Earthquake Hazards in Clark County

Presentation for the Nevada Hazard Mitigation Planning Committee

10 November 2011

Jonathan G. Price and Craig M. dePolo
Nevada Bureau of Mines and Geology

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

Nevada Bureau of Mines and Geology

University of Nevada, Reno
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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

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.

Age of Latest Fault Rupture

< 150 years (historical)

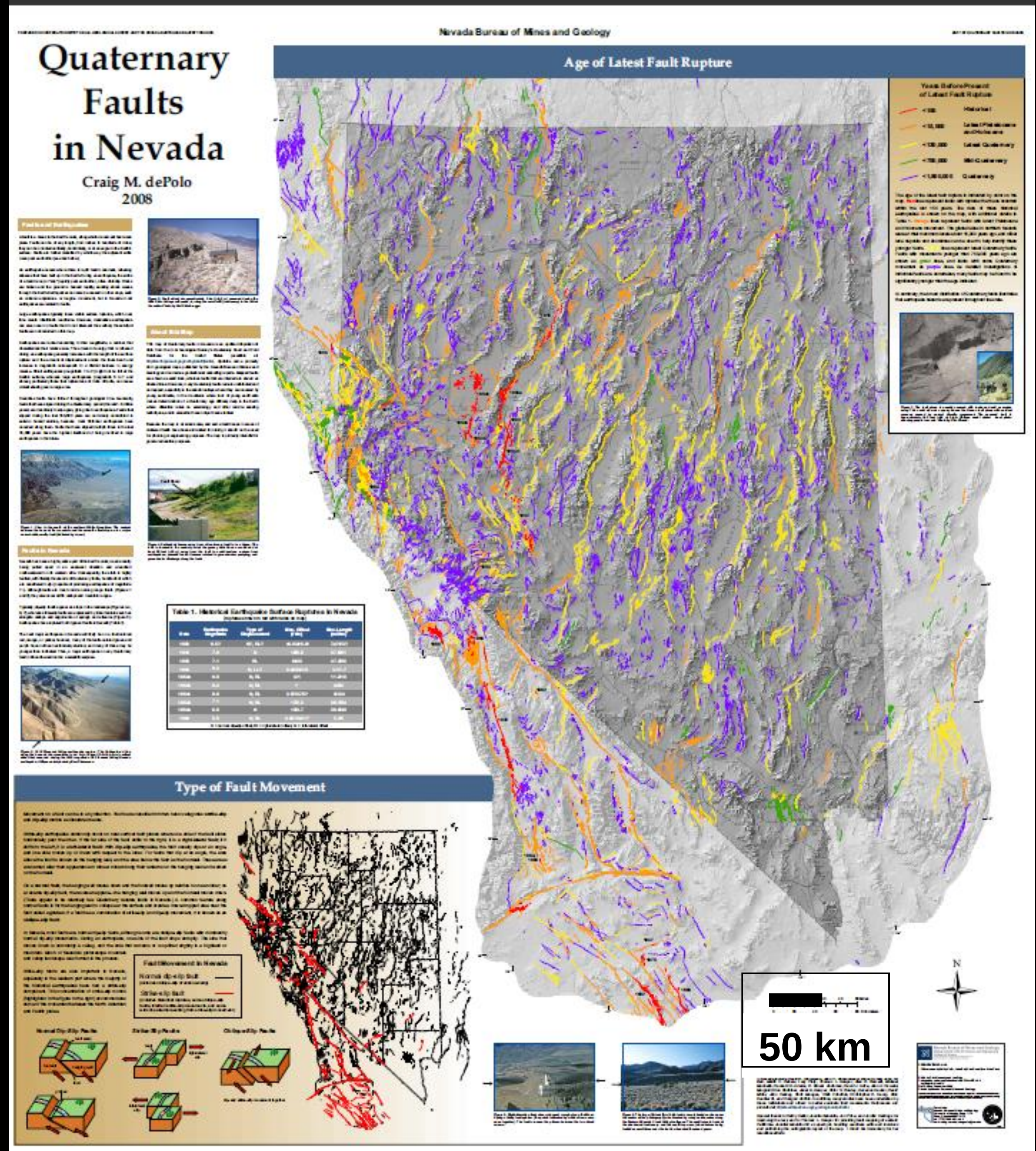
< 15,000 years

< 130,000 years

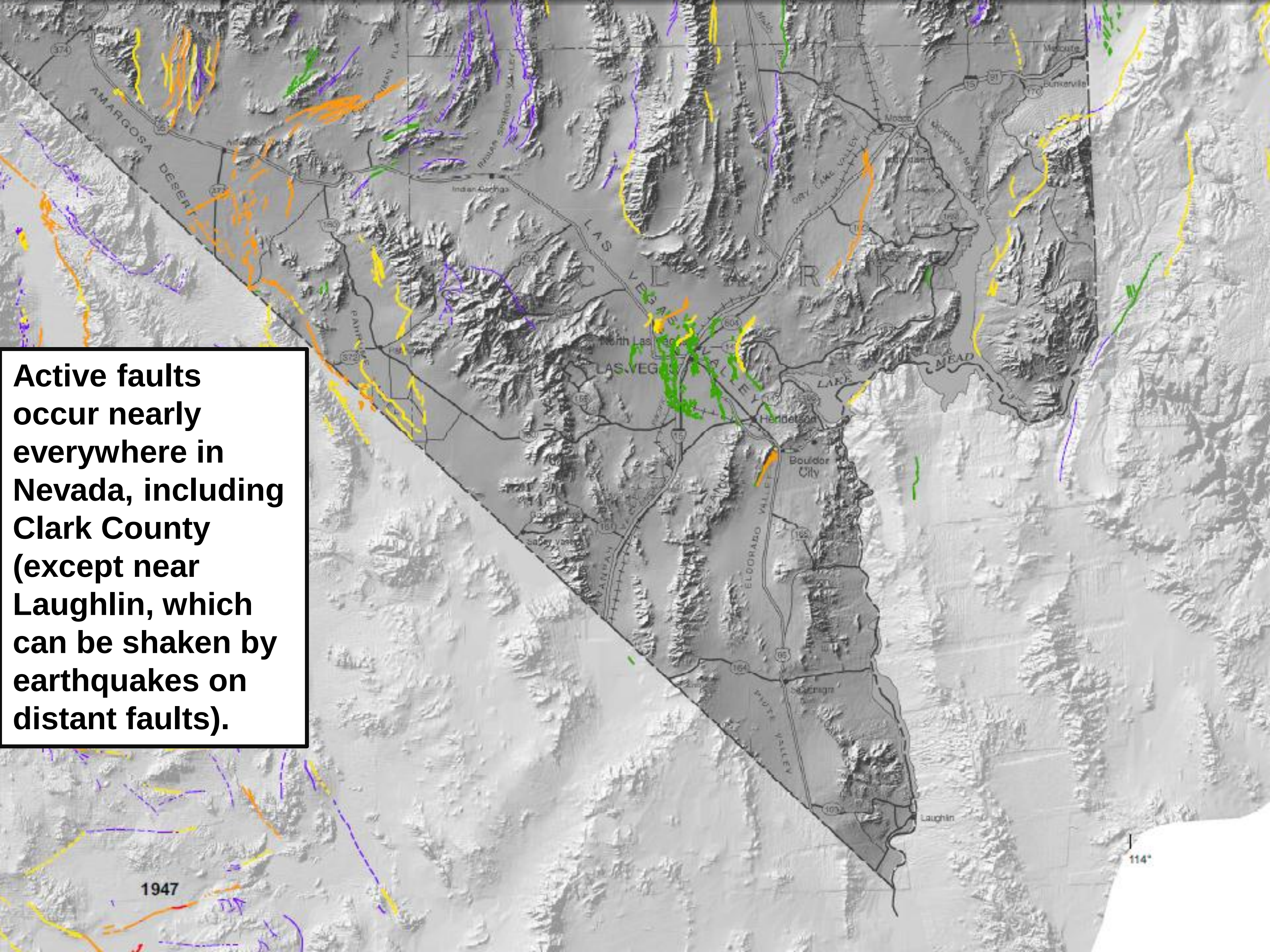
< 750,000 years

< 1,800,000 years (Quaternary)

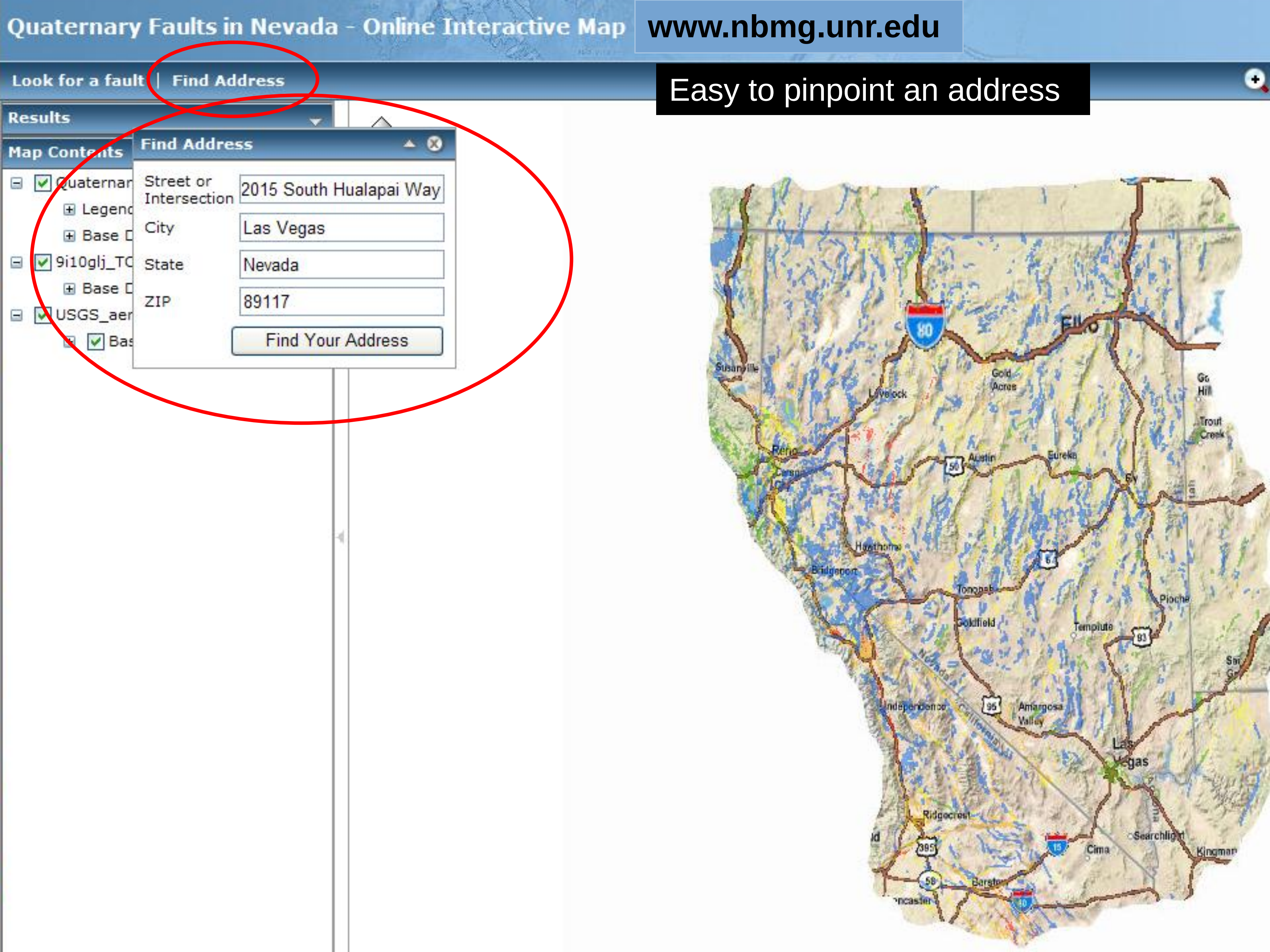
There are active faults nearly everywhere in Nevada. A magnitude 6.0 earthquake can occur anywhere in Nevada.



www.nbmg.unr.edu



Active faults occur nearly everywhere in Nevada, including Clark County (except near Laughlin, which can be shaken by earthquakes on distant faults).


Quaternary Faults in Nevada - Online Interactive Map
www.nbmg.unr.edu
Look for a fault
Find Address
Easy to pinpoint an address
Results
Map Contents
Find Address
Street or Intersection
2015 South Hualapai Way
City
Las Vegas
State
Nevada
ZIP
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Find Your Address
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Elko
Austin
Eureka
Ely
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Goldfield
Pioche
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Hawthorne
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Lovelock
Susanville
Ridgecrest
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Searchlight
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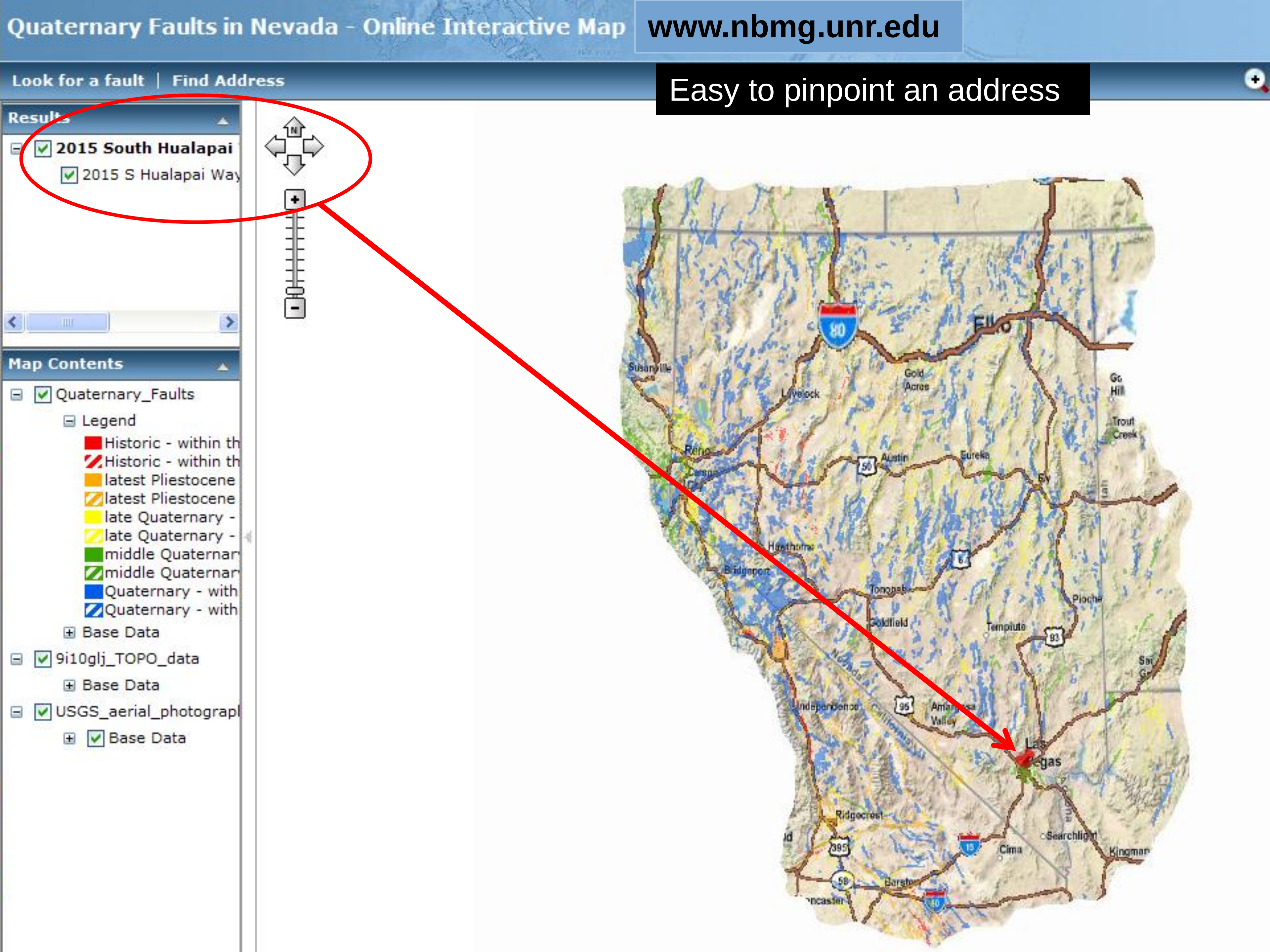

Quaternary Faults in Nevada - Online Interactive Map
www.nbmg.unr.edu
Look for a fault | Find Address
Easy to pinpoint an address
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Las Vegas
Ridgecrest
Barstow
Kingman

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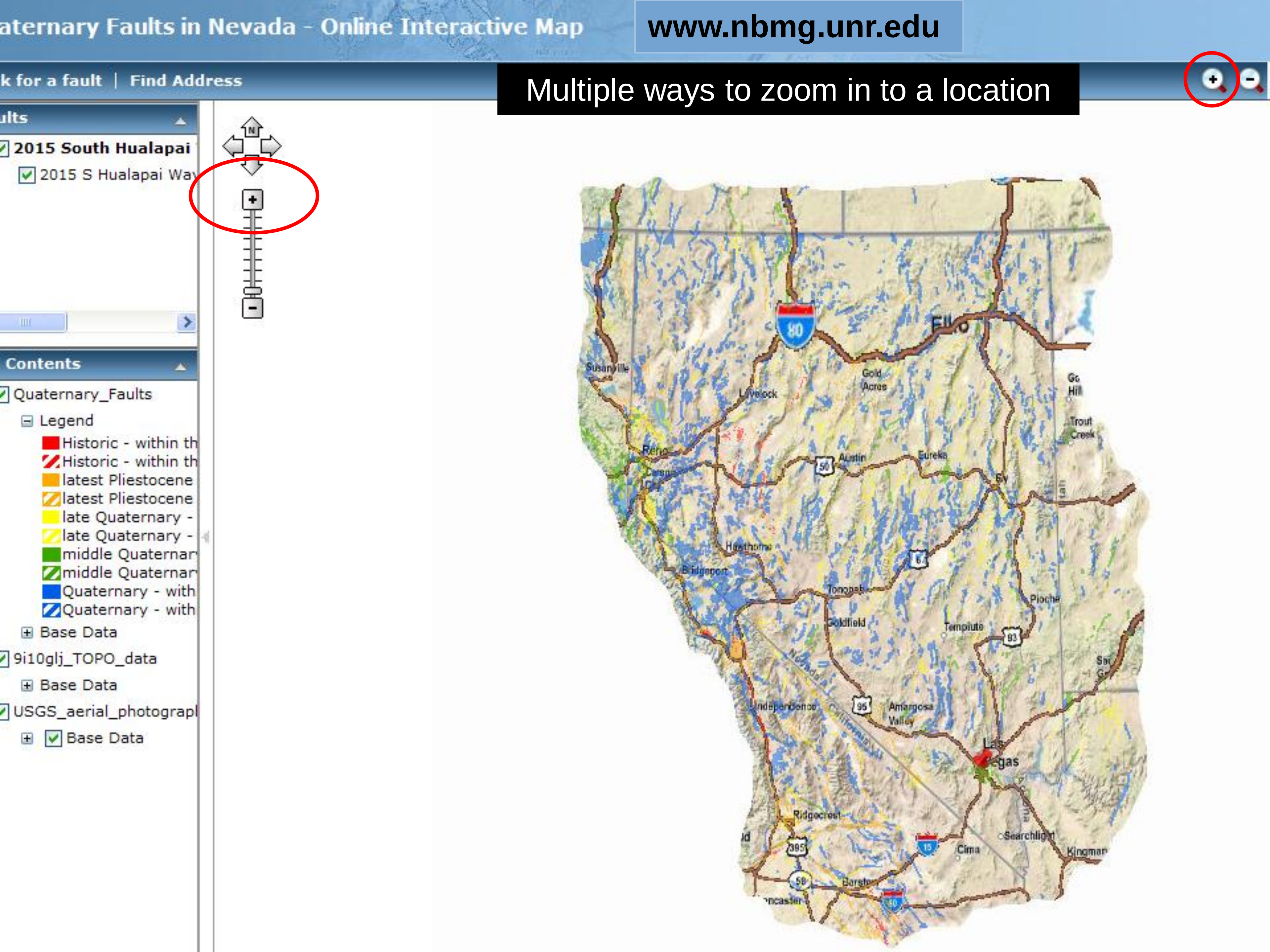
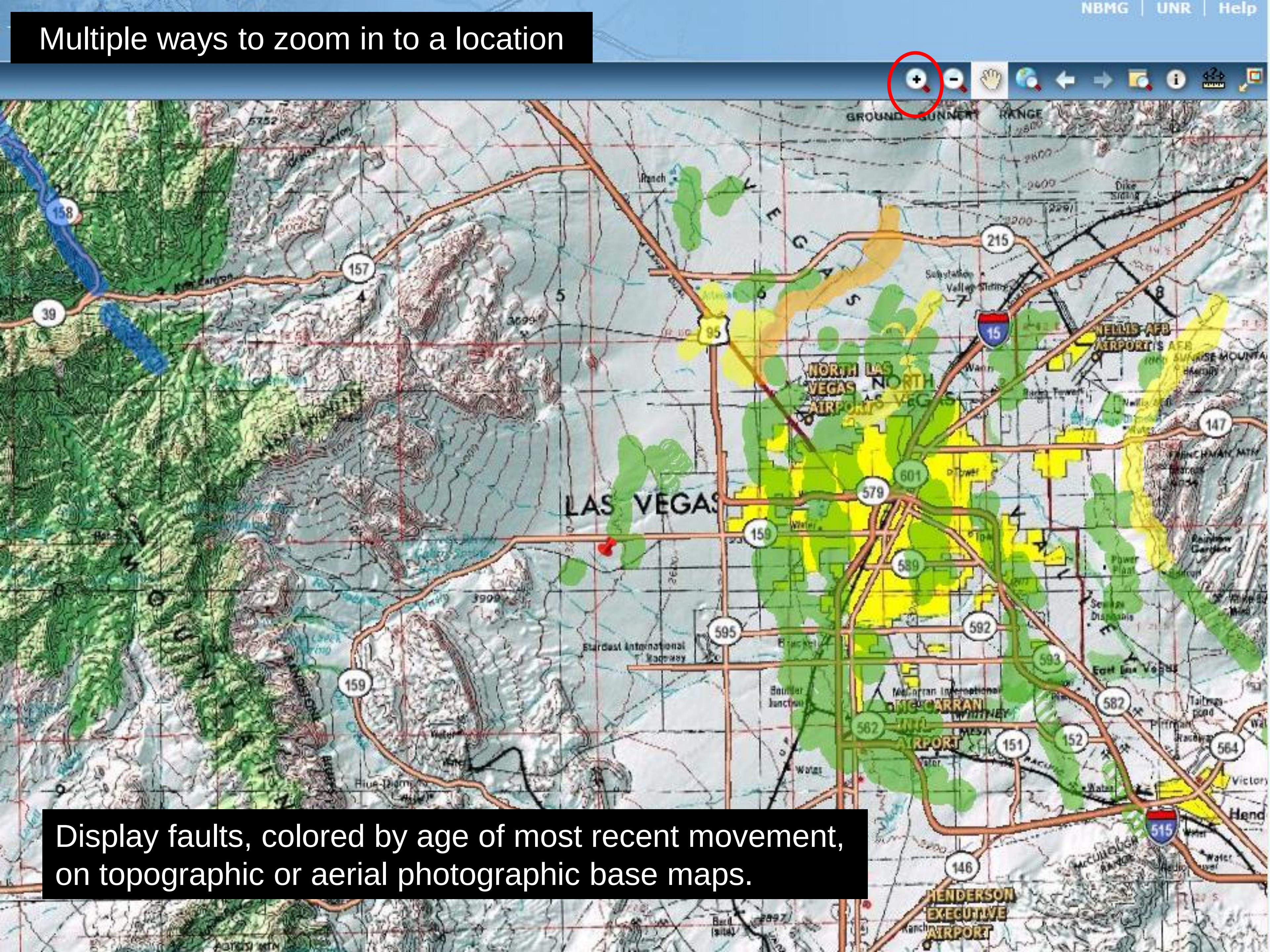
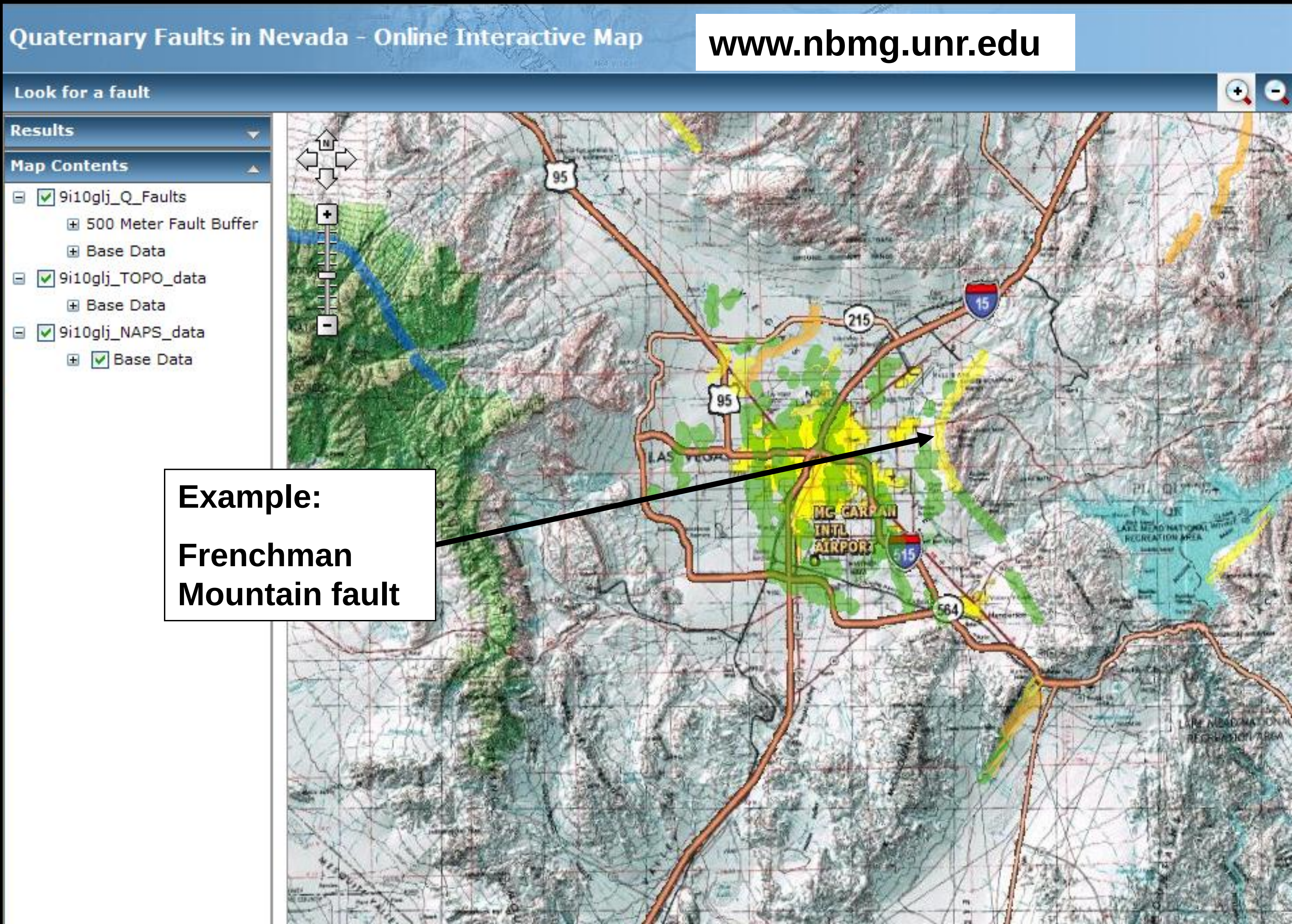
Multiple ways to zoom in to a location



Multiple ways to zoom in to a location



Display faults, colored by age of most recent movement, on topographic or aerial photographic base maps.


Quaternary Faults in Nevada - Online Interactive Map
www.nbmg.unr.edu
Look for a fault
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9i10glj_Q_Faults
500 Meter Fault Buffer
Base Data
9i10glj_TOPO_data
Base Data
9i10glj_NAPS_data
Base Data
Example:
Frenchman Mountain fault
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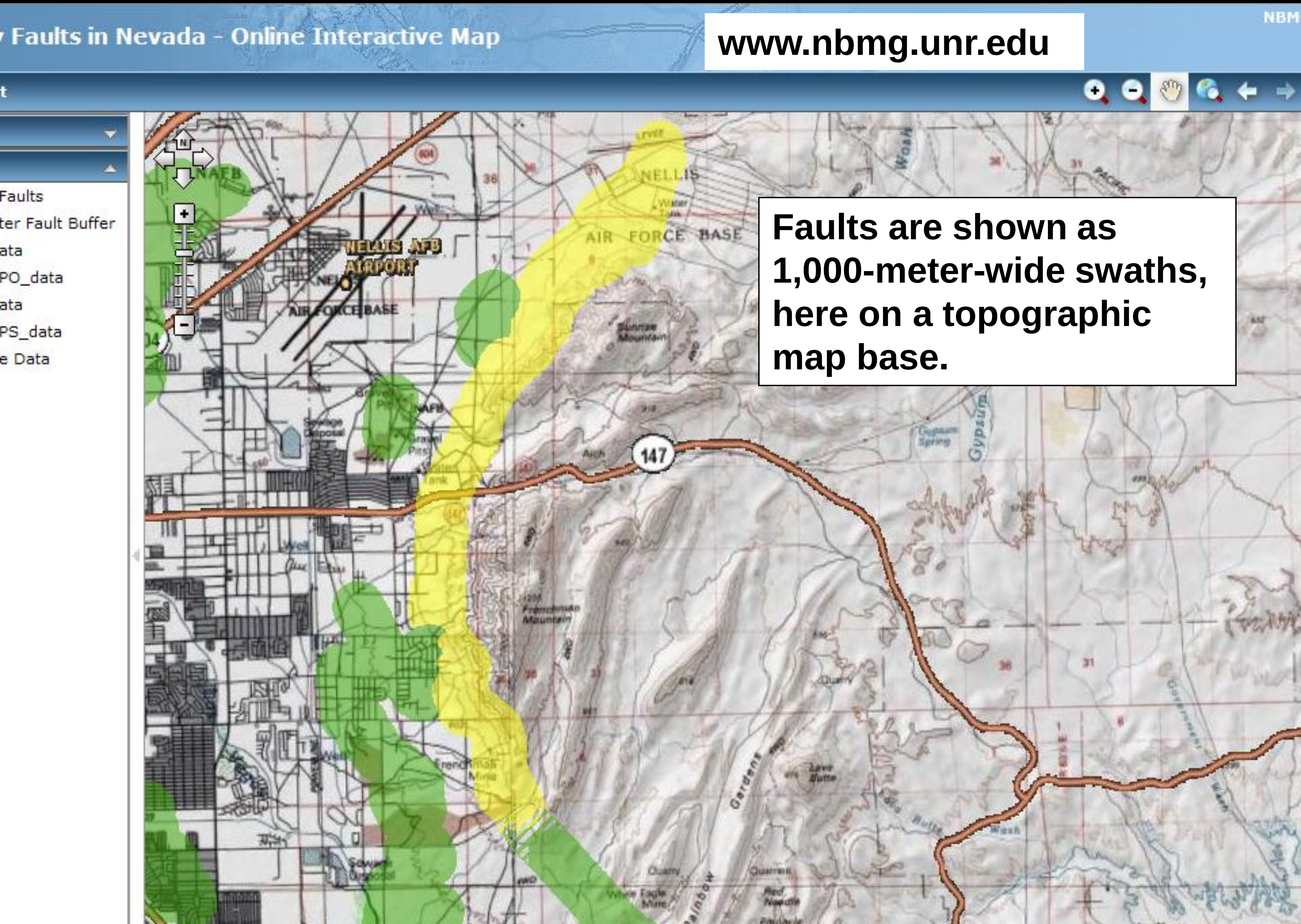
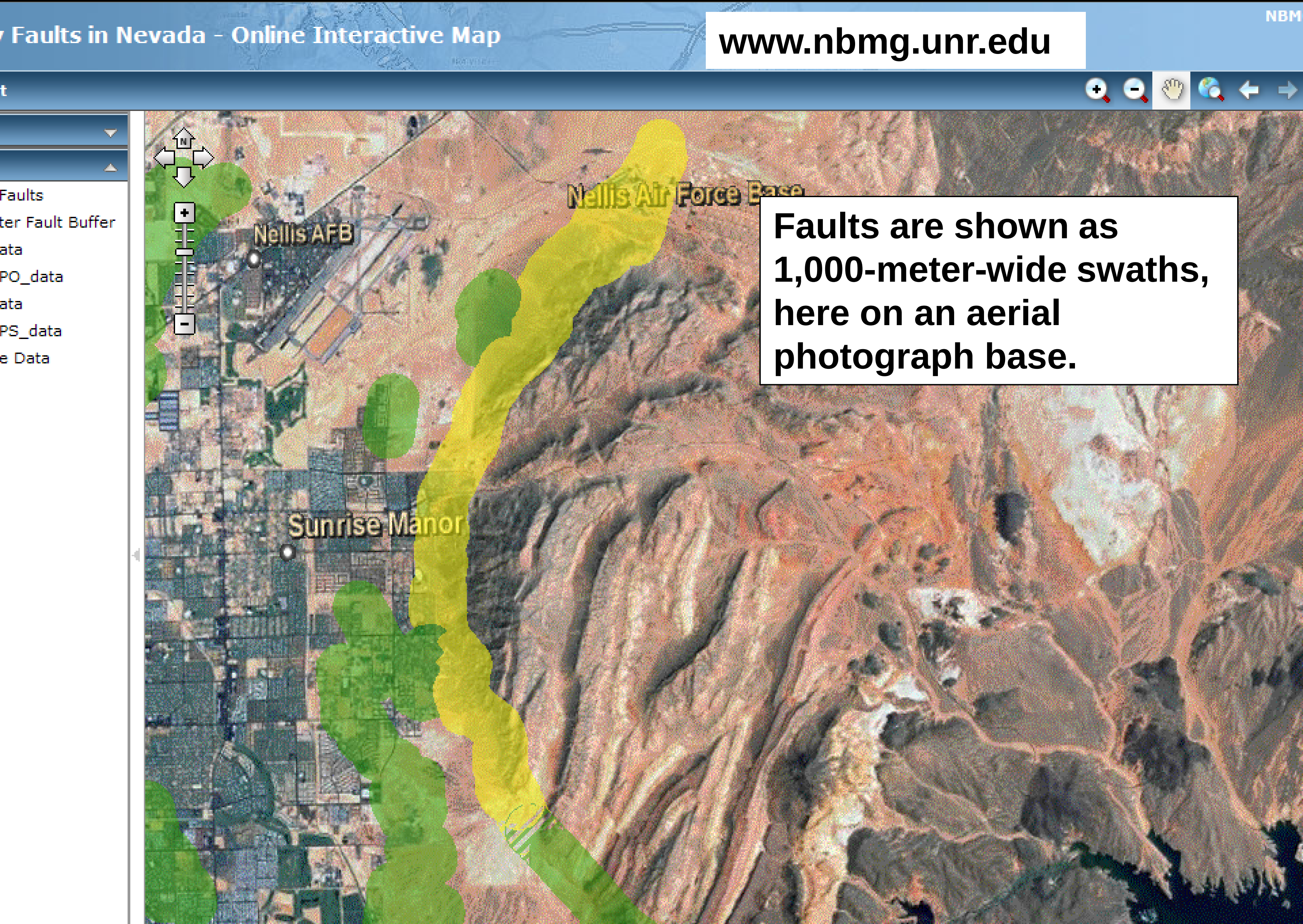
MC CARRAN INTL AIRPORT
LAKE MEAD NATIONAL RECREATION AREA

www.nbmg.unr.edu

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





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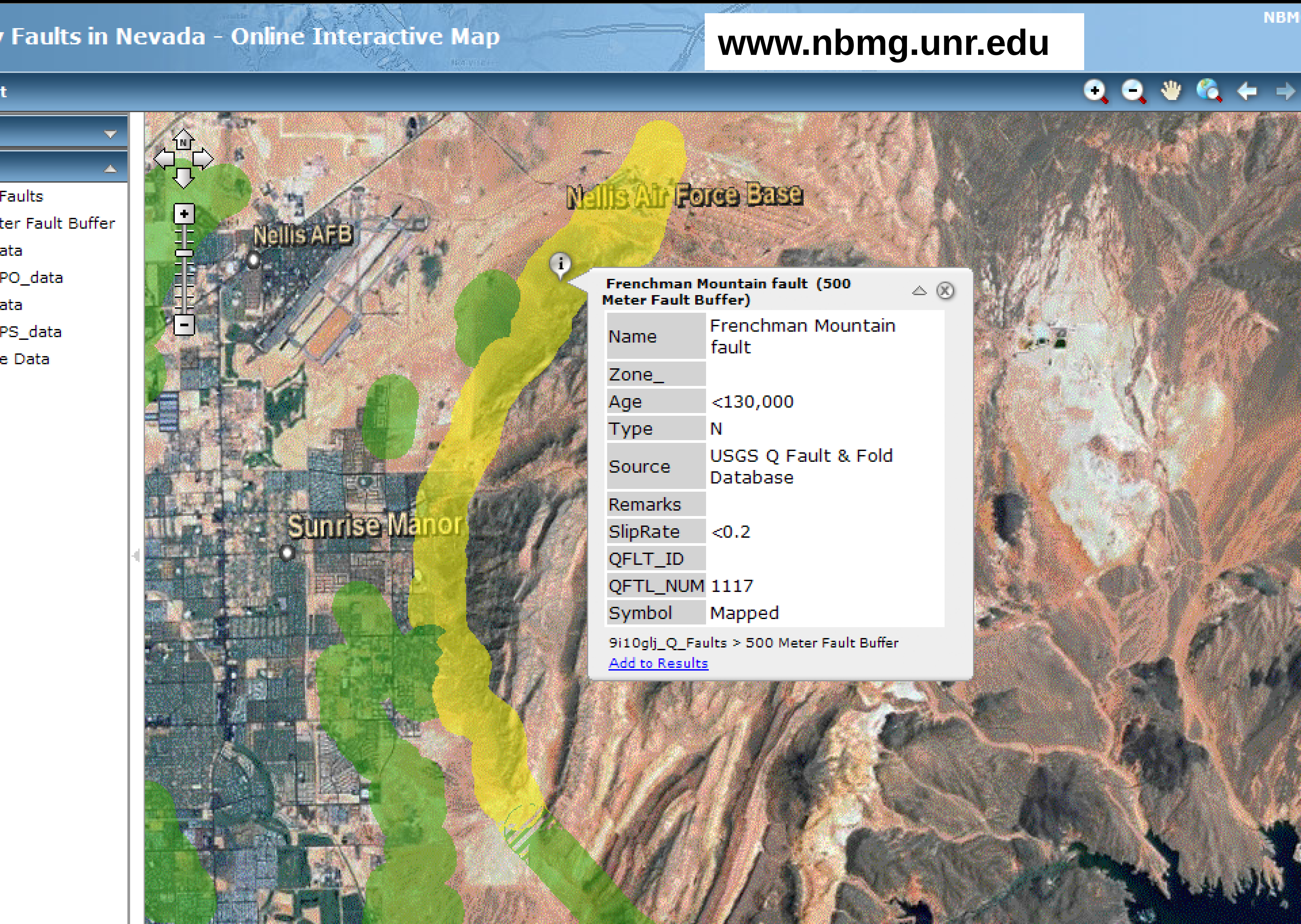
Faults are shown as 1,000-meter-wide swaths, here on an aerial photograph base.



Faults in Nevada - Online Interactive Map
www.nbmg.unr.edu
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Sunrise Manor
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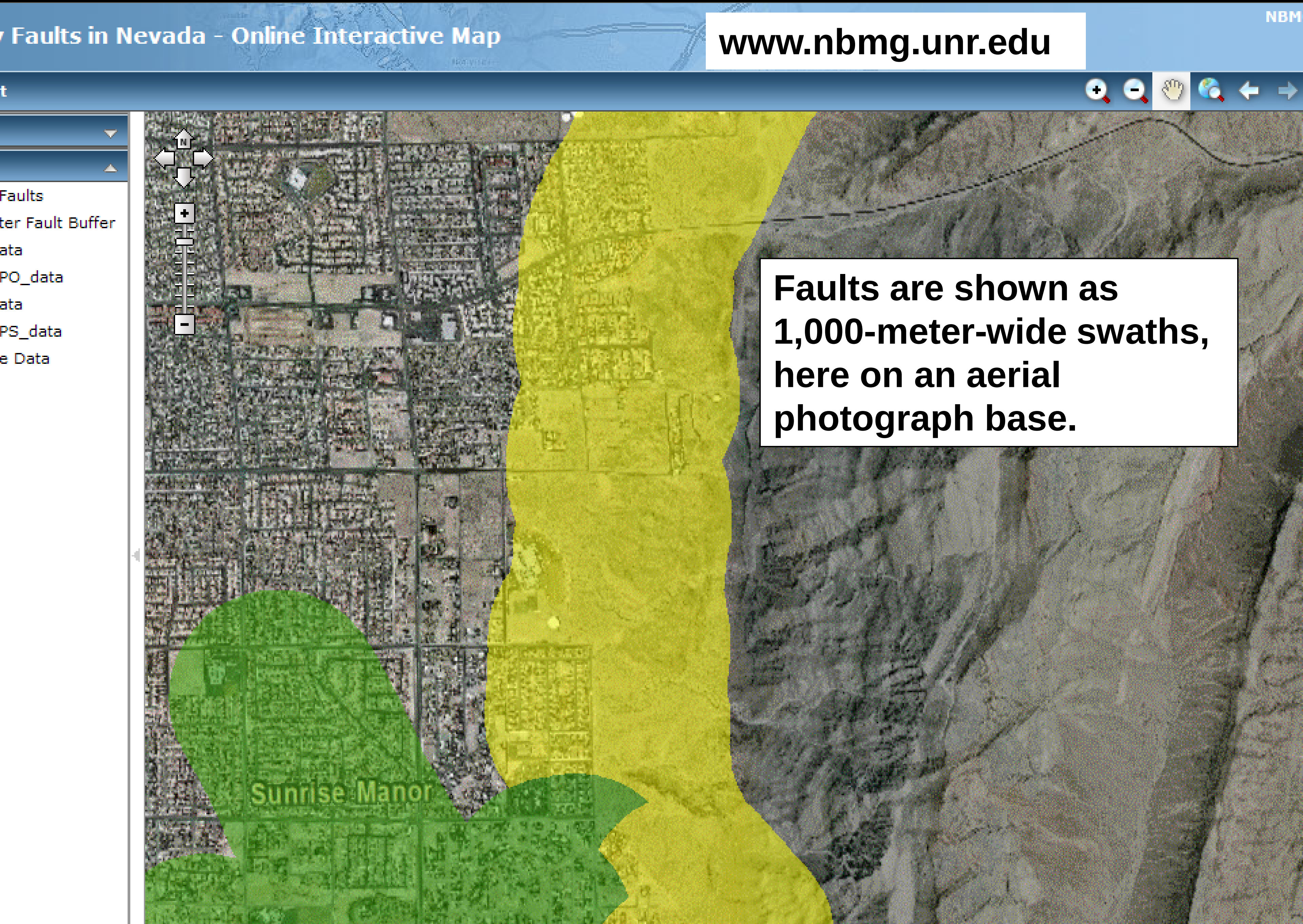

Faults in Nevada - Online Interactive Map
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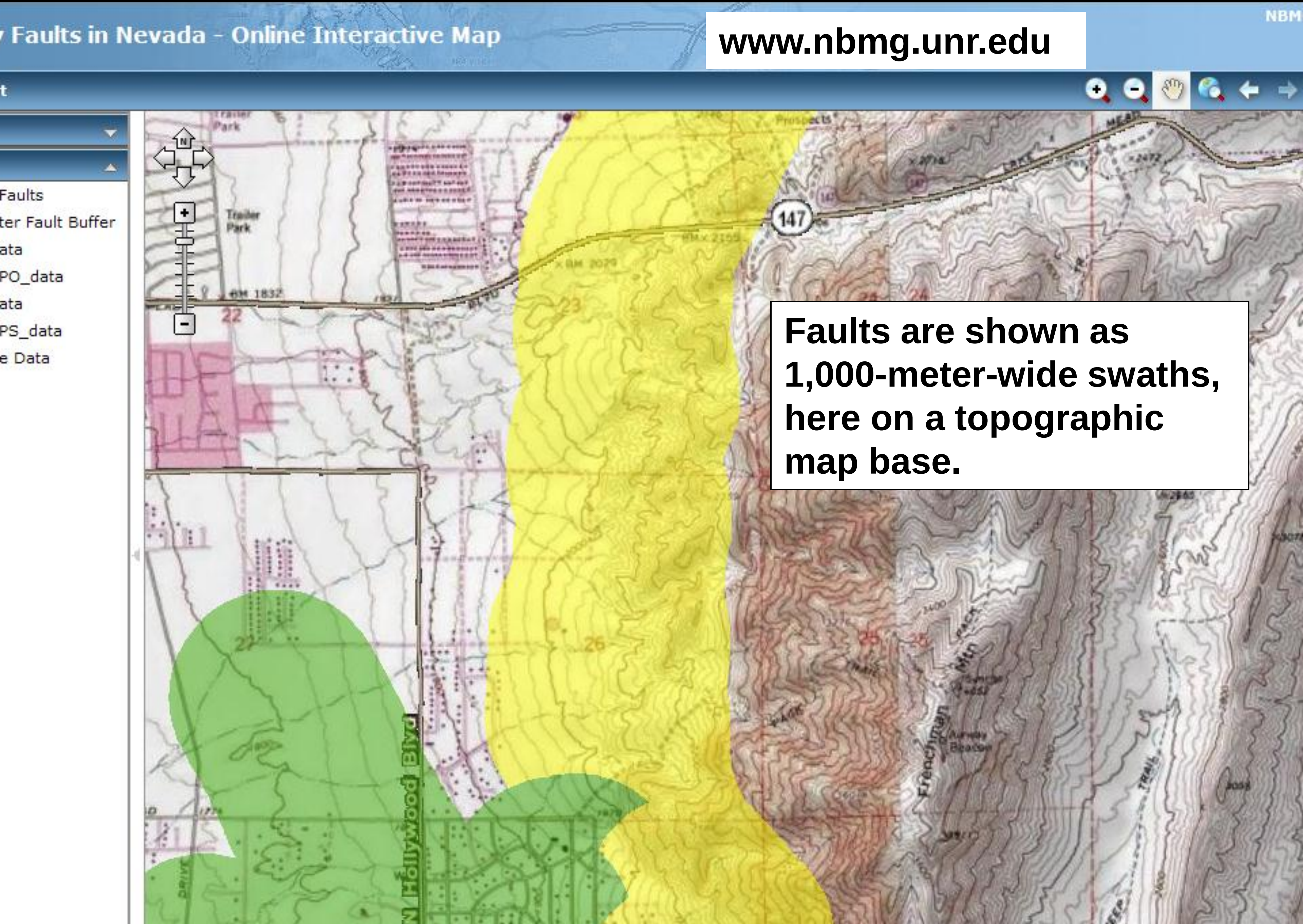
www.nbmg.unr.edu



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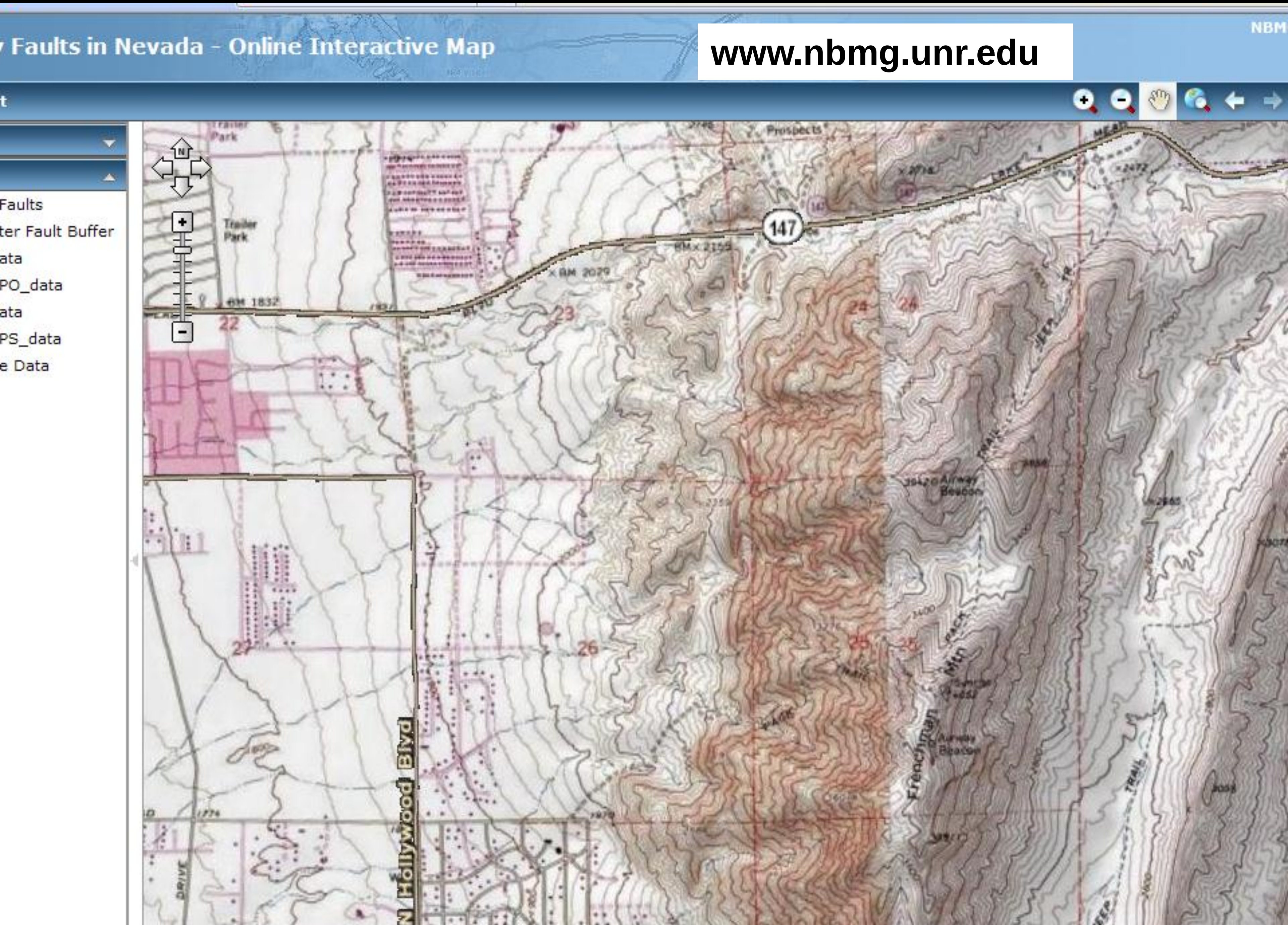
Faults in Nevada - Online Interactive Map
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Faults in Nevada - Online Interactive Map
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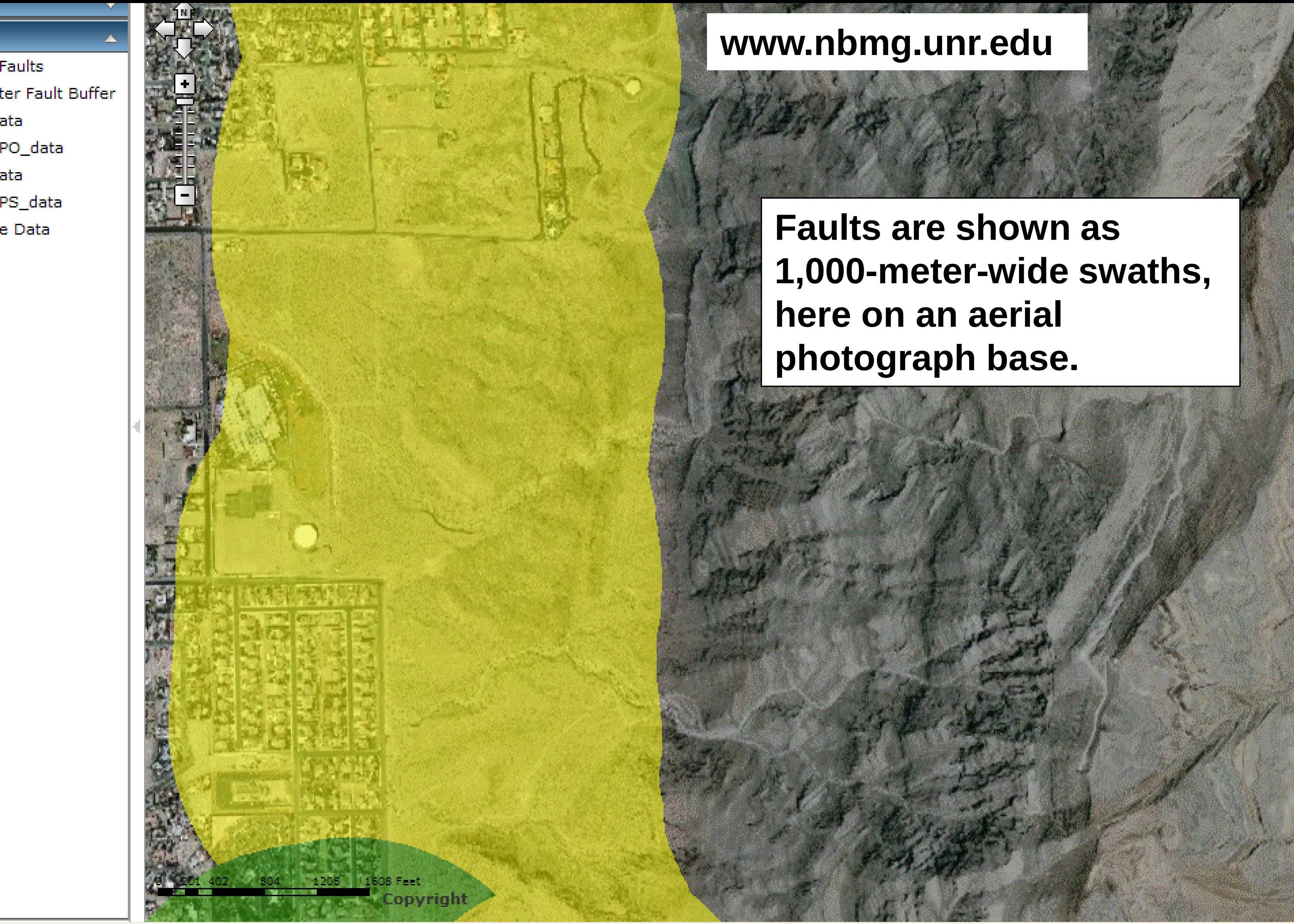
www.nbmg.unr.edu



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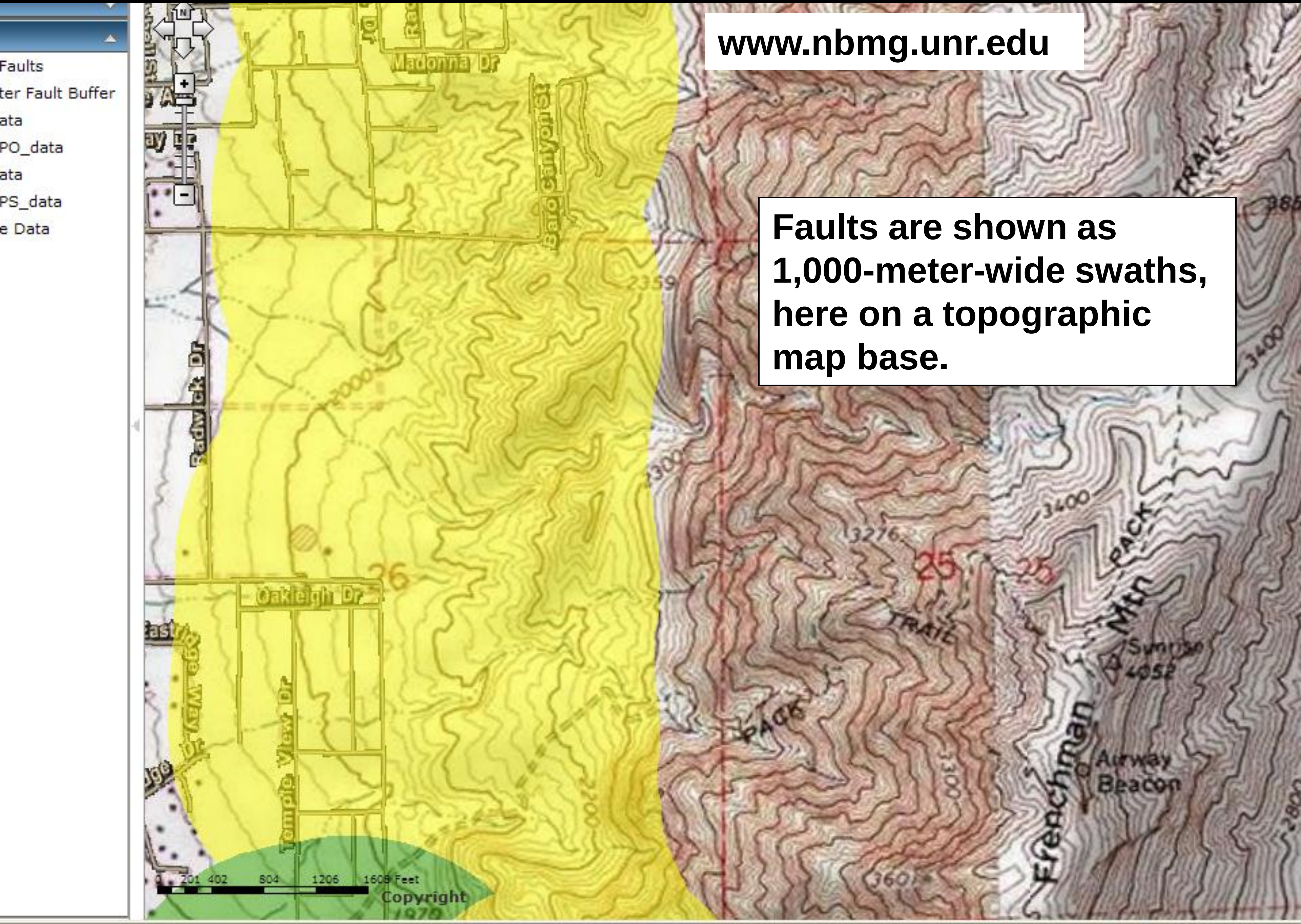

www.nbmg.unr.edu

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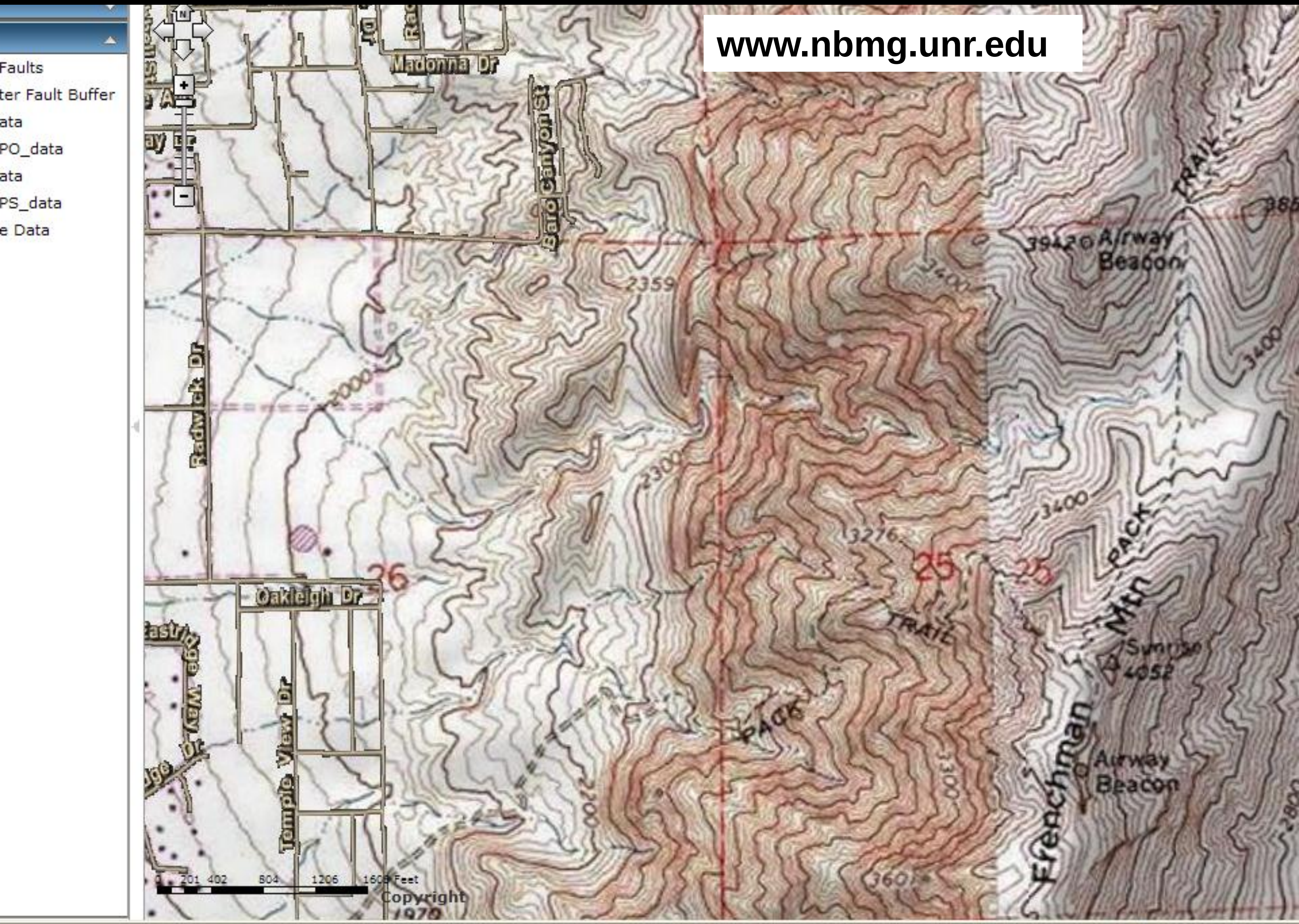
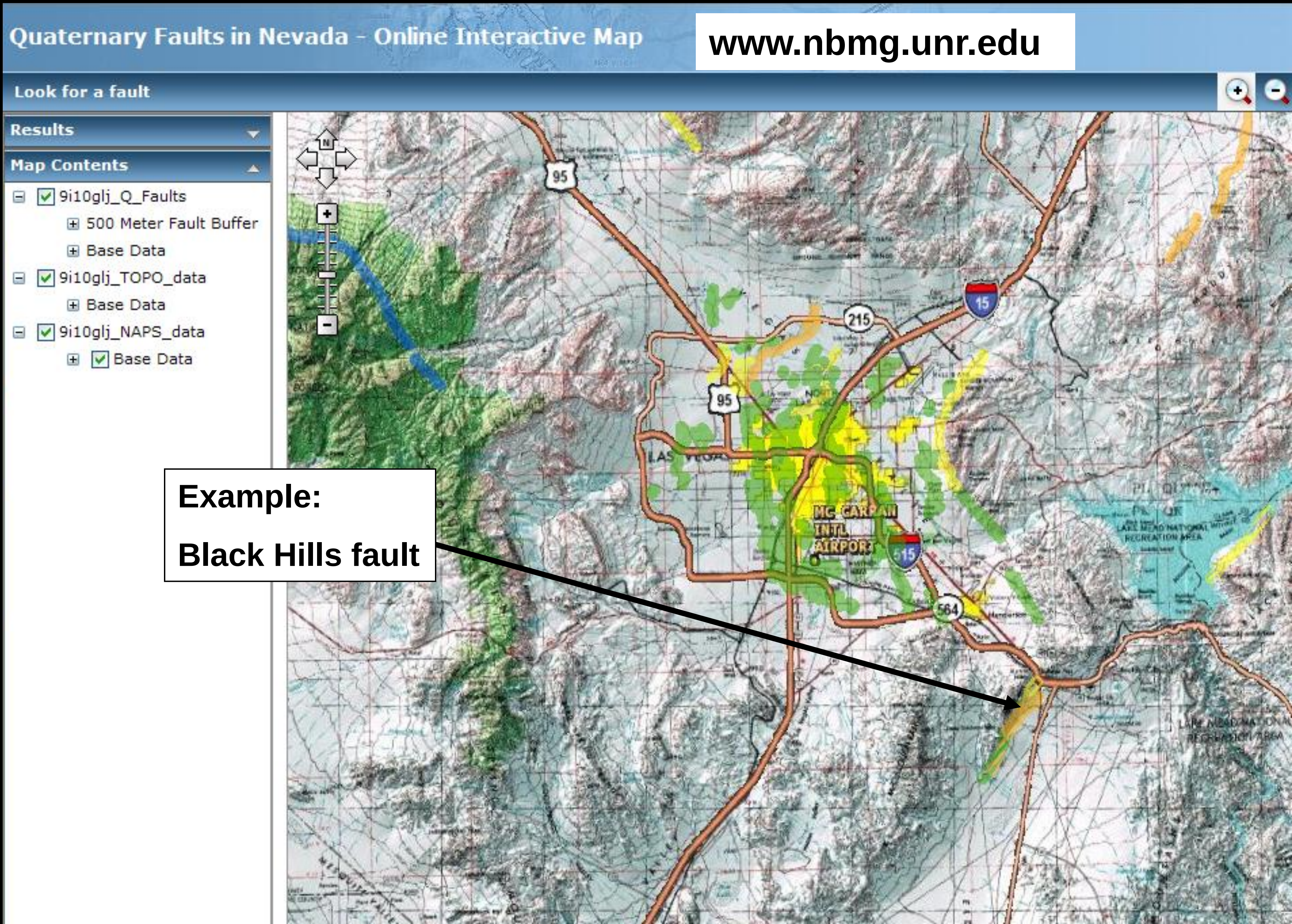
www.nbmg.unr.edu

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Look for a fault
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Map Contents
9i10glj_Q_Faults
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Example:
Black Hills fault
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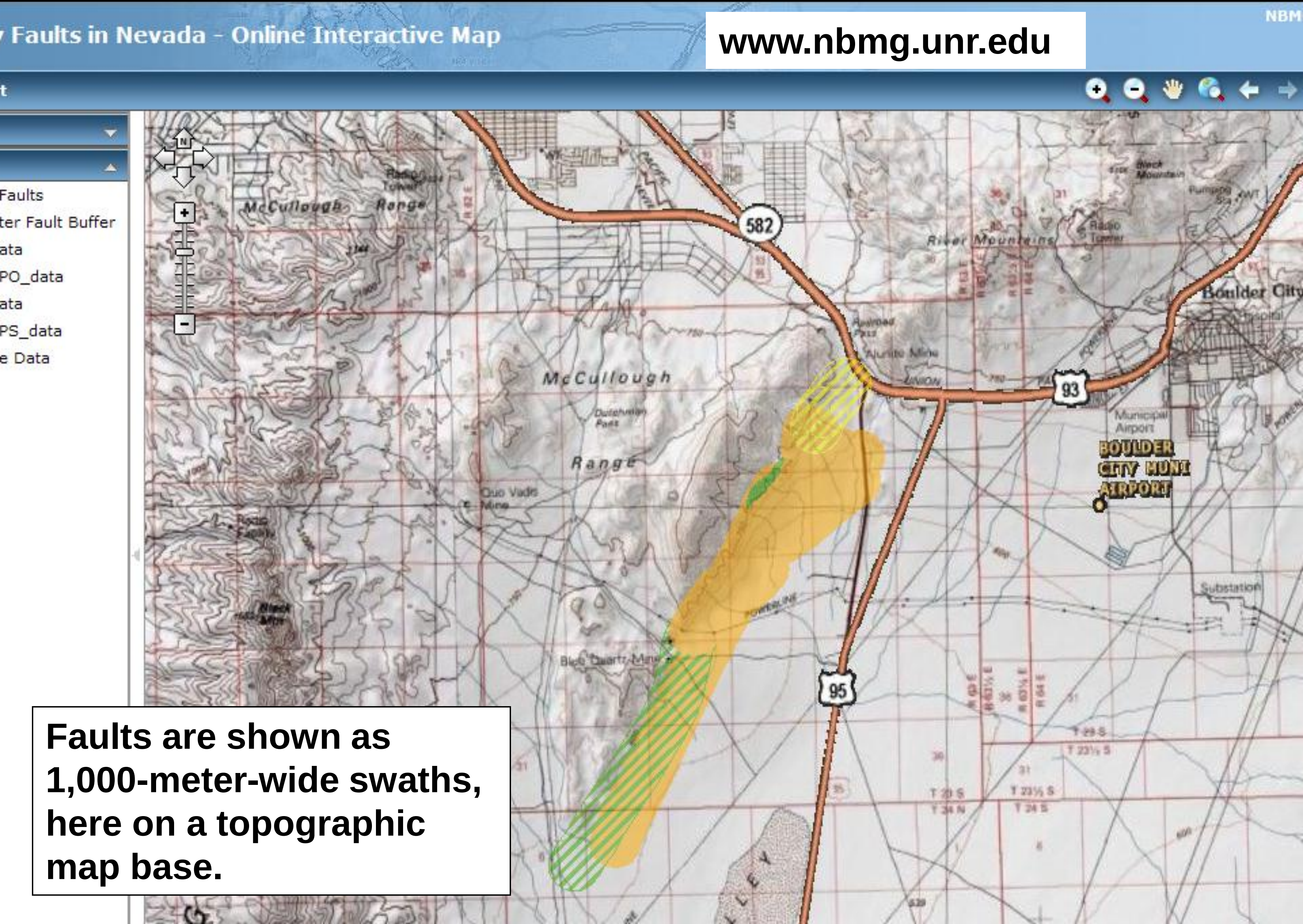

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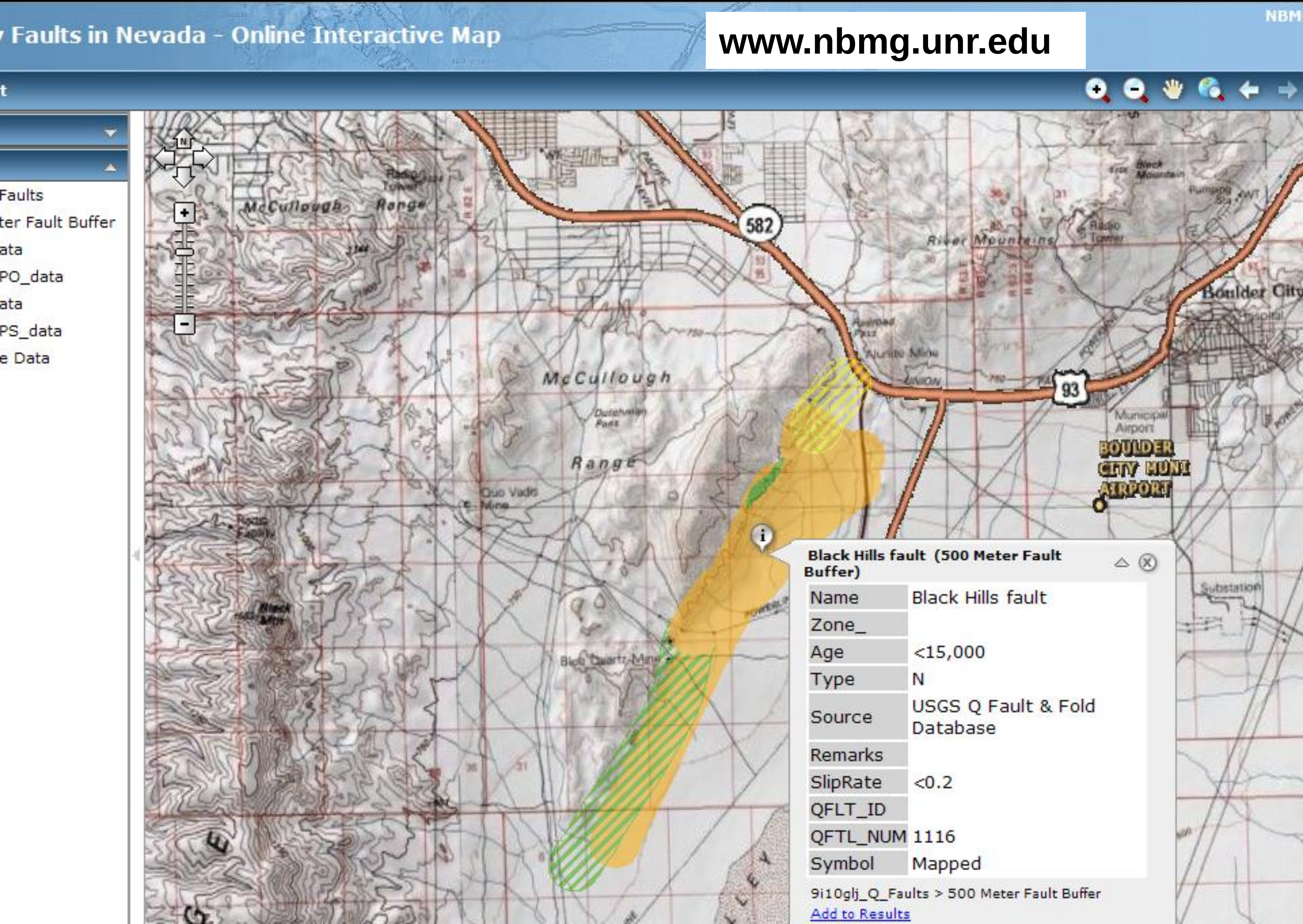
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Faults in Nevada - Online Interactive Map
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River Mountains
Boulder City
BOULDER CITY MUNI AIRPORT
Black Hills fault (500 Meter Fault Buffer)
Name Black Hills fault
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Age <15,000
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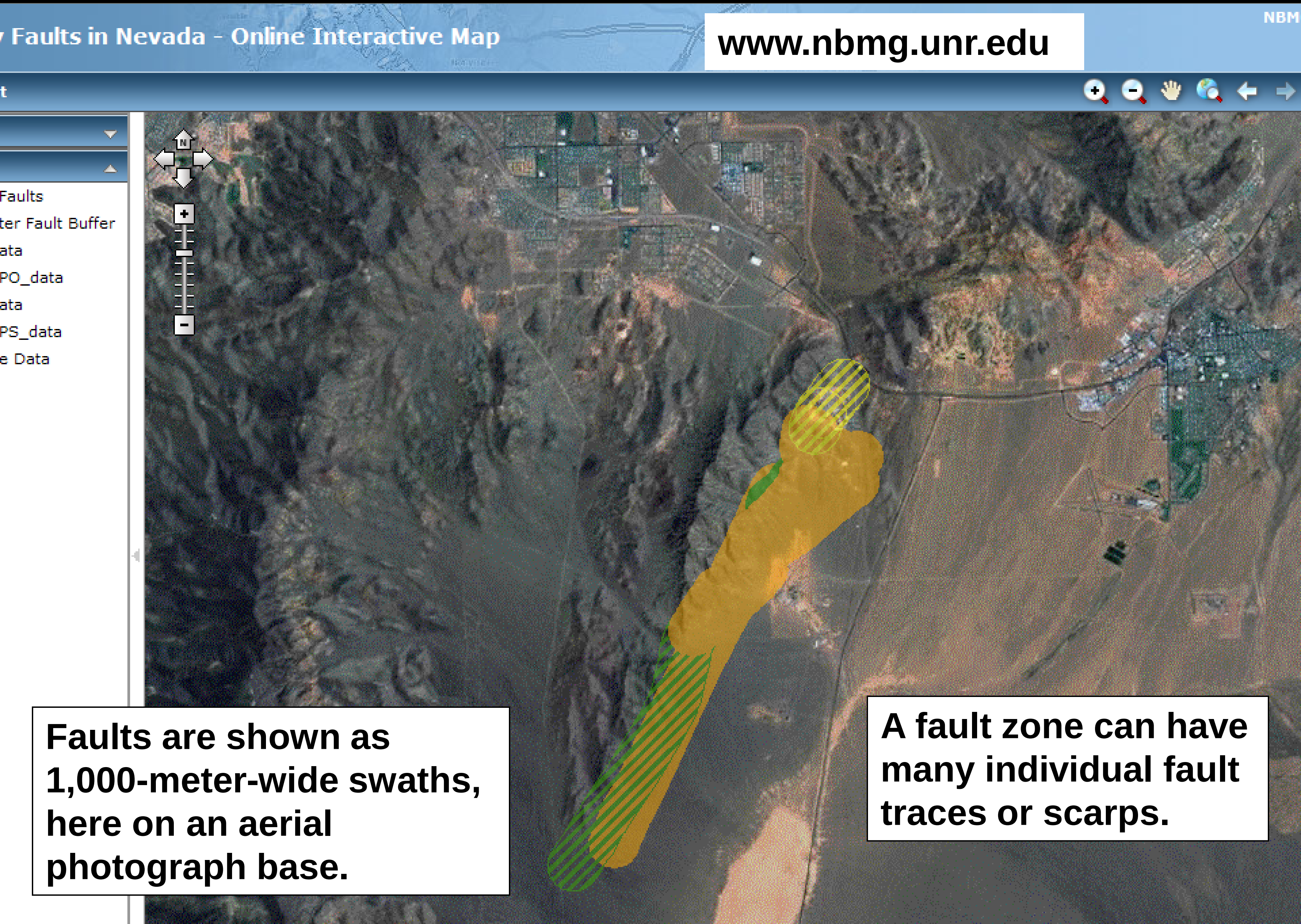

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Faults are shown as 1,000-meter-wide swaths, here on an aerial photograph base.

A fault zone can have many individual fault traces or scarps.

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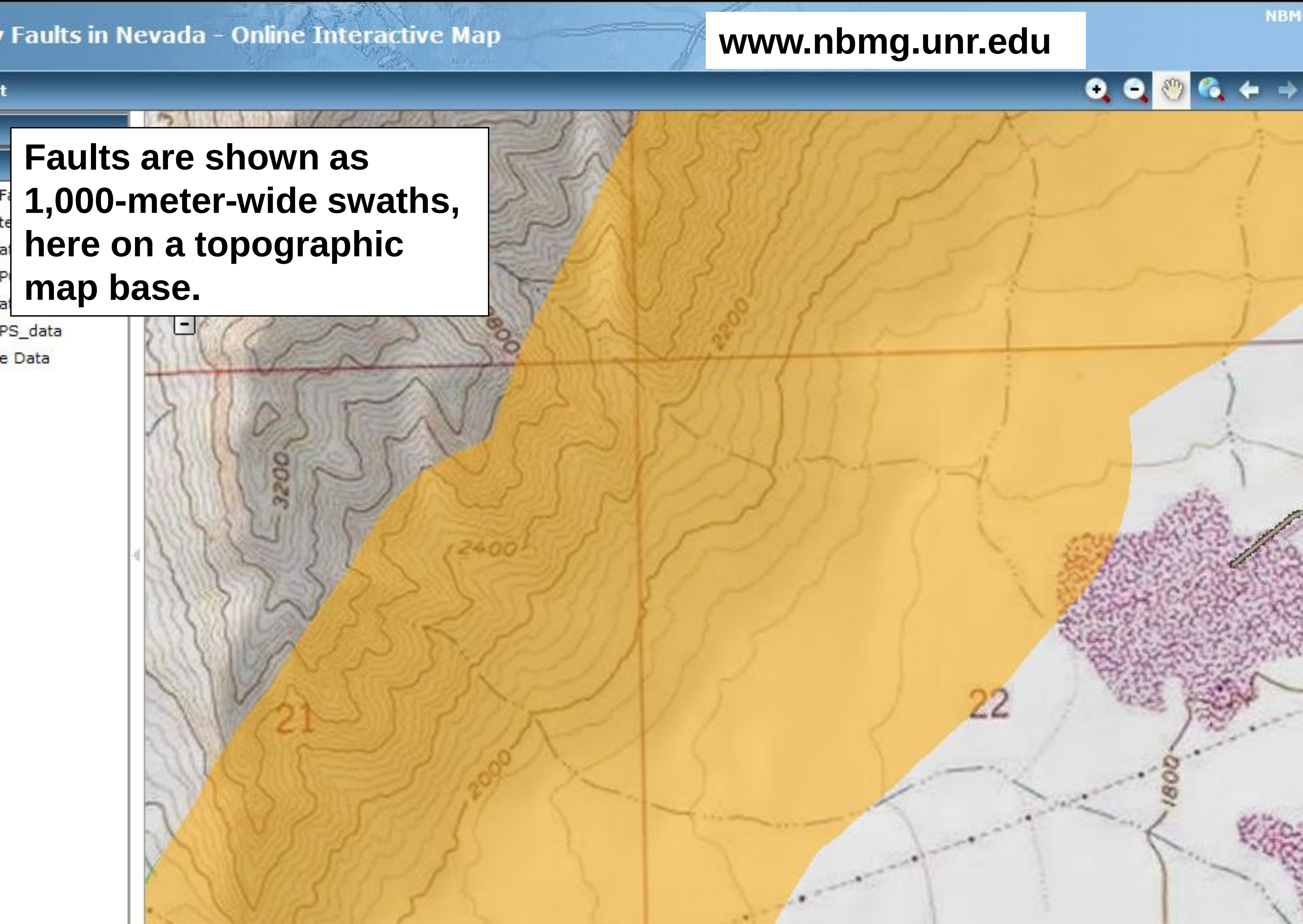

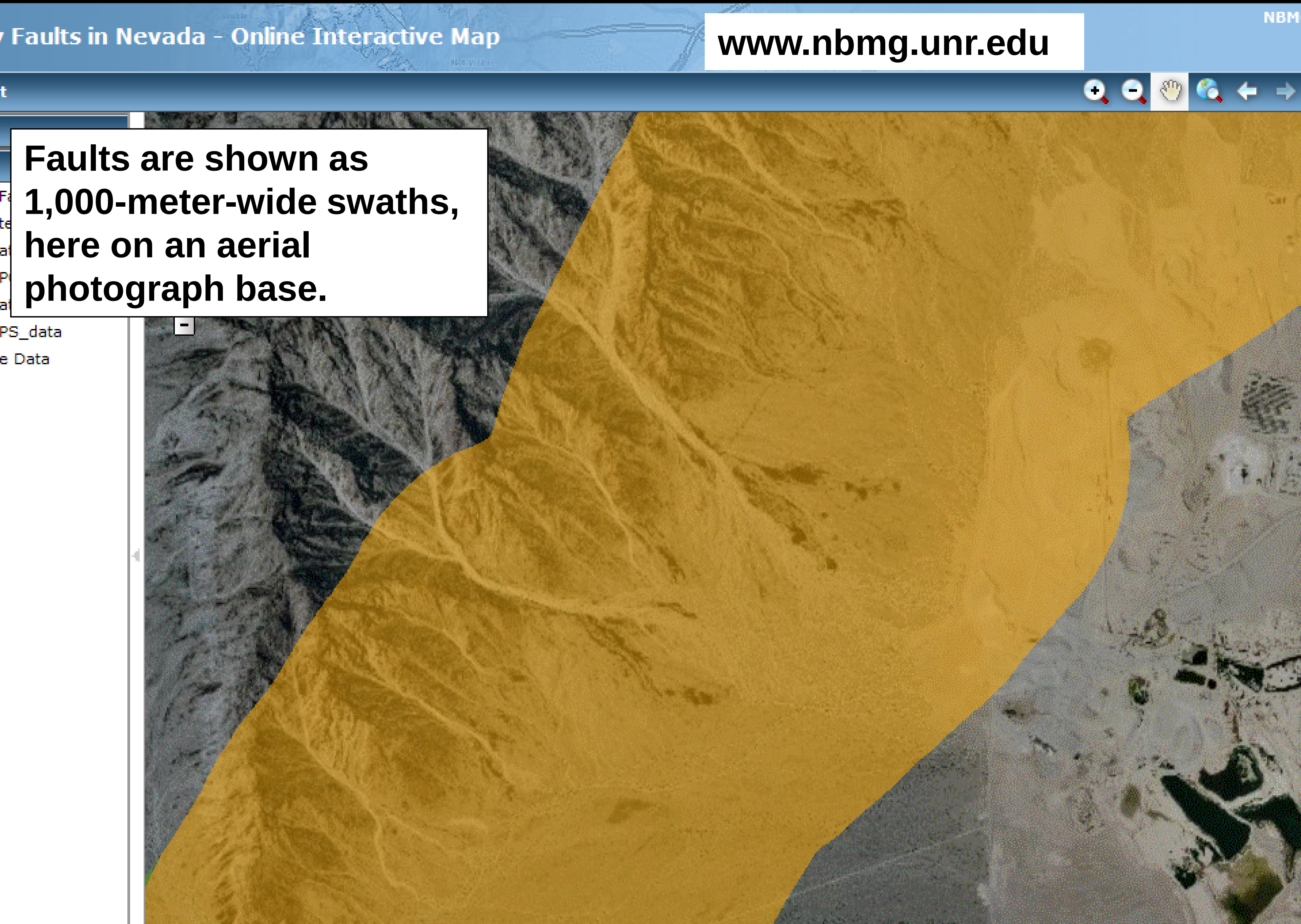

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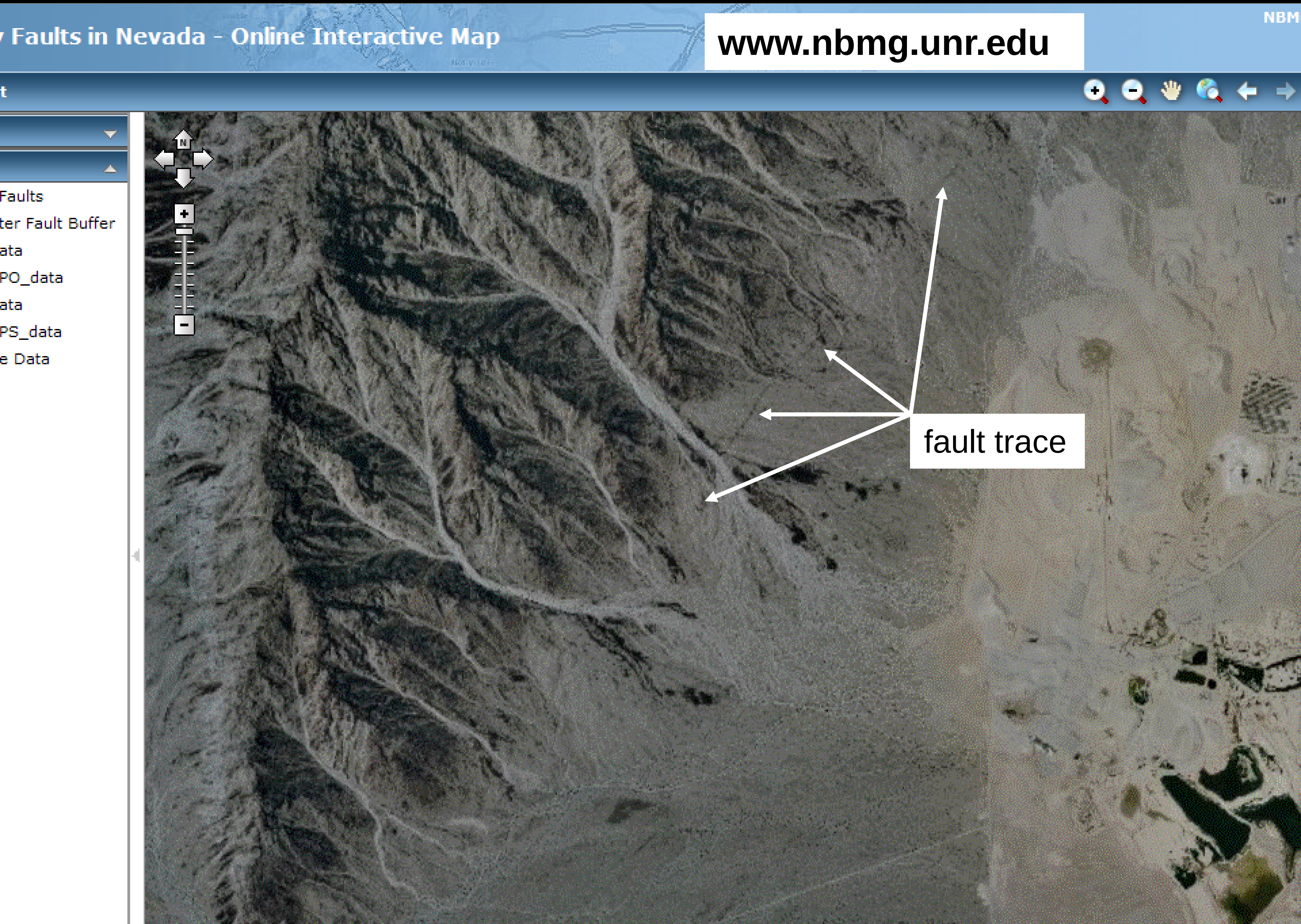

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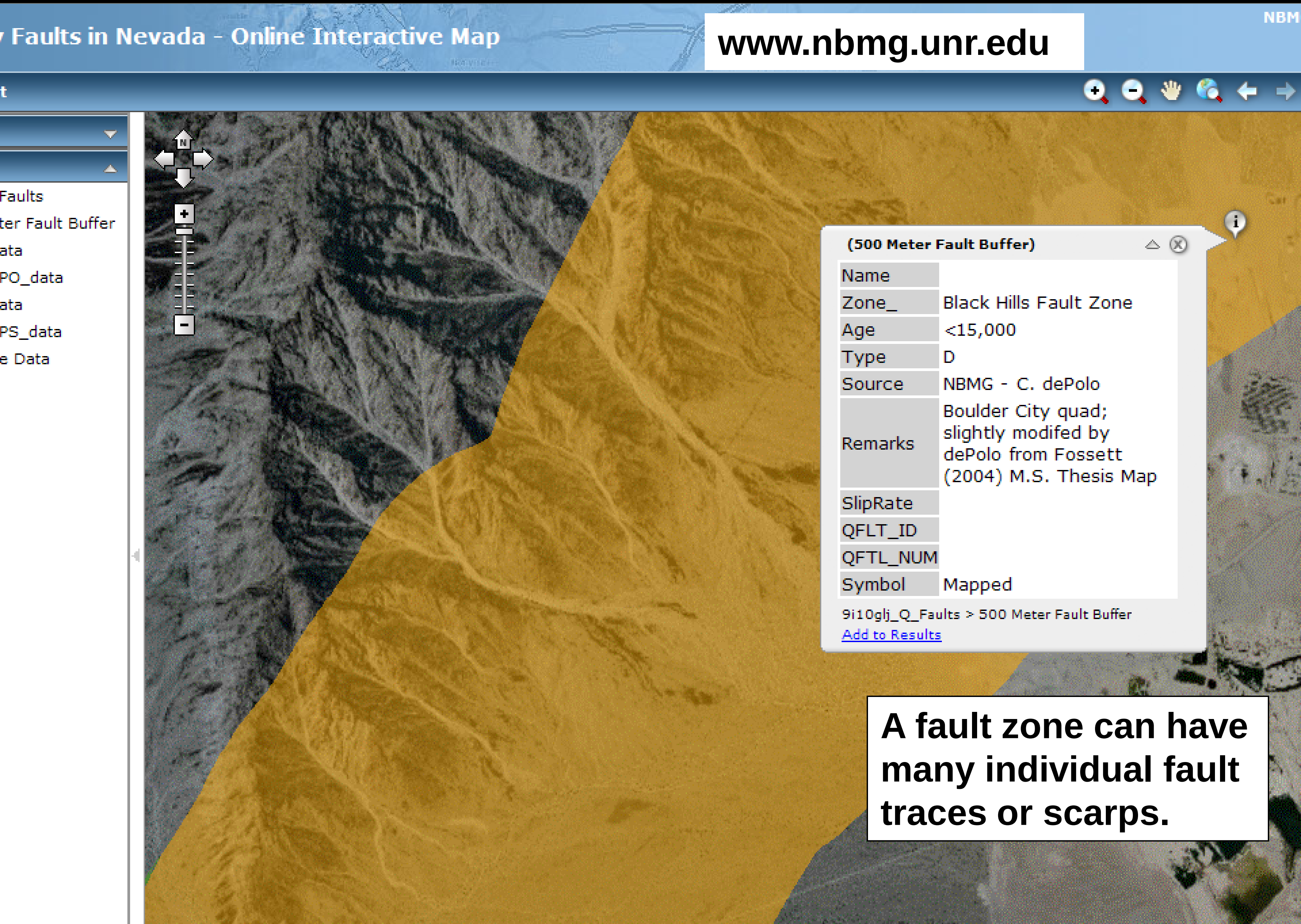
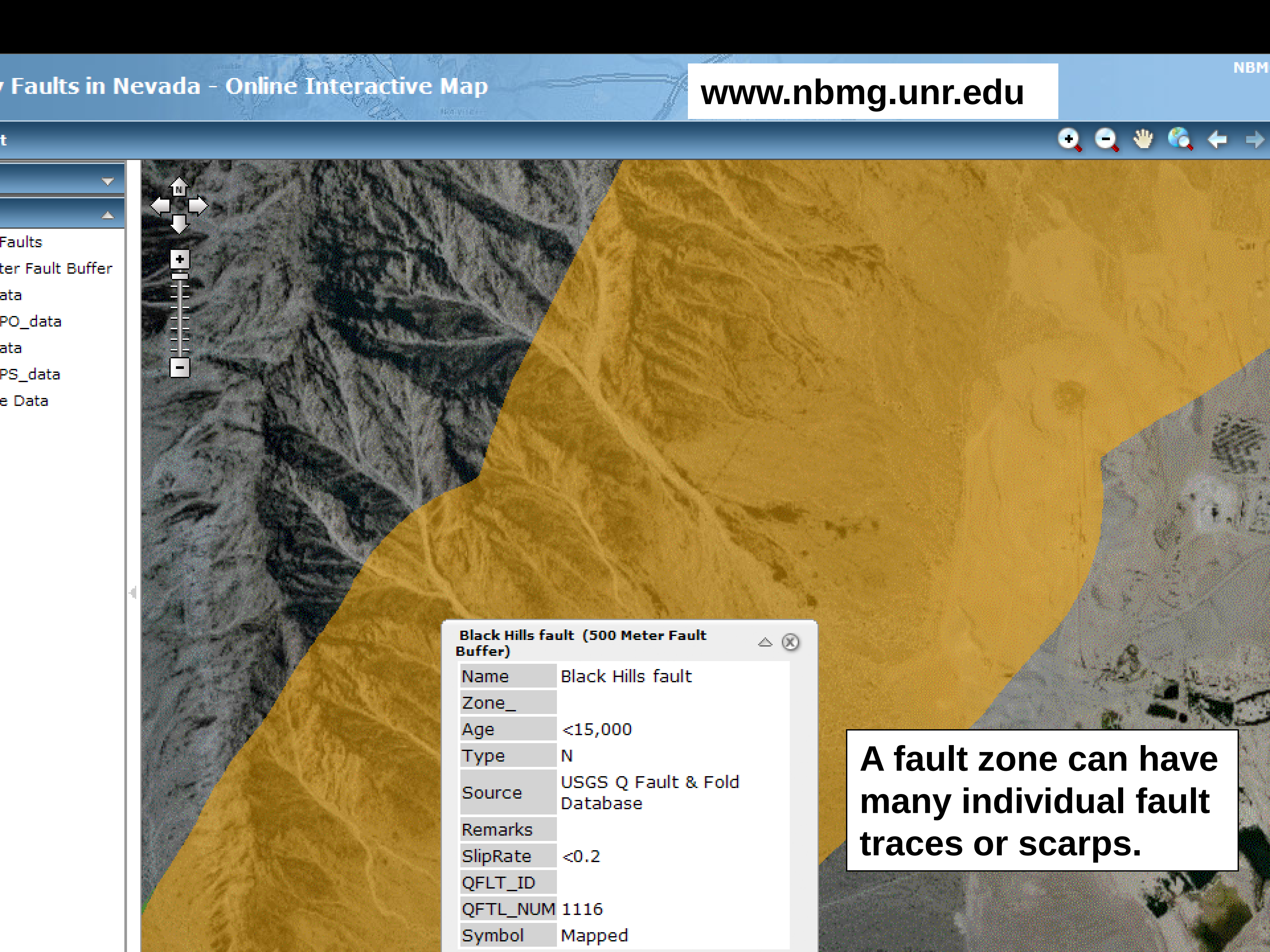


www.nbmg.unr.edu

A fault zone can have many individual fault traces or scarps.


Faults in Nevada - Online Interactive Map
www.nbmg.unr.edu
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Black Hills fault (500 Meter Fault Buffer)
Name Black Hills fault
Zone_
Age <15,000
Type N
Source USGS Q Fault & Fold Database
Remarks
SlipRate <0.2
QFLT_ID
QFTL_NUM 1116
Symbol Mapped
A fault zone can have many individual fault traces or scarps.

Quaternary fault exposed at construction site in Las Vegas Valley

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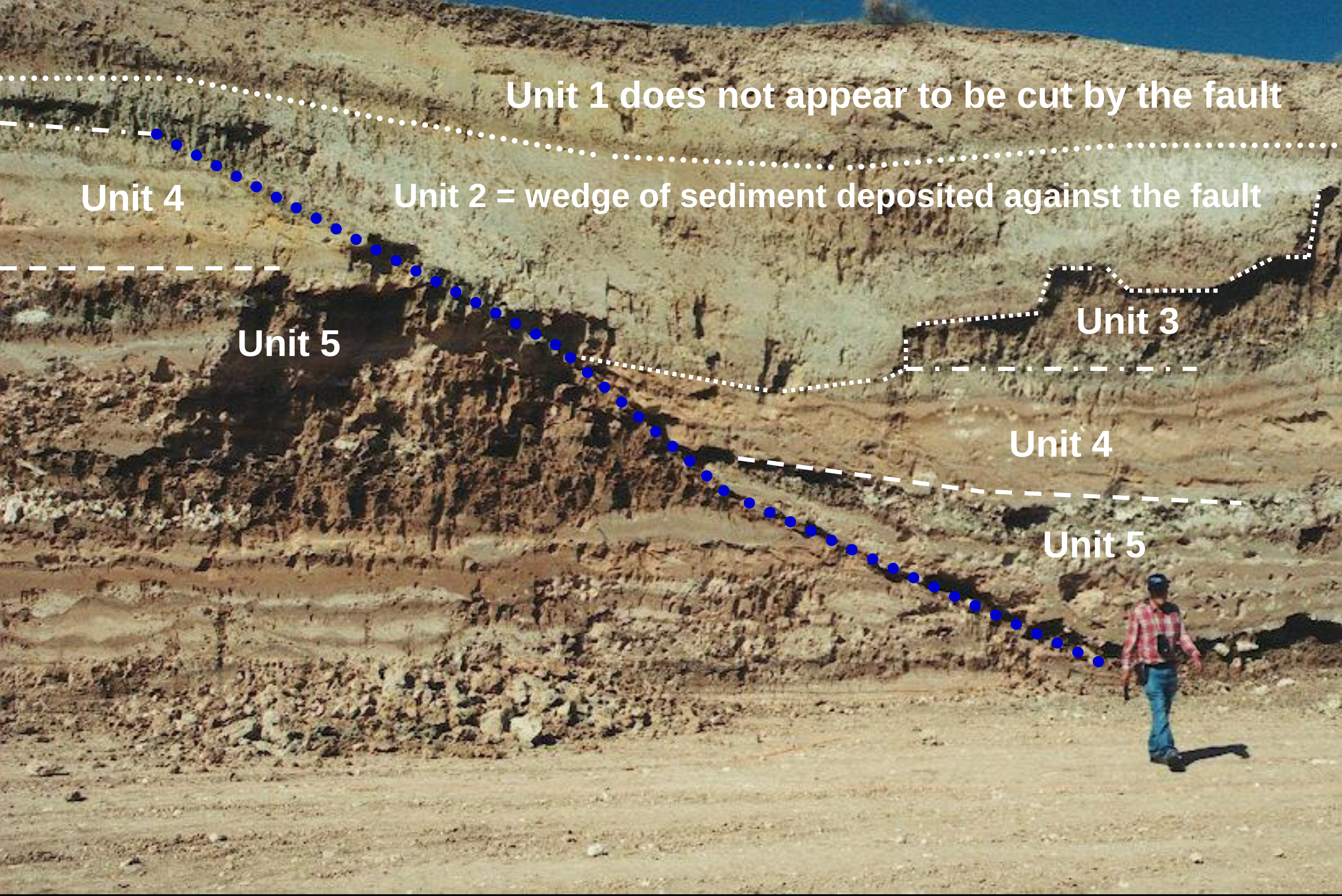
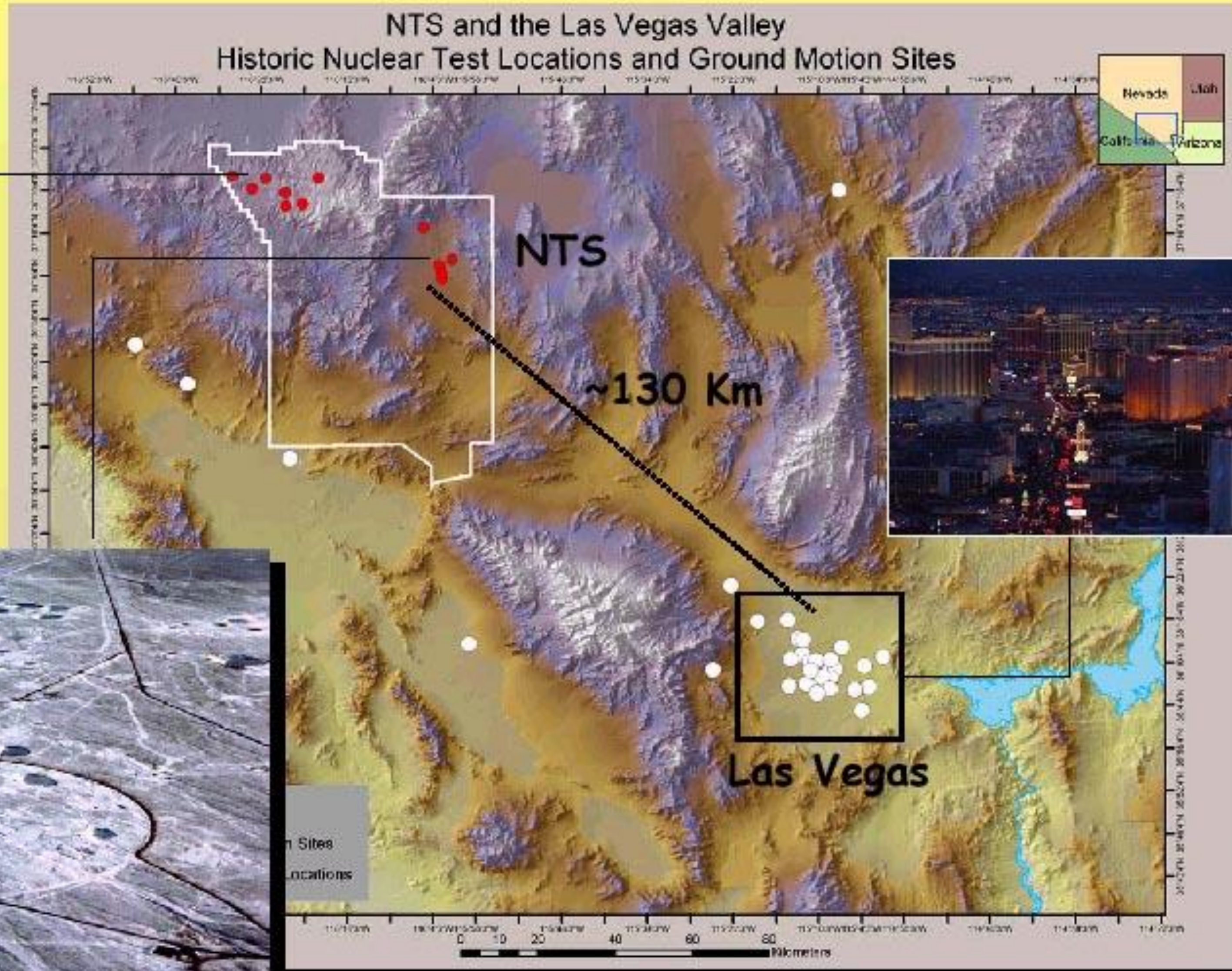


Quaternary fault exposed at construction site in Las Vegas Valley

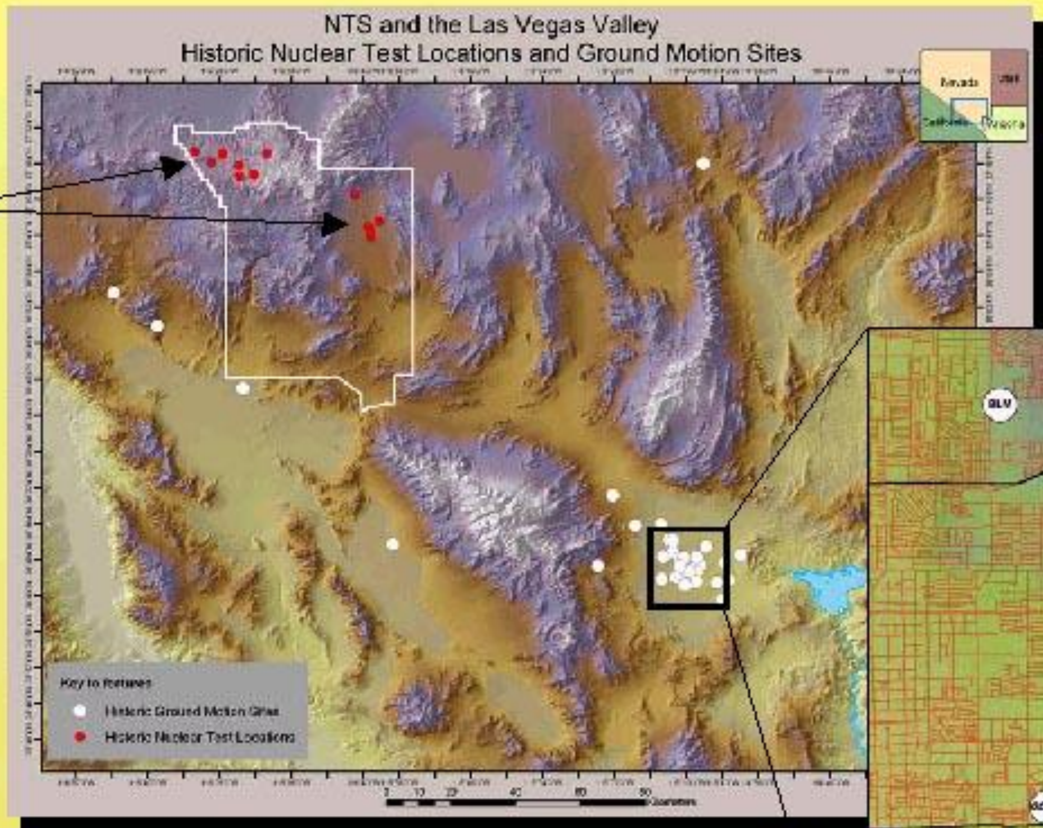
Between 1951 and 1992, 904 nuclear tests were performed at the Nevada Test Site (NTS)



D. McCallen 925-423-1219

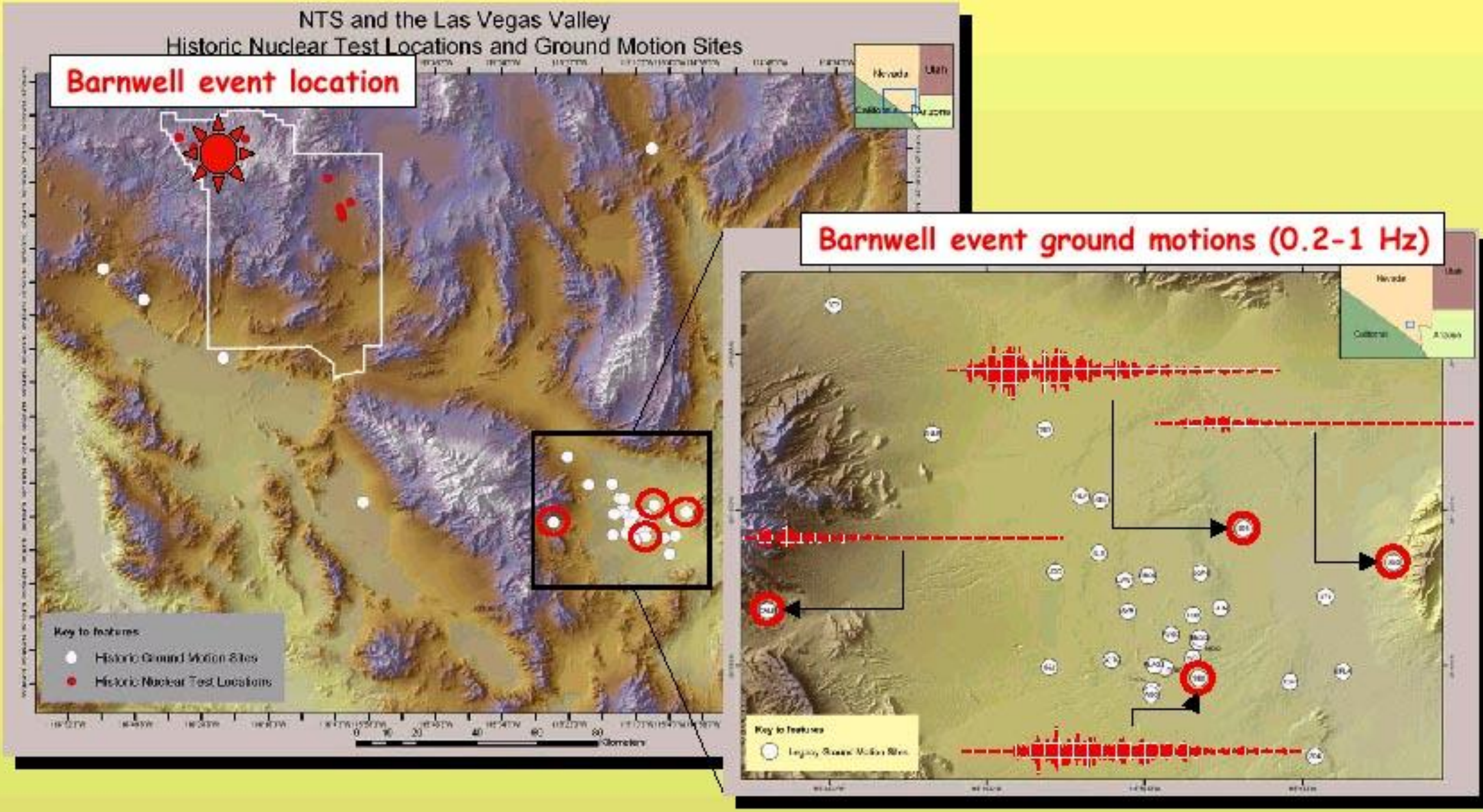
The Blume ground motion and structure instrumentation arrays captured a huge volume of data

Historical nuclear test locations (13 events available)



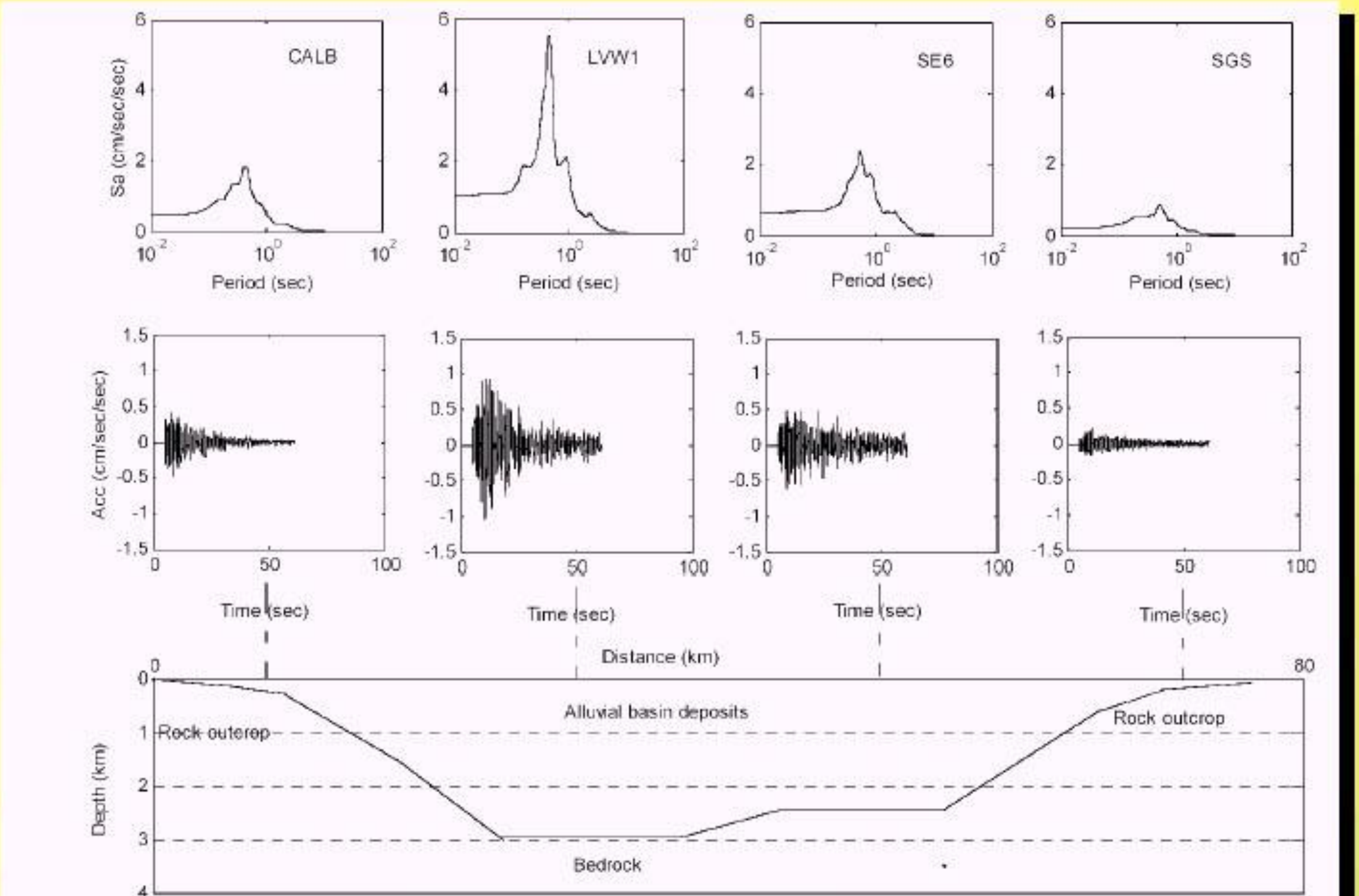
- Ground motion station
- Instrumented structure

Blume array ground motion and structure instruments



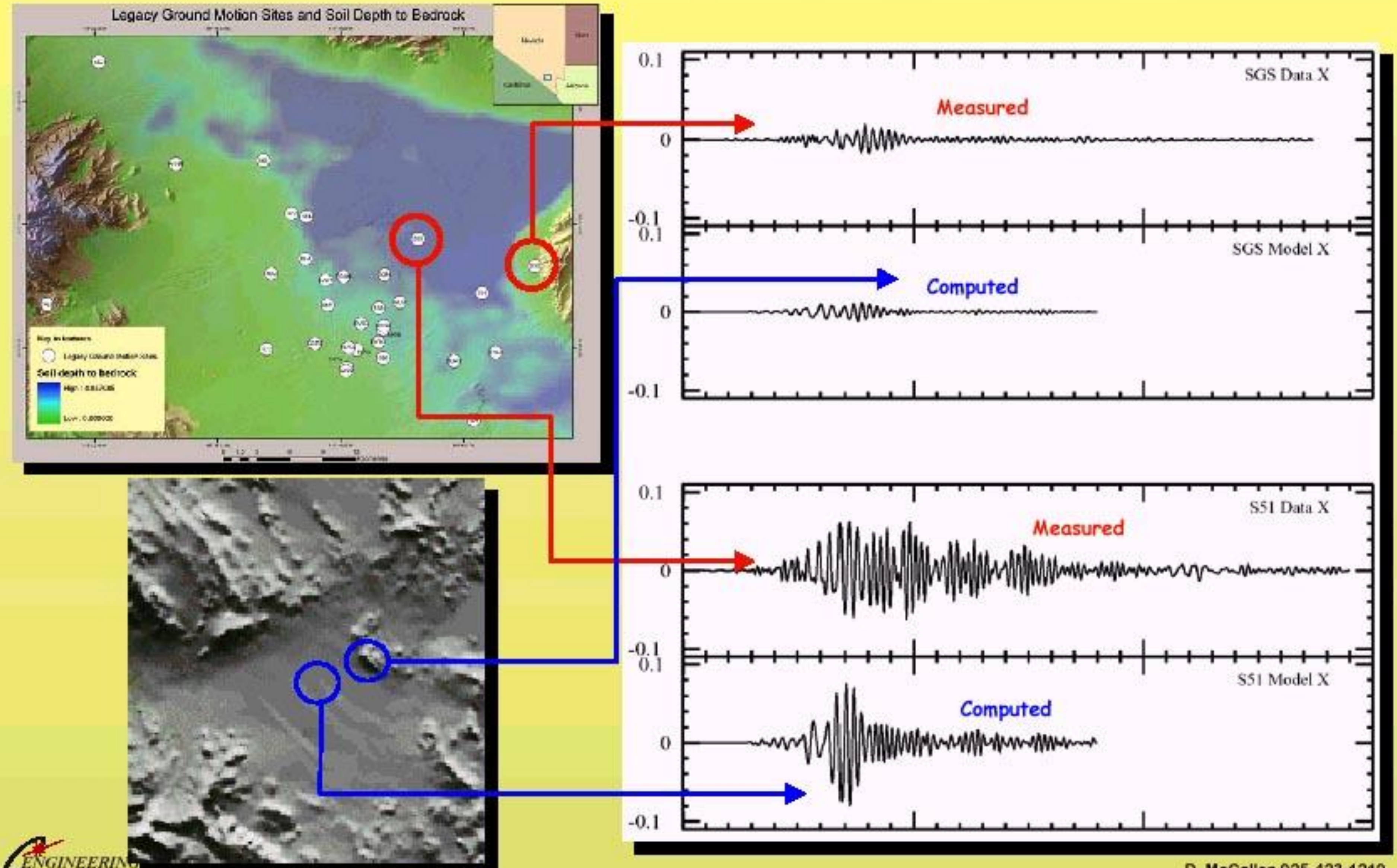
Data from NTS shots showed that sites in Las Vegas Valley shake more than sites on bedrock (because of loose soils and/or amplification of seismic waves due to the geometry of the basin).

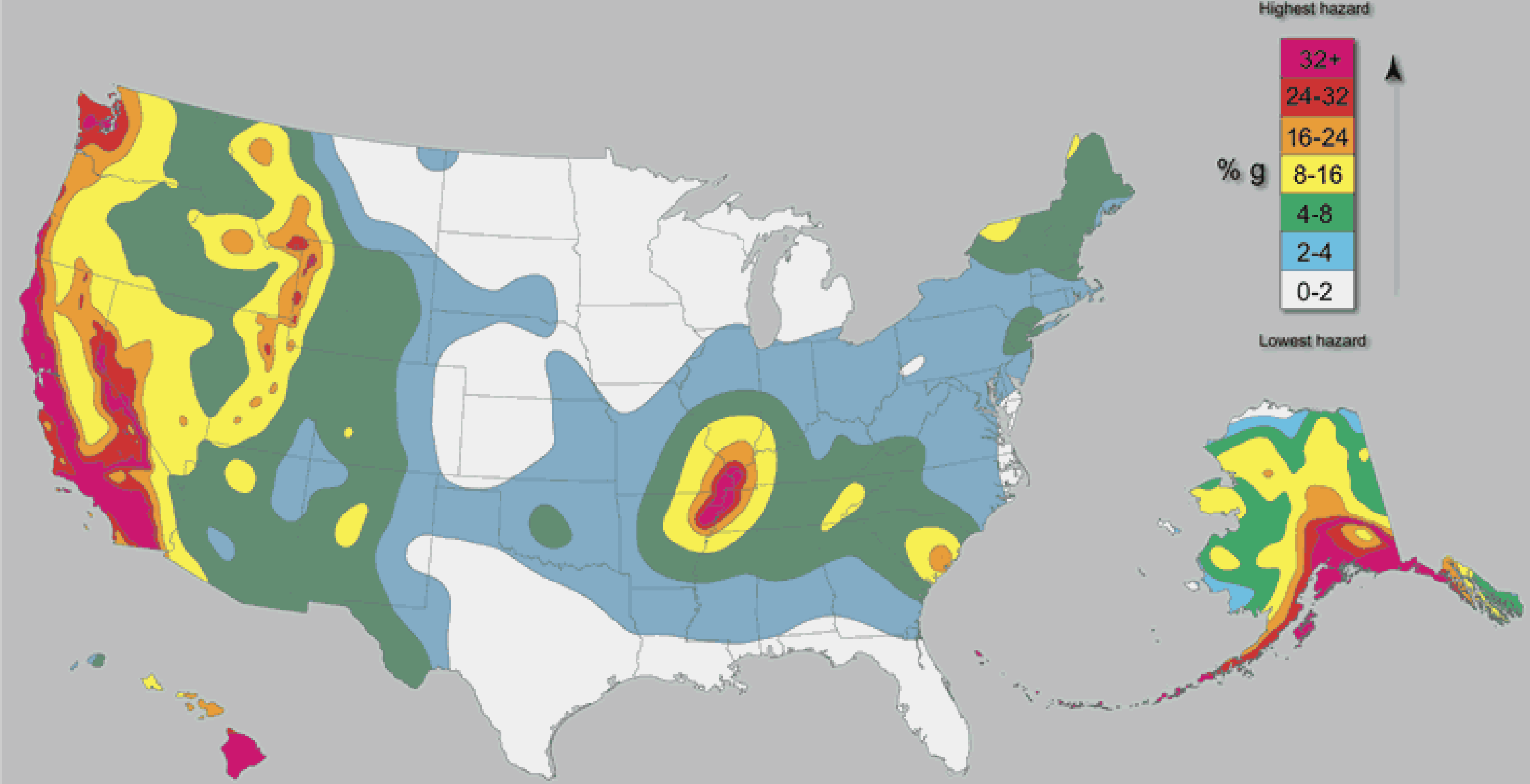
Ground motions across the Valley as a function of sedimentary depth (Luke et. al.)



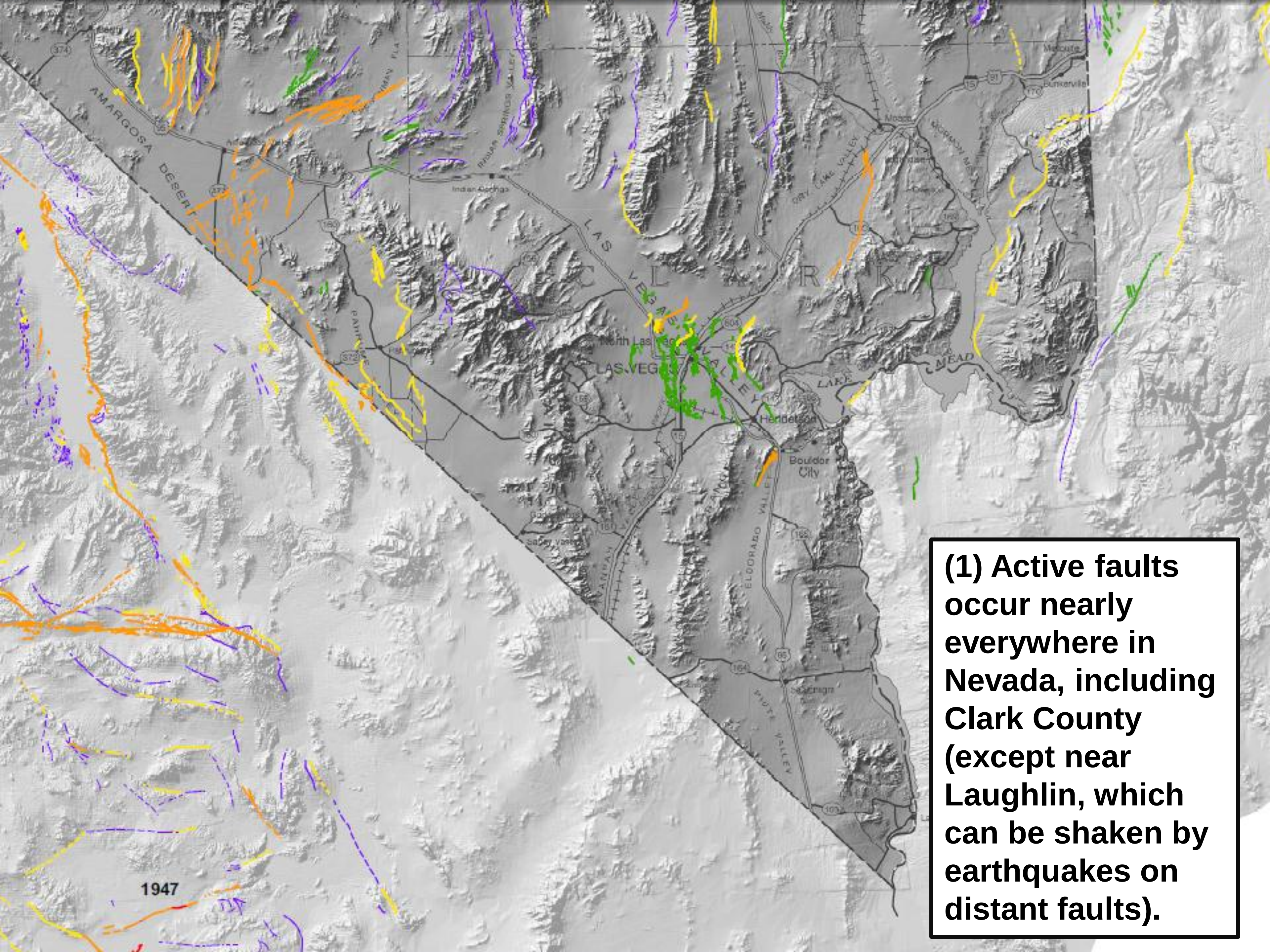
Simplified cross section (W to E) of Las Vegas basin

First ground motion simulation results look very promising when compared to actual data

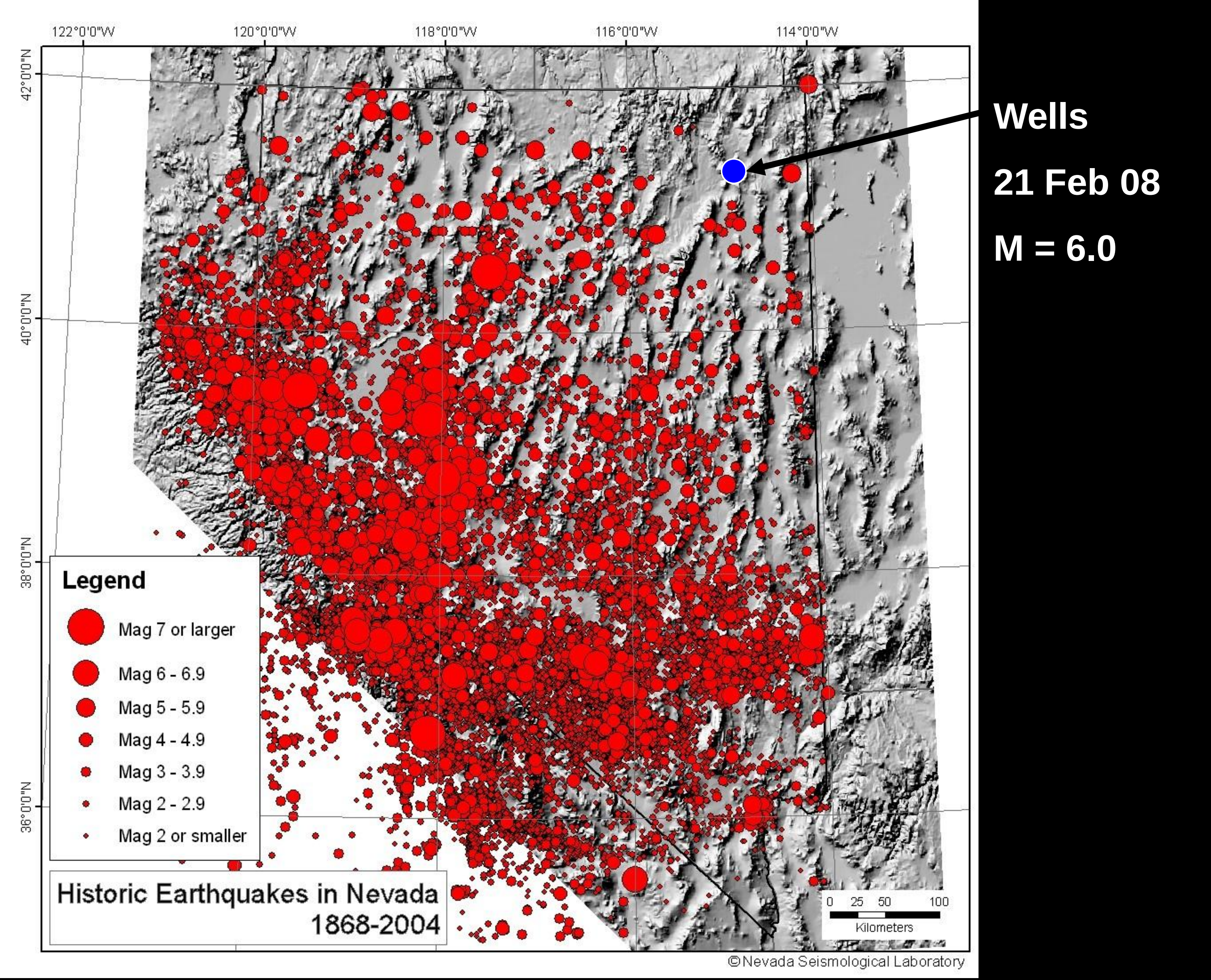




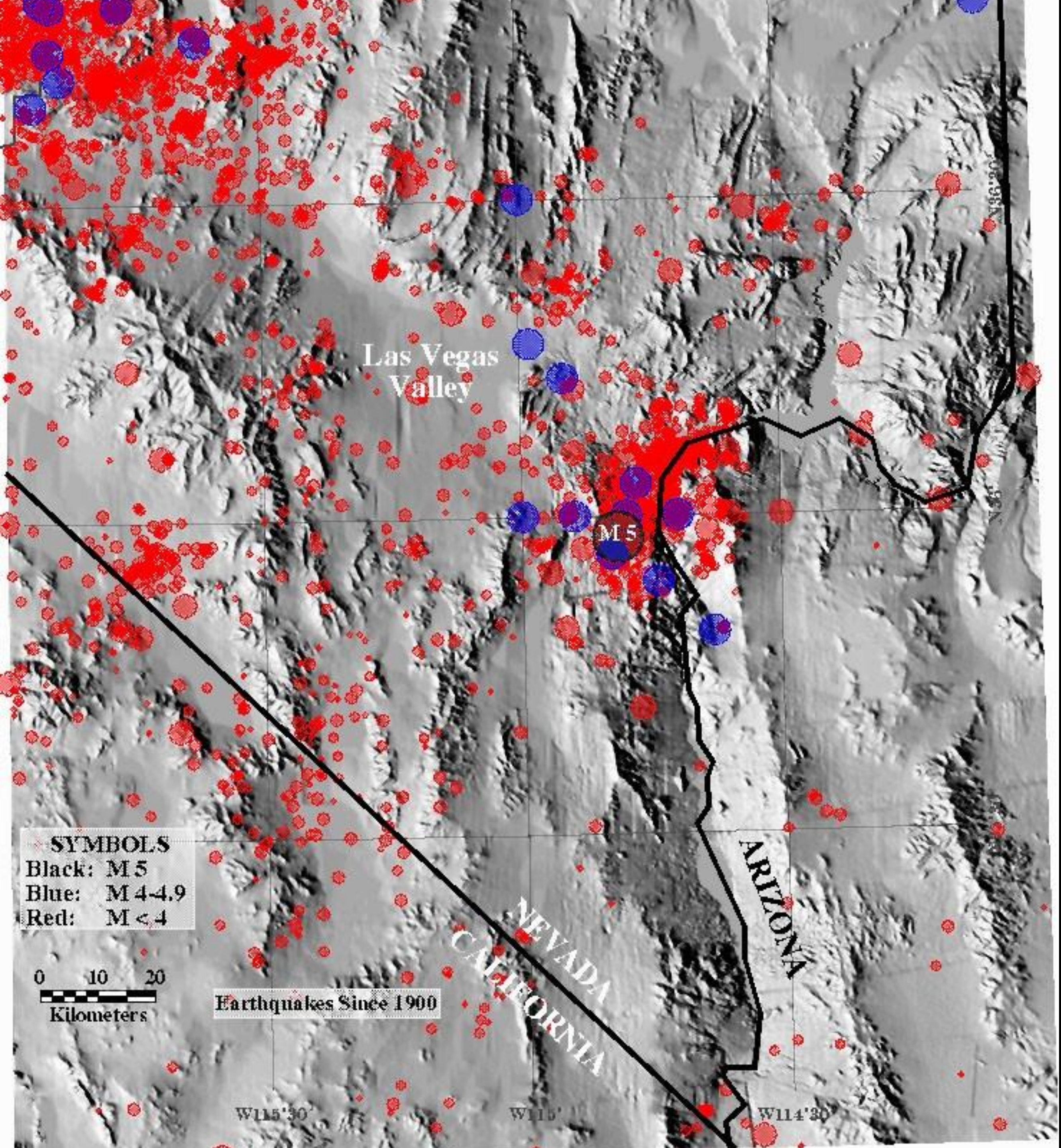
The USGS integrates (1) fault, (2) earthquake, and (3) geodetic data into its probabilistic seismic hazard analysis.



(1) Active faults occur nearly everywhere in Nevada, including Clark County (except near Laughlin, which can be shaken by earthquakes on distant faults).

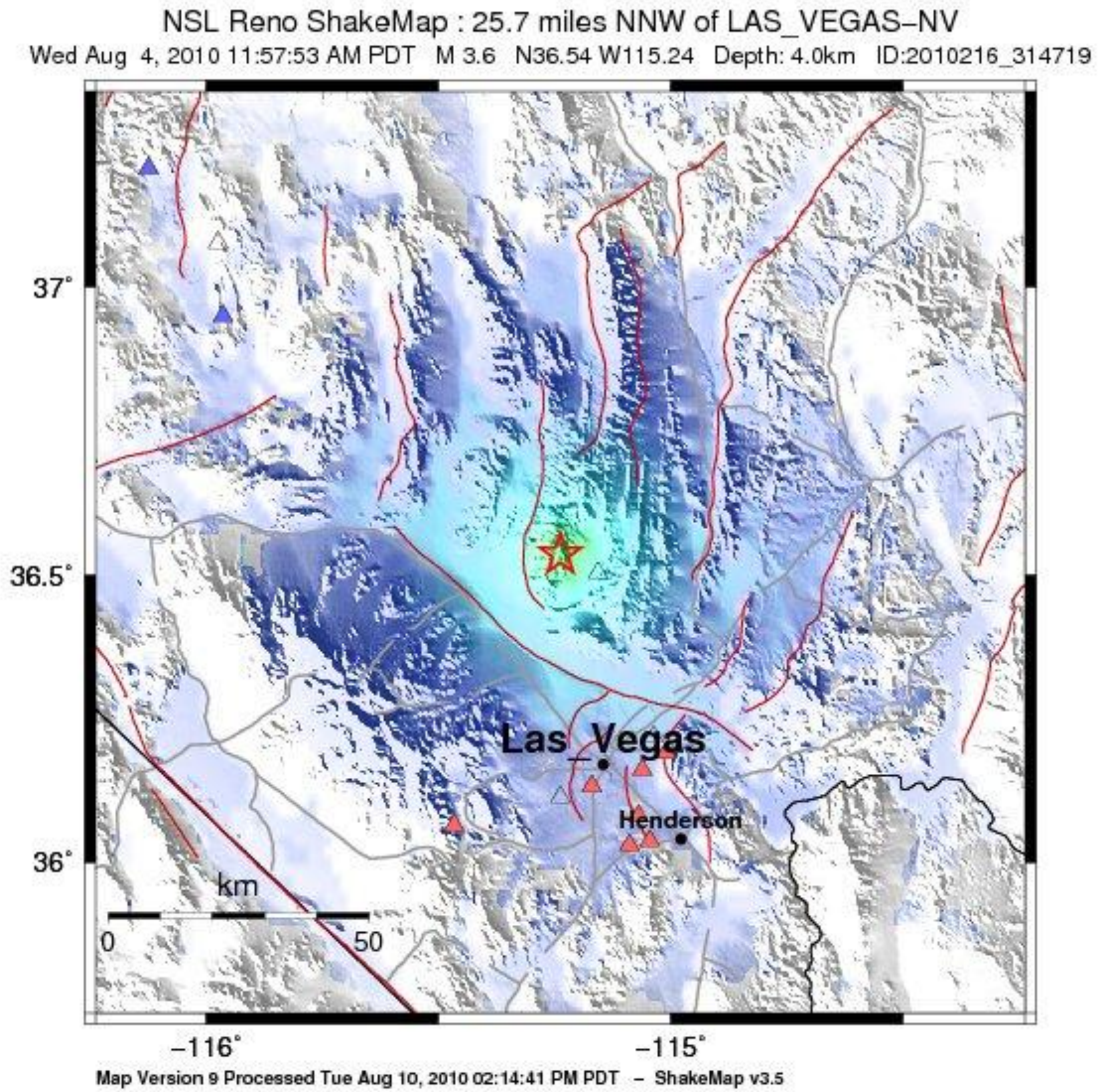


(2) Earthquakes have occurred throughout Nevada.



Measured earthquakes in the Las Vegas area

Source: Nevada Seismological Laboratory, UNR



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 for the Magnitude 3.6 earthquake near Las Vegas on 4 August 2010

NEVADA Seismological Laboratory

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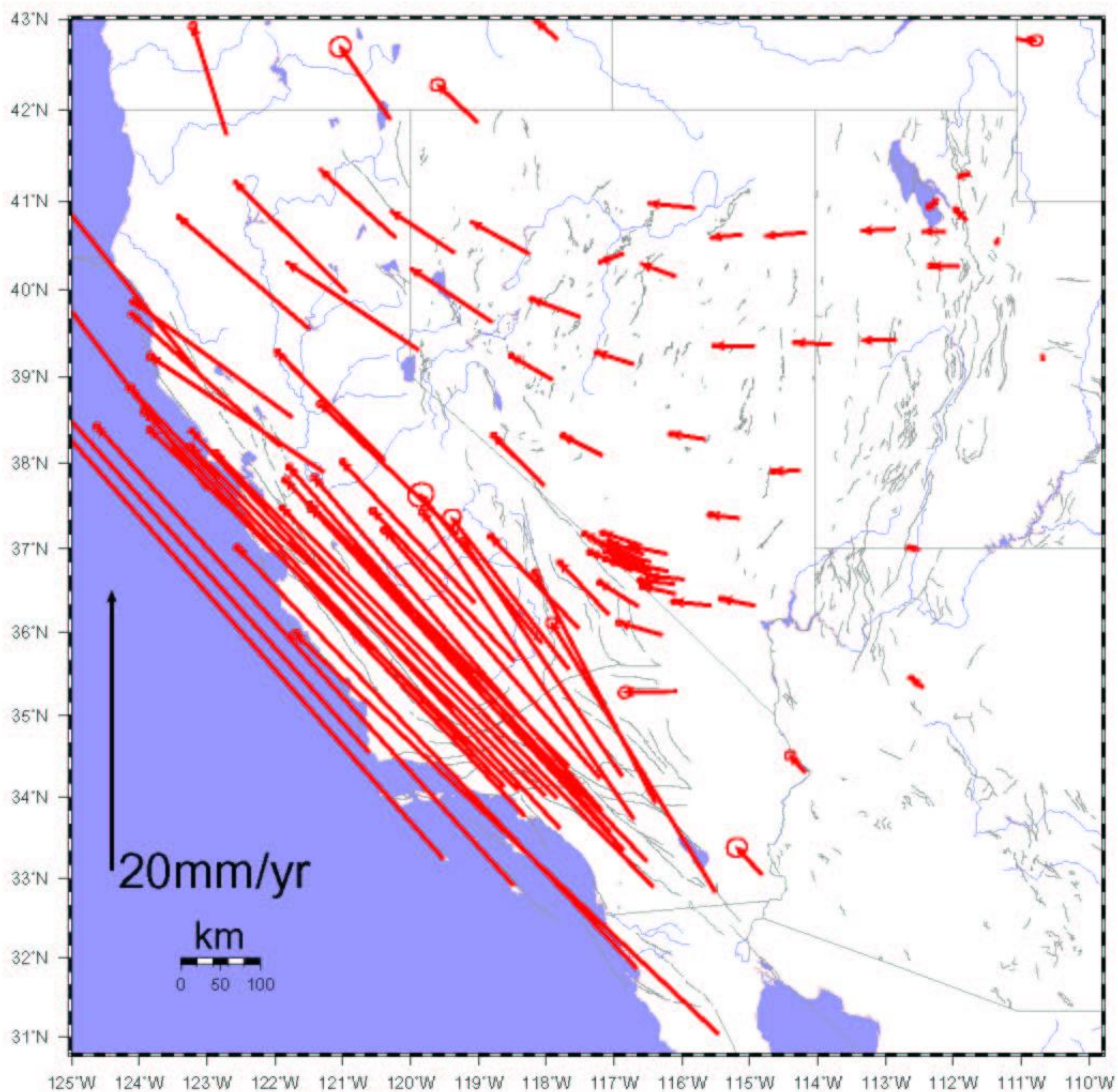
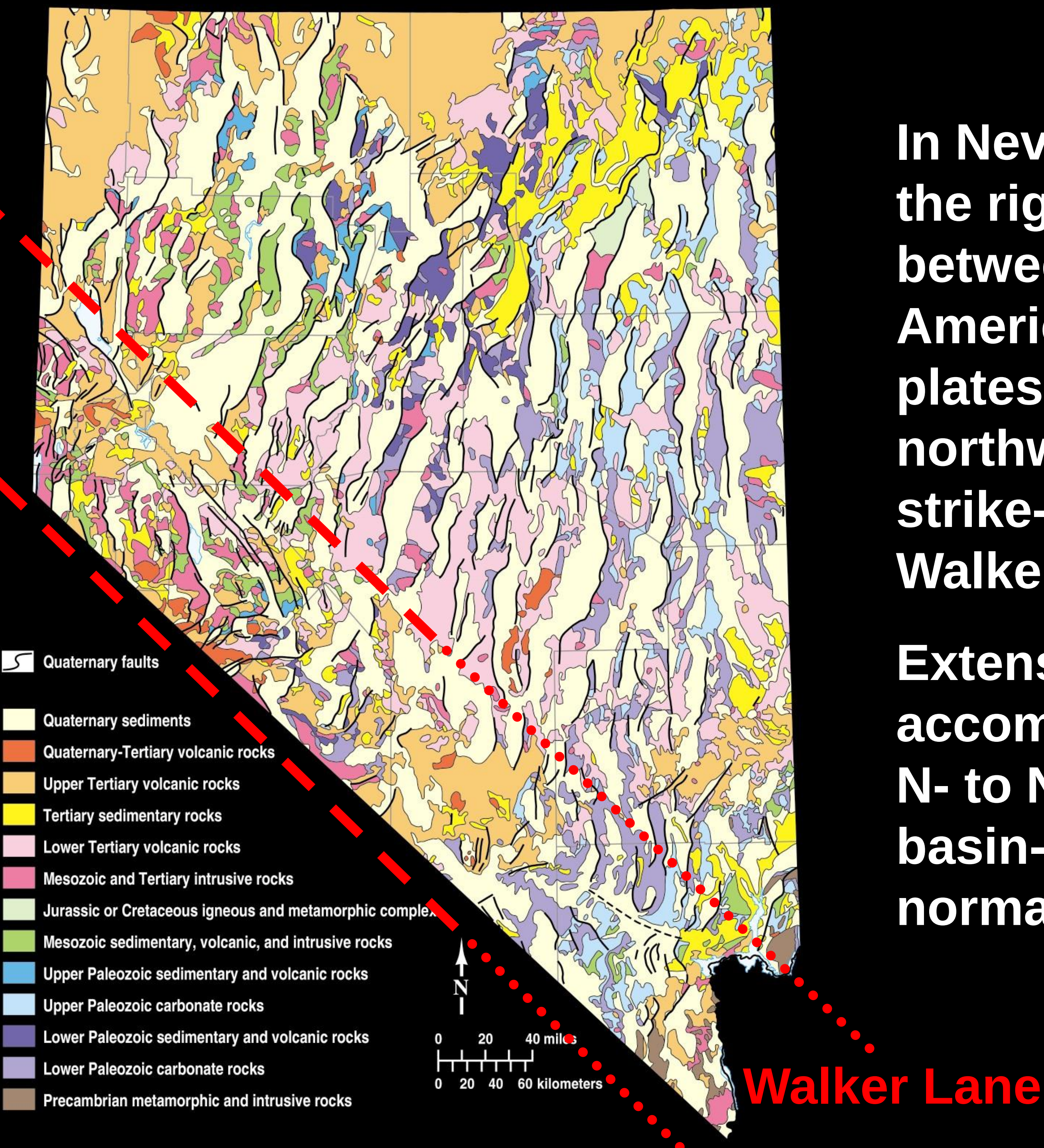


(3) Geodetic data indicate that the Basin and Range province is gaining about 1.3 acres of area per year through crustal extension, and that western Nevada is accommodating ~20% of the North American-Pacific plate interaction.

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.

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.

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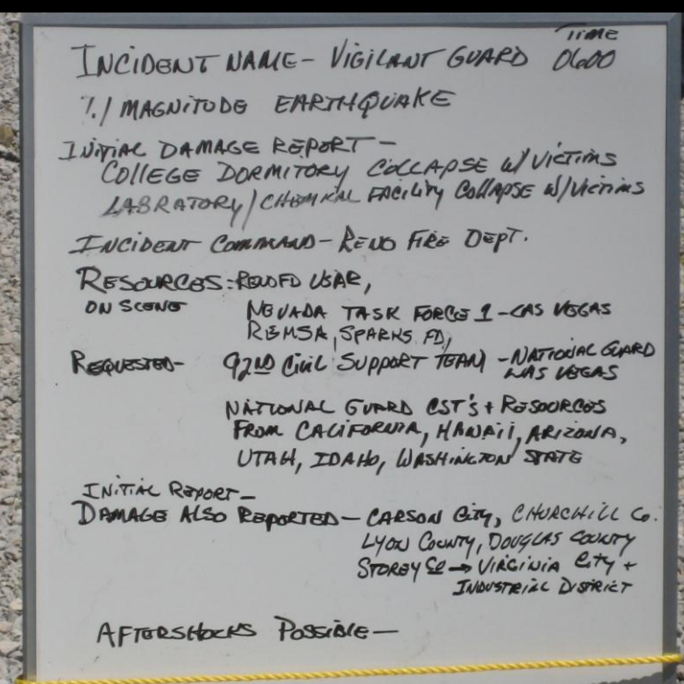
The Great Seal of the State of Nevada
All for our country

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.

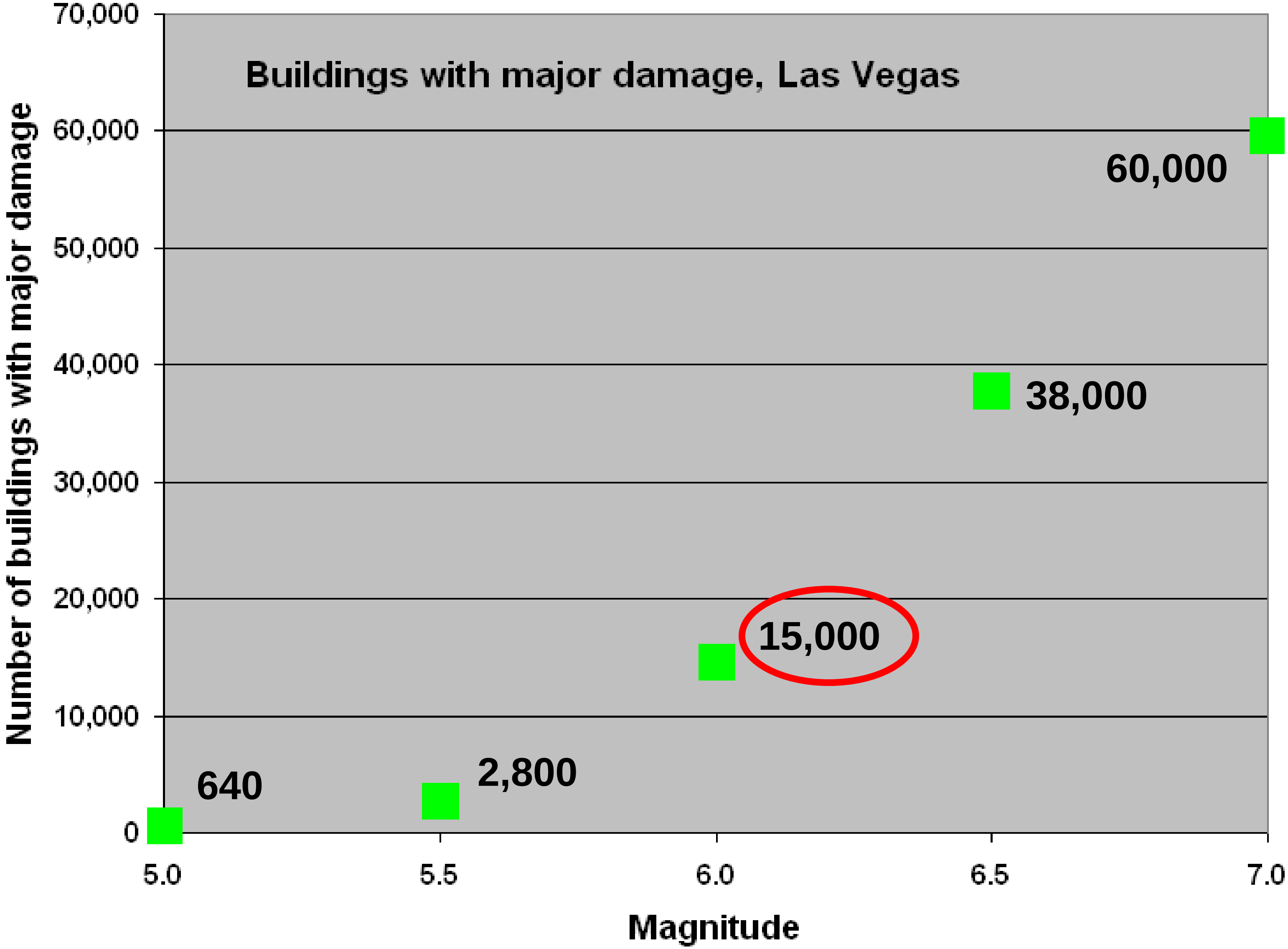
	% Probability of magnitude greater than or equal to magnitude				
Community	5.0	5.5	6.0	6.5	7.0
Dayton	>90	~80	70-75	50-55	12-15
Carson City	>90	~80	70	50-55	12-15
Reno	>90	~80	67	50	12-15
Las Vegas	40-50	~30	12	4-5	<0.5
Elko	30-40	~25	10-15	6-8	0.5-1
Wells	30-40	~20	9	6	0.5-1
Laughlin	10-20	~5	2-3	0.5-1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

Dayton and Laughlin have the highest and lowest earthquake hazards, respectively, among 38 Nevada communities evaluated.

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.

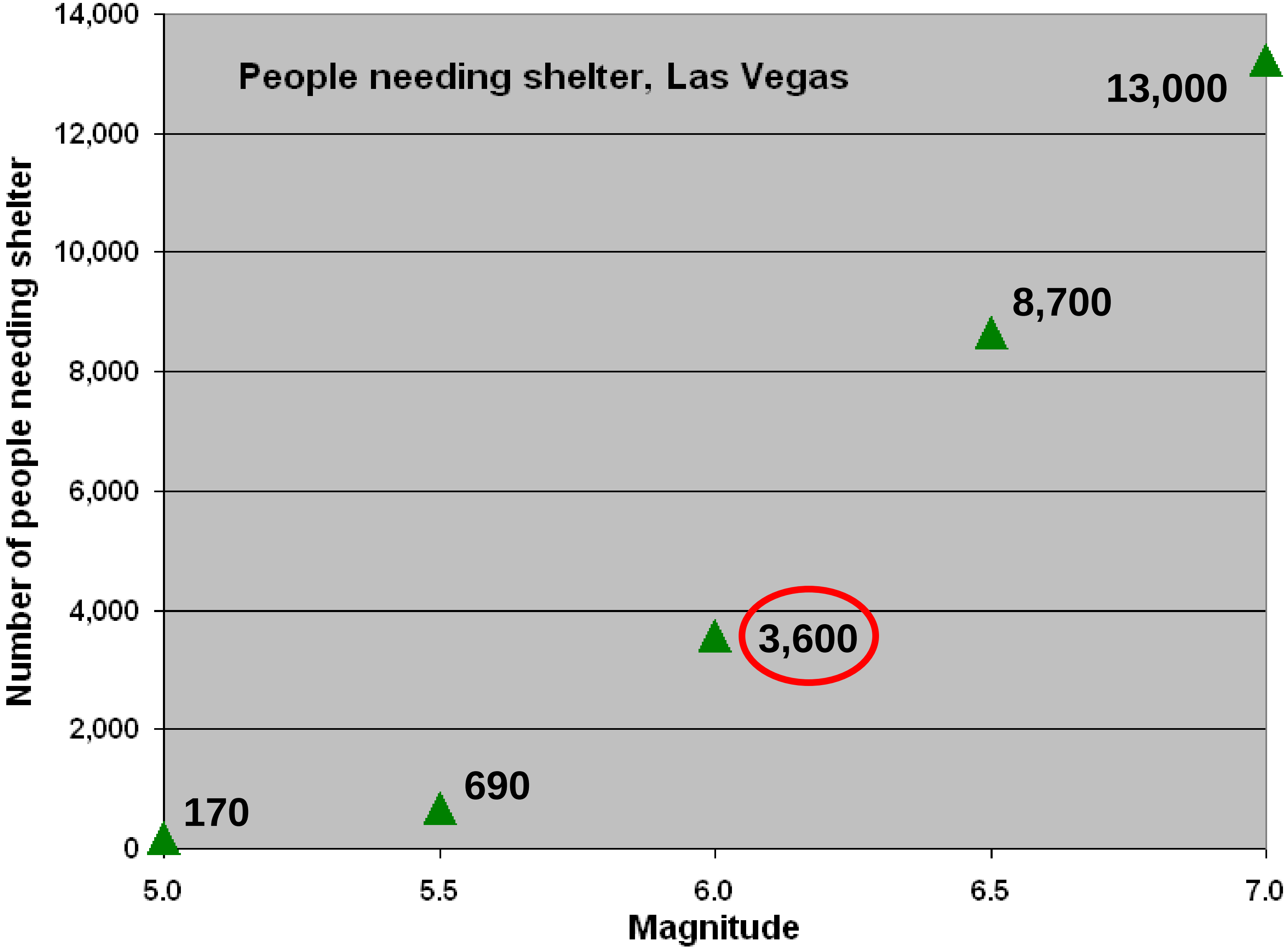
Uncertainties in the location of epicenters, depths, and magnitude, when combined with changing population and uncertainties in local effects (soil and rock types, assumptions about attenuation, basin geometry, liquefaction potential, and directivity), make loss estimates generally consistent within one order of magnitude (a factor of 10), although experience with urban earthquakes in the US has generally yielded numbers within a factor of 2 or 3 of the actual damages.

HAZUS estimates building damage:



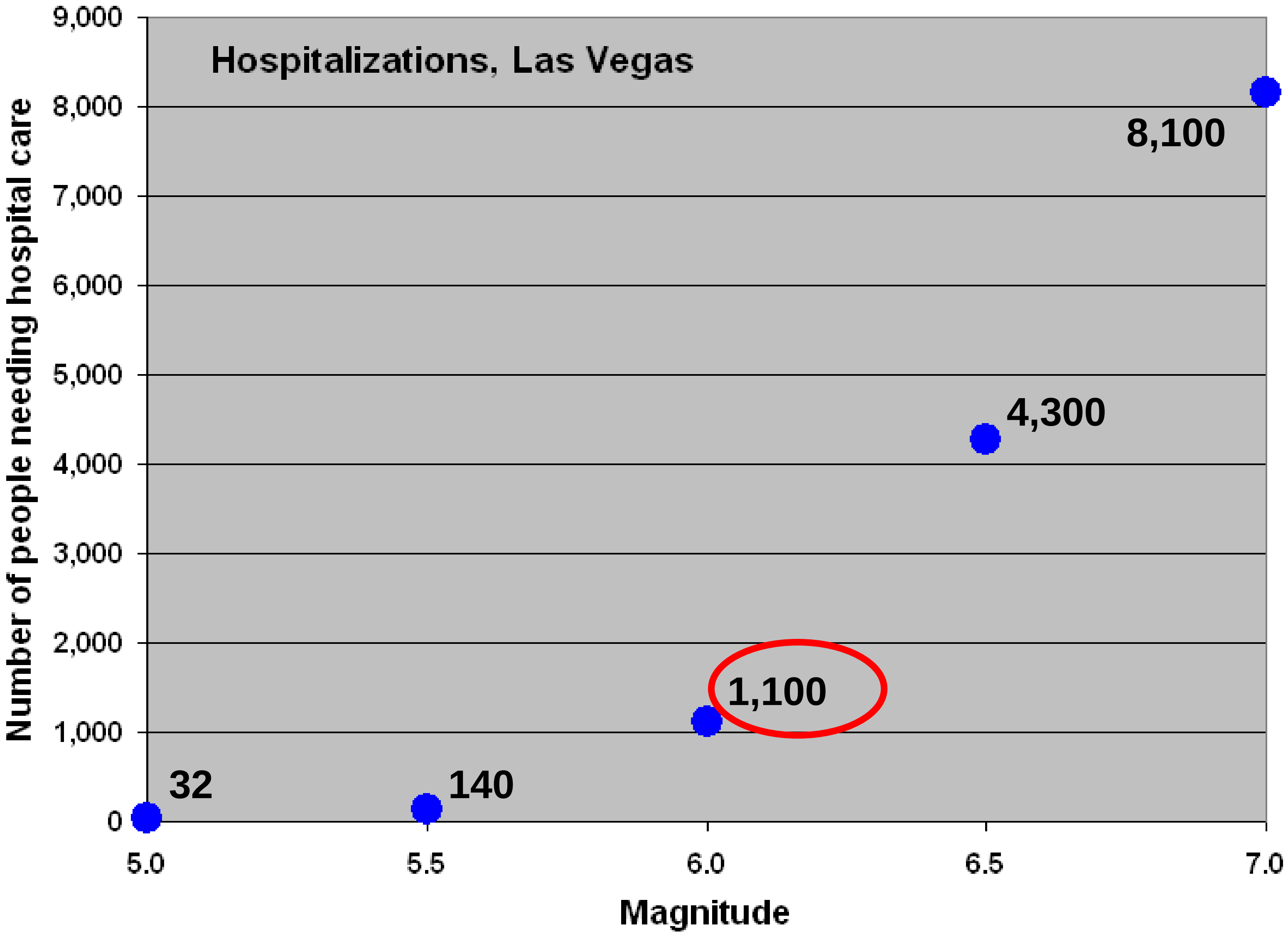
Note that the graphs are similar, but the scale changes with what is at risk.

HAZUS estimates public shelter needs:



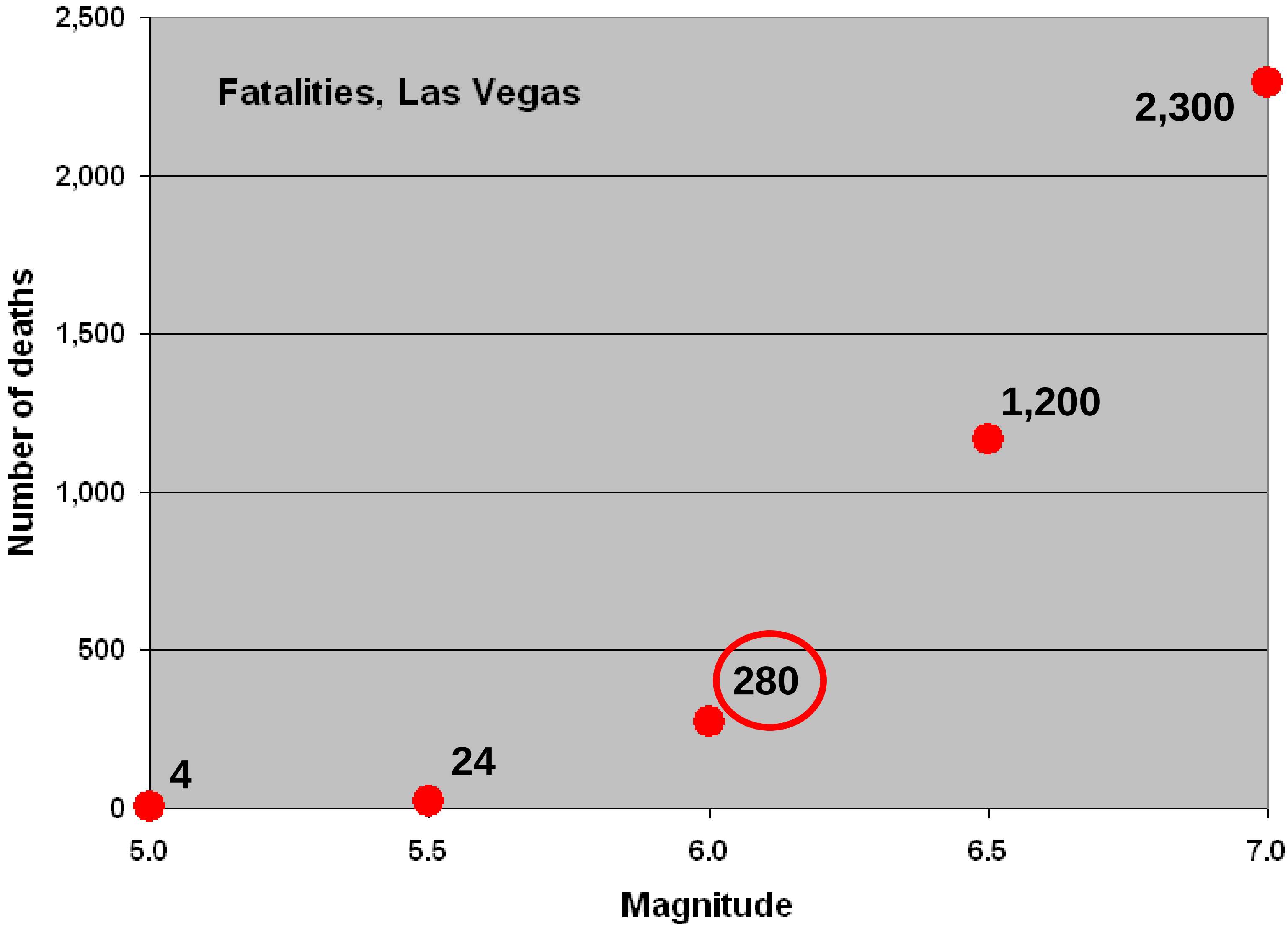
Note that the graphs are similar, but the scale changes with what is at risk.

HAZUS estimates hospital needs:



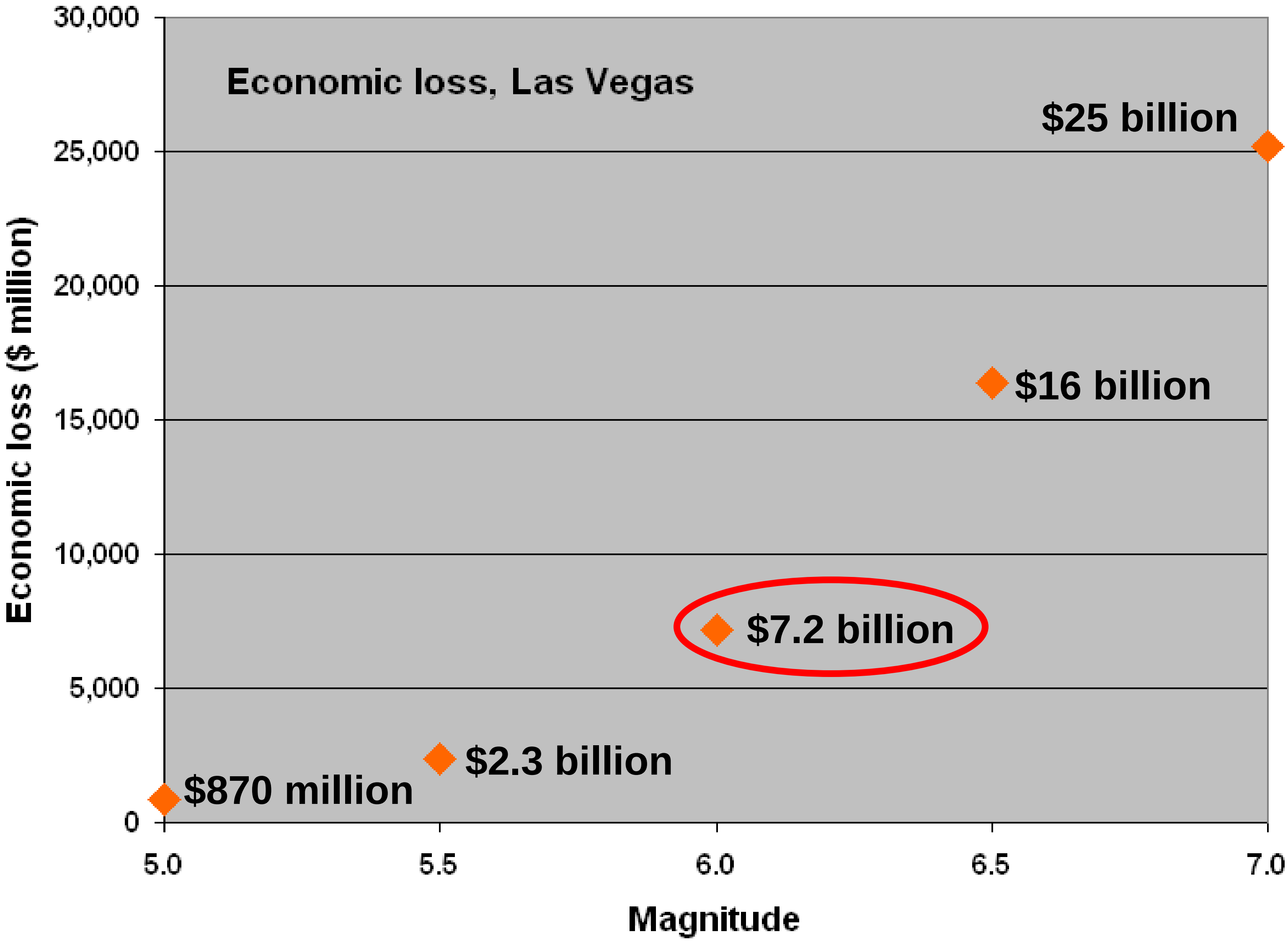
Note that the graphs are similar, but the scale changes with what is at risk.

HAZUS estimates fatalities:



Note that the graphs are similar, but the scale changes with what is at risk.

HAZUS estimates (total) economic loss:



Note that the graphs are similar, but the scale changes with what is at risk.

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.

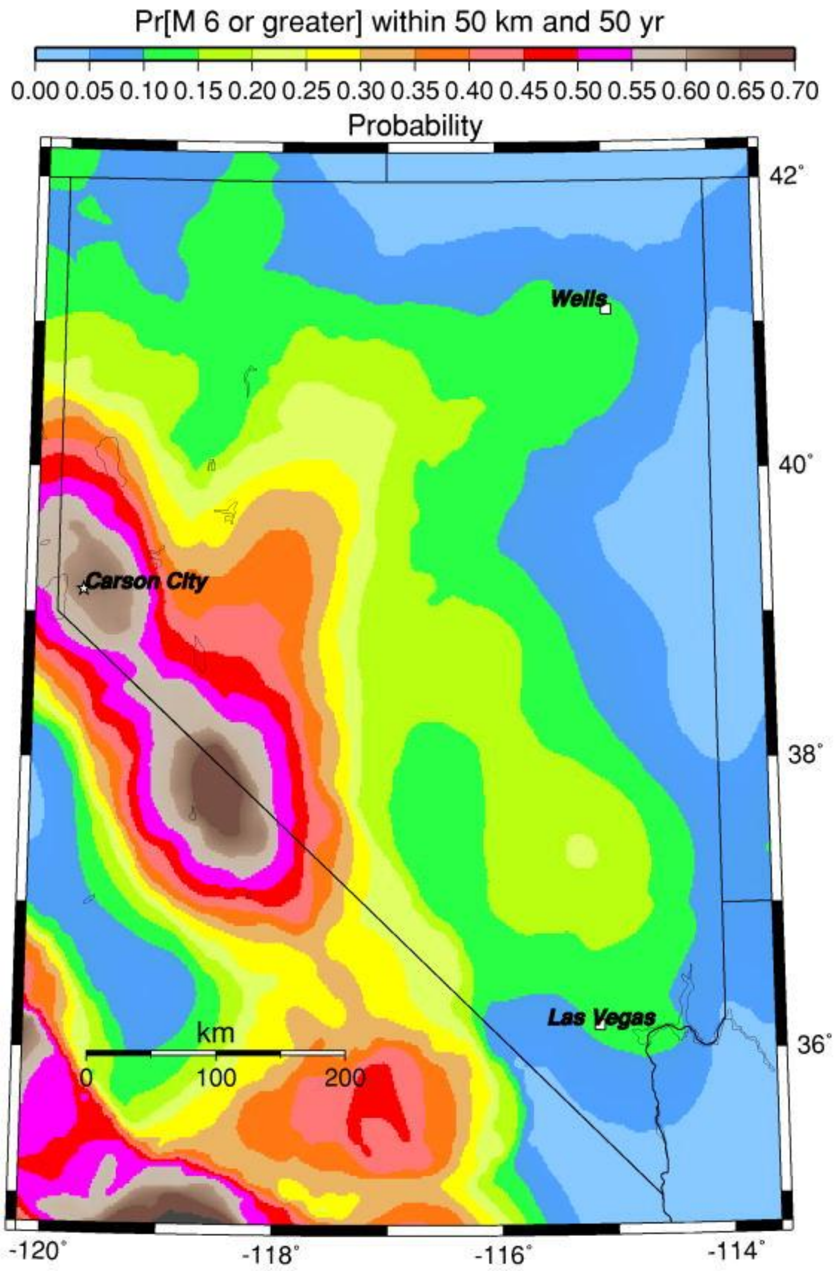
C. Mitigate nonstructural risks.

San Marin Hotel, an unreinforced masonry building (URM) that collapsed during the Wells, Nevada earthquake

before the 21 February 2008 magnitude 6.0 earthquake

after the earthquake

See http://www.nbmg.unr.edu/Pubs/sp/sp36/



“What happens in Las Vegas stays in Las Vegas,” but what happened in Wells can happen anywhere in Nevada.

Map by the USGS showing the probability of an earthquake of magnitude 6.0 (the size of the 21 February 2008 earthquake at Wells) or greater occurring within 50 kilometers (31 miles) in 50 years.

See http://www.nbmg.unr.edu/Pubs/sp/sp36/

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.**

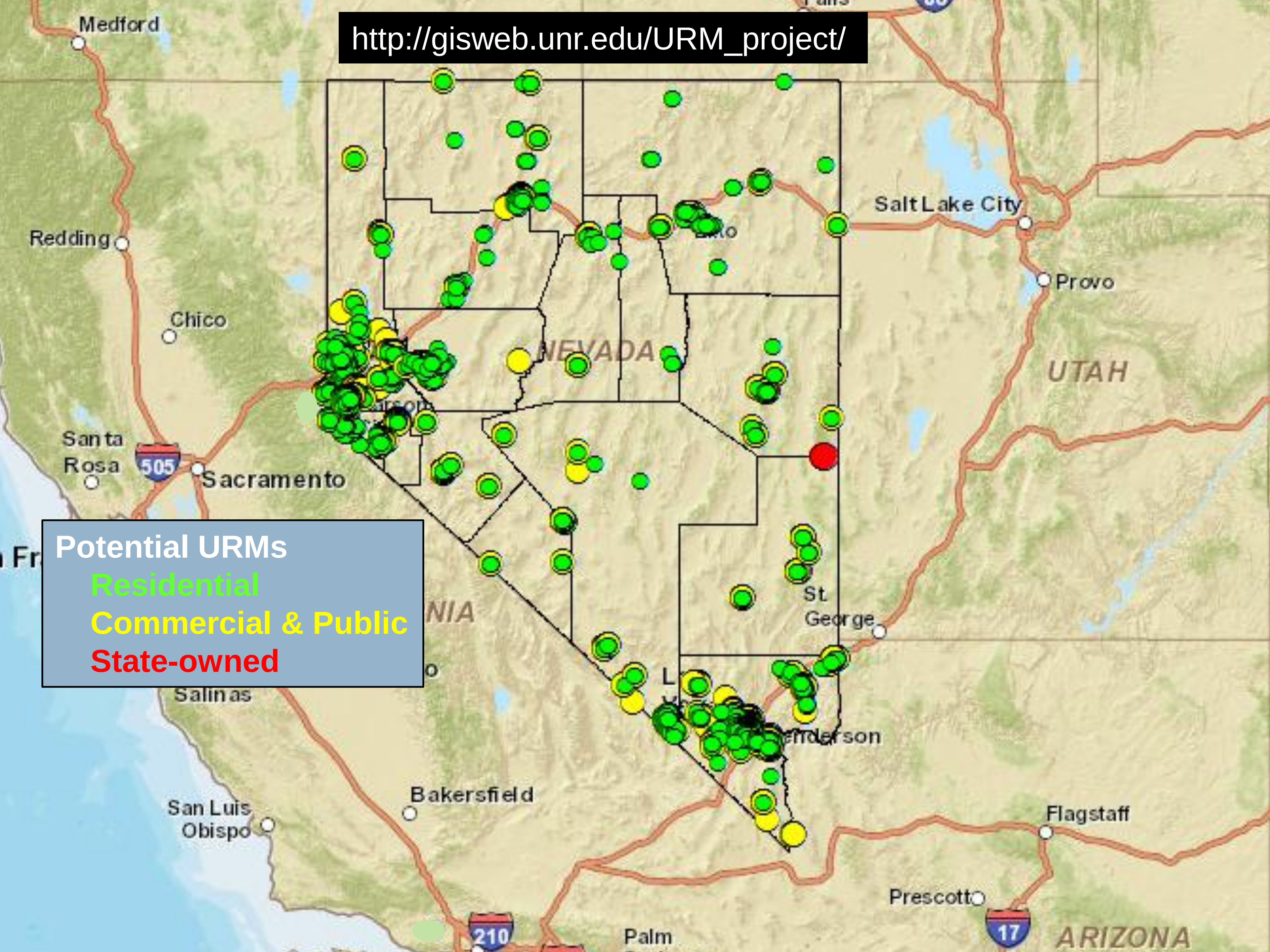
Recommendation 1 (draft): Jurisdictions (cities, counties, state) should use this County Assessors' data to follow up with on-the-ground inspections and checks of building plans. Individuals should determine if their buildings are URMs.

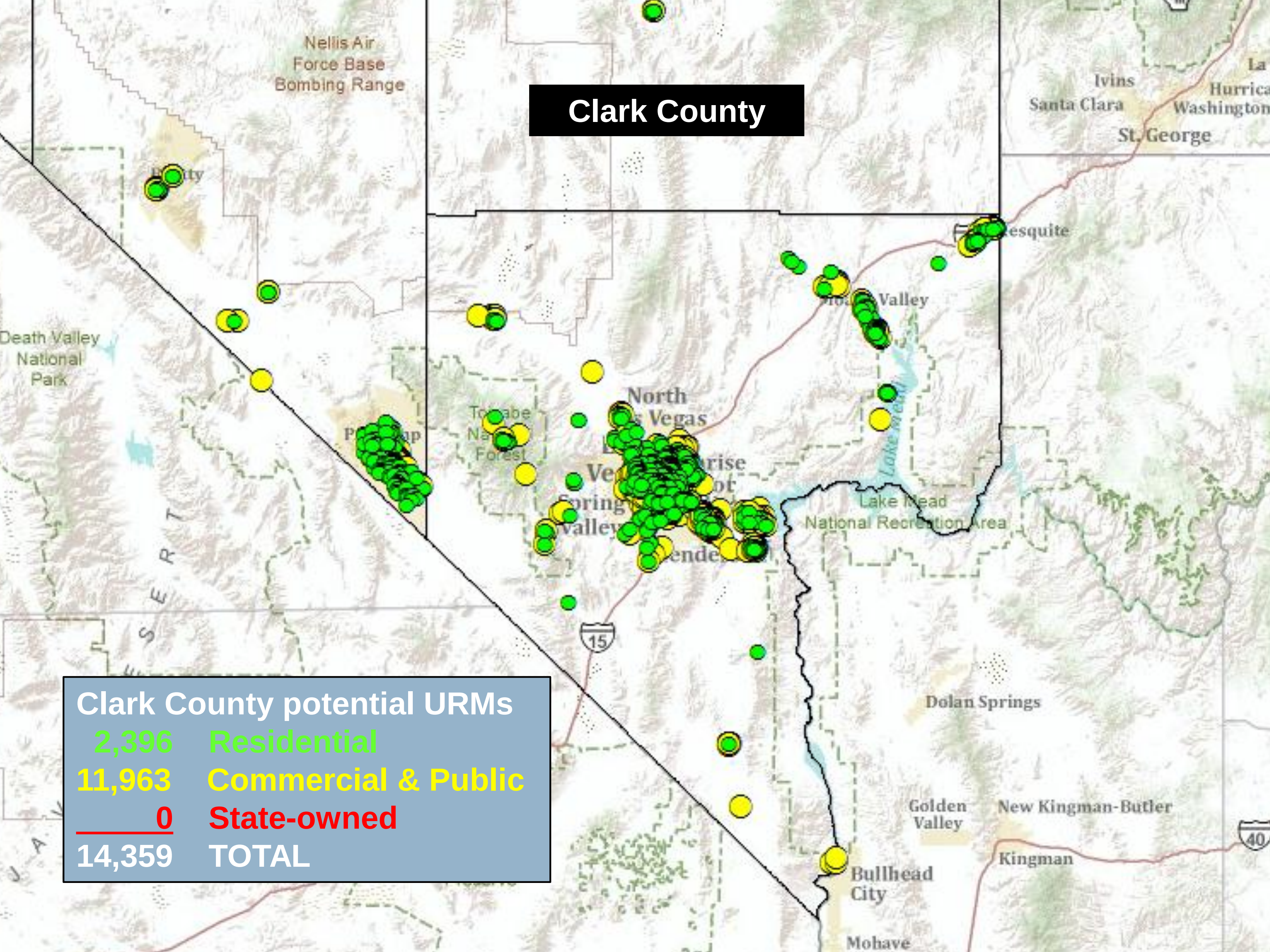
Potential URMs in Nevada – totals*

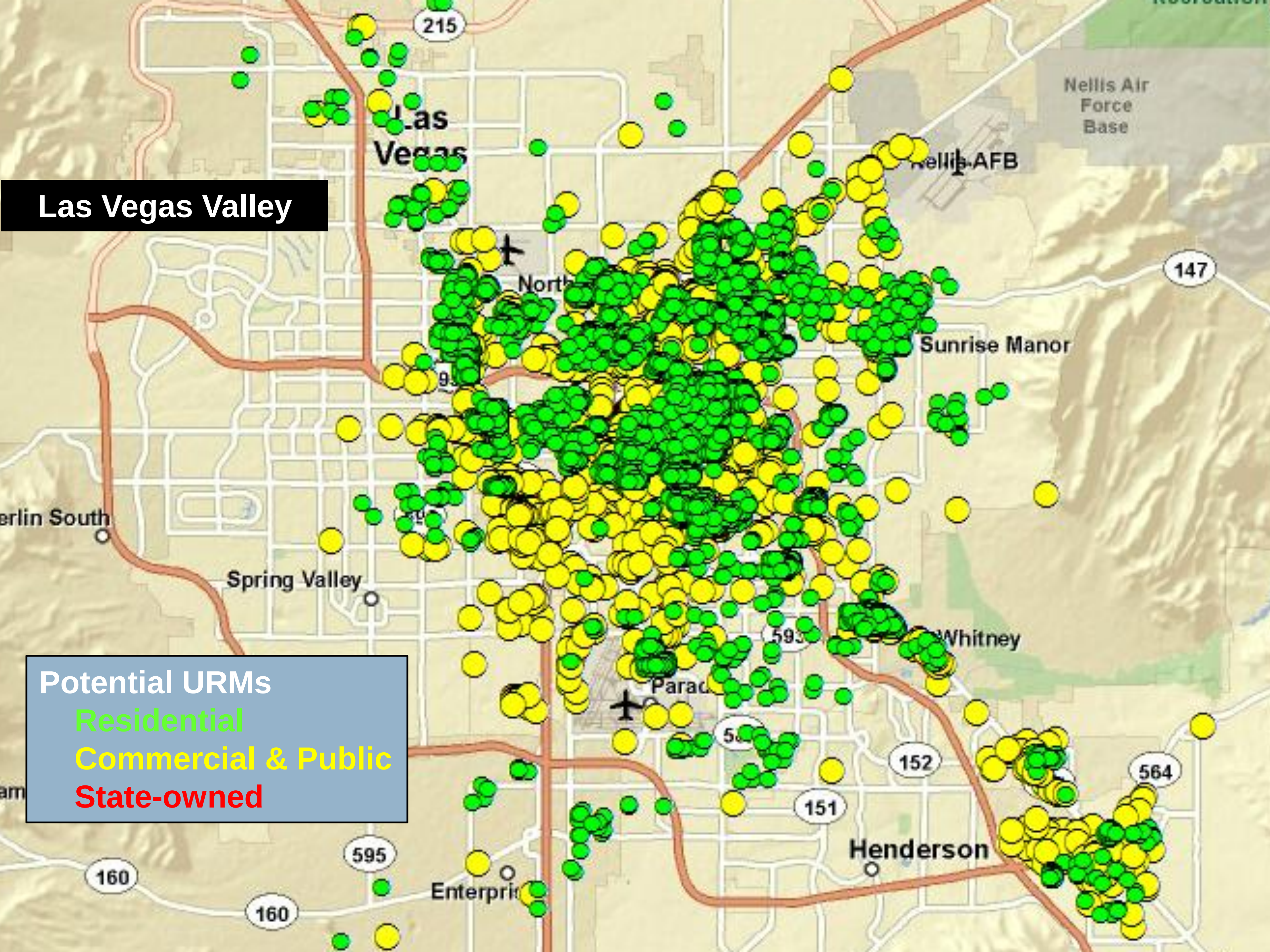
7,354	Residential
16,145	Commercial & Public (city and county)
98	State-owned
23,597	TOTAL*

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

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

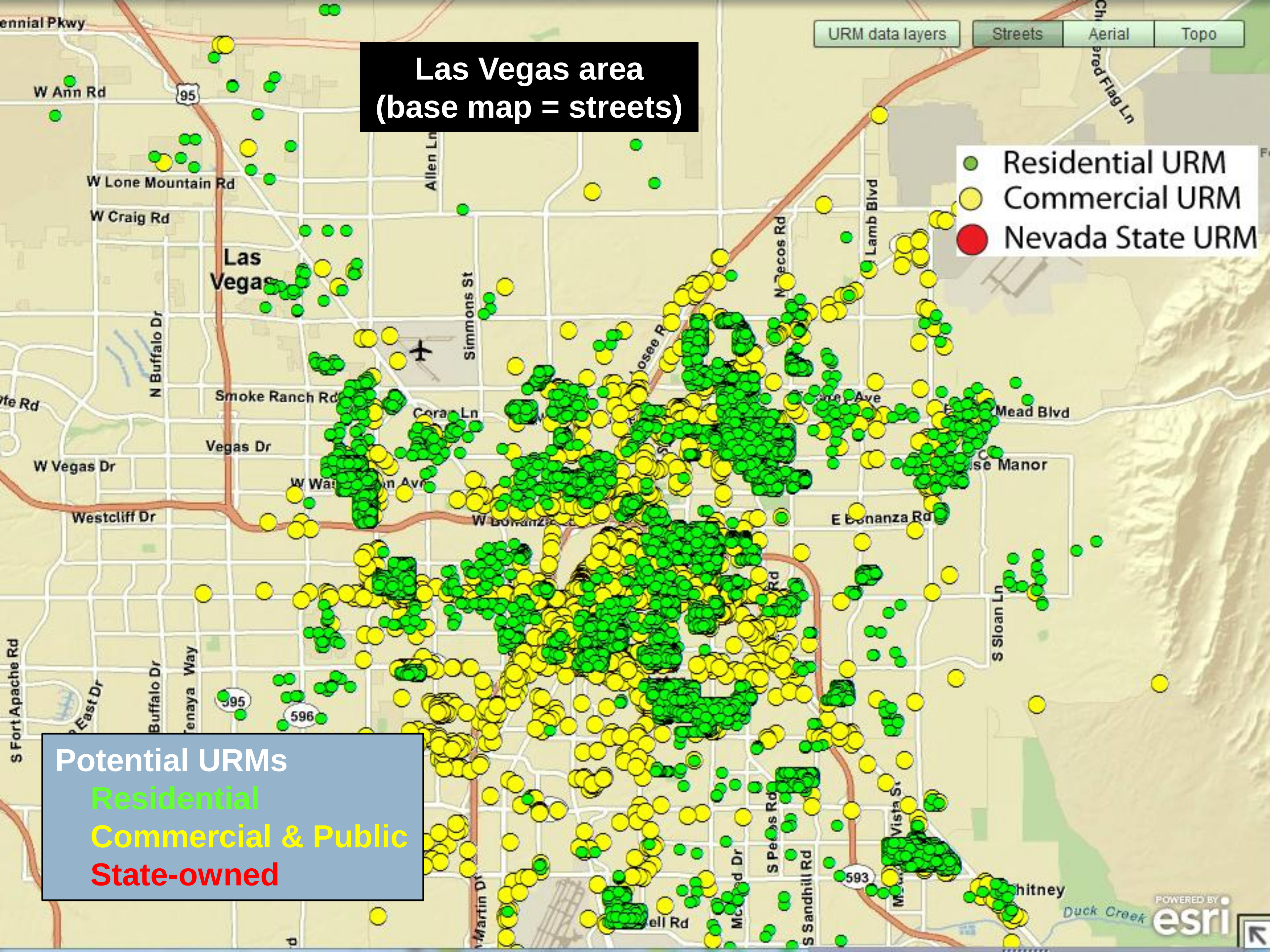

http://gisweb.unr.edu/URM_project/
Potential URMs
Residential
Commercial & Public
State-owned
Medford
Redding
Chico
Santa Rosa
Sacramento
505
Salinas
San Luis Obispo
Bakersfield
210
Palm
NEVADA
Salt Lake City
Provo
UTAH
St George
Flagstaff
Prescott
17
ARIZONA


Clark County
Clark County potential URMs
2,396 Residential
11,963 Commercial & Public
0 State-owned
14,359 TOTAL
Nellis Air Force Base Bombing Range
Death Valley National Park
North Las Vegas
Spring Valley
Mesquite
Lake Mead National Recreation Area
Lake Mead
Ivins
Santa Clara
St. George
Washington
Dolan Springs
Golden Valley
New Kingman-Butler
Kingman
Bullhead City
Mohave
15
40

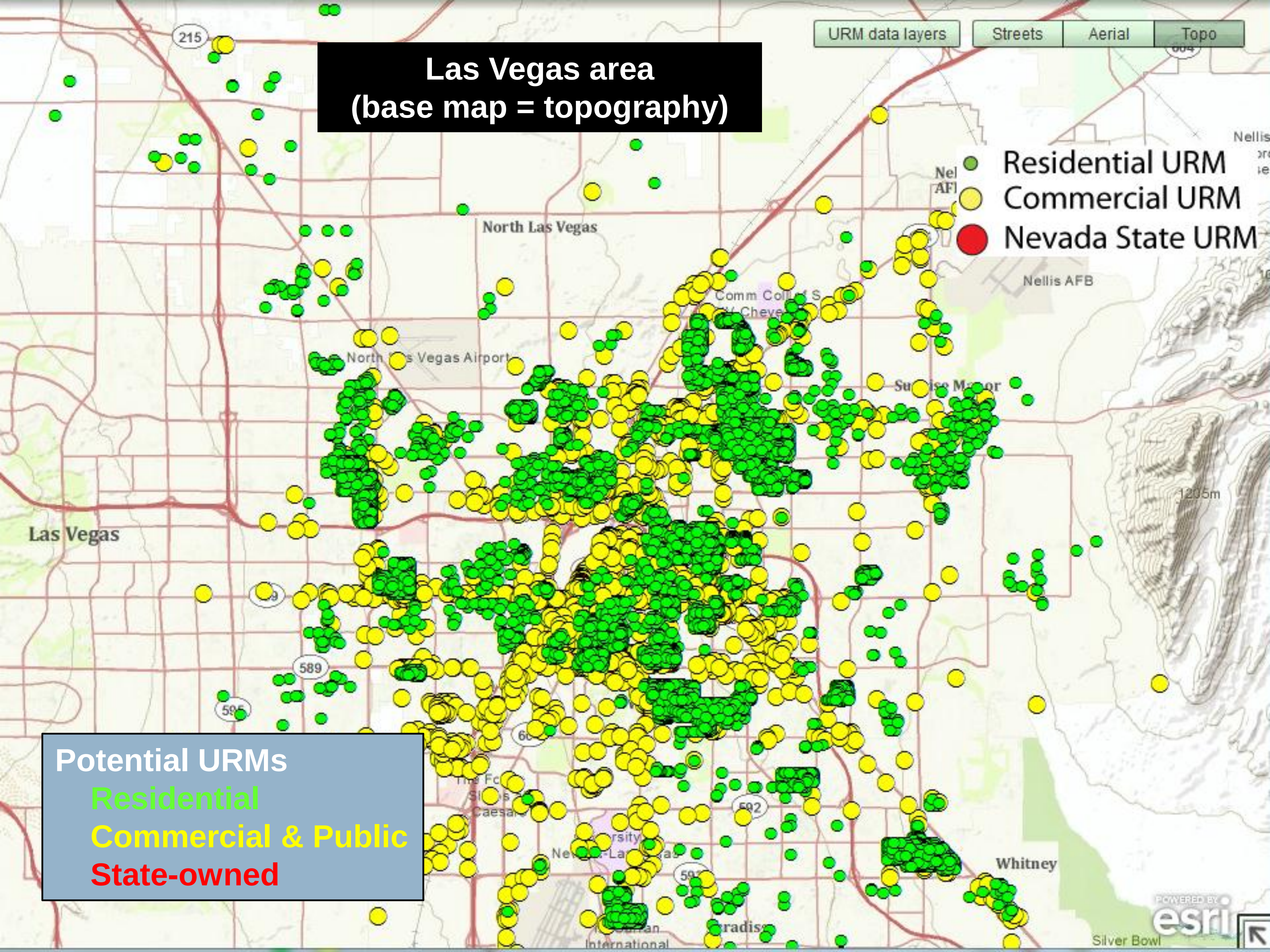


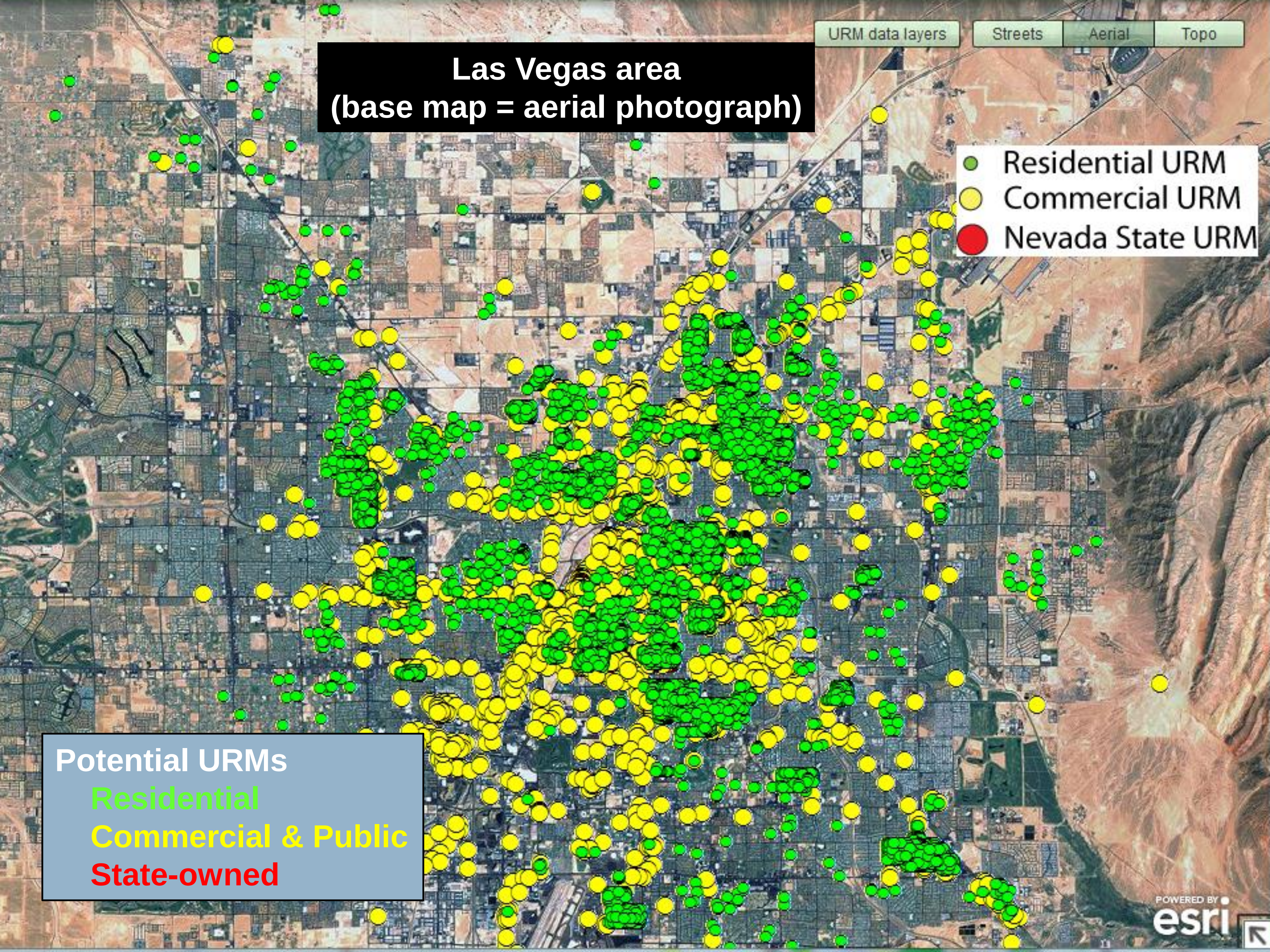
Las Vegas Valley
Potential URMs
Residential
Commercial & Public
State-owned
215
Las Vegas
Nellis Air Force Base
147
Sunrise Manor
Spring Valley
Whitney
152
564
151
Henderson
595
160
160

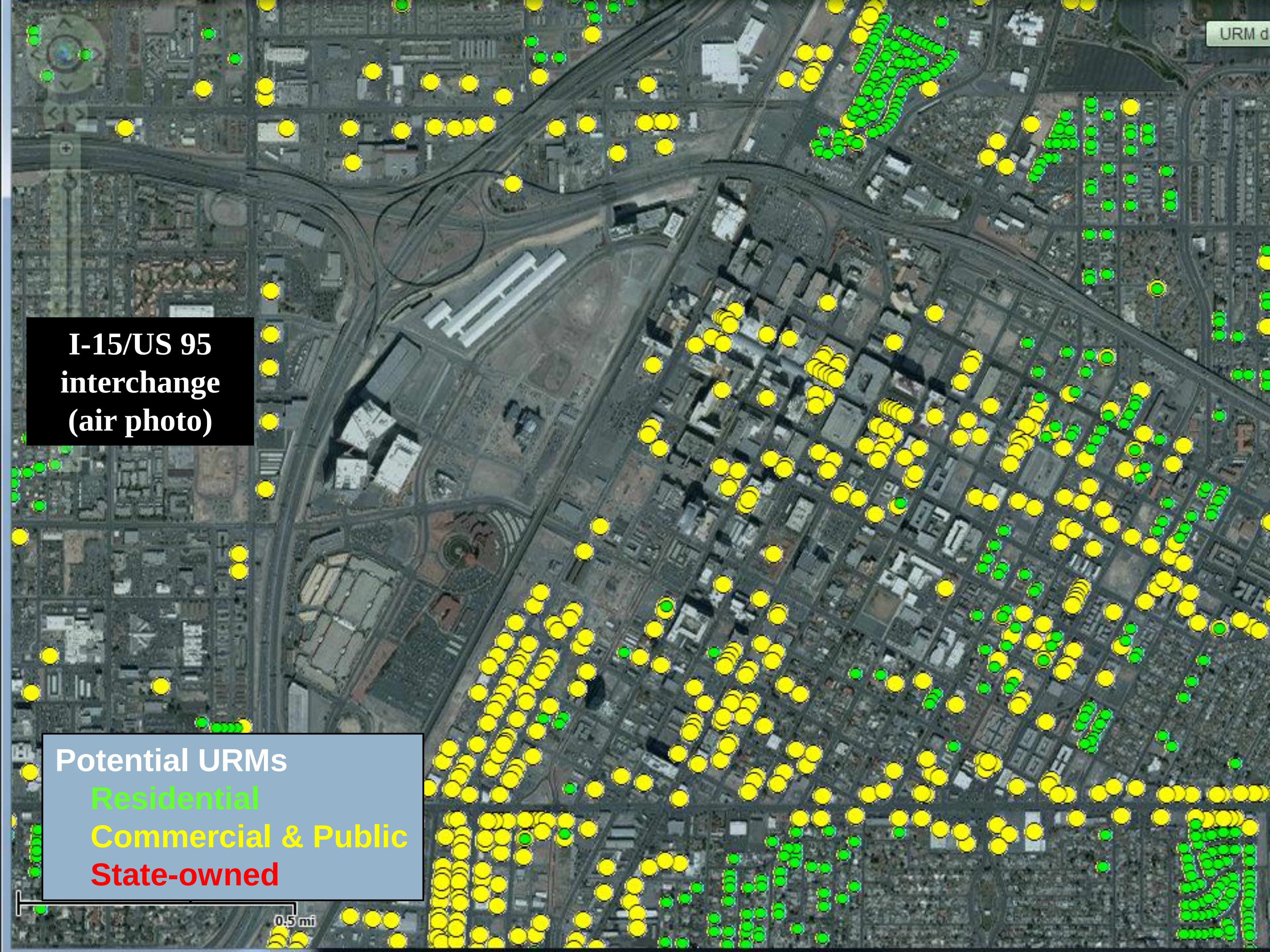
Las Vegas area (base map = streets)

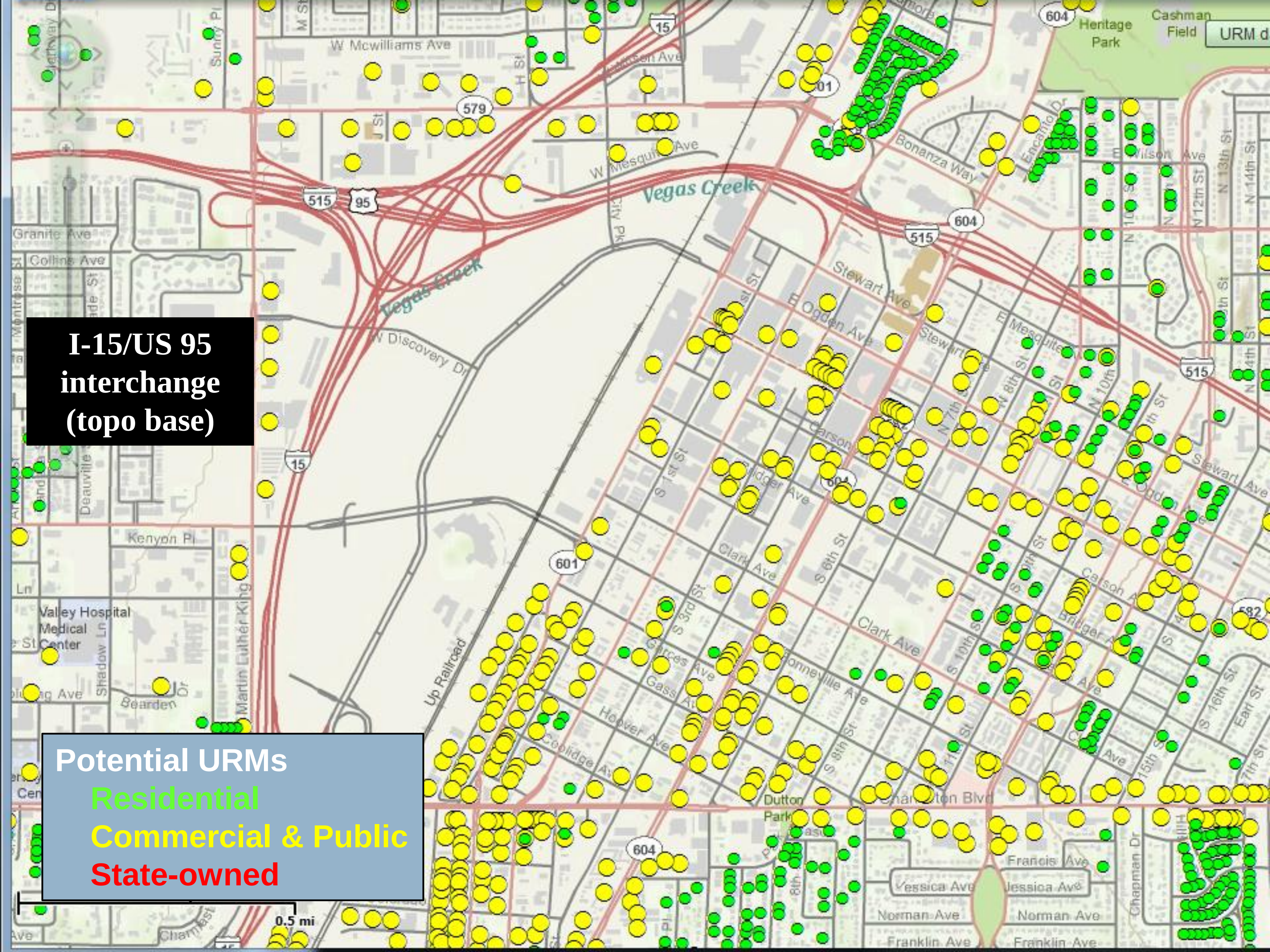


Potential URMs
- Residential
- Commercial & Public
- State-owned

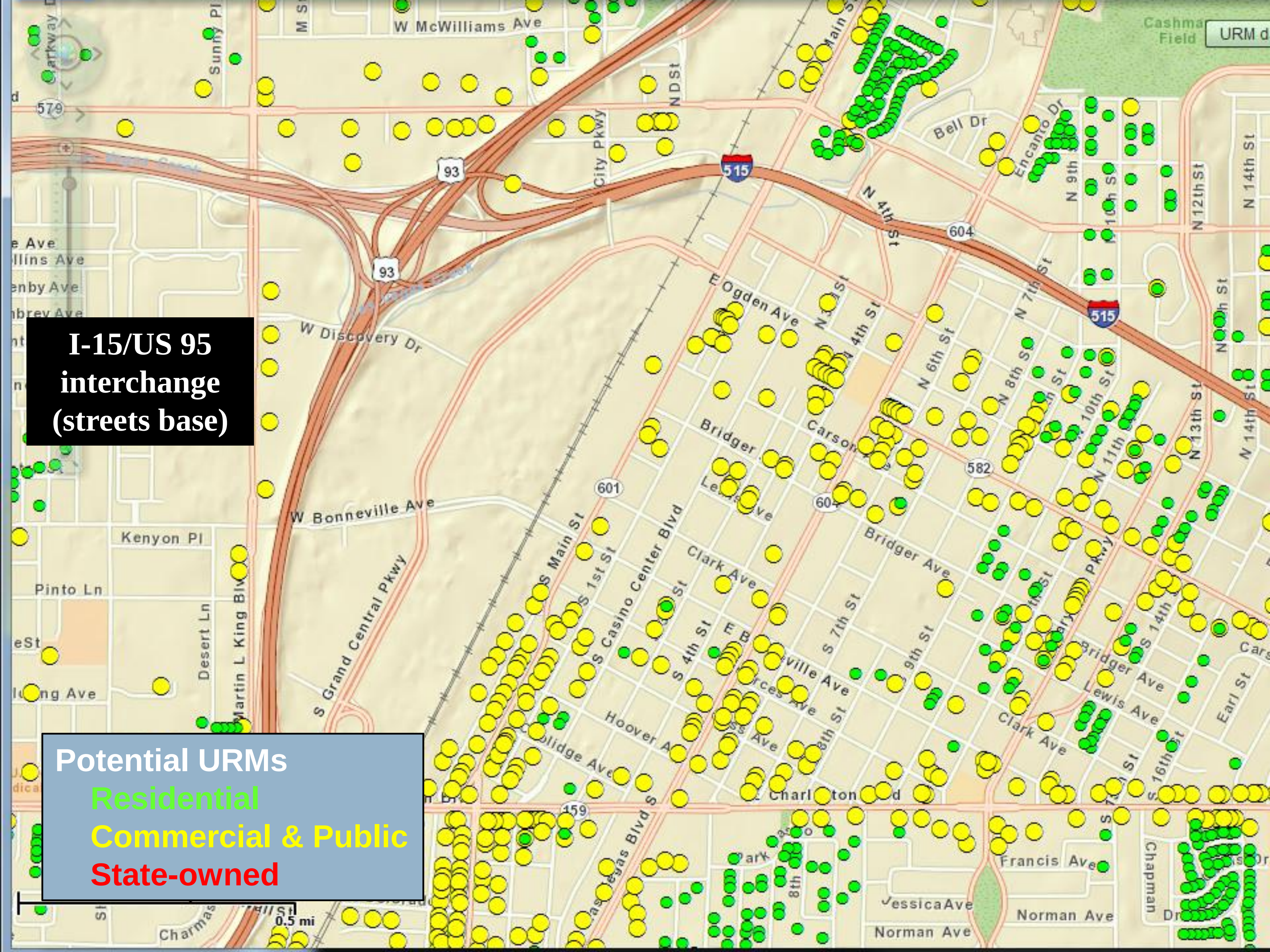

Las Vegas area
(base map = topography)
URM data layers
Streets
Aerial
Topo
Residential URM
Commercial URM
Nevada State URM
North Las Vegas
Nellis AFB
Las Vegas
Whitney
Silver Bowl
Potential URMs
Residential
Commercial & Public
State-owned

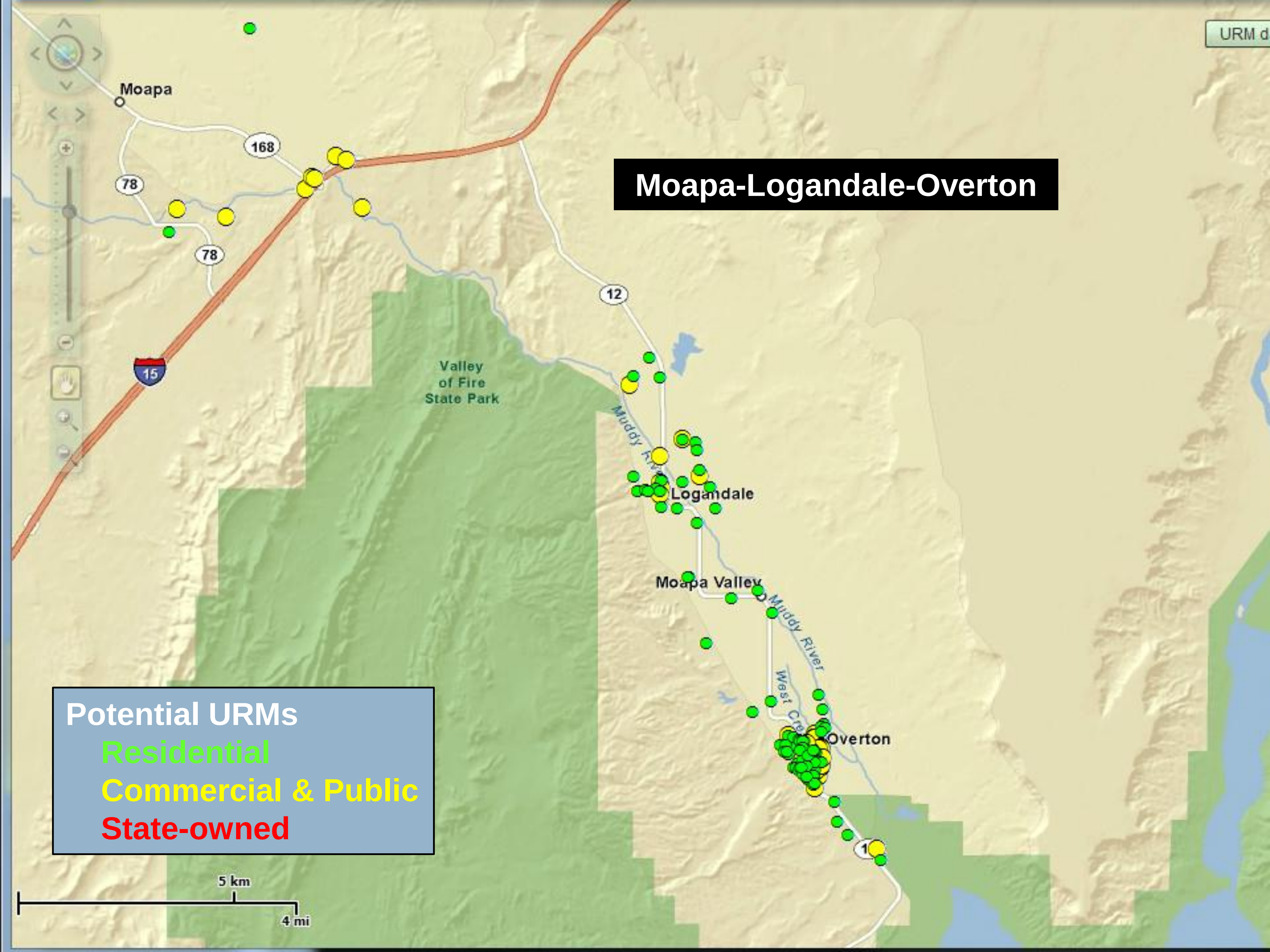

Las Vegas area
(base map = aerial photograph)
URM data layers
Streets
Aerial
Topo
Residential URM
Commercial URM
Nevada State URM
Potential URMs
Residential
Commercial & Public
State-owned
POWERED BY esri


URM d
I-15/US 95 interchange (air photo)
Potential URMs
Residential
Commercial & Public
State-owned
0.5 mi



I-15/US 95 interchange (topo base)
Potential URMs
Residential
Commercial & Public
State-owned
W Mcwilliams Ave
Vegas Creek
Vegas Creek
W Discovery Dr
Bonanza Way
Stewart Ave
E Ogden Ave
Carson
Bridger Ave
Clark Ave
Garces Ave
Gass Ave
Hoover Ave
Coolidge Ave
Bonneville Ave
Charleston Blvd
Dutton Park
Francis Ave
Jessica Ave
Norman Ave
Franklin Ave
Granite Ave
Collins Ave
Kenyon Pl
Valley Hospital Medical Center
Bearden Dr
Martin Luther King
Up Railroad
Heritage Park
Cashman Field
Chapman Dr
S 1st St
S 3rd St
S 6th St
S 8th St
N 13th St
N 14th St
N 12th St
E Wilson Ave
0.5 mi
15
515
95
579
601
604
582


I-15/US 95 interchange (streets base)
Potential URMs
Residential
Commercial & Public
State-owned
URM d
Cashman Field
W McWilliams Ave
W Discovery Dr
W Bonneville Ave
Kenyon Pl
Pinto Ln
Desert Ln
Martin L King Blvd
S Grand Central Pkwy
S Main St
S 1st St
S Casino Center Blvd
S Las Vegas Blvd
City Pkwy
N D St
N 4th St
E Ogden Ave
Bridger Ave
Carson Ave
Clark Ave
Hoover Ave
Coolidge Ave
E Charleston Blvd
Bell Dr
Encanto Dr
N 6th St
N 7th St
N 8th St
N 9th St
N 10th St
N 11th St
N 12th St
N 13th St
N 14th St
Lewis Ave
Francis Ave
Jessica Ave
Norman Ave
Chapman Dr
Earl St
S 7th St
S 9th St
S 14th St
S 16th St
579
93
515
604
582
601
159
0.5 mi



Moapa-Logandale-Overton
Potential URMs
Residential
Commercial & Public
State-owned
URM d
Moapa
168
78
78
12
15
Valley
of Fire
State Park
Muddy River
Logandale
Moapa Valley
Muddy River
West Creek
Overton
5 km
4 mi

Conclusions:

There are tens of thousands of potential URMs in Nevada.

Potential URMs in Nevada – totals*

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

URMs are located in every county and nearly every community in Nevada.

Many URMs are historically significant.

Many URMs are concentrated in downtown business districts and along thoroughfares.

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

URMs are structures that commonly collapse in large earthquakes.

There are thousands of potential URMs in Nevada.

So what? Who cares?

This is a problem of life safety and economic loss.

We can reduce the risks from URMs.

Western States Seismic Policy Council:

"Unreinforced masonry bearing-wall structures represent one of the greatest life safety threats and economic burdens to the public during a damaging earthquake. WSSPC recommends that each state, province or territory adopt a program to identify the extent of risk that unreinforced masonry structures represent in their communities and develop recommendations that will effectively address the reduction of this risk." Policy Recommendation 11-4

URMs are structures that commonly collapse in large earthquakes.

There are thousands of potential URMs in Nevada.

So what? Who cares?

We can reduce the risks from URMs.

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.

Recommendation 2 (draft): Jurisdictions should work toward seismically retrofitting URMs or removing them from human occupation. Take advantage of opportunities for federal funding for mitigation through FEMA. Bring buildings up to current code when remodeling. Learn from what other jurisdictions have done successfully. Provide incentives for individuals and businesses to retrofit URMs or to replace them with new buildings.

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

Washoe County EOC, 30 September 2007 – computers secure

Thank you!

And thanks to Craig dePolo, 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.

Nevada Earthquake Safety Council

www.nbmg.unr.edu/nesc

Nevada Bureau of Mines and Geology

www.nbmg.unr.edu

Nevada Seismological Laboratory

www.seismo.unr.edu

Nevada Division of Emergency Management

dem.state.nv.us