Earthquake Hazards in Douglas County

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Nevada Bureau of Mines and Geology

Nevada Hazard Mitigation Planning Committee

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Earthquake Truths

- The consequences of bad earthquakes to unprepared communities are unacceptable.

- We know how to plan for, prepare for, and mitigate against disastrous earthquake effects. We know how to minimize injuries and property loss.

The Earthquake Hazard

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

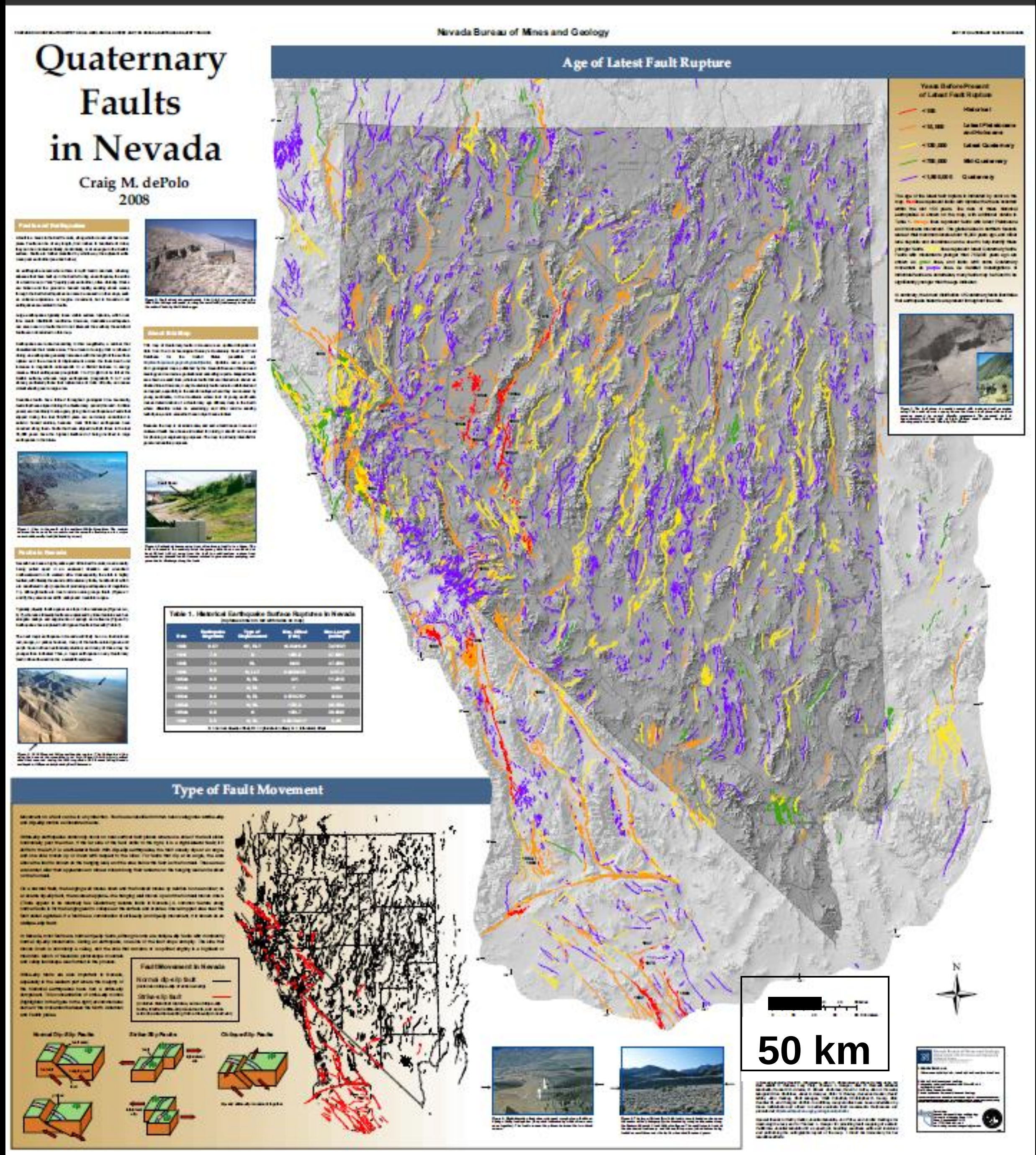
NBMG Map 167, *Quaternary Faults in Nevada*, is available as a poster and as an interactive map (Open-File Report 09-9) on line at www.nbmg.unr.edu. You can use it to locate your home or business.

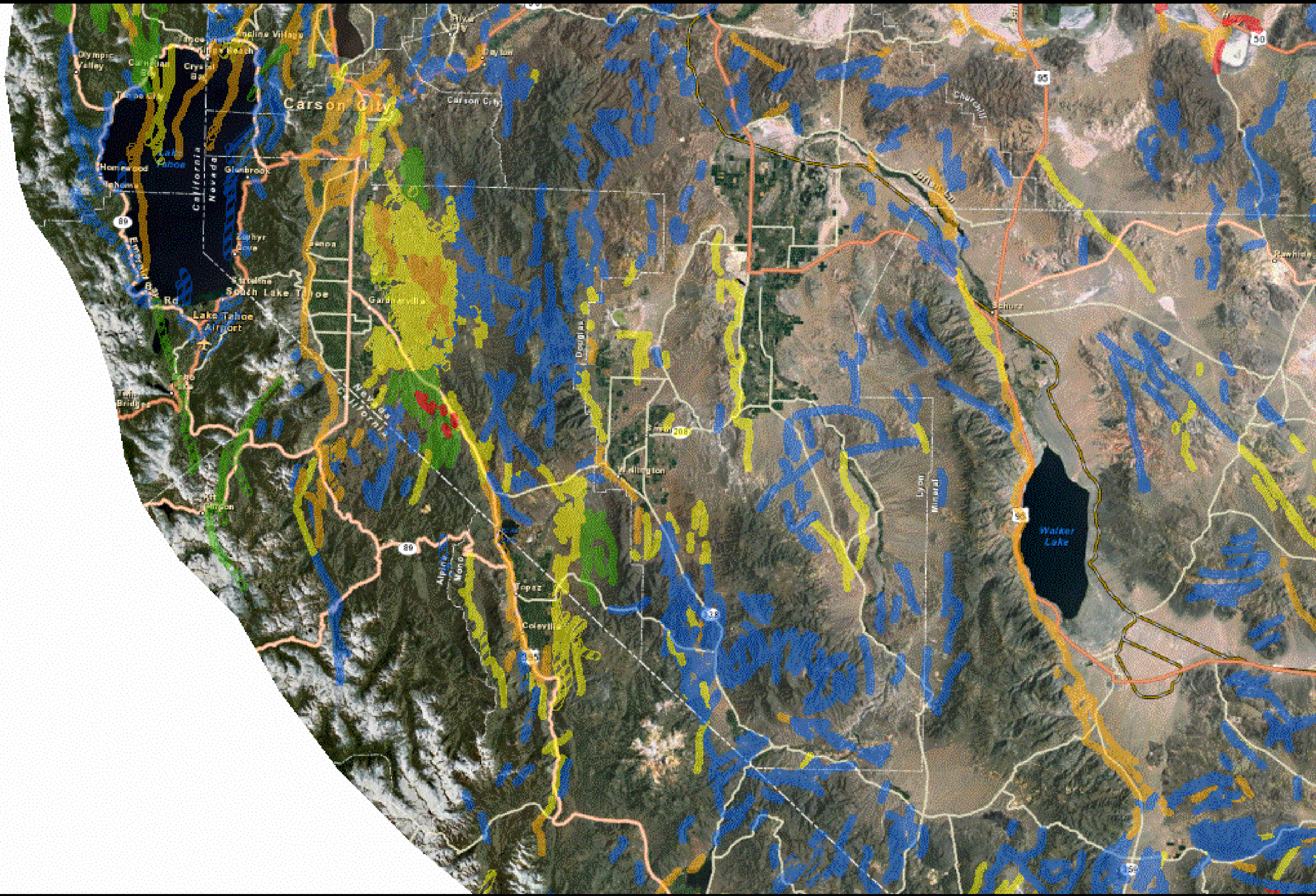
Age of Latest Fault Rupture

- < 150 years (historical)
- < 15,000 years
- < 130,000 years
- < 750,000 years
- < 1,800,000 years (Quaternary)

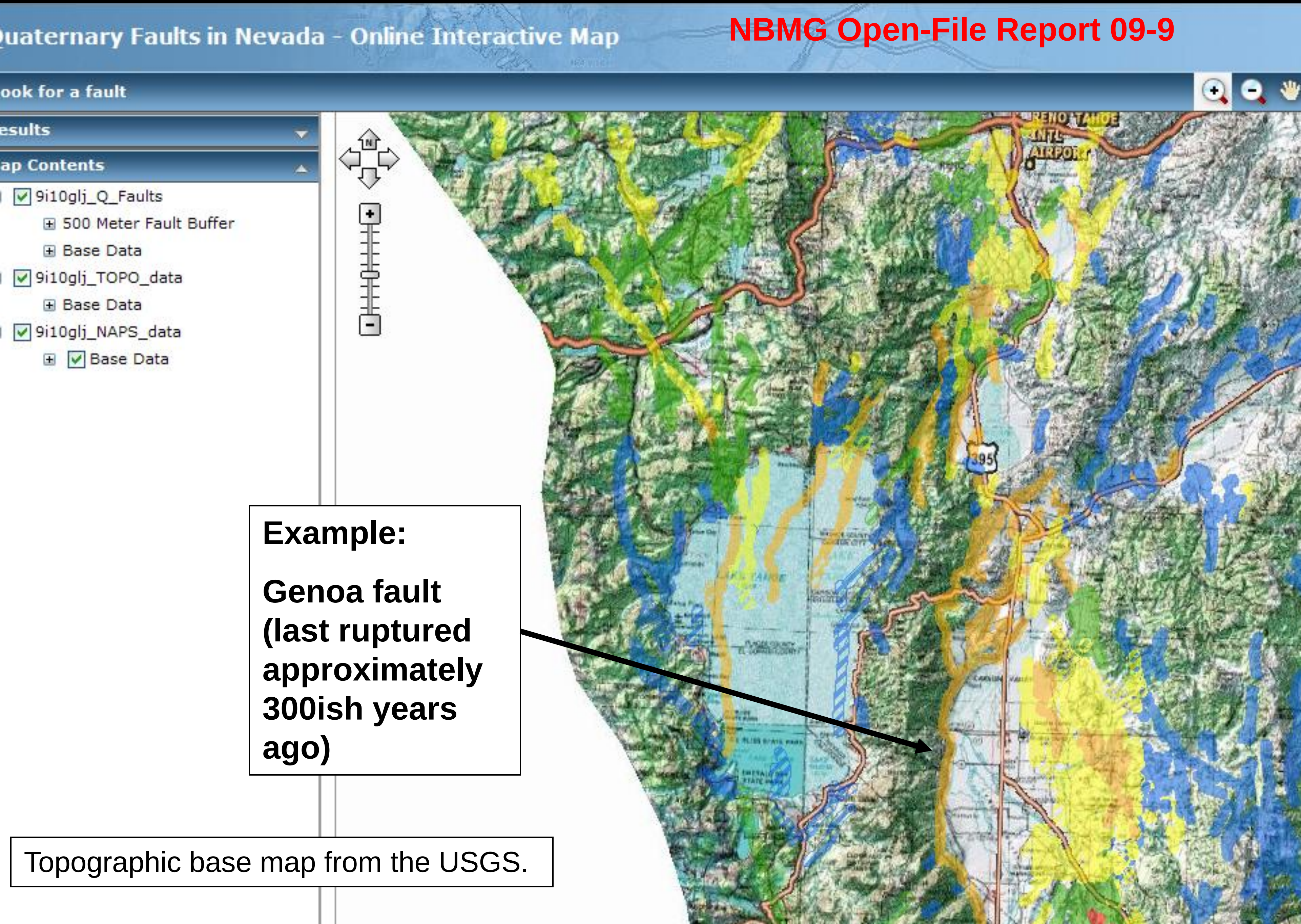
Active faults are nearly everywhere in Nevada.
A magnitude 6.0 earthquake can occur anywhere in Nevada.

www.nbmg.unr.edu




Carson City
Lake Tahoe
South Lake Tahoe
Lake Tahoe Airport
Homewood
Glenbrook
Zephyr Cove
Tahoe City
Crystal Bay
Incline Village
Olympic Valley
California
Nevada
Gardnerville
Wellington
Topaz
Coleville
Douglas
Lyon
Mineral
Schurz
Walker Lake
Rawhide
Churchill
95
50
89
208
338

NBMG Open-File Report 09-9

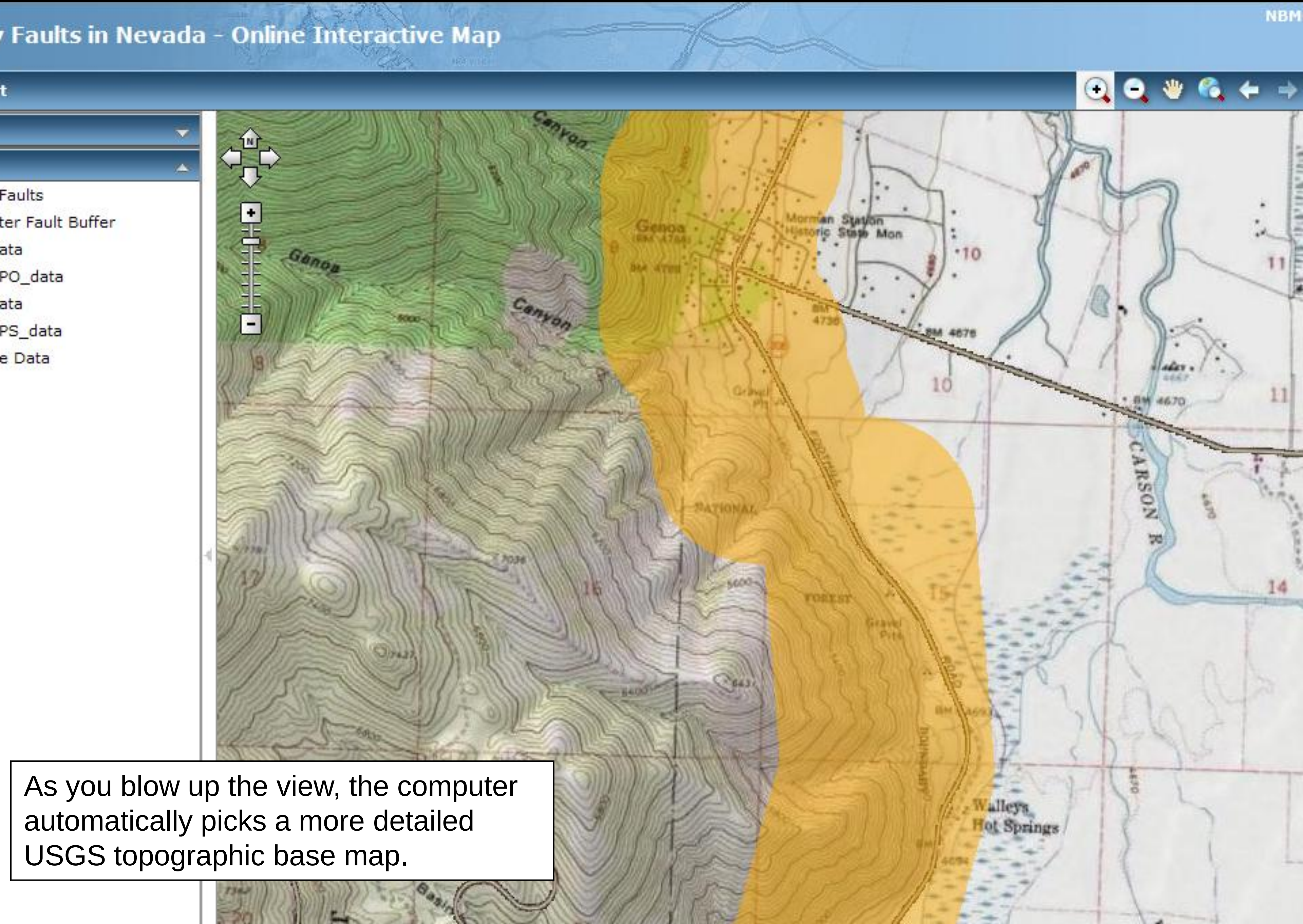


Example:

Genoa fault (last ruptured approximately 300ish years ago)

Topographic base map from the USGS.

As you blow up the view, the computer automatically picks a more detailed USGS topographic base map.



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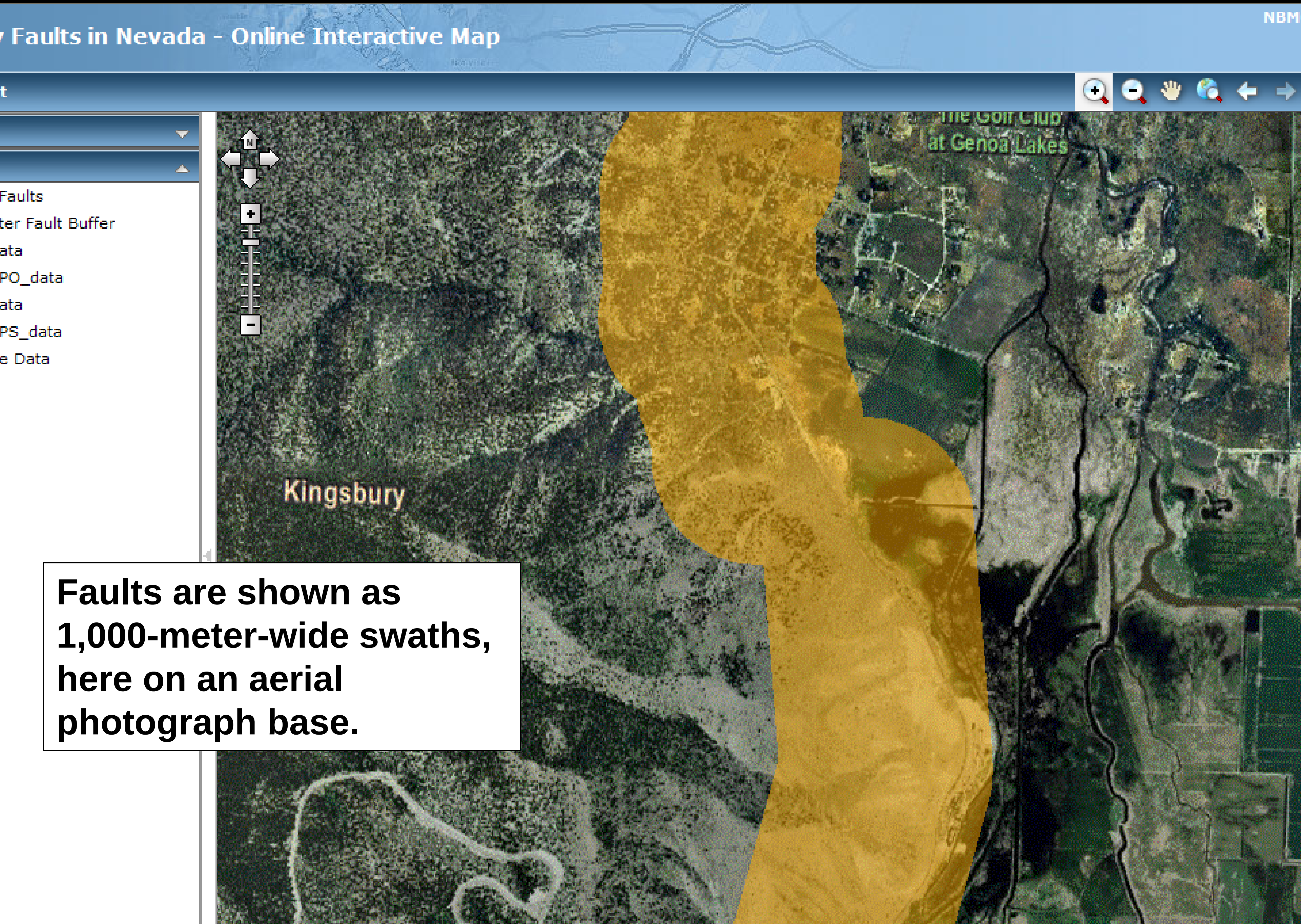
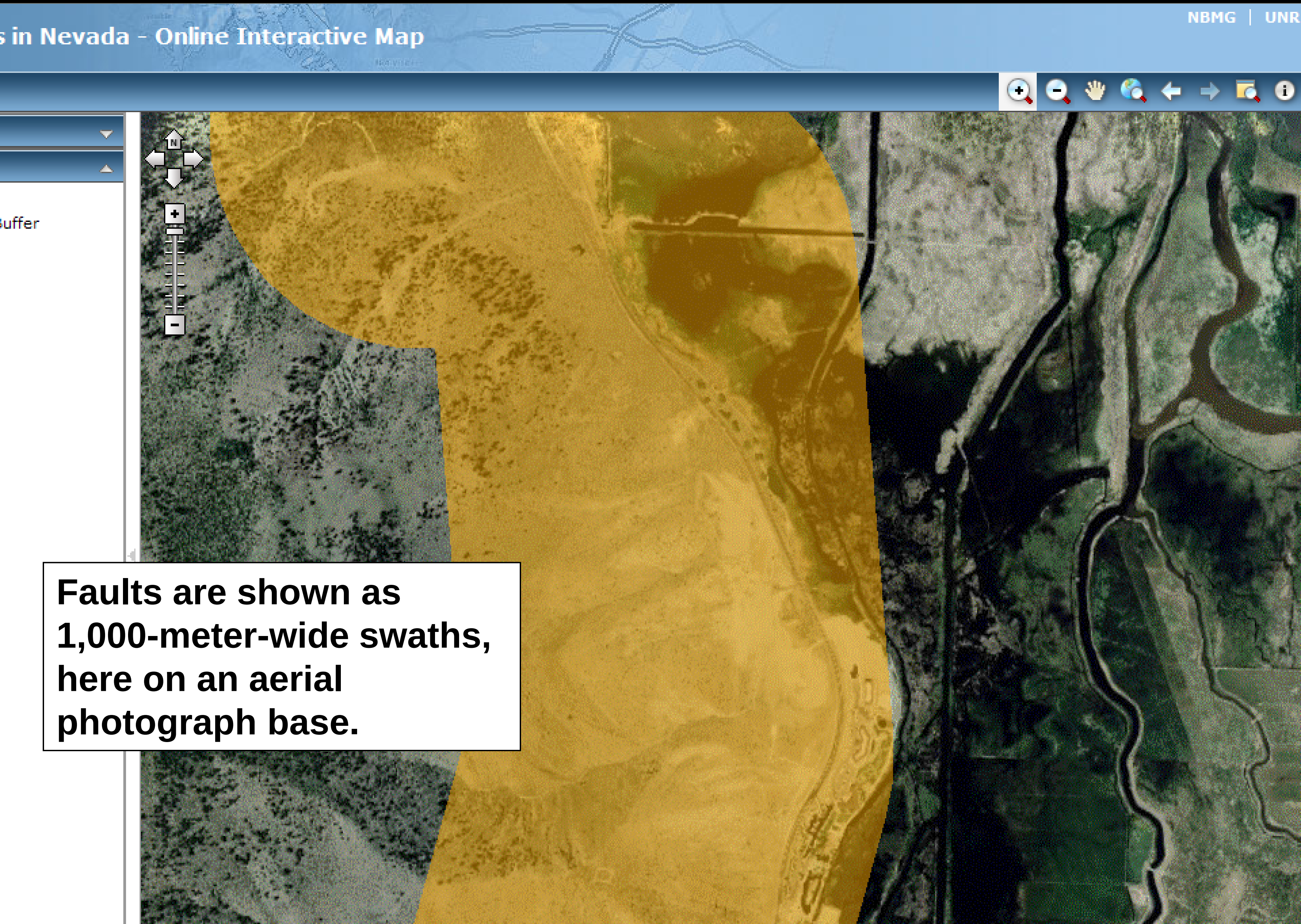


Faults are shown as 1,000-meter-wide swaths, here on an aerial photograph base.

s in Nevada - Online Interactive Map

NBMG | UNR

uffer



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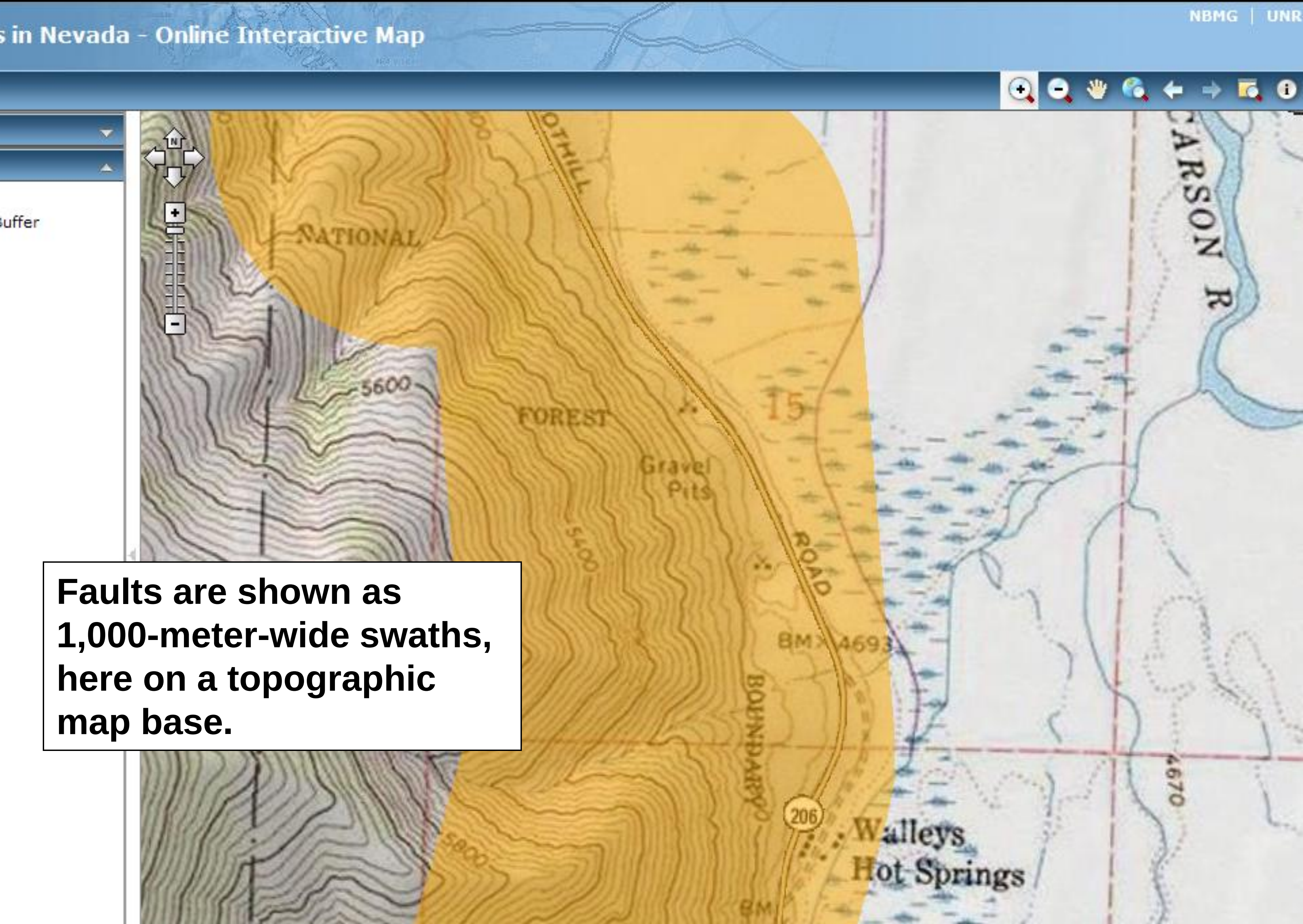
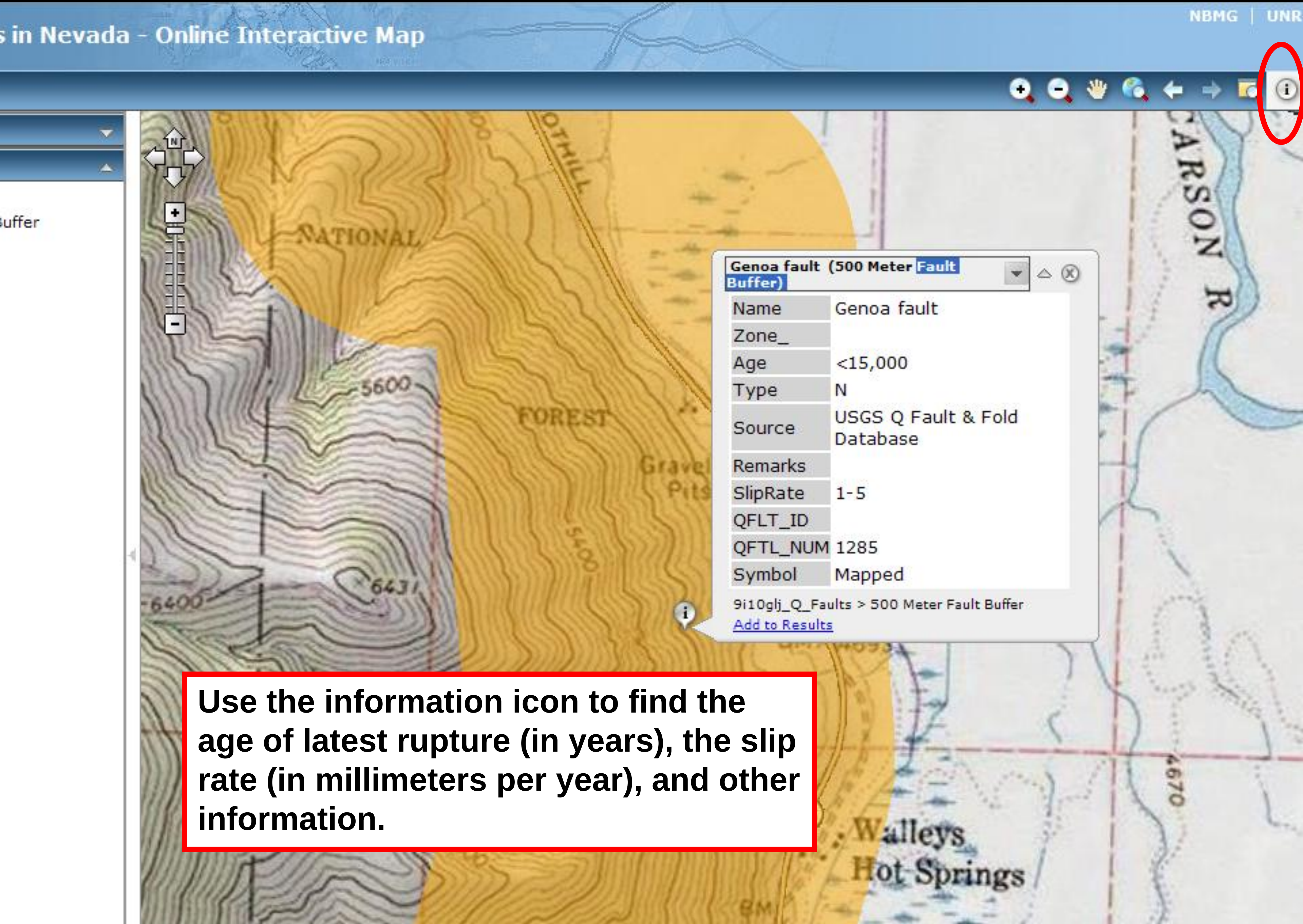
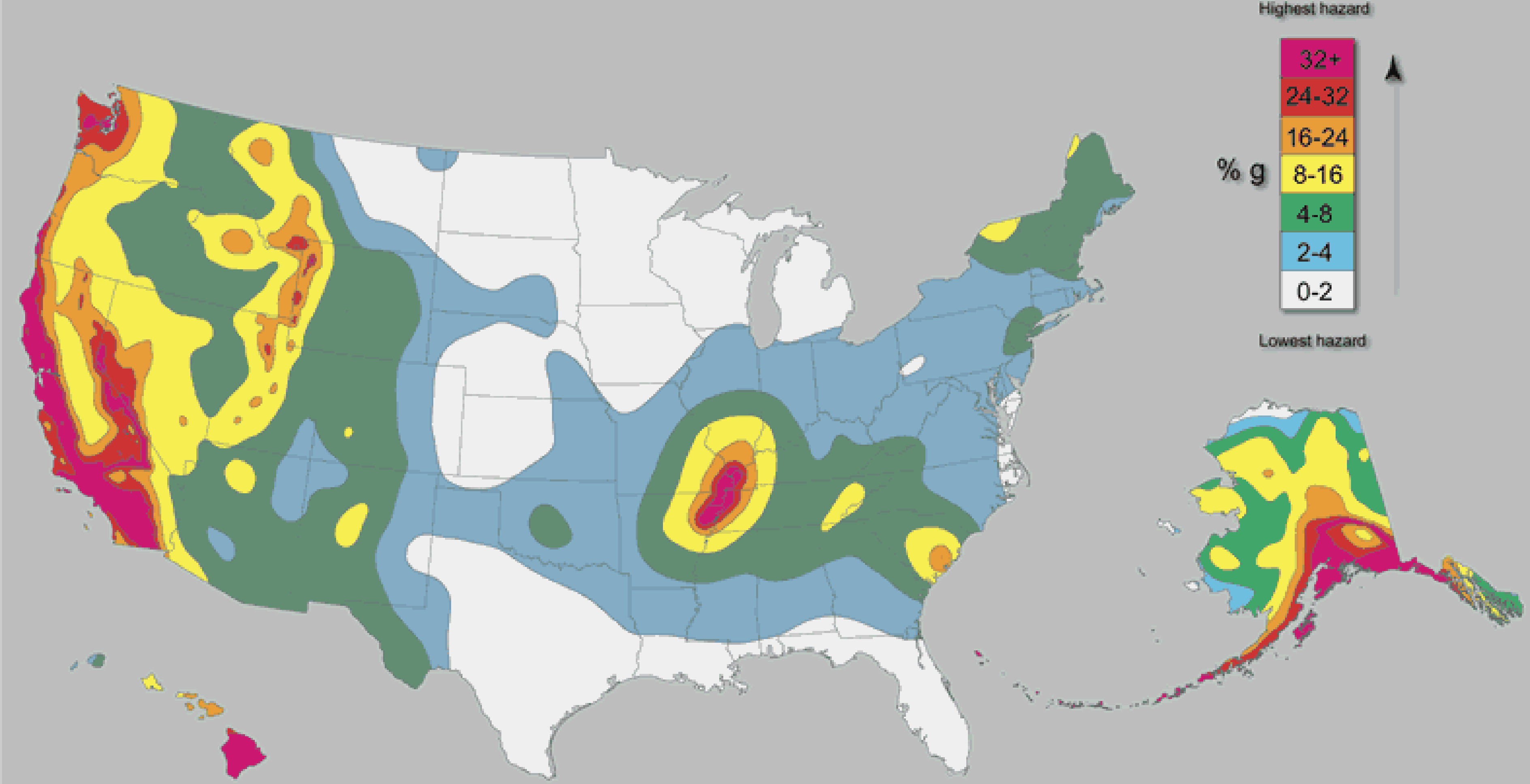


Faults are shown as 1,000-meter-wide swaths, here on a topographic map base.

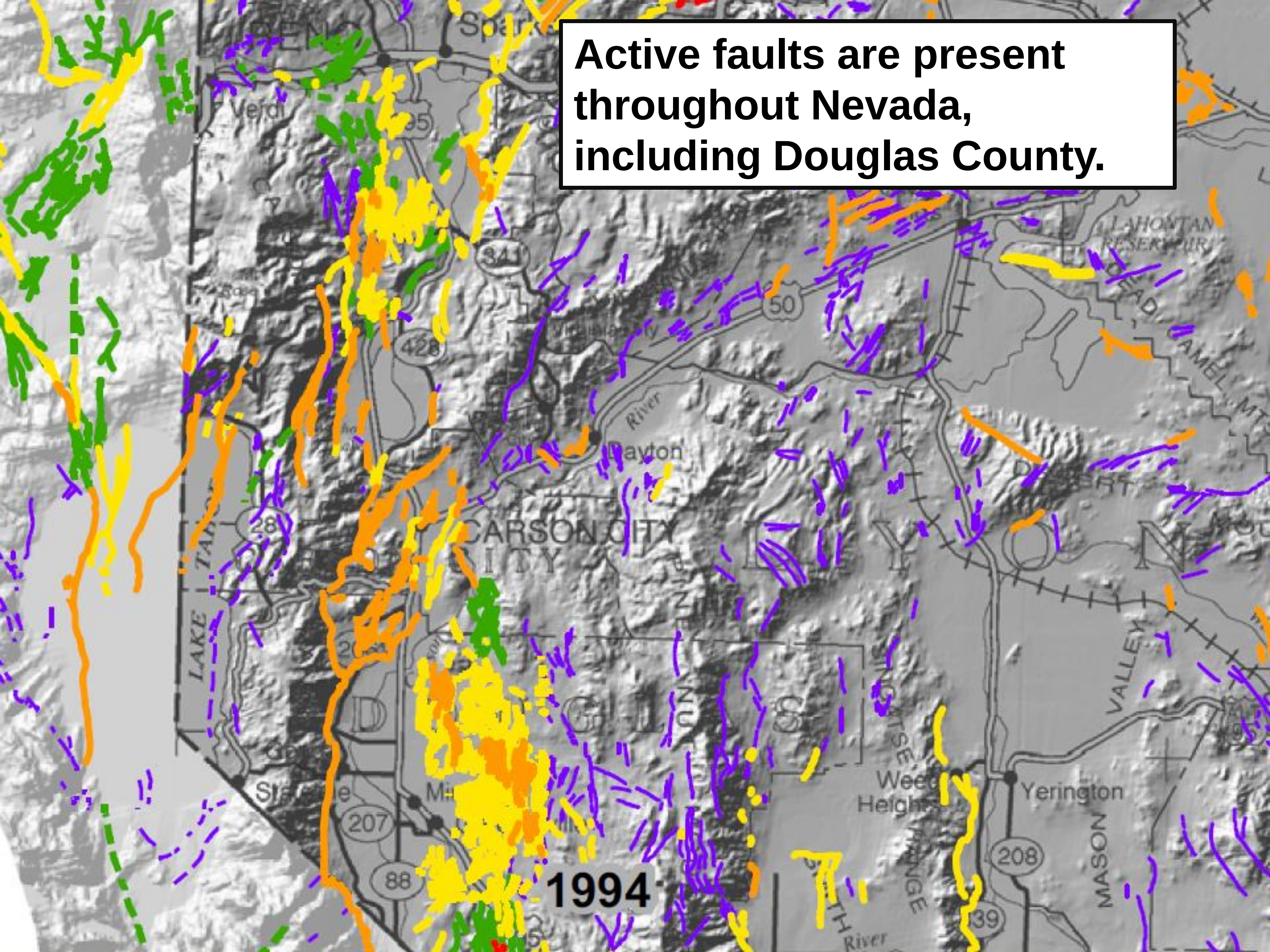
Use the information icon to find the age of latest rupture (in years), the slip rate (in millimeters per year), and other information.

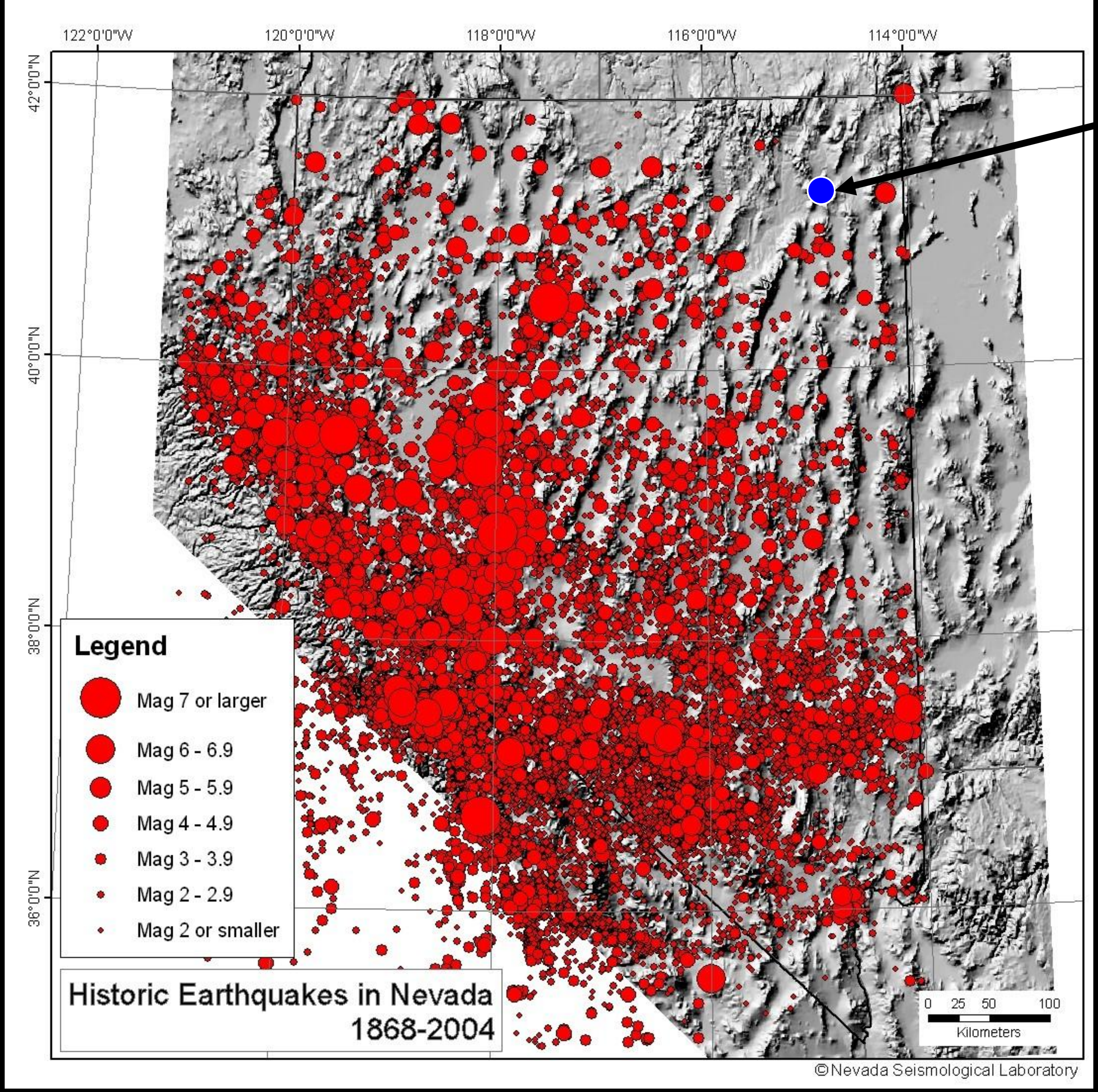




The USGS integrates (1) fault, (2) earthquake, and (3) geodetic data into its probabilistic seismic hazard analysis.

Active faults are present throughout Nevada, including Douglas County.





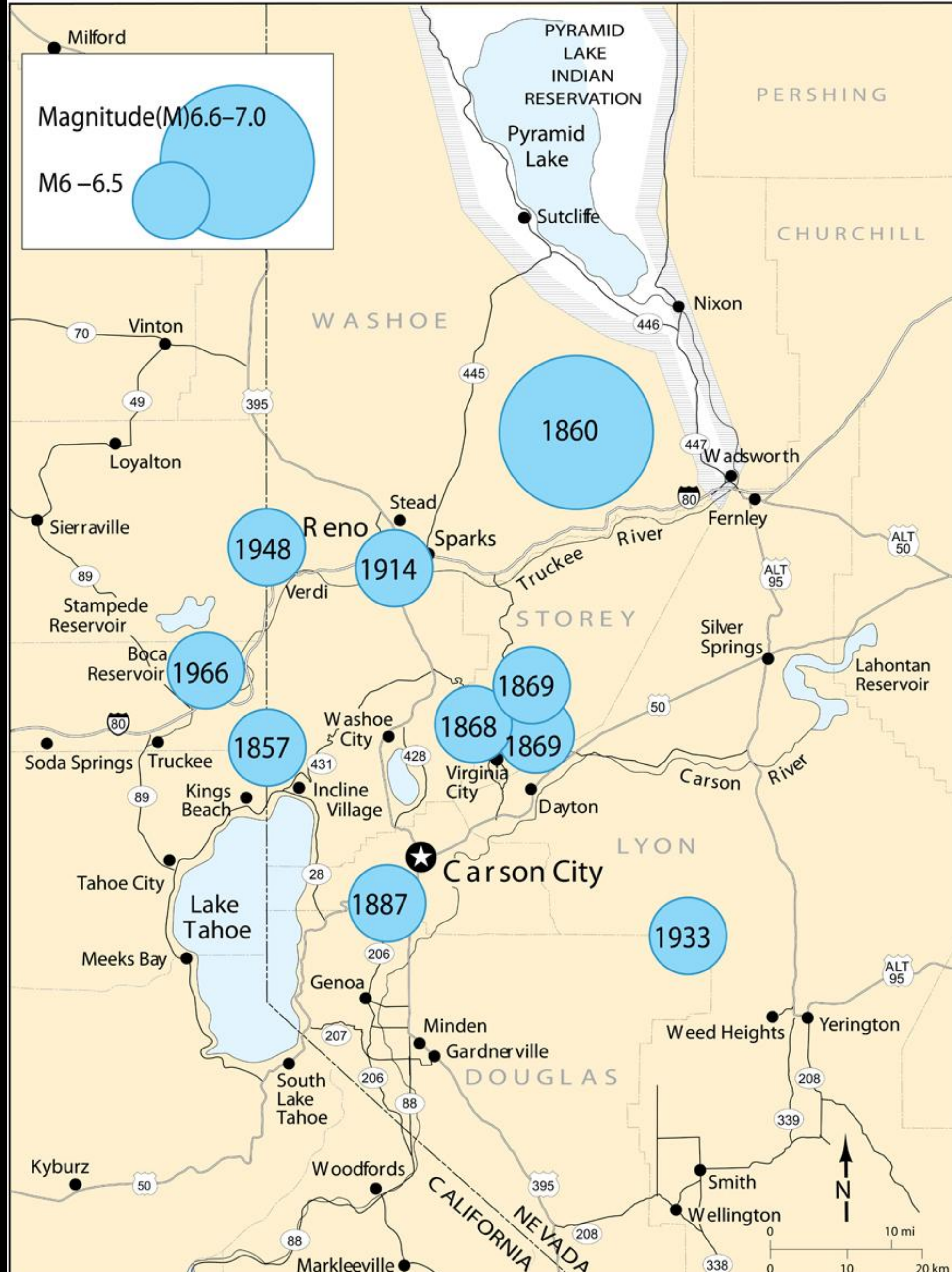
Wells

21 Feb 08

M = 6.0

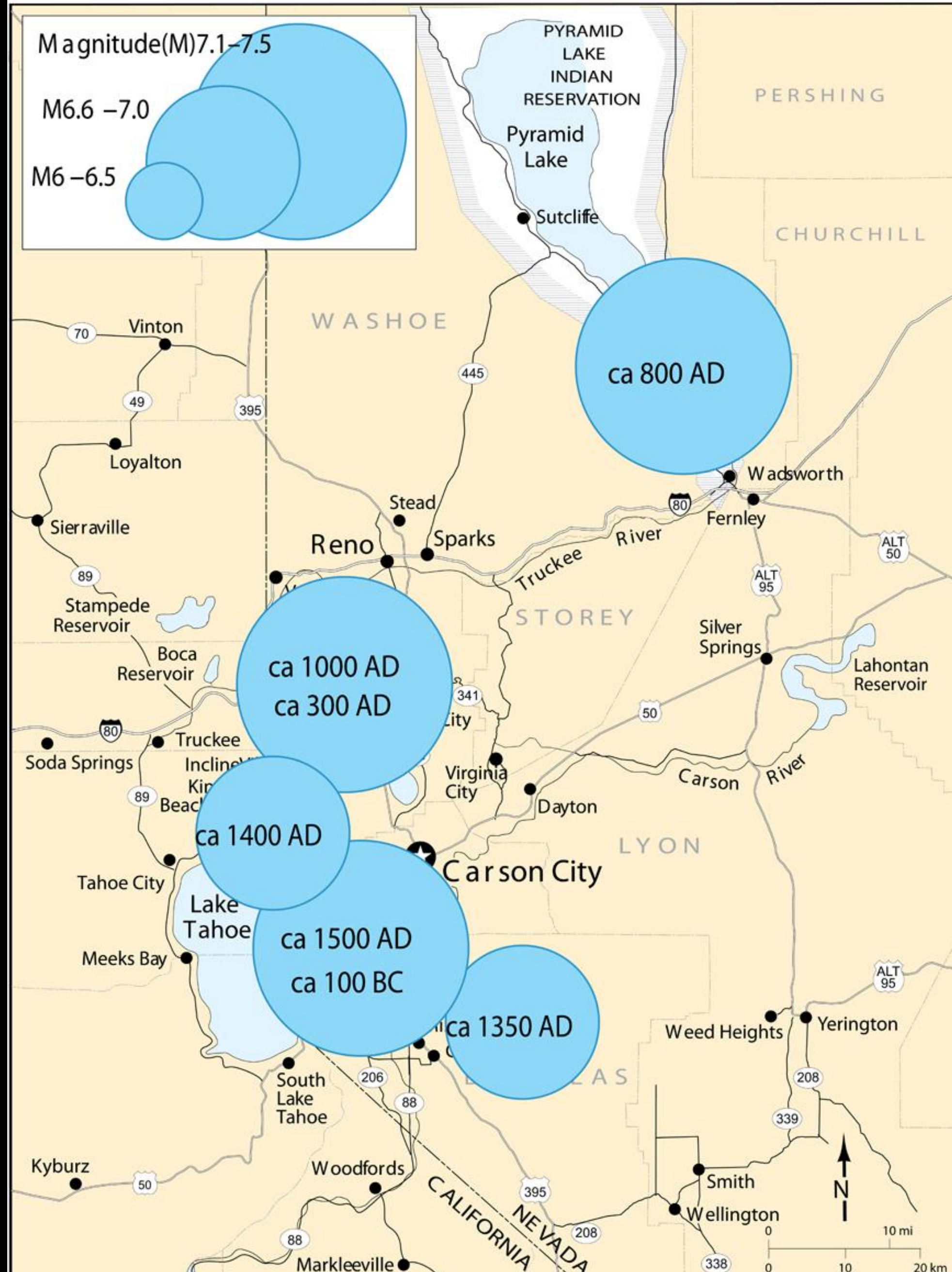
(2) Earthquakes have occurred throughout Nevada.

Major Historical Earthquakes in Western Nevada*



dePolo and others (2007 unpub. res.), Nevada Bureau of Mines and Geology

Some Major Earthquakes in Western Nevada (approximately 100 BC—1850 AD)*

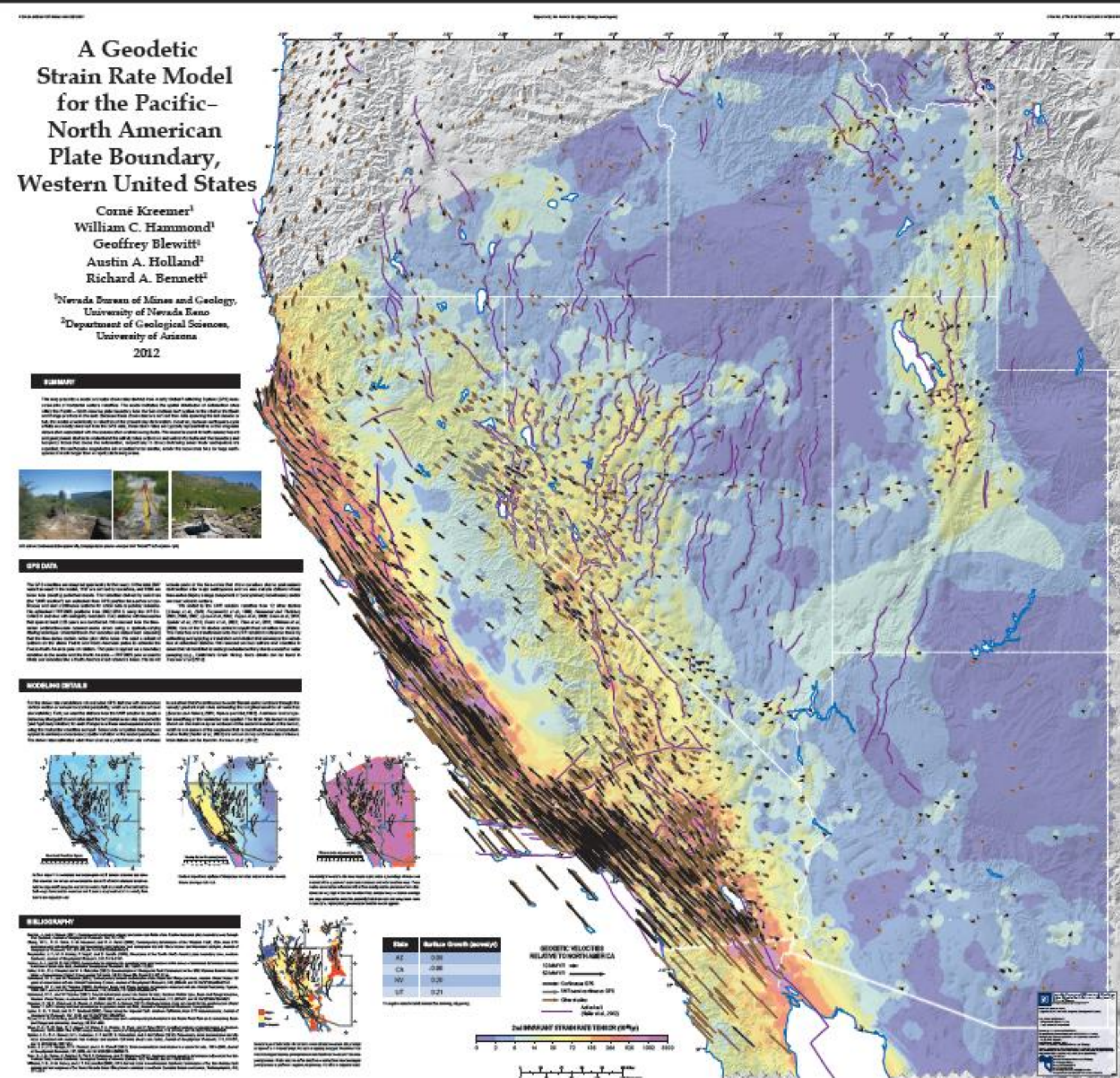


dePolo and others (2007 unpub. res.), Nevada Bureau of Mines and Geology

*This map is incomplete because of limited research. Dates are approximate. Earthquake magnitudes are estimated from the size of the fault and the amount of offset of the ground.

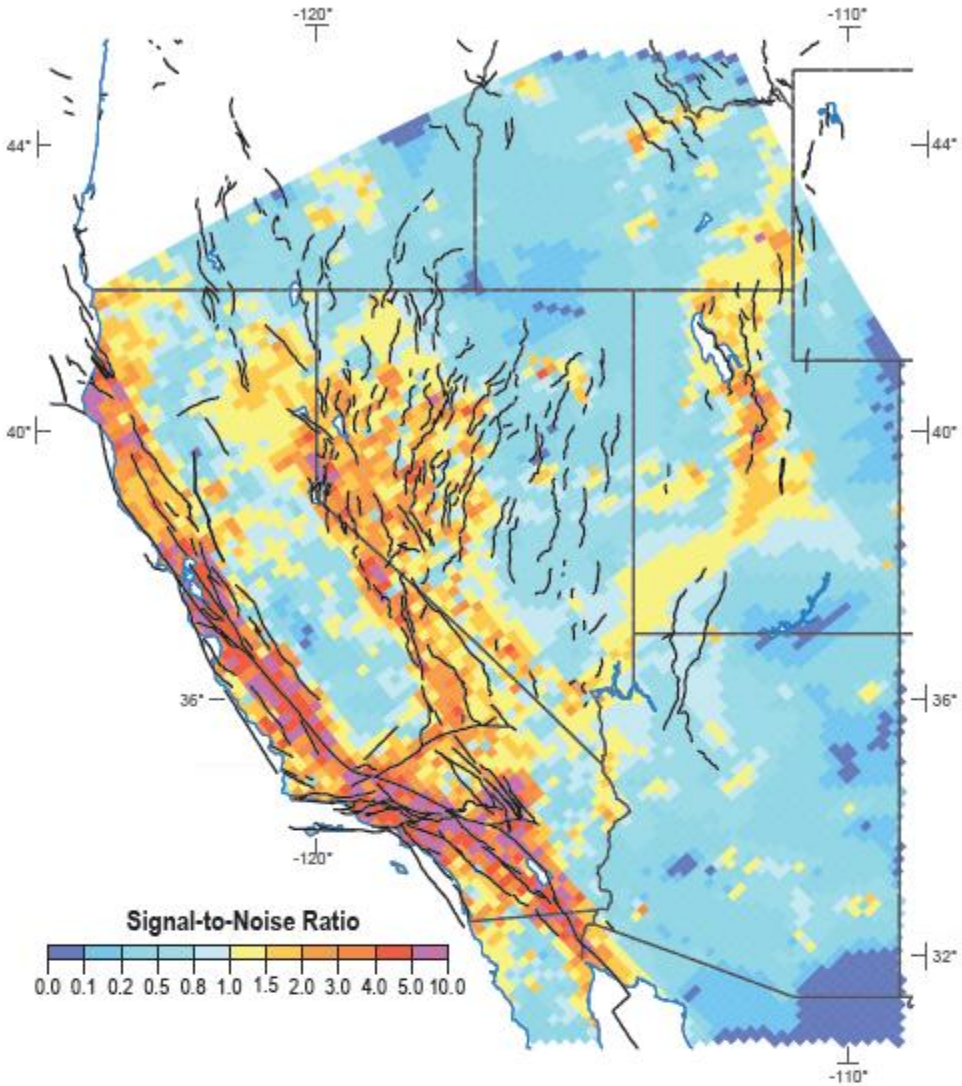
Historical Earthquakes

- 1887 Carson Valley earthquake (M6.3)
- 1932 Cedar Mountain earthquake (M7.1)
- 1933 Wabuska earthquake (M6.0)
- 1994 Double Spring Flat earthquake (M5.8)



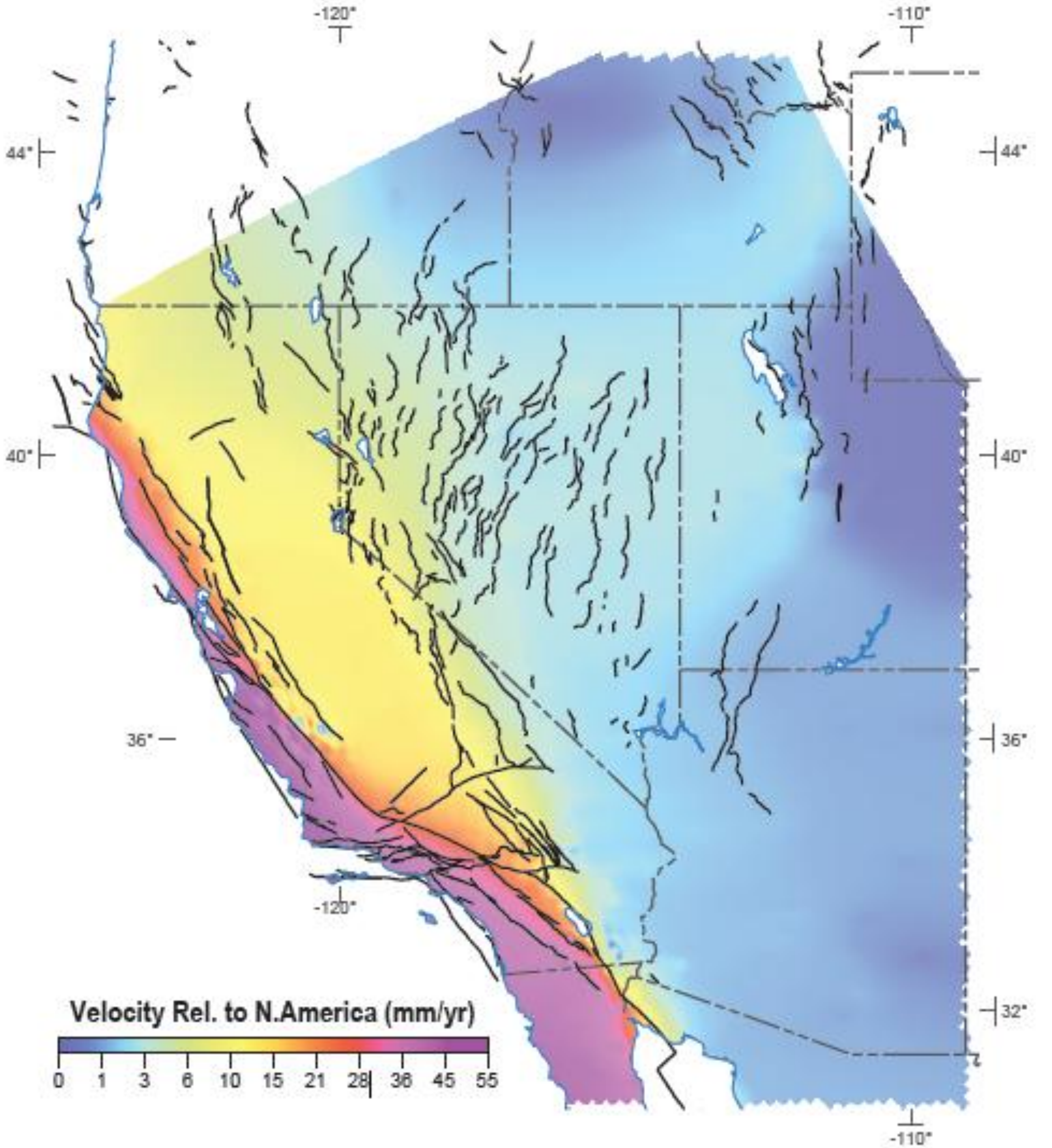
Kreemer et al. (2012)

Geodetic data indicate that the Nevada is gaining about 0.2 acre of area per year through crustal extension, and that western Nevada is accommodating ~20% of the North American-Pacific plate interaction.



Signal-to-noise (SNR) ratio defined as the ratio of second invariant of the strain rate over the a posteriori standard deviation These values are strongly affected by the GPS station density and the precision of velocities. Everywhere where SNR<1 the area could be considered rigid within one standard deviation. Conversely, for areas that the model suggests are nearly rigid and where SNR<1 (e.g., Arizona, eastern Nevada) strain rates may be much more localized (i.e., higher) than the model suggests.

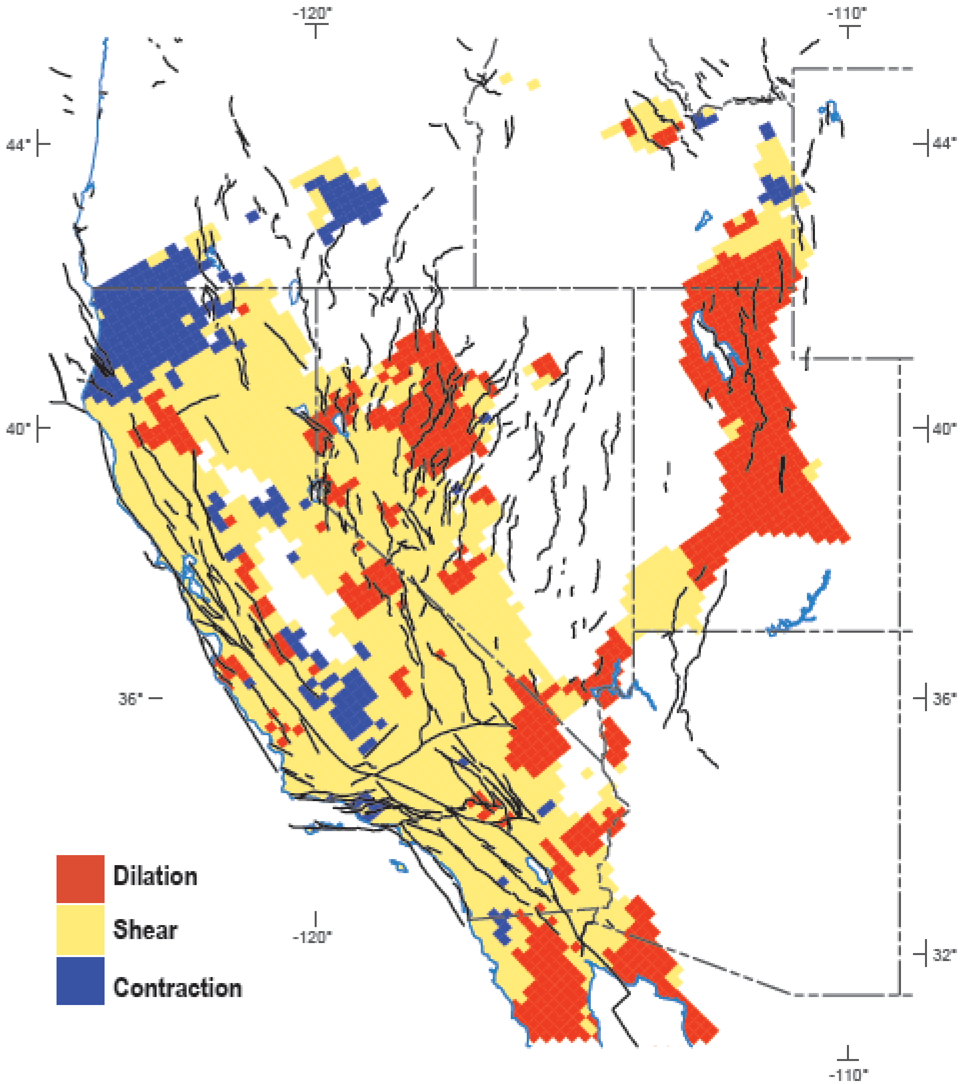
Uncertainty is high in areas with few geodetic GPS data points (areas in blue on this map).



Contour map of the amplitude of interpolated velocities relative to North America. Results are clipped at coast.

West of the San Andreas fault in California, the Pacific Plate is moving northwest relative to the North American Plate.

Kreemer et al. (2012)

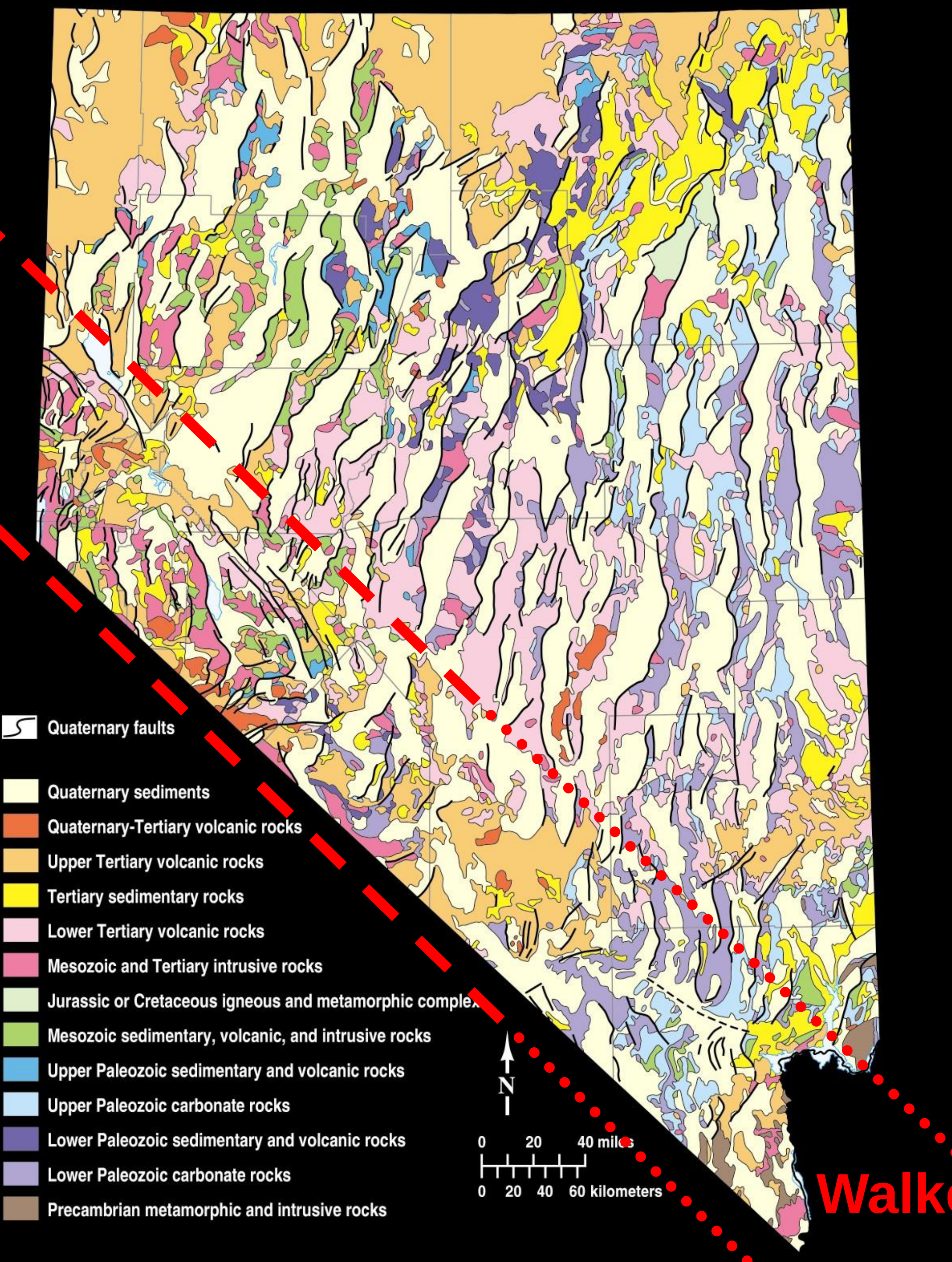


General style of deformation for all areas where at least one strain rate principal component is > 6 nanostrain/yr. Results are spatially averaged. We define shear where the largest absolute principal value is less than twice the smallest absolute principal value. If not shear, we define dilatation or contraction when the largest principal value is positive or negative, respectively. Results are clipped at coast.

Western Nevada is accommodating ~20% of the North American-Pacific plate interaction, mostly along right-lateral strike-slip faults and oblique-slip normal faults.

Extension is occurring mostly in western and central Nevada (and along the Wasatch front in Utah) along normal faults.

Kreemer et al. (2012)



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 hazard: expressed in terms of probability of an earthquake of a given magnitude occurring within 50 years and within 50 km (31 miles) of the community.

% Probability of > or = 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
Minden	>90%	~80%	67%	50-60%	10-12%
Reno	>90	~80	67	50	12-15
Incline Village	>90	~80	60-70	40-50	10-12
Stateline	>90	~80	60-70	40-50	10
Fallon	80-90	~60	35	20-25	6-8
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.

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.

HAZUS scenarios for magnitude 5.0, 5.5, 6.0, 6.5, and 7.0 earthquakes near 38 communities in Nevada

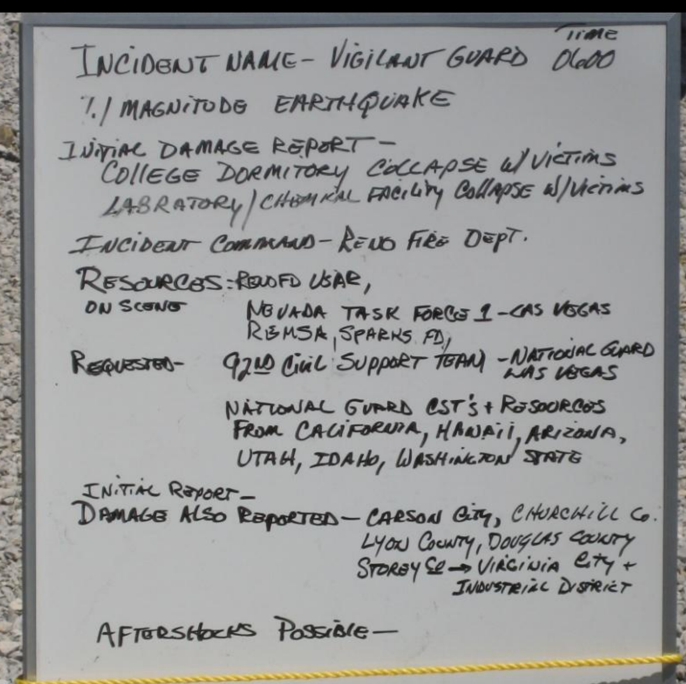
Earthquake RISKS in Nevada

NBMG OFR-09-8

used 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.



Uncertainties in the location of epicenters, depths, and magnitude, combined with changing population, 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), although experience with urban earthquakes in the US has generally yielded numbers within a factor of 2 or 3 of the actual damages.

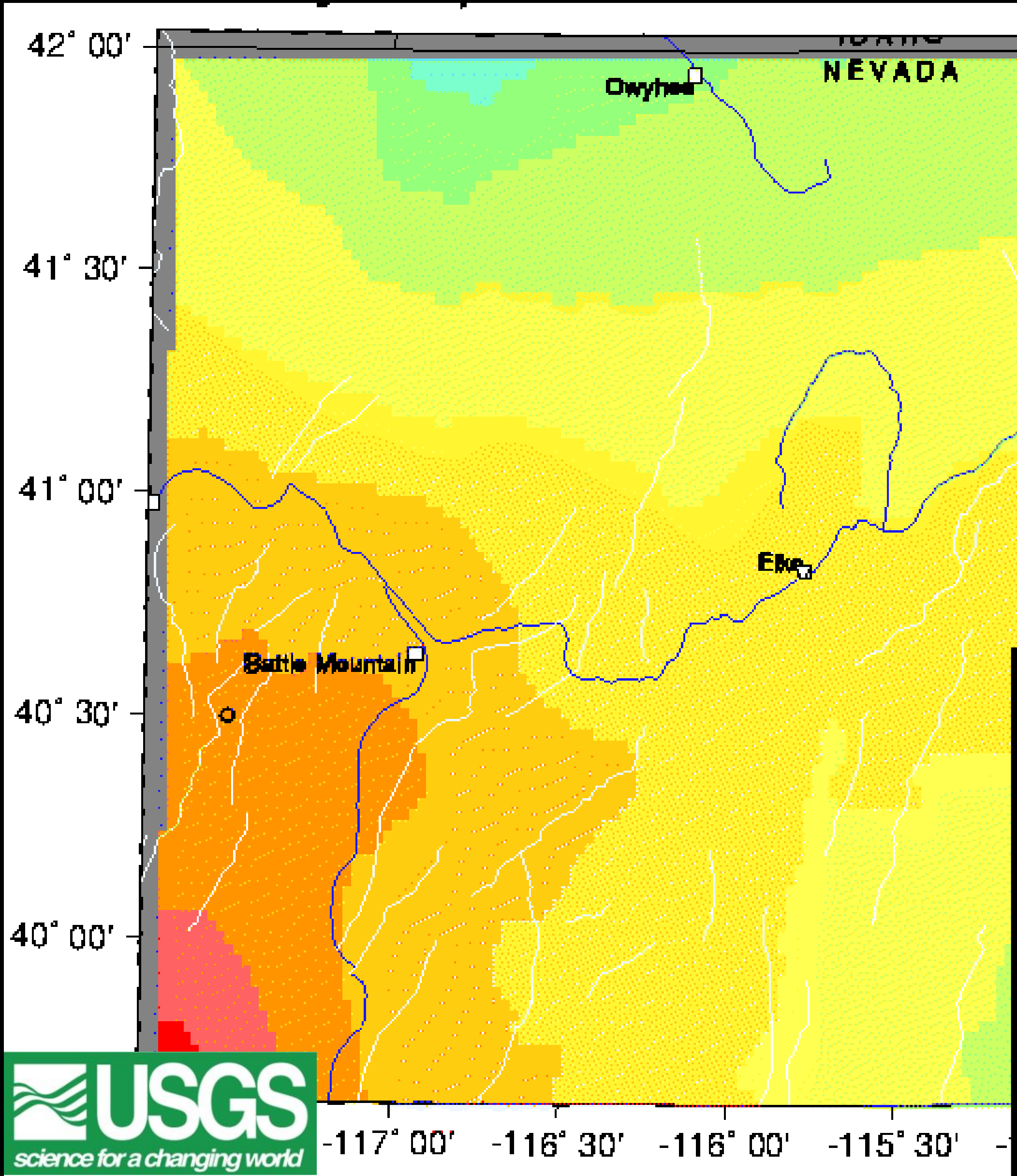
2008 Mw 6.0 Wells Earthquake

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 31 mi (50 km) of the community.

Community	Total Economic Loss	Probability M6 in 50 yrs within 31 mi
Las Vegas	$7.2 billion	12%
Reno	$1.9 billion	67%
Carson City	$650 million	70%
Stateline	$590 million	60-70%
Minden	$340 million	67%
Elko	$160 million	10-15%
Fallon	$110 million	35%
Wells	$30 million	9%

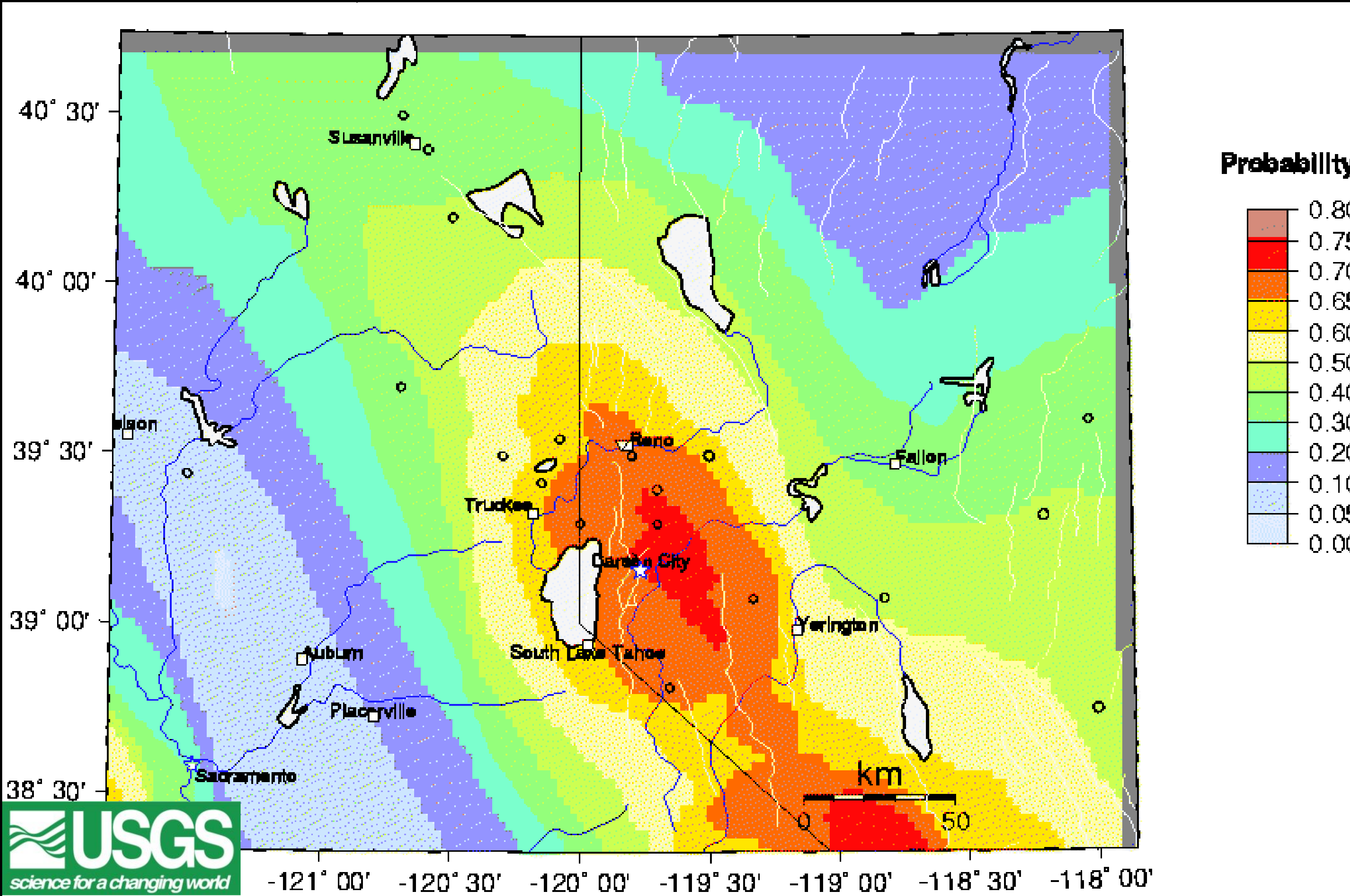
Total economic loss is from HAZUS. Probabilities are from the USGS at http://eqint.cr.usgs.gov/eqprob/2002/index.php.

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.

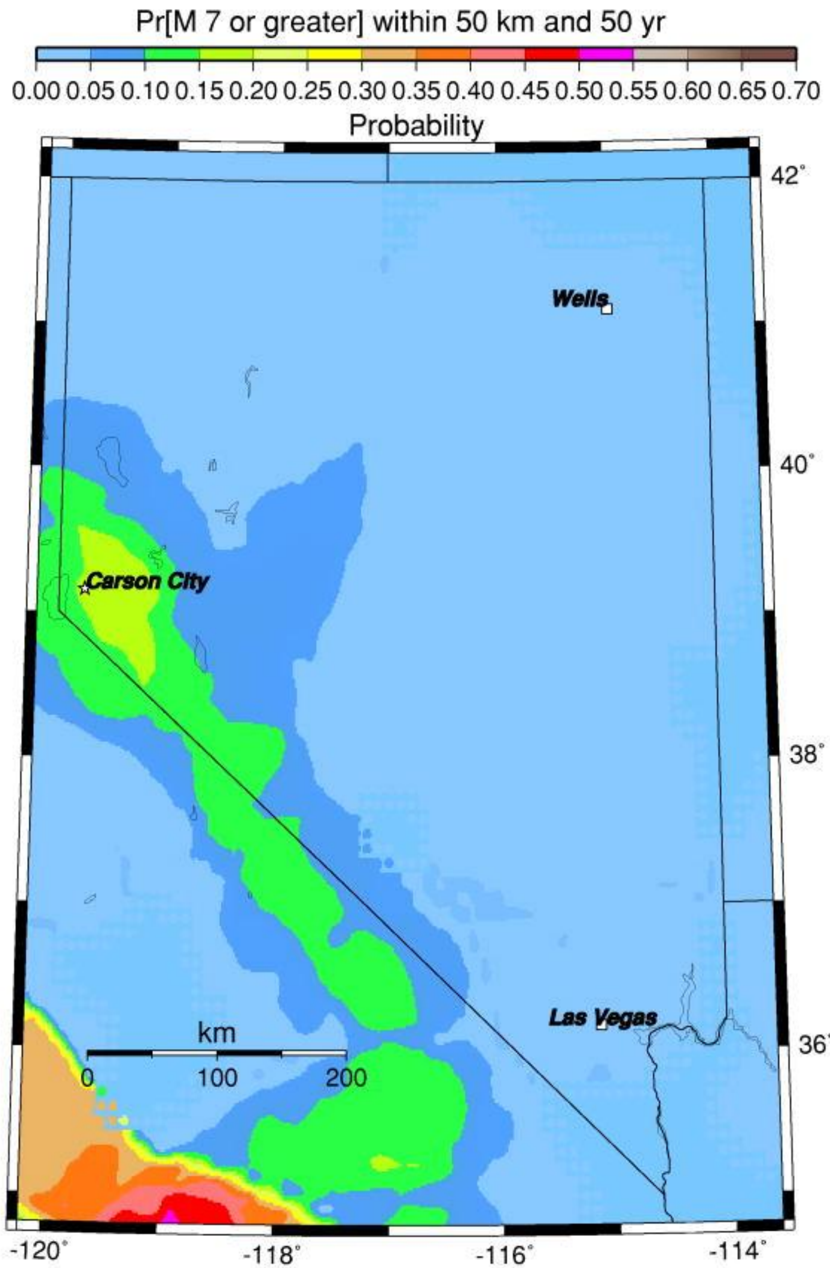


C. dePolo photo

The probability of a magnitude 6.0 earthquake occurring within 50 km of Carson City within the next 50 years is approximately 70%, 7.8 times higher than for Wells.

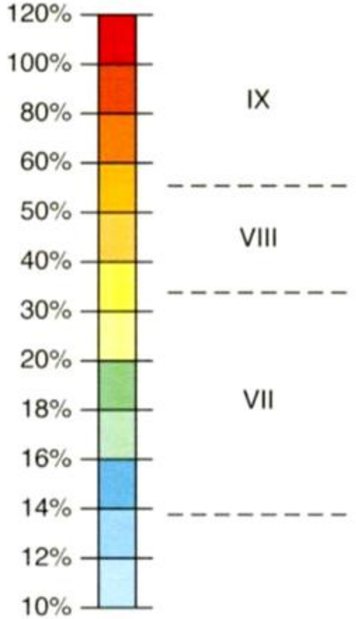


USGS
science for a changing world

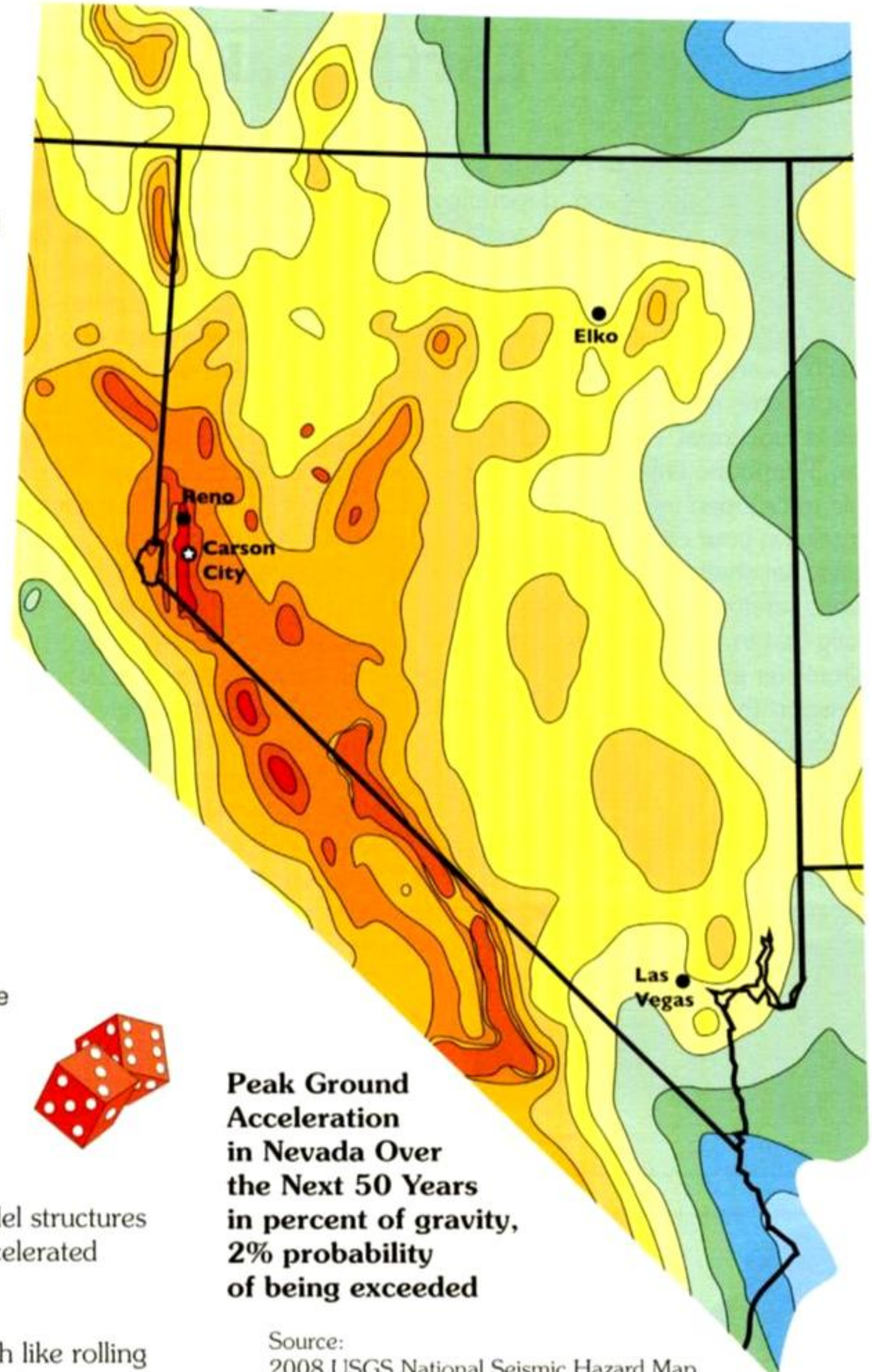

Pr[M 7 or greater] within 50 km and 50 yr
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70
Probability
42˚
40˚
38˚
36˚
Wells
Carson City
Las Vegas
km
0
100
200
-120˚
-118˚
-116˚
-114˚

Shaking Potential Map for Nevada

Possible Shaking in Peak Acceleration (percent of gravity)	Possible Maximum Modified Mercalli Intensity*



* See page 4 for descriptions of Intensity VII and VIII. In Intensity IX, general panic occurs and there may be damage to some well-built structures.



Peak Ground Acceleration in Nevada Over the Next 50 Years in percent of gravity, 2% probability of being exceeded

Source:
2008 USGS National Seismic Hazard Map

Engineers use computer models and model structures to see how buildings hold up to being accelerated sideways by a seismic wave.

The notion of a map like this is very much like rolling the dice and calculating odds. If a rarer, but

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 Buildings

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


BAR
306
302
RENO


BEAUJOLAIS
STUDIOS
& APTS


Definition of potential unreinforced masonry (URM) buildings in Nevada:

buildings listed by County Assessors or State Public Works as built before 1974 with brick, stone, or block masonry structure.

Caution: This is a preliminary study based on data provided by the County Assessors and the State of Nevada. We know there are errors in the database:

- **URMs missed - not recorded as masonry structures**
- **URMs missed – ones on federal or Indian lands**
- **URMs counted due to wrong building type in the database**
- **Wrong locations due to poor address coding**
- **Misidentifications due to lack of construction date**
- **Buildings that may have been seismically retrofitted**
- **Buildings that have been removed.**

Recommendation 1 (draft): Jurisdictions (cities, counties, state) should use this County Assessors' data to follow up with on-the-ground inspections and checks of building plans. Individuals should determine if their buildings are URMs.

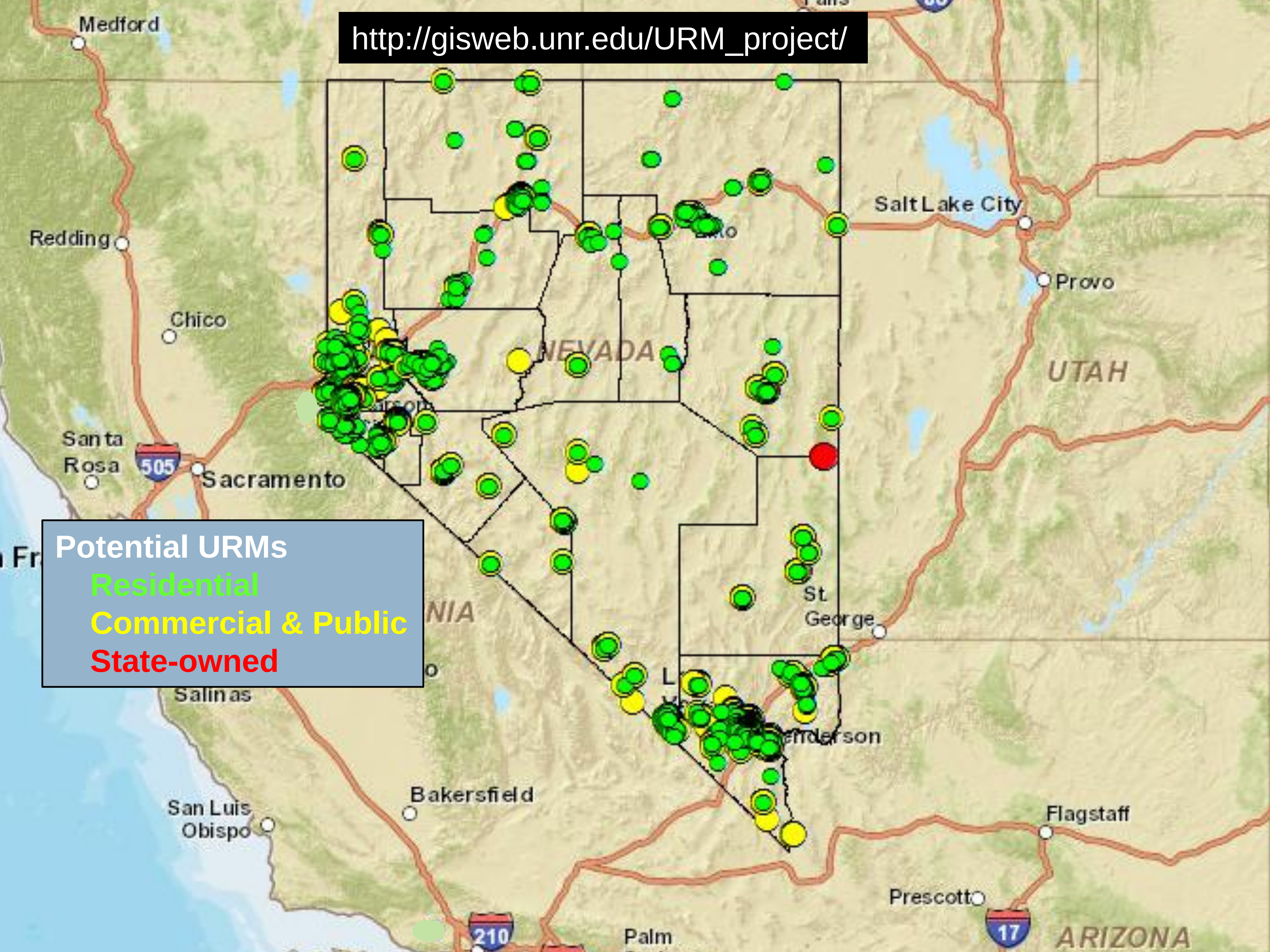
Potential URMs in Nevada – totals*

7,354	Residential
16,145	Commercial & Public (city and county)
98	State-owned
23,597	TOTAL*

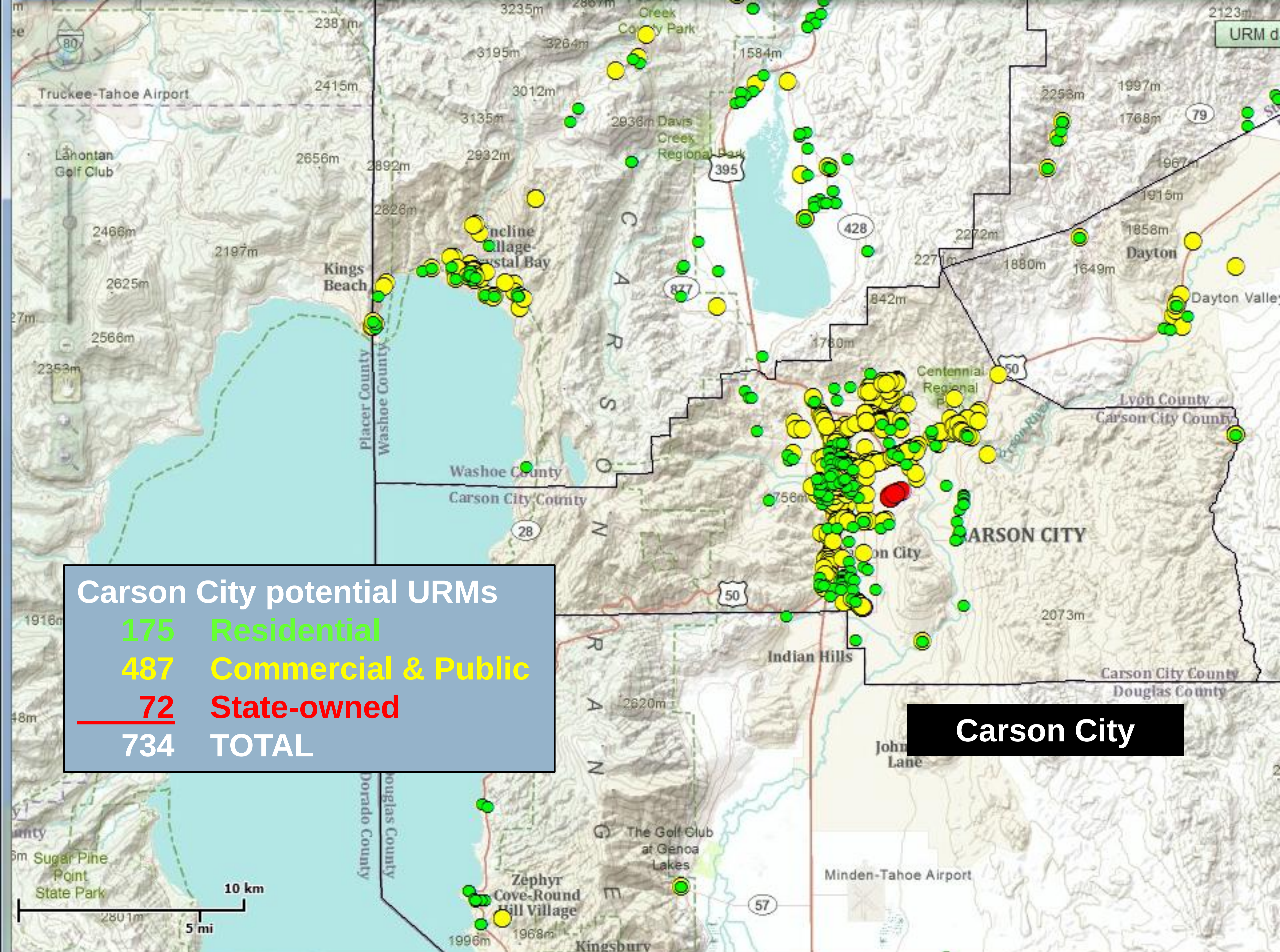
* The total does not include buildings owned by the federal government.

http://gisweb.unr.edu/URM_project/

http://gisweb.unr.edu/URM_project/

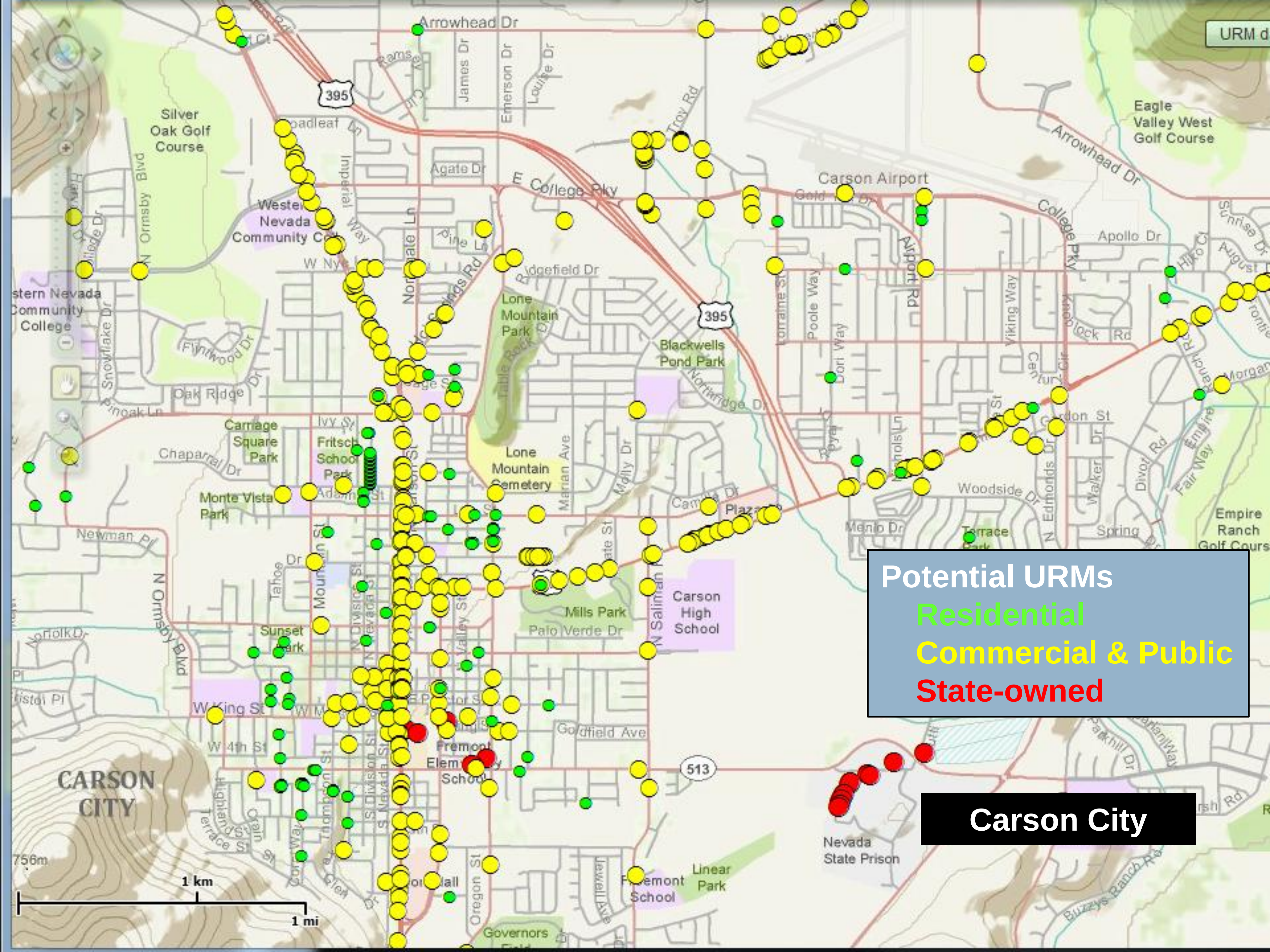


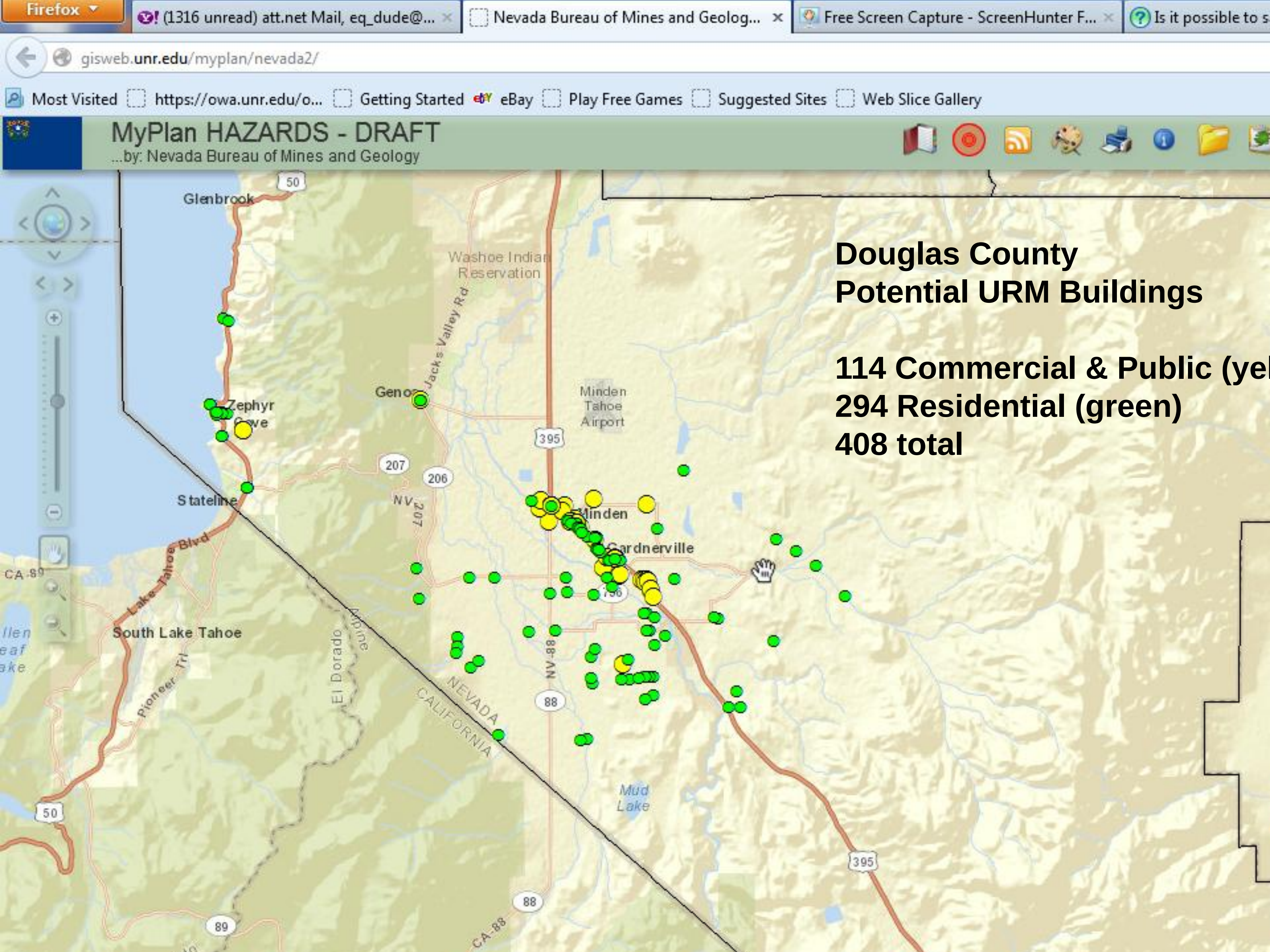
Carson City



Carson City potential URMs

175	Residential
487	Commercial & Public
72	State-owned
734	TOTAL


Potential URMs
Residential
Commercial & Public
State-owned
Carson City



Douglas County
Potential URM Buildings

114 Commercial & Public (yel
294 Residential (green)
408 total

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 Jon Price, 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.nbmg.unr.edu.

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

nbmg Nevada Bureau of Mines and Geology

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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

Web Addresses

- Earthquake Fault Map
  - http://gisweb.unr.edu/OF09_9