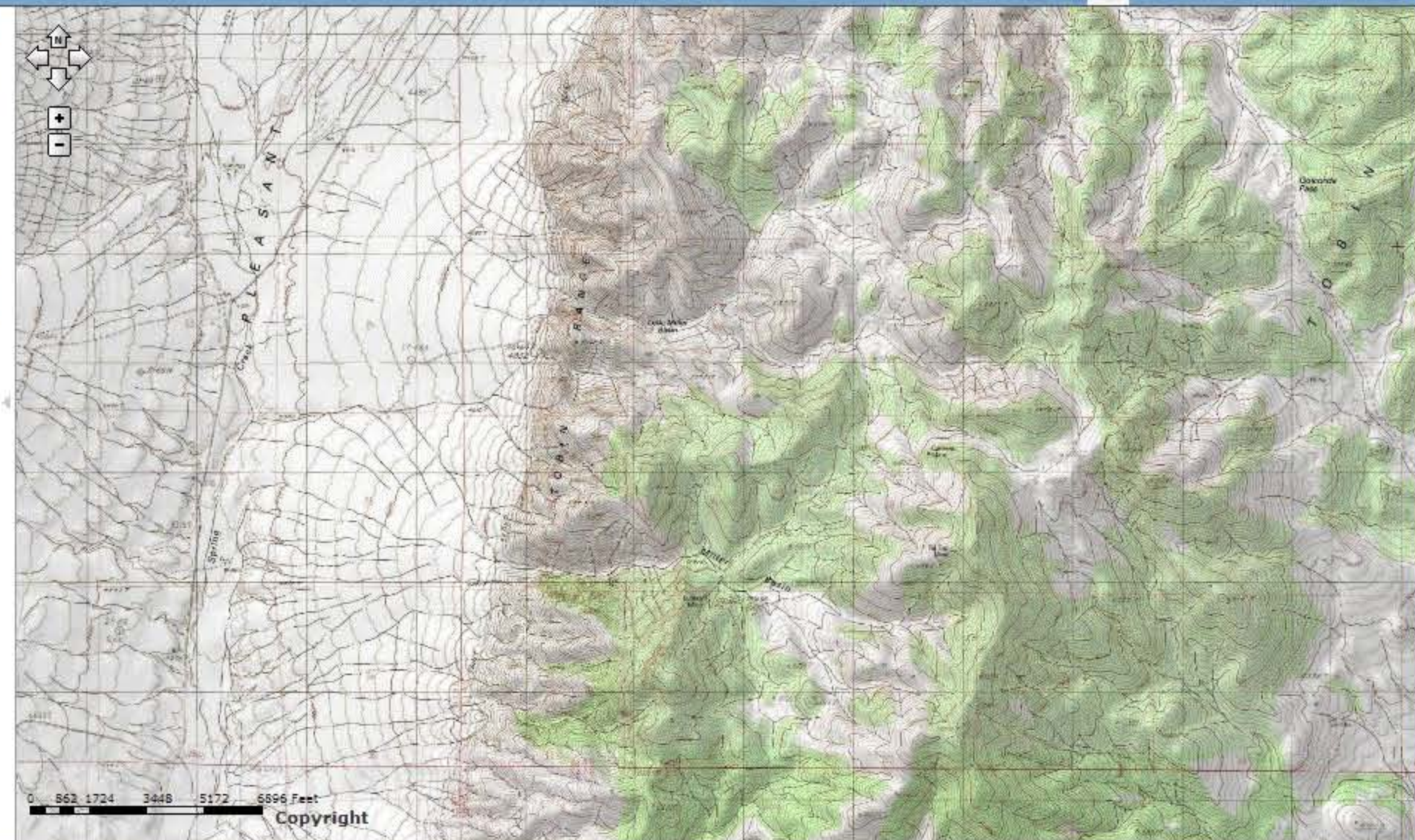
The Pleasant Valley fault had a magnitude 7.3 earthquake in 1915.

Print a Map



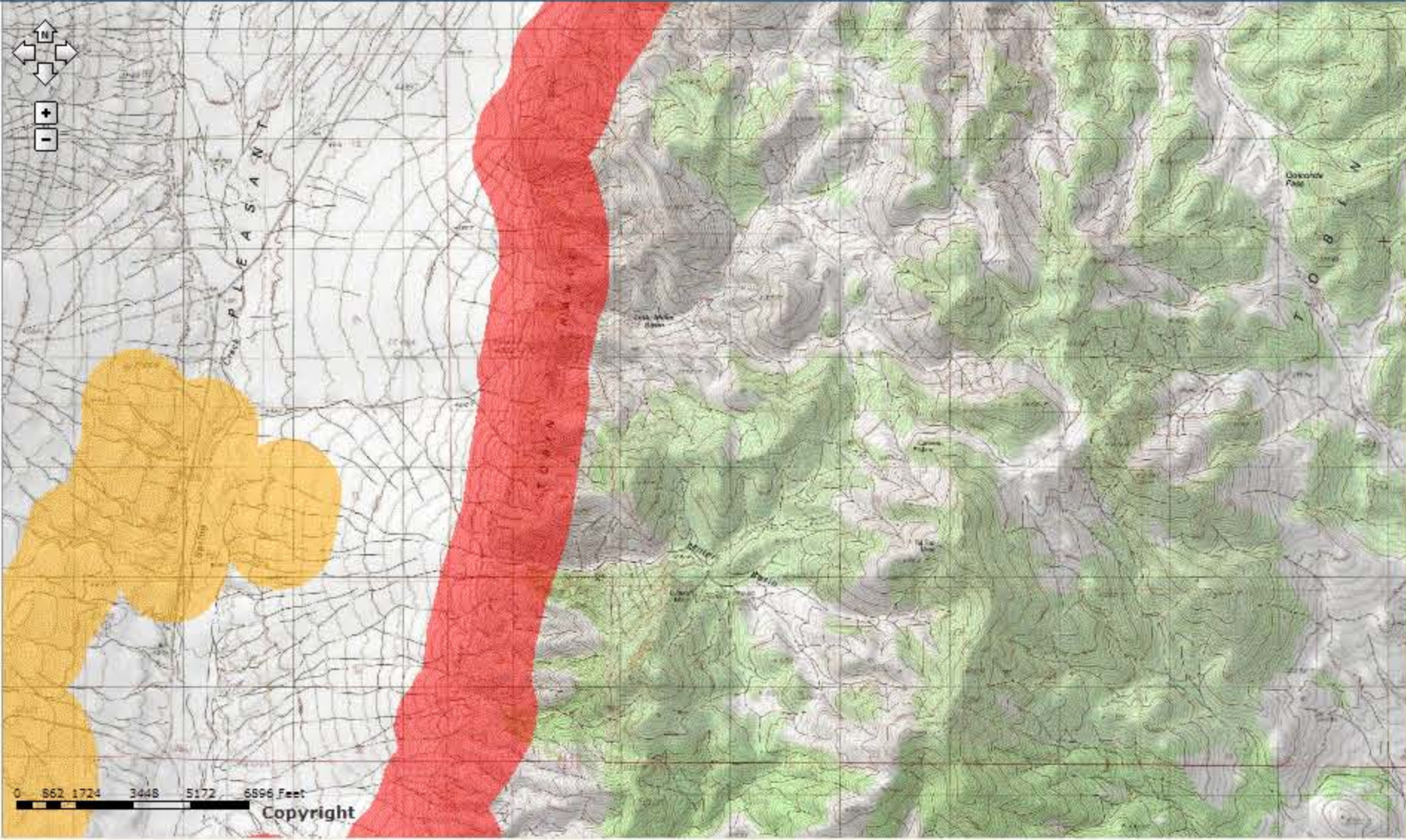
The Pleasant Valley fault had a magnitude 7.3 earthquake in 1915.

Print a Map

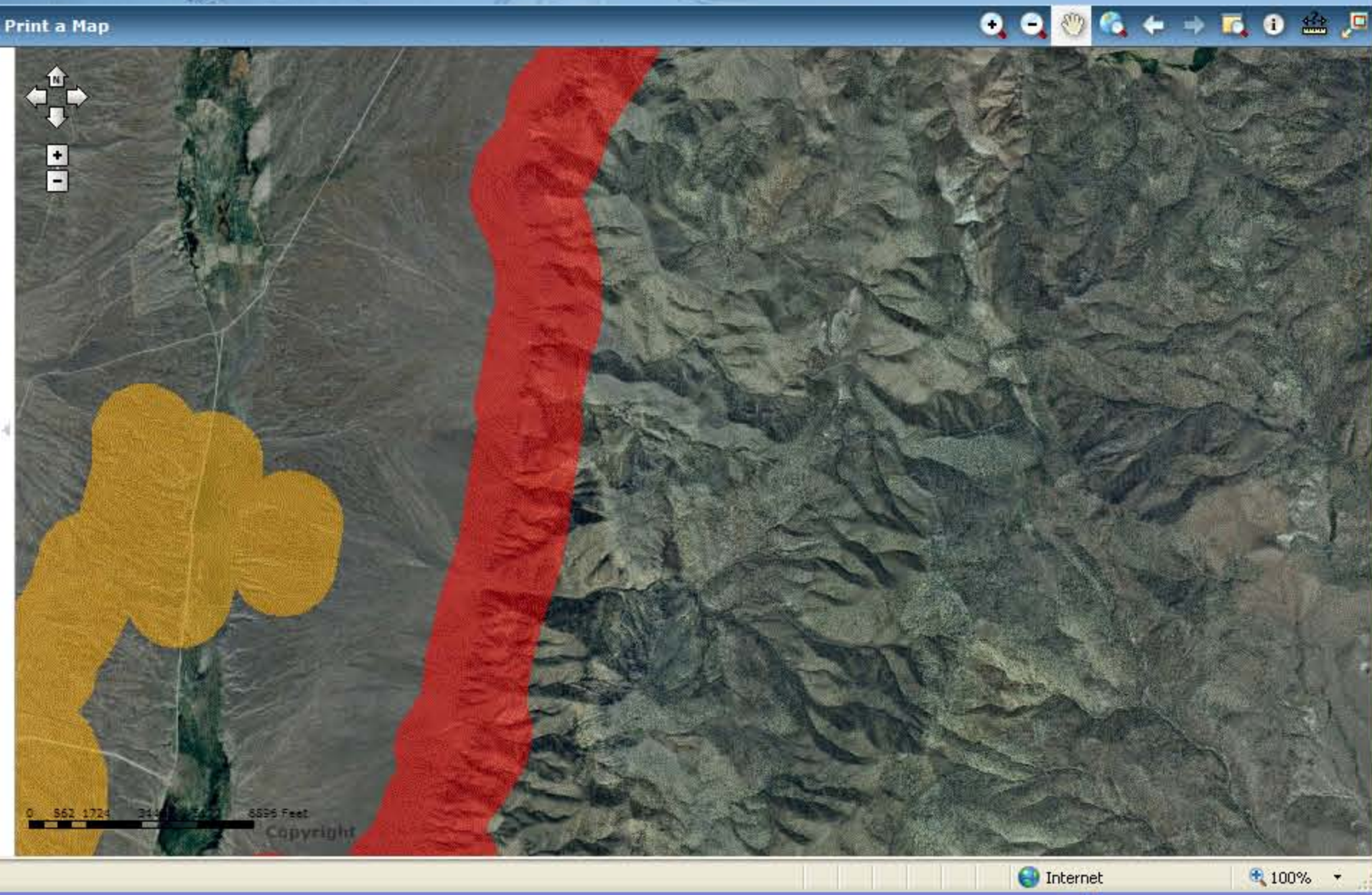


The Pleasant Valley fault had a magnitude 7.3 earthquake in 1915.

Print a Map

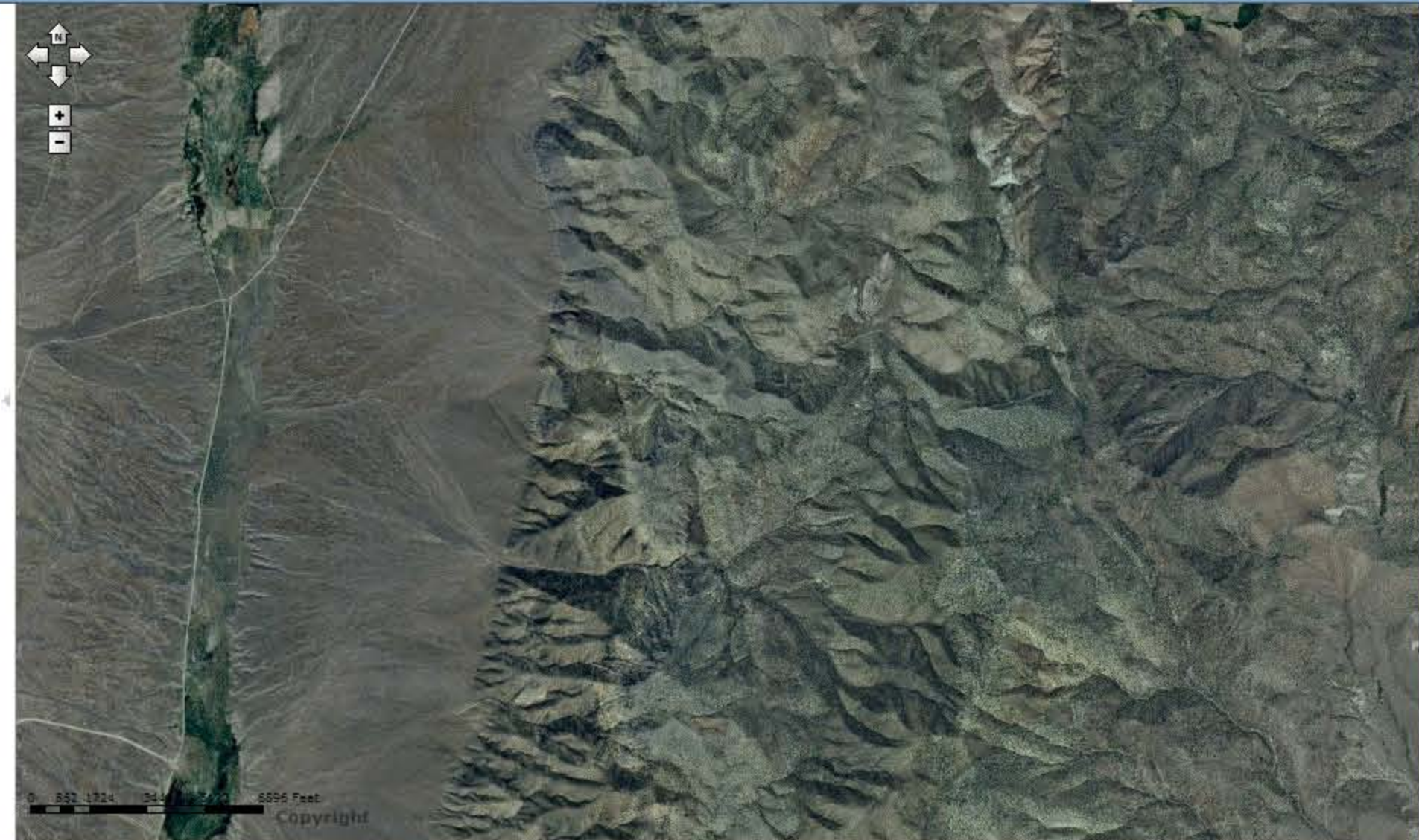


Quaternary faults are commonly visible on aerial photographs.



Quaternary faults are commonly visible on aerial photographs.

Print a Map



Quaternary faults are commonly visible on aerial photographs.

Print a Map



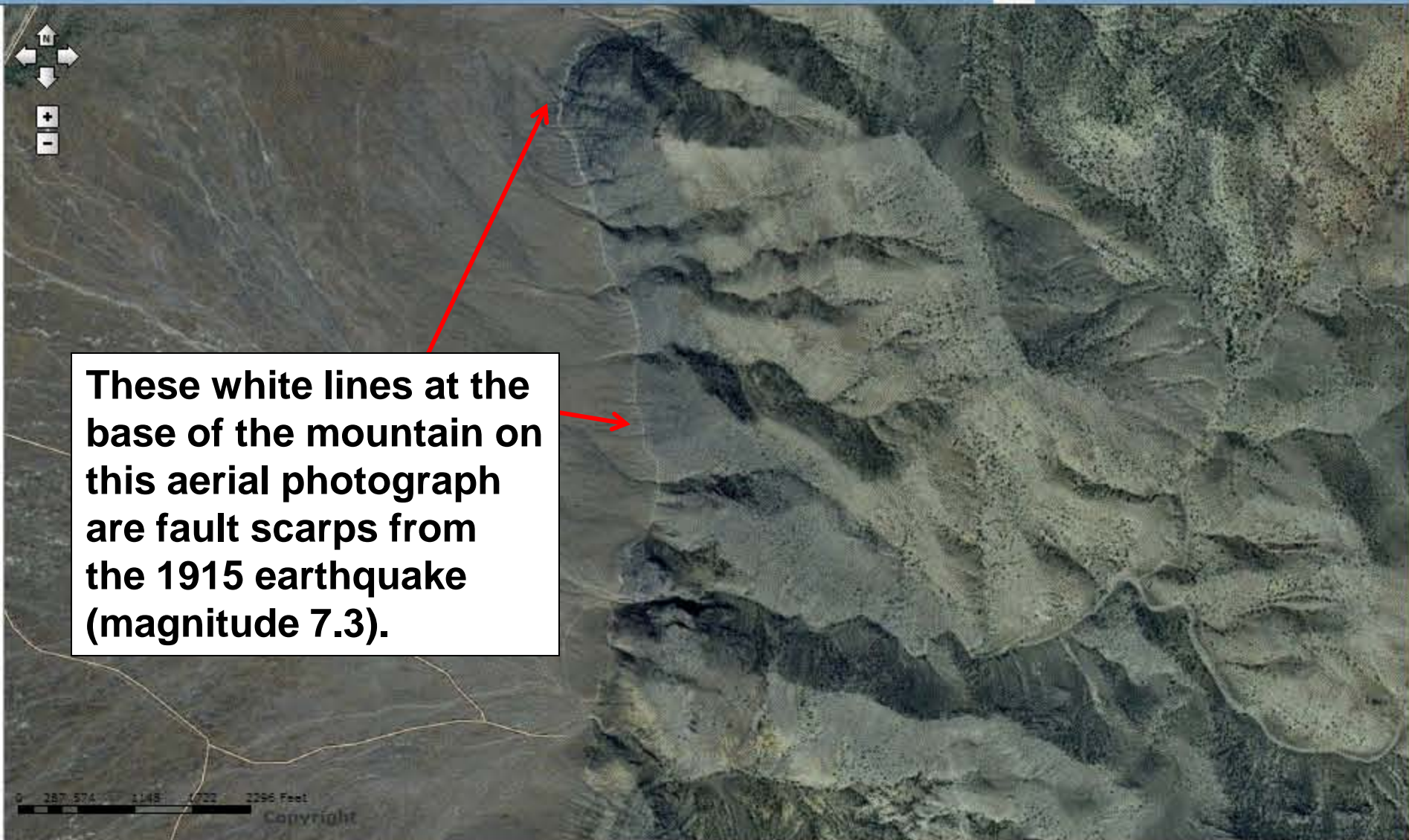
Quaternary faults are commonly visible on aerial photographs.

Print a Map

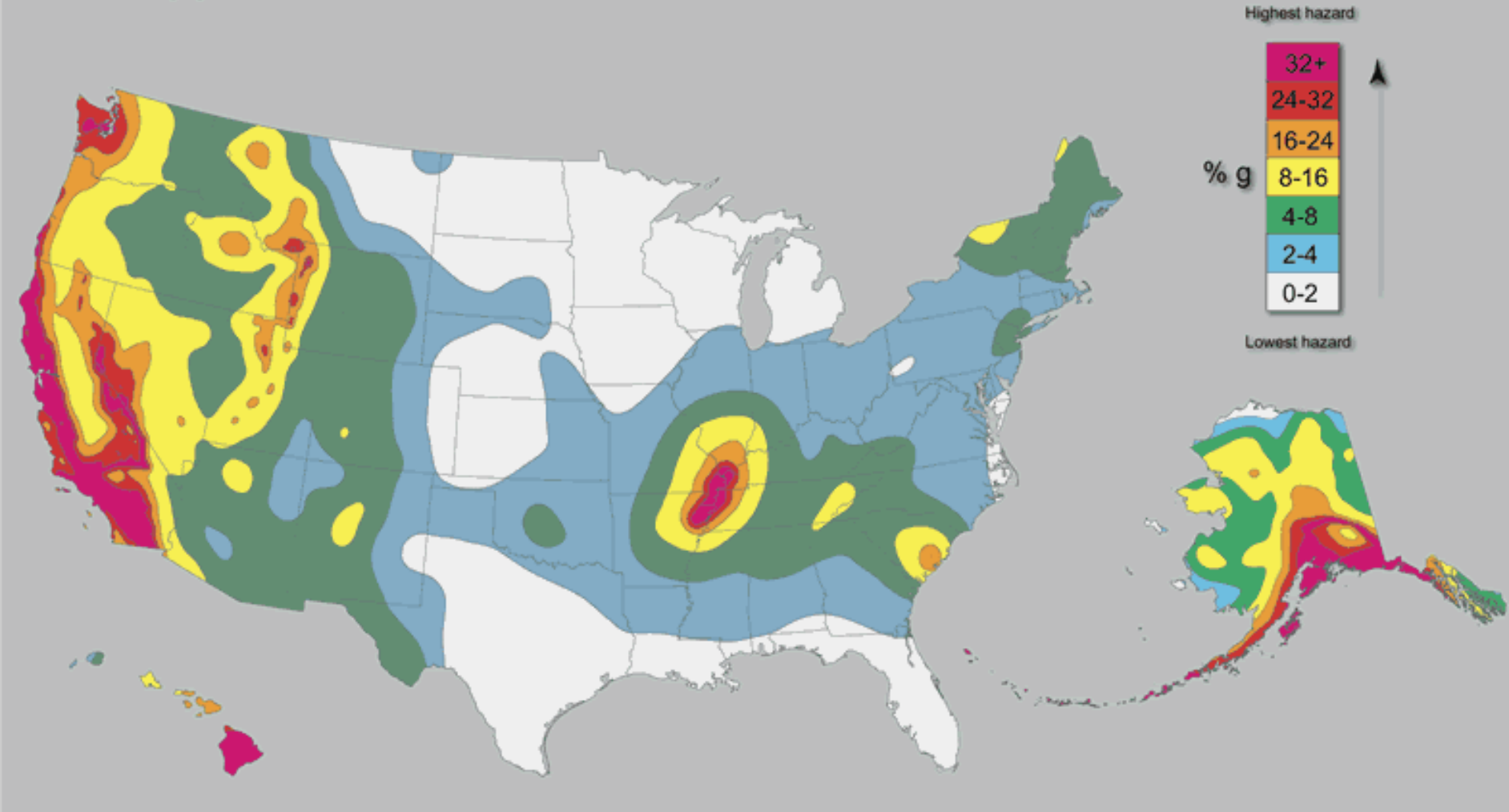


Quaternary faults are commonly visible on aerial photographs.

Print a Map

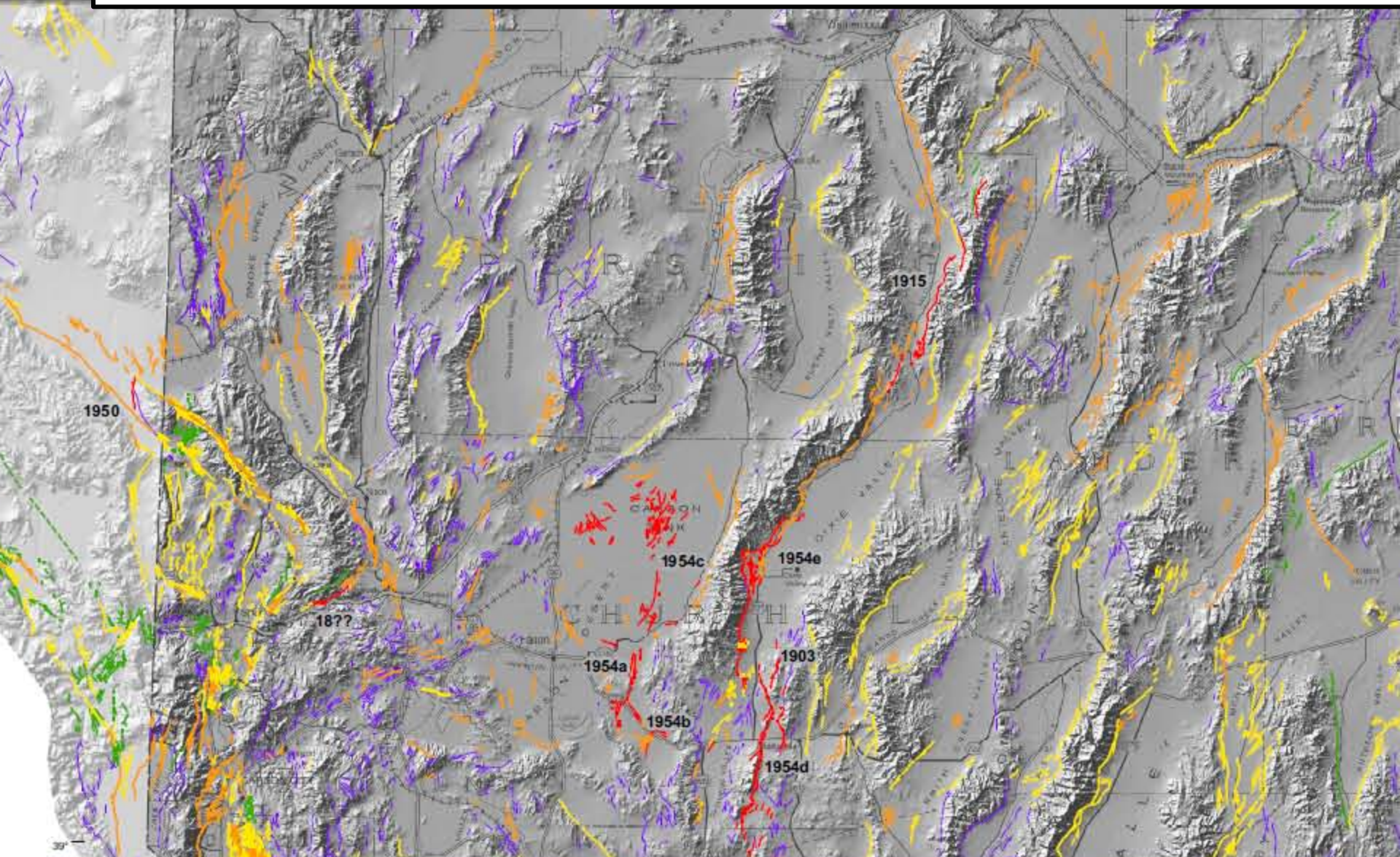


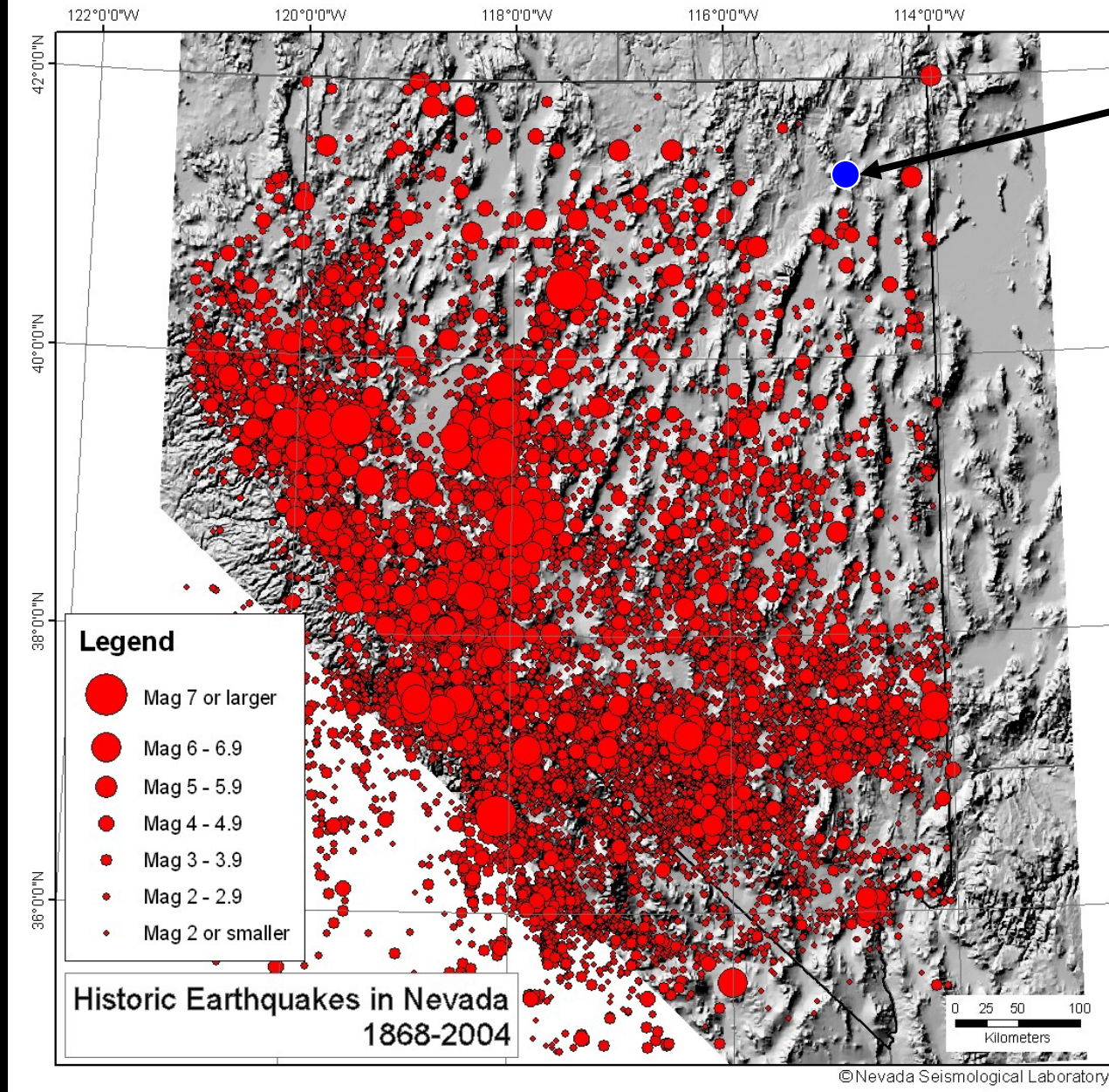
These white lines at the base of the mountain on this aerial photograph are fault scarps from the 1915 earthquake (magnitude 7.3).



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 Pershing County.





Wells
21 Feb 08
M = 6.0

(2) Earthquakes have occurred throughout Nevada.

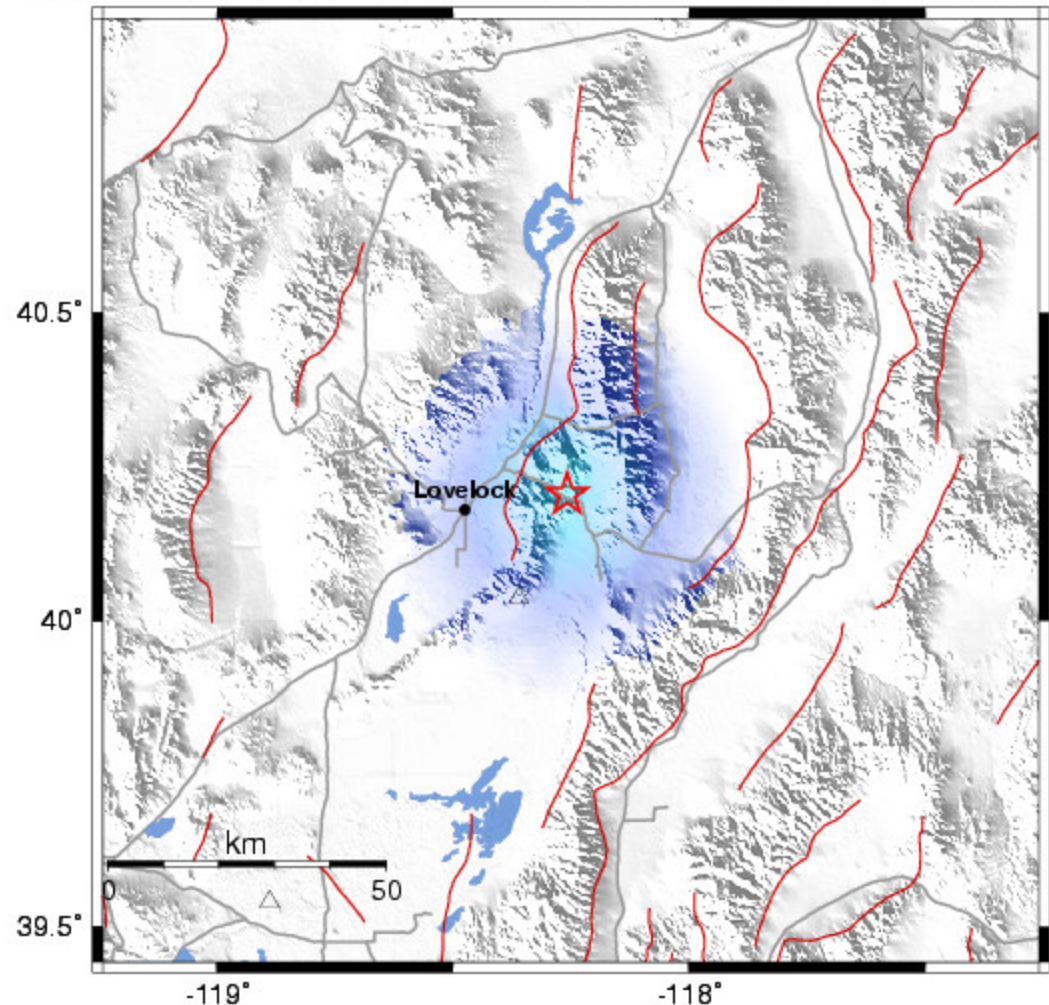
Large Historical Earthquakes in Pershing and Churchill Counties

<u>Date</u>	<u>Magnitude</u>	<u>Near</u>
1852?	7.3	Fallon
1915	7.3	Pleasant Valley
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

NSL ShakeMap : 11.6 miles E of LOVELOCK-NV
 Wed Nov 8, 2006 12:03:10 AM PST M 3.7 N40.21 W118.26 Depth: 10.1km ID:2006312_191620

ShakeMap from the Nevada Seismological Laboratory at UNR

**Magnitude 3.7
12 miles E of
Lovelock
on Nov. 8, 2006**



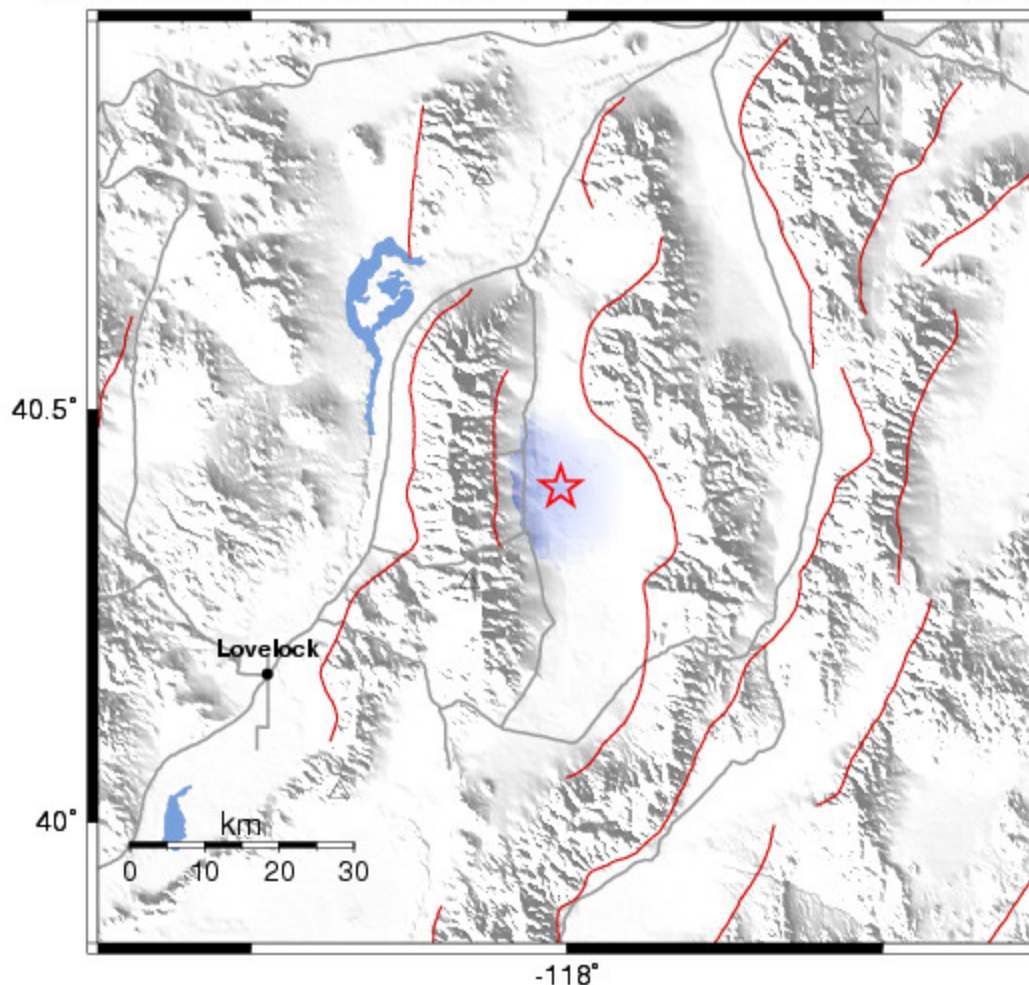
Map Version 11 Processed Wed Mar 7, 2007 02:08:13 PM PST,

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+

ShakeMap from the Nevada Seismological Laboratory at UNR

**Magnitude 2.9
29 miles ENE of
Lovelock
on Dec. 6, 2007**

NSL ShakeMap : 29.1 miles ENE of LOVELOCK-NV
Thu Dec 6, 2007 12:40:50 PM PST M 2.9 N40.41 W118.01 Depth: 0.0km ID:2007340_226392



Map Version 1 Processed Thu Dec 6, 2007 12:56:38 PM PST, – NOT REVIEWED BY HUMAN

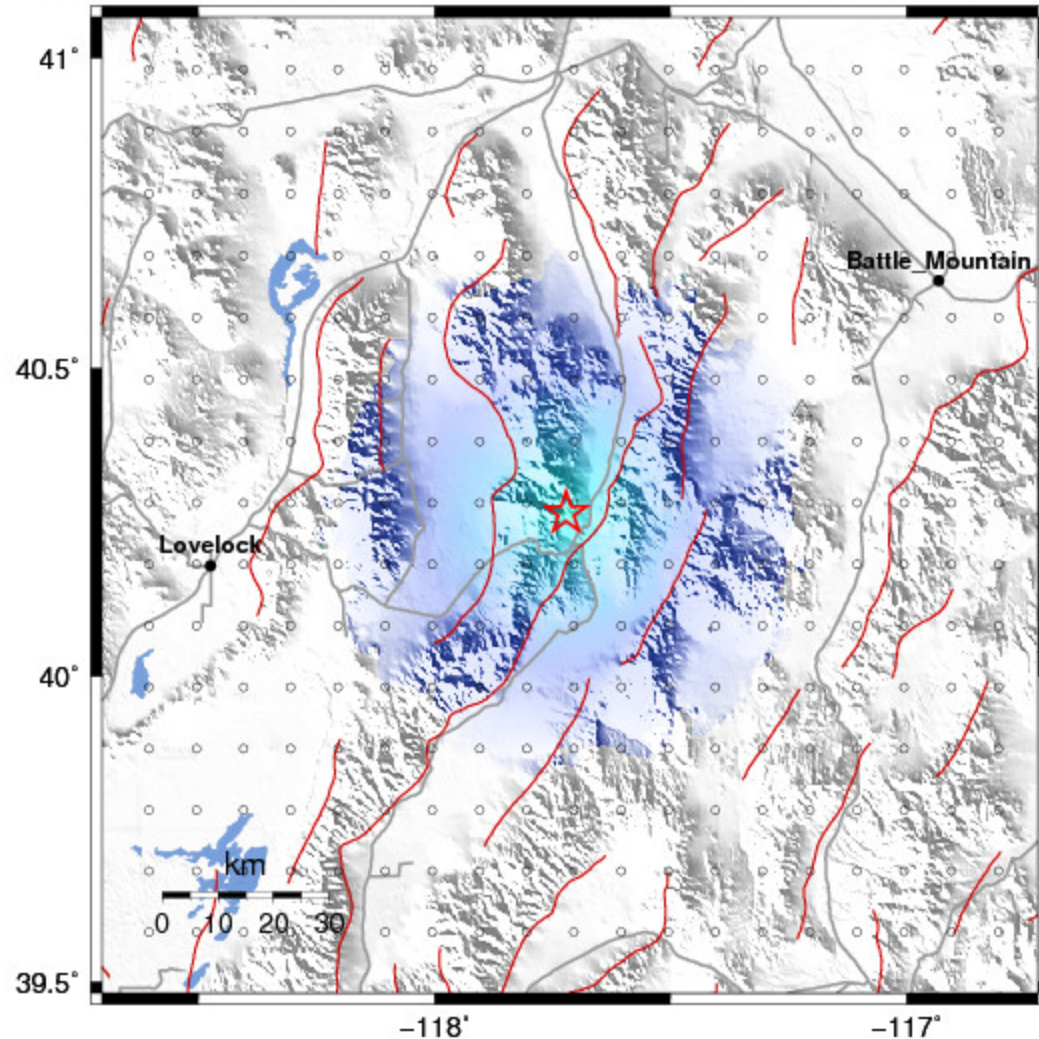
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC (%g)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL (cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16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

NSL ShakeMap : 40.2 miles E of LOVELOCK-NV

Sat Jan 3, 2009 11:57:18 AM PST M 3.7 N40.27 W117.72 Depth: 16.0km ID:2009003_270754

ShakeMap from the
Nevada
Seismological
Laboratory at UNR

Magnitude 3.7
40 miles E of
Lovelock
on January 3, 2009

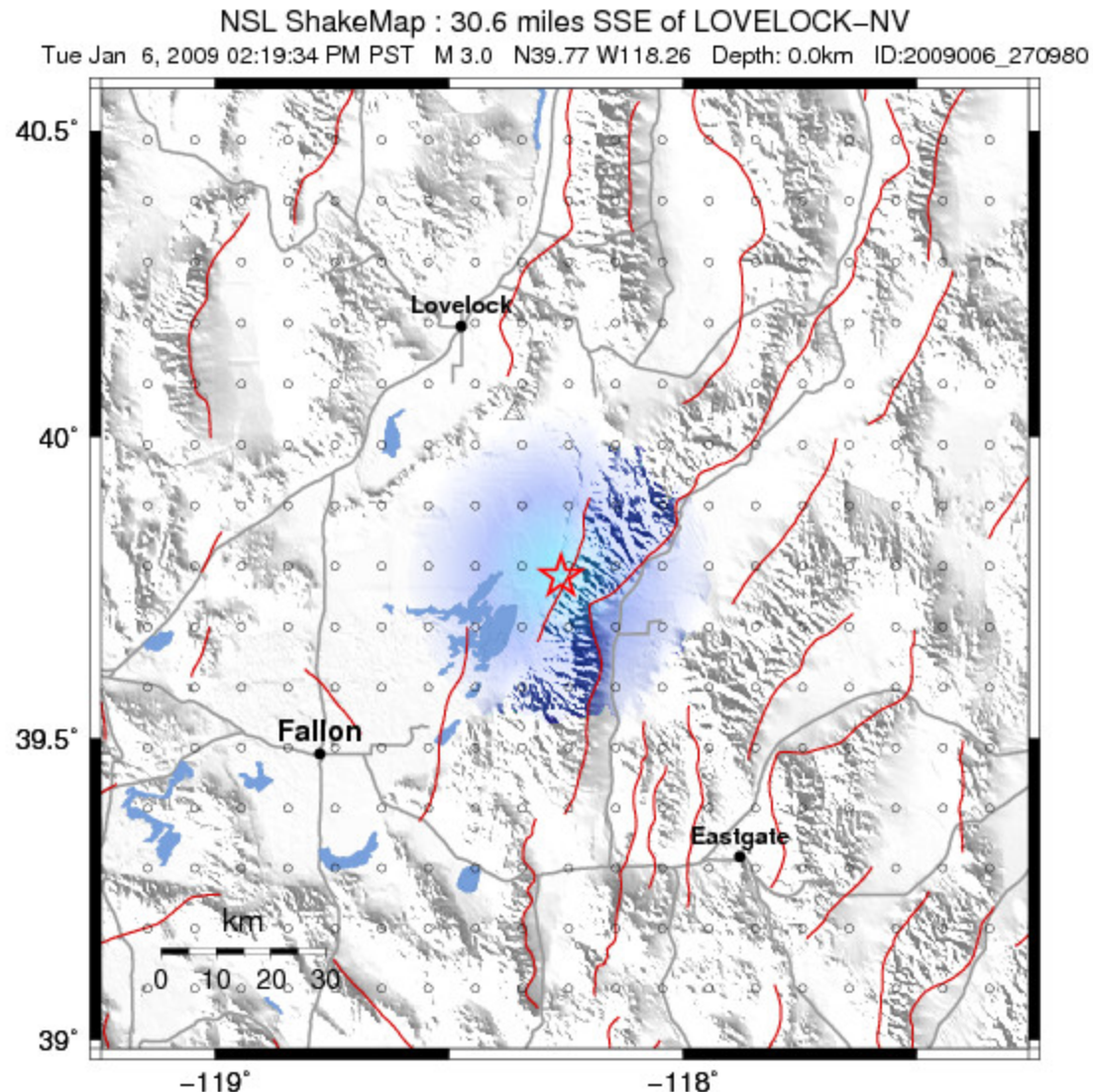


Map Version 1 Processed Tue Oct 6, 2009 11:48:18 AM PDT, — NOT REVIEWED BY HUMAN

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+

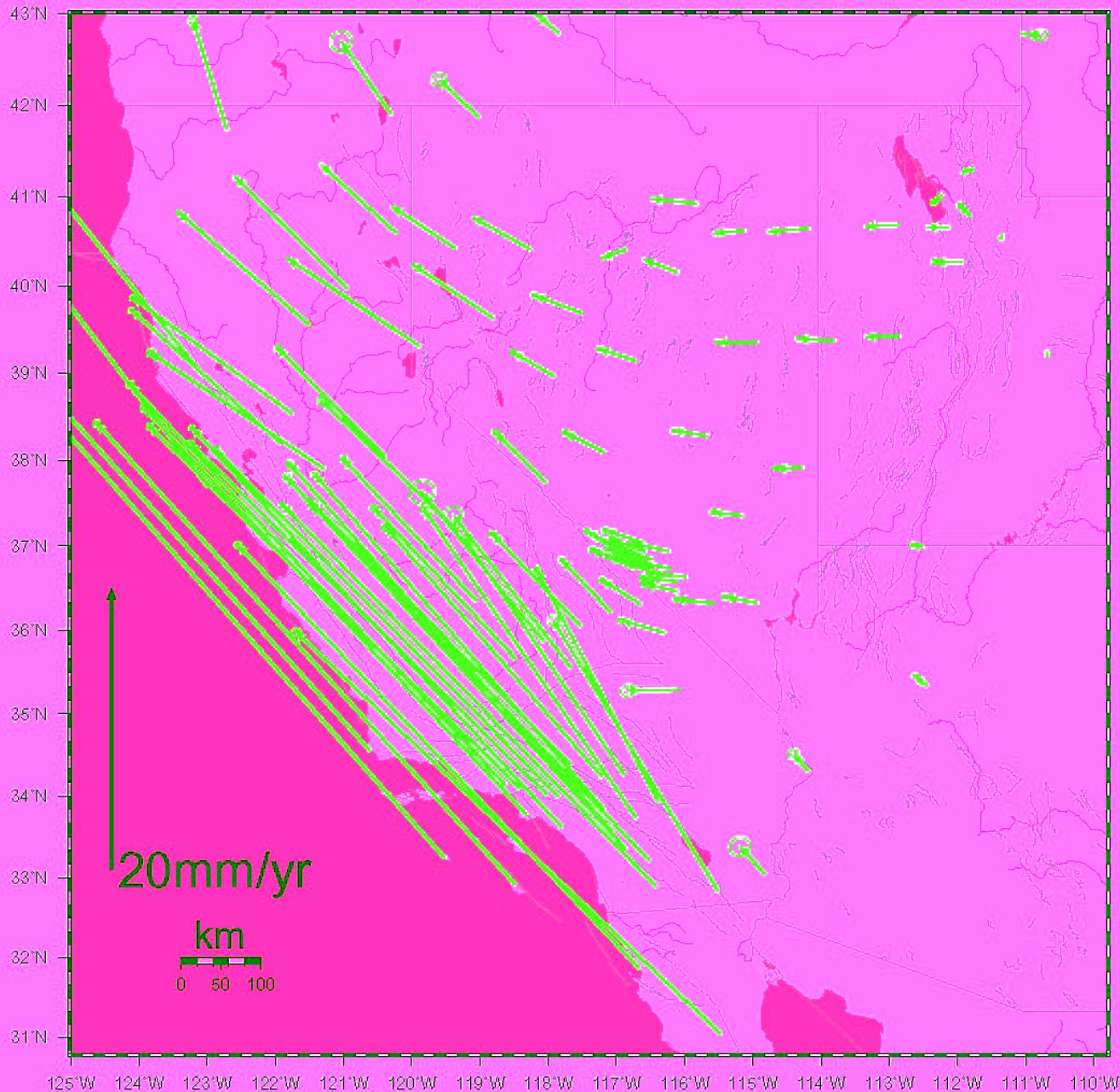
ShakeMap from the Nevada Seismological Laboratory at UNR

**Magnitude 3.0
31 miles SSE of
Lovelock
on January 6, 2009**



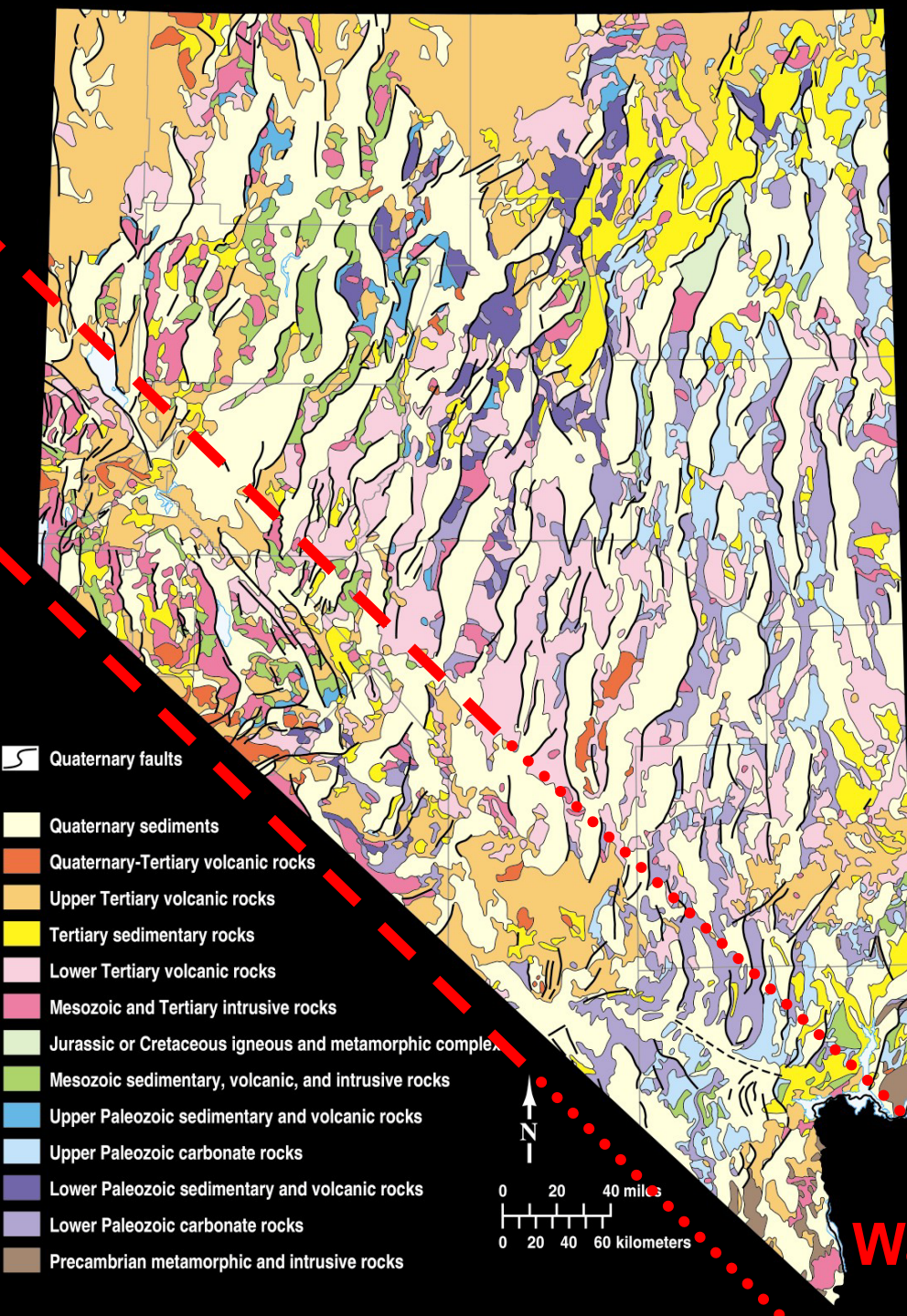
Map Version 1 Processed Tue Oct 6, 2009 03:54:53 PM PDT, — NOT REVIEWED BY HUMAN

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+



(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)



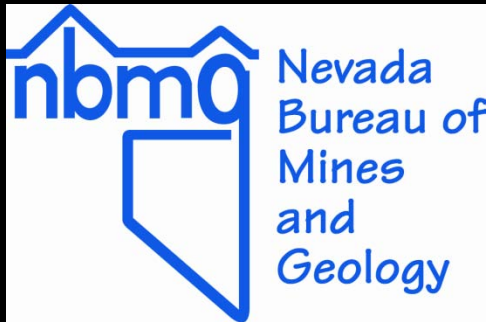
In Nevada, much of the right-lateral shear between the North American and Pacific plates occurs along northwest-striking strike-slip faults of the Walker Lane.

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

Walker Lane

**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.

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
RENSA, SPARKS PD,
REQUESTED - 92ND CIVIL SUPPORT TEAM - NATIONAL GUARD
LAS VEGAS
NATIONAL GUARD BATT'L + RESOURCES
FROM CALIFORNIA, HAWAII, ARIZONA,
UTAH, IDAHO, WASHINGTON STATE
INITIAL REPORT -
DAMAGE ALSO REPORTED - CARSON CITY, CHURCHILL CO.
LYON COUNTY, DOUGLAS COUNTY
STORSEY 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.

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	12-15
Carson City	>90	~80	70	50-55	12-15
Reno	>90	~80	67	50	12-15
Stateline	>90	~80	60-70	40-50	10
Lovelock	50-60	~35	10-20	10	1-2
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.

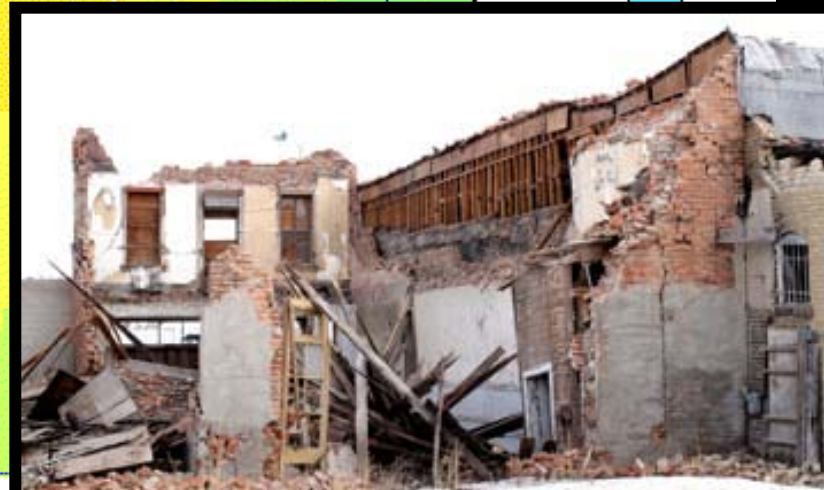
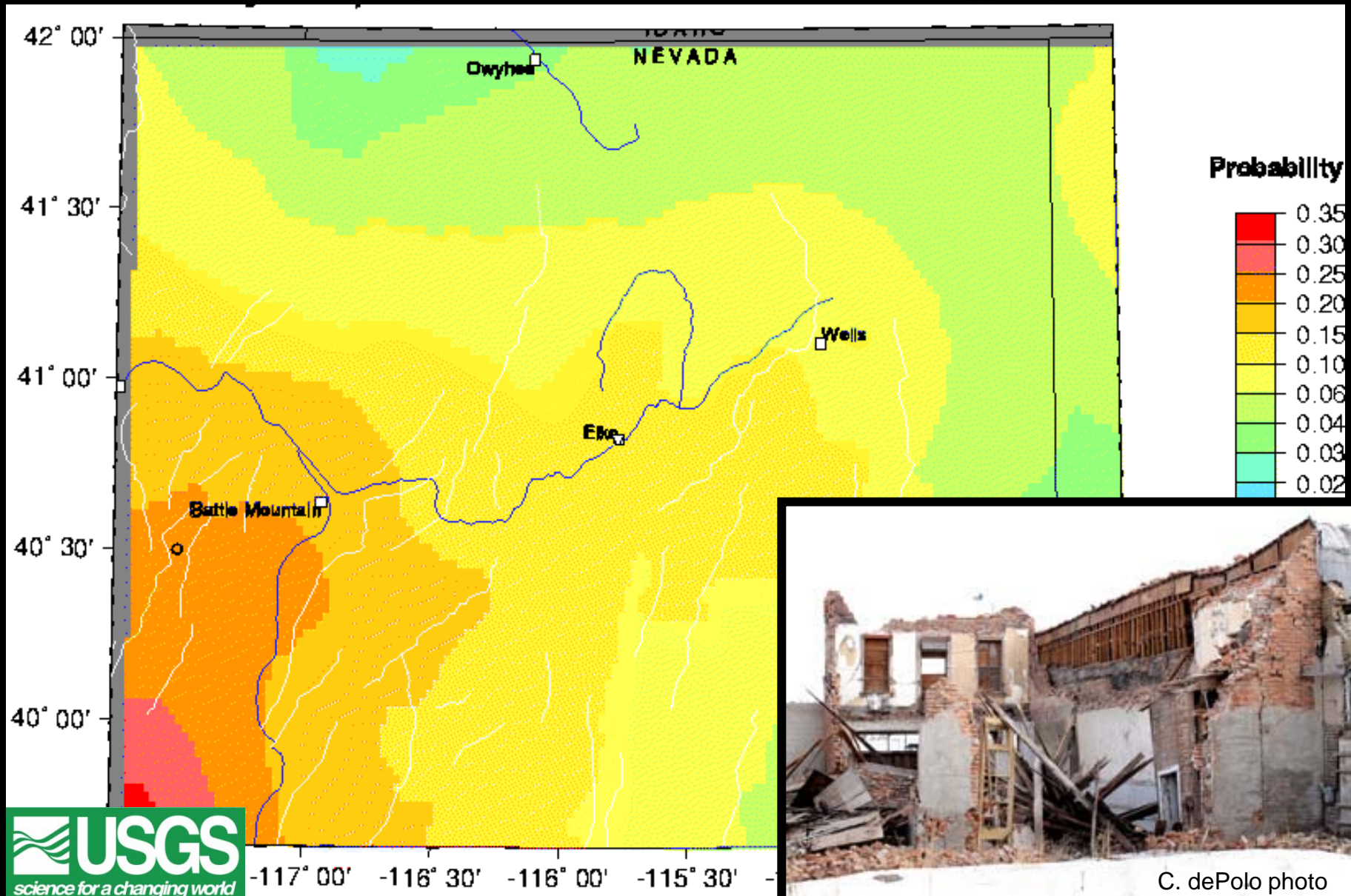
Uncertainties in the location of epicenters, depths, and magnitude, when combined with changing population and uncertainties in local effects (soil and rock types, assumptions about attenuation, basin geometry, liquefaction potential, and directivity), make loss estimates generally consistent within 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%
Elko	\$160 million	10 to 15%
Wells	\$30 million	9%
Lovelock	\$17 million	10 to 20%

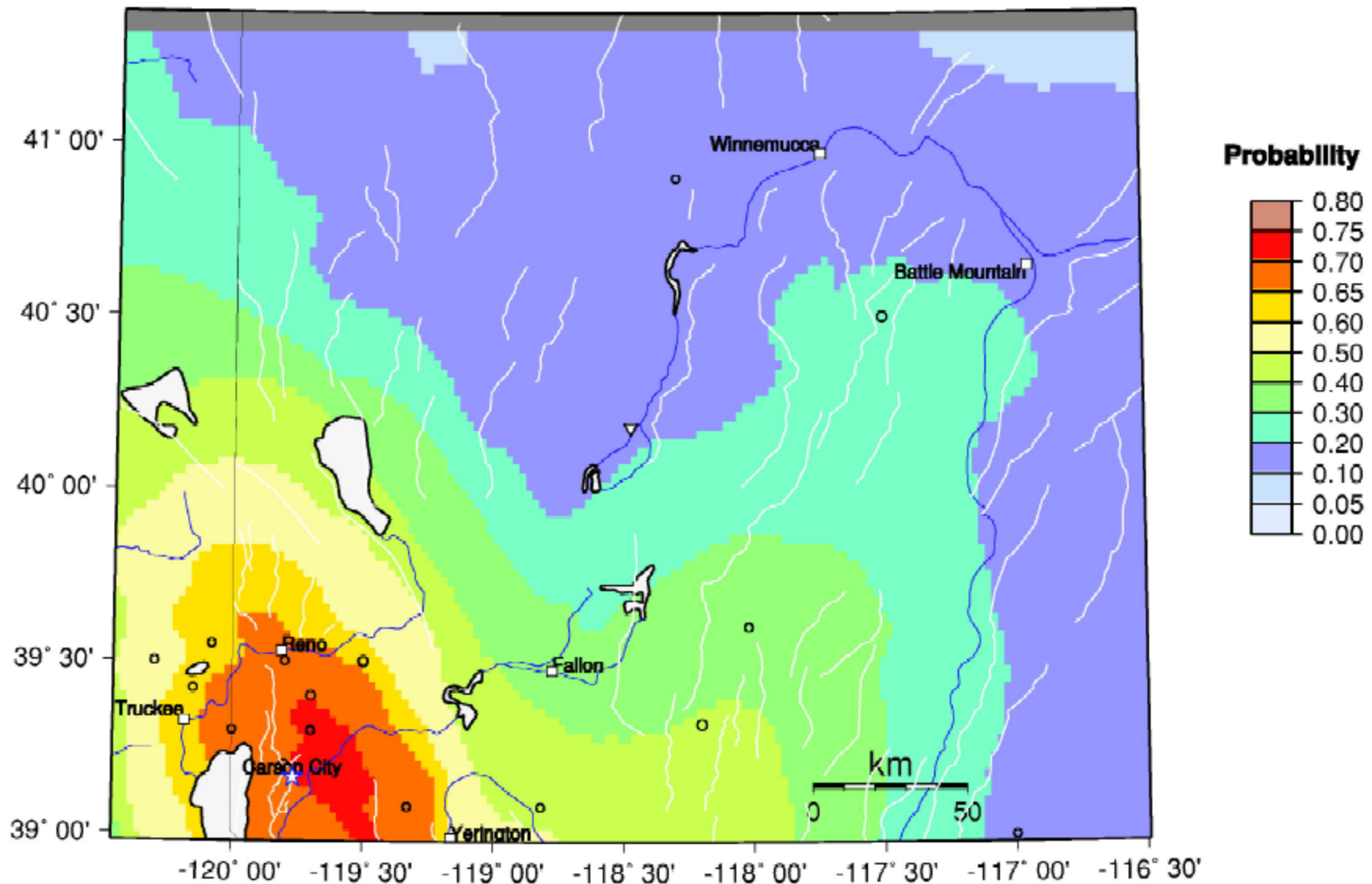
Total economic loss is from HAZUS. Probabilities are from the USGS at <http://eqint.cr.usgs.gov/eqprob/2002/index.php> .

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

The probability of a magnitude 6.0 earthquake occurring within 50 km of Lovelock within the next 50 years is approximately 10 to 20%, a bit higher than for Wells.



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



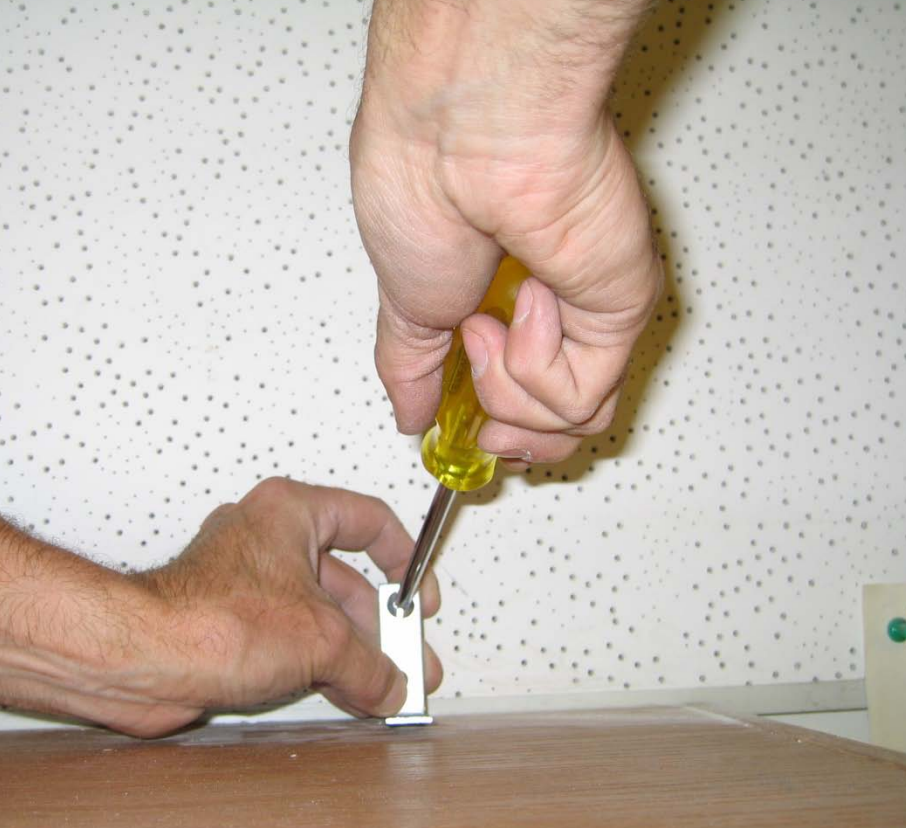
View from back, 20 May 2009



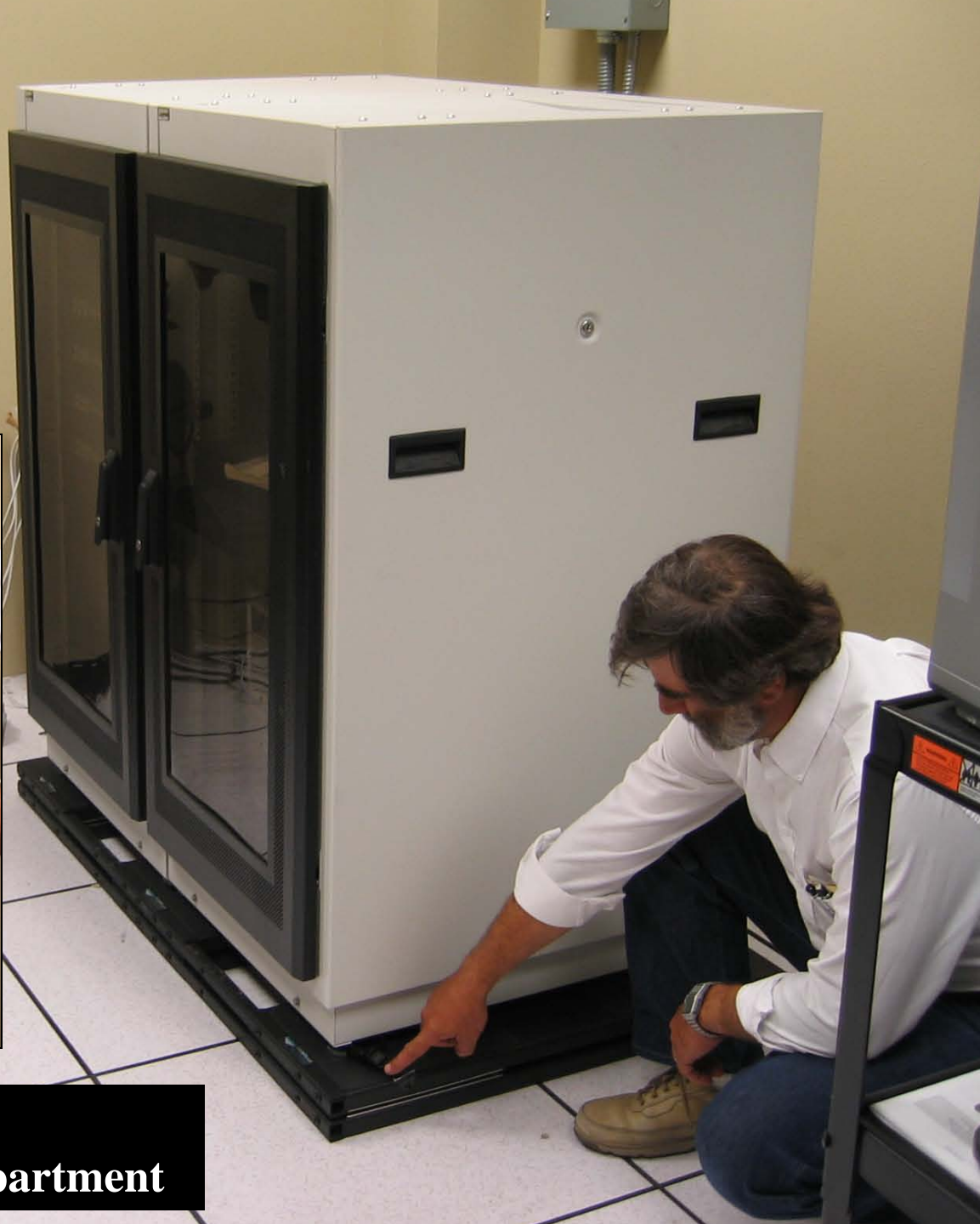
View from front, 20 May 2009



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 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.

