Loss-Estimation Modeling of Earthquake Scenarios for Each County in Nevada Using HAZUS-MH

Nevada Bureau of Mines and Geology
Open-File Report 06-1
University of Nevada, Reno

There are huge risks.

We can take action to reduce the risks.

THE UNIVERSITY OF NEVADA RENO

nbmg Nevada Bureau of Mines and Geology

NEVADA Seismological Laboratory

Nevada Earthquake Safety Council

Nevada Department of Public Safety
Division of Emergency Management

FEMA

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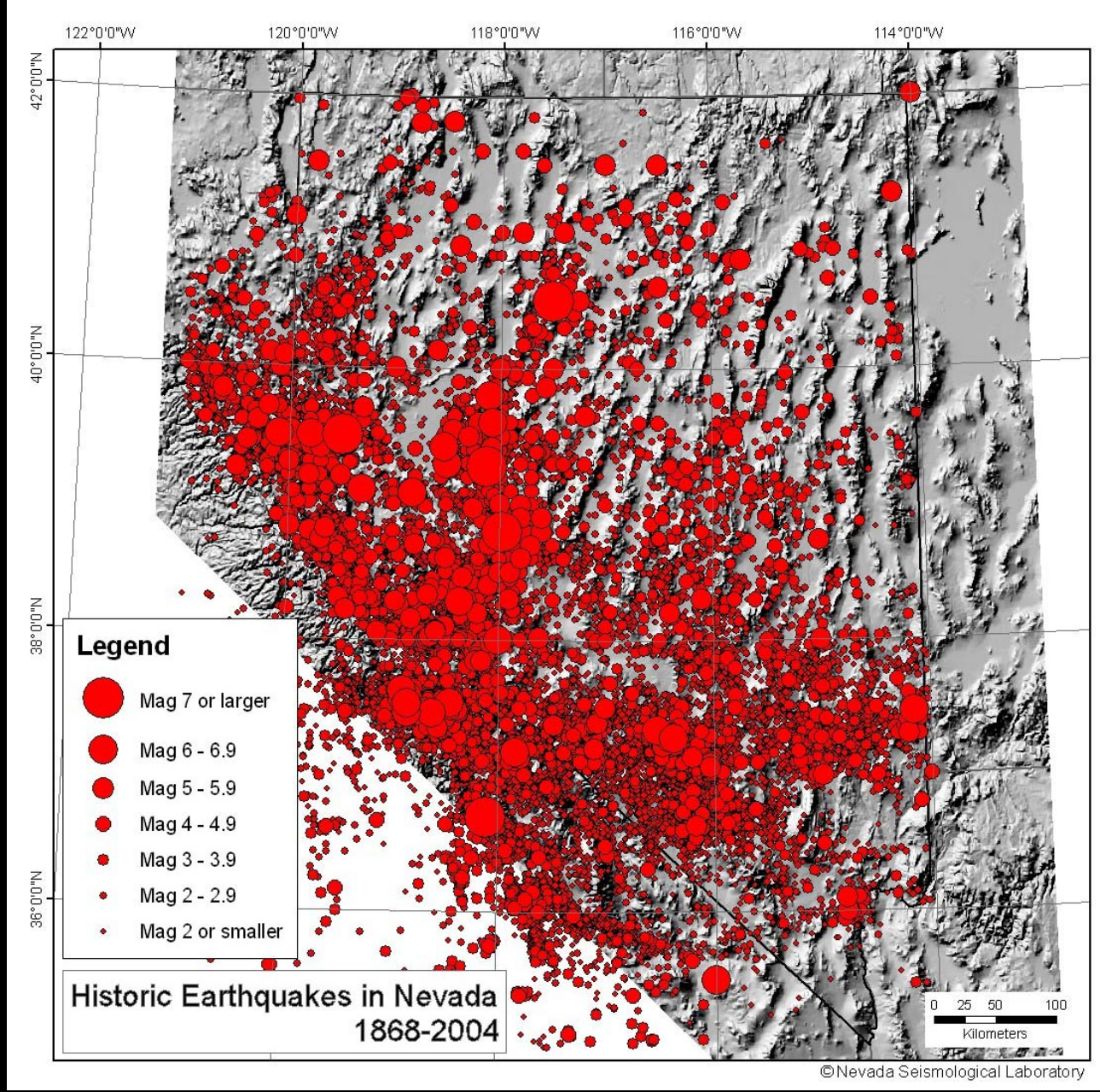
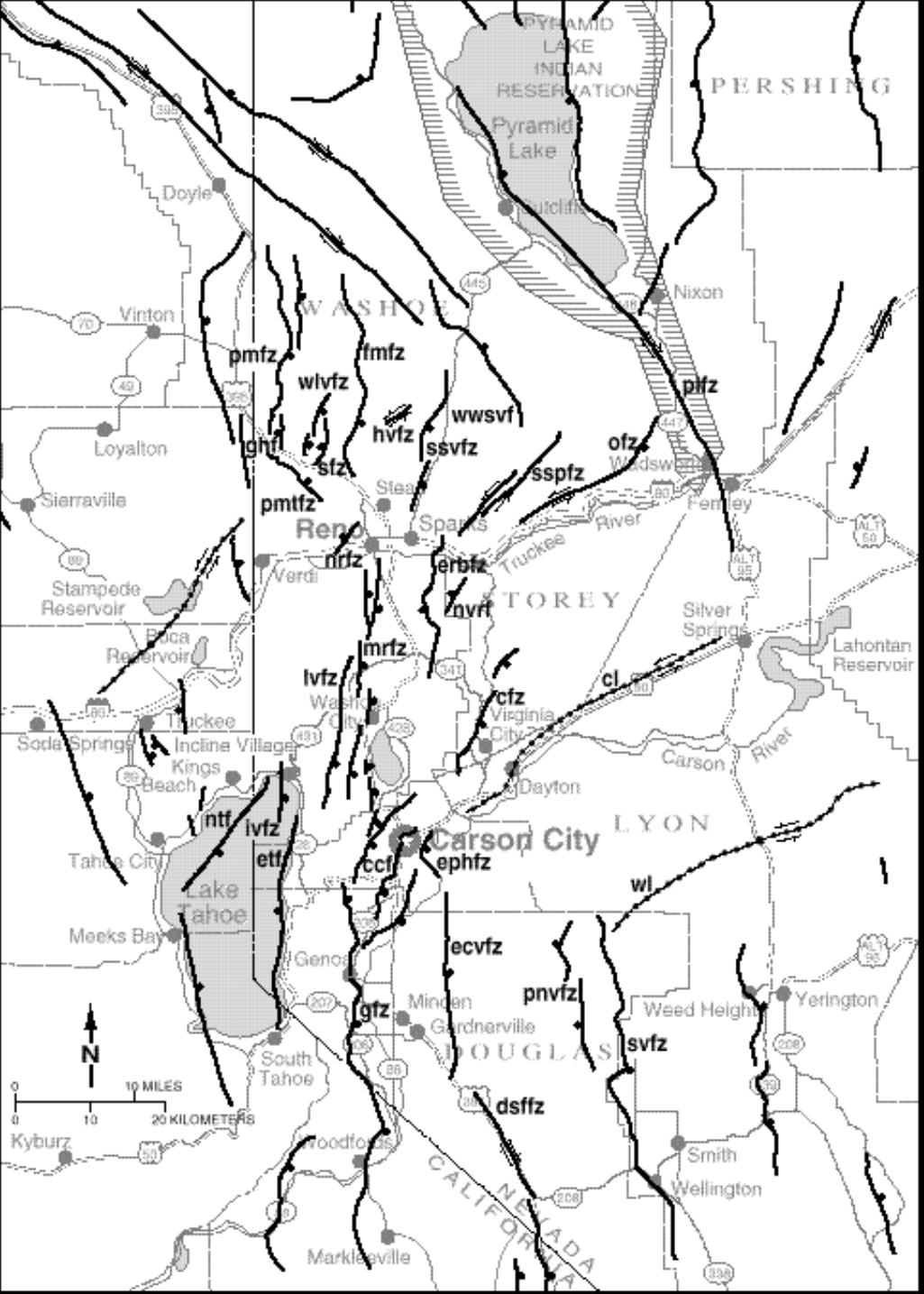
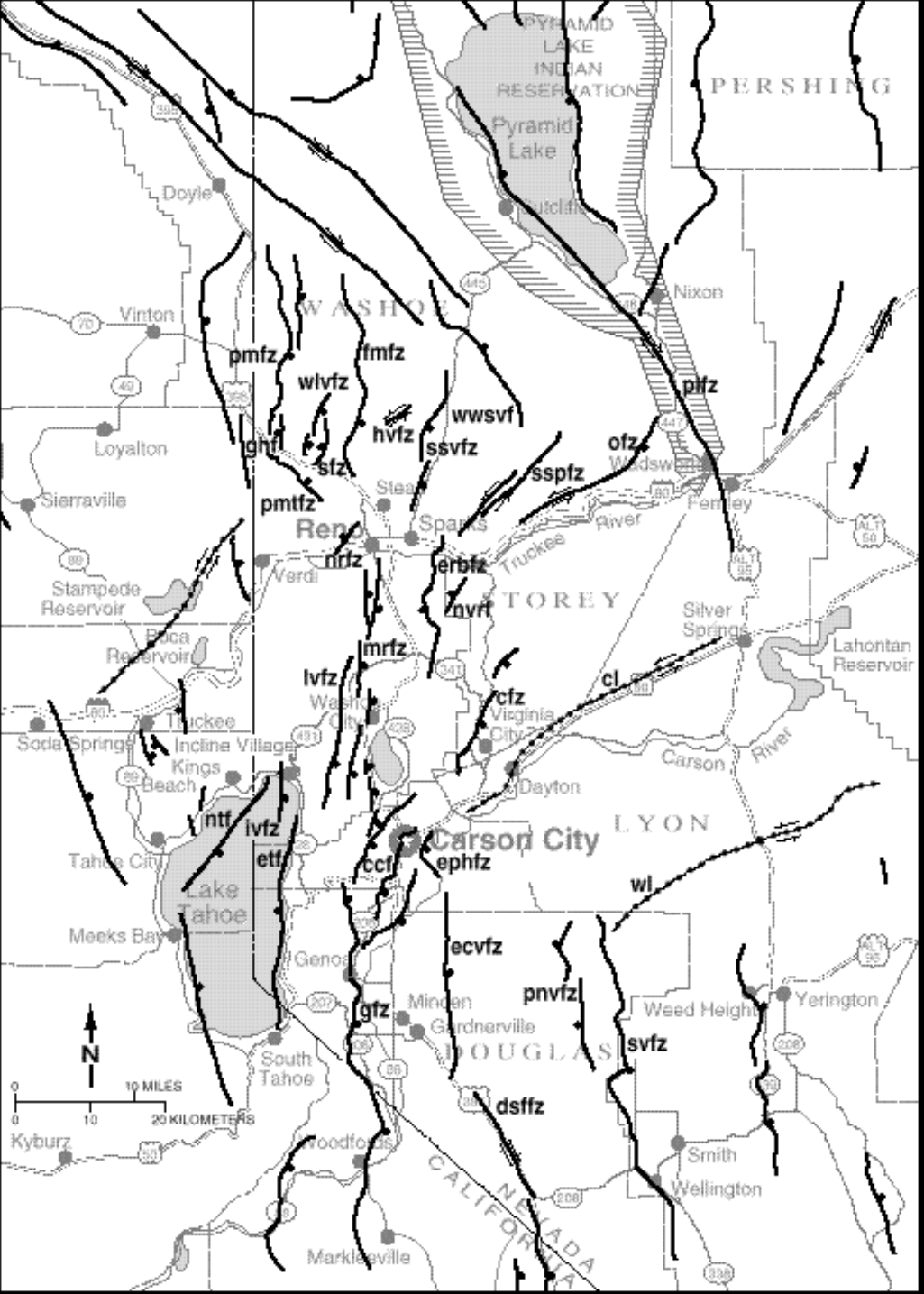
We can take action to reduce the risks.



Earthquakes have occurred throughout Nevada.



There is a good chance that you will experience a major earthquake. There are at least 30 faults that could cause damage in the Reno-Carson City urban corridor.



The probability of at least one magnitude 6 or greater event in the next fifty years is between 34 and 98%. The probability of at least one magnitude 7 or greater event in the next fifty years is between 4 and 50%. Hazards include intense ground shaking, ruptures of the ground, liquefaction, landslides, and ancillary problems, such as fires and hazardous waste spills.

We used FEMA's loss-estimation model, HAZUS-MH, to estimate the effects of potential earthquakes near each of the county seats in Nevada.

This model is used in emergency-response and recovery exercises and will be used to help rapidly estimate the scope of damage and losses immediately after an earthquake (information that helps with a Presidential Declaration of Disaster).

FEMA used this model in 2000 to estimate annualized loss from earthquakes:
$55 million per year for the State, including $28 million per year for the Las Vegas area, and $18 million per year for the Reno area.

But major earthquakes in Nevada don't occur annually. They happen on any given fault every few thousand to tens of thousands of years. If an earthquake occurs soon near an urban area, the consequences can be devastating.

Because Nevada has so many active faults, the hazards are high, and the risks are huge.

The risks are huge.

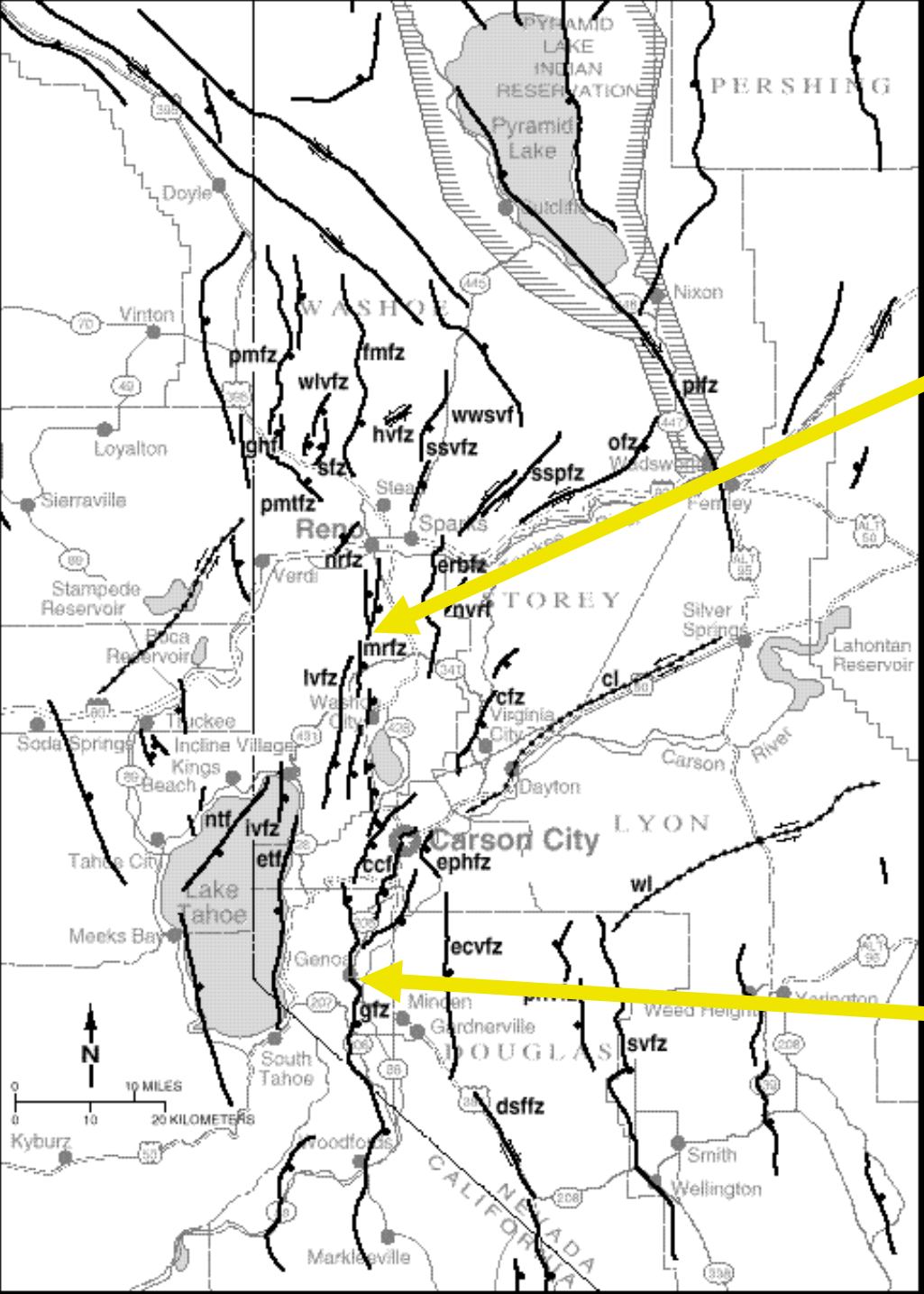
For a magnitude 6.9 earthquake on the Mount Rose fault, HAZUS estimated, for the Washoe-Carson-Storey-Douglas region:

up to $7.6 billion in economic loss
(~2.9 billion in Washoe County alone)

major damage to approximately 12,000 buildings

800 to 3,000 people needing public shelter

80 to 300 fatalities.


Mount Rose fault zone
Genoa fault
pmfz
fmfz
wlvfz
wwsvf
hvfz
ssvfz
ghf
sfz
sspfz
ofz
pmtfz
nrfz
erbfz
znvrf
mrfz
lvfz
cfz
cl
ntf
lvfz
etf
ccf
ephfz
wl
ecvfz
gfz
svfz
dsffz
Reno
Sparks
Carson City
Lake Tahoe
Pyramid Lake
Pyramid Lake Indian Reservation
Virginia City
Dayton
Carson River
Incline Village
Truckee
Verdi
Stampede Reservoir
Boca Reservoir
Lahontan Reservoir
Silver Springs
Fernley
Nixon
Doyle
Vinton
Loyalton
Sierraville
Soda Springs
Kings Beach
Tahoe City
Meeks Bay
South Tahoe
Minden
Gardnerville
Weed Height
Yerington
Smith
Wellington
Kyburz
Markleeville
Woodfords
WASHOE
PERSHING
STOREY
LYON
DOUGLAS
CALIFORNIA
NEVADA
N
0 10 MILES
0 10 20 KILOMETERS

The risks are huge.

For a magnitude 7.1 earthquake on the Genoa fault, HAZUS estimated, for the Washoe-Carson-Storey-Douglas region:

up to $2.5 billion in economic loss
(~$471 million in Douglas County alone)

major damage to approximately 12,000 buildings

800 to 3,000 people needing public shelter

80 to 300 fatalities.

up to 5 meters of vertical displacement when it last moved, ~ 550 years ago

one of the most active faults in Nevada

Genoa fault

well exposed in gravel quarry south of Genoa


up to 5 meters of vertical displacement when it last moved, ~ 550 years ago


one of the most active faults in Nevada

Genoa fault


well exposed in gravel quarry south of Genoa

The risks are huge.

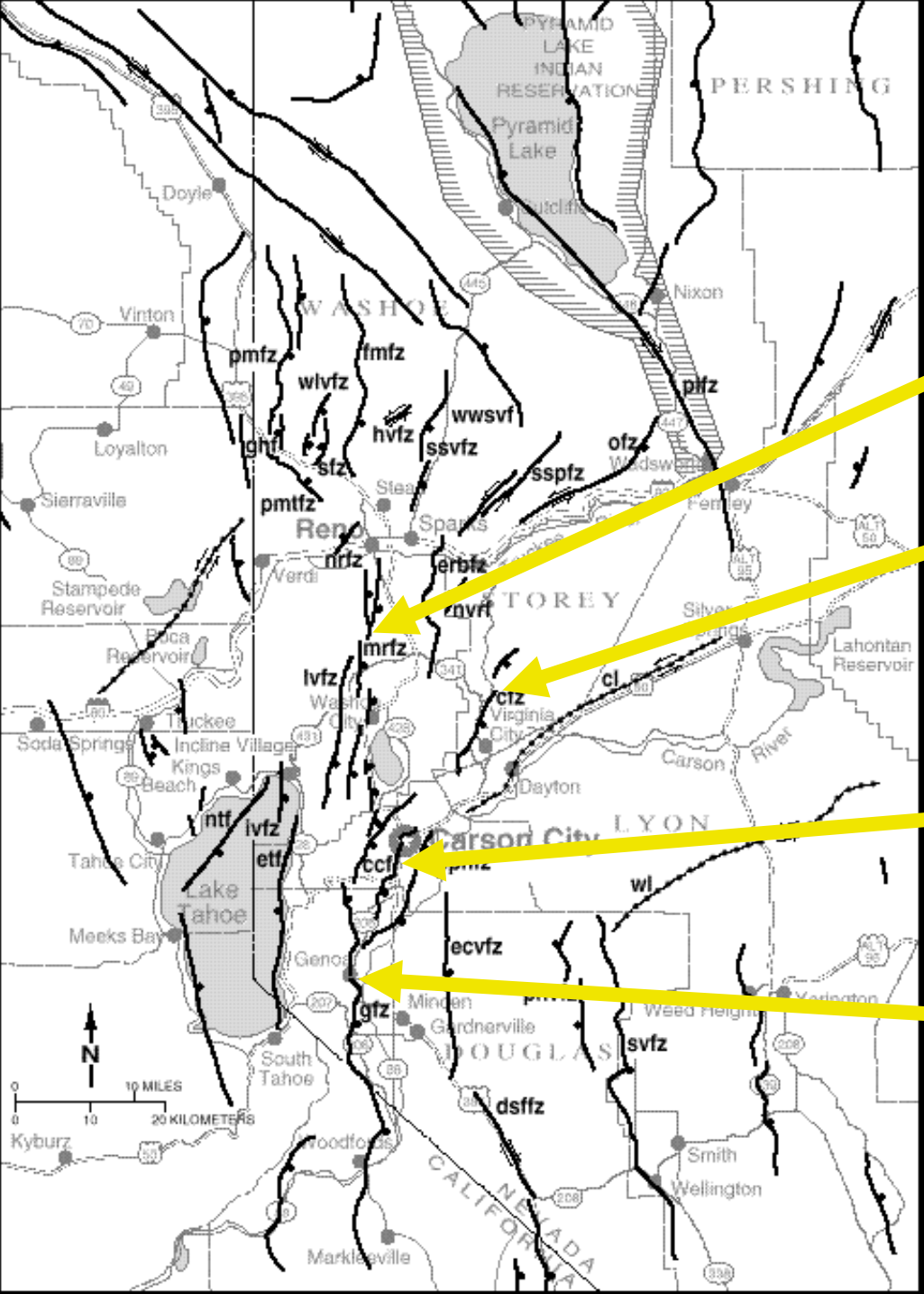
For a magnitude 6.5 earthquake on a fault near Virginia City, HAZUS estimated, for the Washoe-Carson-Storey-Douglas region:

up to $2.5 billion in economic loss
(~$8.5 million in Storey County)

major damage to approximately 3,500 buildings

200 to 800 people needing public shelter

20 to 90 fatalities.



Mount Rose fault zone

Comstock fault zone

Carson City fault zone

Genoa fault

The risks are huge.

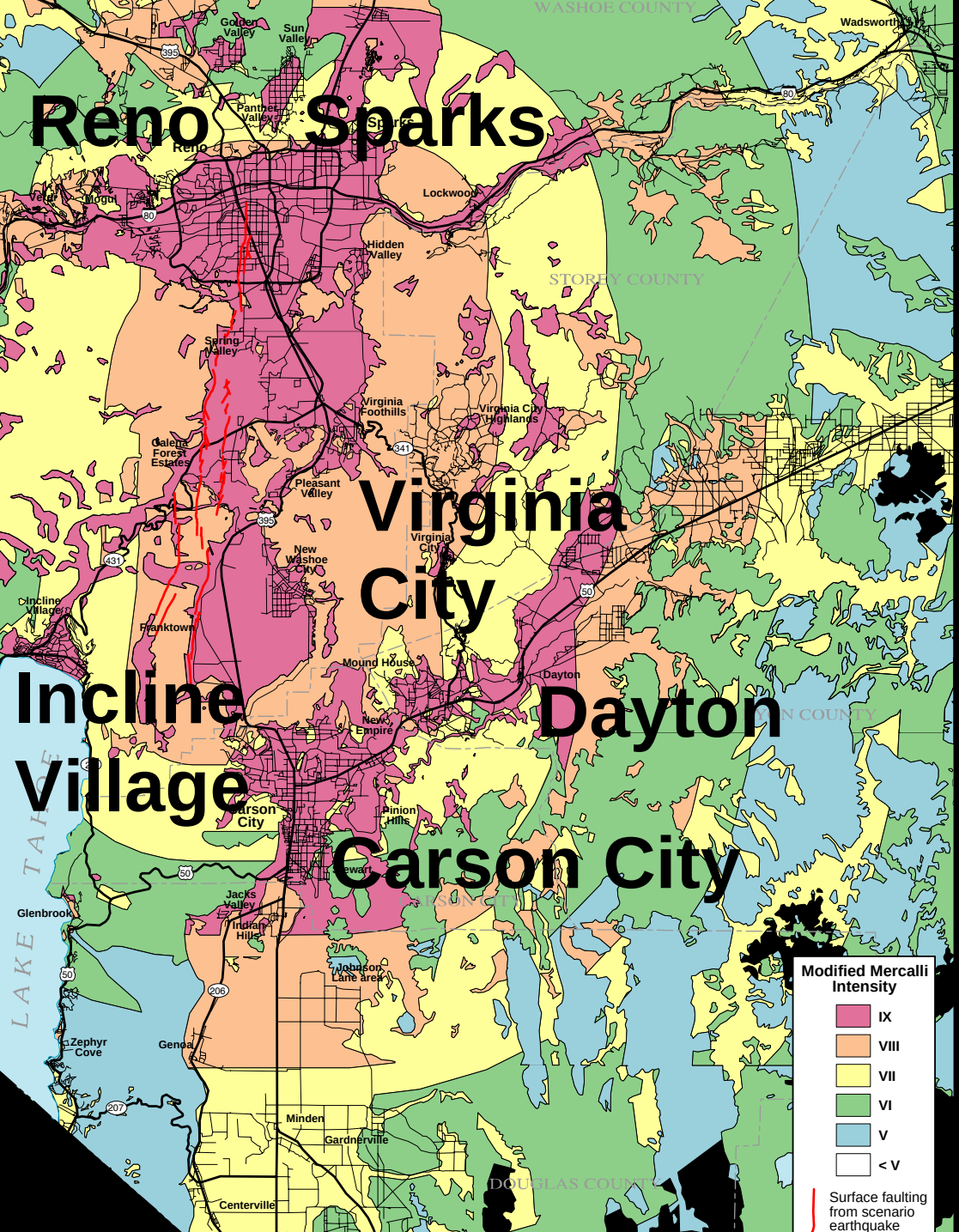
For a magnitude 6.5 earthquake on the Carson City fault, HAZUS estimated, for the Washoe-Carson-Storey-Douglas region:

up to $2.2 billion in economic loss
(~$665 million in Carson City alone)

major damage to approximately 3,900 buildings

170 to 700 people needing public shelter

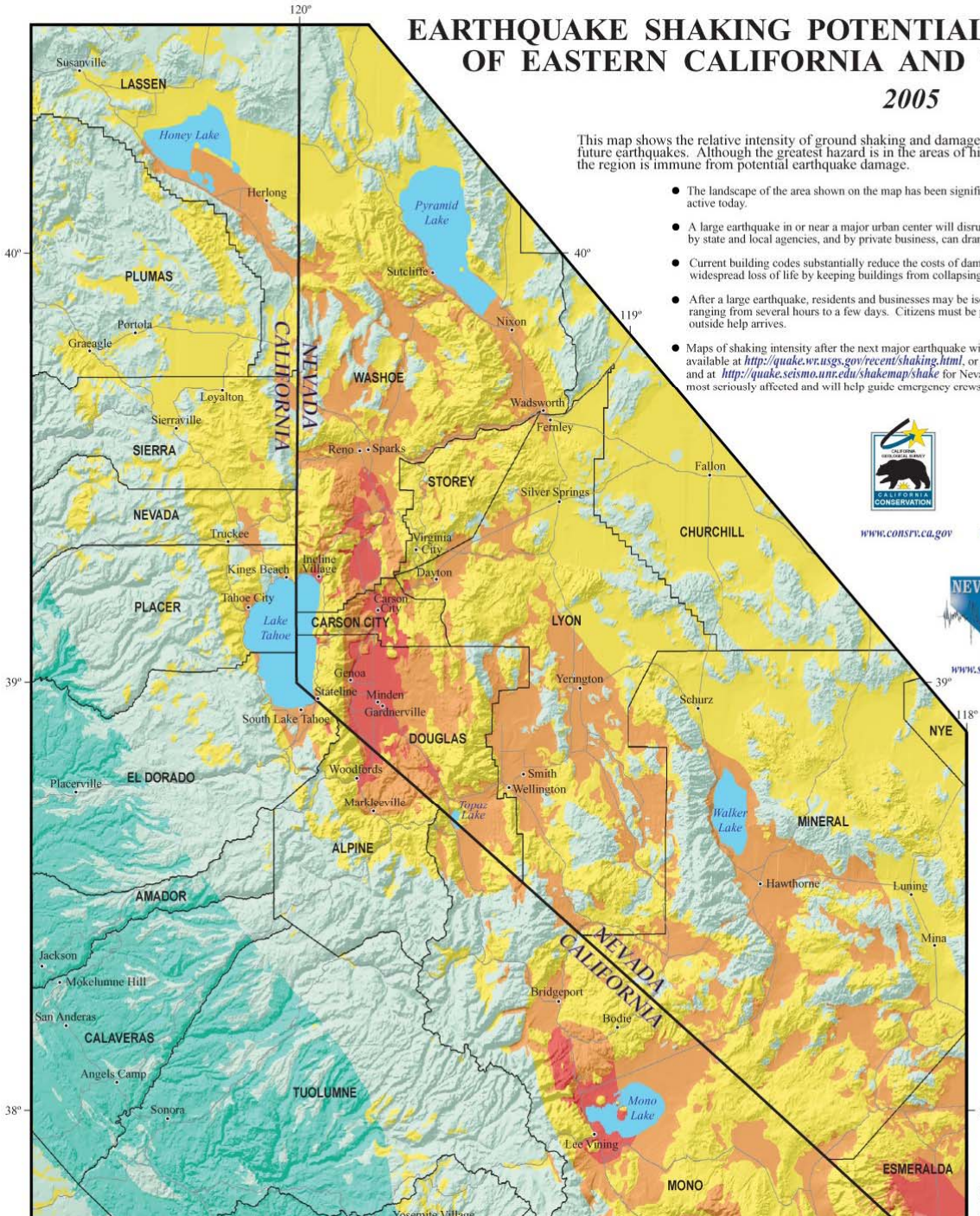
30 to 110 fatalities.



Modified Mercalli Intensity Map from NBMG's 1996 "Planning Scenario for a Major Earthquake in Western Nevada" – A magnitude 7.1 earthquake on the Mt. Rose fault could cause **widespread damage in the area of Intensity IX ("General panic. Cracked ground conspicuous. Damage considerable in specially designed structures, great in substantial masonry buildings with some collapse in large part.")**

EARTHQUAKE SHAKING POTENTIAL MAP FOR PORTIONS OF EASTERN CALIFORNIA AND WESTERN NEVADA

2005



This map shows the relative intensity of ground shaking and damage in parts of California and Nevada from anticipated future earthquakes. Although the greatest hazard is in the areas of highest intensity as shown on the map, no area within the region is immune from potential earthquake damage.

- The landscape of the area shown on the map has been significantly shaped by faulting and erosion. These processes are still active today.
- A large earthquake in or near a major urban center will disrupt the economy of the entire region. Effective disaster planning by state and local agencies, and by private business, can dramatically reduce losses and speed recovery.
- Current building codes substantially reduce the costs of damage from earthquakes, but the codes are intended only to prevent widespread loss of life by keeping buildings from collapsing, not to protect buildings from damage.
- After a large earthquake, residents and businesses may be isolated from basic police, fire and emergency support for a period ranging from several hours to a few days. Citizens must be prepared to survive solely on their own, and to help others, until outside help arrives.
- Maps of shaking intensity after the next major earthquake will be available within minutes on the internet. The maps will be available at *http://quake.wr.usgs.gov/recent/shaking.html*, or at *http://www.cisn.org/shakemap/nc/shake* for northern California and at *http://quake.seismo.unr.edu/shakemap/shake* for Nevada. The maps will help identify areas most seriously affected and will help guide emergency crews to the most damaged regions.

www.consrv.ca.gov www.seismic.ca.gov www.oes.ca.gov www.usgs.gov

www.seismo.unr.edu www.nbmg.unr.edu/nesc www.nbmg.unr.edu

Level of Potential Shaking

These regions are near major, active faults and will on average experience stronger earthquake shaking more frequently. This intense shaking can damage even strong, modern buildings.

Increasing intensity

These regions are distant from known, active faults and will experience lower levels of shaking less frequently. In most earthquakes, only weaker, masonry buildings would be damaged. However, very infrequent earthquakes could still cause strong shaking here.

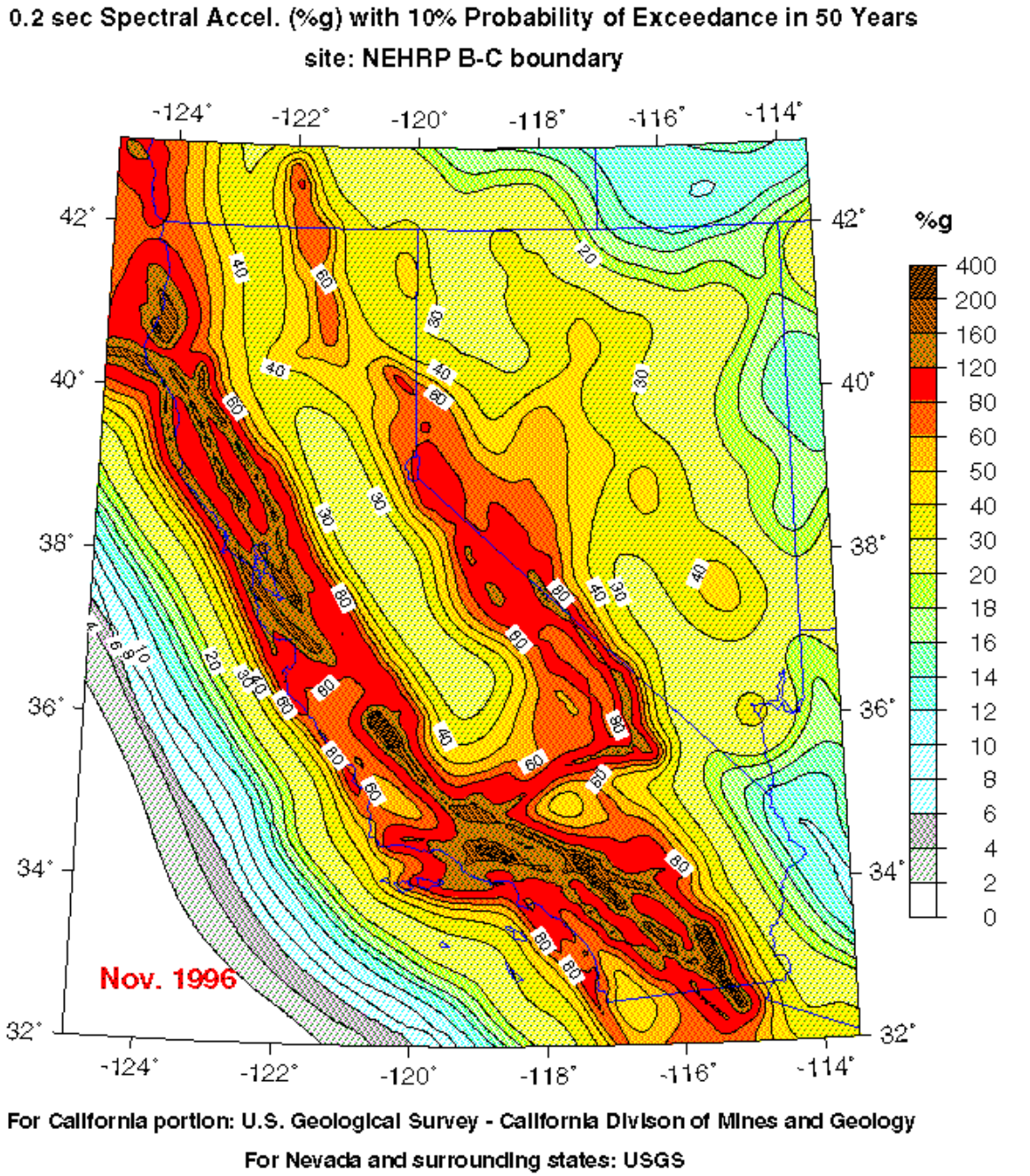
County boundaries

Highways

Water

Seismic Shaking Hazard calculated by the California Geological Survey from the USGS/CGS seismic hazards model (Frankel and others, 2002) considering amplification in near surface soils as shown by Wills and others (2000)in California and estimated by C. dePolo of UNR using geology from Stewart and Carlson (1978) for Nevada. Amplification factors recommended by the Building Seismic Safety

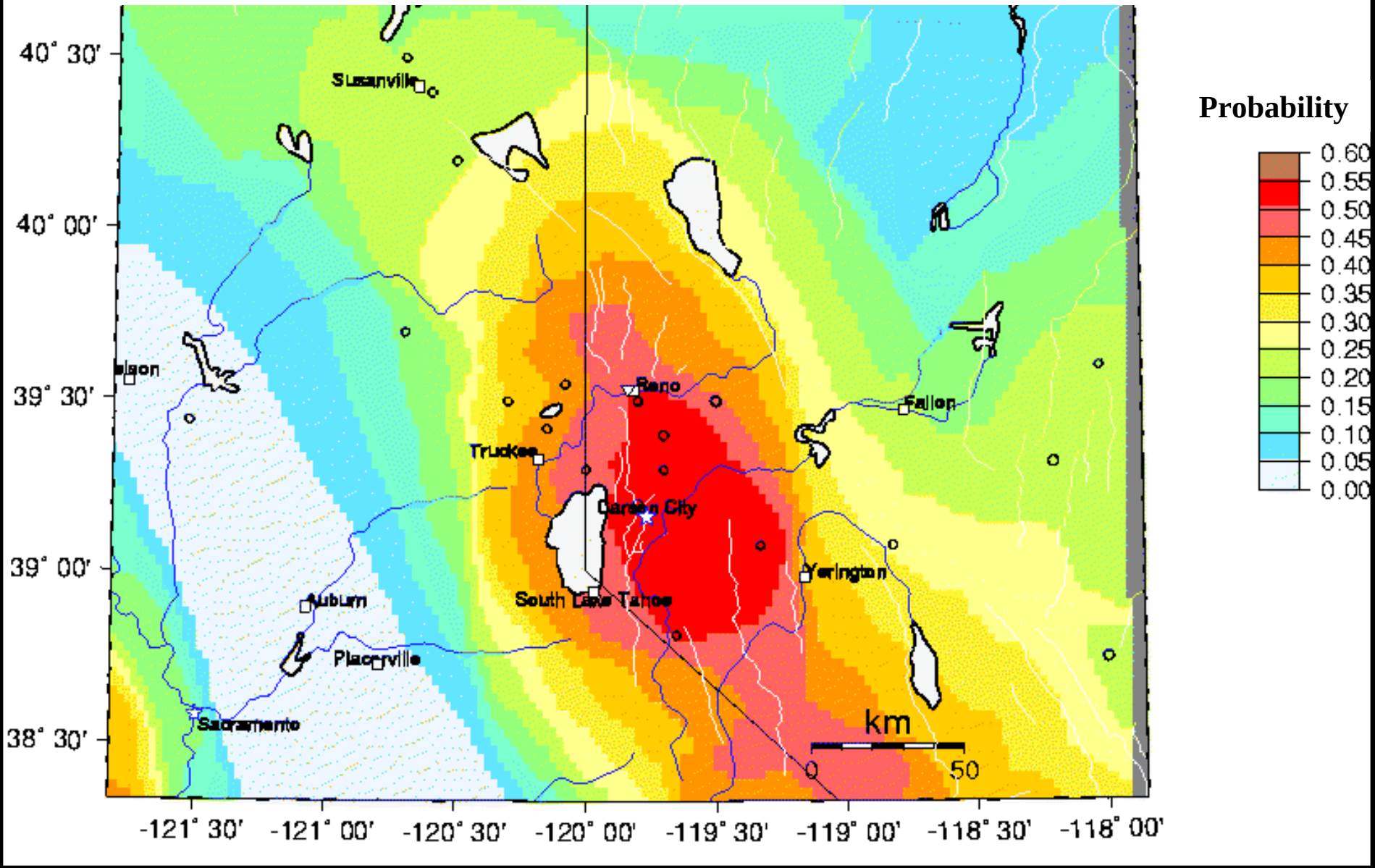
We don’t know exactly how often these specific earthquakes occur, but we do have reasonable estimates of earthquake rates for each region.

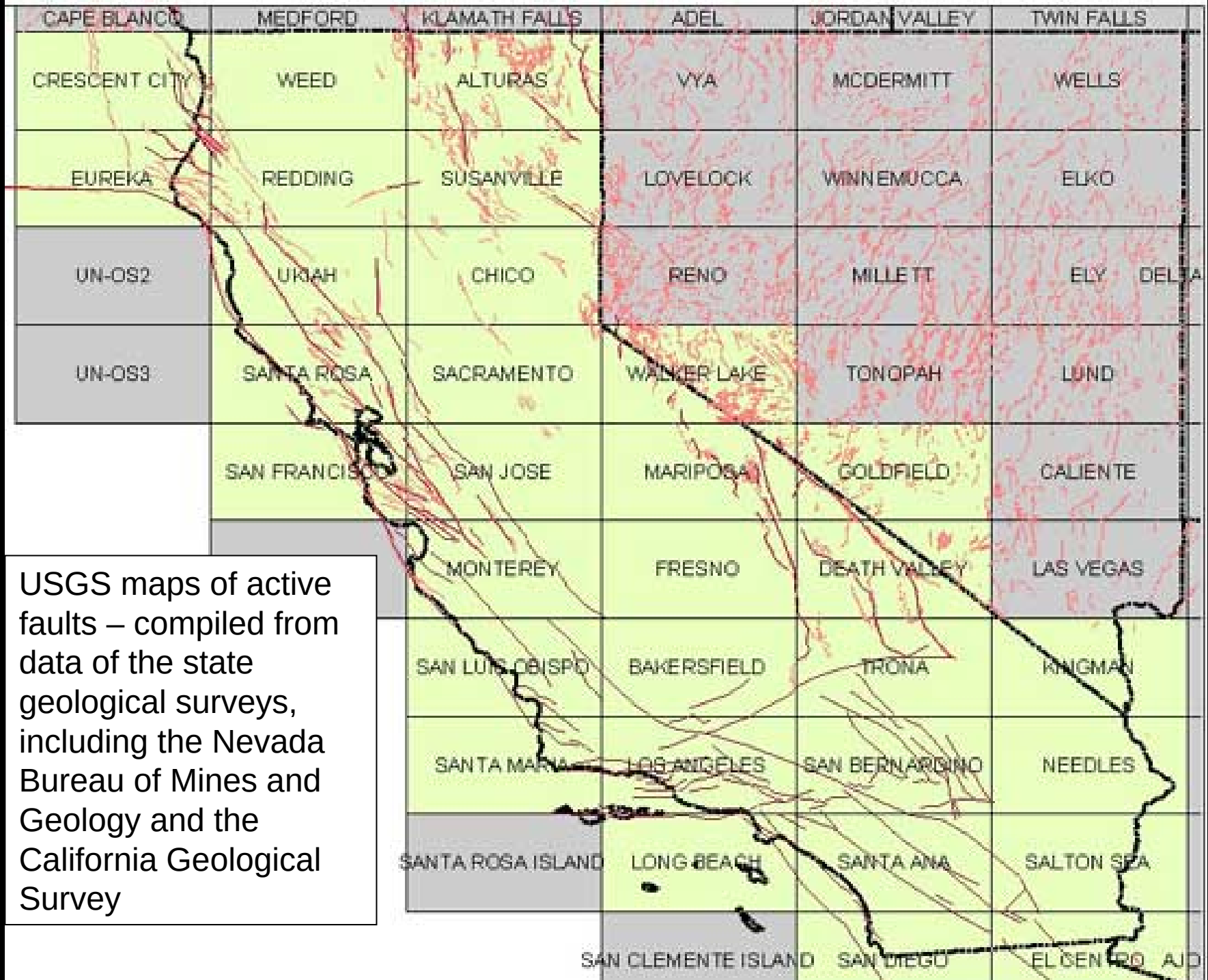


The earthquake hazards in Nevada are comparable to those in seismically active areas of California.

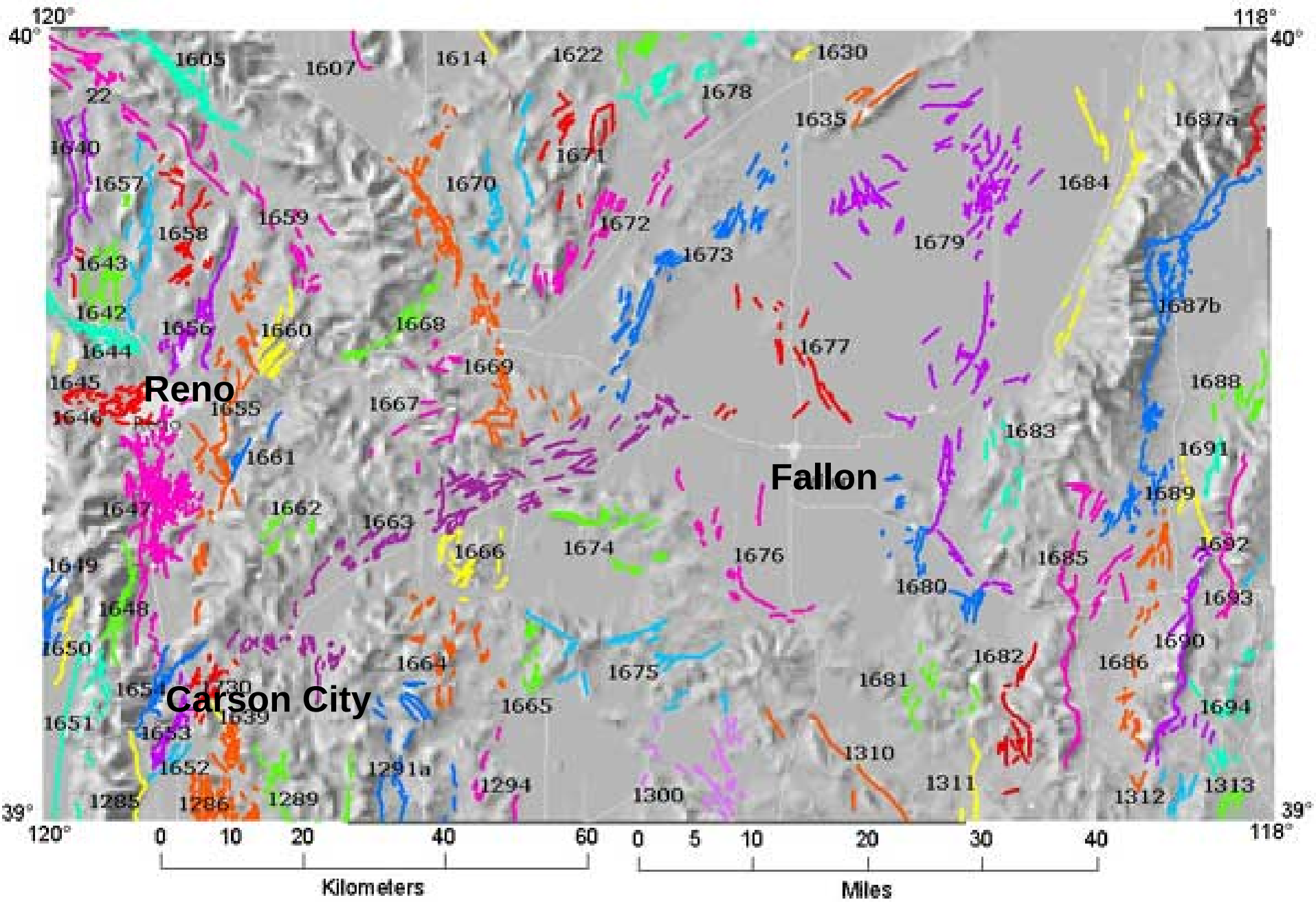
Probability of an earthquake of magnitude 6.5 or greater occurring within 50 km in 50 years (from USGS probabilistic seismic hazard analysis)

~50% chance for Reno and Carson City, magnitude 6.5





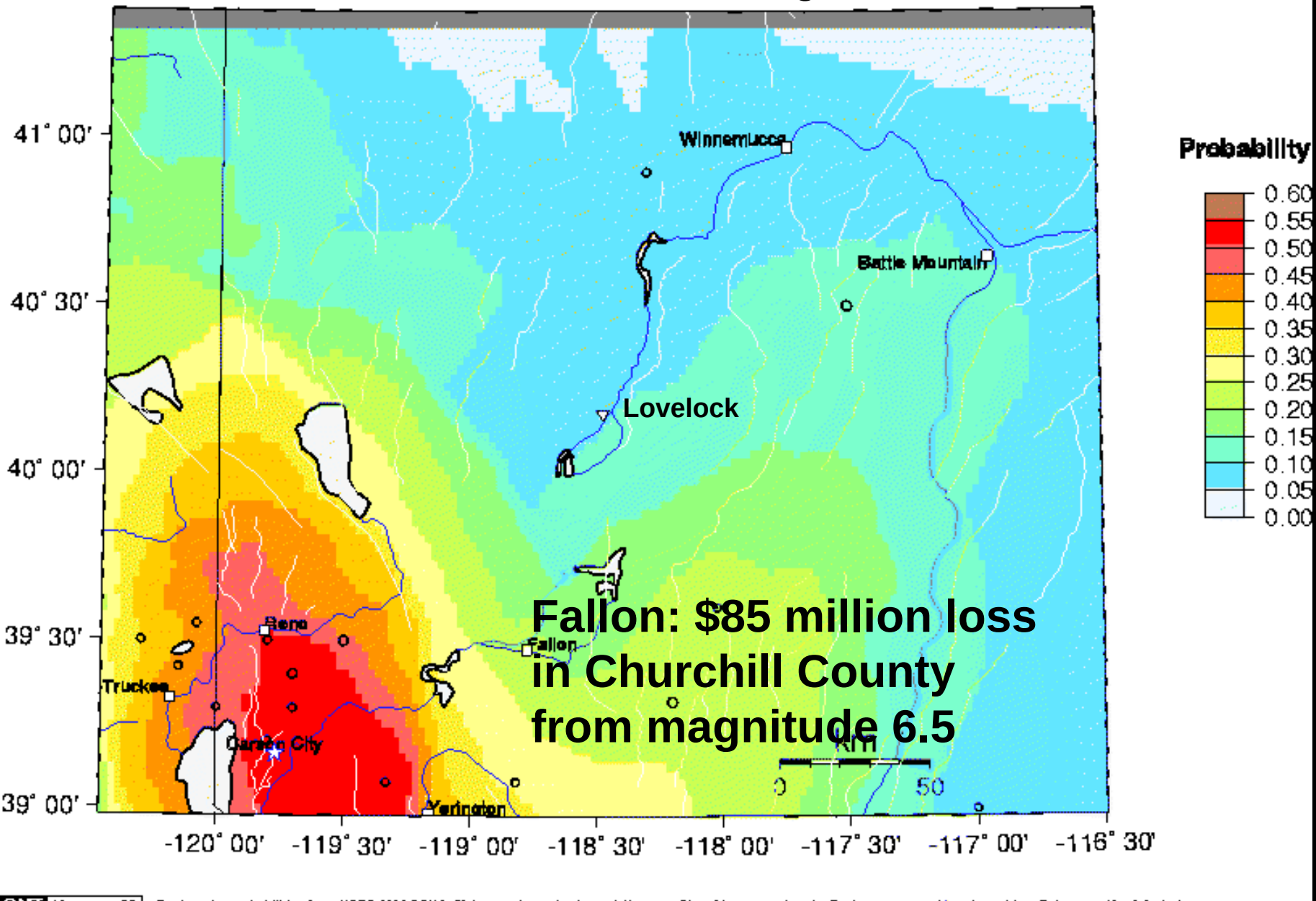
USGS maps of active faults – compiled from data of the state geological surveys, including the Nevada Bureau of Mines and Geology and the California Geological Survey

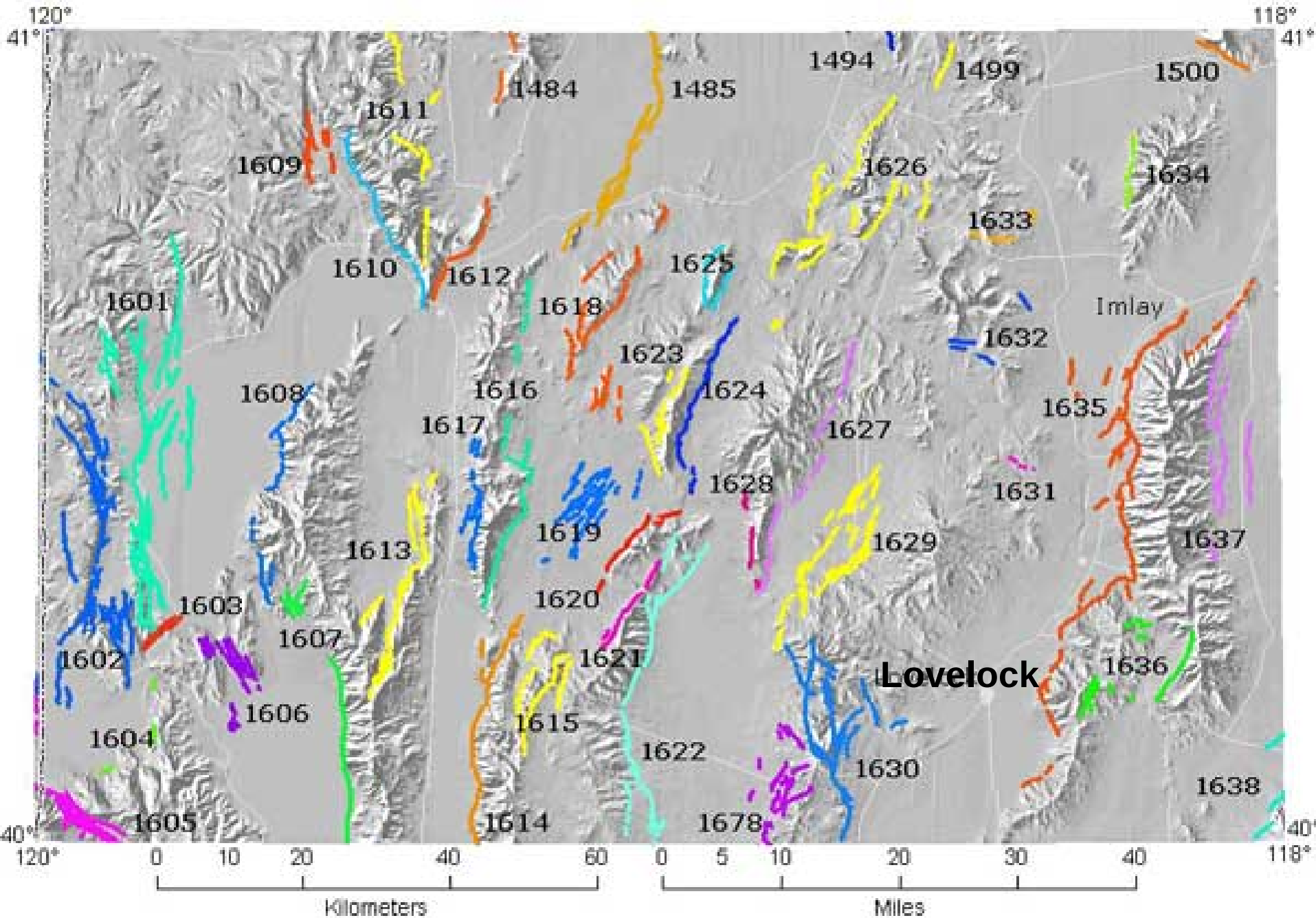


Active faults on the Reno 1 x 2-degree sheet

Probability of an earthquake of magnitude 6.5 or greater occurring within 50 km in 50 years (from USGS probabilistic seismic hazard analysis)

20-25% chance for Fallon, magnitude 6.5

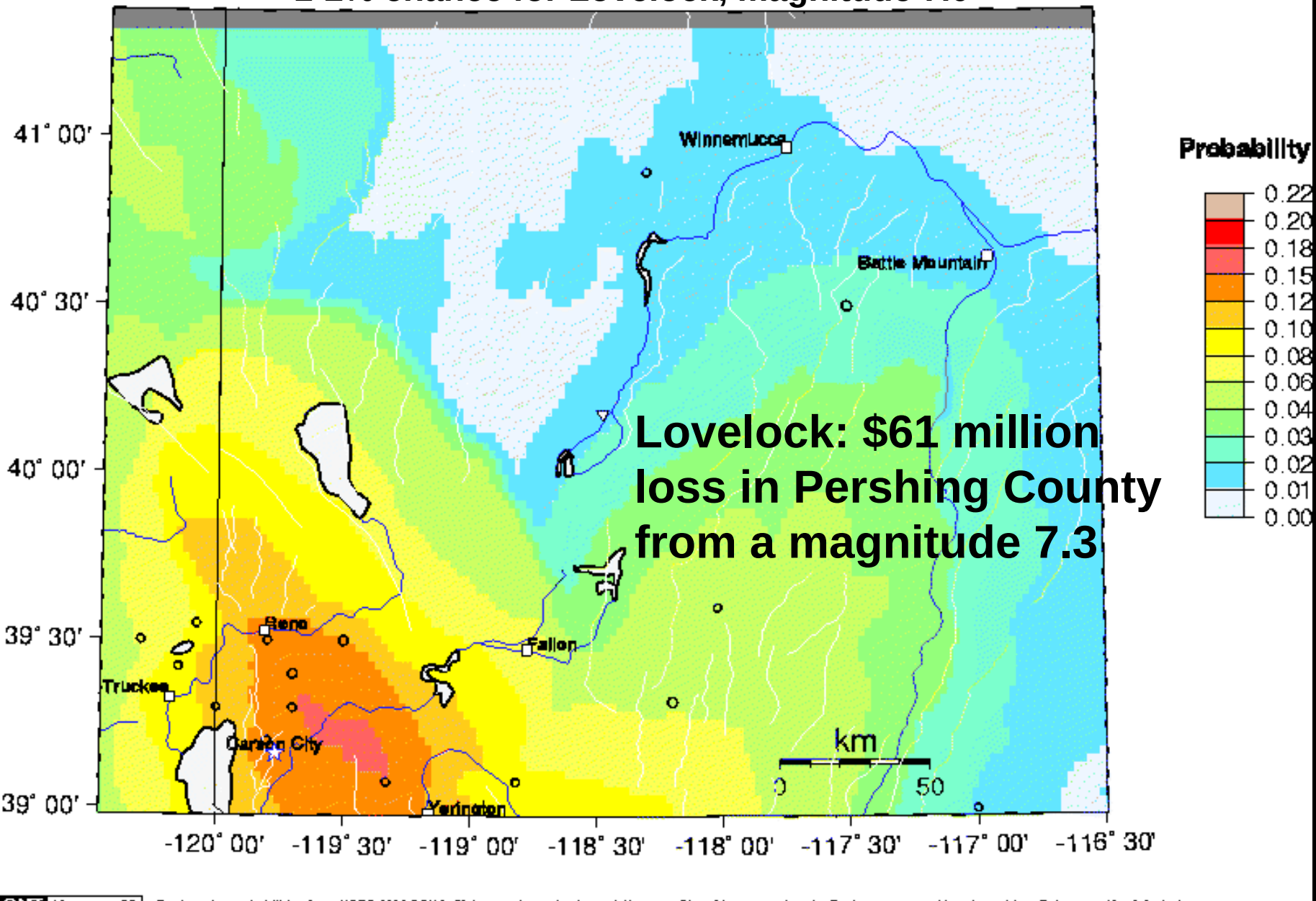




Active faults on the Lovelock 1 x 2-degree sheet

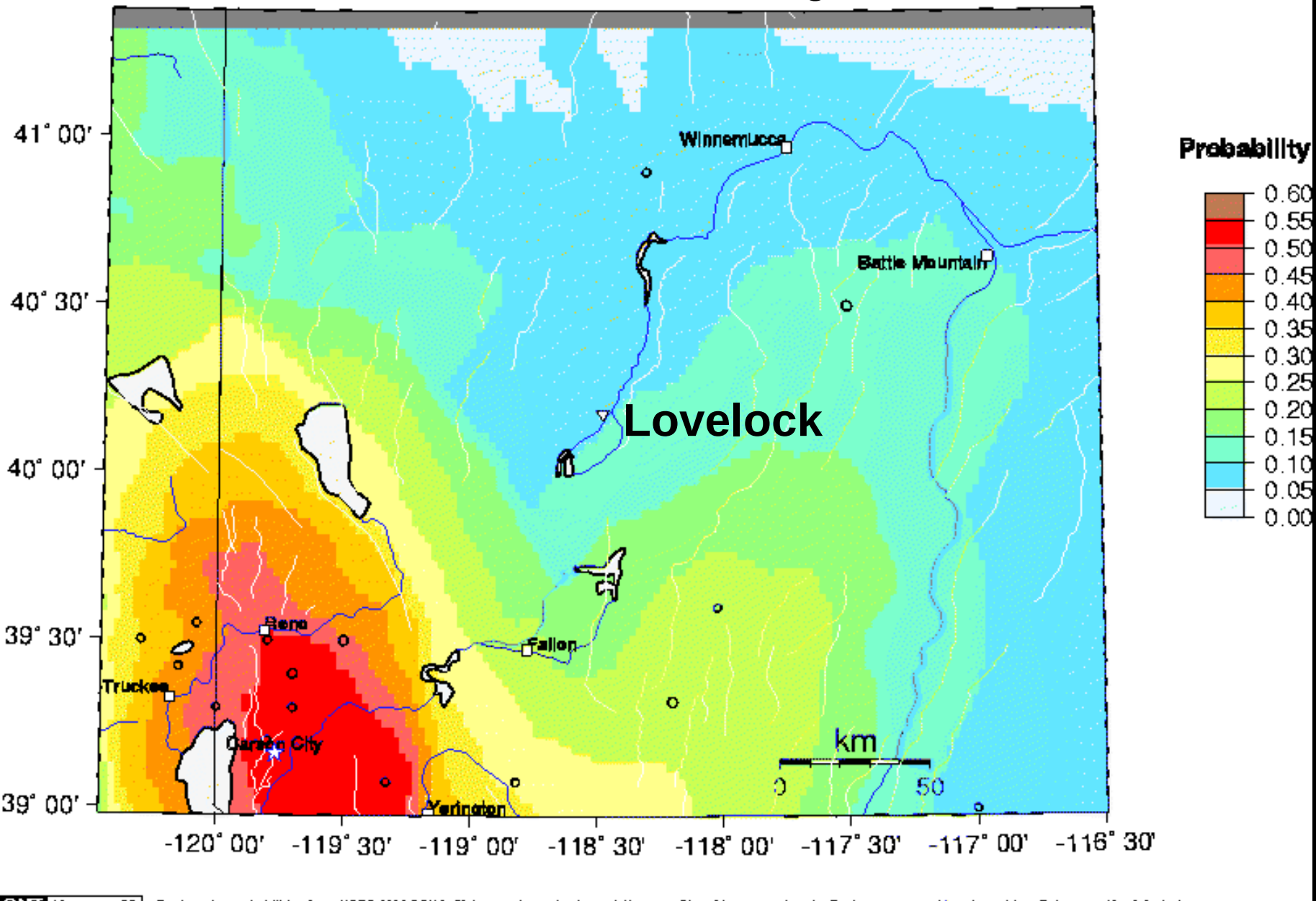
Probability of an earthquake of magnitude 7.0 or greater occurring within 50 km in 50 years (from USGS probabilistic seismic hazard analysis)

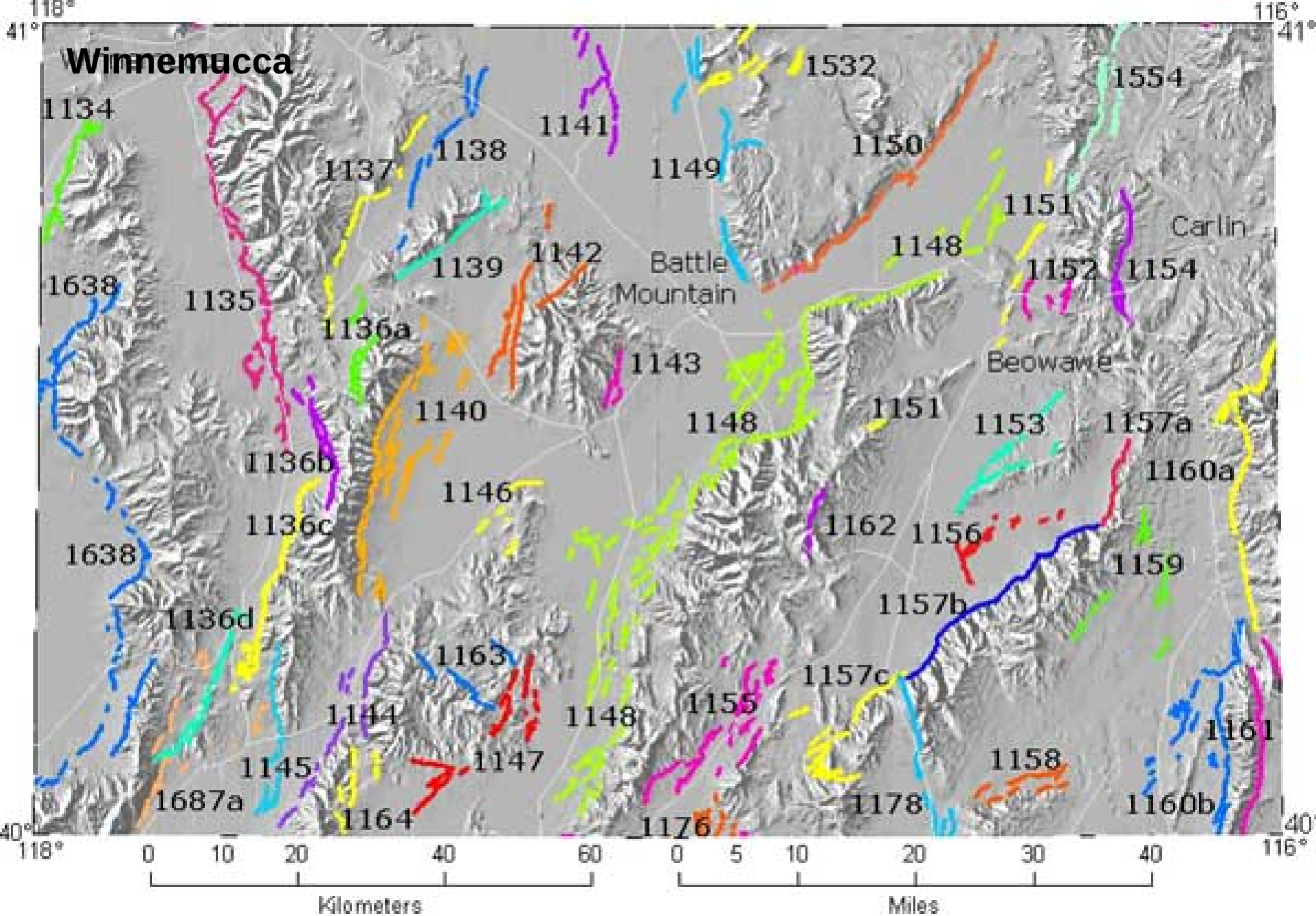
1-2% chance for Lovelock, magnitude 7.0



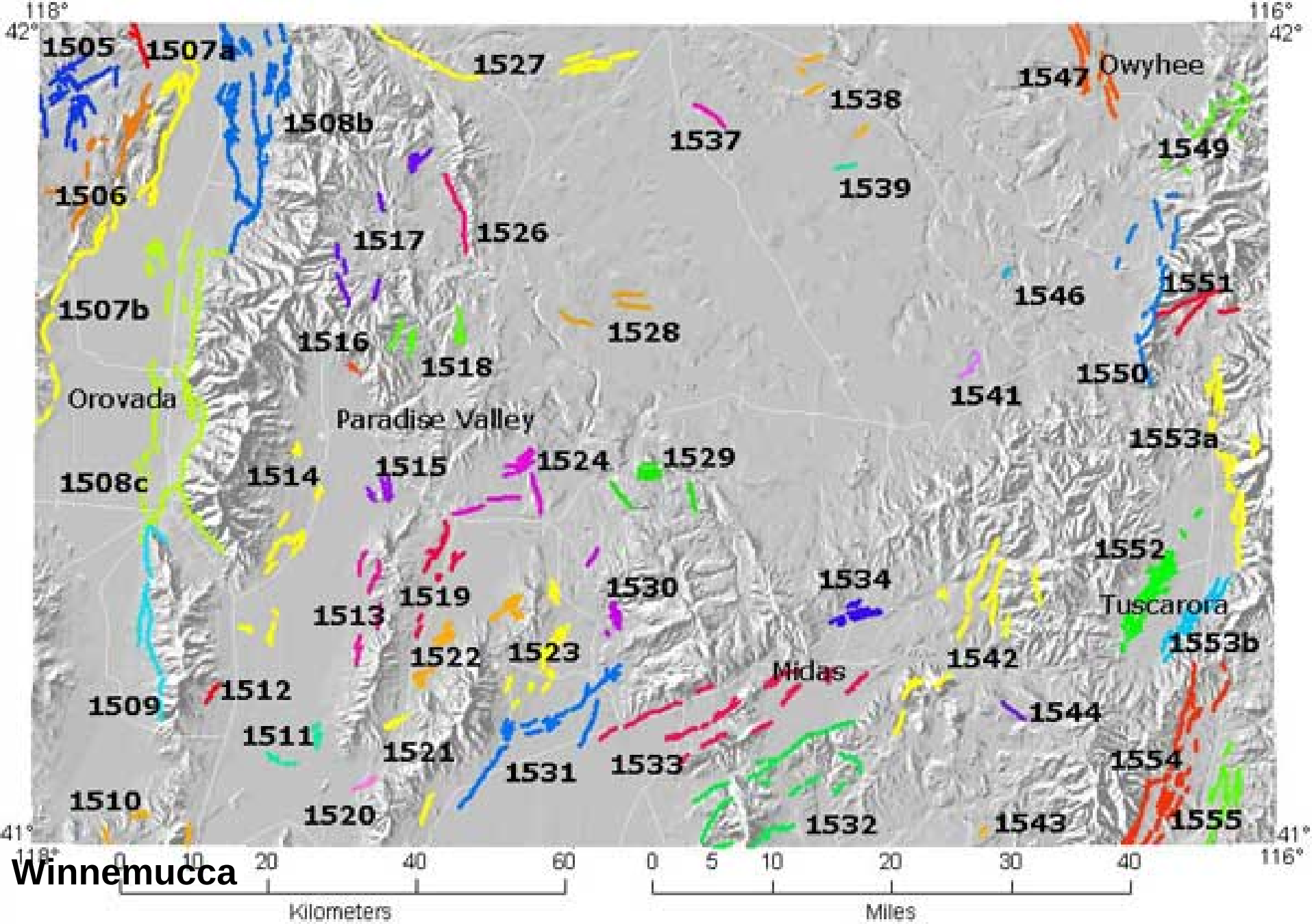
Probability of an earthquake of magnitude 6.5 or greater occurring within 50 km in 50 years (from USGS probabilistic seismic hazard analysis)

~10% chance for Lovelock, magnitude 6.5

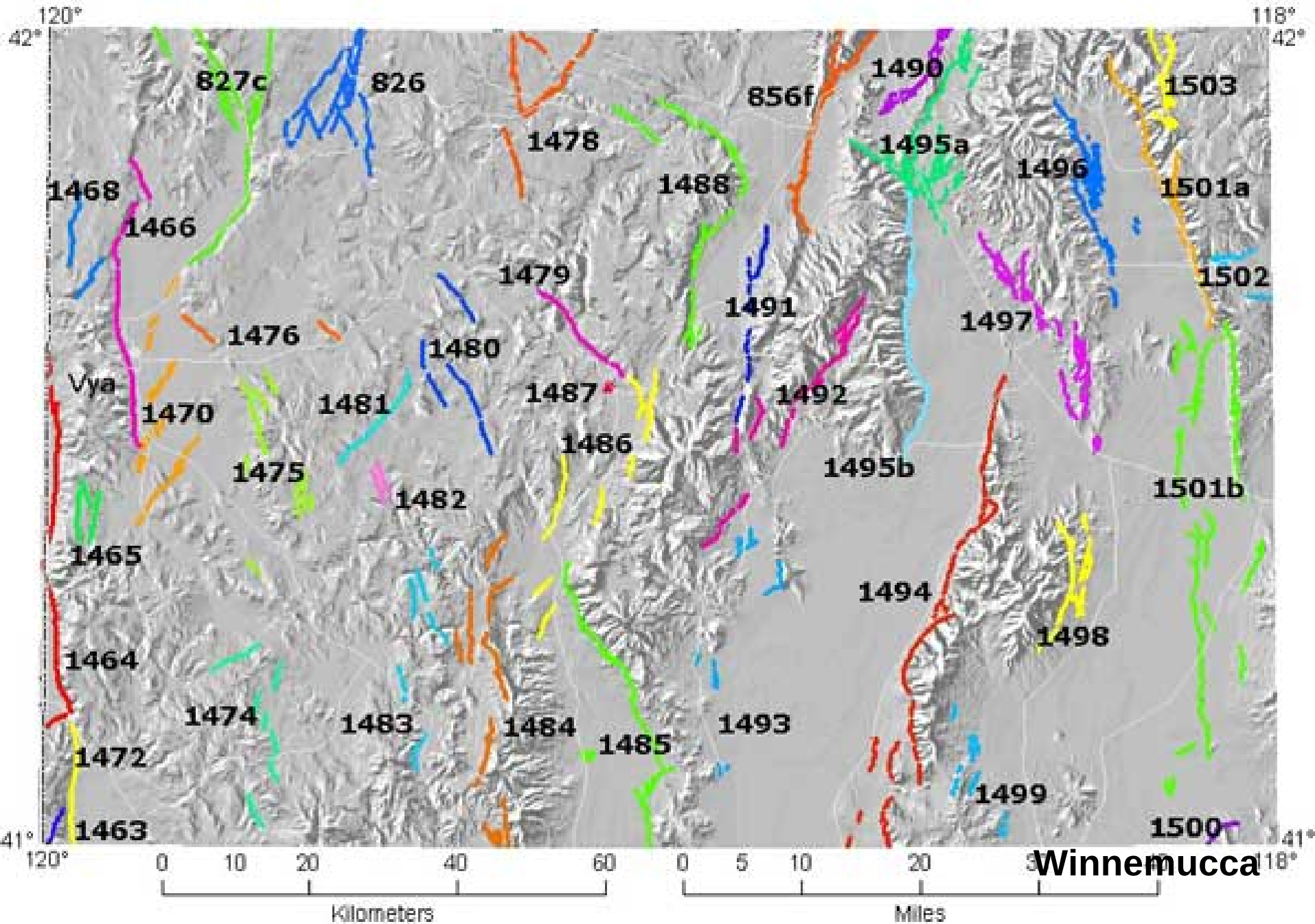




Active faults on the Winnemucca 1 x 2-degree sheet



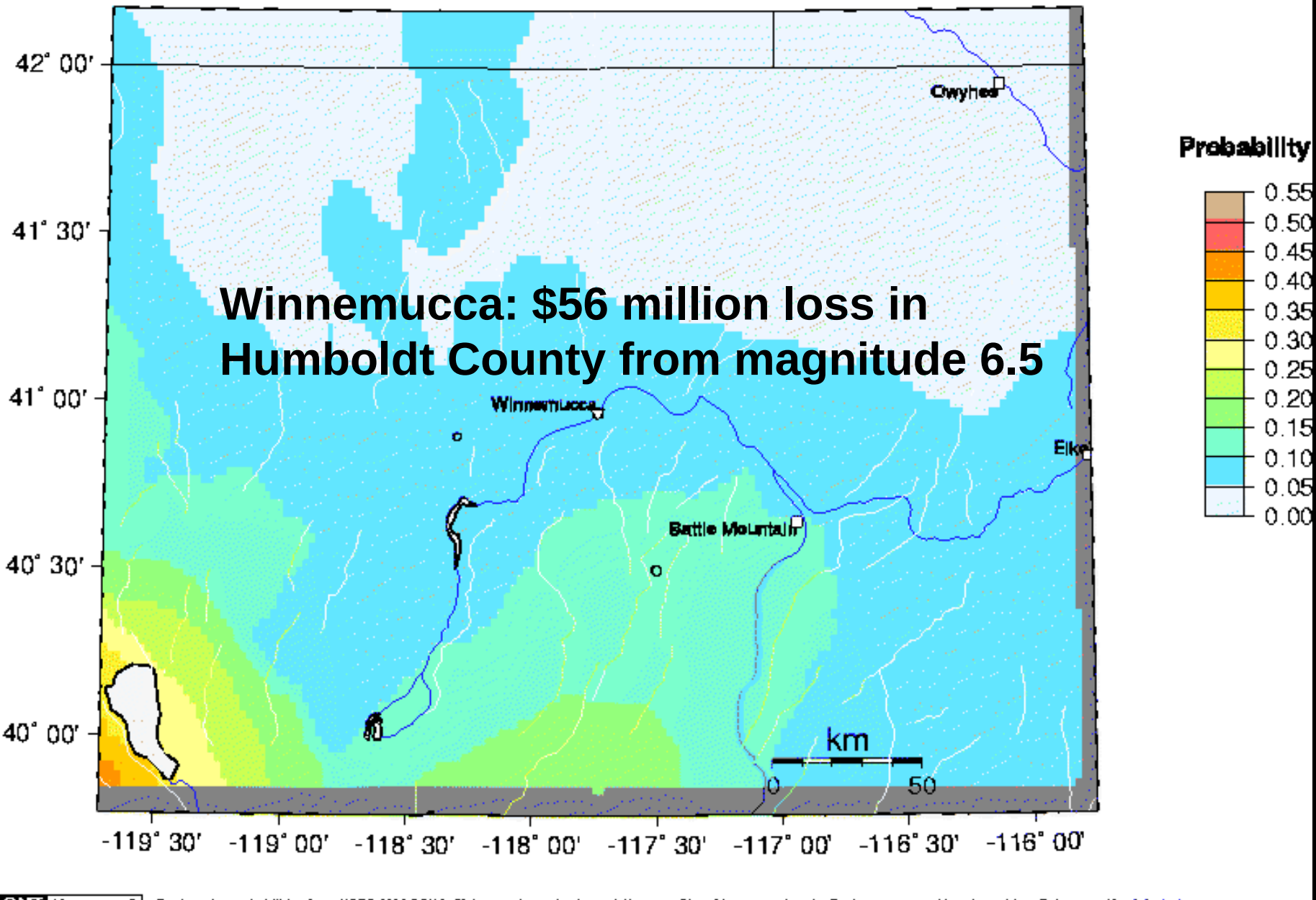
Active faults on the McDermitt 1 x 2-degree sheet

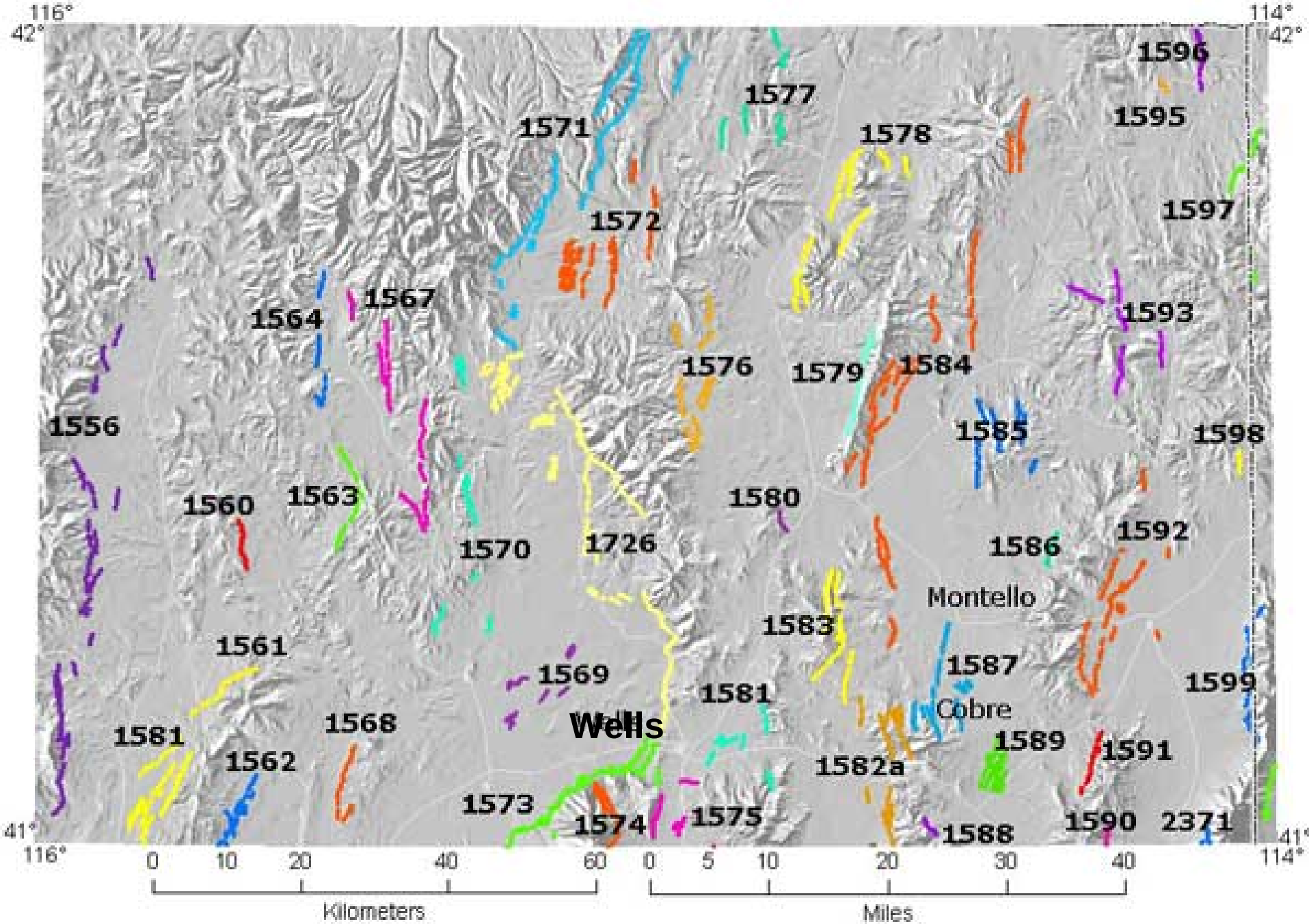


Active faults on the Vya 1 x 2-degree sheet

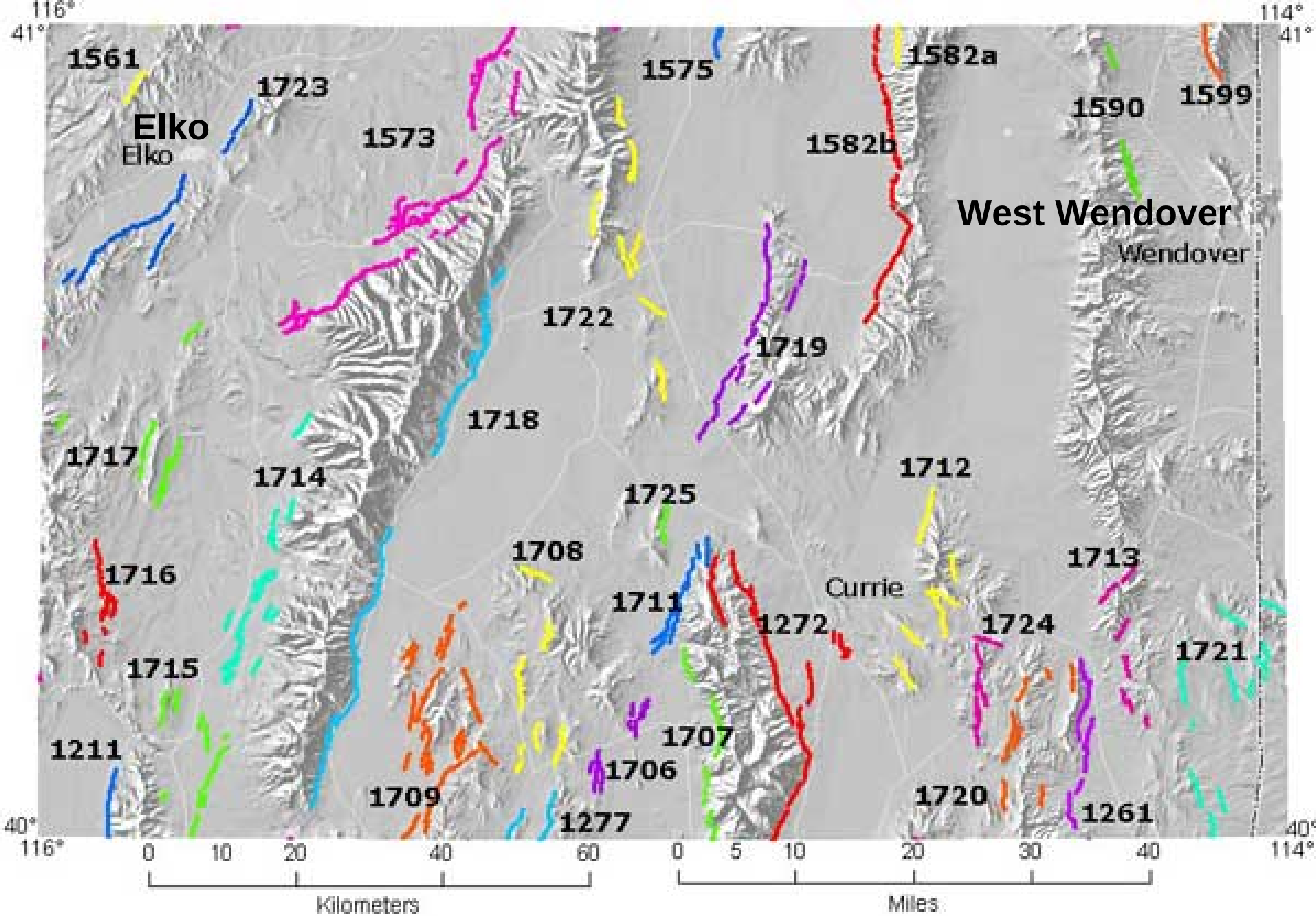
Probability of an earthquake of magnitude 6.5 or greater occurring within 50 km in 50 years (from USGS probabilistic seismic hazard analysis)

5-10% chance for Winnemucca, magnitude 6.5





Active faults on the Wells 1 x 2-degree sheet



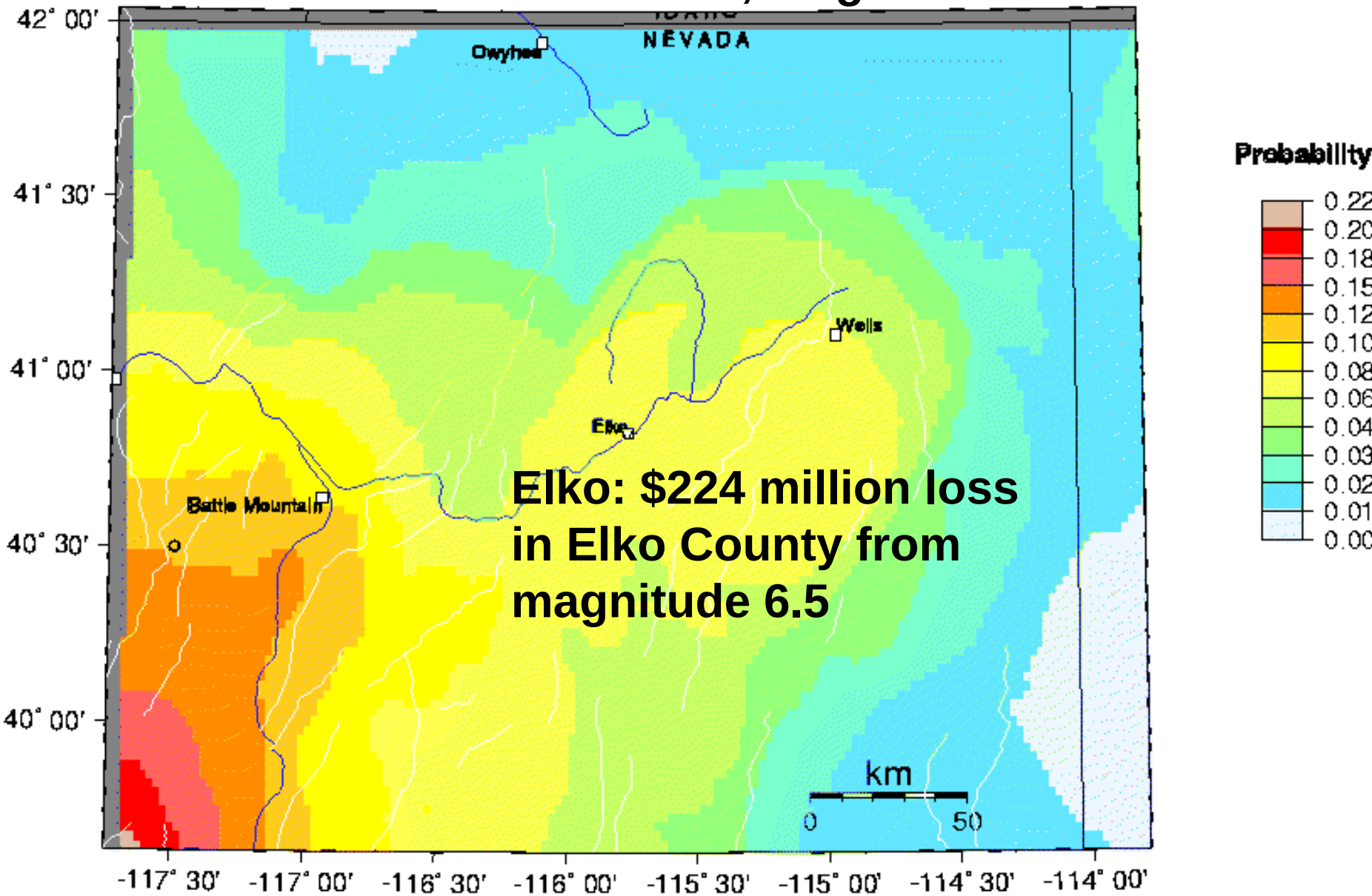
Active faults on the Elko 1 x 2-degree sheet

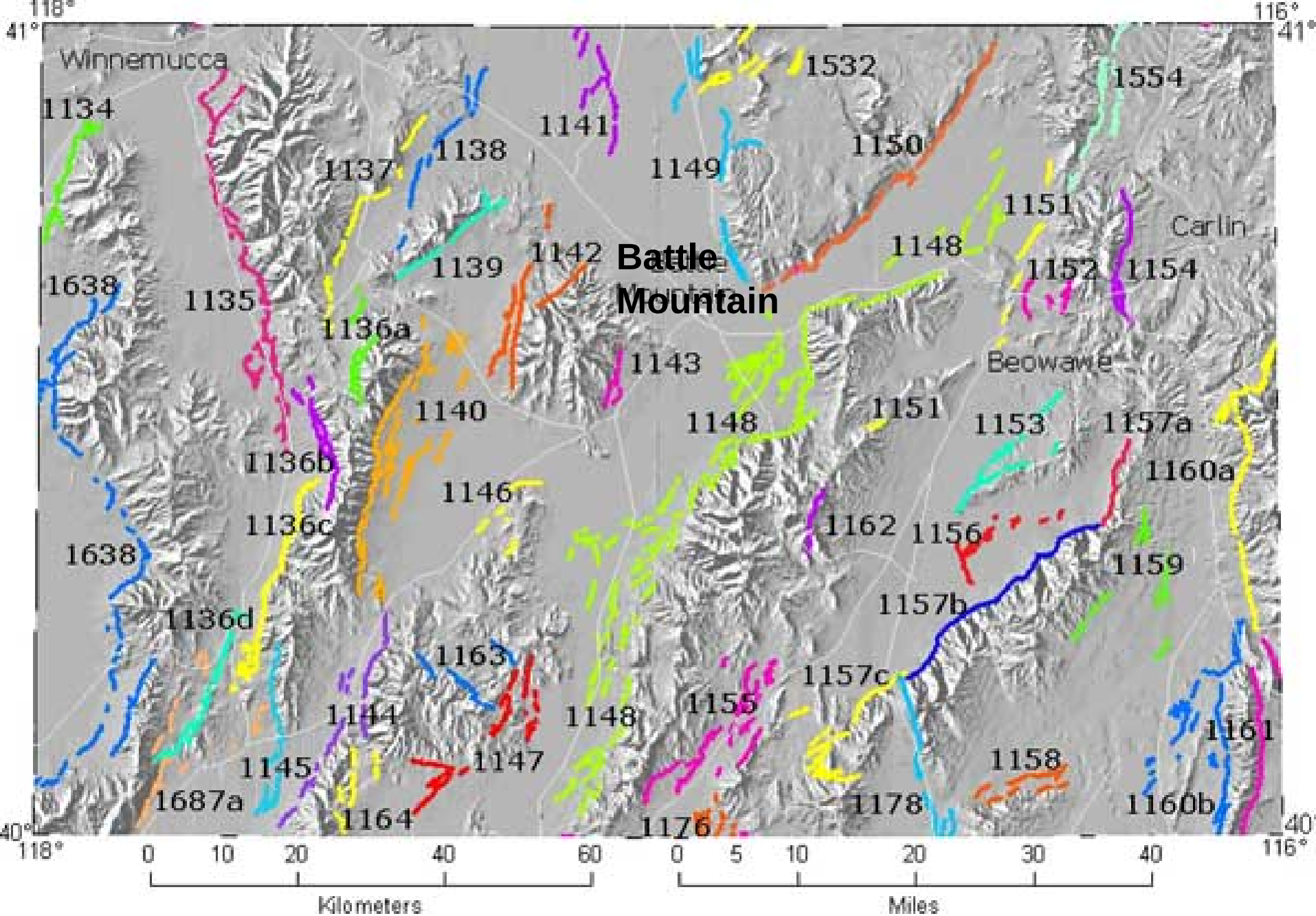
Active fault on the west side of the Ruby Mountains, on the haul road to the Rat pit at the Bald Mountain mine


Paleozic bedrock
Quaternary gravels
Active fault on the west side of the Ruby Mountains, on the haul road to the Rat pit at the Bald Mountain mine

Probability of an earthquake of magnitude 6.5 or greater occurring within 50 km in 50 years (from USGS probabilistic seismic hazard analysis)

6-8% chance for Elko, magnitude 6.5

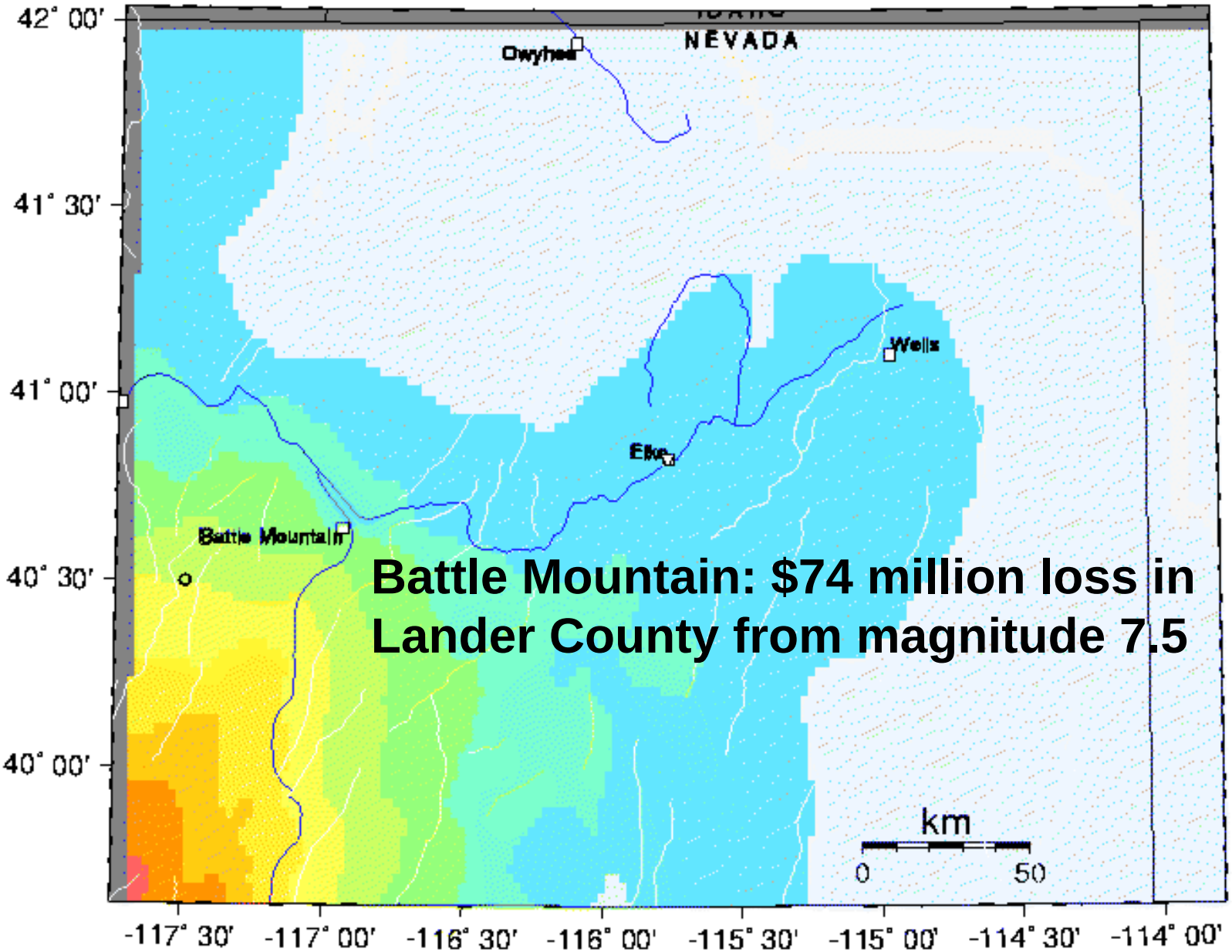




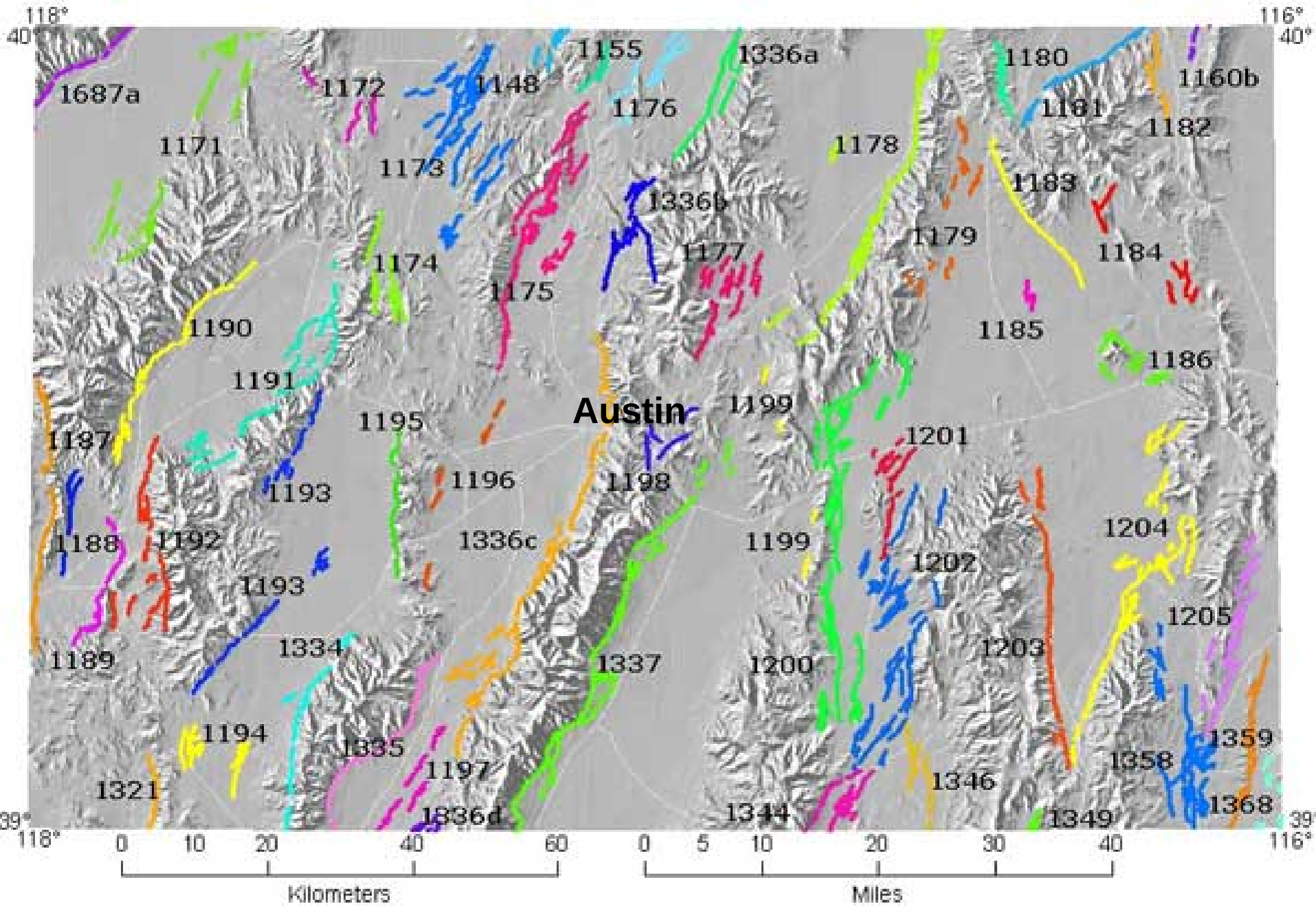
Active faults on the Winnemucca 1 x 2-degree sheet

Probability of an earthquake of magnitude 7.0 or greater occurring within 50 km in 50 years (from USGS probabilistic seismic hazard analysis)

~1.5% chance for Battle Mountain, magnitude 7.0



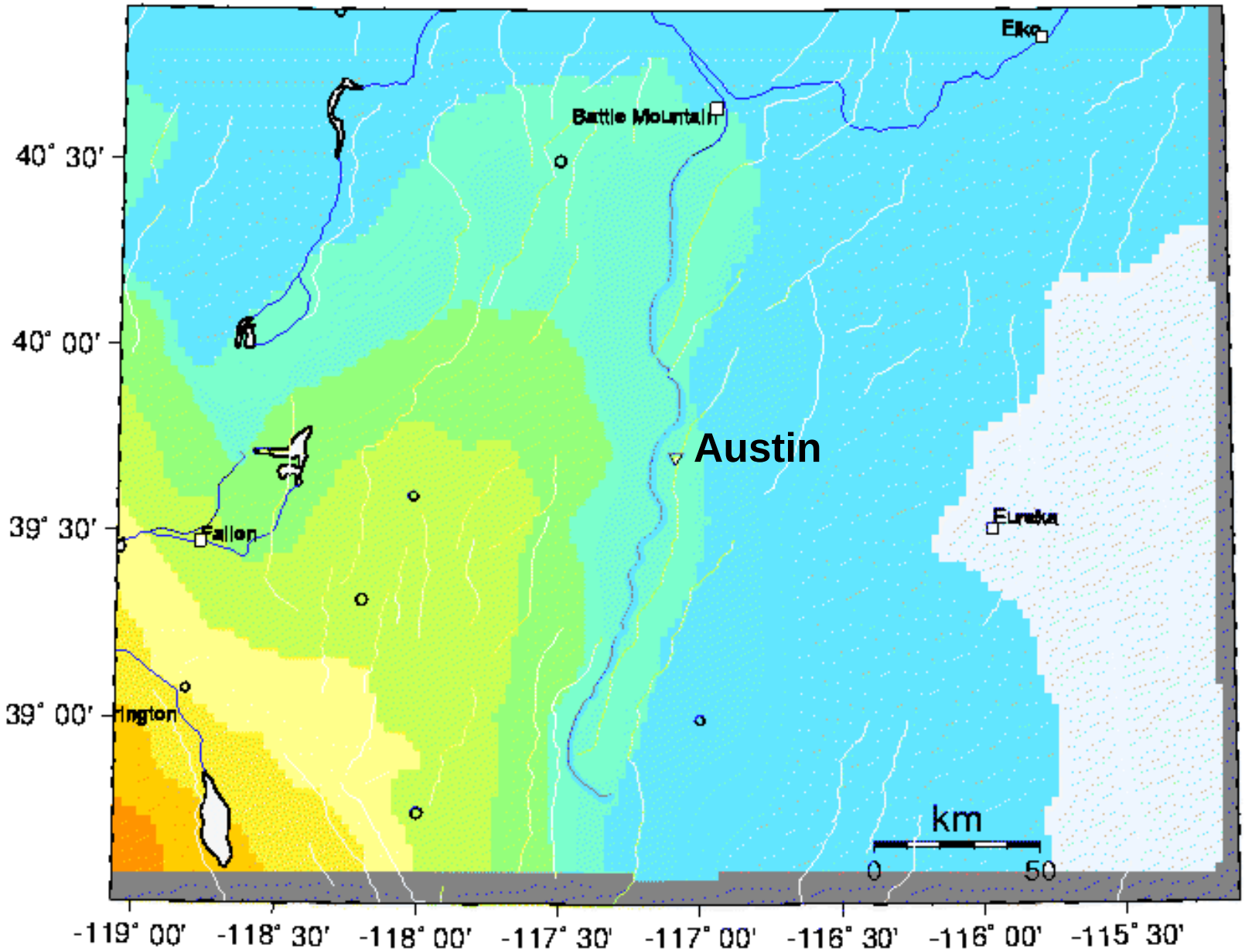
Battle Mountain: $74 million loss in Lander County from magnitude 7.5

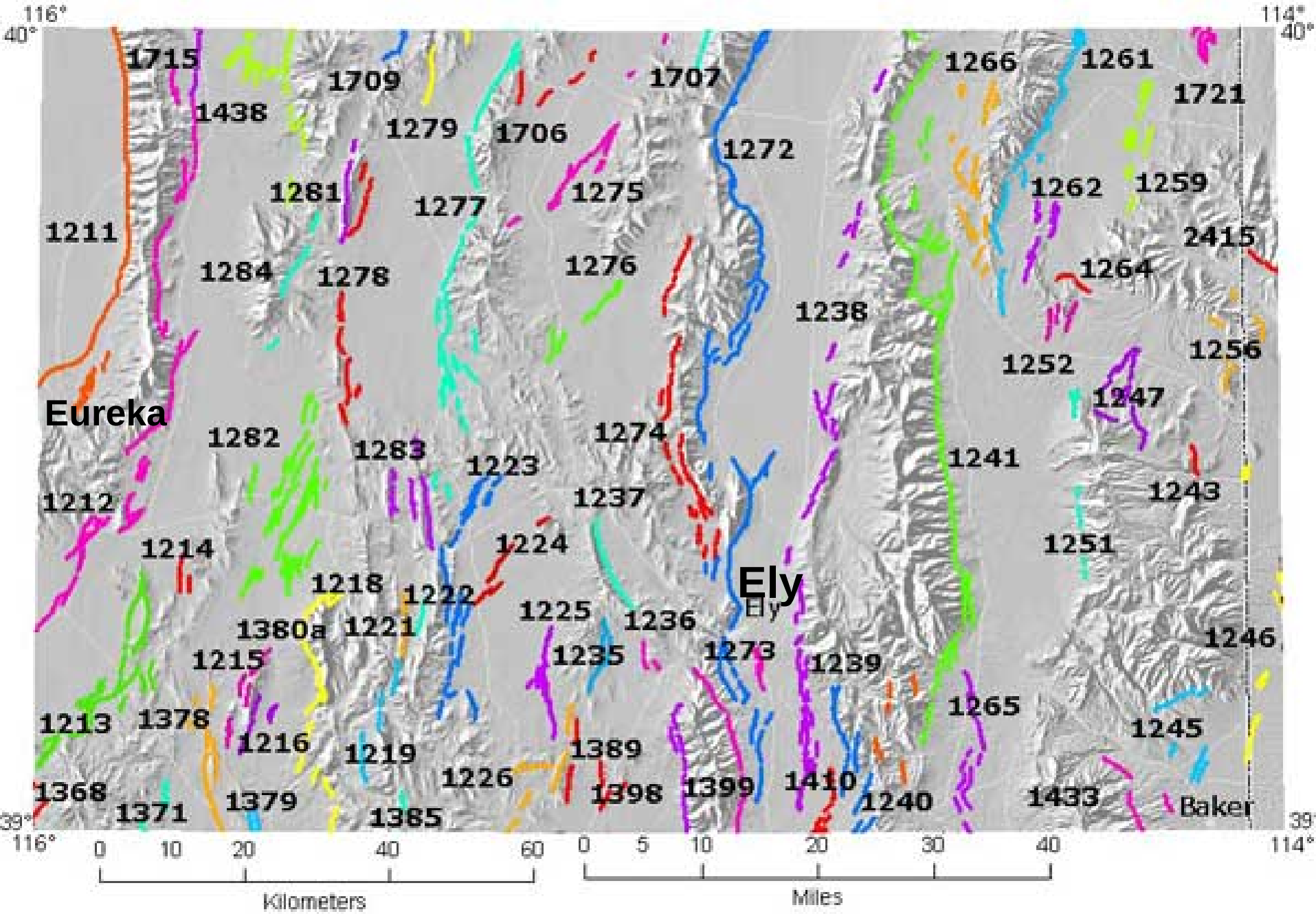


Active faults on the Millitt 1 x 2-degree sheet

Probability of an earthquake of magnitude 6.5 or greater occurring within 50 km in 50 years (from USGS probabilistic seismic hazard analysis)

10-15% chance for Austin, magnitude 6.5

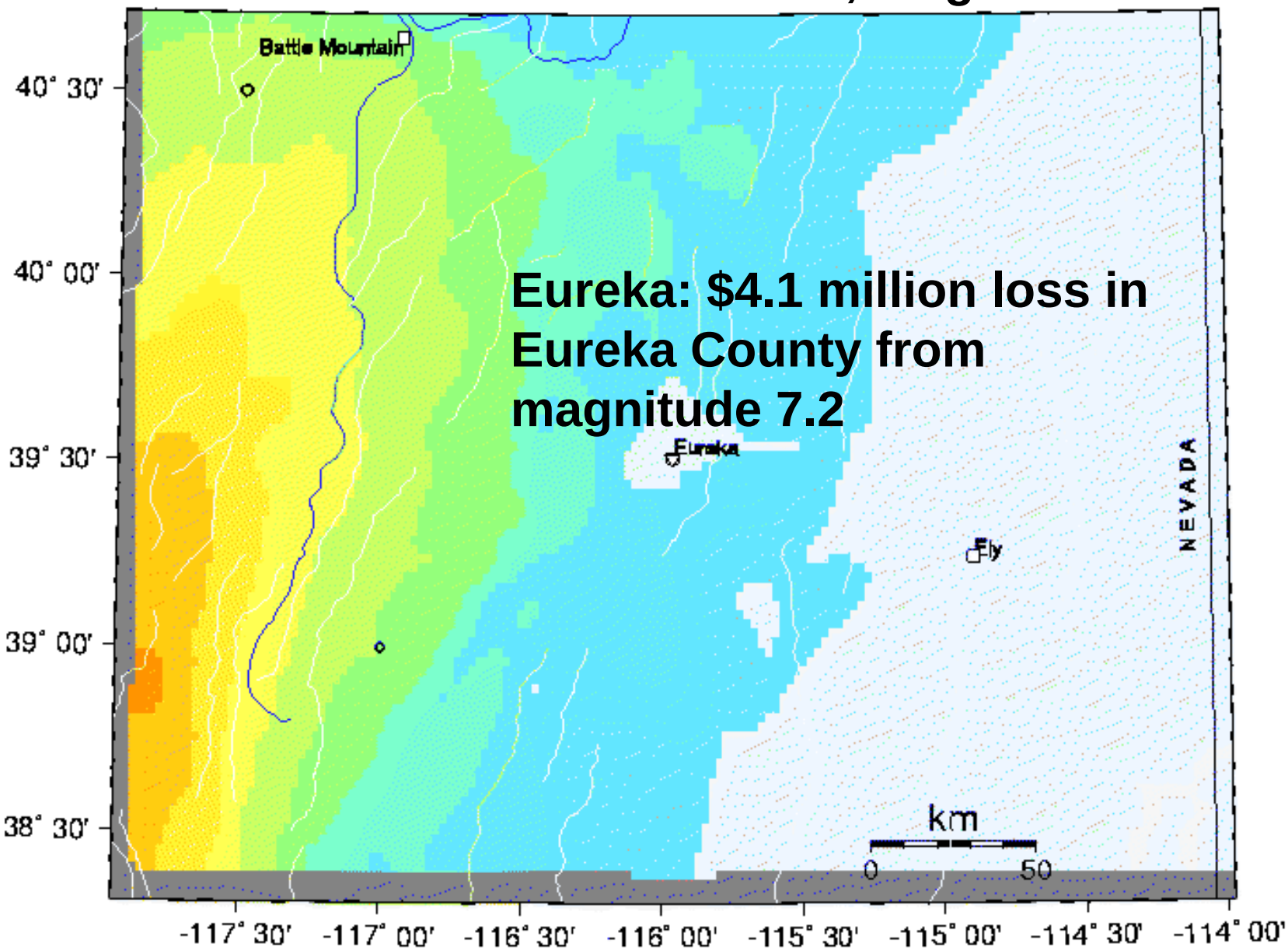




Active faults on the Ely 1 x 2-degree sheet

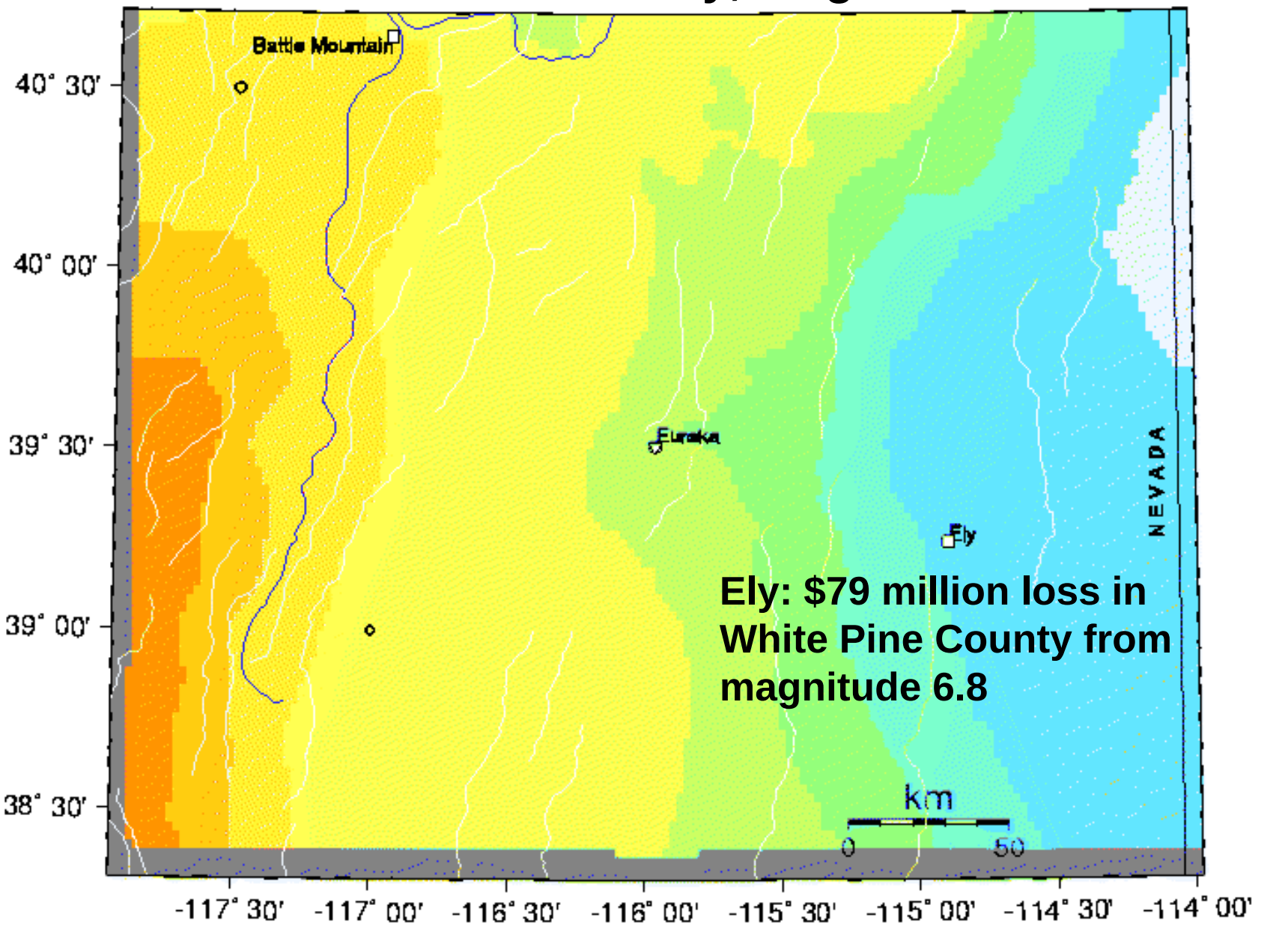
Probability of an earthquake of magnitude 7.0 or greater occurring within 50 km in 50 years (from USGS probabilistic seismic hazard analysis)

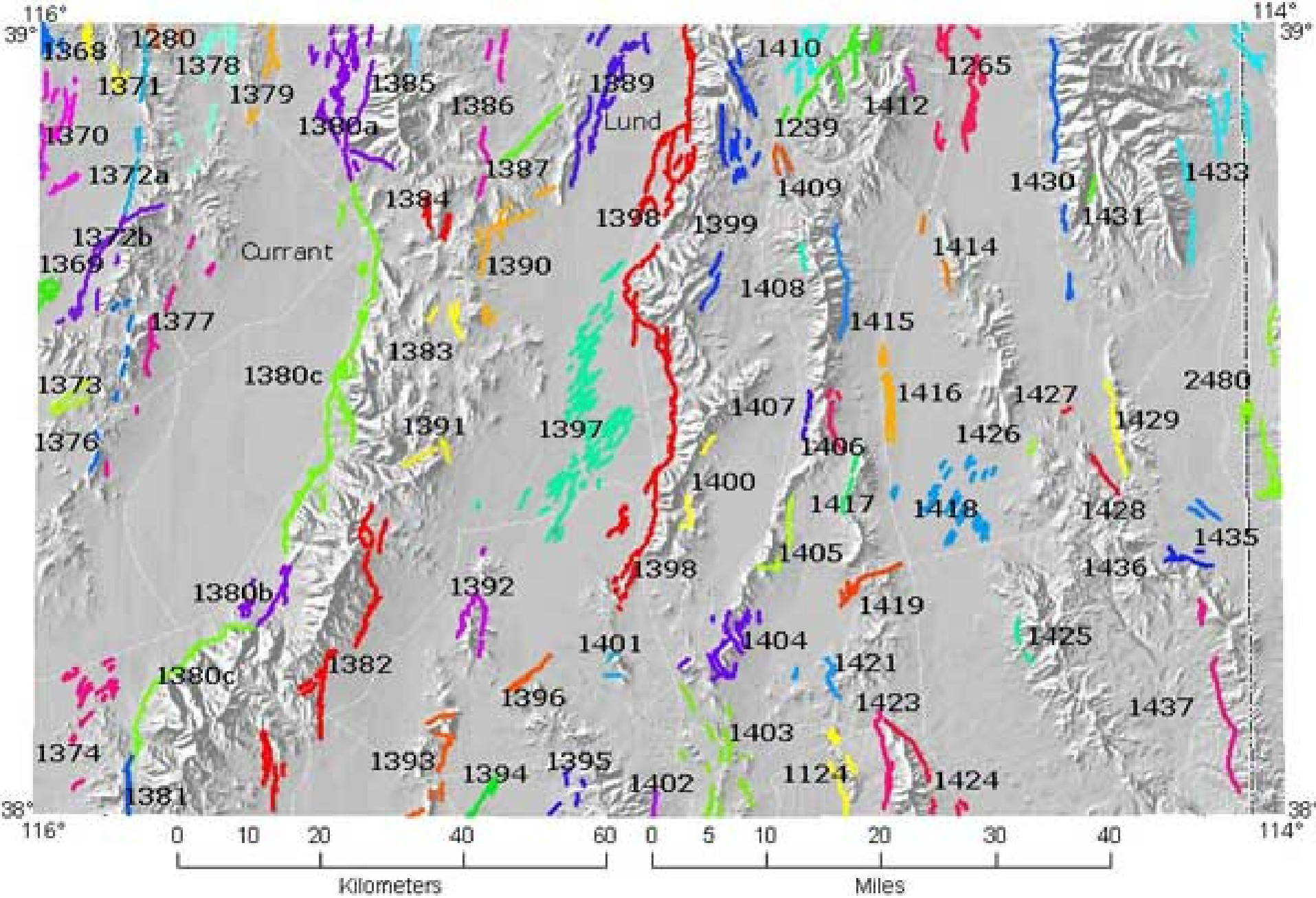
<0.5% chance for Eureka, magnitude 7.0



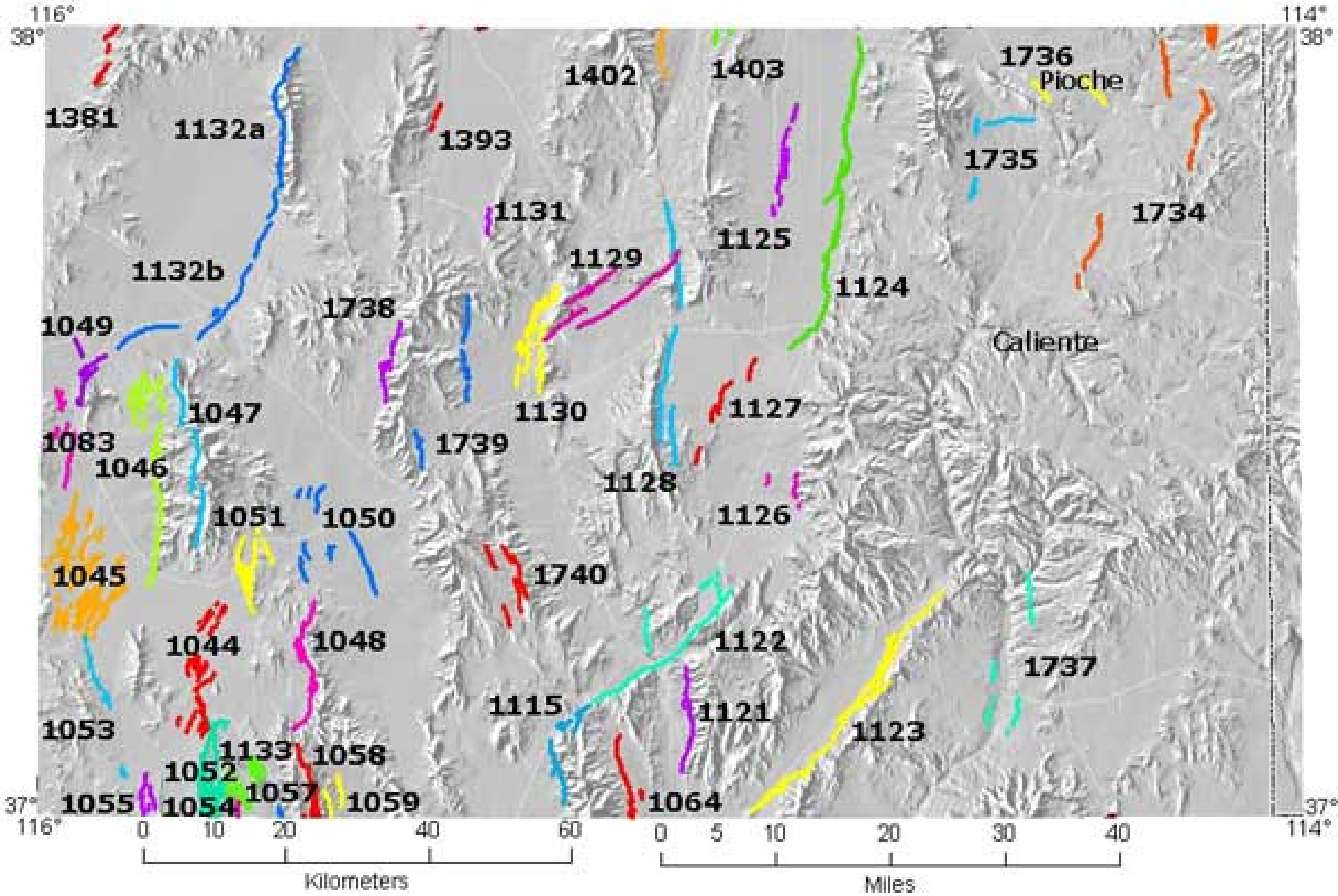
Probability of an earthquake of magnitude 6.5 or greater occurring within 50 km in 50 years (from USGS probabilistic seismic hazard analysis)

1.5-2% chance for Ely, magnitude 6.5





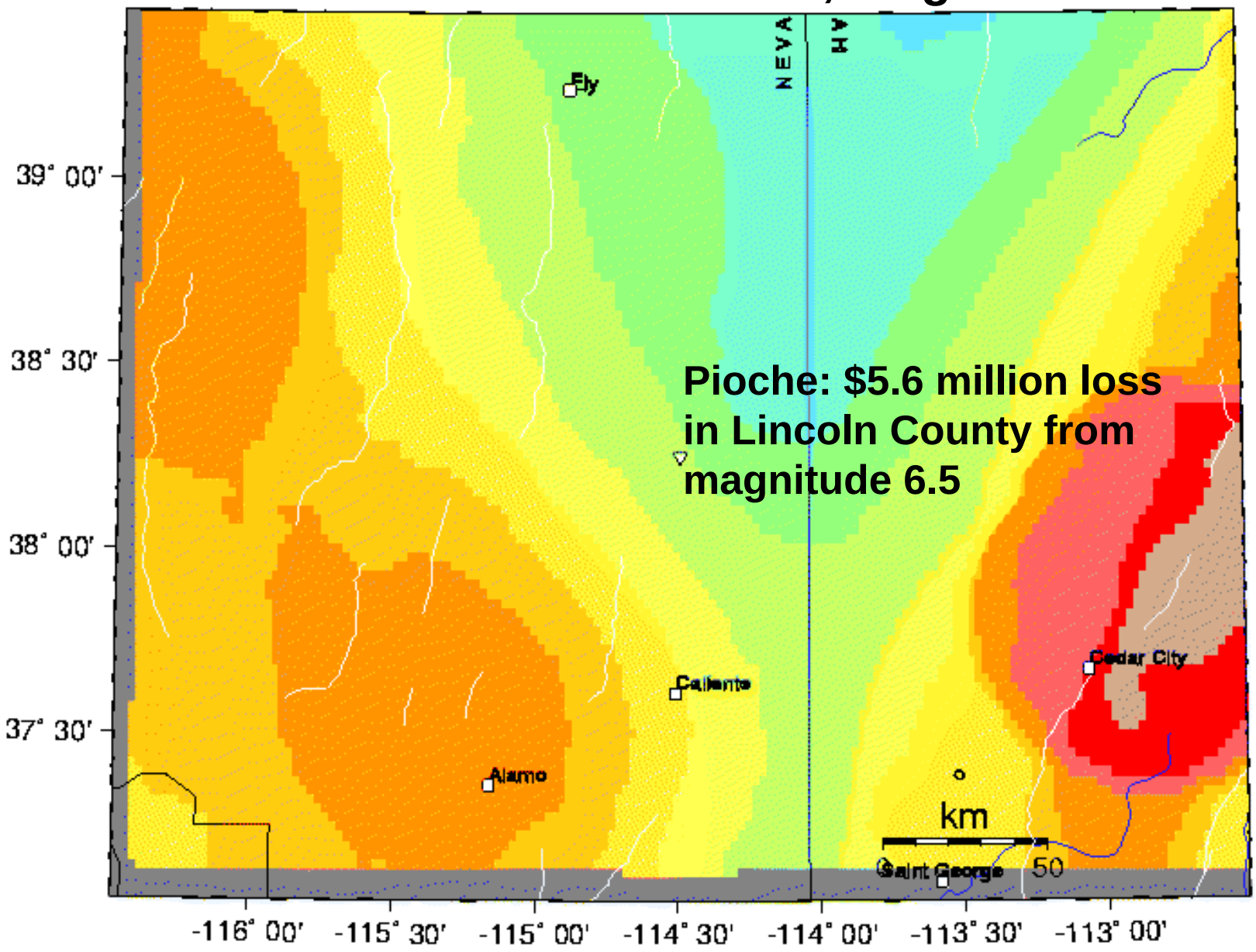
Active faults on the Lund 1 x 2-degree sheet

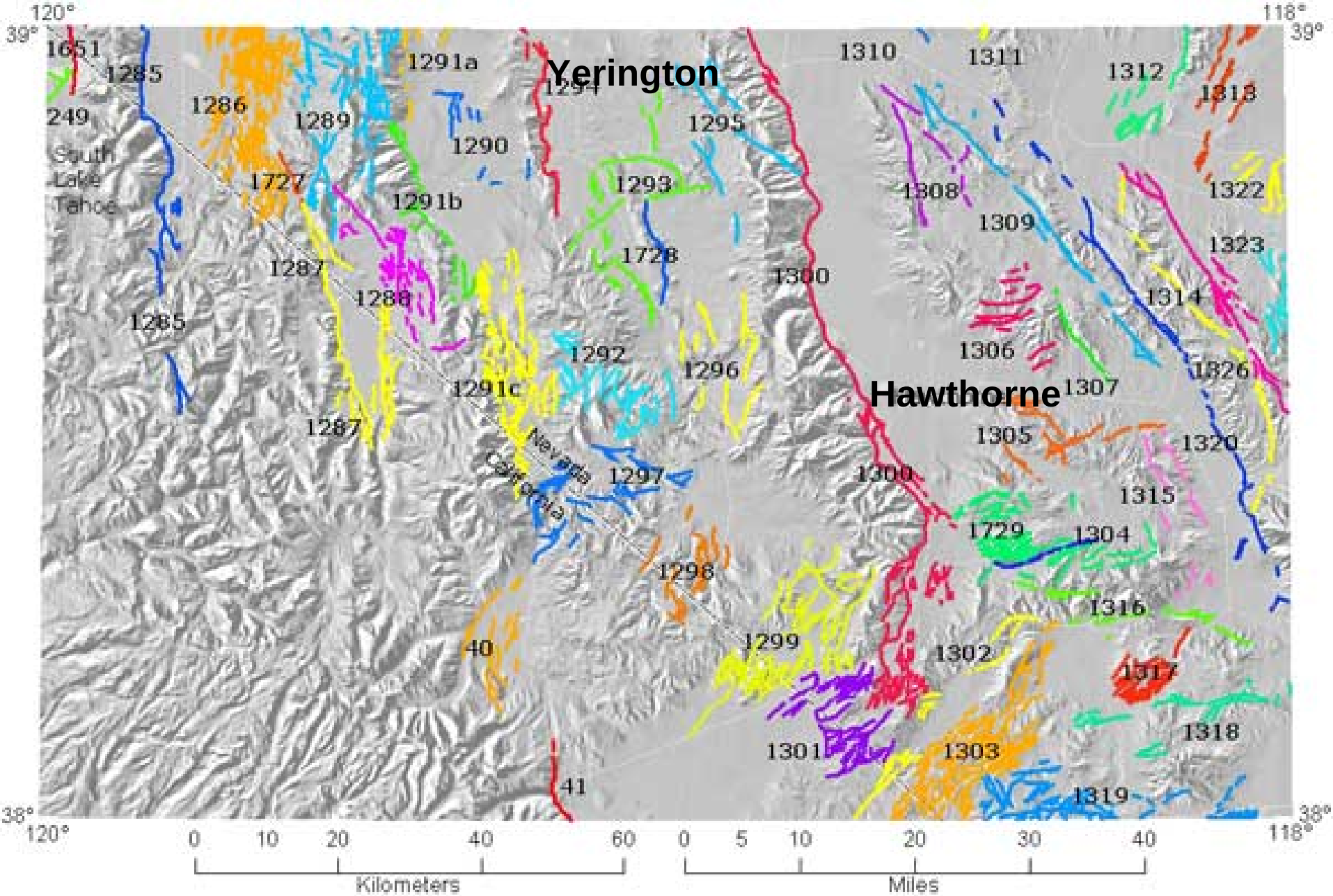


Active faults on the Caliente 1 x 2-degree sheet

Probability of an earthquake of magnitude 6.5 or greater occurring within 50 km in 50 years (from USGS probabilistic seismic hazard analysis)

2-3% chance for Pioche, magnitude 6.5

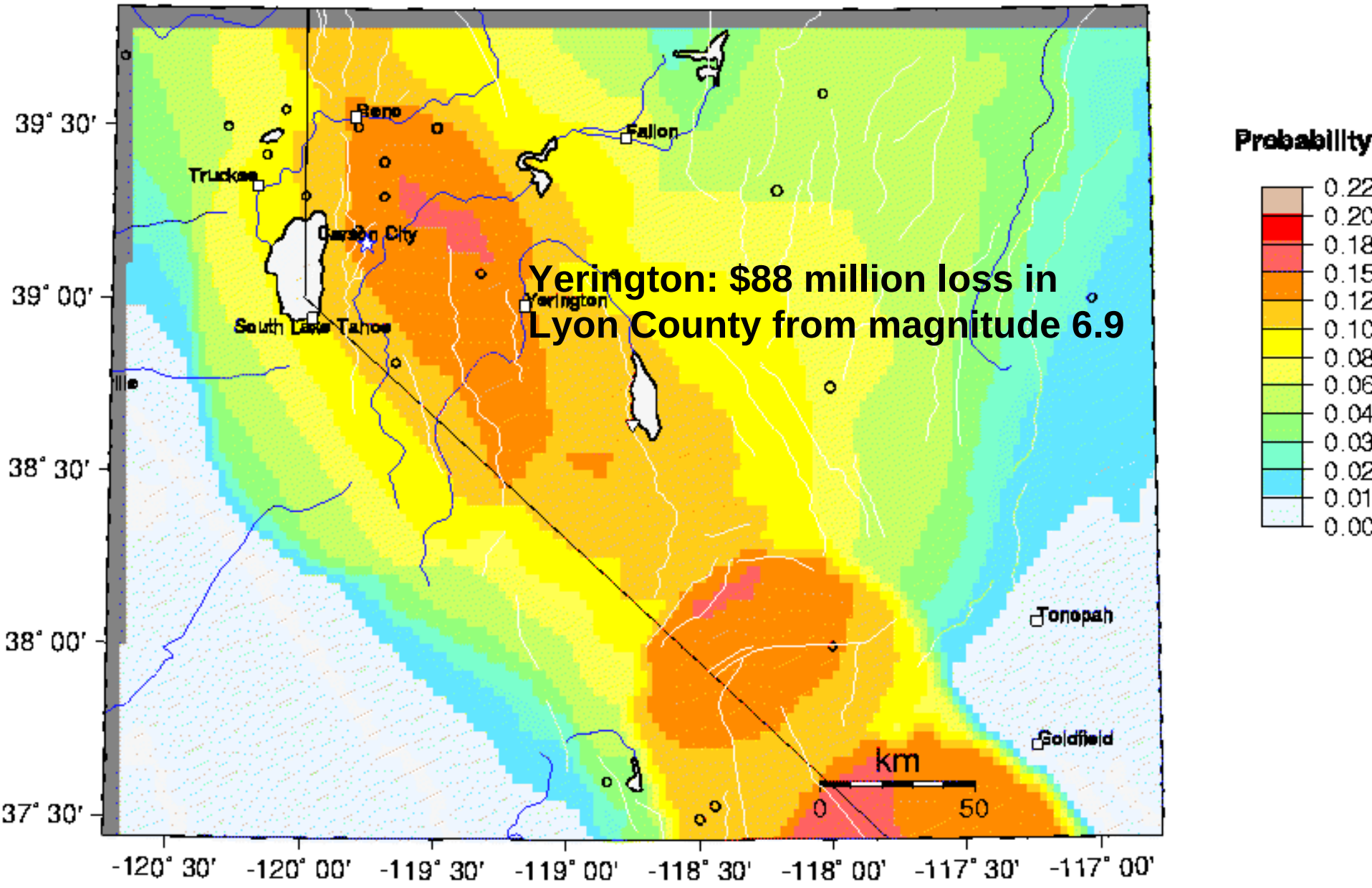




Active faults on the Walker Lake 1 x 2-degree sheet

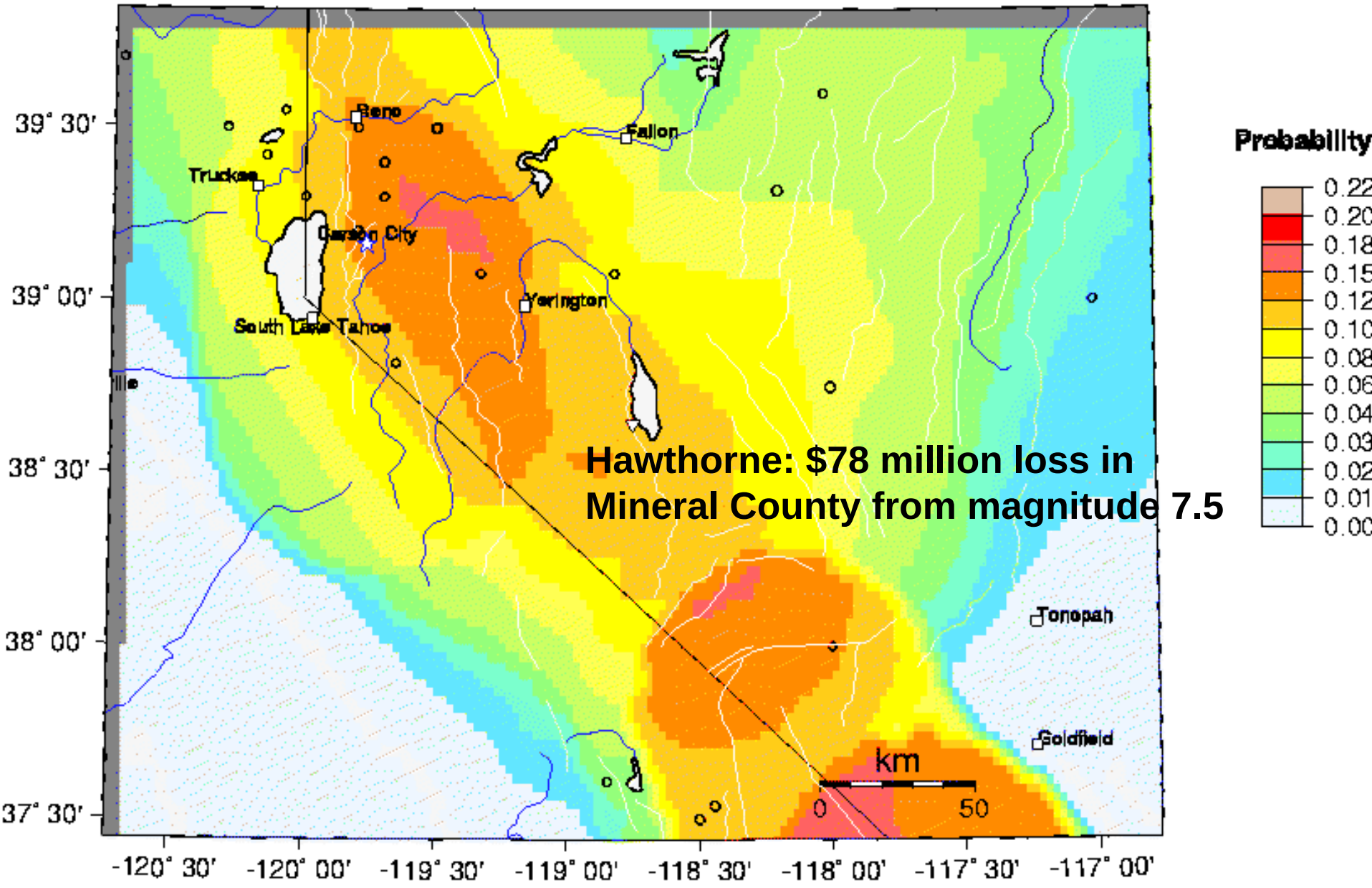
Probability of an earthquake of magnitude 7.0 or greater occurring within 50 km in 50 years (from USGS probabilistic seismic hazard analysis)

12% chance for Yerington, magnitude 7.0



Probability of an earthquake of magnitude 7.0 or greater occurring within 50 km in 50 years (from USGS probabilistic seismic hazard analysis)

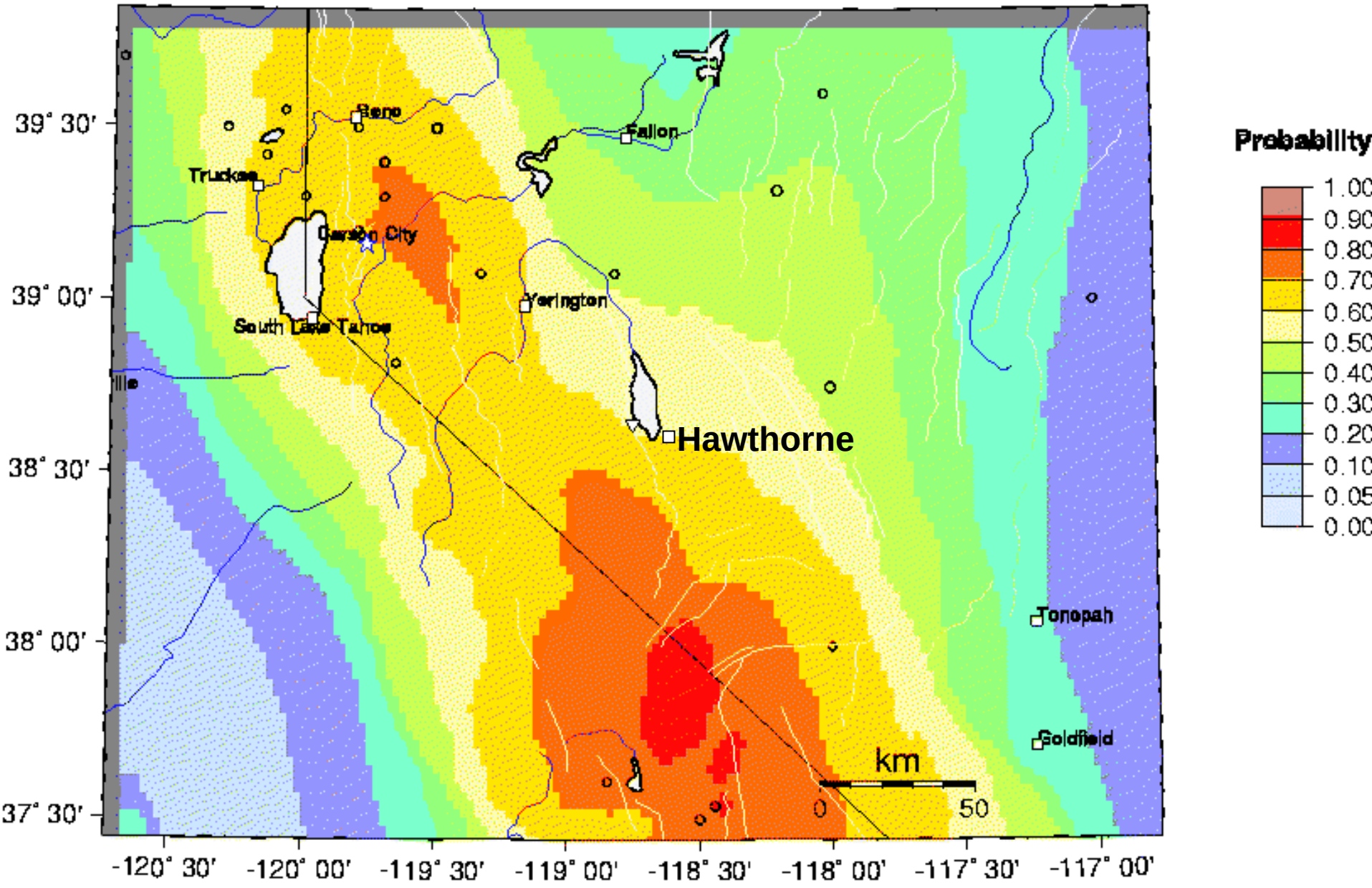
10-12% chance for Hawthorne, magnitude 7.0

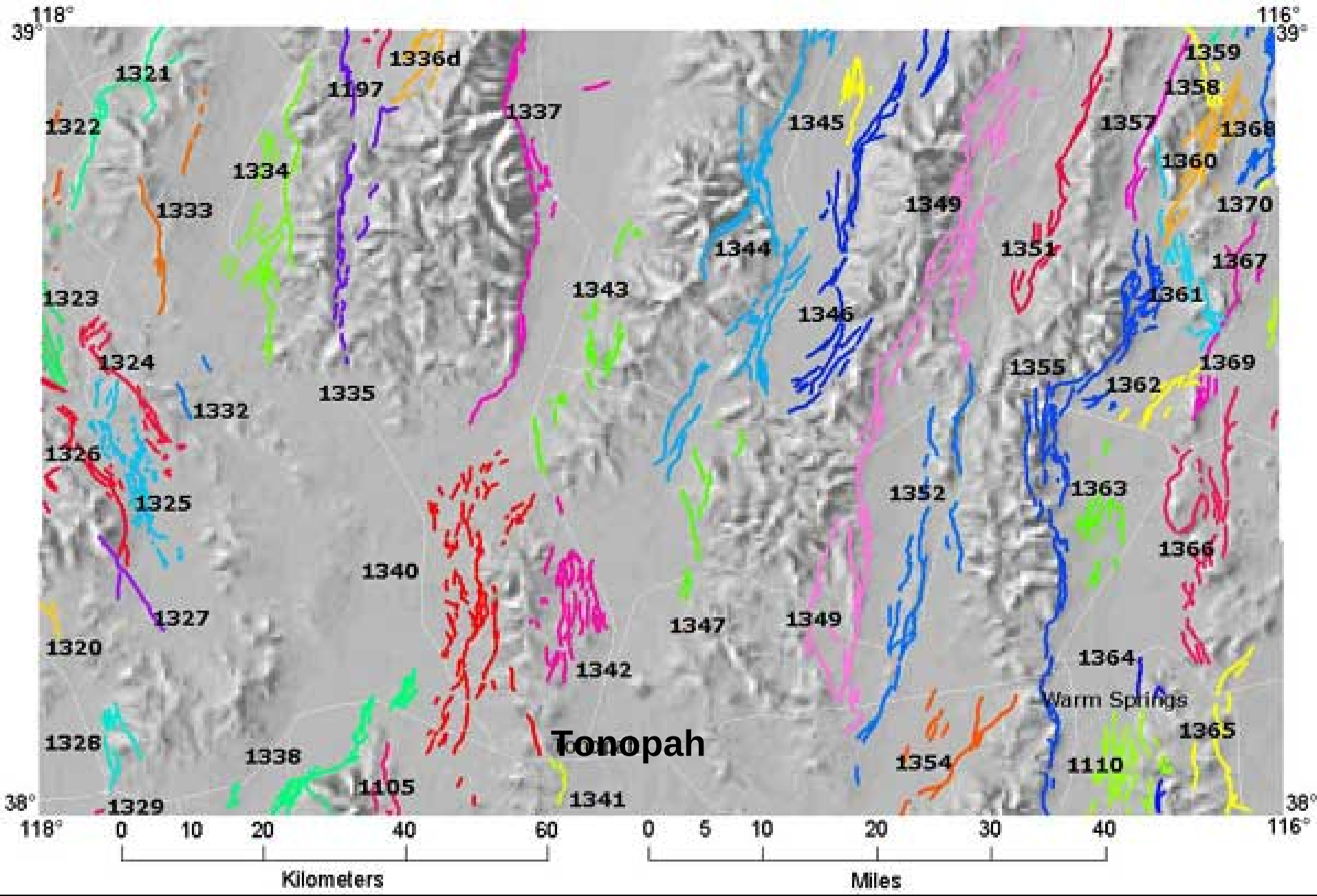


Hawthorne: $78 million loss in Mineral County from magnitude 7.5

Probability of an earthquake of magnitude 6.0 or greater occurring within 50 km in 50 years (from USGS probabilistic seismic hazard analysis)

>60% chance for Reno, Carson City, Yerington, & Hawthorne

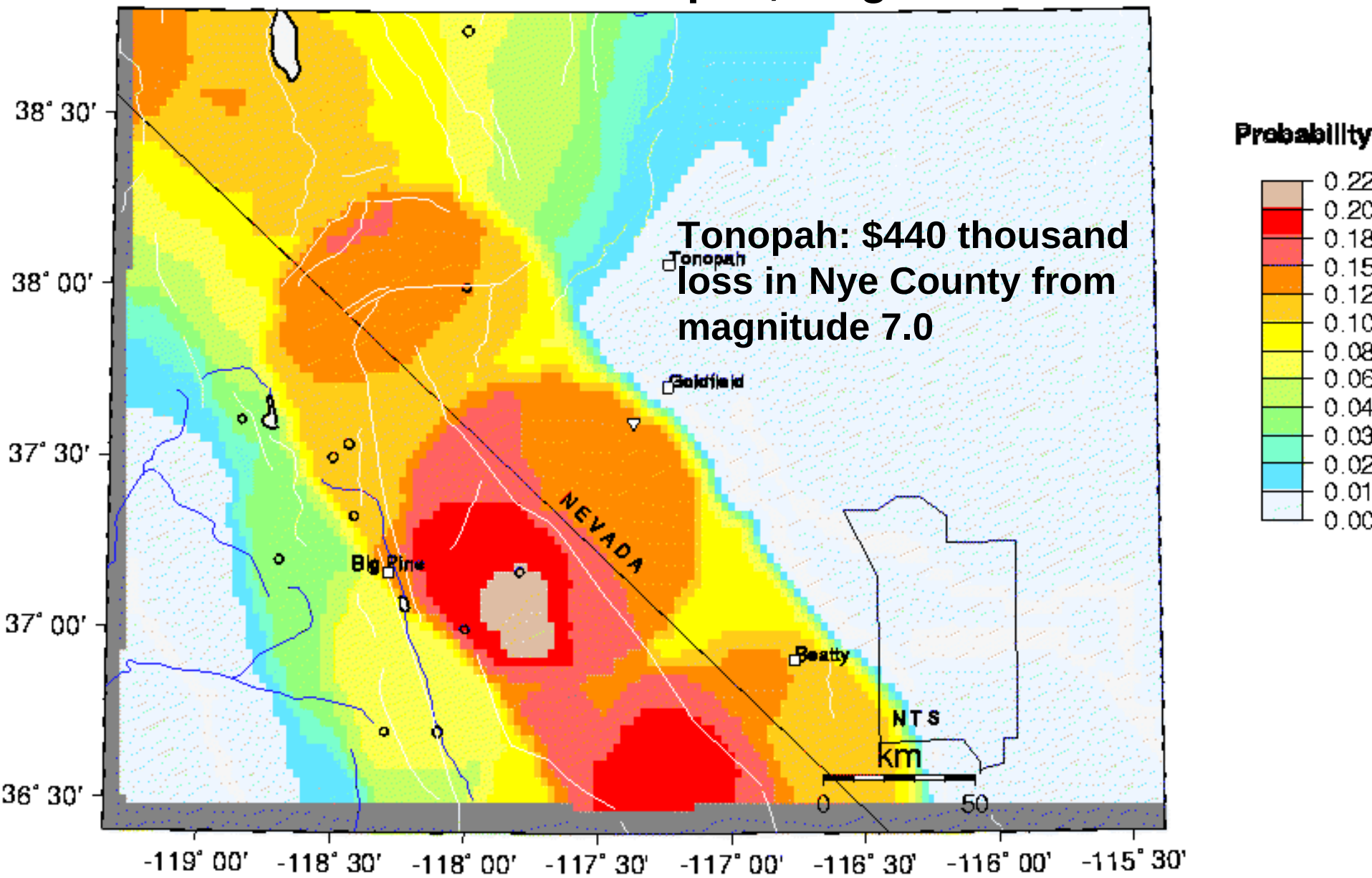




Active faults on the Tonopah 1 x 2-degree sheet

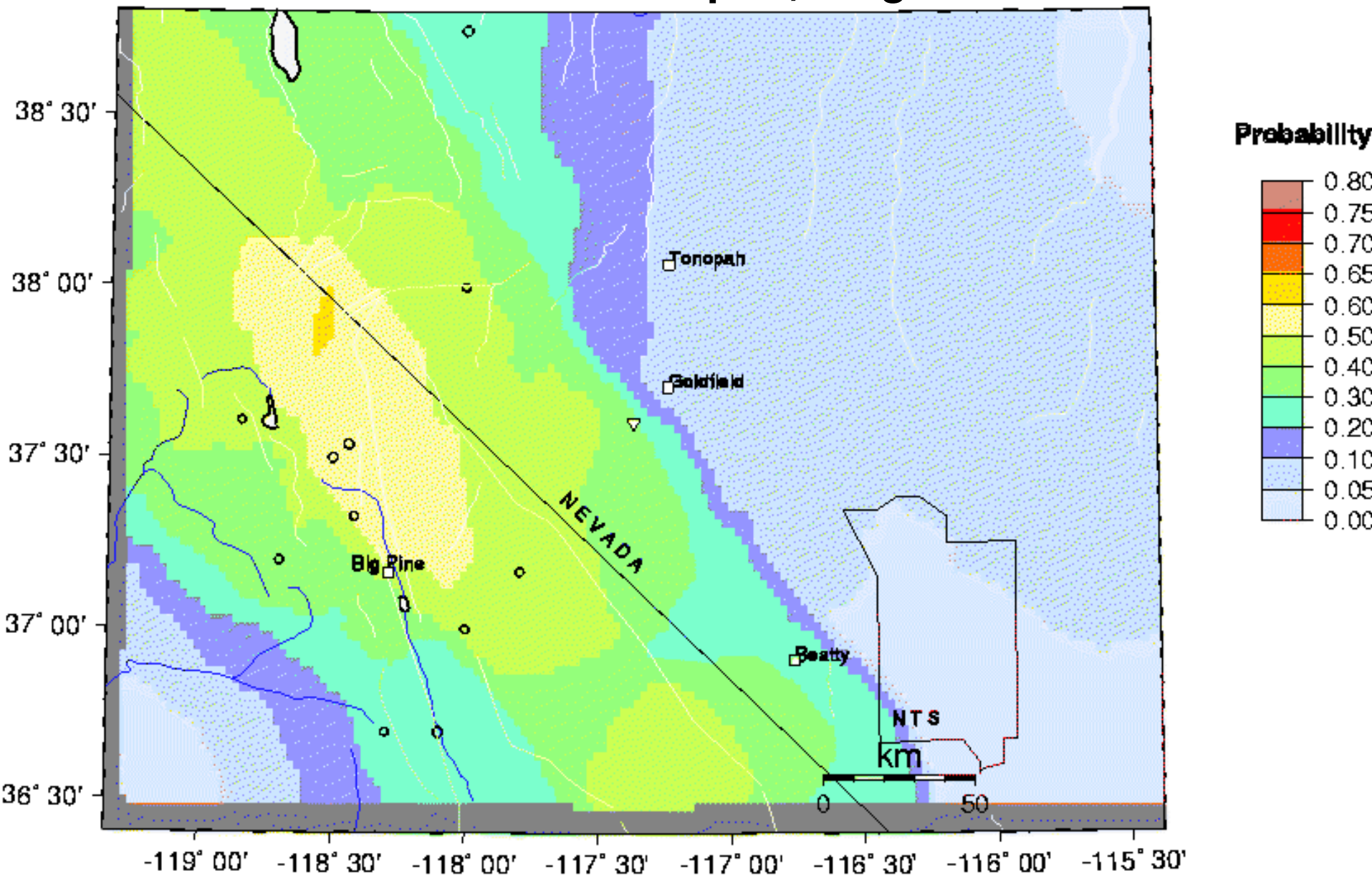
Probability of an earthquake of magnitude 7.0 or greater occurring within 50 km in 50 years (from USGS probabilistic seismic hazard analysis)

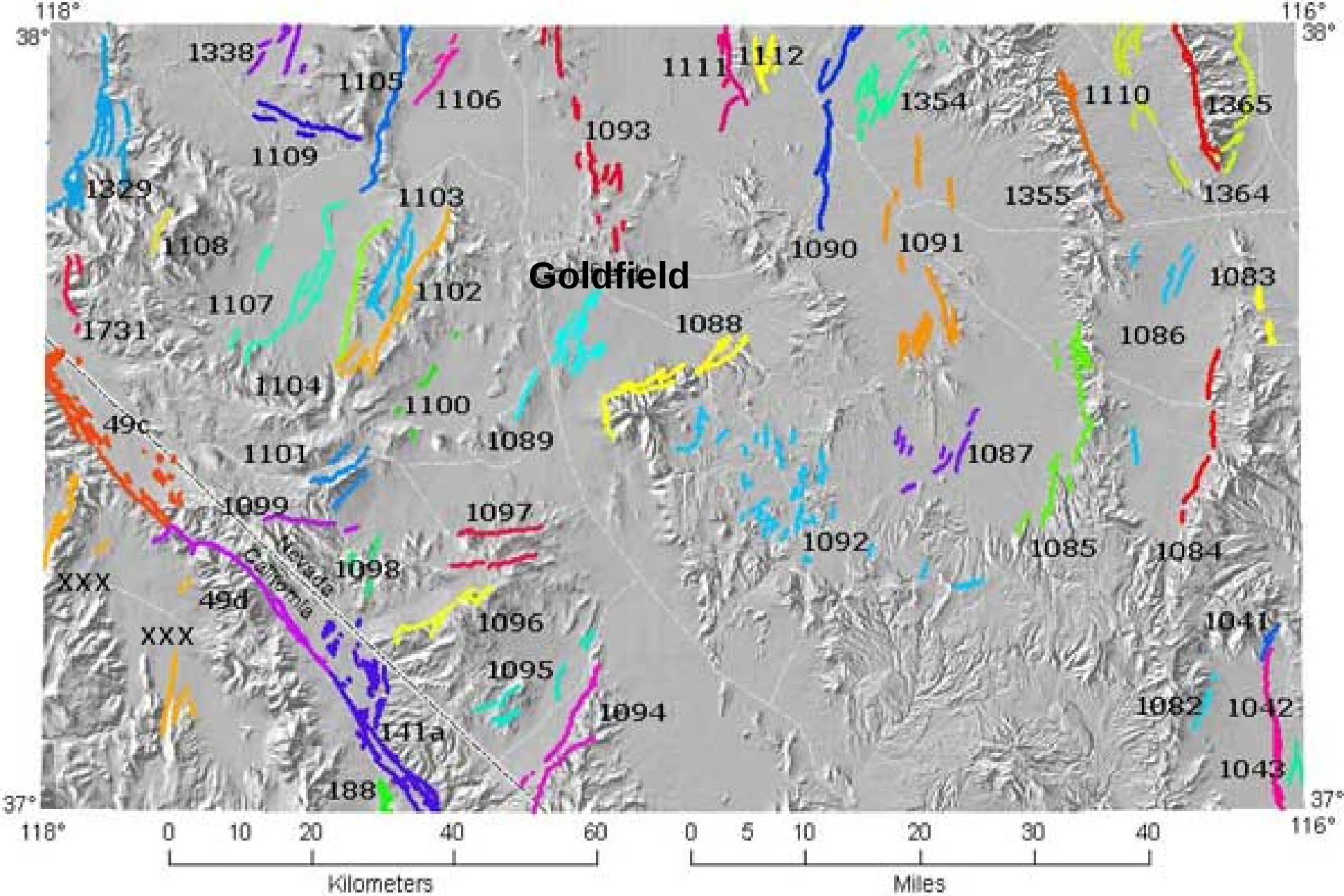
<1% chance for Tonopah, magnitude 7.0



Probability of an earthquake of magnitude 6.5 or greater occurring within 50 km in 50 years (from USGS probabilistic seismic hazard analysis)

5-10% chance for Tonopah, magnitude 6.5

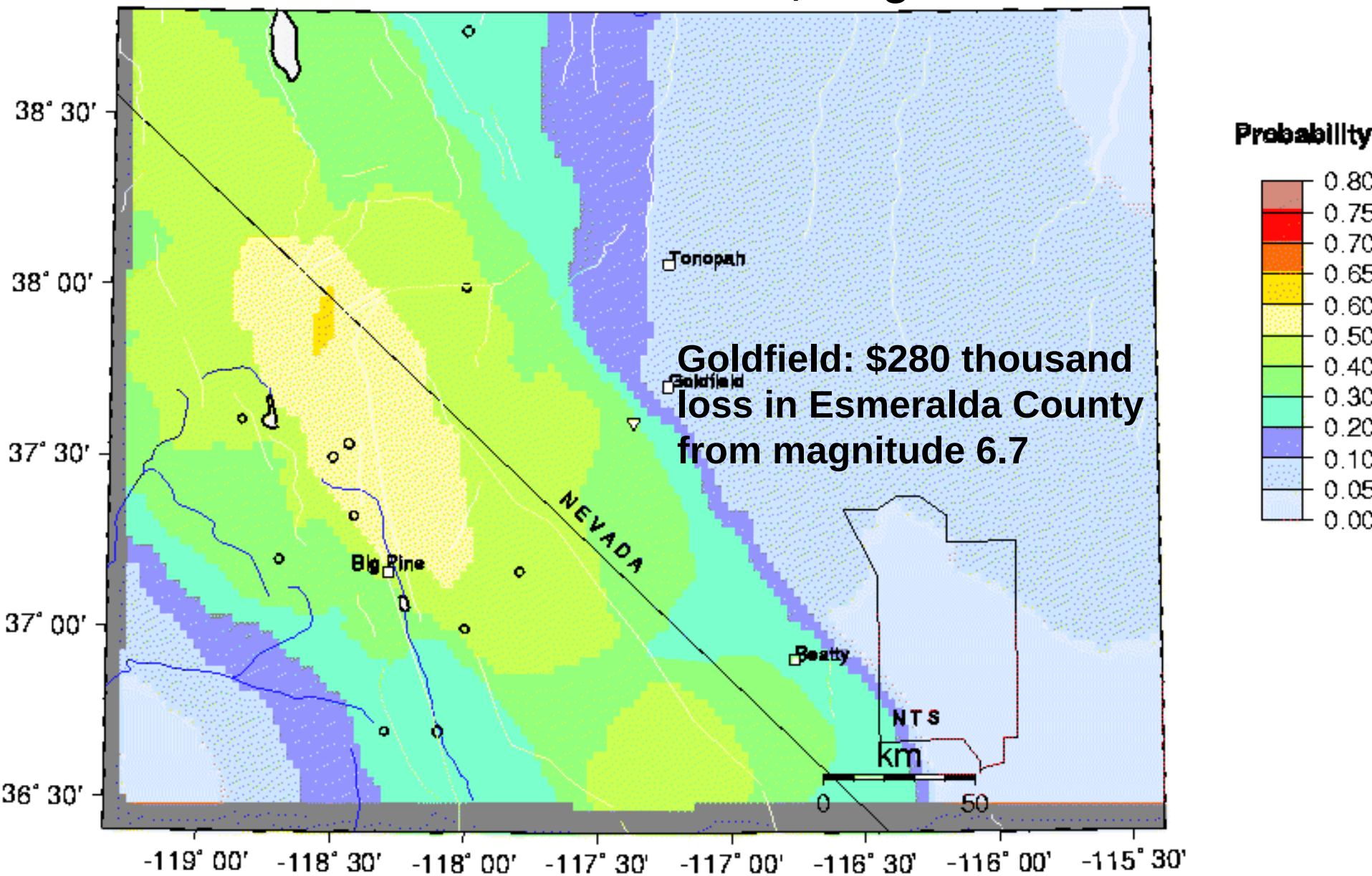


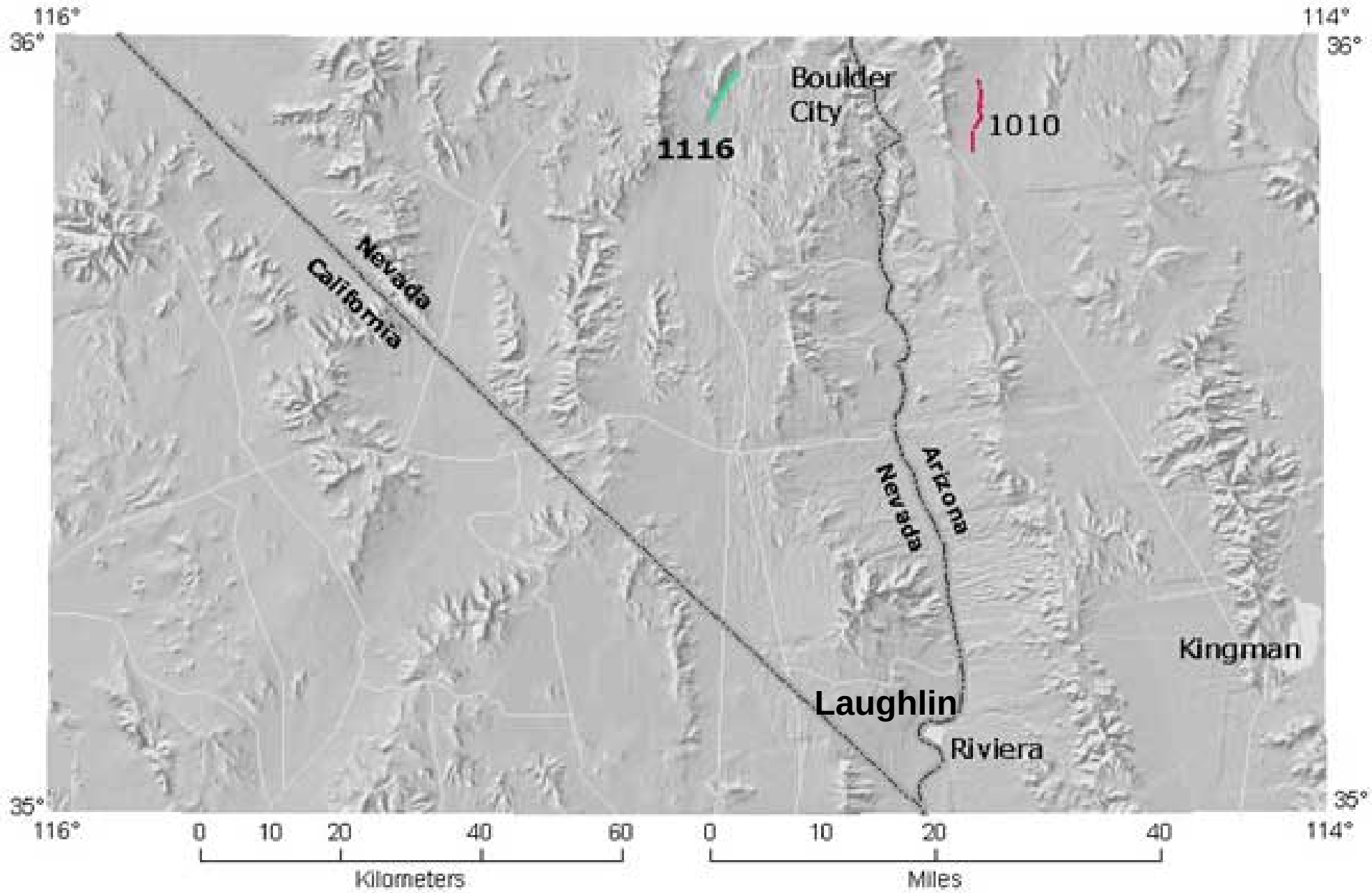


Active faults on the Goldfield 1 x 2-degree sheet

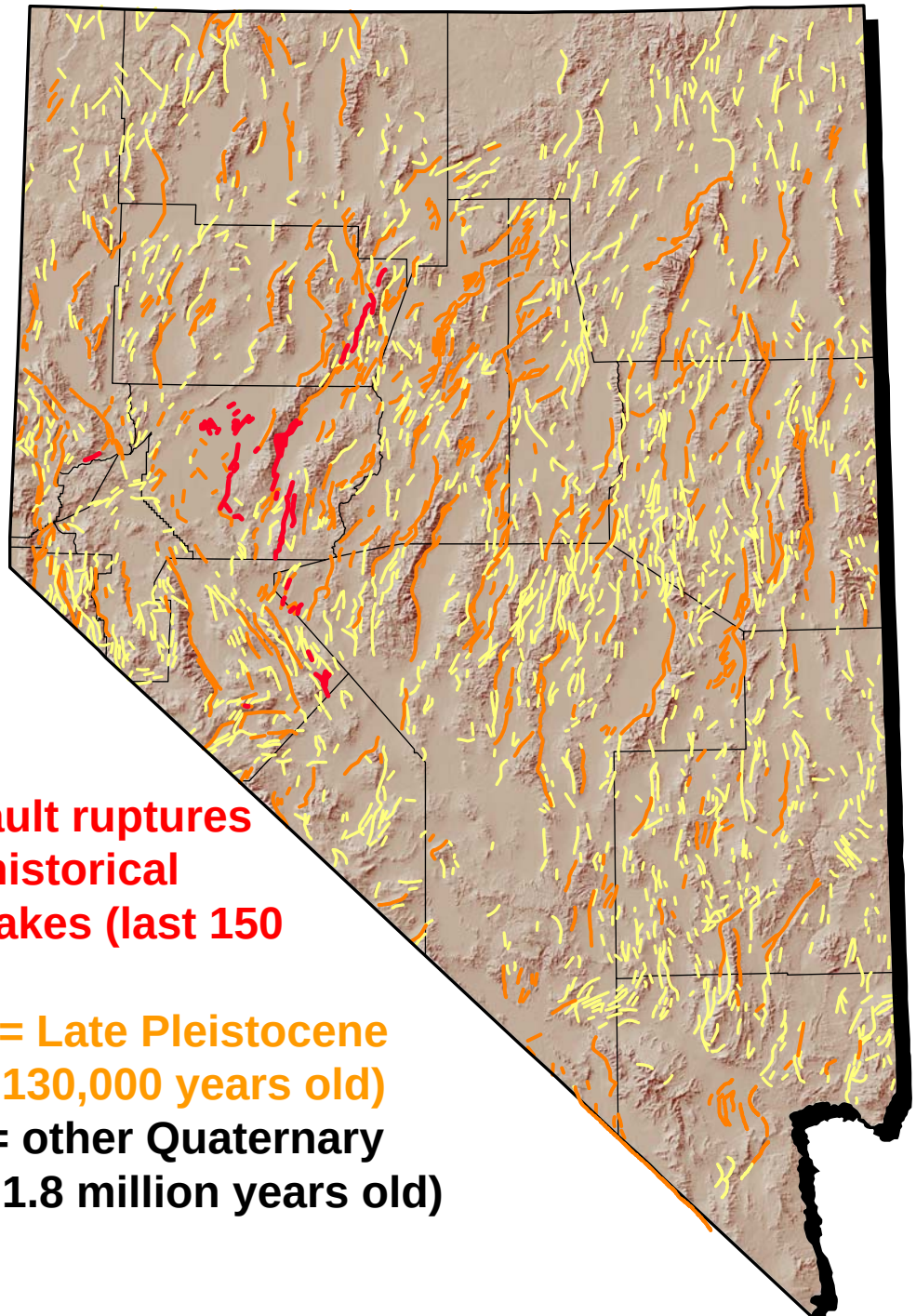
Probability of an earthquake of magnitude 6.5 or greater occurring within 50 km in 50 years (from USGS probabilistic seismic hazard analysis)

5-10% chance for Goldfield, magnitude 6.5





Faults on the Kingman 1 x 2-degree sheet



Red = fault ruptures during historical earthquakes (last 150 years)

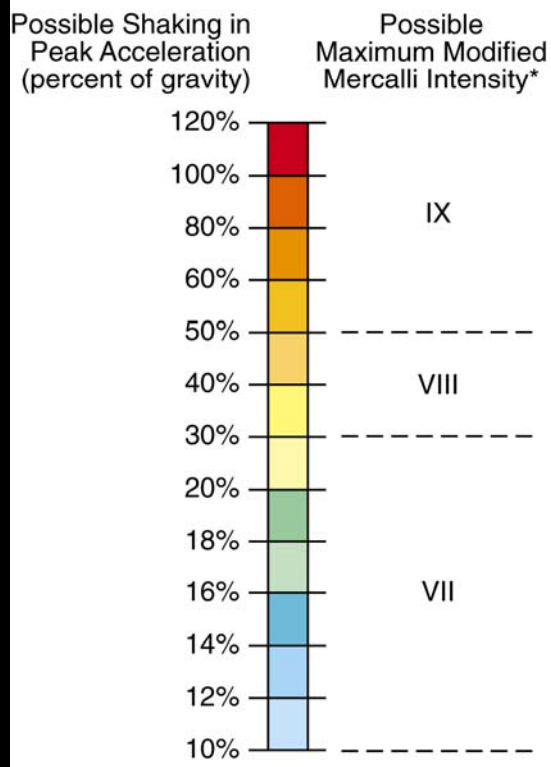
Orange = Late Pleistocene faults (<130,000 years old)

Yellow = other Quaternary faults (<1.8 million years old)

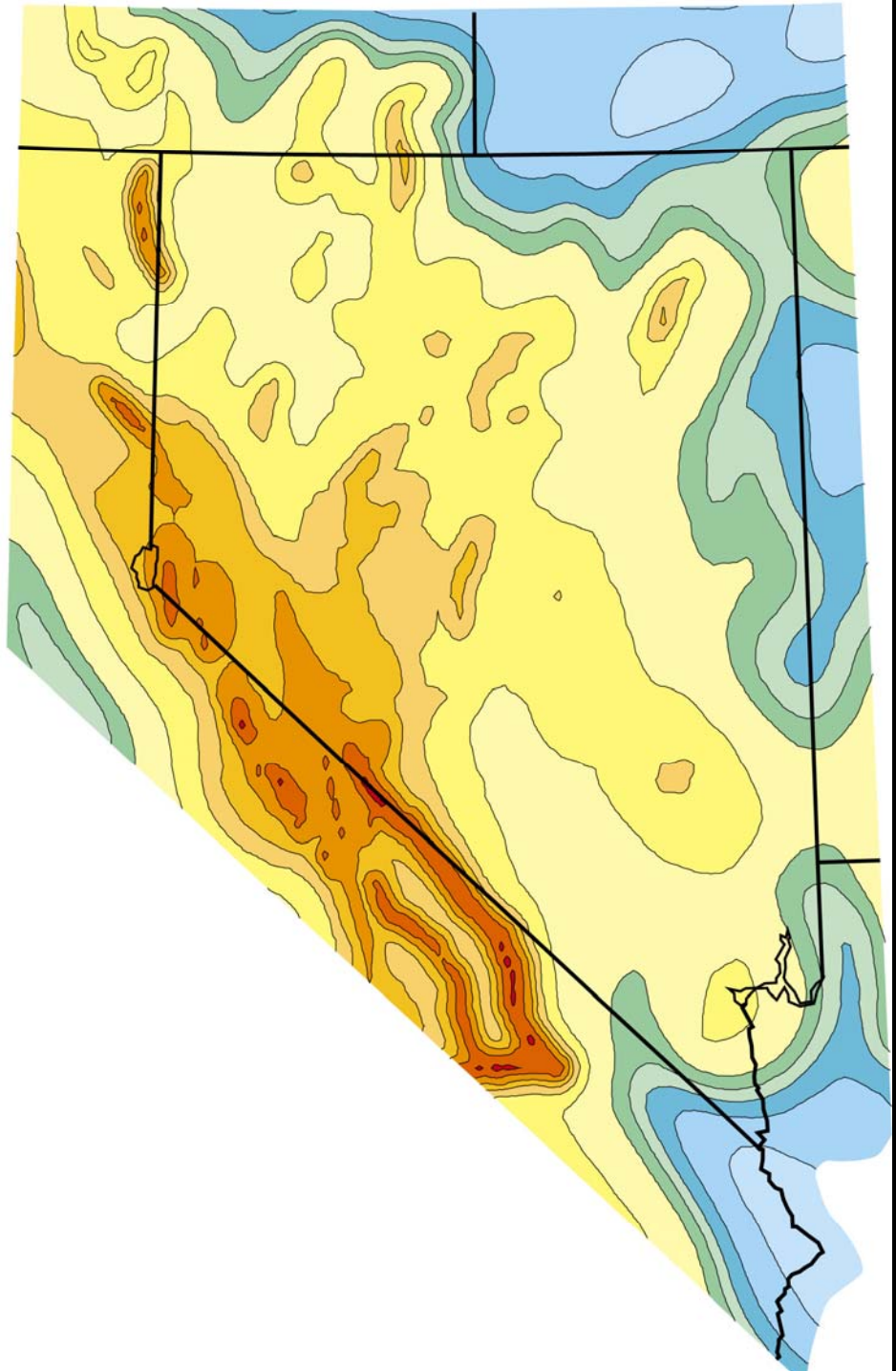
There are active faults nearly everywhere in Nevada,

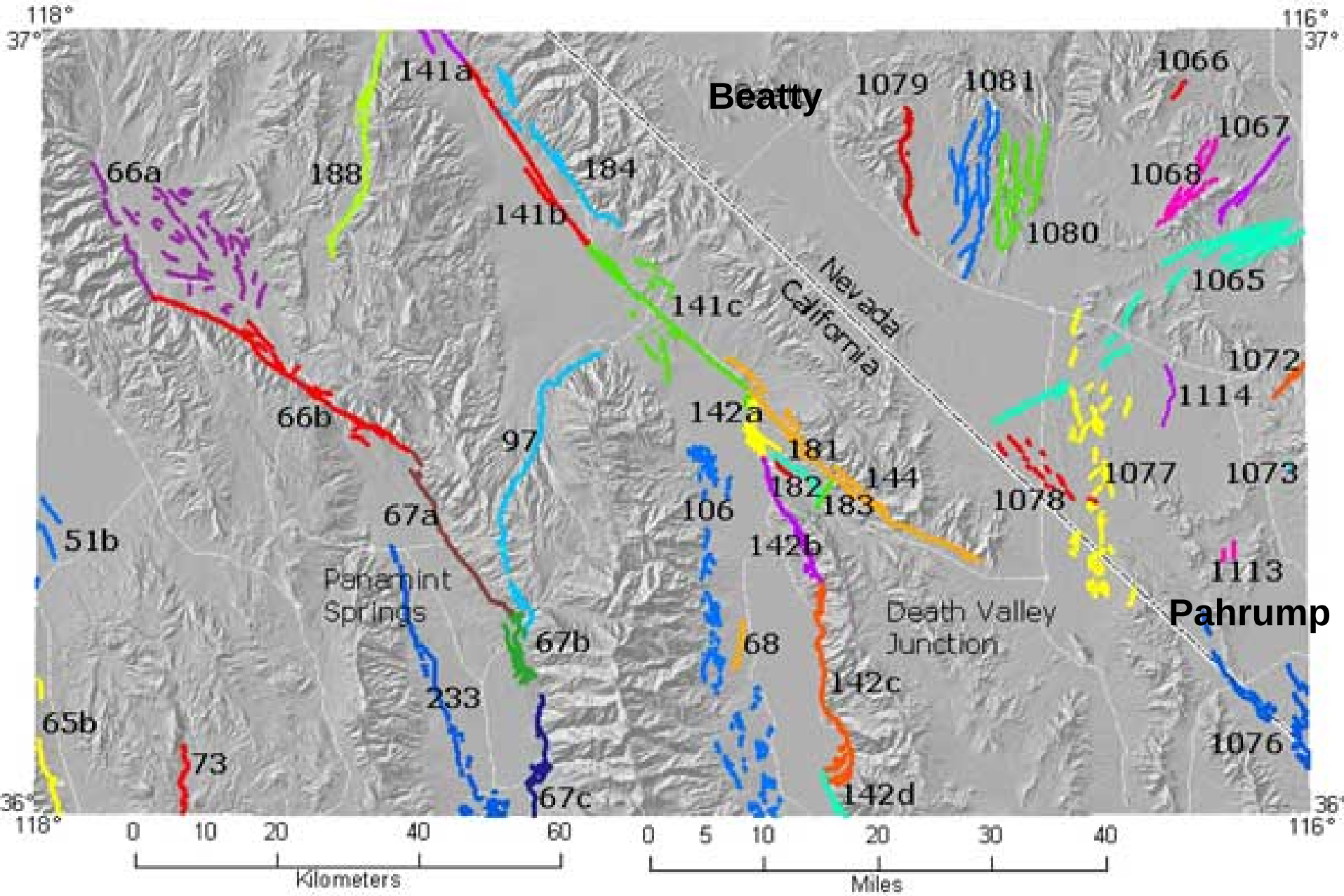
but not everywhere.

Shaking Potential Map for Nevada

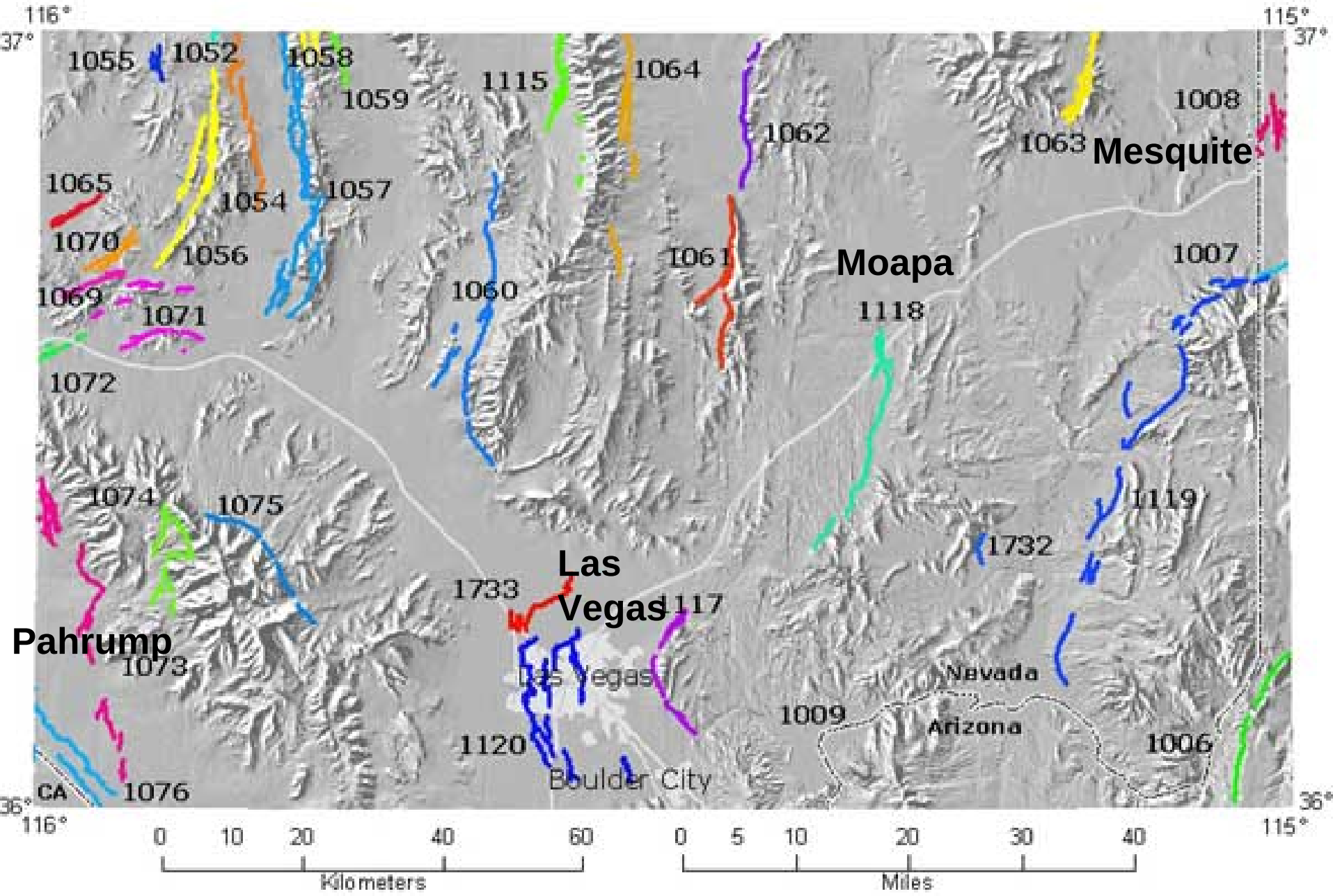


* See page 4 for descriptions of Intensity VII and VIII. In Intensity IX, general panic occurs and there may be damage to some well-built structures.



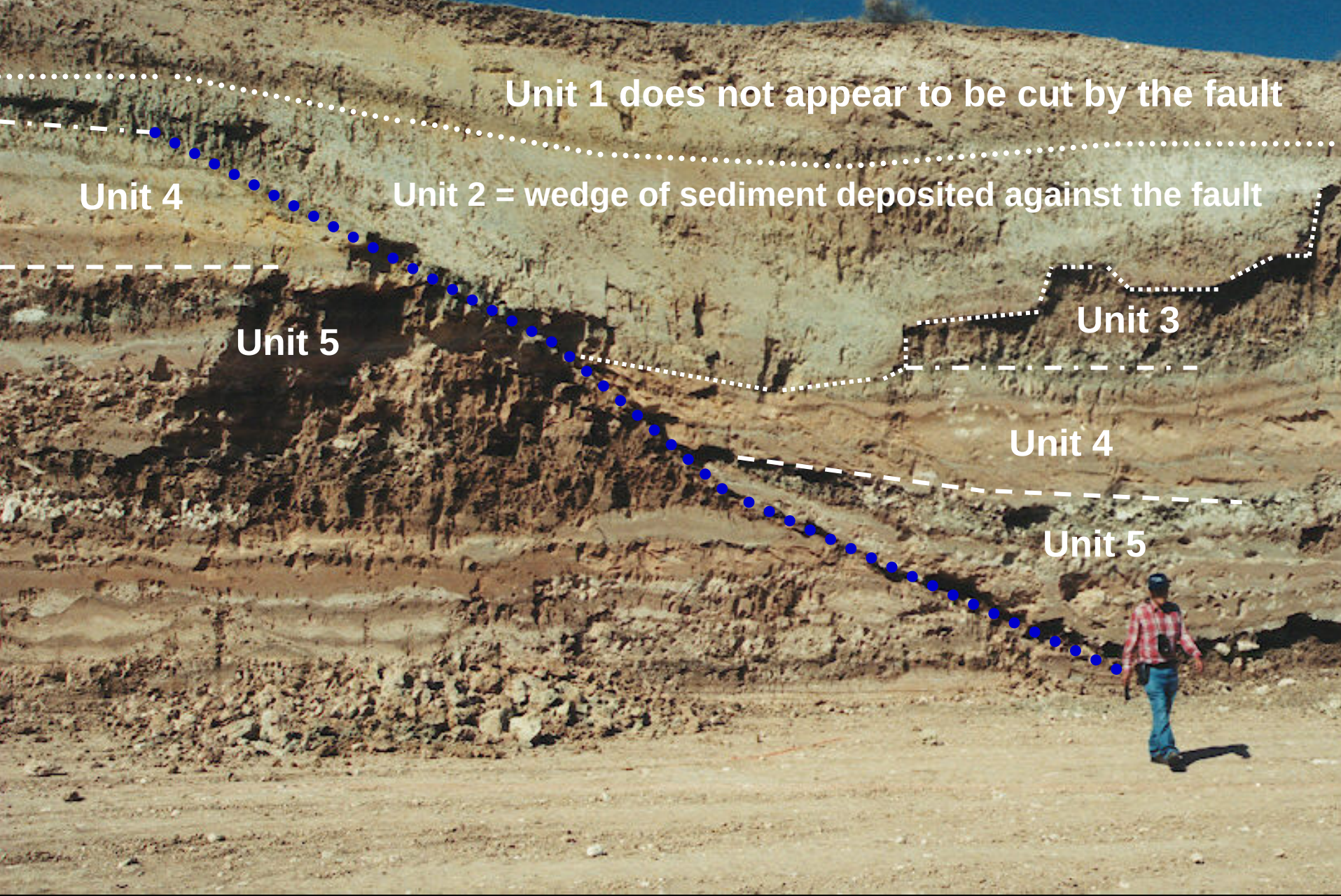


Faults on the Death Valley 1 x 2-degree sheet

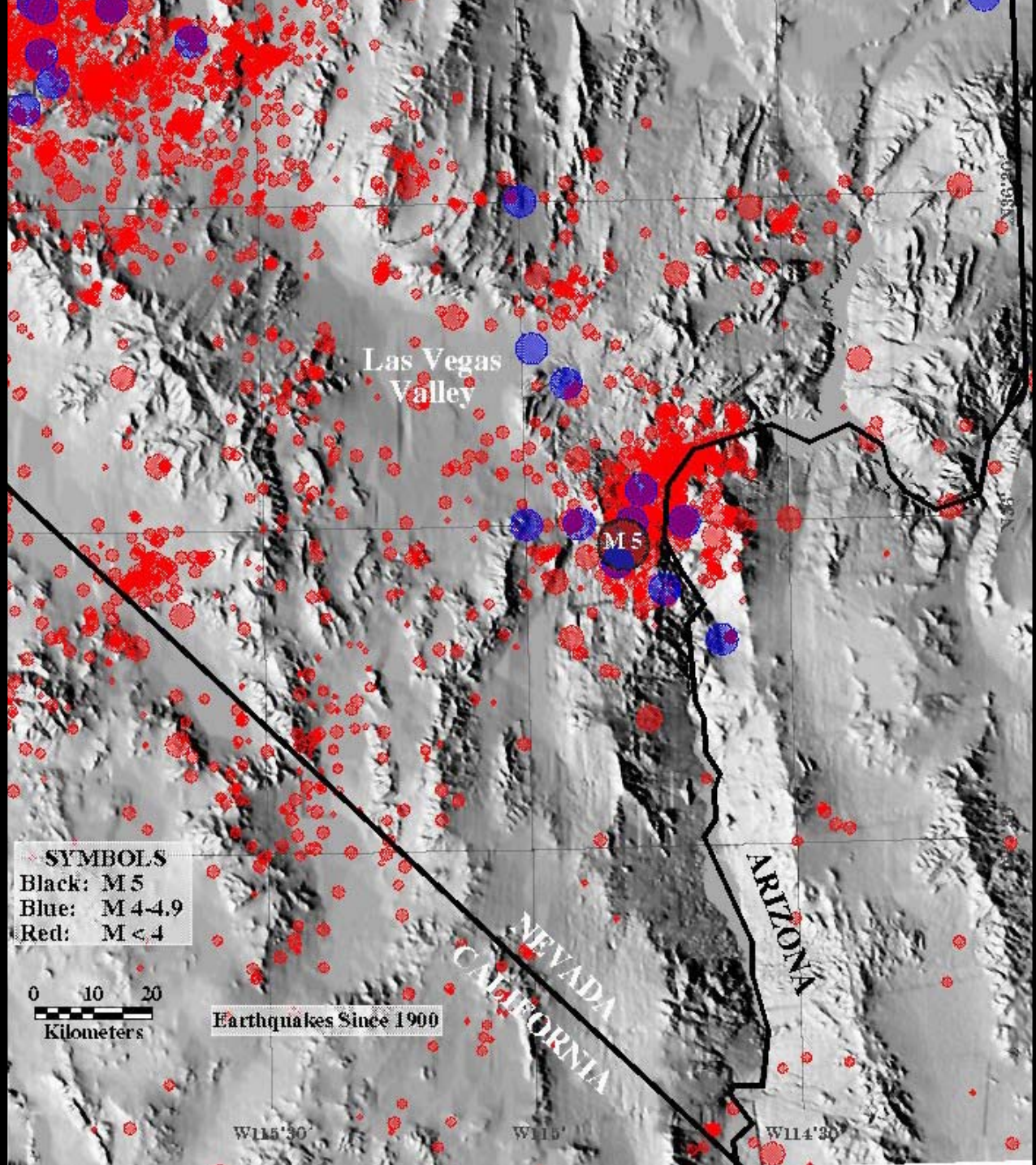


Faults on the Las Vegas 1 x 2-degree sheet

Quaternary fault exposed at construction site in Las Vegas Valley



Quaternary fault exposed at construction site in Las Vegas Valley



Measured earthquakes in the Las Vegas area

The risks are huge.

For a magnitude 6.6 earthquake on the Frenchman Mountain fault, HAZUS estimated:

$4.4 to 17.7 billion in economic loss

major damage to approximately 30,000 buildings

3,000 to 11,000 people needing public shelter

200 to 800 fatalities.

For a magnitude 5.9 daytime earthquake on the Frenchman Mountain fault, HAZUS estimated, for all of Clark County:

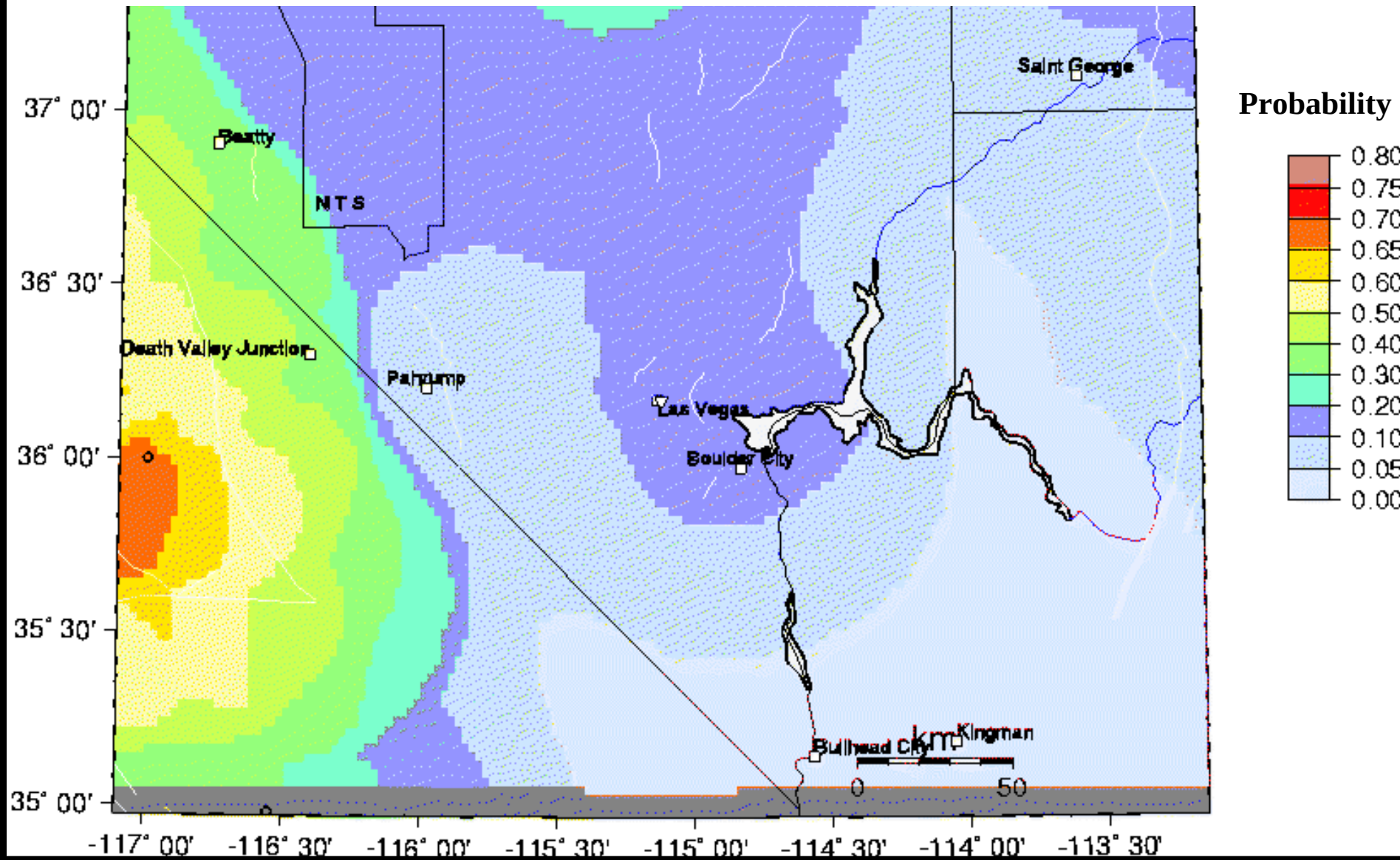
$2.2 to 8.9 billion in economic loss,
of which $1.2 to 4.7 billion would be in building damage,
$0.3 to 1.3 billion would be in damage to building contents, and
$0.7 to 2.9 billion in business interruption losses related to the building stock;

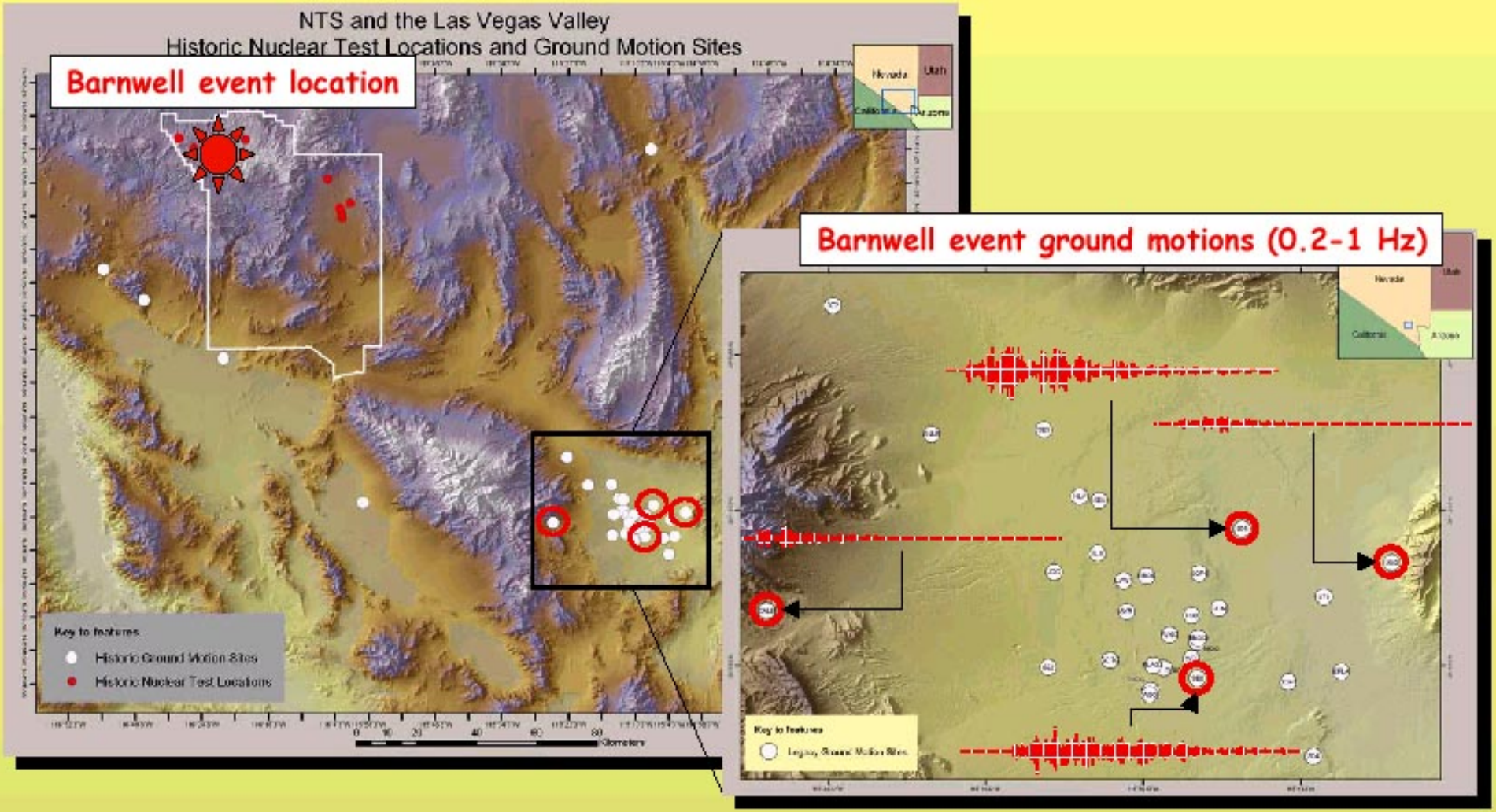
major damage to 4,000 to 17,000 buildings
(655 completely destroyed),
3,000 to 12,000 people needing public shelter,
300 to 1,200 people needing hospital care (*but only 768 of 2,341 beds would be available in the county during the first day, up to 910 at Day 3 and 1,730 at Day 30*)**; and**
80 to 300 fatalities.
(Casualty numbers are expected to be less for either a night-time or commute-time earthquake.)

(from NBMG-NDEM-FEMA-sponsored earthquake exercise for the City of Las Vegas, 2003)

Probability of an earthquake of magnitude 6.0 or greater occurring within 50 km in 50 years (from USGS probabilistic seismic hazard analysis)

10-20% chance for Las Vegas area, magnitude 6





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).

The main points:

1. The earthquake risks are huge in Nevada.

2. We can do something about it.

   a. Be prepared to respond.

   b. Mitigate structural risks, largely through building codes and avoiding faults and areas of liquefaction.

   c. Mitigate nonstructural risks.

Nonstructural damage often can be easily prevented.

Earthquake-secure bookshelves in the office of the State Geologist

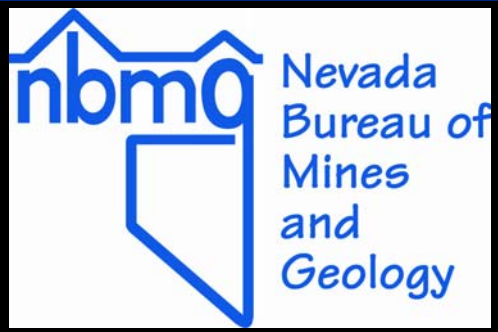
Secured computers at the Clark County Building Department


PHILIPS
Desktop Editor

Information about Nevada earthquakes and what you can do:

Nevada Bureau of Mines and Geology
www.nbmg.unr.edu

Nevada Seismological Laboratory
www.seismo.unr.edu



Loss-Estimation Modeling of Earthquake Scenarios for Each County in Nevada Using HAZUS-MH

Nevada Bureau of Mines and Geology
Open-File Report 06-1
University of Nevada, Reno

There are huge risks.

We can take action to reduce the risks.

THE UNIVERSITY OF NEVADA RENO

nbmg Nevada Bureau of Mines and Geology

NEVADA Seismological Laboratory

Nevada Earthquake Safety Council

Nevada Department of Public Safety
Division of Emergency Management

FEMA

Be prepared for fires (Loma Prieta = World Series Earthquake, 1989).

Loma Prieta = World Series Earthquake, 1989

San Francisco, 1906


COPYRIGHTED 1906
BY STEWART & ROGERS

San Francisco, 1906, after the earthquake and fire

Expect damage to the infrastructure (I-5, Northridge Earthquake, 1994).

Expect damage to highways (Oakland, 1989 World Series Earthquake).

Retrofitting can sometimes help (Oakland, 1989).

Expect disruptions to utilities (electricity, water, sewage, telephones, etc., Northridge, 1994).

Expect disruptions to communications (radio tower, Bay area, 1989).

Expect damage in areas with poor soil or rock conditions
(Loma Prieta, 1989).

Expect liquefaction (Loma Prieta, 1989).

Loma Prieta Earthquake, Marina district, San Francisco, 1989

Expect lateral spreading (Loma Prieta, 1989).

Expect damage to unreinforced masonry buildings (Northridge, 1994).

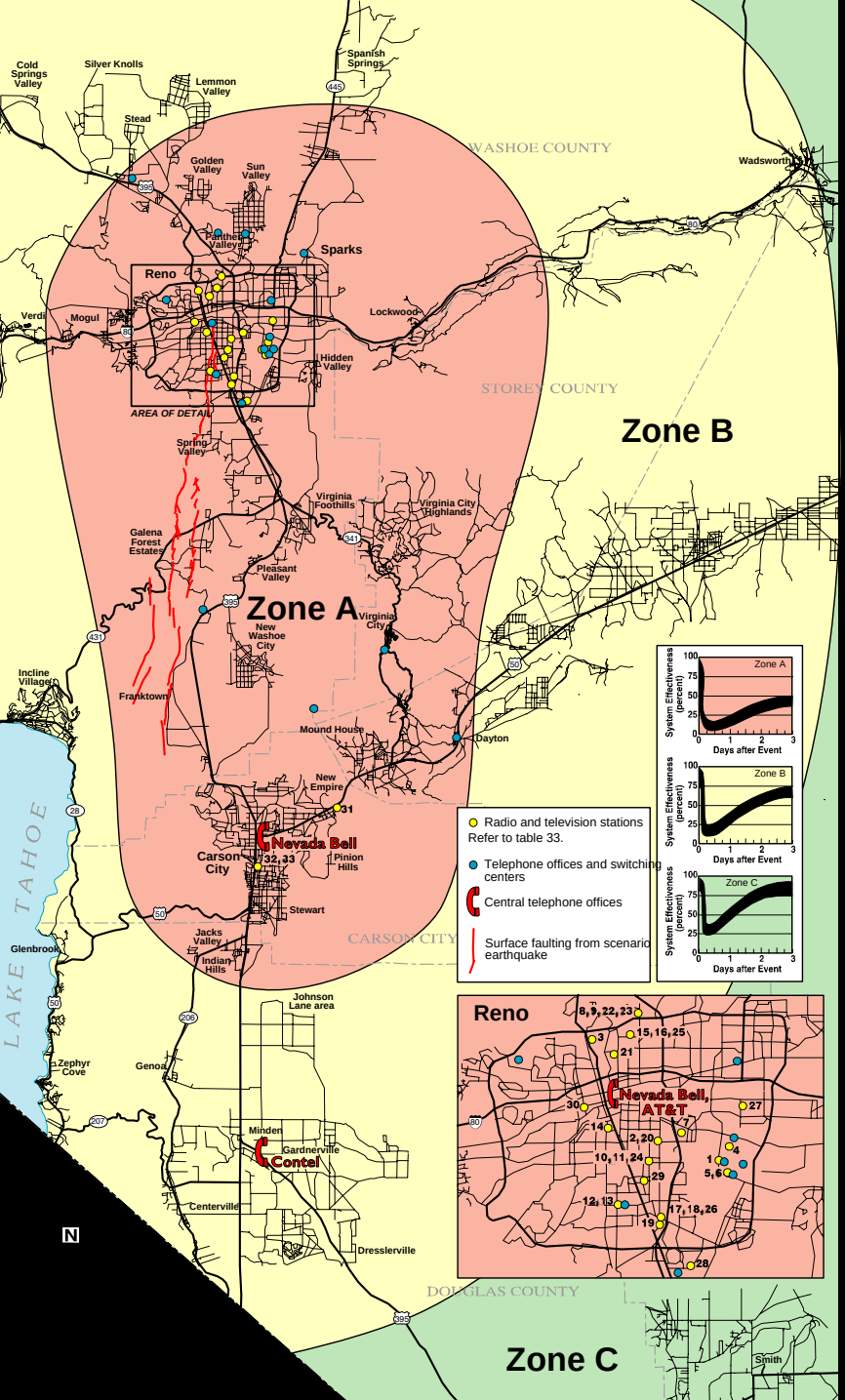
Expect damage to older buildings with soft-story construction (Northridge, 1994).

Hope that construction practices were up to code (6-story bldg, Izmit, Turkey, 1999).

Expect problems with unusual construction (Cal State Northridge parking structure, 1994).

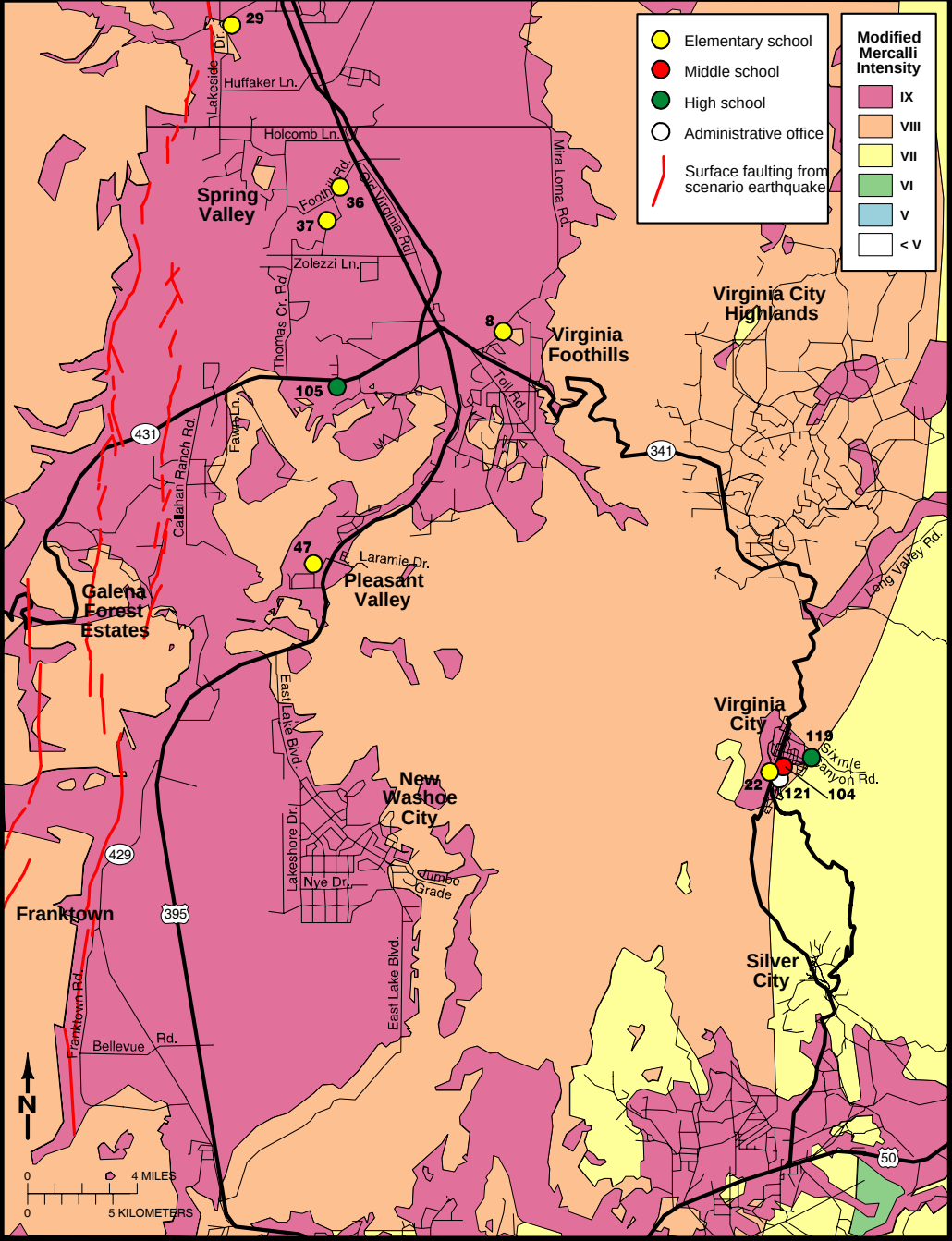
Hope people keep a sense of humor (but expect looting).

Expect large numbers of people needing food, clothing, and shelter (Loma Prieta, 1989).



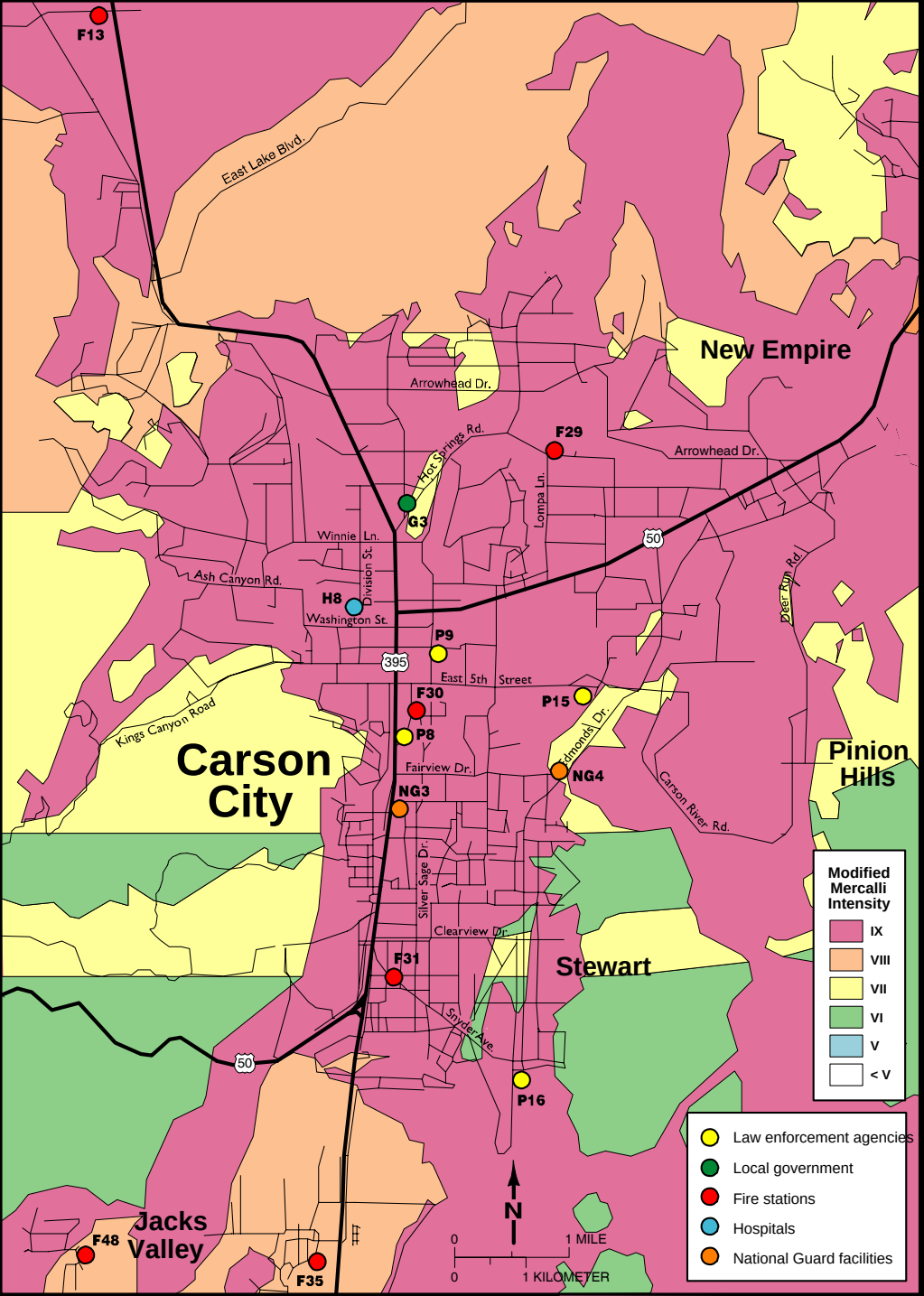
Be aware of potential loss of normal communications by telephones and cell phones.

from NBMG's 1996 "Planning Scenario for a Major Earthquake in Western Nevada" – A magnitude 7.1 earthquake on the Mt. Rose fault near Reno could cause loss of telephone and cell communications.



Be aware that potential shelters may be damaged.

from NBMG's 1996 "Planning Scenario for a Major Earthquake in Western Nevada"



Be aware of potential damage to fire, police, and other emergency operations.

from NBMG's 1996 "Planning Scenario for a Major Earthquake in Western Nevada" – A magnitude 7.1 earthquake on the Mt. Rose fault near Reno could cause significant shaking in Carson City.

Loss-Estimation Modeling of Earthquake Scenarios for Each County in Nevada Using HAZUS-MH

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