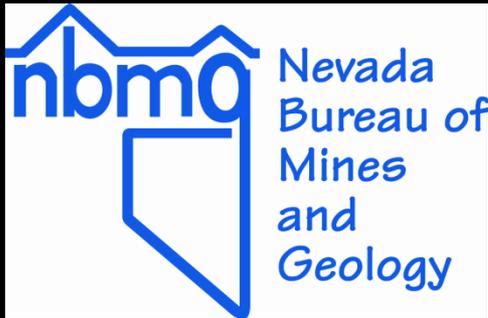


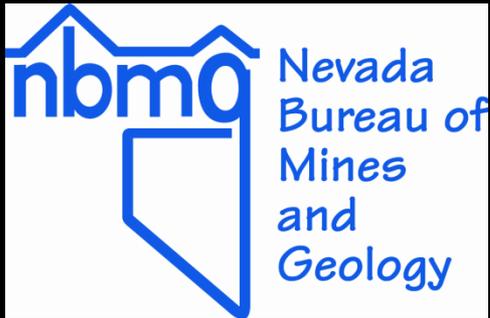
Earthquake Hazards in Nevada

Presentation by Jonathan G. Price
State Geologist and Director
Nevada Bureau of Mines and Geology
and
Secretary, Nevada Earthquake Safety Council

for the
Interim Finance Committee's
Subcommittee to Review Public Works Board Matters
Senator Bob Coffin, Chair

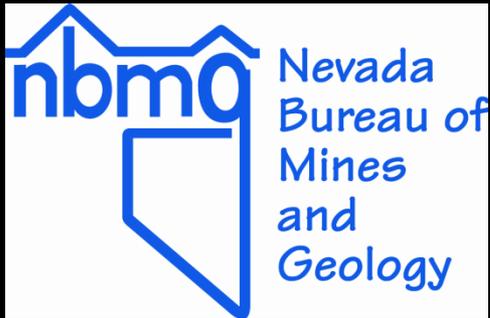


Earthquake hazards occur throughout Nevada, and potential losses from earthquakes are high for many communities, including Carson City, Reno, and Las Vegas.



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

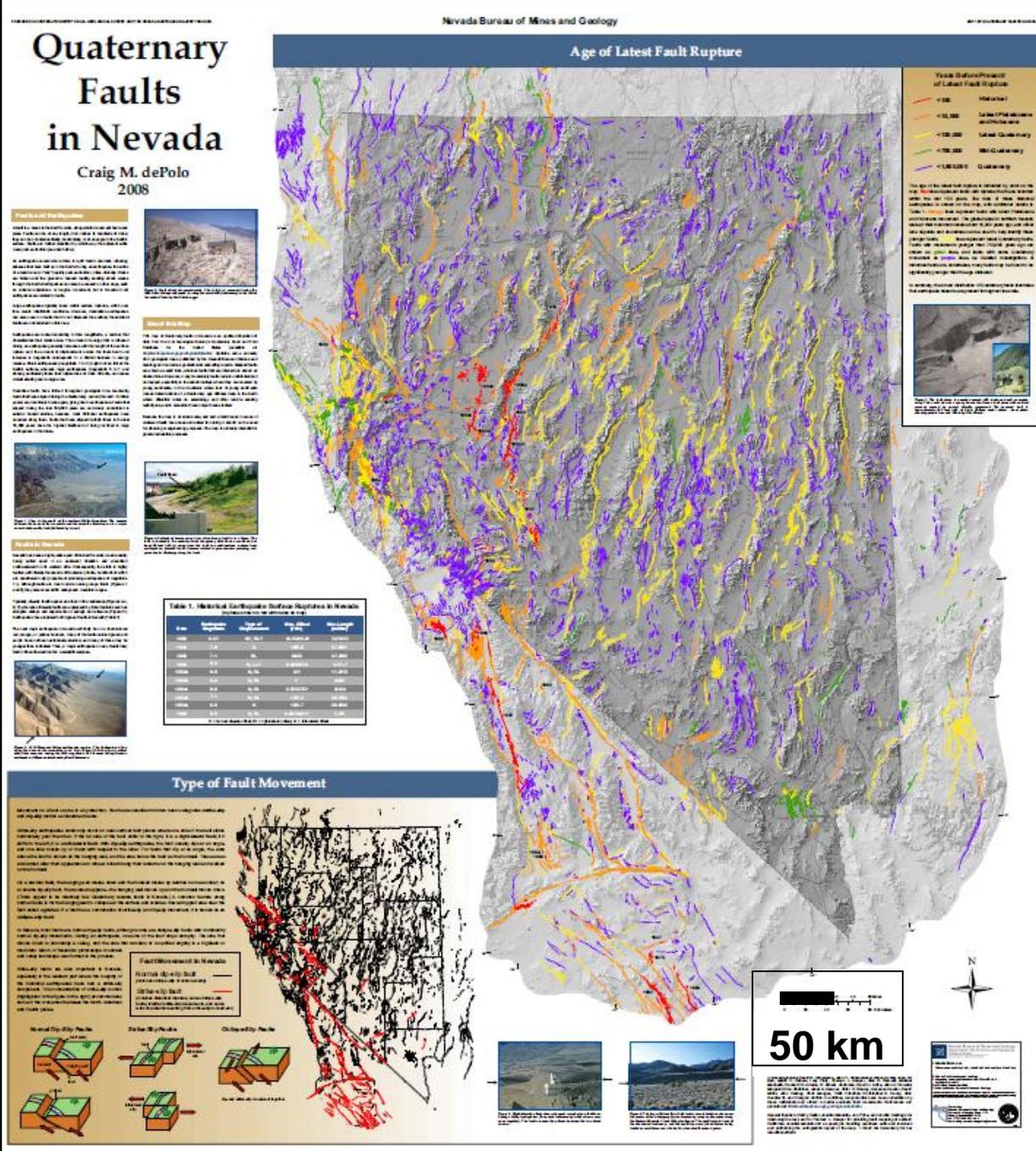
< 750,000 years

< 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



Look for a fault | Find Address

Easy to pinpoint an address

Results

Map Contents

Find Address

Street or Intersection: 1402 West King Street

City: Carson City

State: Nevada

ZIP:

Find Your Address



Look for a fault | Find Address

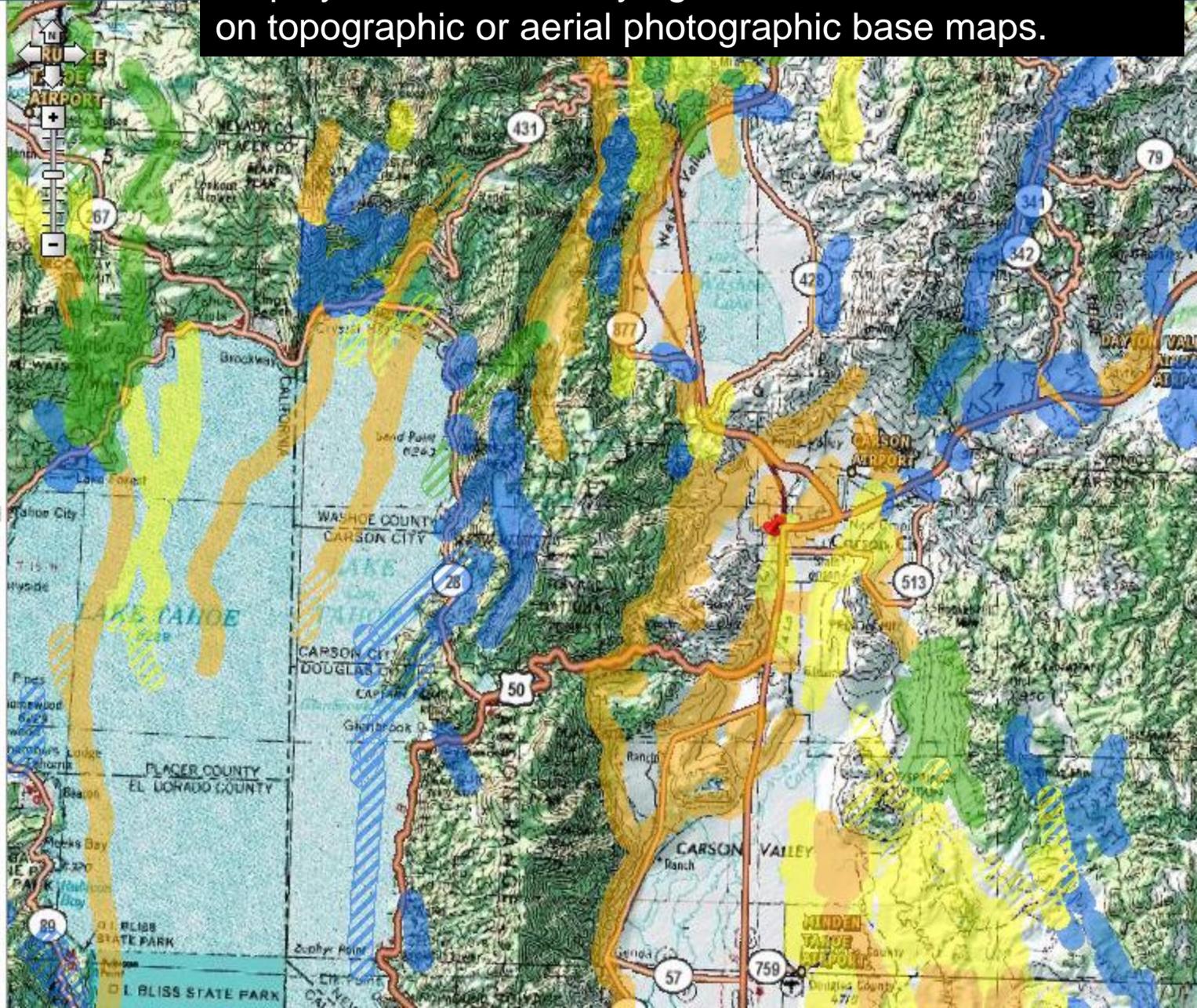
Display faults, colored by age of most recent movement, on topographic or aerial photographic base maps.

Results

- 1402 West King Street, Carson
- 1402 W King St, Carson

Map Contents

- Quaternary_Faults
 - Legend
 - Historic - within the latest Pleistocene & late Quaternary - within
 - Historic - within the latest Pleistocene & late Quaternary - within
 - late Quaternary - within
 - middle Quaternary - within
 - middle Quaternary - within
 - Quaternary - within
 - Quaternary - within
 - Base Data
- 9i10glj_TOPO_data
 - Base Data
- USGS_aerial_photographs
 - Base Data



Look for a fault | Find Address

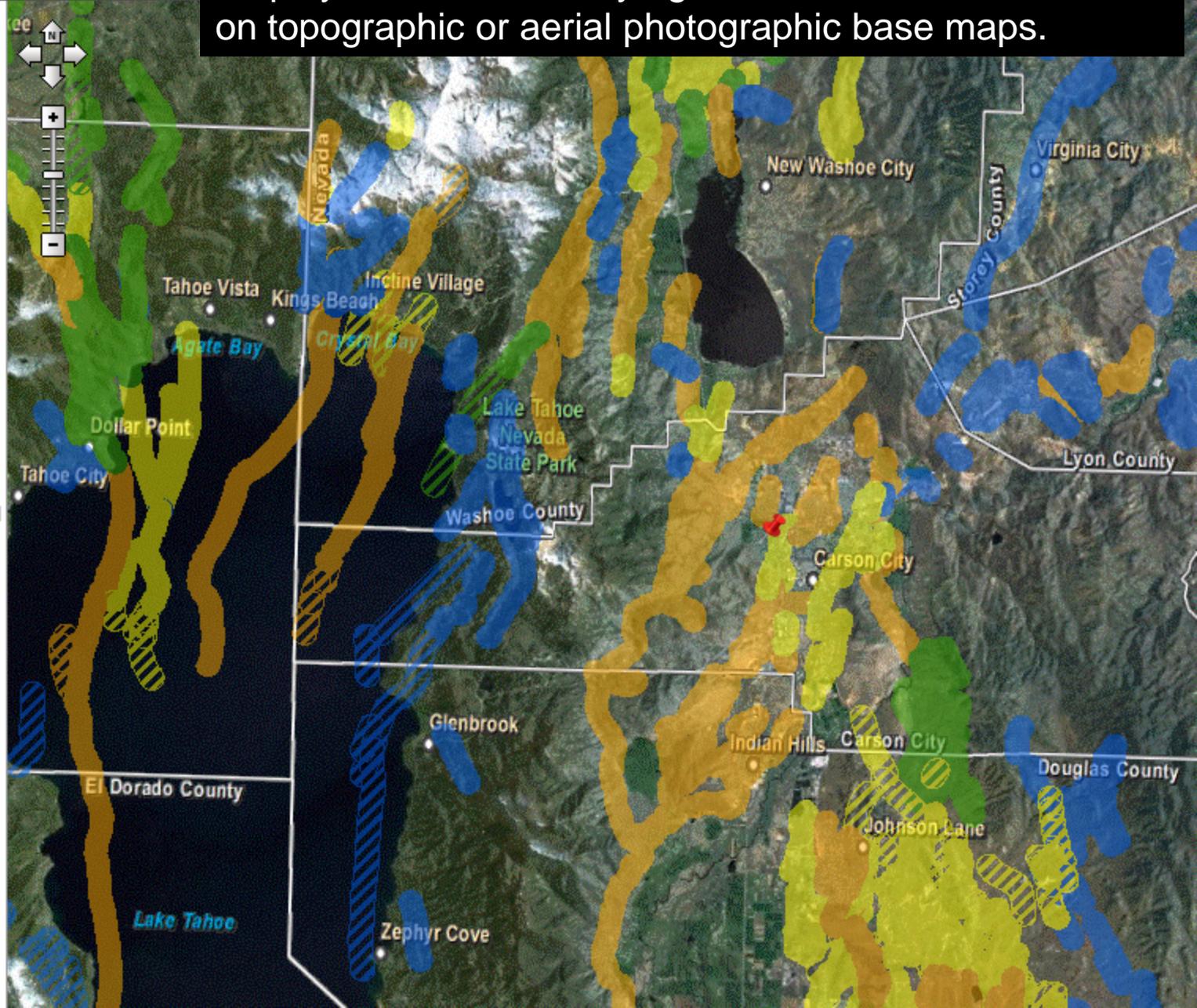
Display faults, colored by age of most recent movement, on topographic or aerial photographic base maps.

Results

- 1402 West King Street, Carson City
- 1402 W King St, Carson City

Map Contents

- Quaternary_Faults
 - Legend
 - Historic - within the
 - Historic - within the
 - latest Pleistocene &
 - latest Pleistocene &
 - late Quaternary - wi
 - late Quaternary - wi
 - middle Quaternary -
 - middle Quaternary -
 - Quaternary - within
 - Quaternary - within
 - Base Data
- 9i10glj_TOPO_data
 - Base Data
- USGS_aerial_photographs
 - Base Data



Look for a fault | Find Address

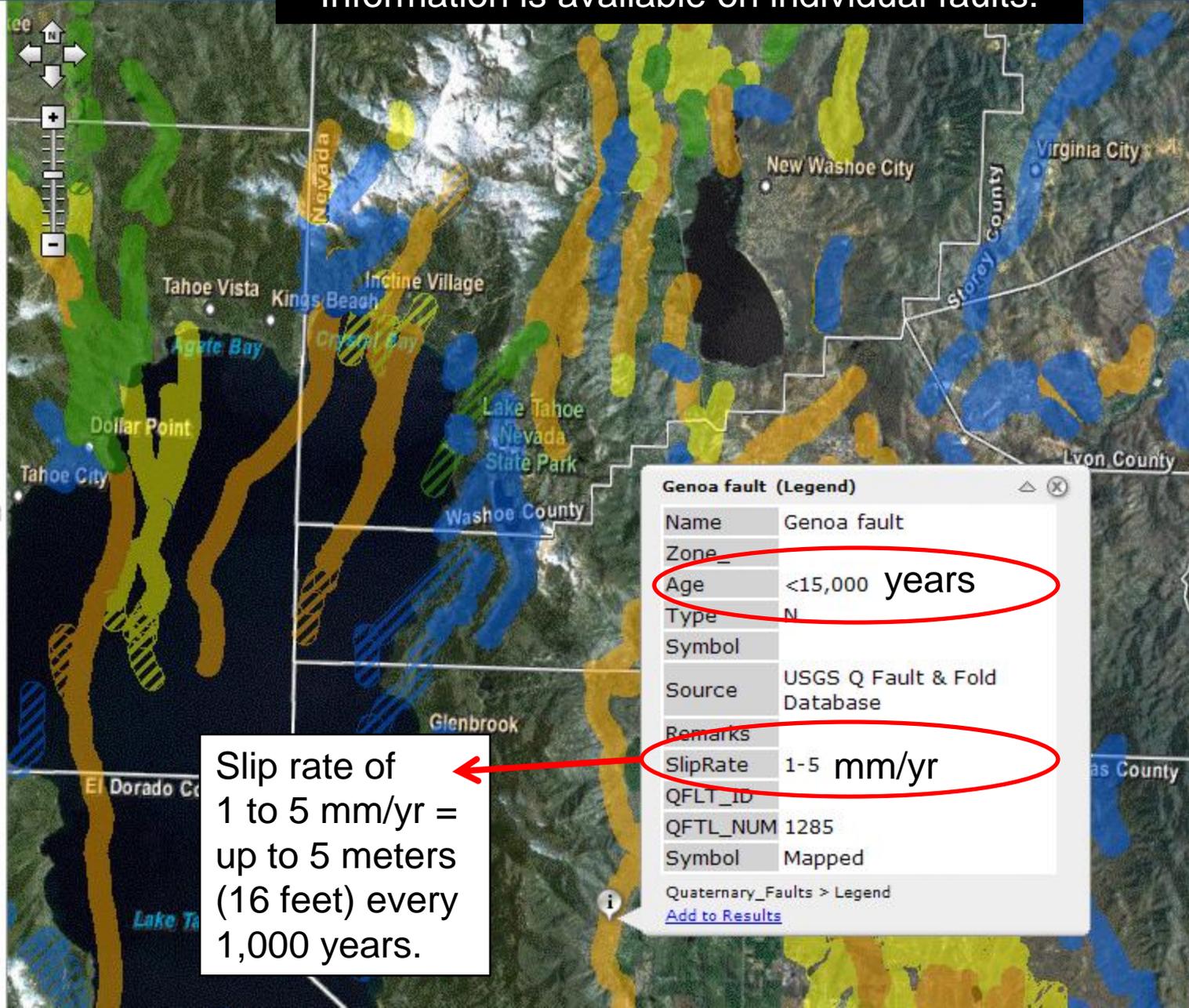
Information is available on individual faults.

Results

- 1402 West King Street,
- 1402 W King St, Carson

Map Contents

- Quaternary_Faults
 - Legend
 - Historic - within the
 - Historic - within the
 - latest Pleistocene &
 - latest Pleistocene &
 - late Quaternary - wi
 - late Quaternary - wi
 - middle Quaternary -
 - middle Quaternary -
 - Quaternary - within
 - Quaternary - within
 - Base Data
- 9i10glj_TOPO_data
 - Base Data
- USGS_aerial_photographs
 - Base Data



Genoa fault (Legend)

Name	Genoa fault
Zone_	
Age	<15,000 years
Type	N
Symbol	
Source	USGS Q Fault & Fold Database
Remarks	
SlipRate	1-5 mm/yr
QFLT_ID	
QFTL_NUM	1285
Symbol	Mapped

Quaternary_Faults > Legend
[Add to Results](#)

Slip rate of 1 to 5 mm/yr = up to 5 meters (16 feet) every 1,000 years.

Look for a fault | Find Address

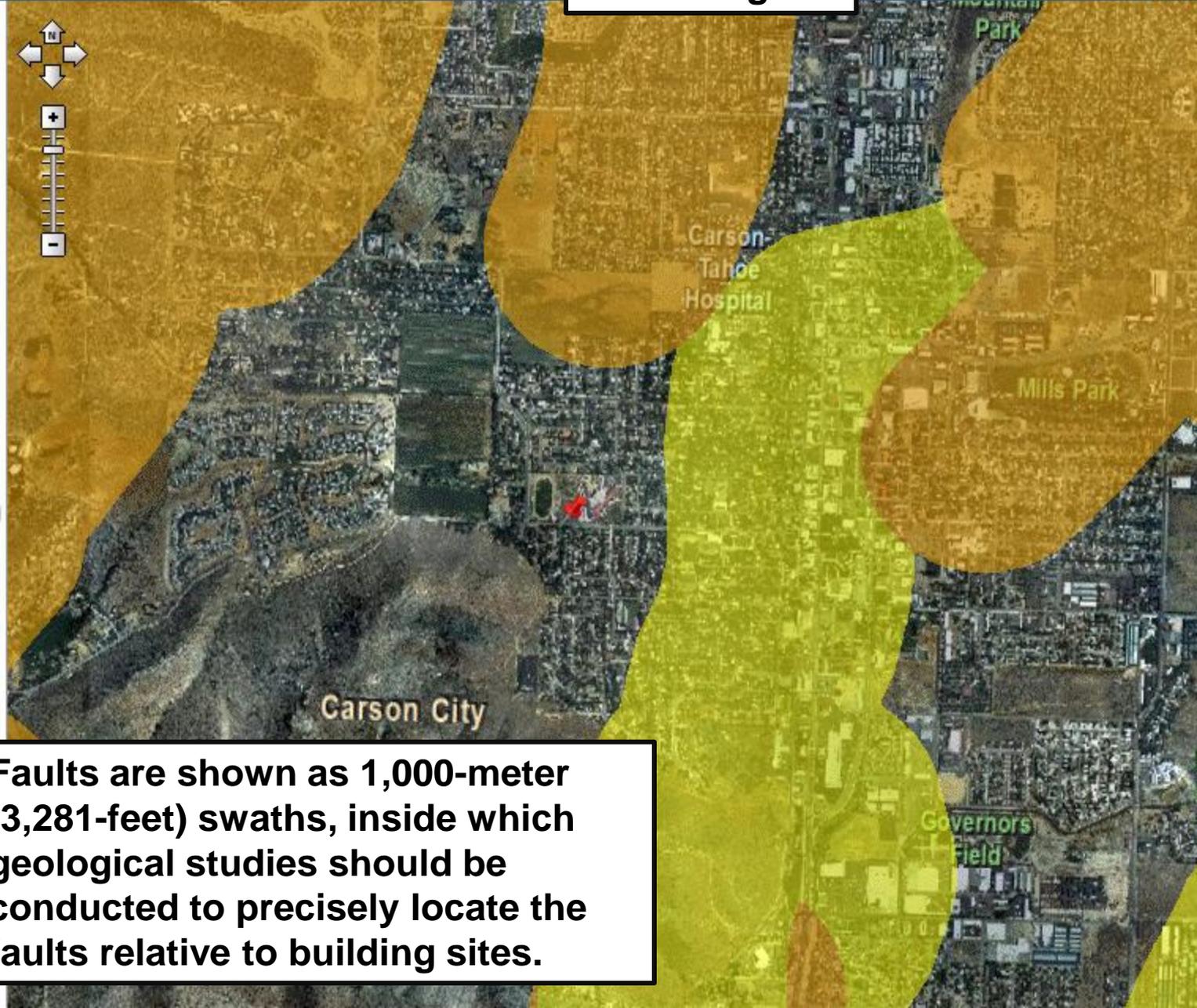
Zooming in

Results

- 1402 West King Street, Carson
- 1402 W King St, Carson

Map Contents

- Quaternary_Faults
 - Legend
 - Historic - within the
 - Historic - within the
 - latest Pleistocene &
 - latest Pleistocene &
 - late Quaternary - wi
 - late Quaternary - wi
 - middle Quaternary -
 - middle Quaternary -
 - Quaternary - within
 - Quaternary - within
 - Base Data
- 9i10glj_TOPO_data
 - Base Data
- USGS_aerial_photographs
 - Base Data



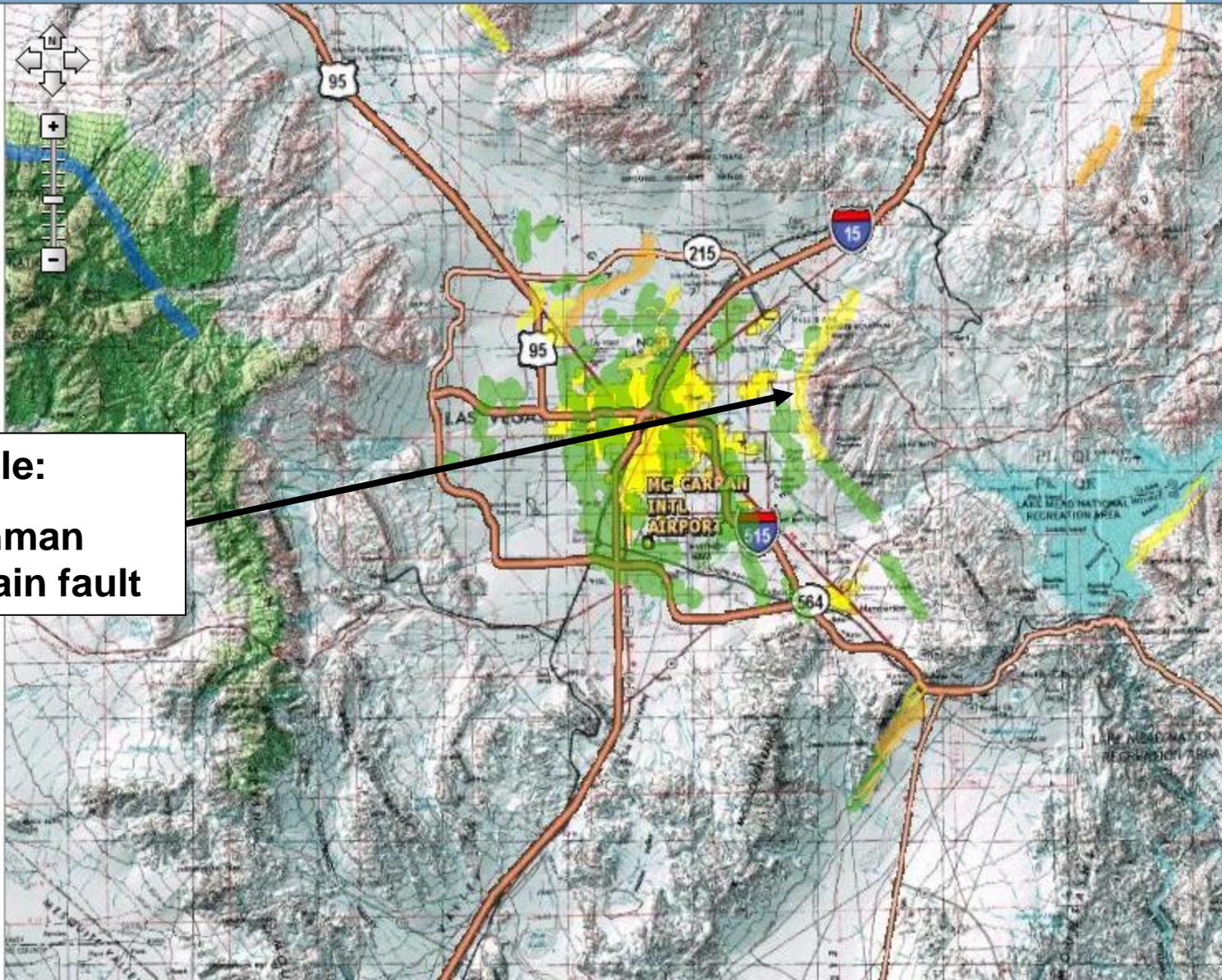
Faults are shown as 1,000-meter (3,281-feet) swaths, inside which geological studies should be conducted to precisely locate the faults relative to building sites.

Quaternary Faults in Nevada - Online Interactive Map

Look for a fault



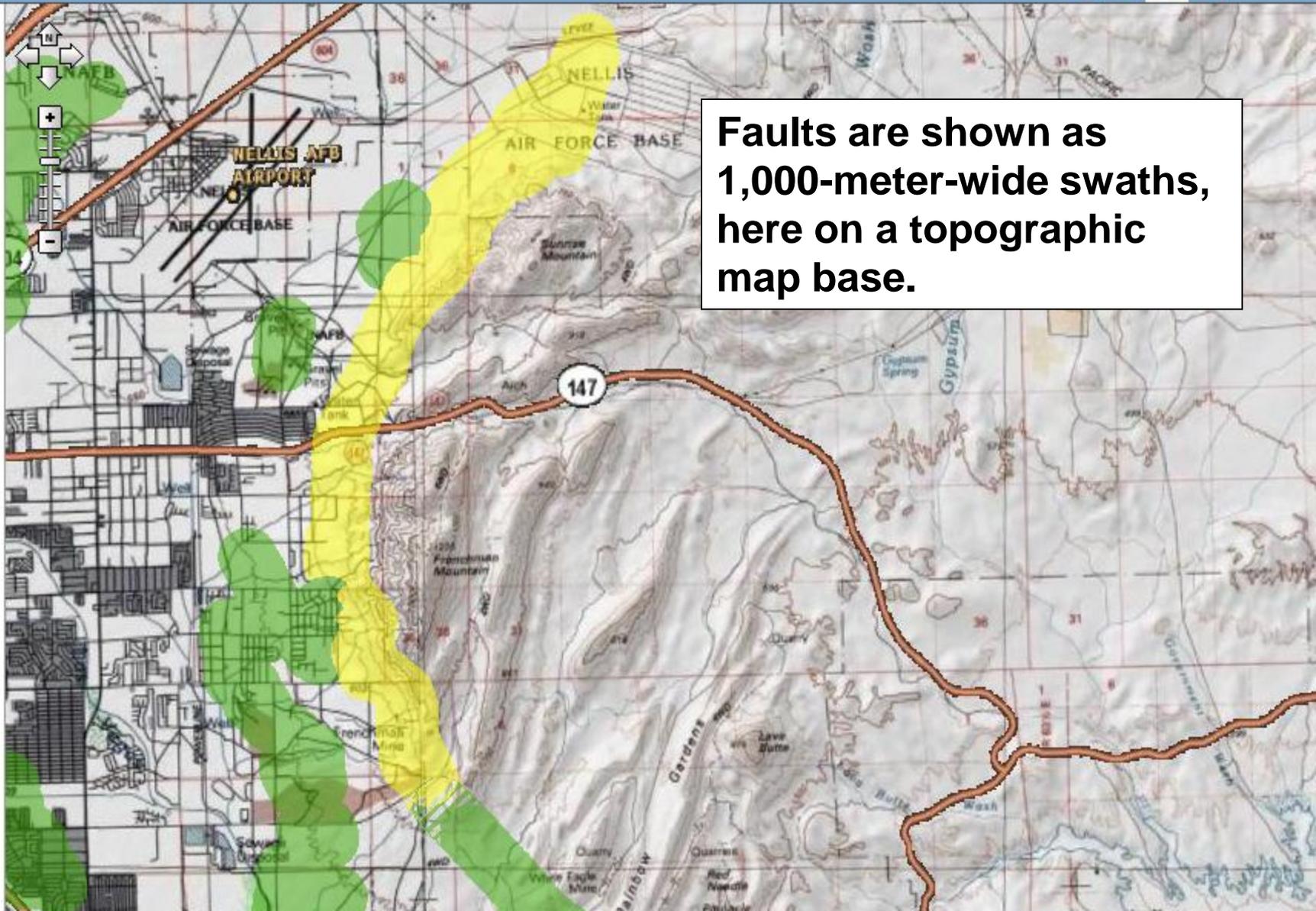
- Results** ▾
- Map Contents** ▲
- 9i10glj_Q_Faults
 - 500 Meter Fault Buffer
 - Base Data
 - 9i10glj_TOPO_data
 - Base Data
 - 9i10glj_NAPS_data
 - Base Data



Example:
Frenchman
Mountain fault



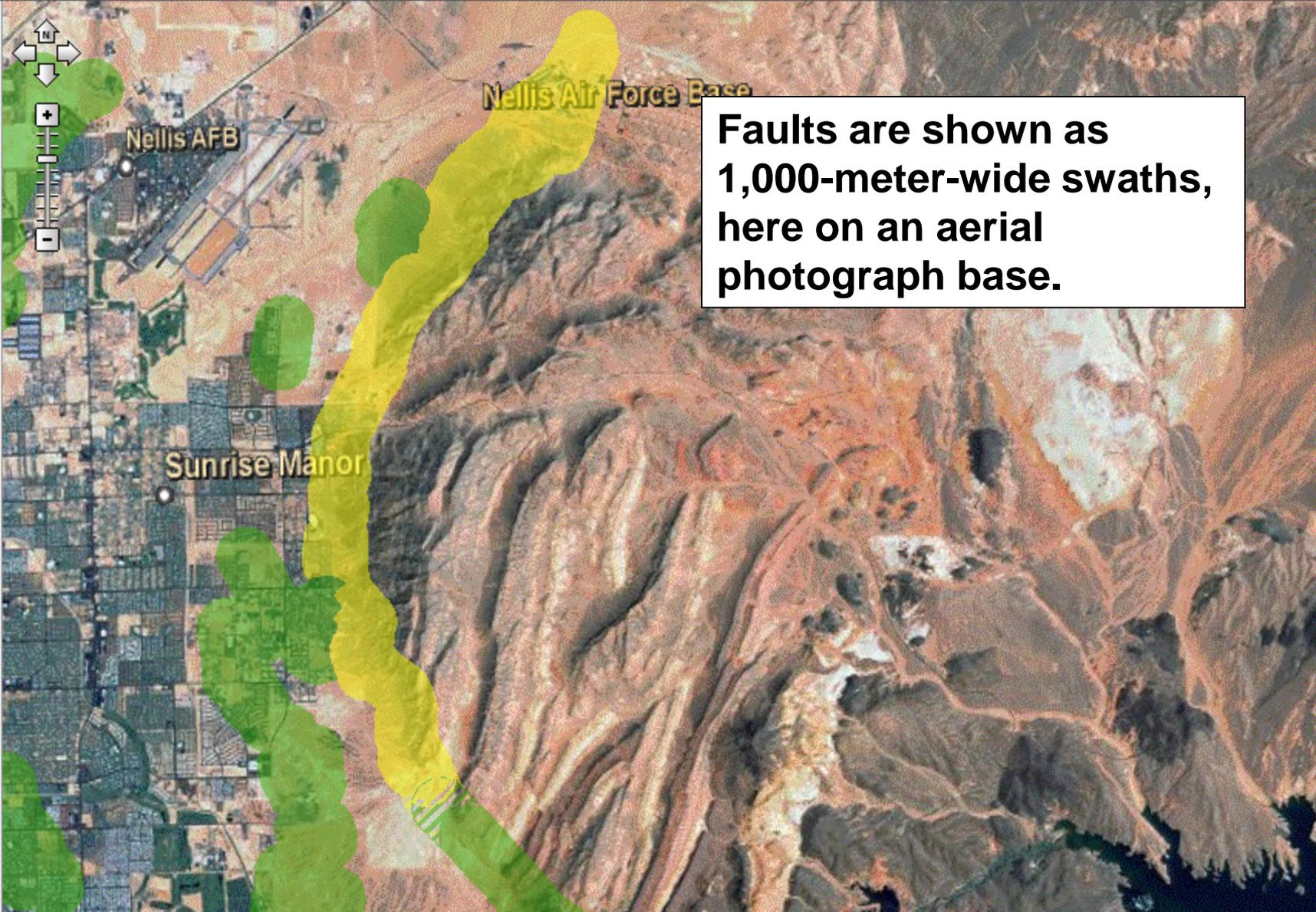
- Faults
- Water Fault Buffer
- PO_data
- PS_data
- Ge Data



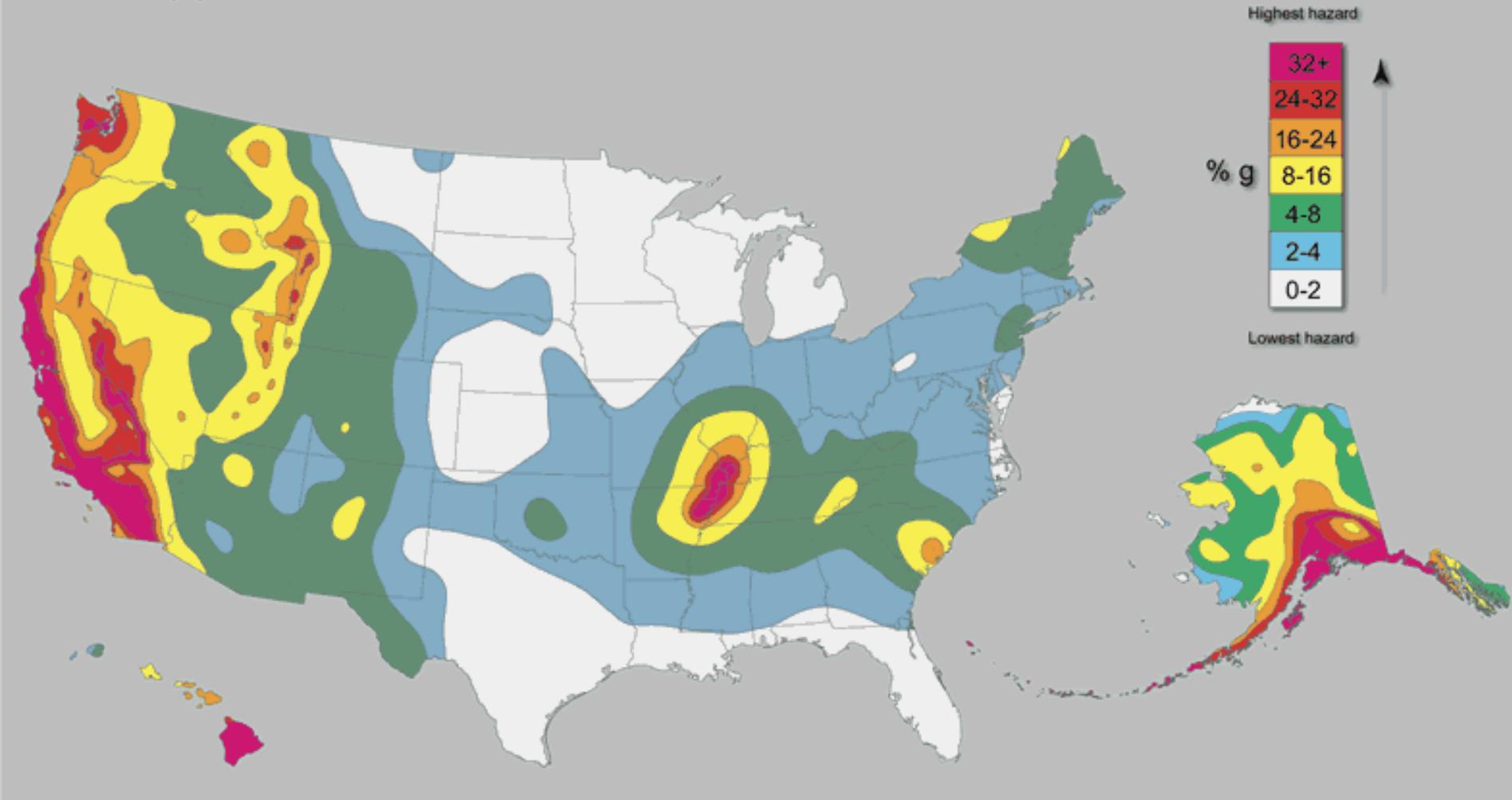
Faults are shown as 1,000-meter-wide swaths, here on a topographic map base.



- Faults
- Center Fault Buffer
- PO_data
- PS_data
- e Data

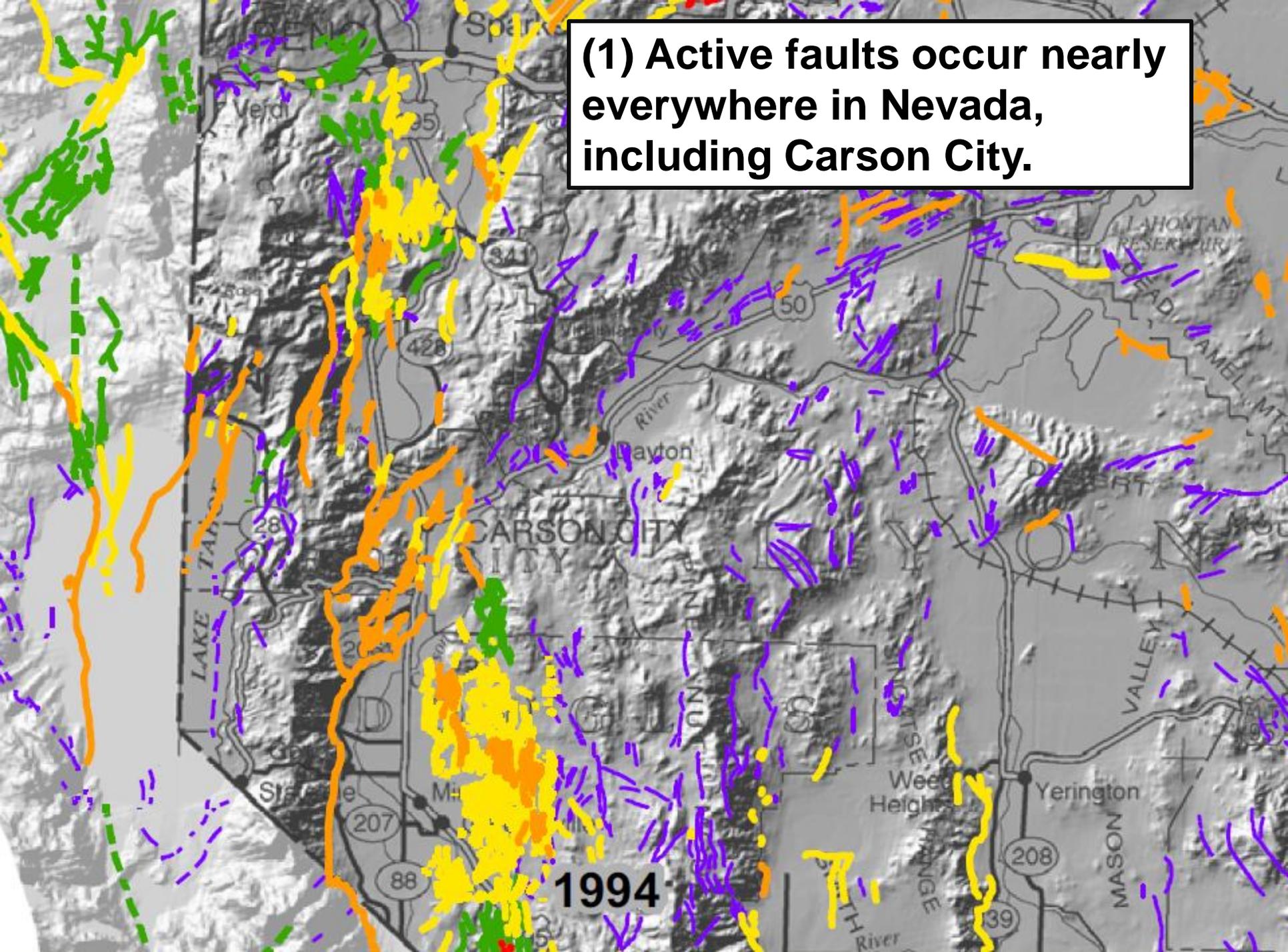


Faults are shown as 1,000-meter-wide swaths, here on an aerial photograph base.

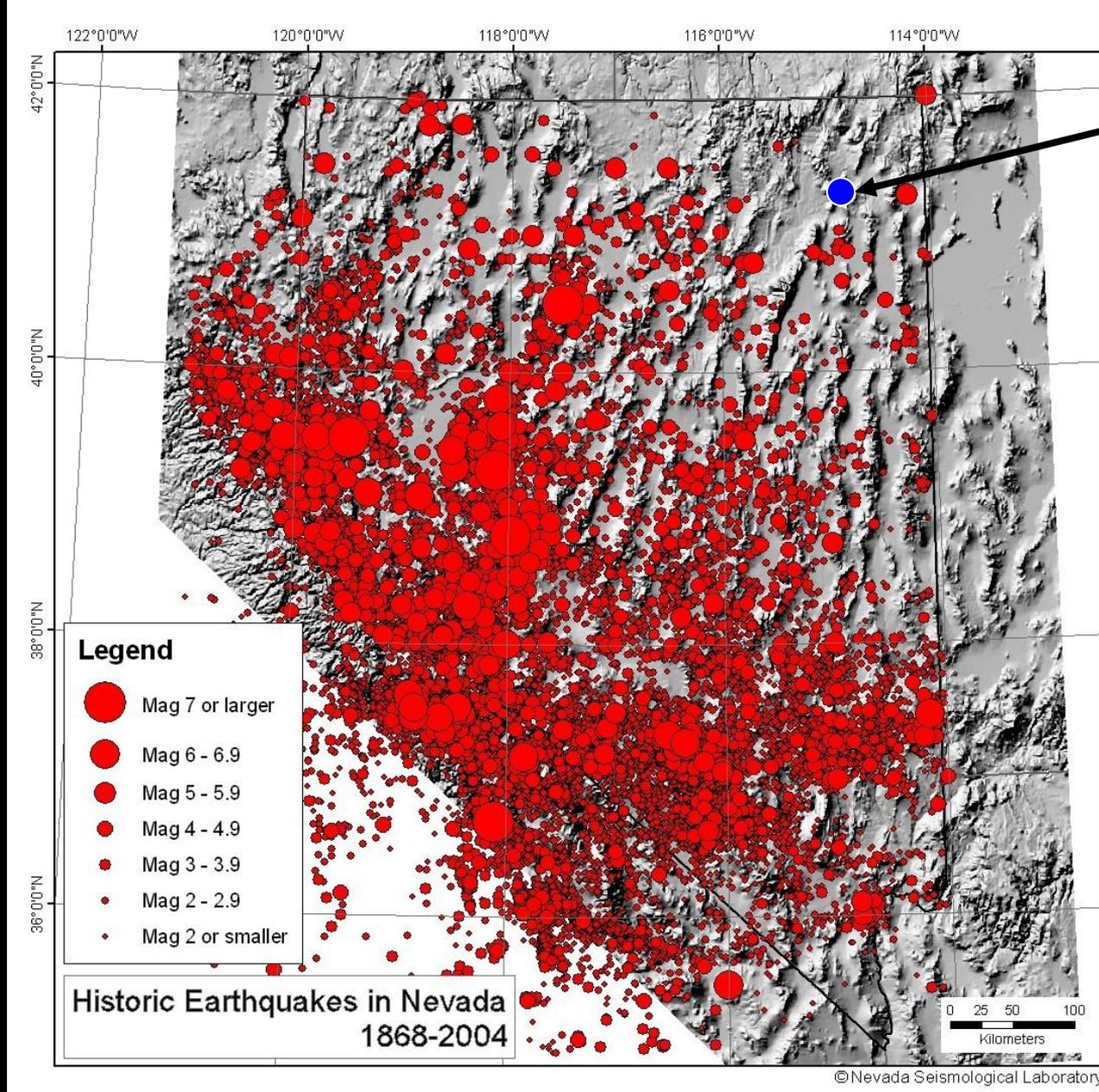


The USGS integrates (1) fault, (2) earthquake, and (3) geodetic data into its probabilistic seismic hazard analysis.

(1) Active faults occur nearly everywhere in Nevada, including Carson City.

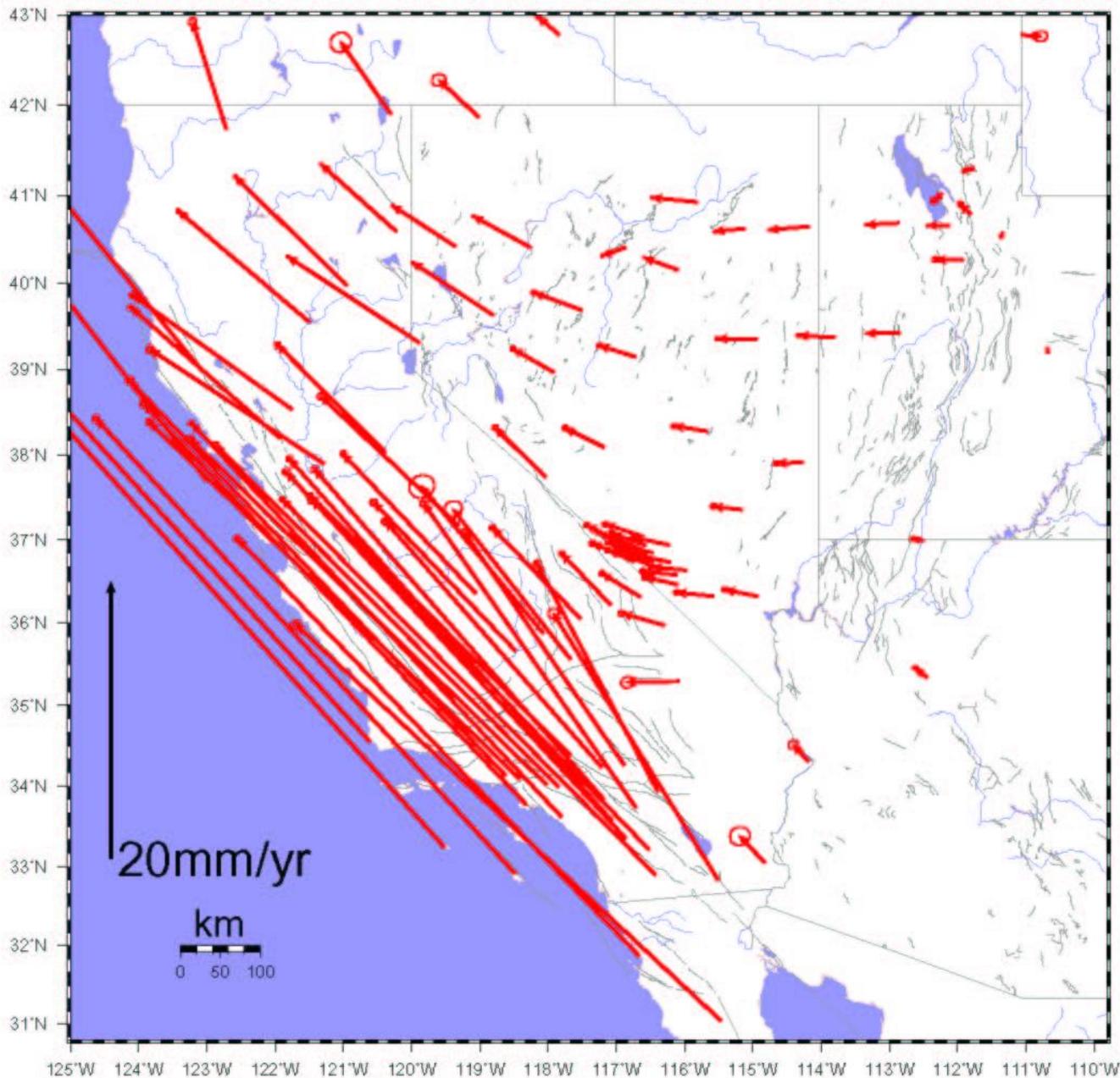


1994



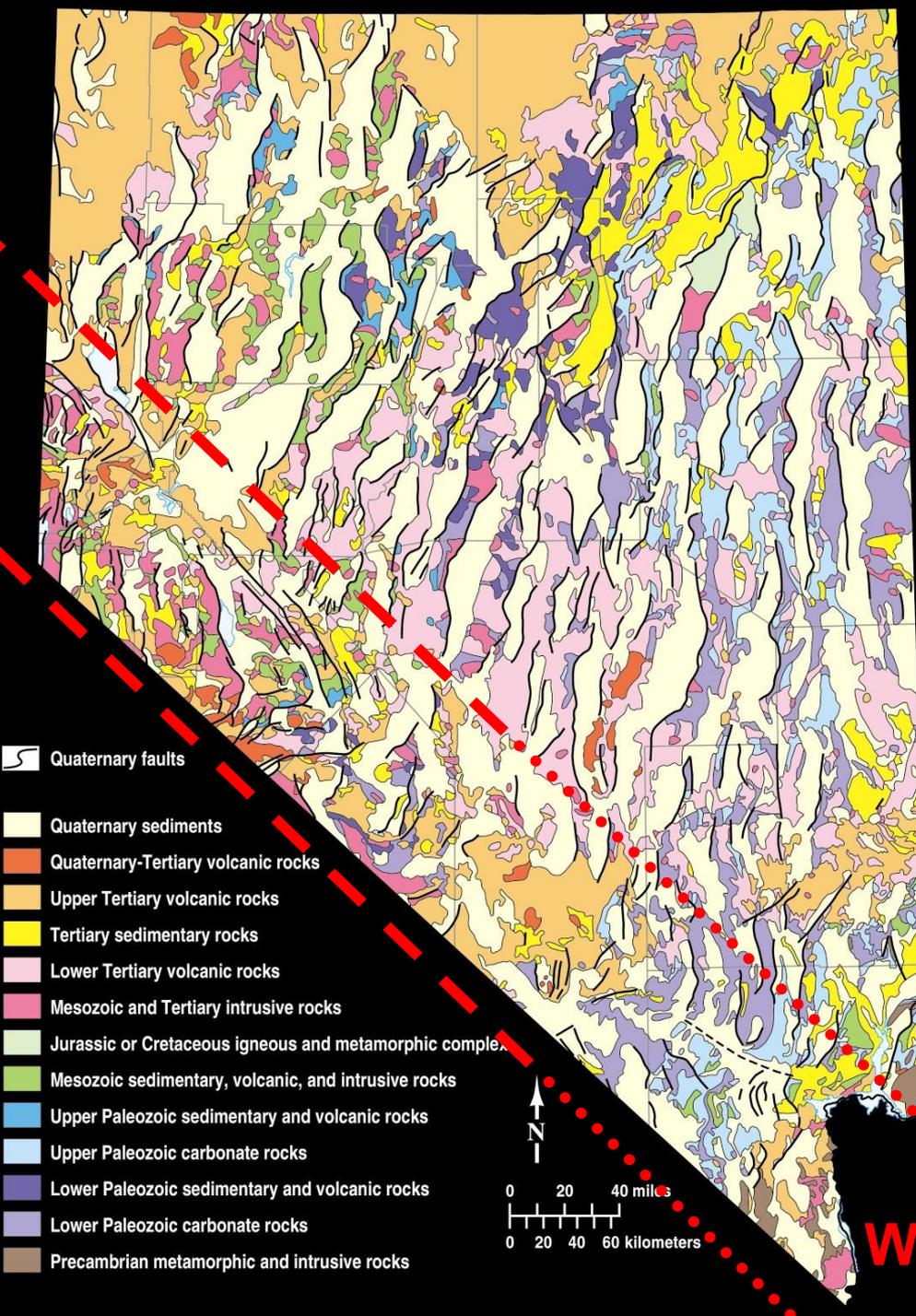
Wells
21 Feb 08
M = 6.0

(2) Earthquakes have occurred throughout Nevada.



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

Kreemer and Hammond (2007)



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

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

Walker Lane

The 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
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 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.

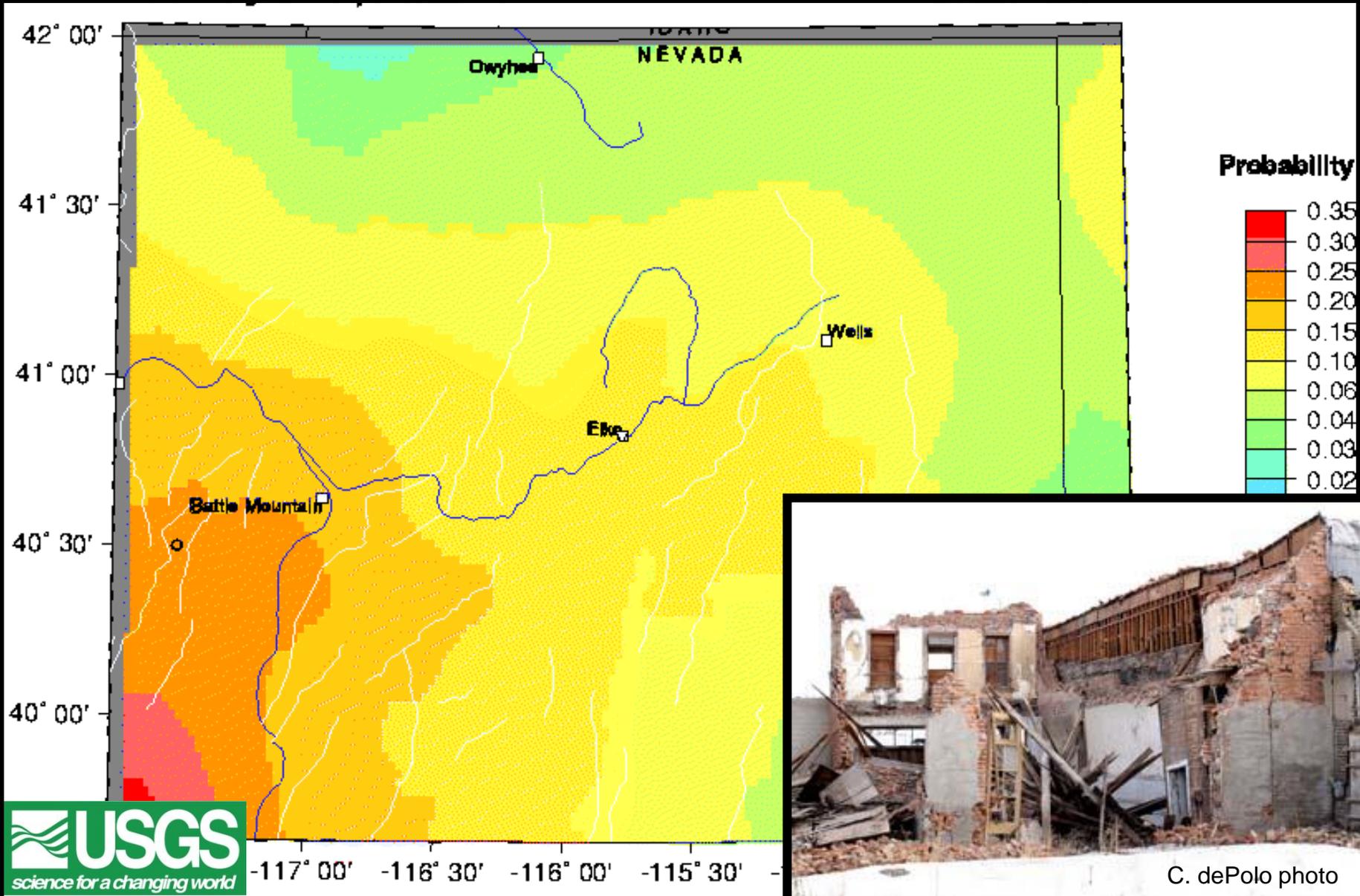
Uncertainties in the location of epicenters, depths, and magnitude, when combined with changing population and uncertainties in local effects (soil and rock types, assumptions about attenuation, basin geometry, liquefaction potential, and directivity), make loss estimates generally consistent within one order of magnitude (a factor of 10), 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 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.

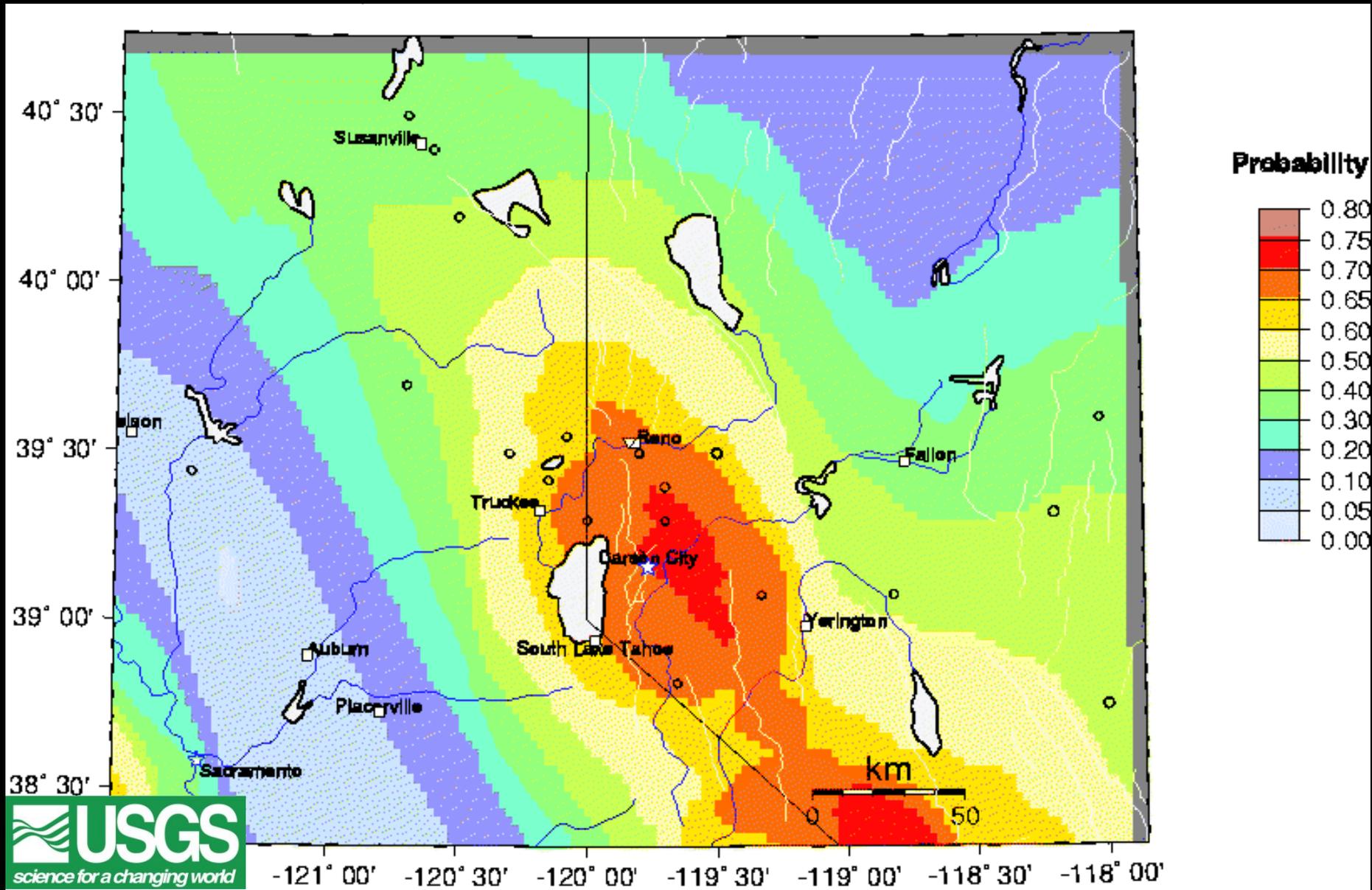
Community	Total Economic Loss	Probability in 50 years within 50 km
Las Vegas	\$7.2 billion	12%
Reno	\$1.9 billion	67%
Carson City	\$650 million	70%
Elko	\$160 million	10 to 15%
Fallon	\$110 million	35%
Wells	\$30 million	9%

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

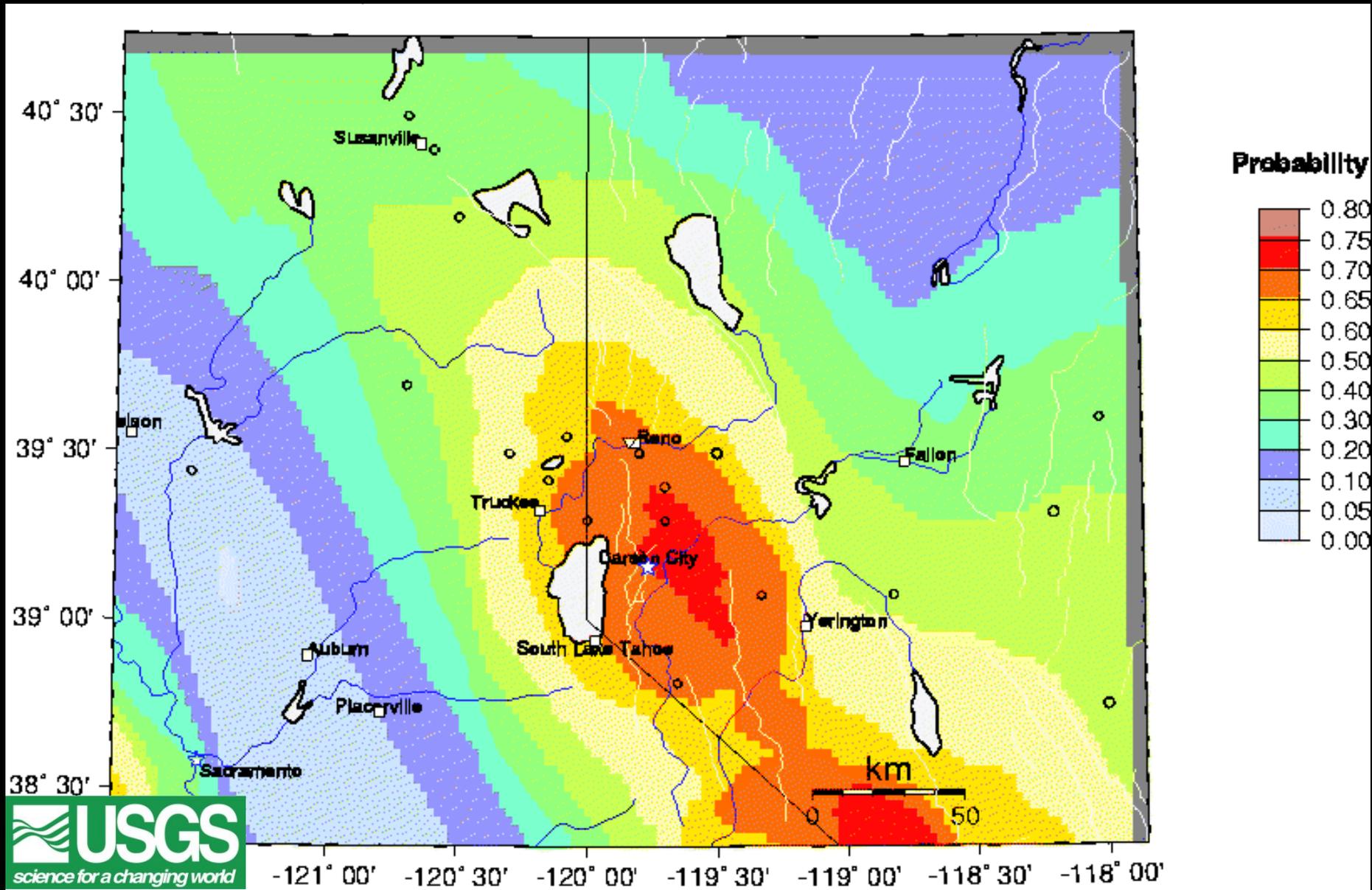
**The probability of a magnitude 6.0 earthquake occurring within 50 km of Wells, Nevada within the next 50 years is approximately 9%.
It happened on 21 February 2008.**



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.



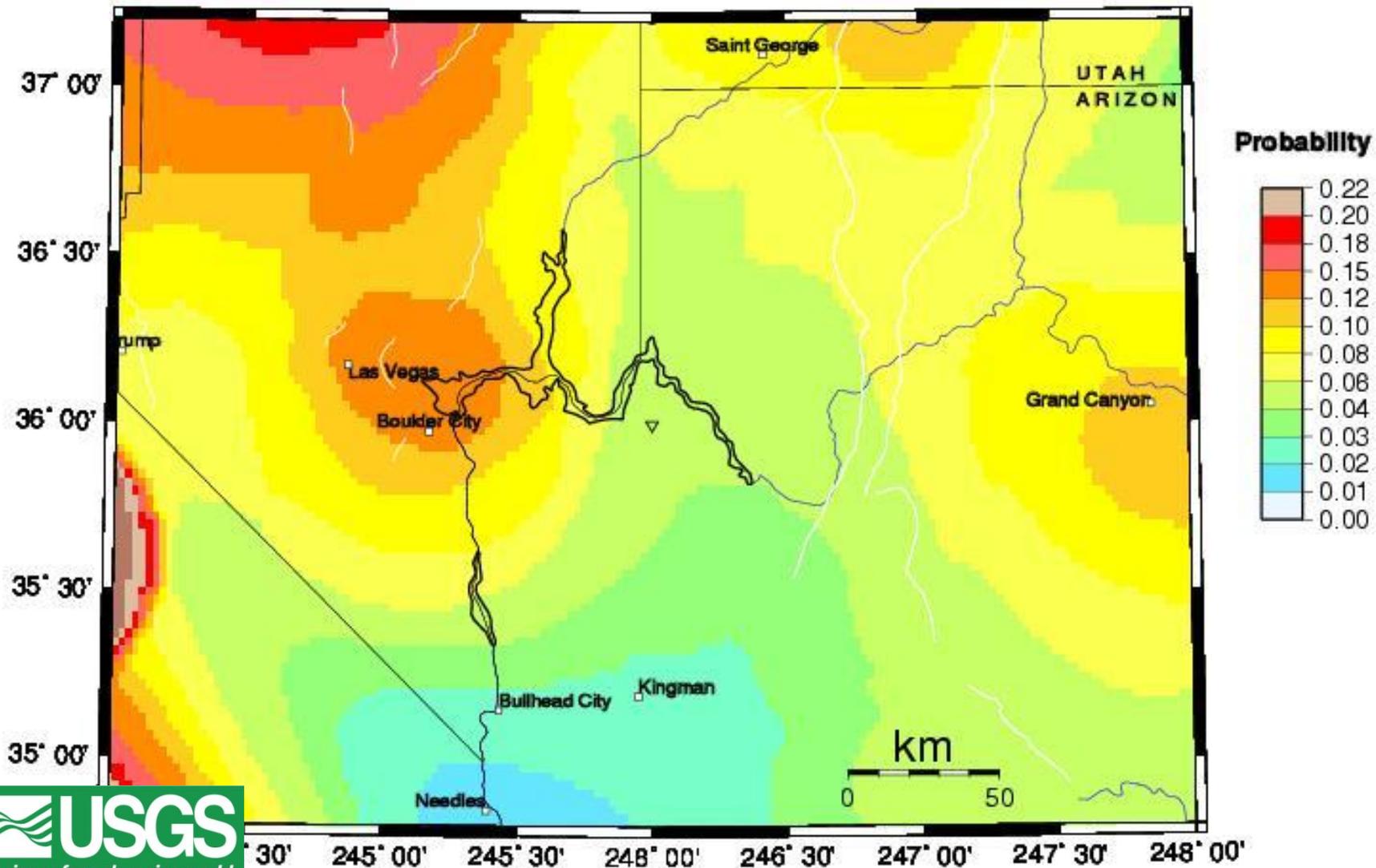
The probability of a magnitude 6.0 earthquake occurring within 50 km of Reno or Sparks within the next 50 years is approximately 67%, 7.4 times higher than for Wells.



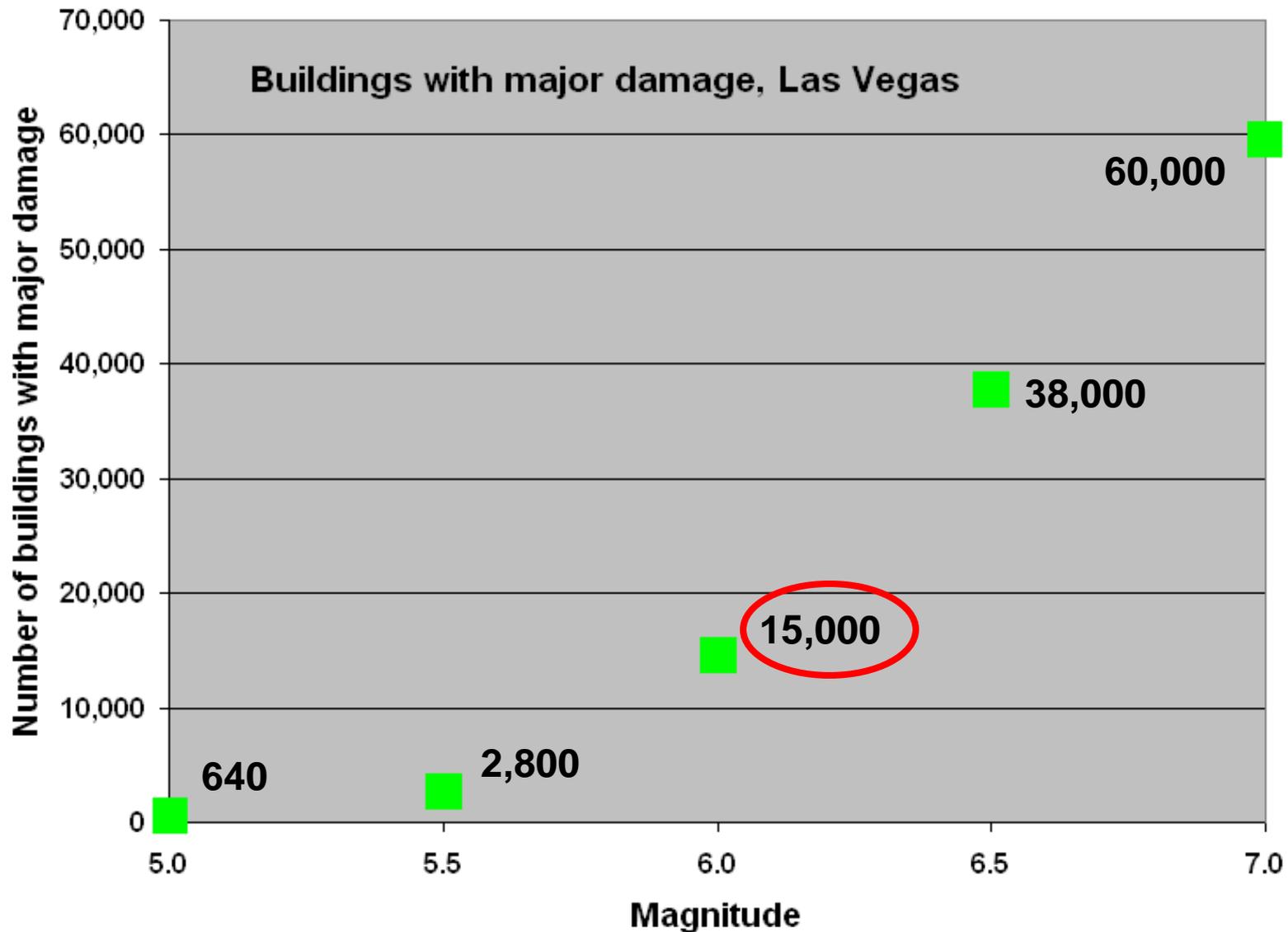
The probability of a magnitude 6.0 earthquake occurring within 50 km of Las Vegas within the next 50 years is approximately 12%, 1.3 times higher than for Wells.

U.S. Geological Survey PSHA Model

Site: -114 d_E 36 d_N

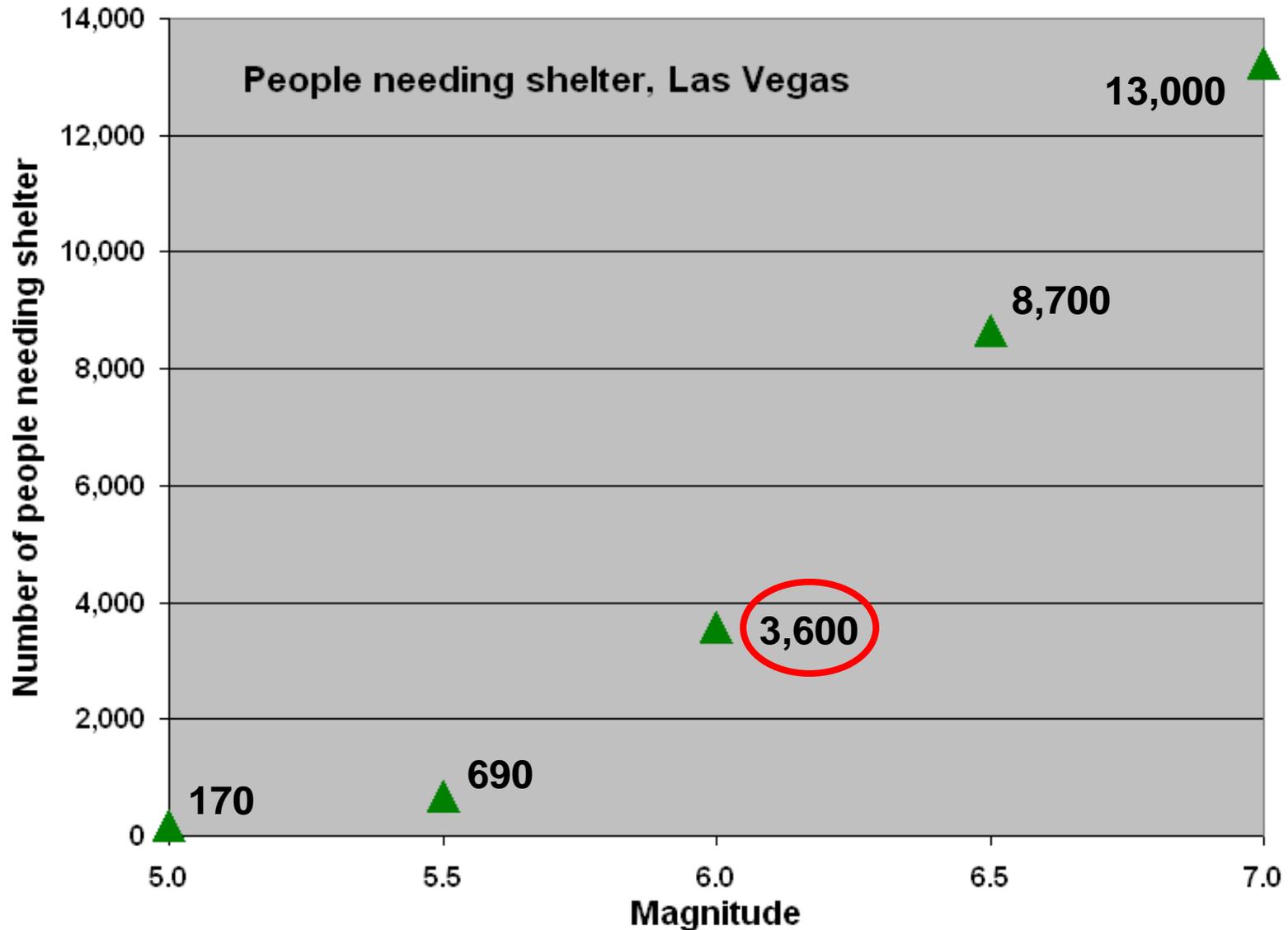


HAZUS estimates building damage:



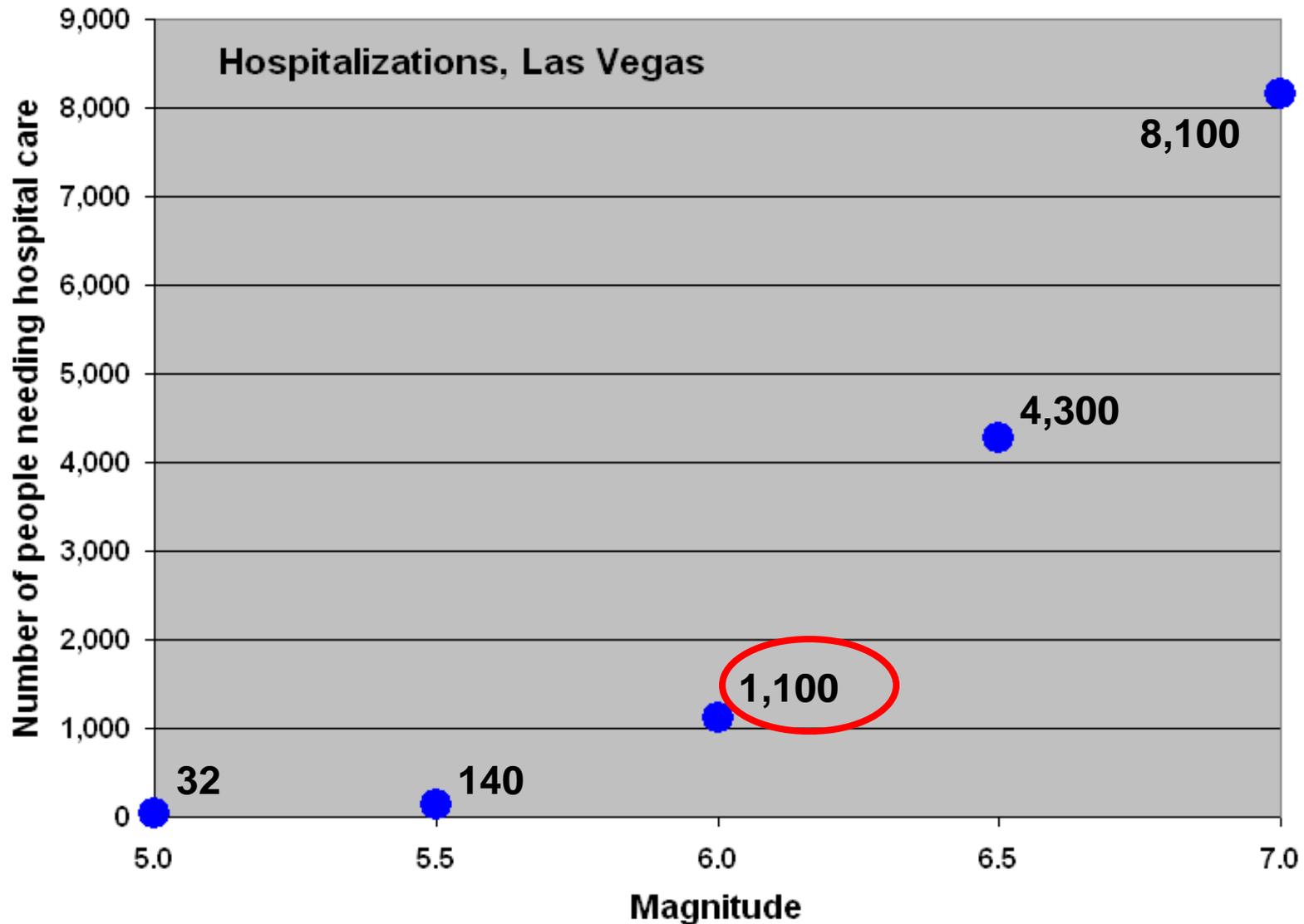
Note that the graphs are similar, but the scale changes with what is at risk.

HAZUS estimates public shelter needs:



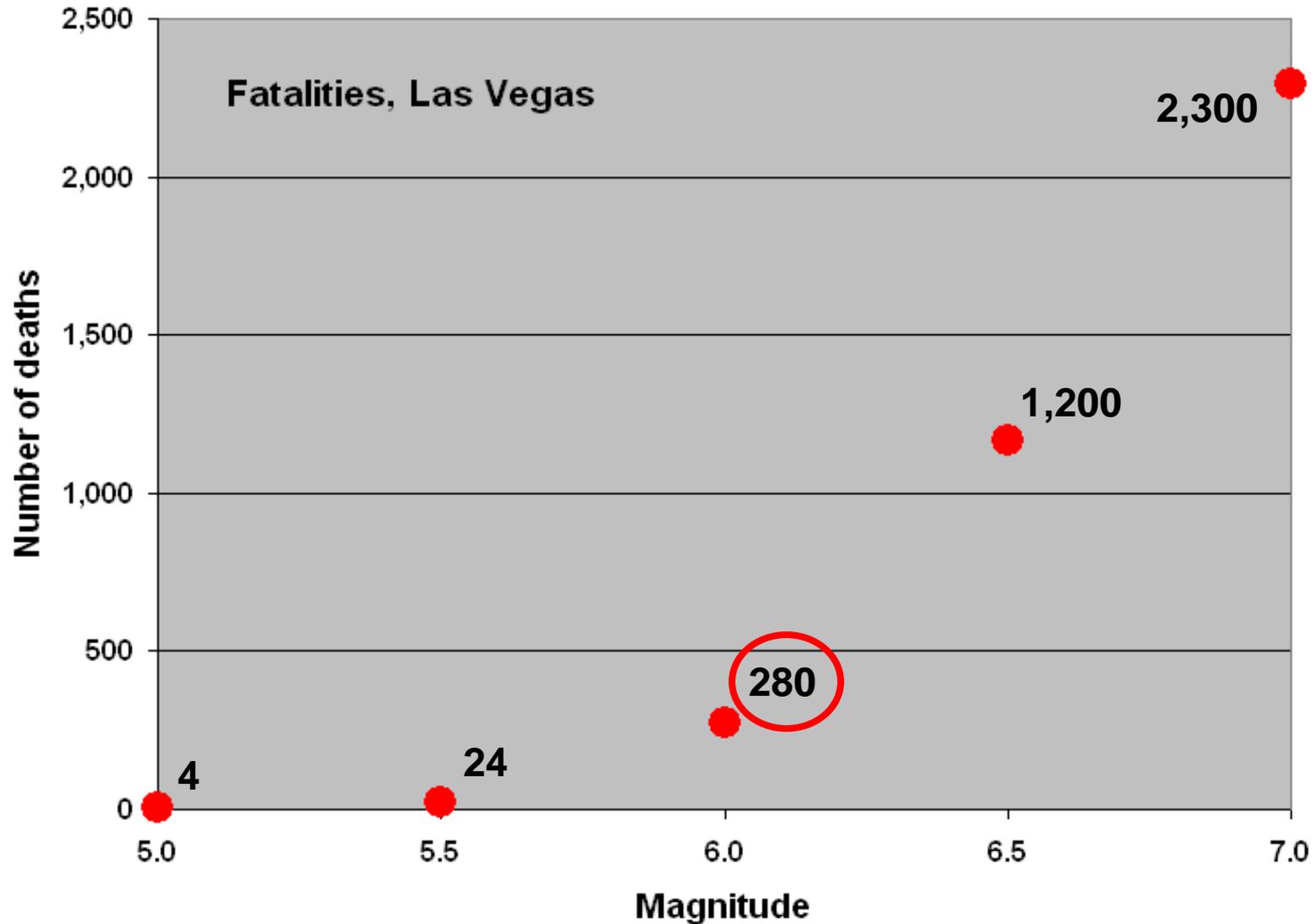
Note that the graphs are similar, but the scale changes with what is at risk.

HAZUS estimates hospital needs:



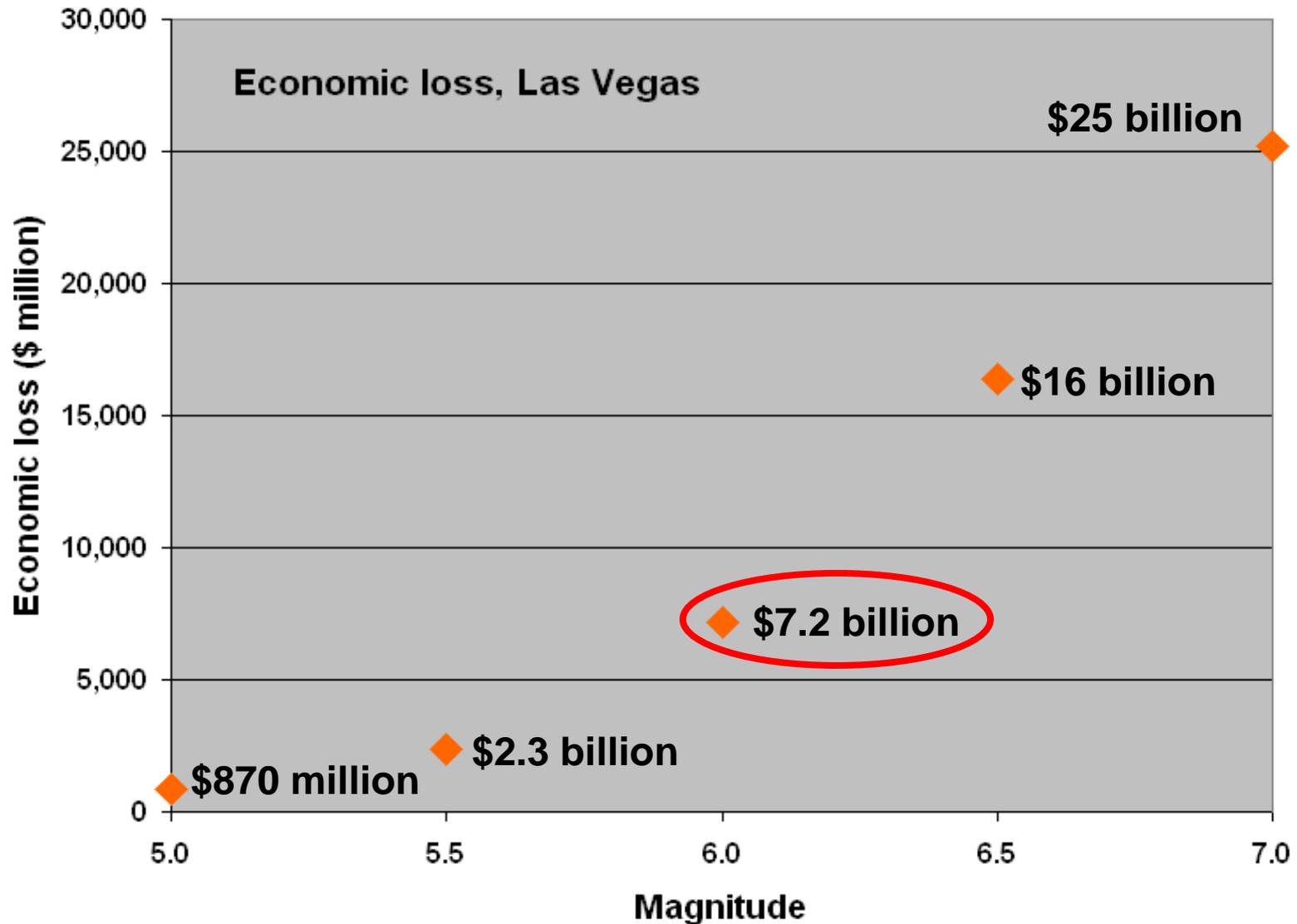
Note that the graphs are similar, but the scale changes with what is at risk.

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 hazards 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 – more to do with URMs.

C. Mitigate nonstructural risks – more to do.

Unreinforced masonry building (URM)
that collapsed during the Wells
earthquake on 21 February 2008



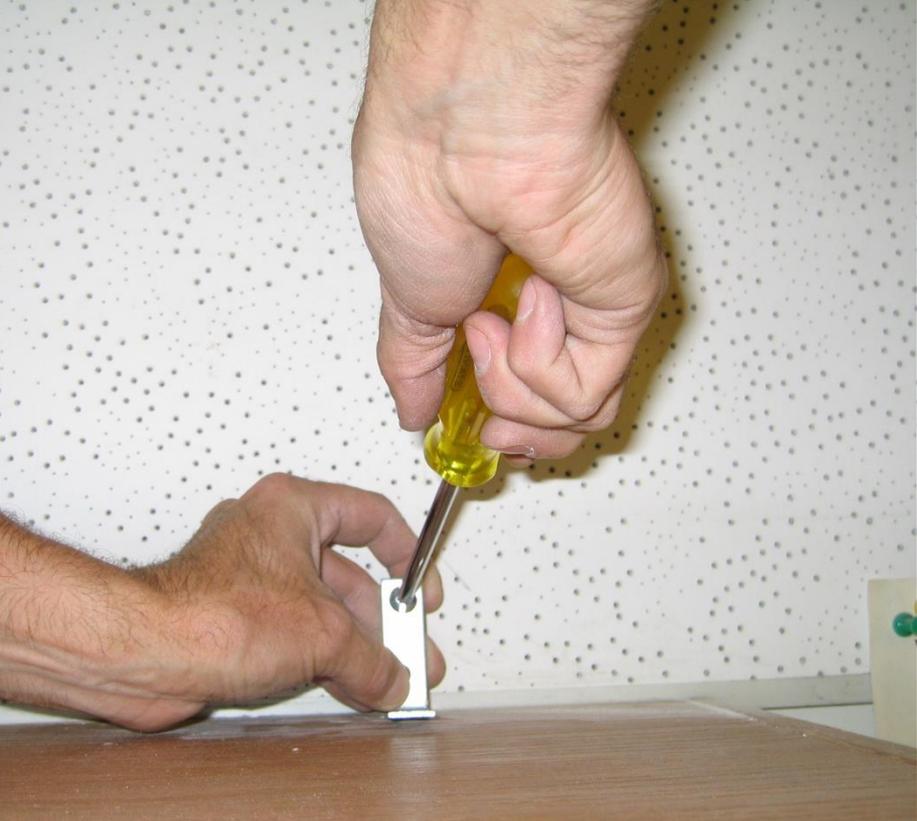
View from back, 20 May 2009



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**



The Nevada Earthquake Safety Council

Charged to advise the State Division of Emergency Management on issues related to earthquakes.

Members are volunteers from state and local governmental agencies, industry, engineers, scientists, concerned citizens from southern and northern Nevada, plus a State Senator (Warren Hardy) and State Assemblyman (Bernie Anderson).

Supported by FEMA with matching funds through the support provided by UNR – the Nevada Bureau of Mines and Geology and the Nevada Seismological Laboratory.

Quarterly meetings of the Council – with agendas and minutes posted on the web – <http://www.nbmgs.unr.edu/nesc/index.html> – addressing emerging issues and reporting on recent earthquakes, lessons learned, and recent publications.



Recent progress -

Presentations to county commissioners and emergency managers during quarterly meetings of the Nevada Hazard Mitigation Planning Committee, another advisory body for the Nevada Division of Emergency Management – helping local and state agencies compete for FEMA hazard-mitigation funds.

Ongoing project to inventory the URMs (unreinforced masonry buildings) in Nevada – with data from county assessors' offices and Public Works Board.

Ongoing project to document the effects and lessons learned from the 21 February 2008 magnitude 6.0 Wells earthquake.

Linking with the Great California-Nevada ShakeOut (earthquake exercise at 10:21 a.m. on 10/21/2010).

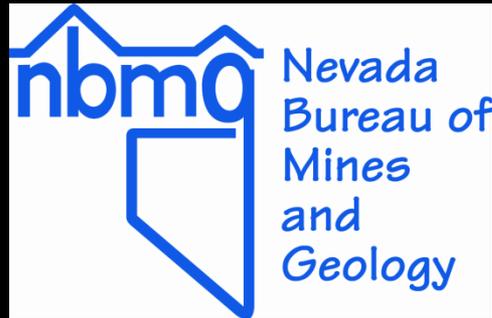
Efforts to improve seismic and geodetic monitoring in the state and obtain detailed locations of and characteristics of faults – the three key aspects of earthquake-hazard analysis feeding into building codes.

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

<http://www.nbmg.unr.edu/Geohazards/Earthquakes/EarthquakeResources.html>.



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