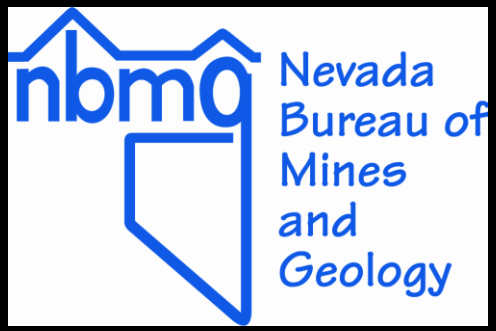
Earthquake faults occur throughout Nevada, and potential losses from earthquakes are high for many communities.

Presentation to the Nevada Earthquake Safety Council
4 November 2009
by 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.

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.

Nevada Bureau of Mines and Geology

University of Nevada, Reno
Statewide • Worldwide

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

Age of Latest Fault Rupture

< 150 years (historical)

< 15,000 years

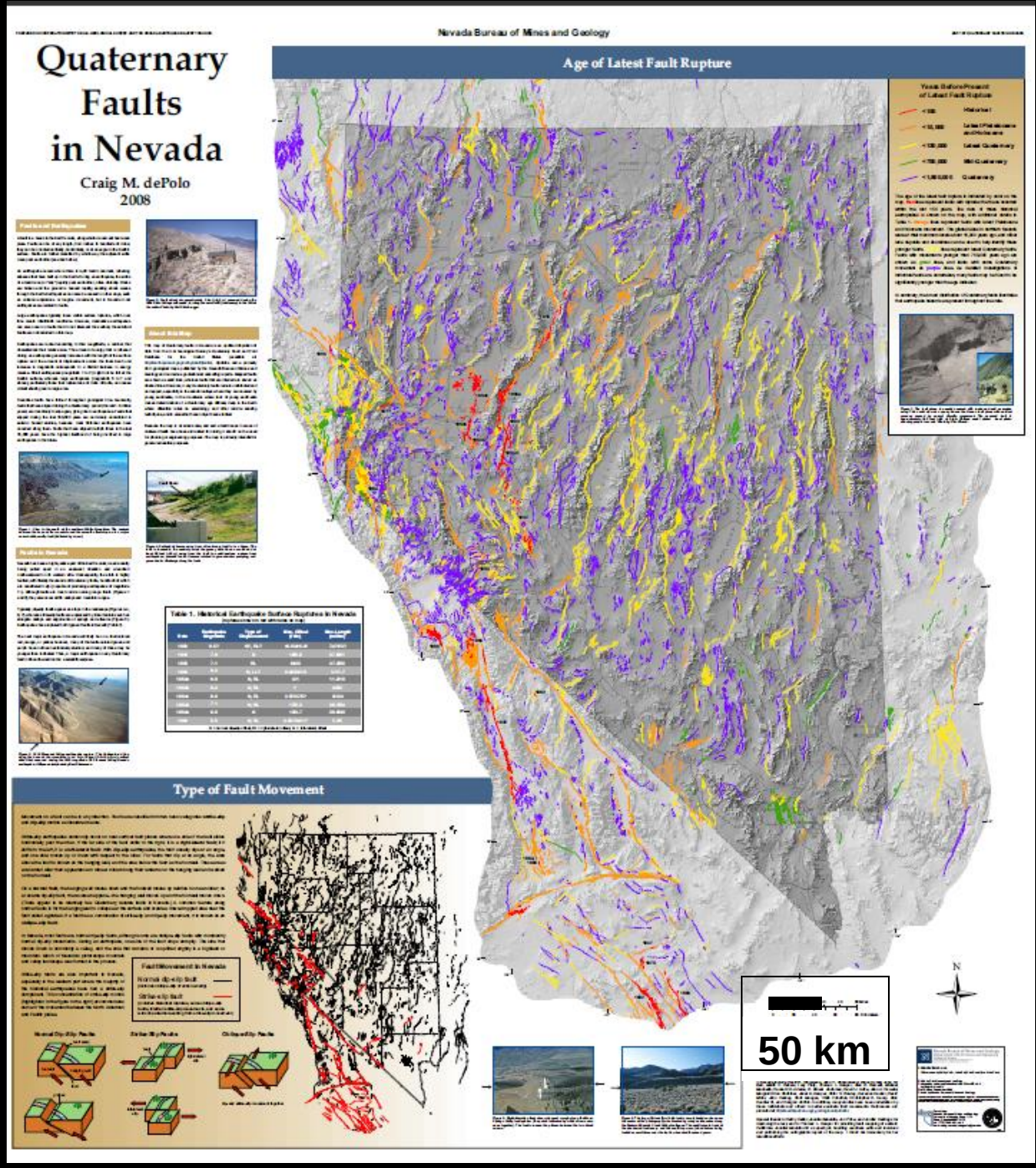
< 130,000 years

< 750,000 years

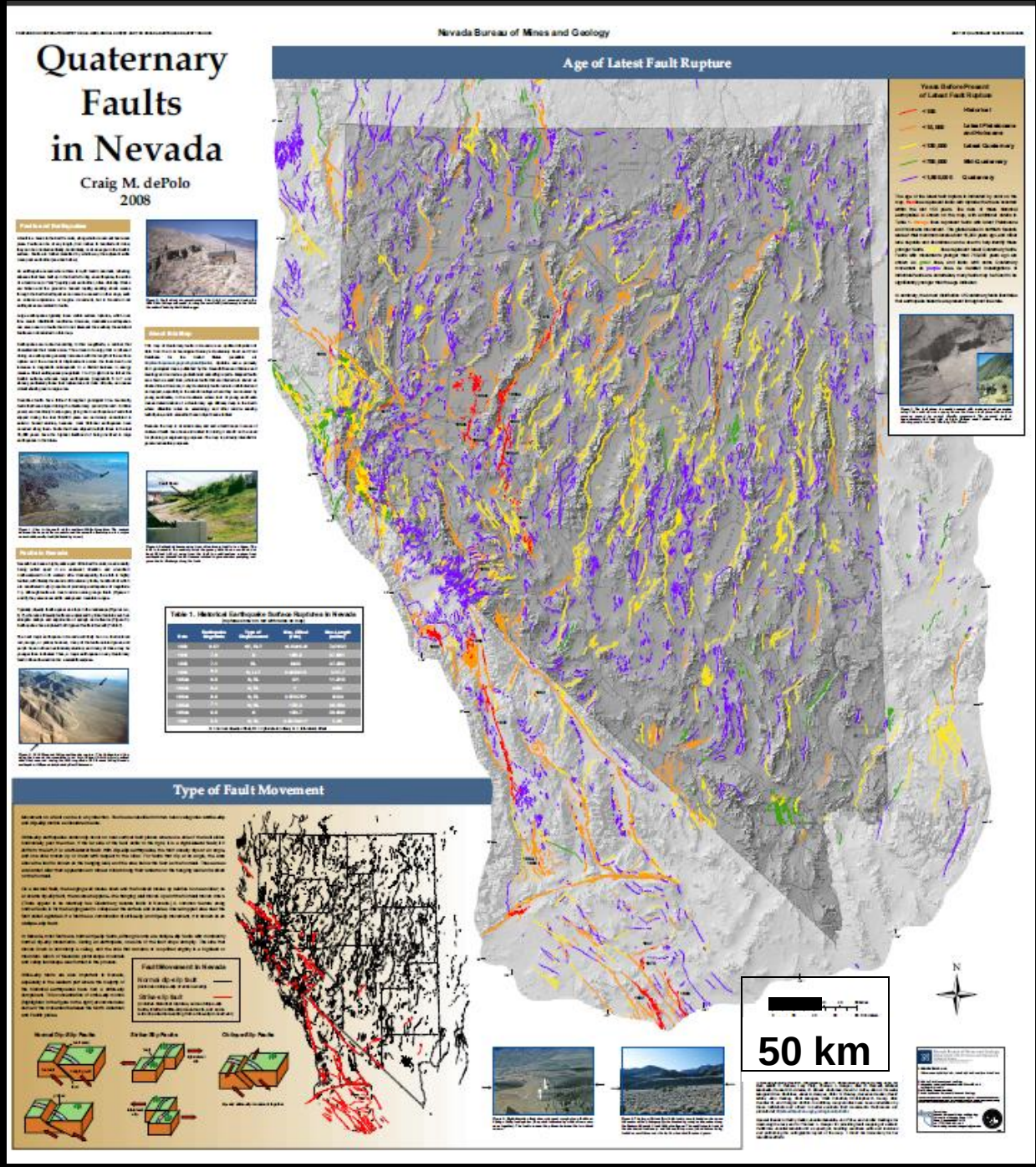
< 1,800,000 years (Quaternary)

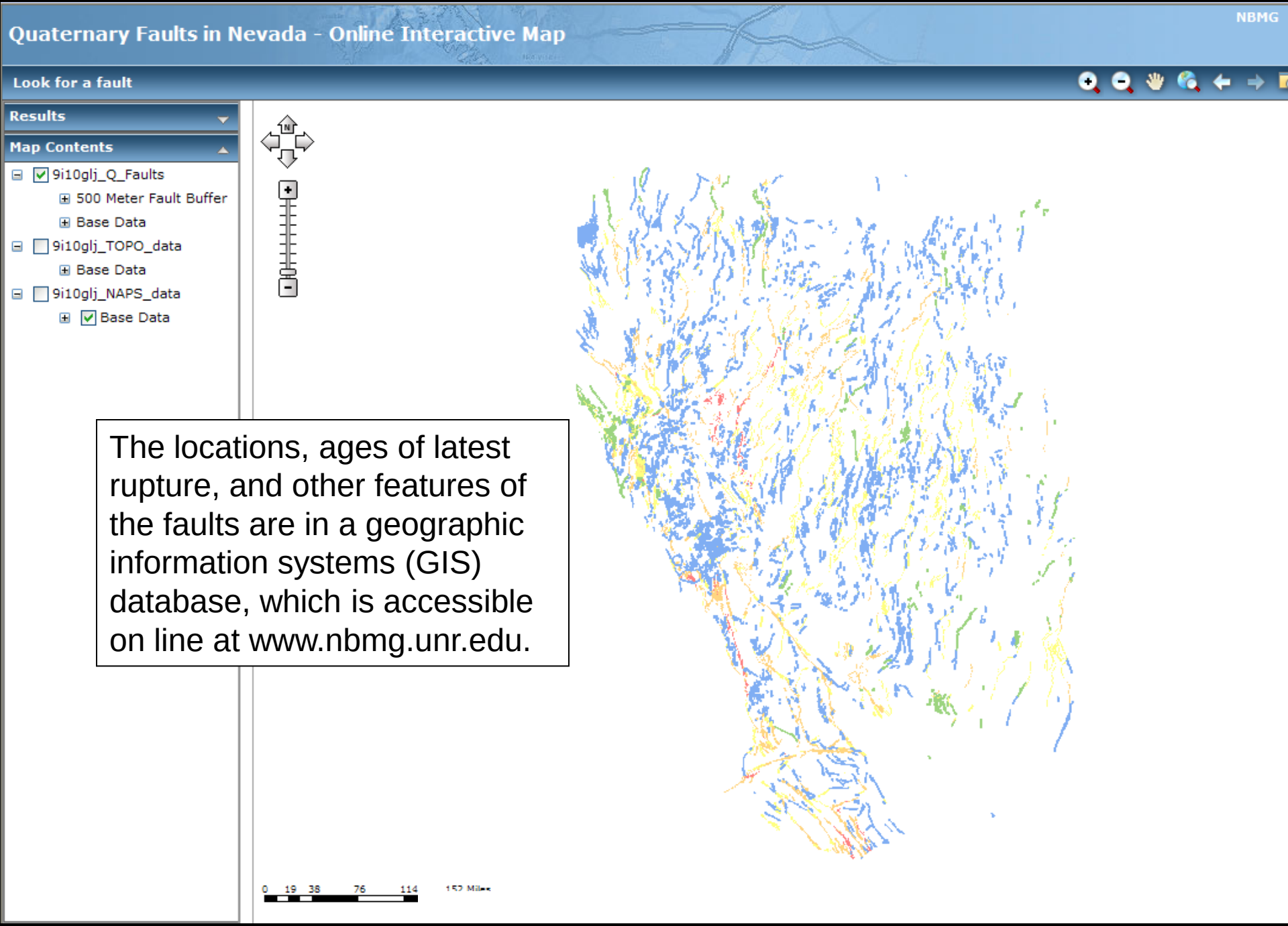
There are active faults nearly everywhere in Nevada. A magnitude 6.0 earthquake can occur anywhere in Nevada.

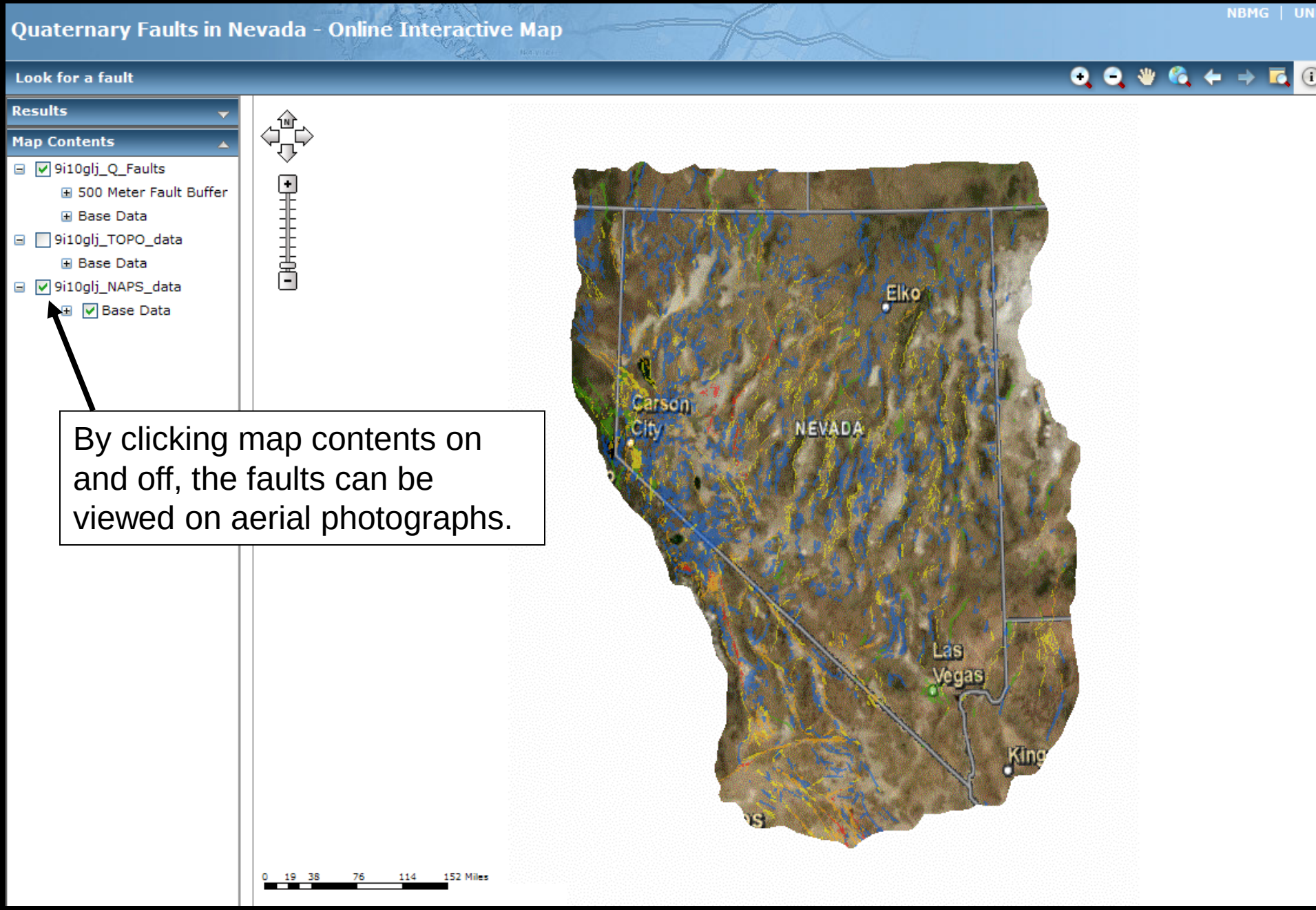
www.nbmg.unr.edu

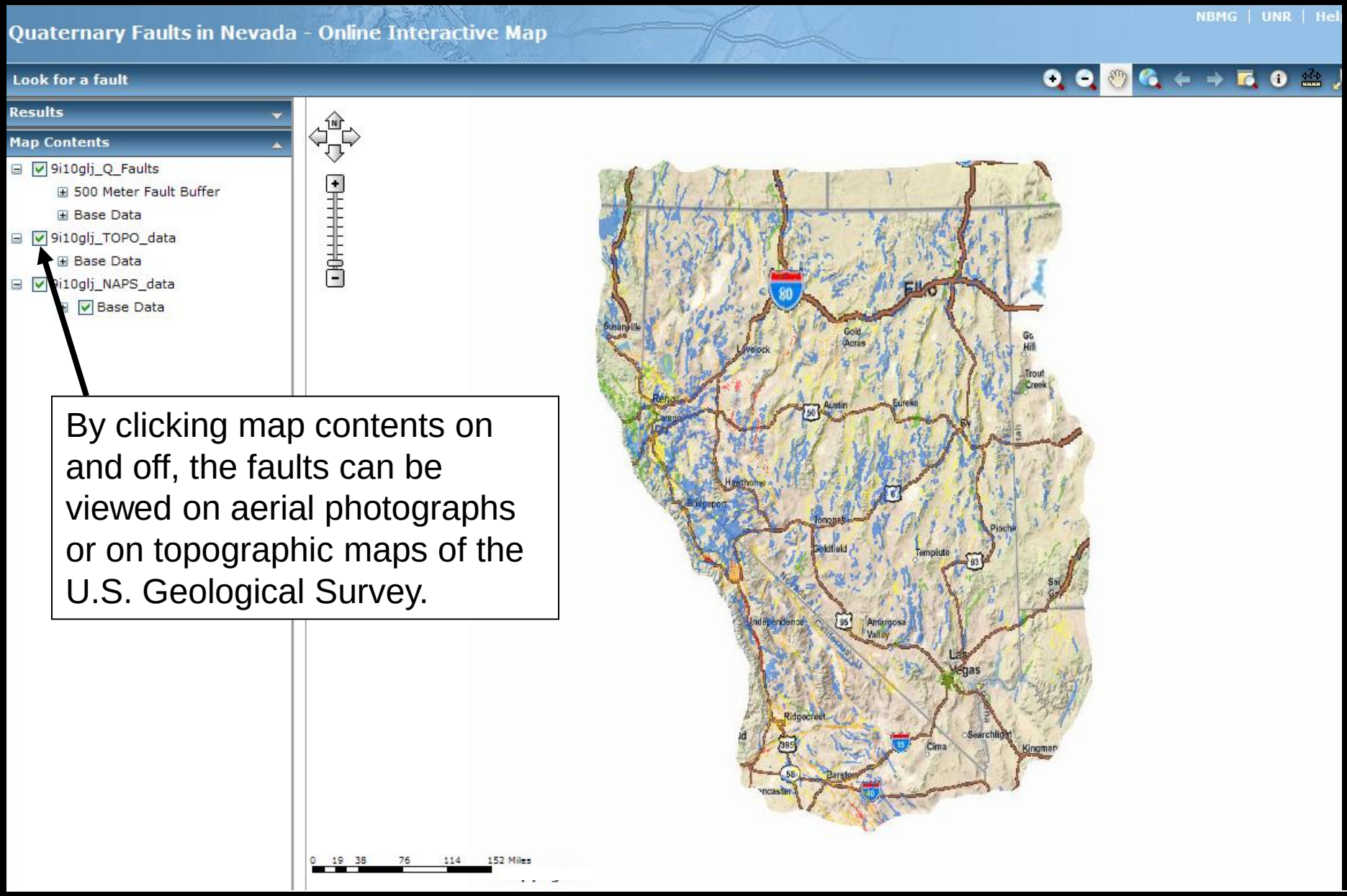


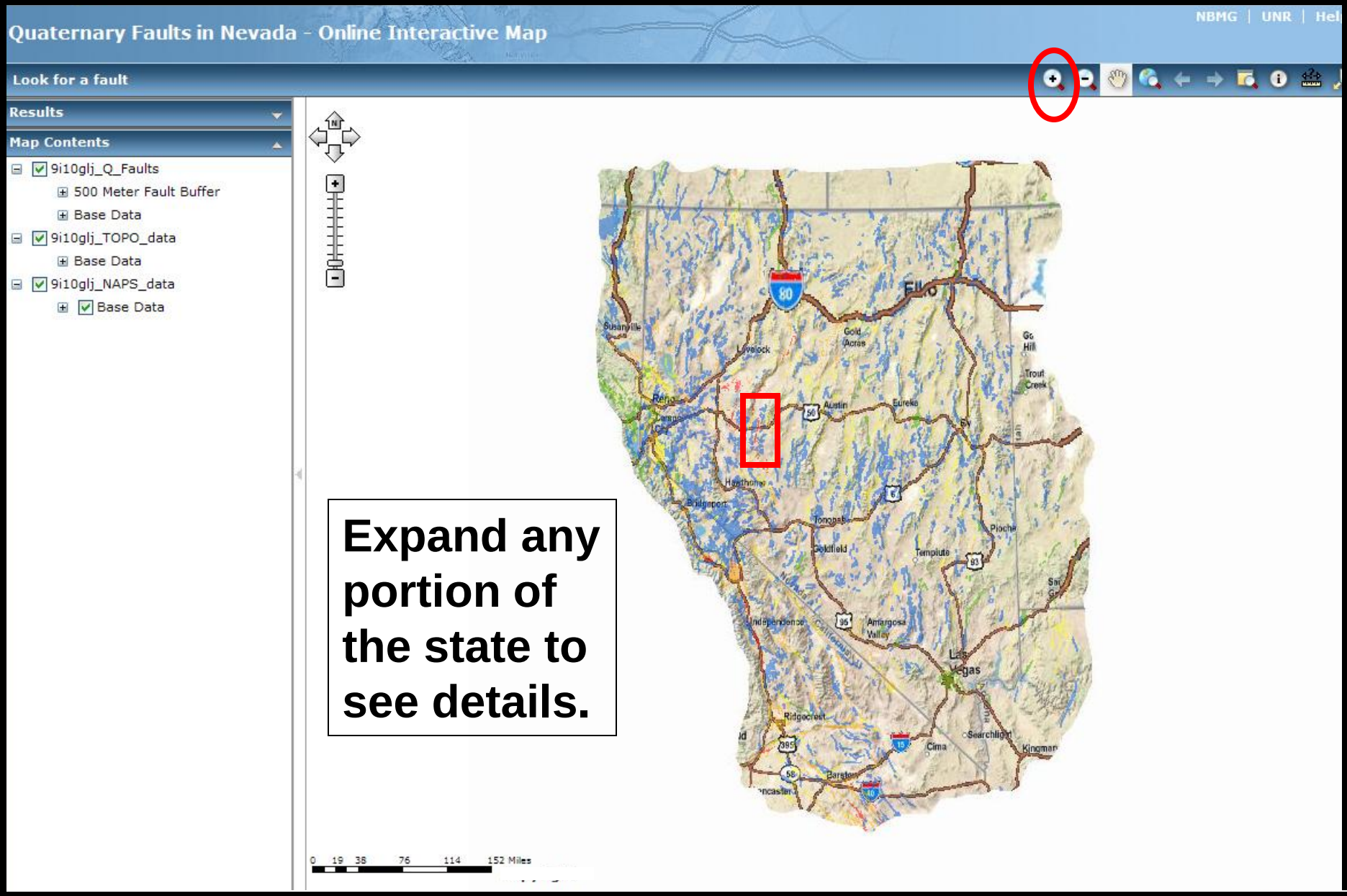
The map has ~130 major faults (with lengths >19 miles or 30 km), ~300 intermediate faults with lengths of 6-19 miles (10-30 km), and >1,150 smaller faults. Surface breakage typically occurs when an earthquake is greater than or equal to magnitude 6.5.

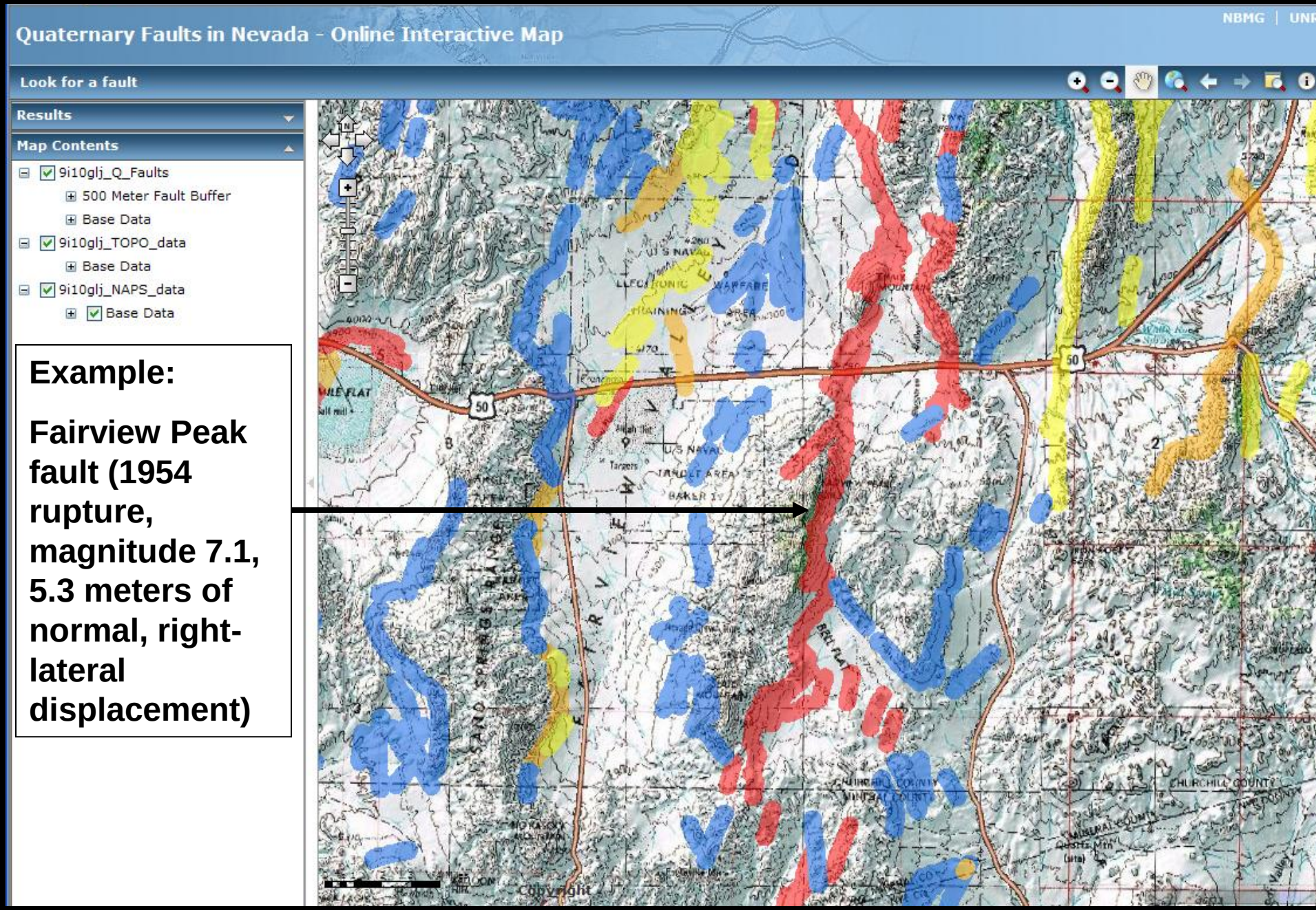


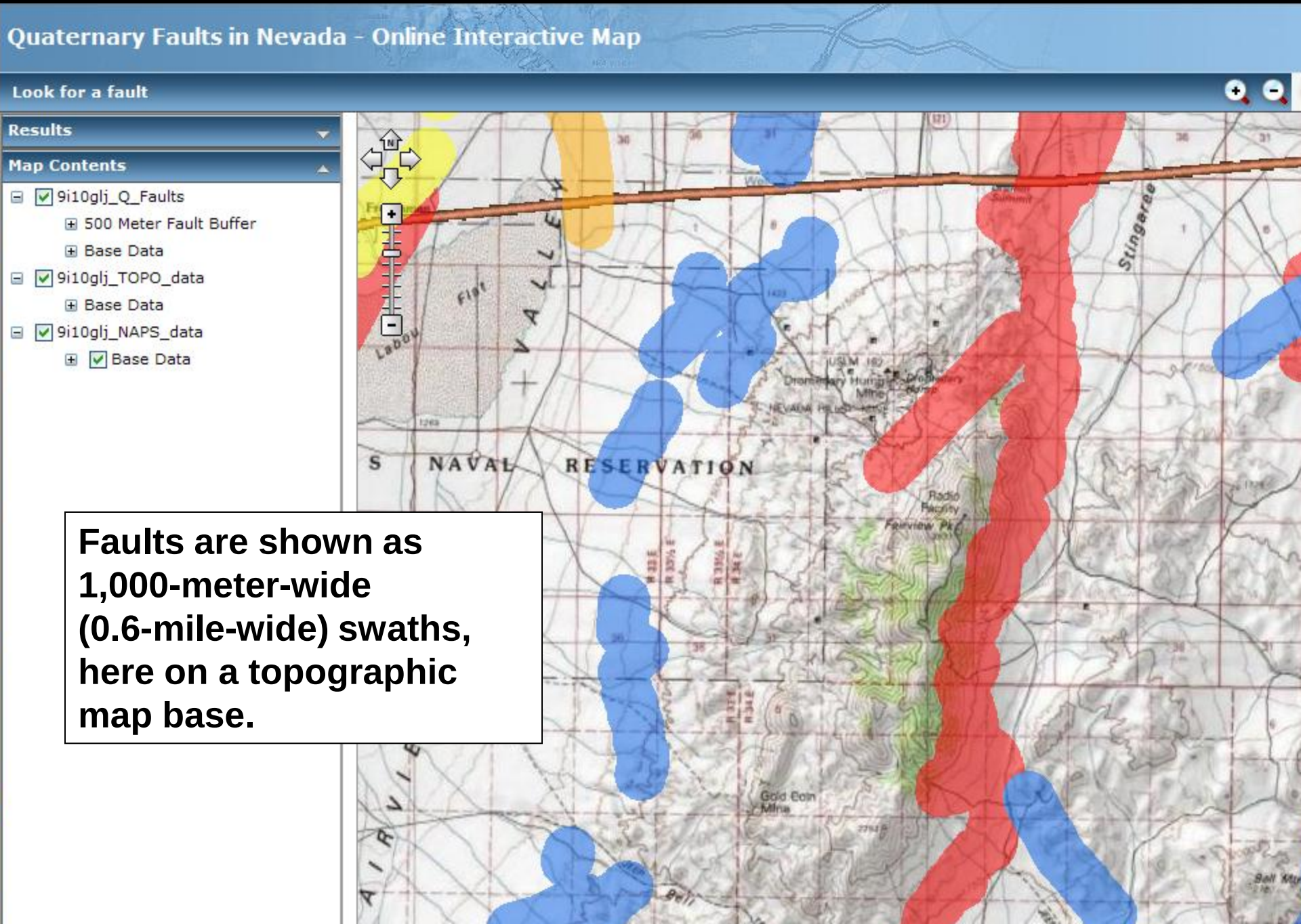

Quaternary Faults in Nevada - Online Interactive Map
NBMG
Look for a fault
Results
Map Contents
9i10glj_Q_Faults
500 Meter Fault Buffer
Base Data
9i10glj_TOPO_data
Base Data
9i10glj_NAPS_data
Base Data
The locations, ages of latest rupture, and other features of the faults are in a geographic information systems (GIS) database, which is accessible on line at www.nbmg.unr.edu.
0 19 38 76 114

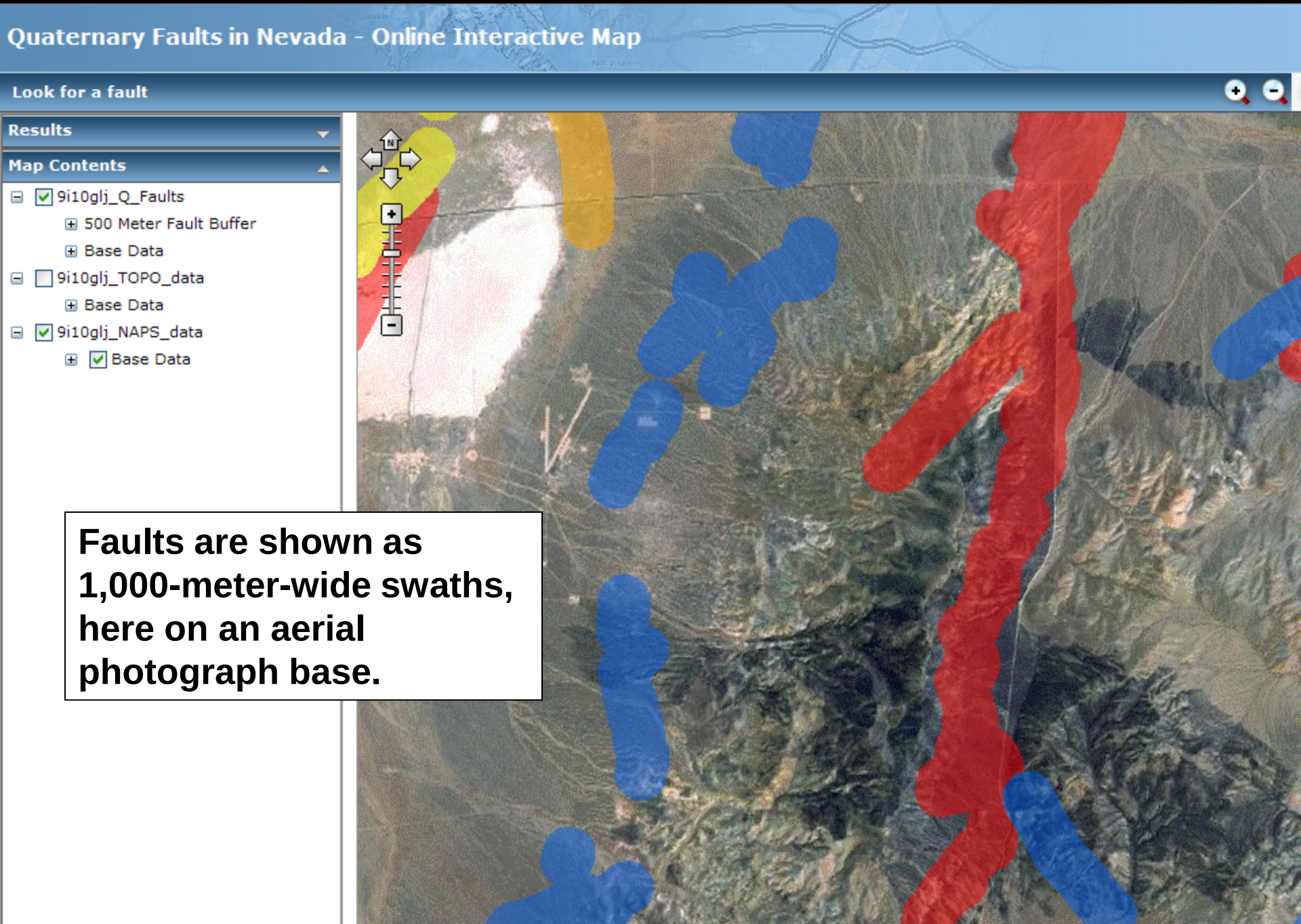

Quaternary Faults in Nevada - Online Interactive Map
NBMG | UN
Look for a fault
Results
Map Contents
9i10glj_Q_Faults
500 Meter Fault Buffer
Base Data
9i10glj_TOPO_data
Base Data
9i10glj_NAPS_data
Base Data
By clicking map contents on and off, the faults can be viewed on aerial photographs.
Elko
Carson City
NEVADA
Las Vegas
0 19 38 76 114 152 Miles

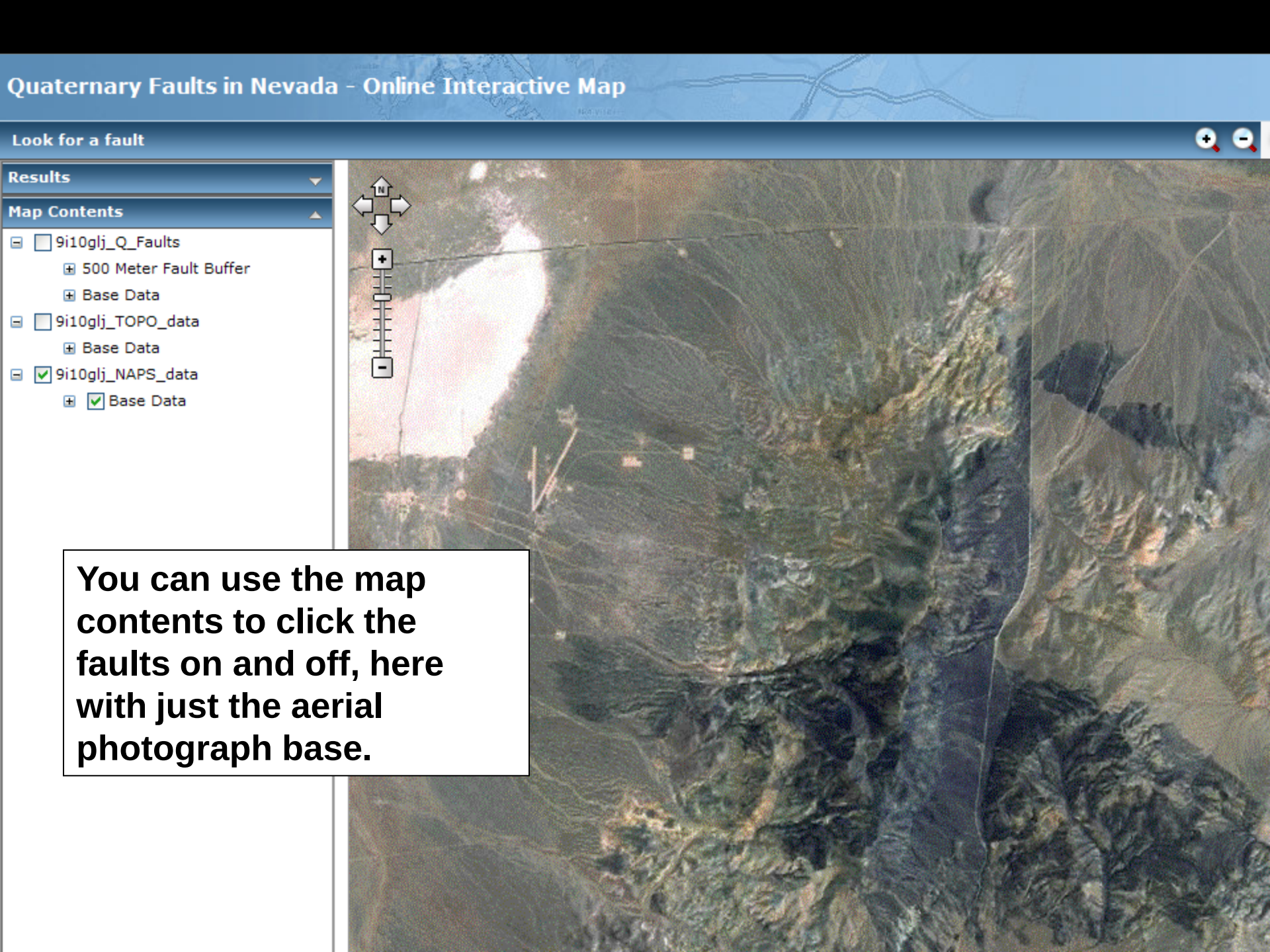

Quaternary Faults in Nevada - Online Interactive Map
NBMG | UNR | Hel
Look for a fault
Results
Map Contents
9i10glj_Q_Faults
500 Meter Fault Buffer
Base Data
9i10glj_TOPO_data
Base Data
9i10glj_NAPS_data
Base Data
By clicking map contents on and off, the faults can be viewed on aerial photographs or on topographic maps of the U.S. Geological Survey.
80
Ely
Susanville
Lovelock
Gold Acres
Trout Creek
Reno
Austin
Eureka
50
6
Hawthorne
Bridgeport
Tonopah
Goldfield
Tempiute
Pioche
93
95
Independence
Amargosa Valley
Las Vegas
Ridgecrest
395
15
Cima
Searchlight
Kingman
58
Barstow
10
0 19 38 76 114 152 Miles

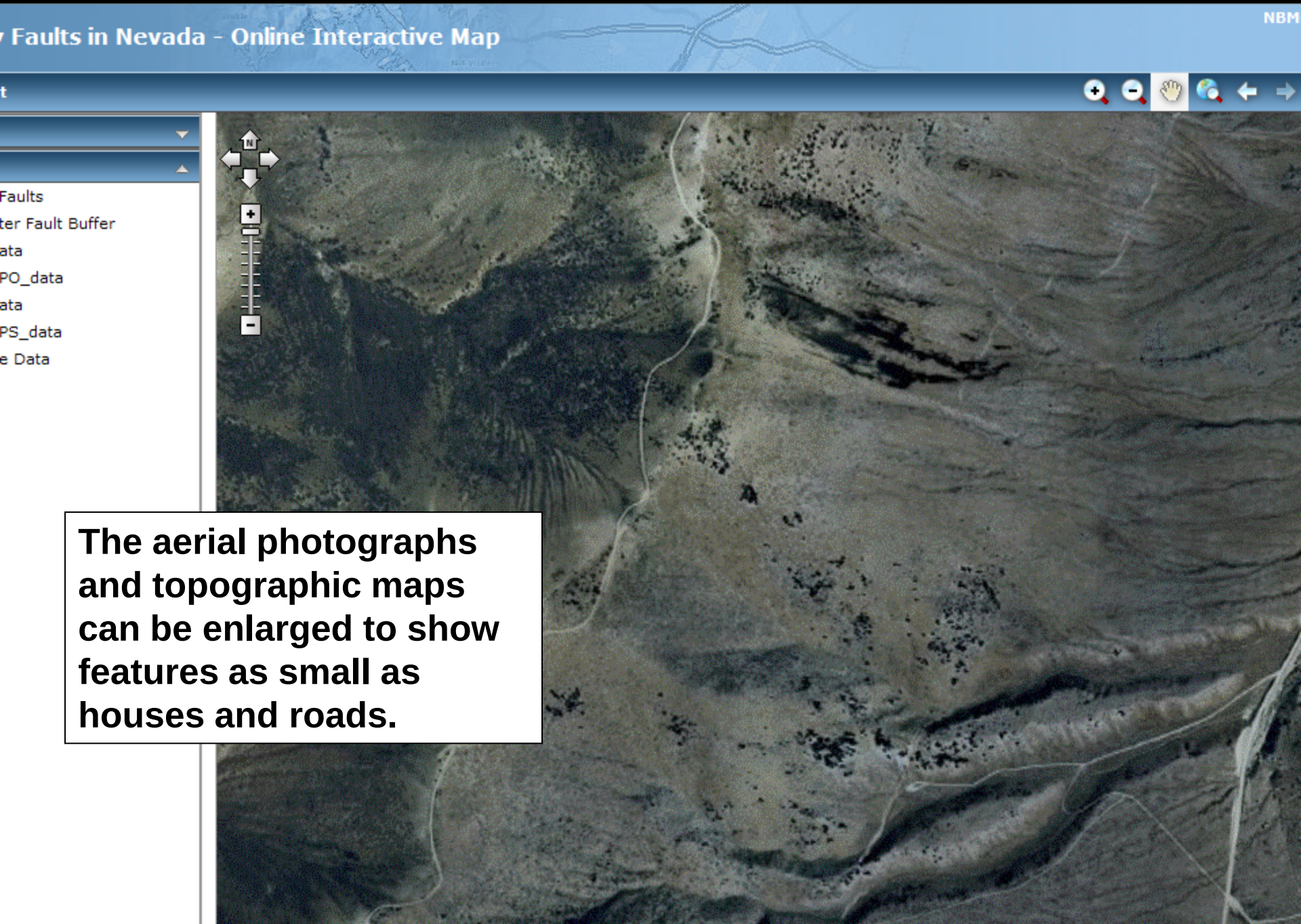

Quaternary Faults in Nevada - Online Interactive Map
NBMG | UNR | Hel
Look for a fault
Results
Map Contents
9i10glj_Q_Faults
500 Meter Fault Buffer
Base Data
9i10glj_TOPO_data
Base Data
9i10glj_NAPS_data
Base Data
Expand any portion of the state to see details.
0 19 38 76 114 152 Miles


Quaternary Faults in Nevada - Online Interactive Map
NBMG | UNR
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:
Fairview Peak fault (1954 rupture, magnitude 7.1, 5.3 meters of normal, right-lateral displacement)
50
Copyright


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


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


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
You can use the map contents to click the faults on and off, here with just the aerial photograph base.


Faults in Nevada - Online Interactive Map
NBM
Faults
ter Fault Buffer
ata
PO_data
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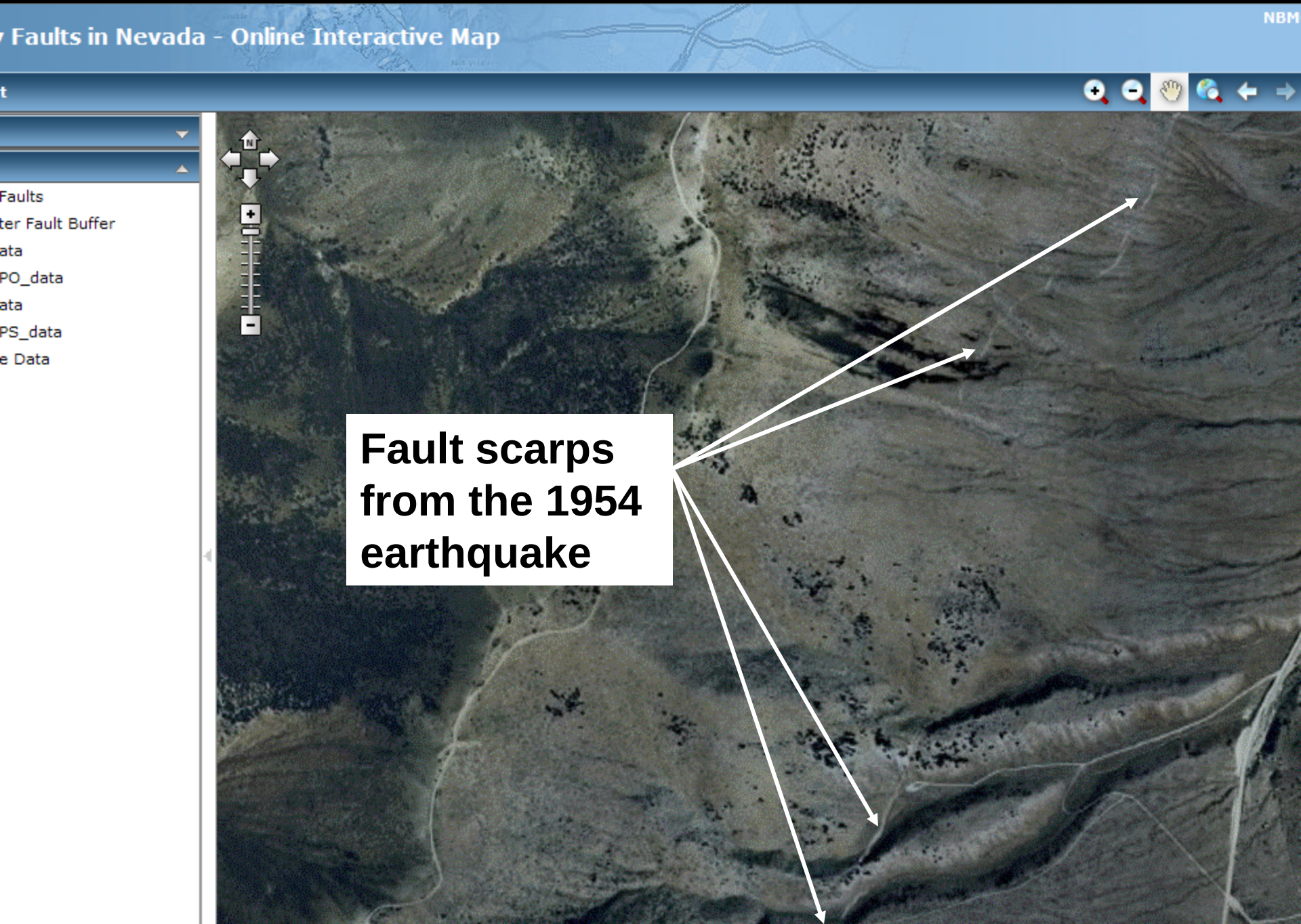
PS_data
e Data
The aerial photographs and topographic maps can be enlarged to show features as small as houses and roads.


Faults in Nevada - Online Interactive Map
NBM
Faults
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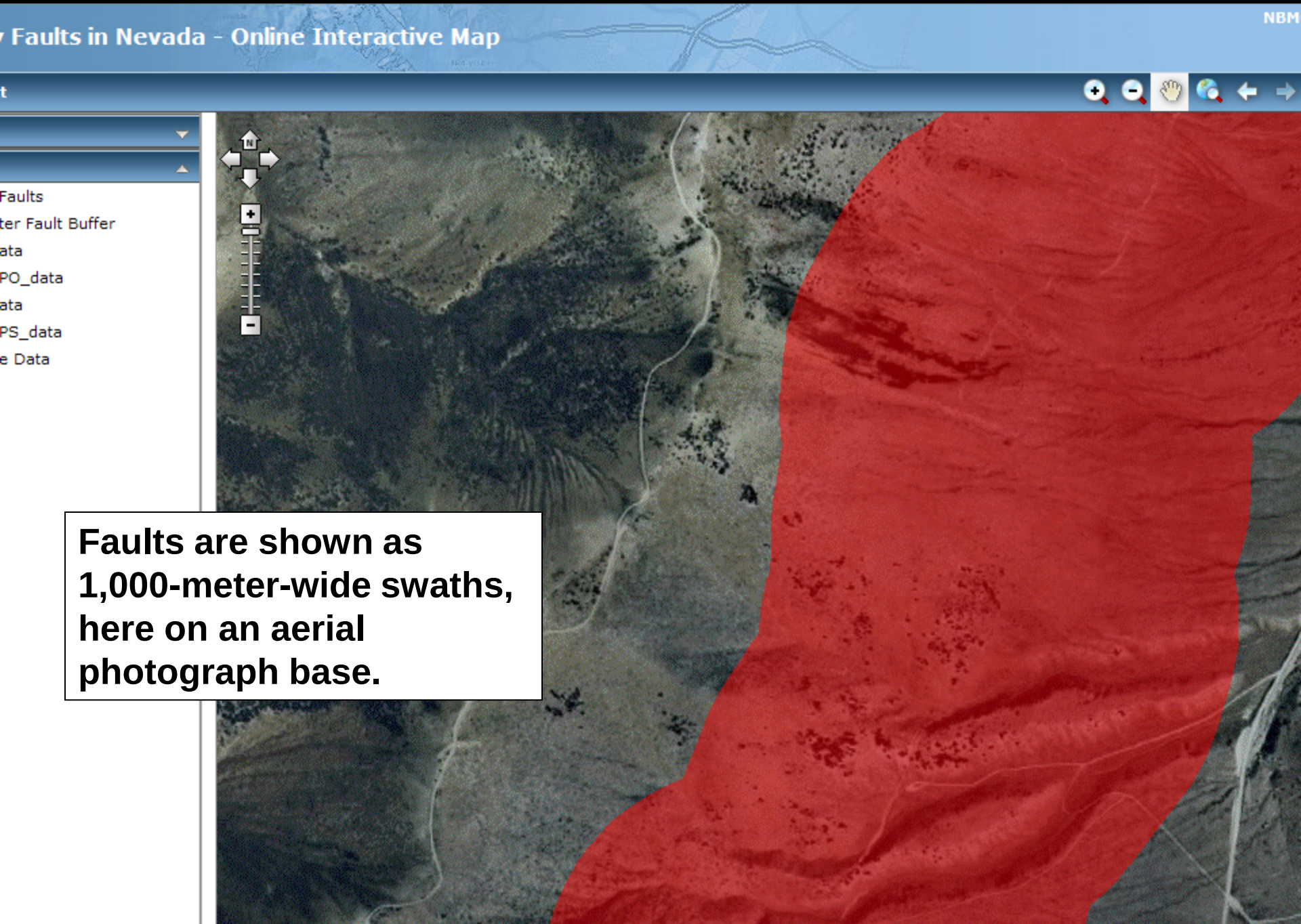
PS_data
e Data
Fault scarps from the 1954 earthquake


Faults in Nevada - Online Interactive Map
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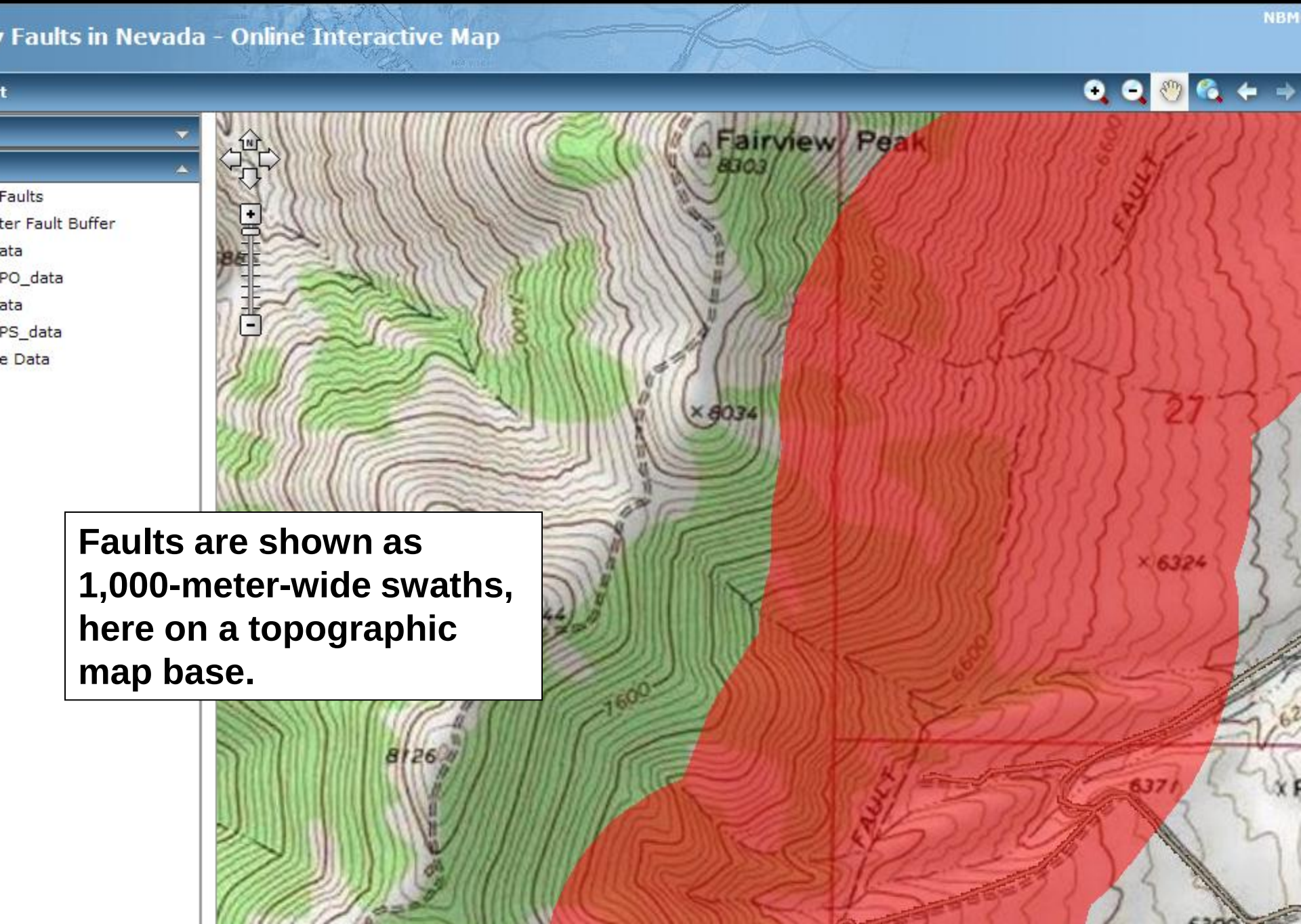
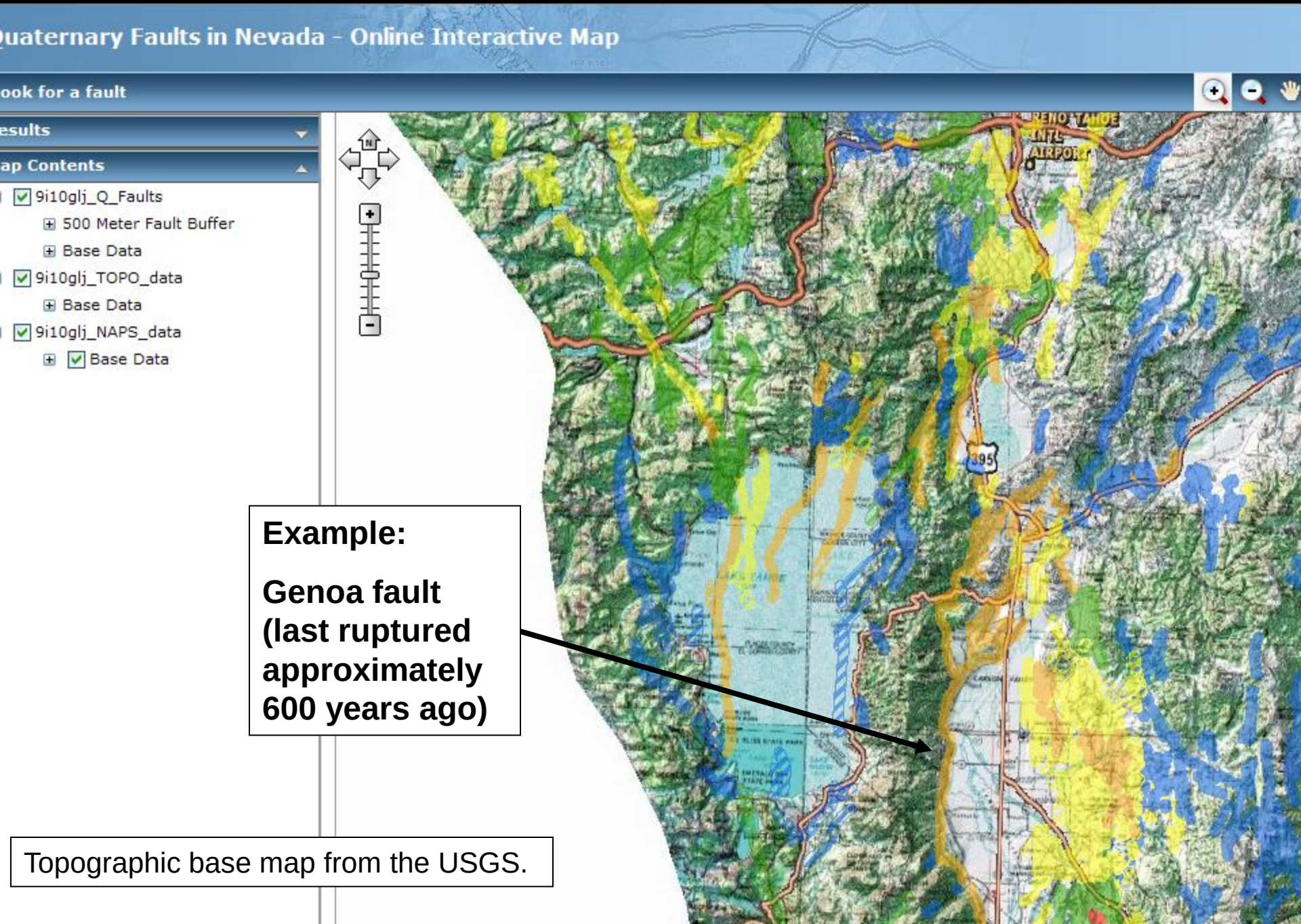
Faults are shown as 1,000-meter-wide swaths, here on an aerial photograph base.


Faults in Nevada - Online Interactive Map
NBM
Faults
ter Fault Buffer
ata
PO_data
ata
PS_data
e Data
Fairview Peak
8303
FAULT
7400
6600
8034
27
6324
7600
8126
6371
FAULT
Faults are shown as 1,000-meter-wide swaths, here on a topographic map base.


uaternary Faults in Nevada - Online Interactive Map
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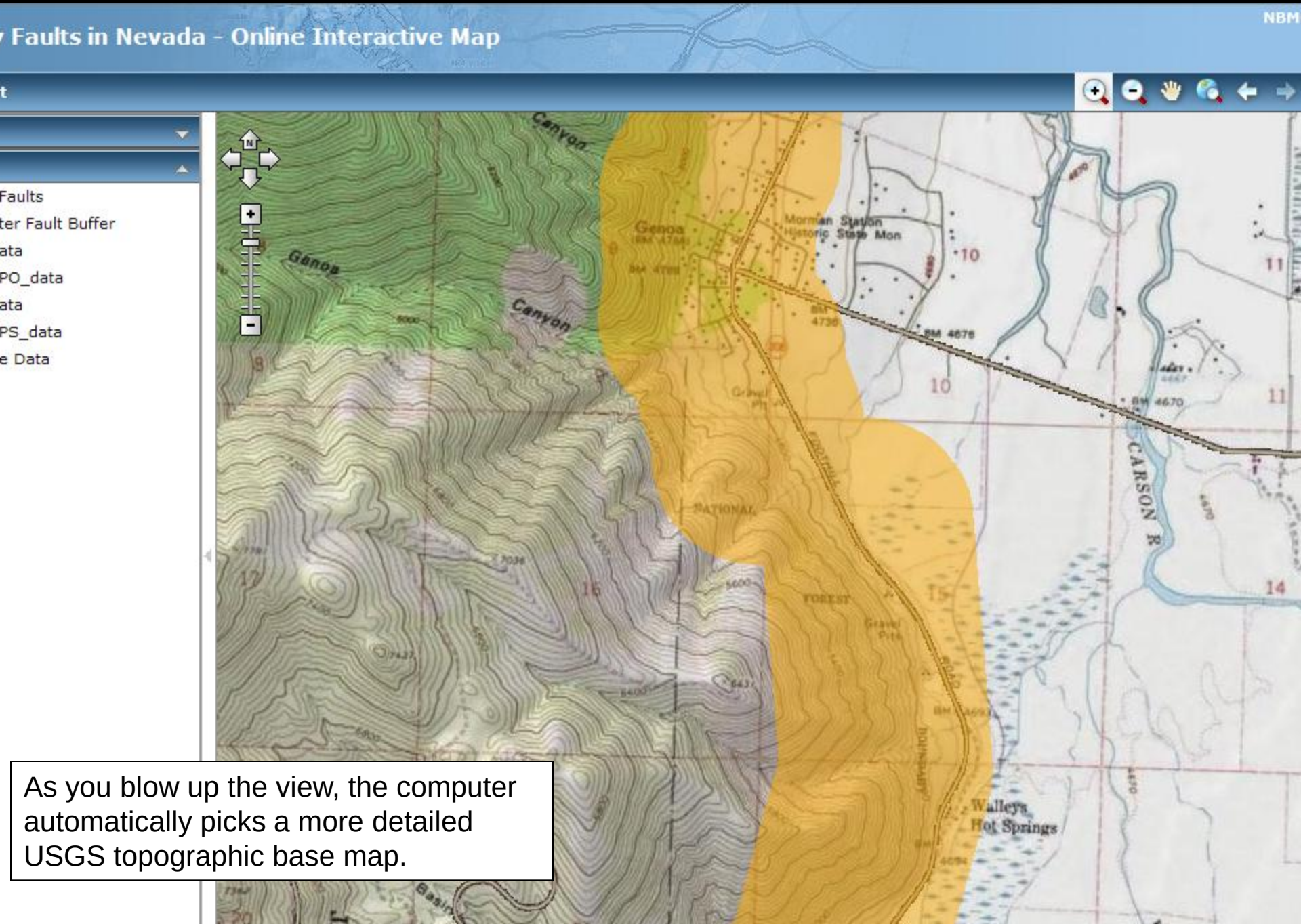
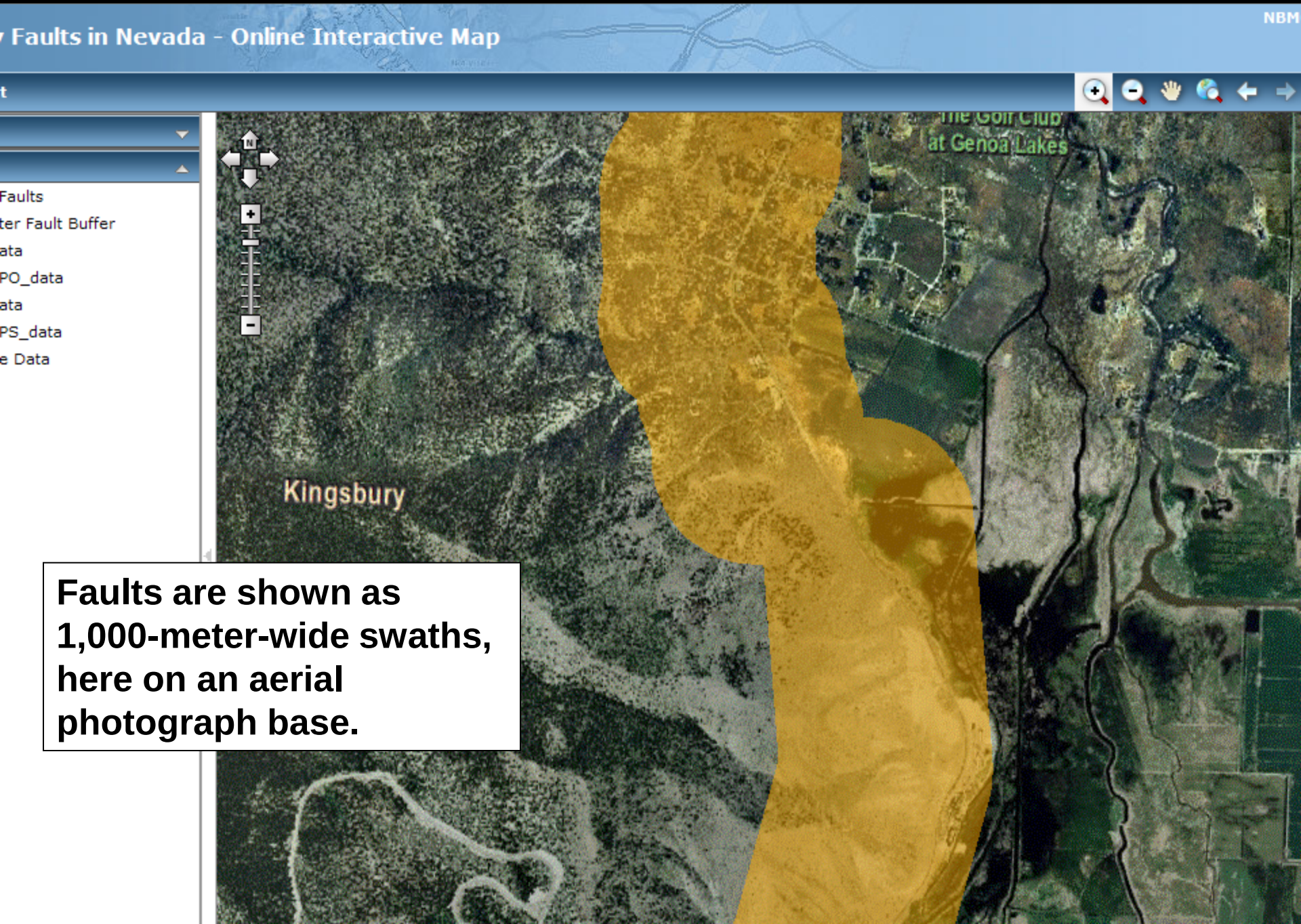
ap Contents
9i10glj_Q_Faults
500 Meter Fault Buffer
Base Data
9i10glj_TOPO_data
Base Data
9i10glj_NAPS_data
Base Data
RENO TAHOE INTL AIRPORT
395
Example:
Genoa fault (last ruptured approximately 600 years ago)
Topographic base map from the USGS.

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


Faults in Nevada - Online Interactive Map
NBM
Faults
ter Fault Buffer
ata
PO_data
ata
PS_data
e Data
Genoa
Canyon
Mormon Station
Historic State Mon
CARSON R
Walleys
Hot Springs
As you blow up the view, the computer automatically picks a more detailed USGS topographic base map.


Faults in Nevada - Online Interactive Map
NBM
Faults
ter Fault Buffer
ata
PO_data
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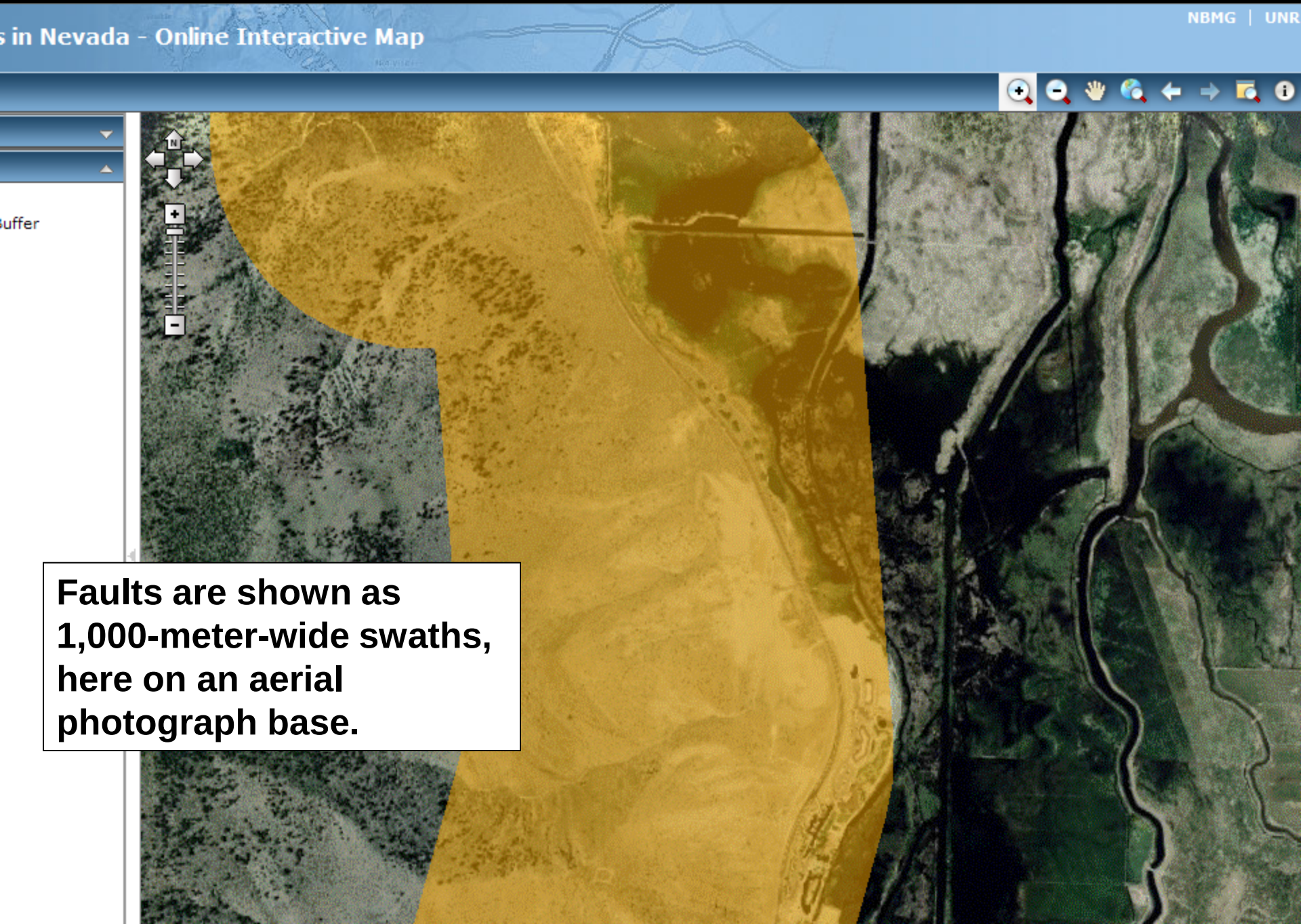
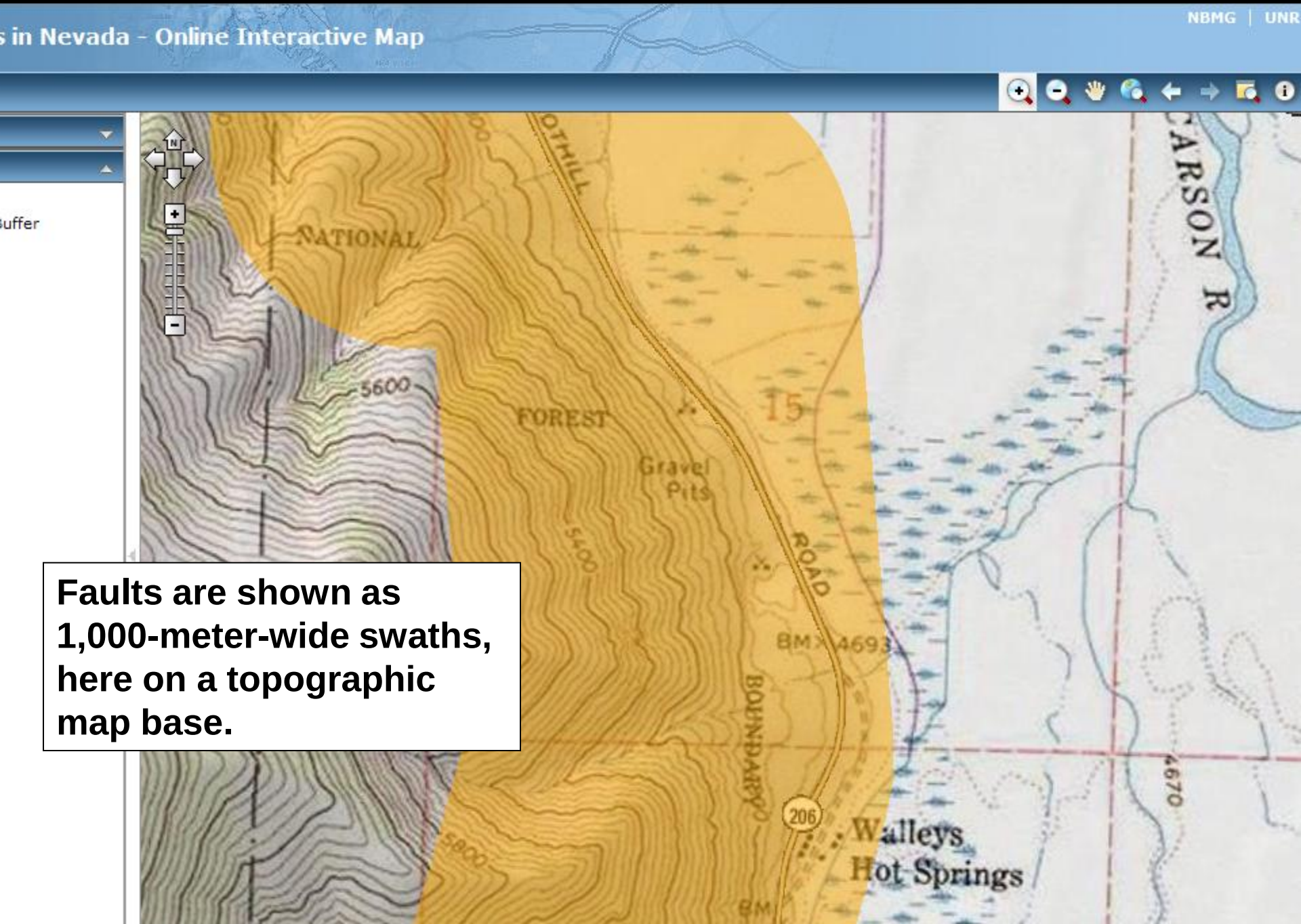
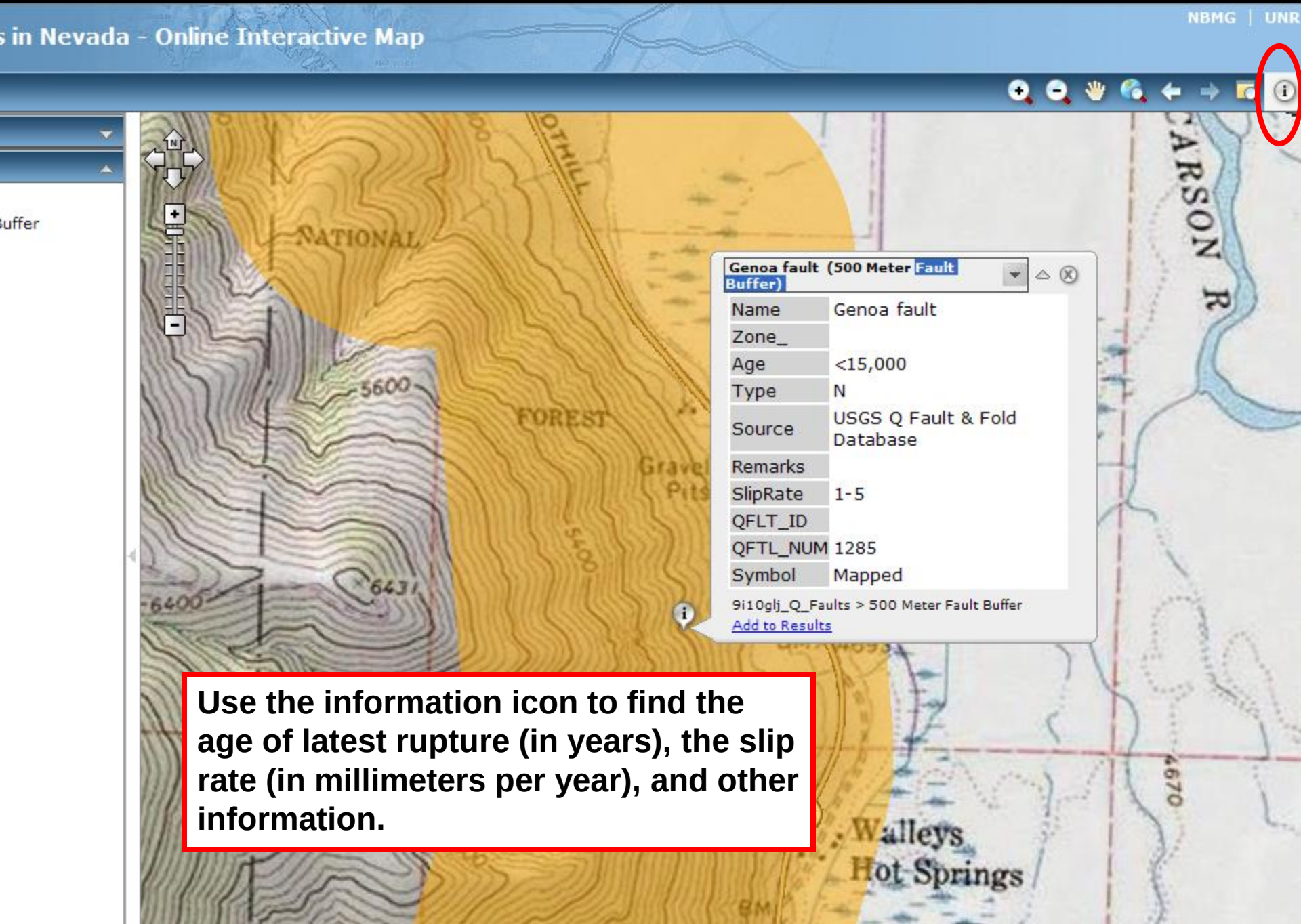
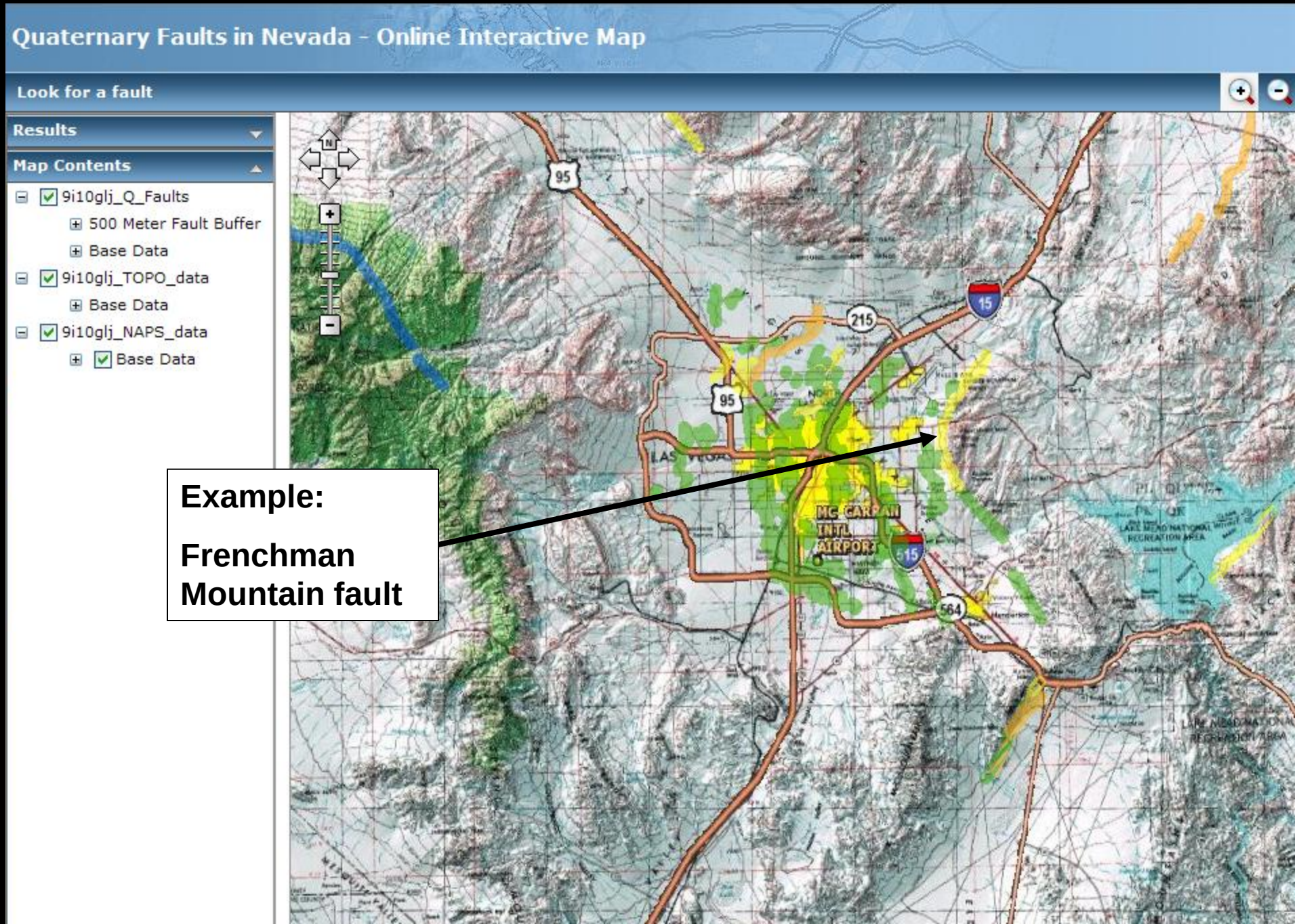
e Data
at Genoa Lakes
Kingsbury
Faults are shown as 1,000-meter-wide swaths, here on an aerial photograph base.

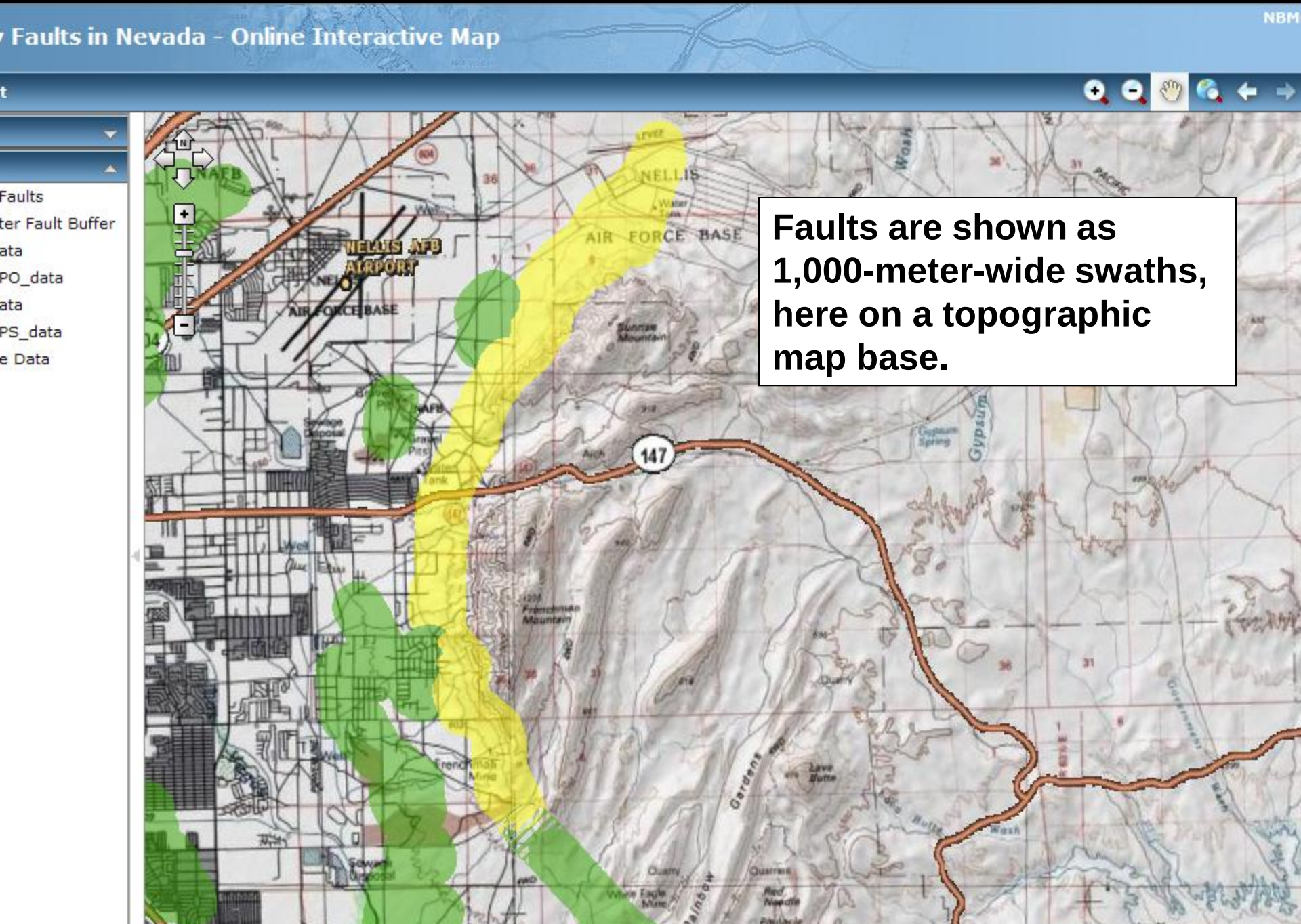

N
Buffer


s in Nevada - Online Interactive Map
NBMG | UNR
Buffer
Faults are shown as 1,000-meter-wide swaths, here on an aerial photograph base.


s in Nevada - Online Interactive Map
NBMG | UNR
Buffer
NATIONAL
FOREST
5600
5400
5800
Gravel Pits
15
ROAD
BOUNDARY
BM 4693
206
Walleys Hot Springs
CARSON R
4670
Faults are shown as 1,000-meter-wide swaths, here on a topographic map base.


s in Nevada - Online Interactive Map
NBMG | UNR
Buffer
NATIONAL
FOREST
5600
6400
6431
5400
Gravel Pits
CARSON R
4670
Walleys Hot Springs
Genoa fault (500 Meter Fault Buffer)
Name Genoa fault
Zone_
Age <15,000
Type N
Source USGS Q Fault & Fold Database
Remarks
SlipRate 1-5
QFLT_ID
QFTL_NUM 1285
Symbol Mapped
9i10glj_Q_Faults > 500 Meter Fault Buffer
Add to Results
Use the information icon to find the age of latest rupture (in years), the slip rate (in millimeters per year), and other information.


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
95
215
15
564
MC CARRAN INTL AIRPORT


Faults in Nevada - Online Interactive Map
NBM
Faults
ter Fault Buffer
ata
PO_data
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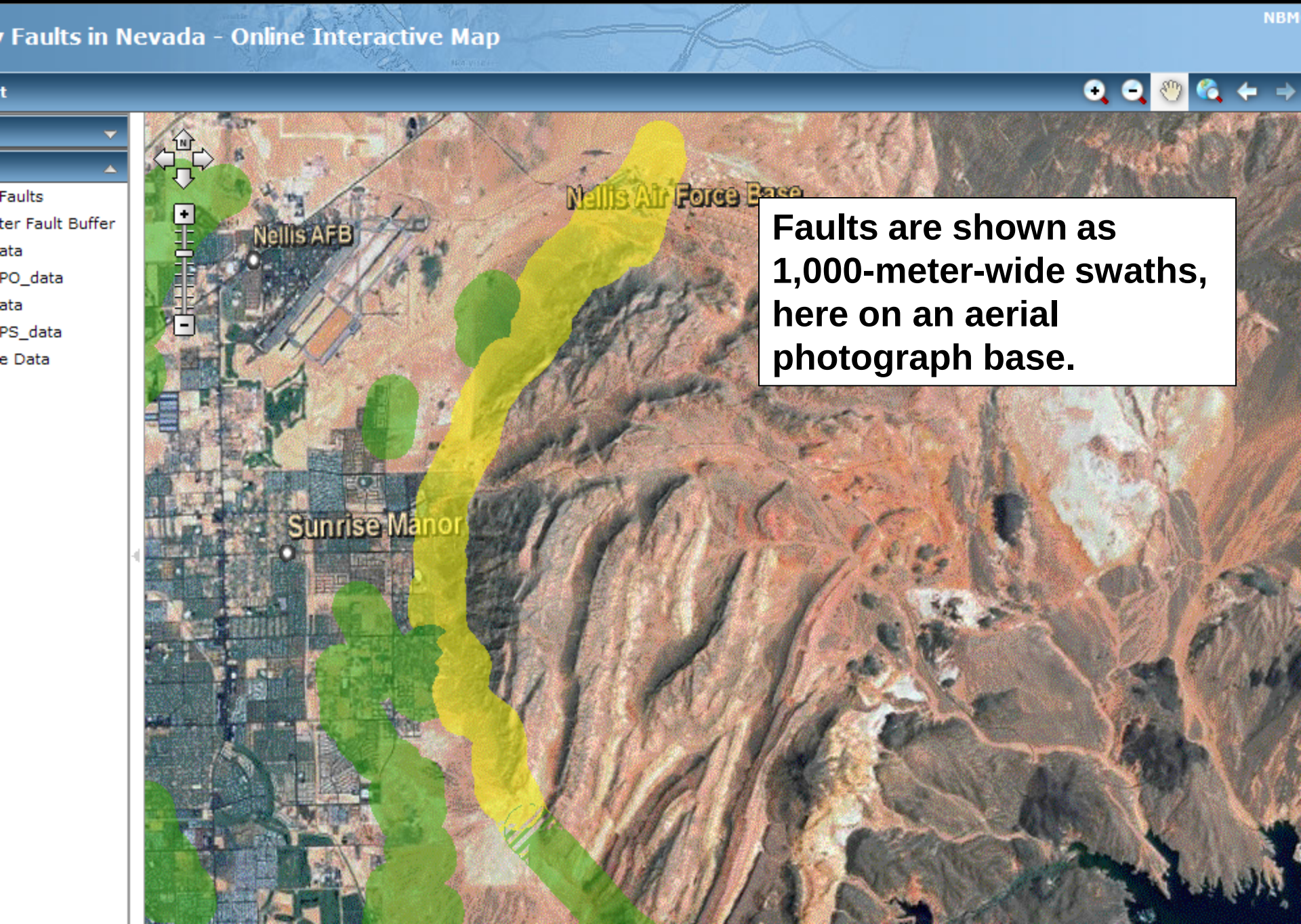
PS_data
e Data
NELLIS
AIR FORCE BASE
NELLIS AFB
AIRPORT
147
Faults are shown as 1,000-meter-wide swaths, here on a topographic map base.


Faults in Nevada - Online Interactive Map
NBM
Faults
ter Fault Buffer
ata
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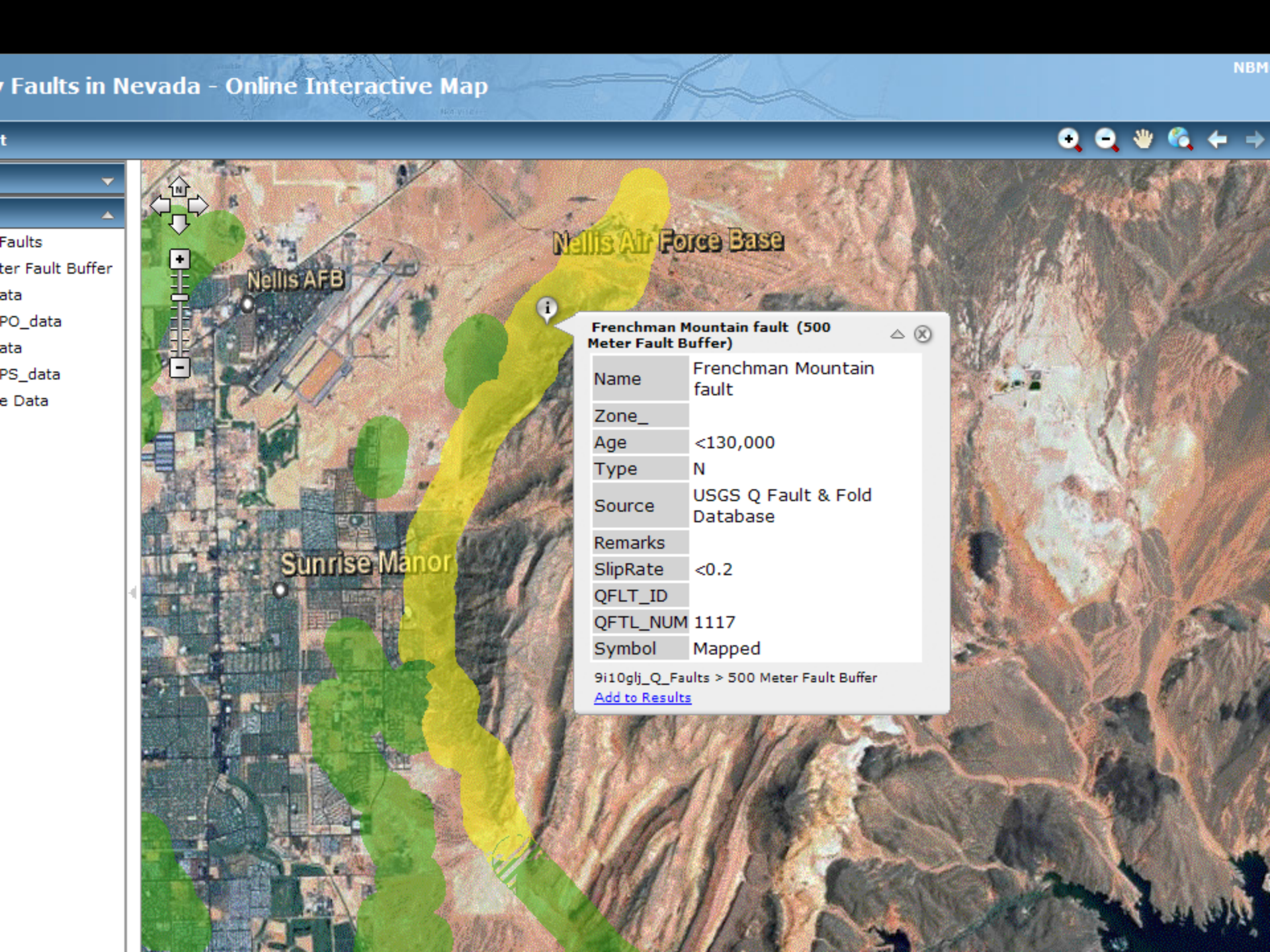
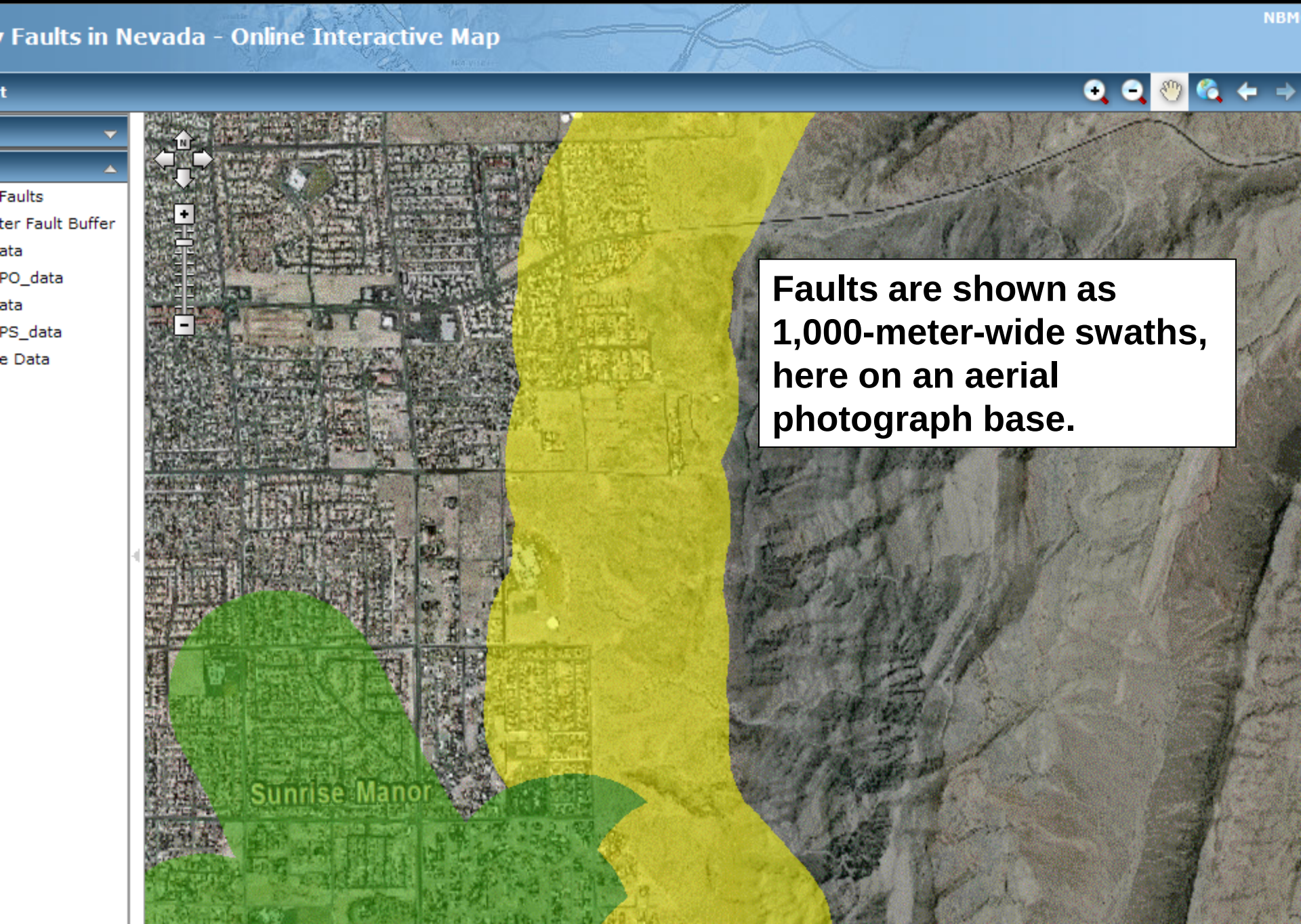
Nellis AFB
Nellis Air Force Base
Sunrise Manor
Faults are shown as 1,000-meter-wide swaths, here on an aerial photograph base.


Faults in Nevada - Online Interactive Map
NBM
Faults
ter Fault Buffer
ata
PO_data
ata
PS_data
e Data
Nellis Air Force Base
Nellis AFB
Sunrise Manor
Frenchman Mountain fault (500 Meter Fault Buffer)
Name
Frenchman Mountain fault
Zone_
Age
<130,000
Type
N
Source
USGS Q Fault & Fold Database
Remarks
SlipRate
<0.2
QFLT_ID
QFTL_NUM
1117
Symbol
Mapped
9i10glj_Q_Faults > 500 Meter Fault Buffer
Add to Results


Faults in Nevada - Online Interactive Map
NBM
Faults
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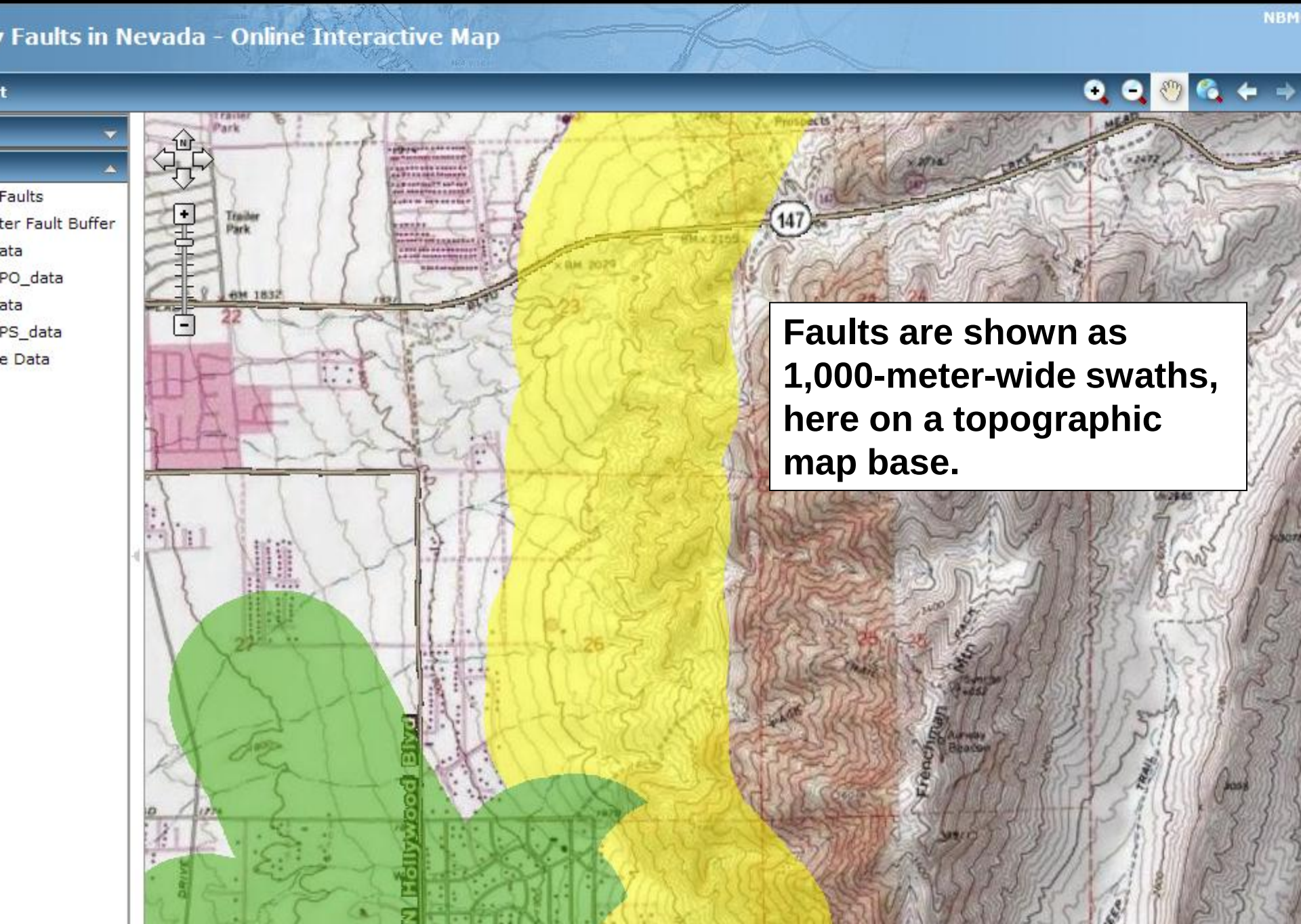
Sunrise Manor
Faults are shown as 1,000-meter-wide swaths, here on an aerial photograph base.


Faults in Nevada - Online Interactive Map
NBM
Faults
ter Fault Buffer
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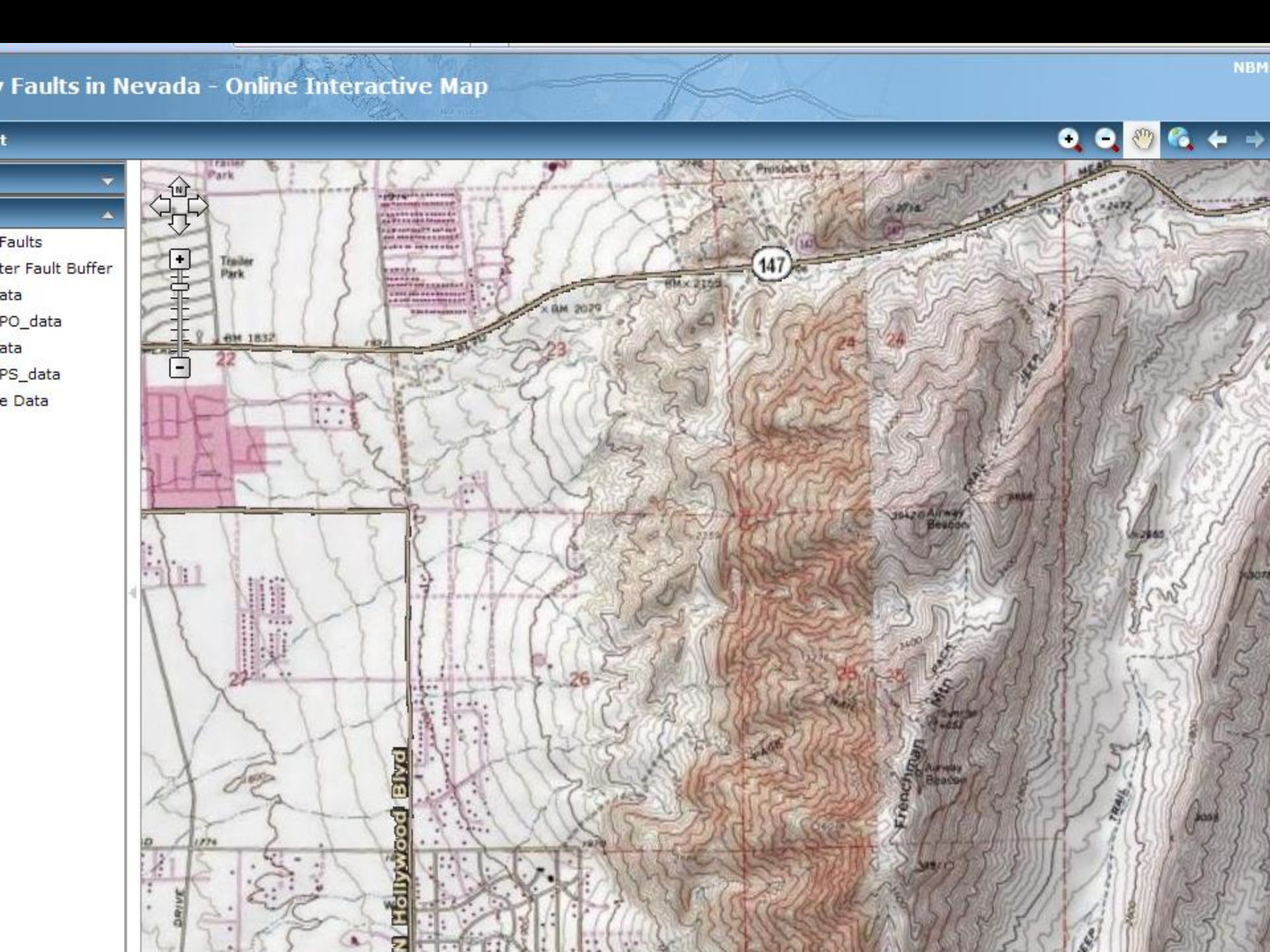
Trailer Park
147
Hollywood Blvd
Frenchman Mtn
Faults are shown as 1,000-meter-wide swaths, here on a topographic map base.


Faults in Nevada - Online Interactive Map
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Faults
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Hollywood Blvd
Frenchman Mtn
Airway Beacon
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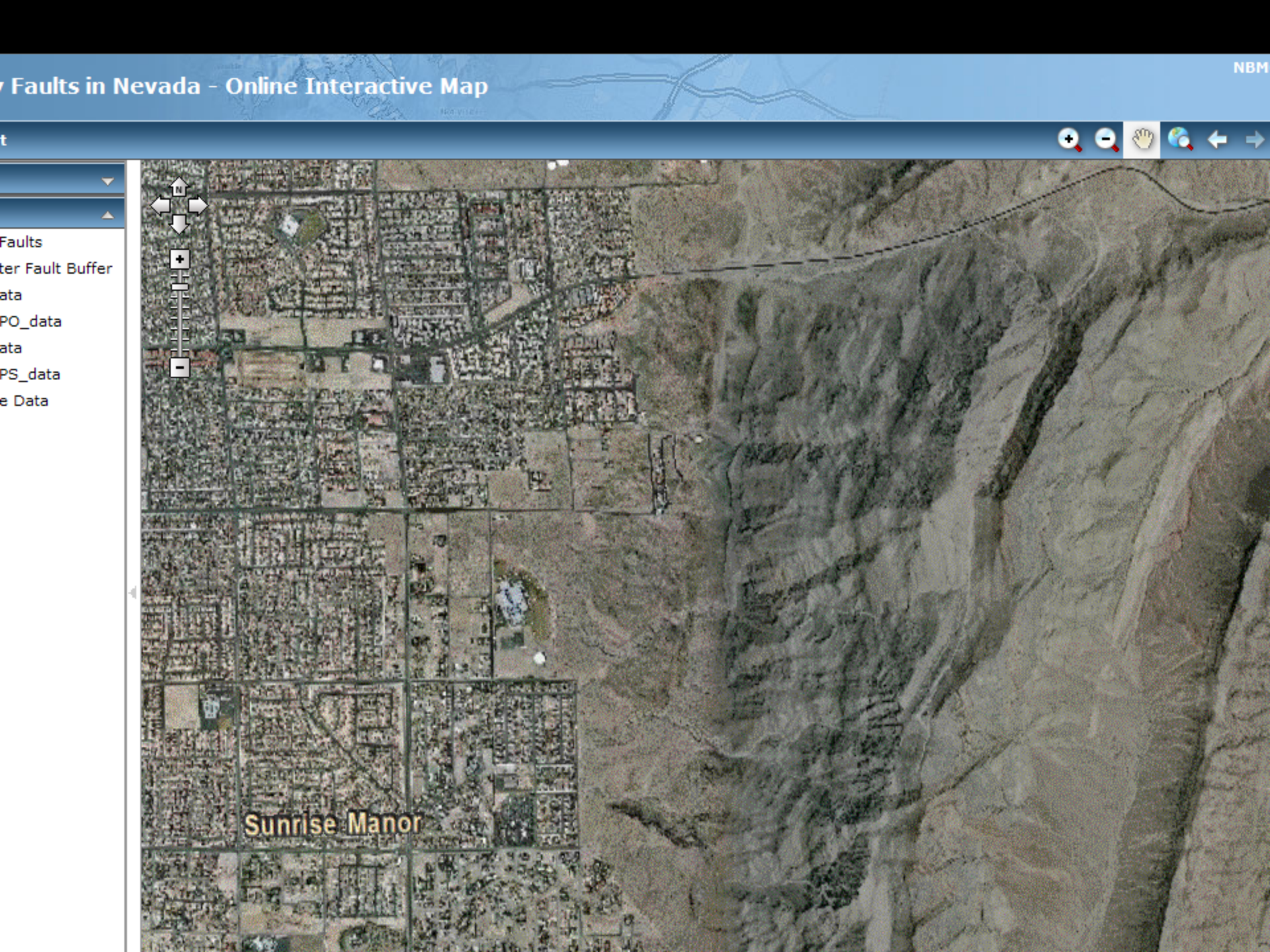
Faults in Nevada - Online Interactive Map
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Faults
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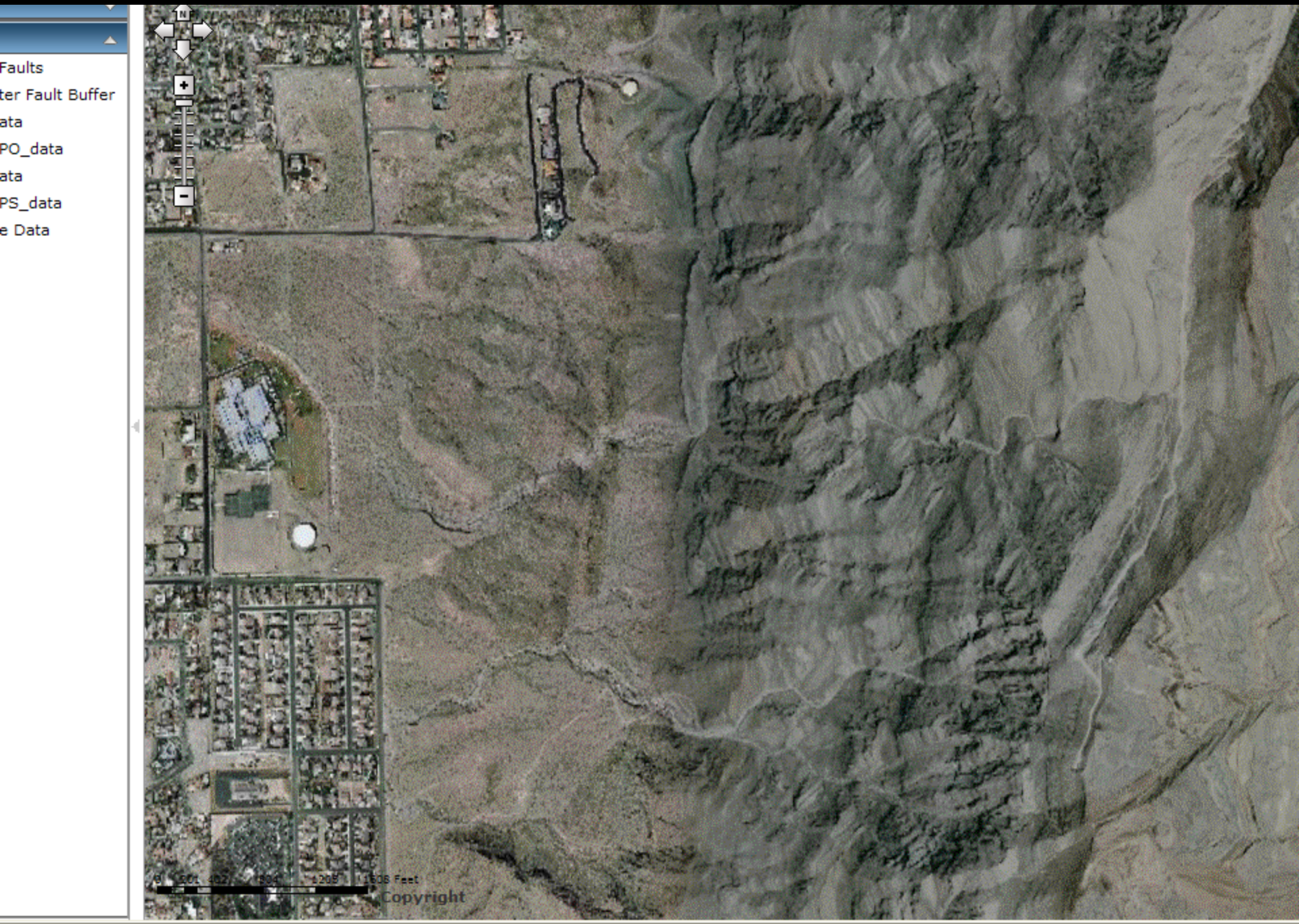
e Data
Sunrise Manor


Faults
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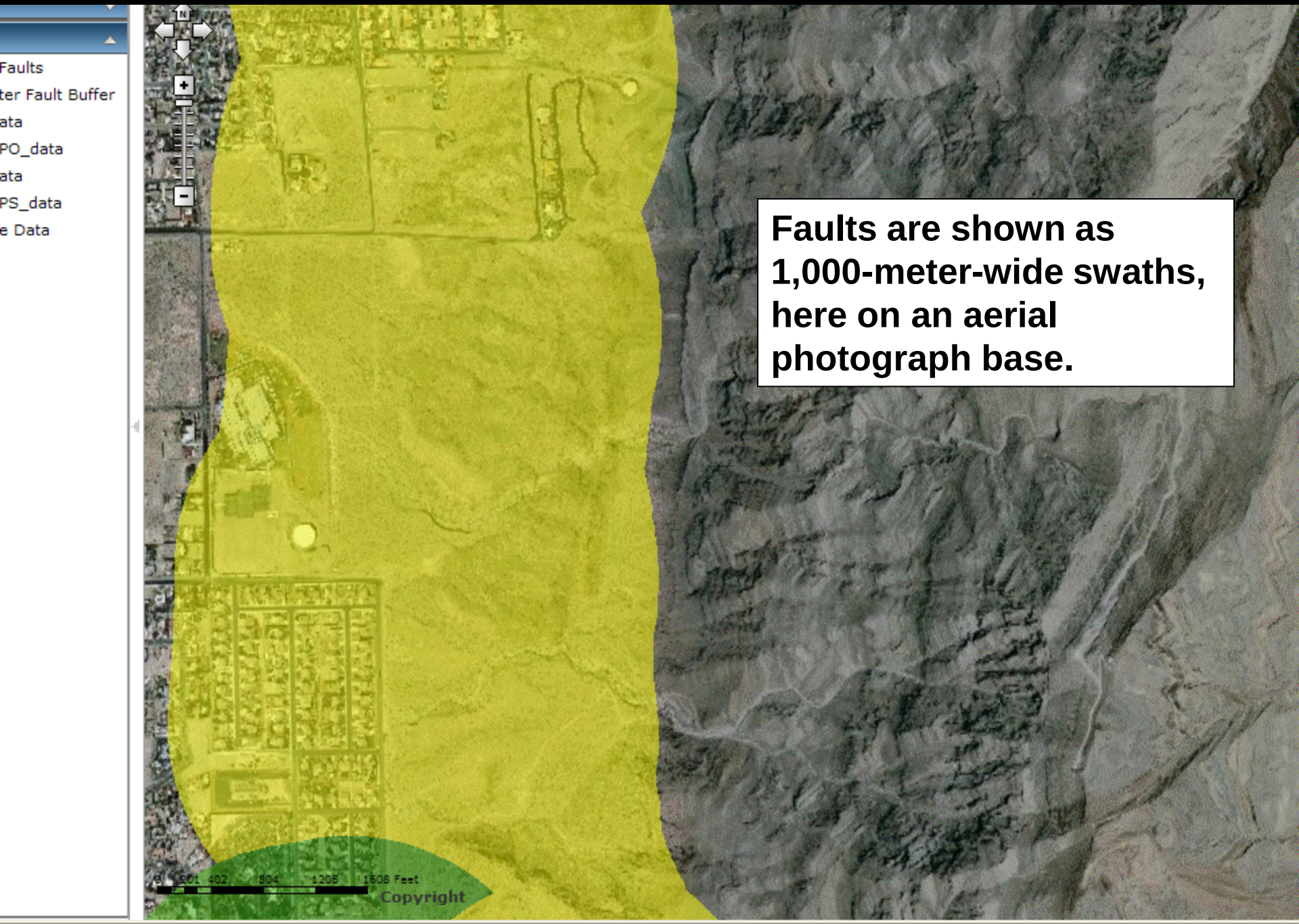
PS_data
e Data
N
Copyright


Faults
ter Fault Buffer
ata
PO_data
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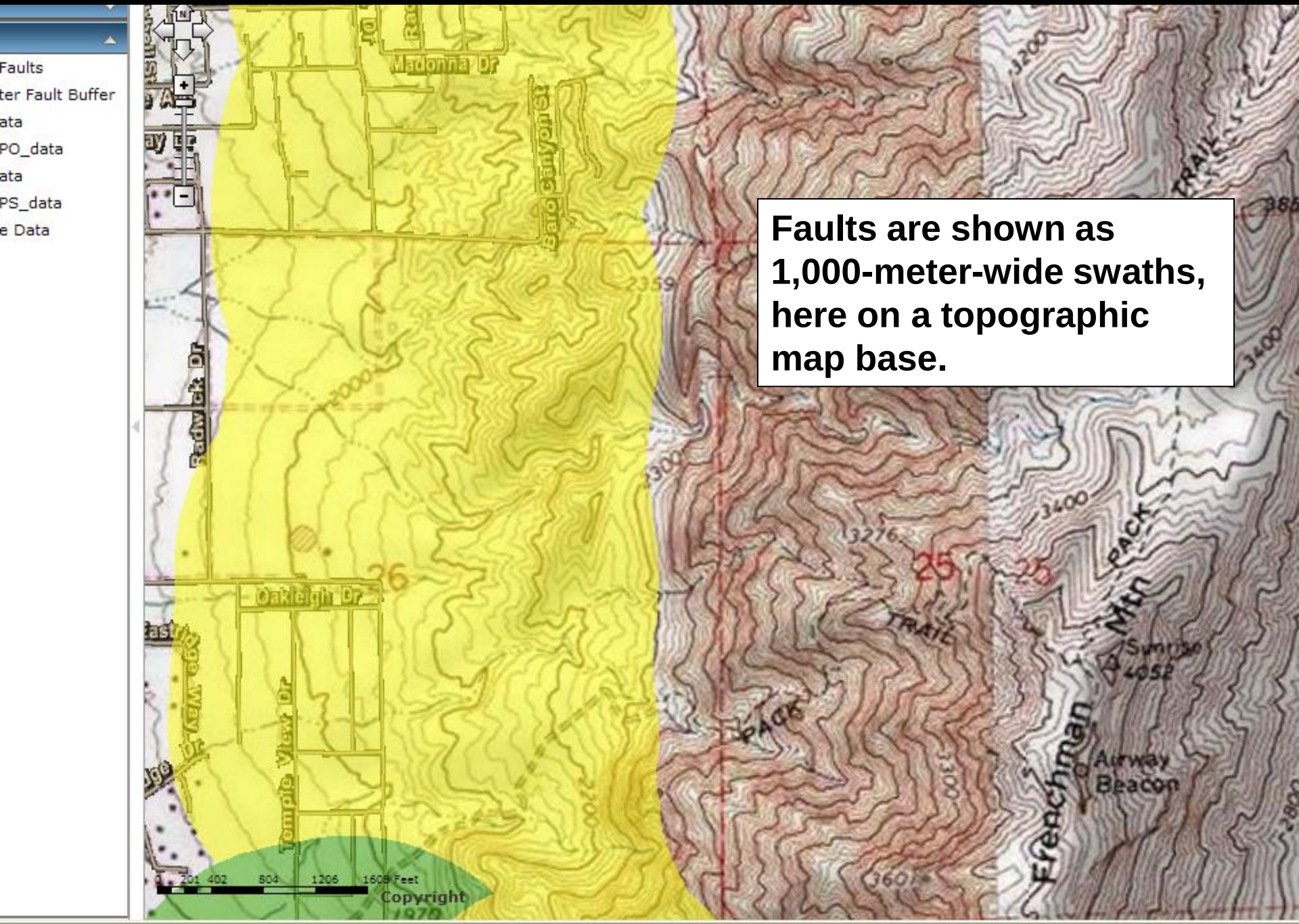
PS_data
e Data
Faults are shown as 1,000-meter-wide swaths, here on an aerial photograph base.
0 201 402 804 1205 1608 Feet
Copyright


Faults
ter Fault Buffer
ata
PO_data
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e Data
Madonna Dr
Radwick Dr
Oakleigh Dr
Temple View Dr
Bare Canyon Rd
TRAIL
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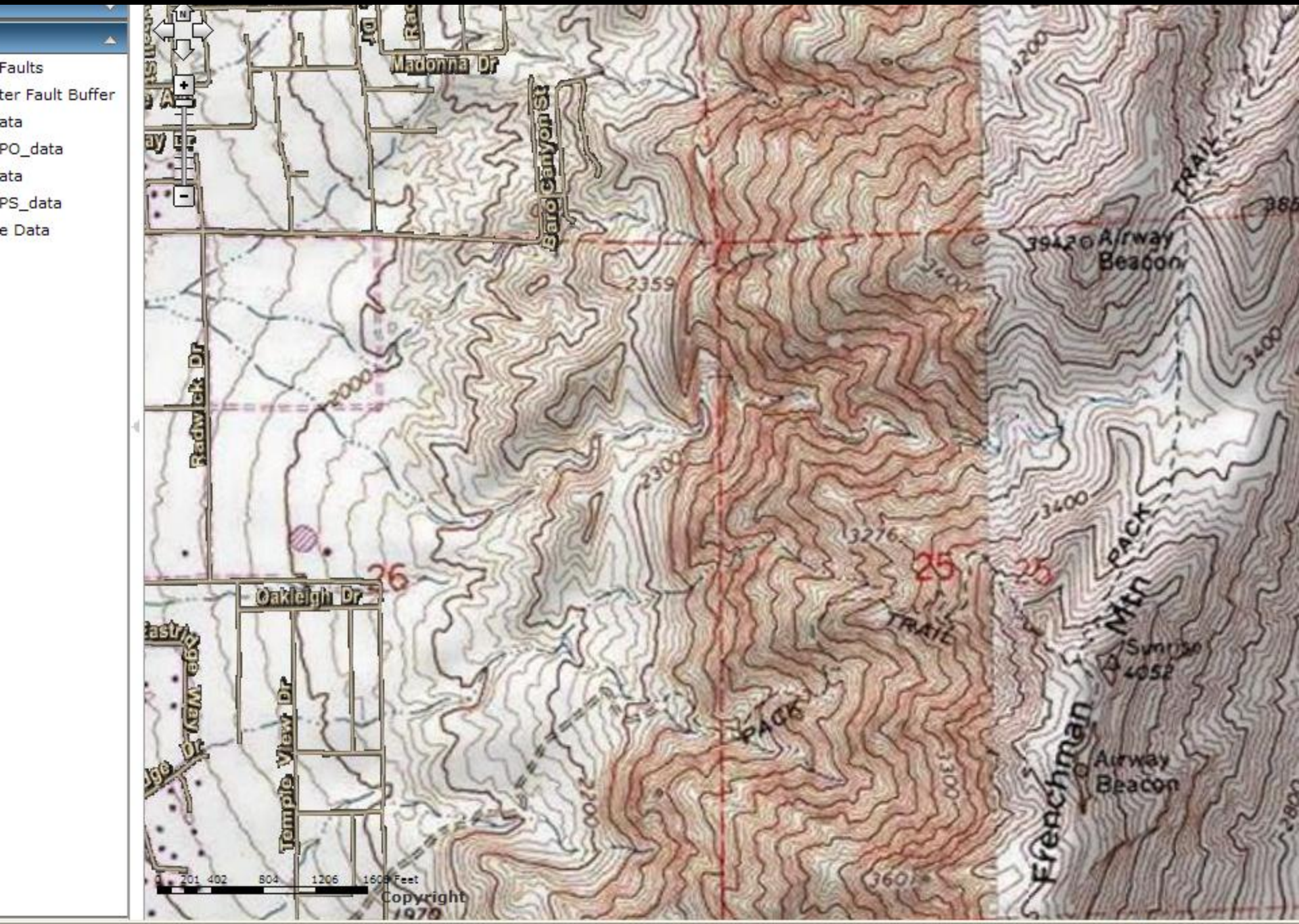
Frenchman
Airway Beacon
Copyright
Faults are shown as 1,000-meter-wide swaths, here on a topographic map base.


Faults
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Madonna Dr
Bard Canyon St
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Oakleigh Dr
Temple View Dr
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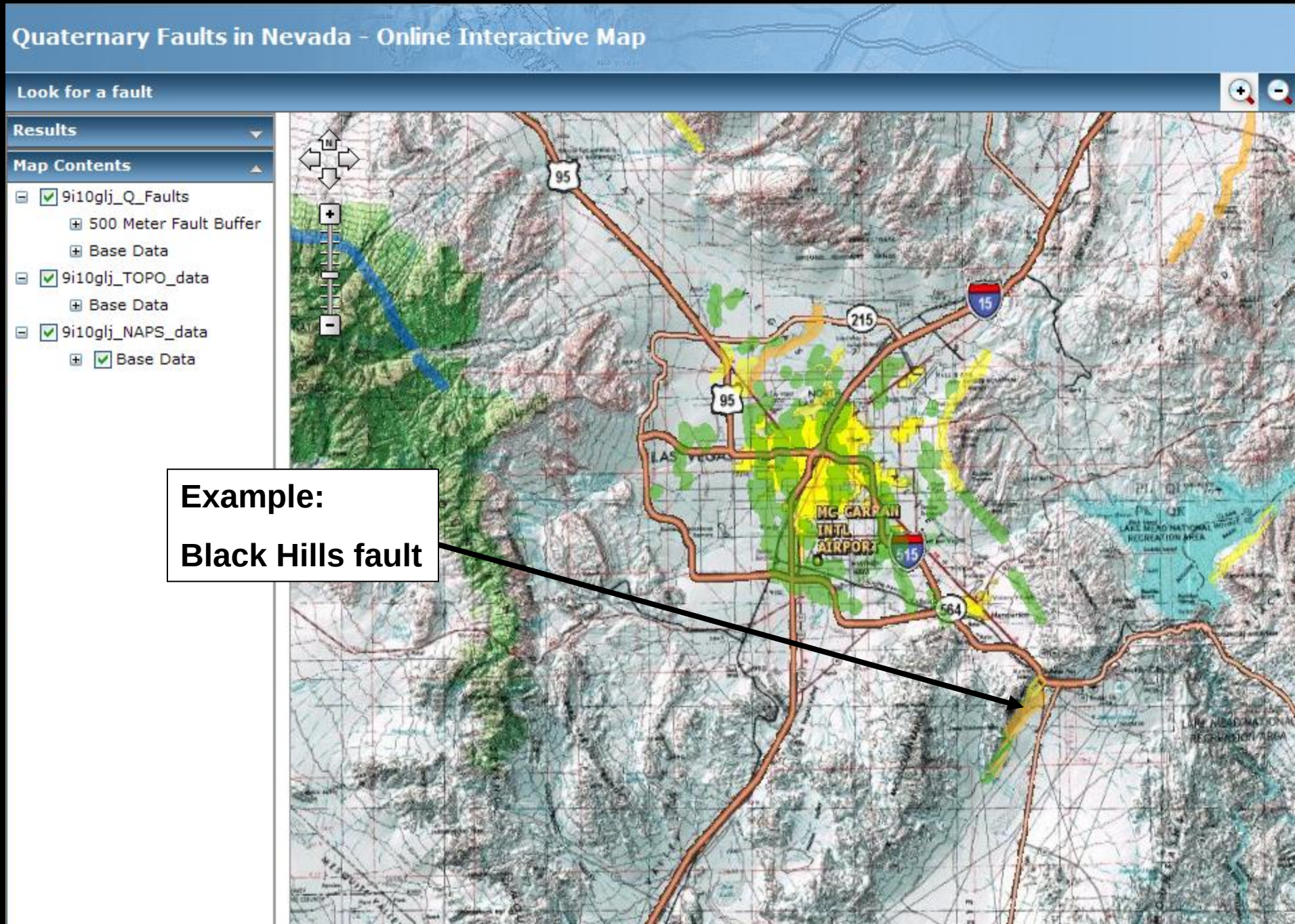
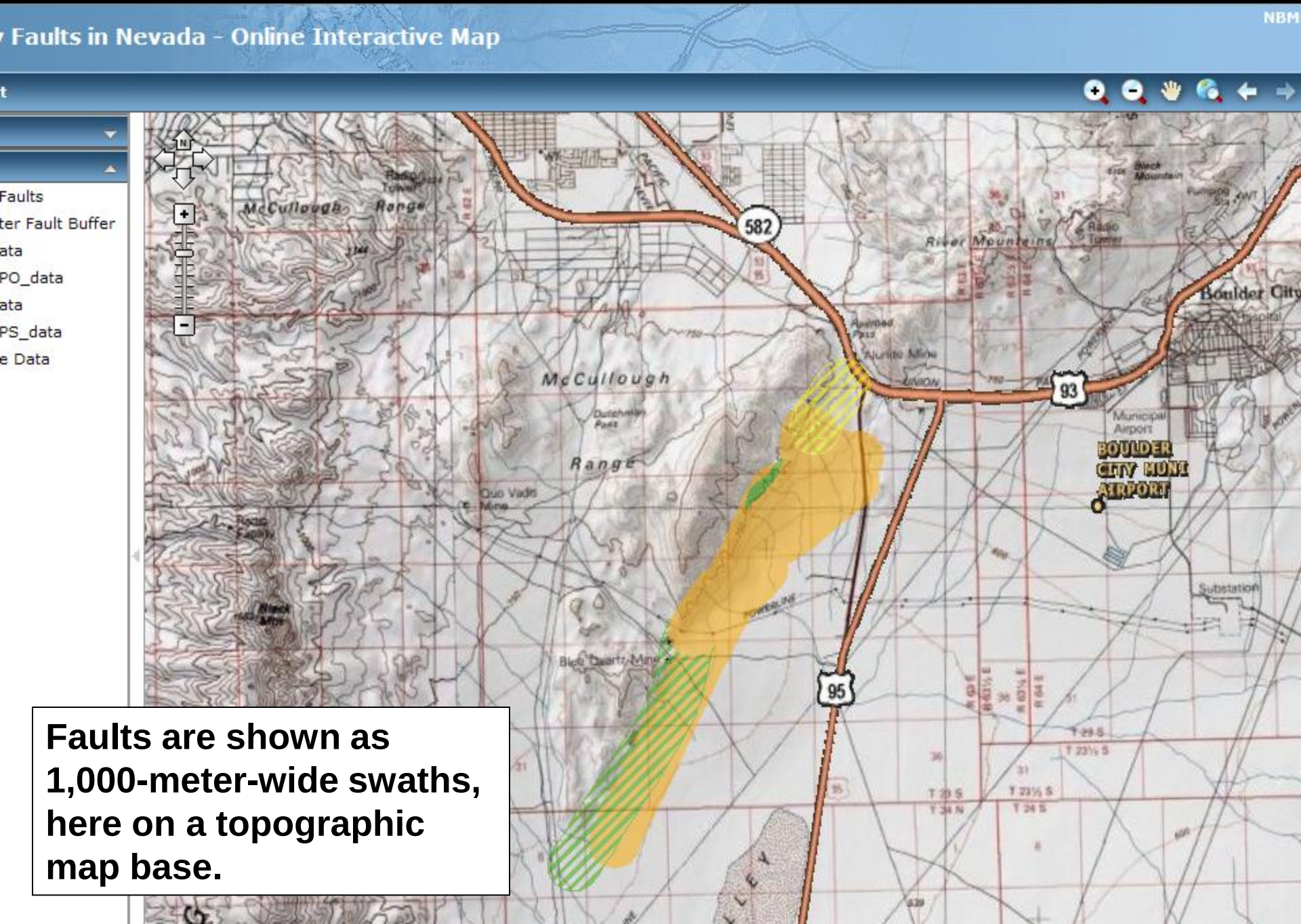
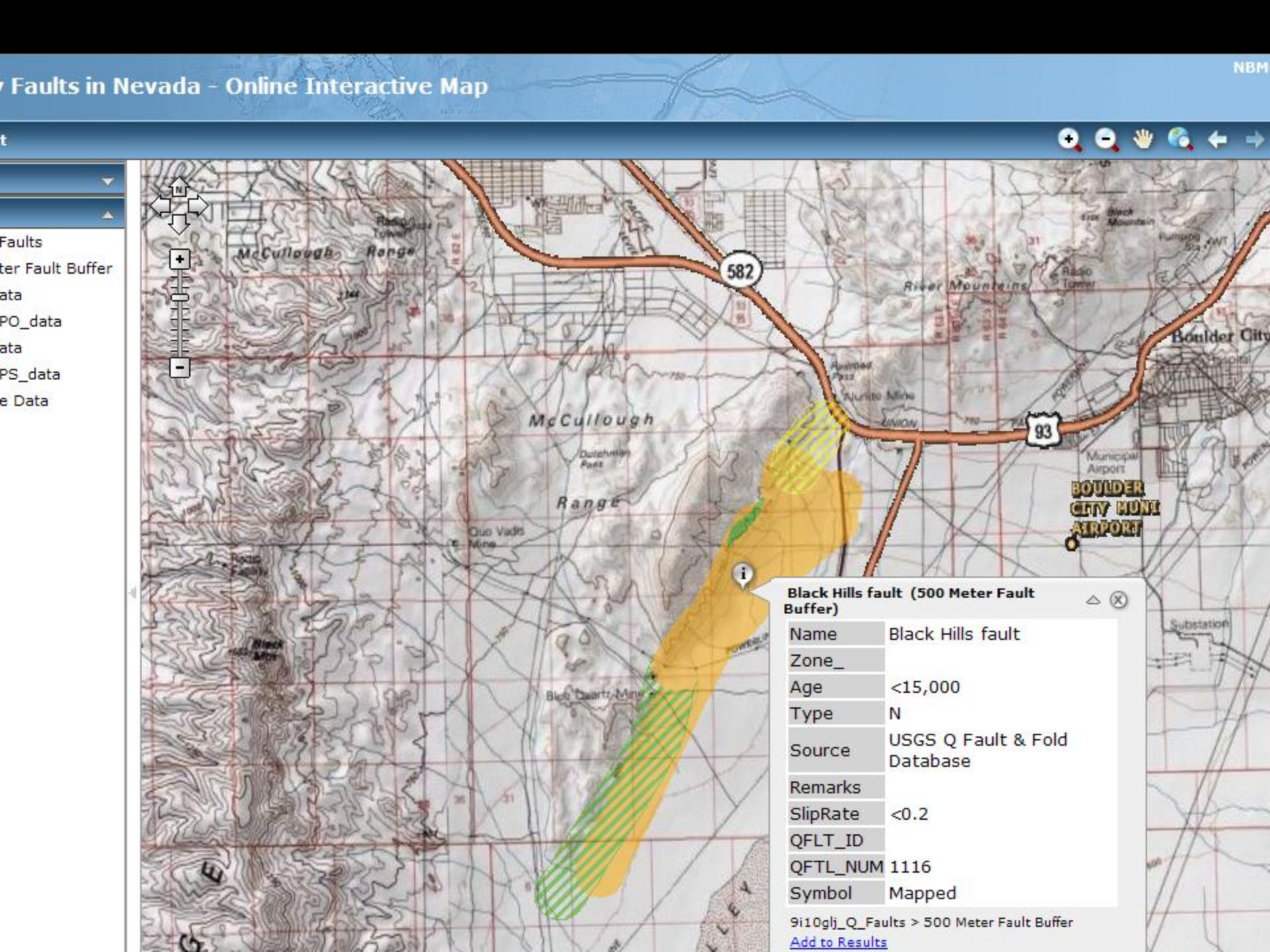
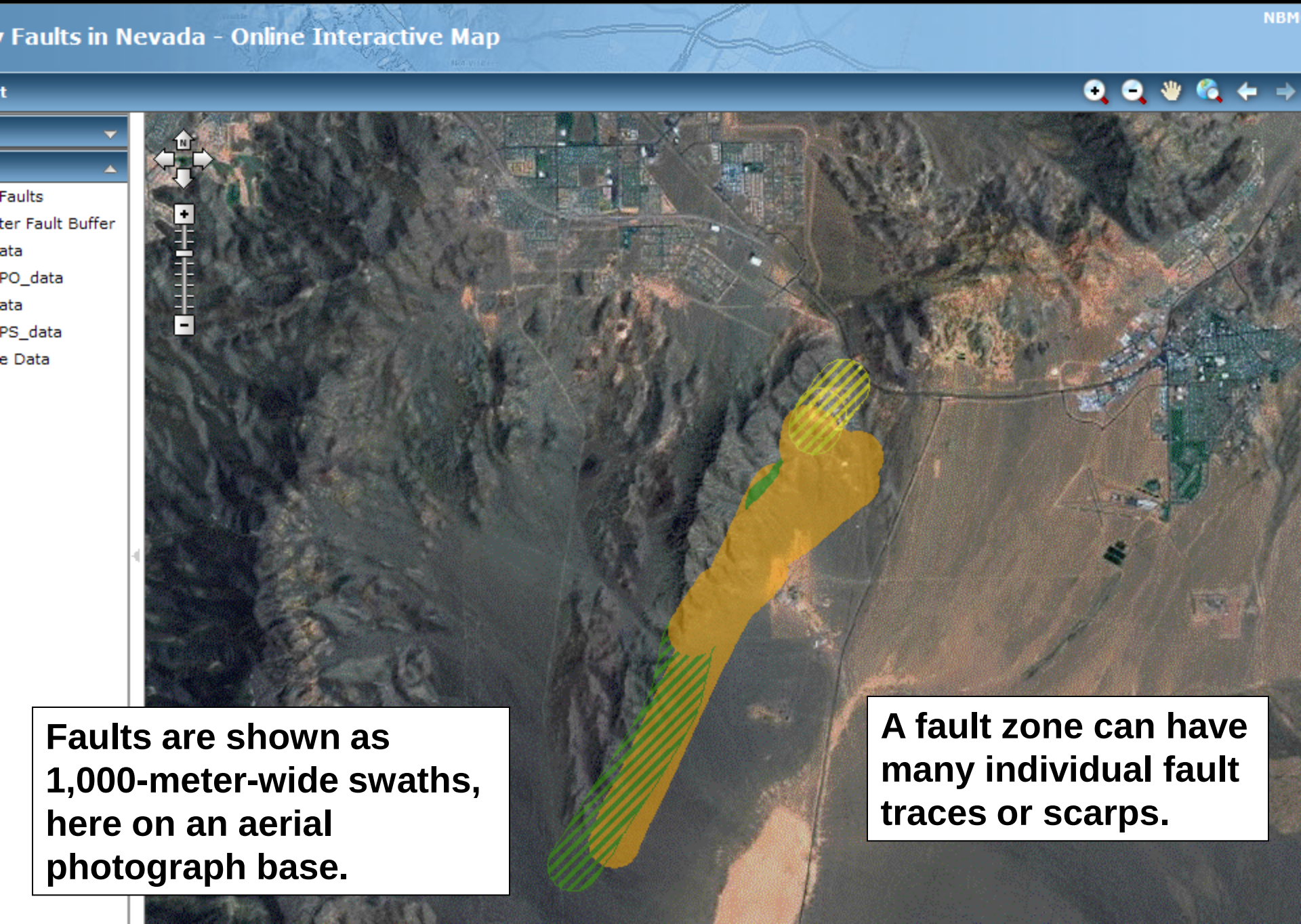
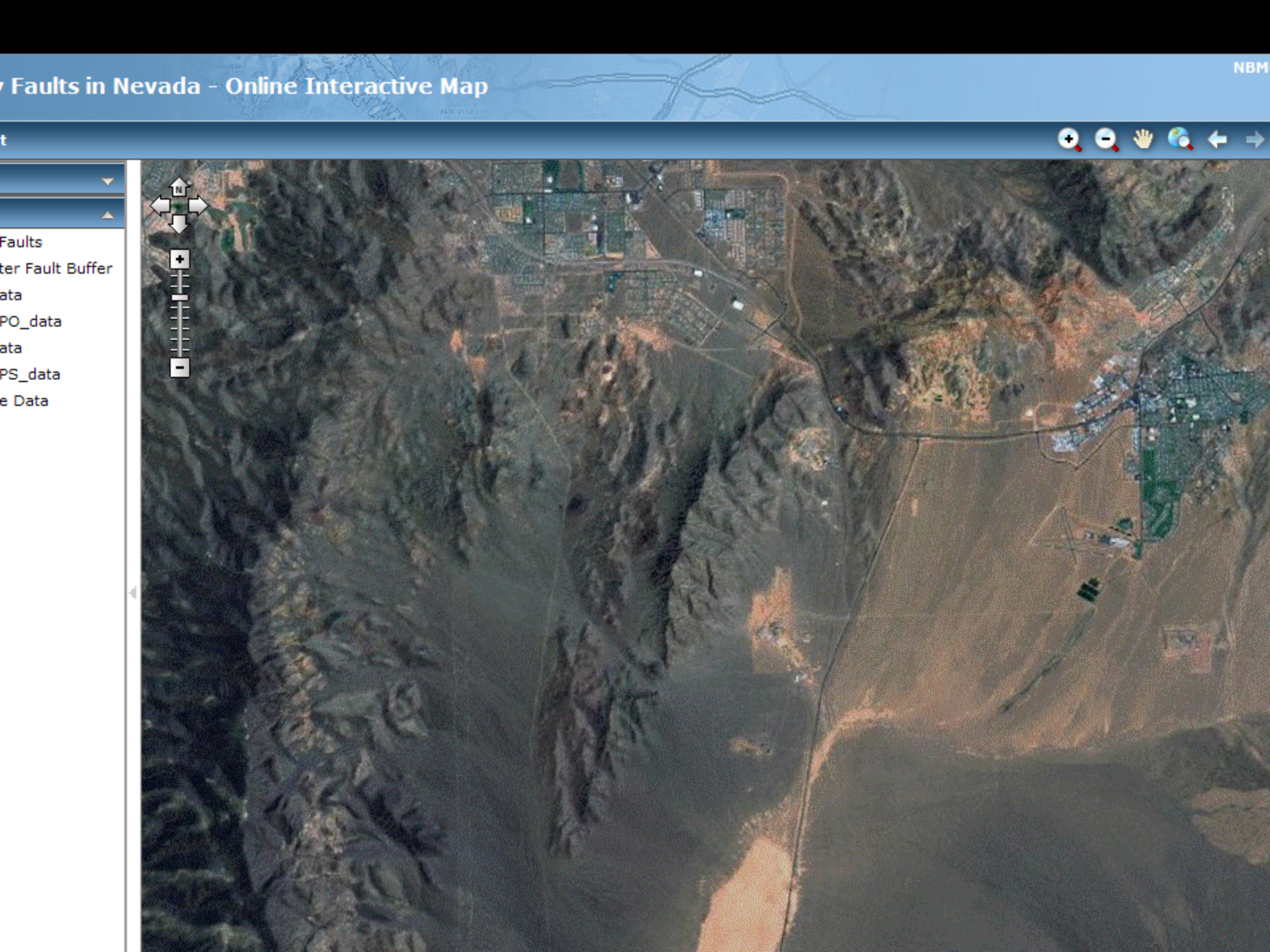

Quaternary Faults in Nevada - Online Interactive Map
Look for a fault
Results
Map Contents
9i10glj_Q_Faults
500 Meter Fault Buffer
Base Data
9i10glj_TOPO_data
Base Data
9i10glj_NAPS_data
Base Data
Example:
Black Hills fault
95
215
15
564
MC CARRAN INTL AIRPORT
LAKE MEAD NATIONAL RECREATION AREA


Faults in Nevada - Online Interactive Map
NBM
Faults
ter Fault Buffer
ata
PO_data
ata
PS_data
e Data
McCullough Range
582
River Mountains
Boulder City
93
McCullough Range
Municipal Airport
BOULDER CITY MUNI AIRPORT
Substation
95
Faults are shown as 1,000-meter-wide swaths, here on a topographic map base.


Faults in Nevada - Online Interactive Map
NBM
Faults
ter Fault Buffer
ata
PO_data
ata
PS_data
e Data
McCullough Range
582
River Mountains
Boulder City
93
McCullough Range
BOULDER CITY MUNI AIRPORT
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
9i10glj_Q_Faults > 500 Meter Fault Buffer
Add to Results


Faults in Nevada - Online Interactive Map
NBM
Faults
ter Fault Buffer
ata
PO_data
ata
PS_data
e Data
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.


Faults in Nevada - Online Interactive Map
NBM
Faults
ter Fault Buffer
ata
PO_data
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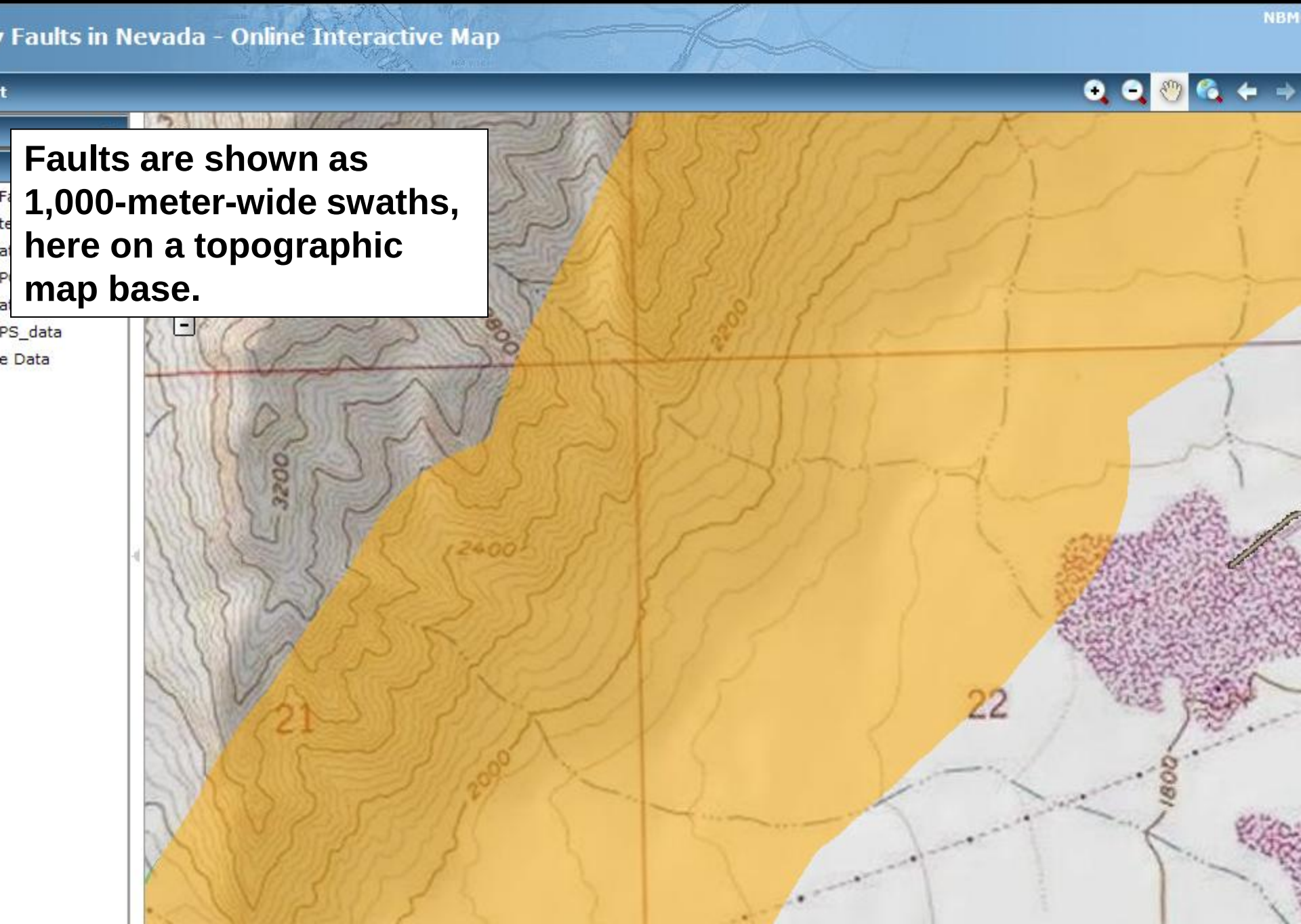
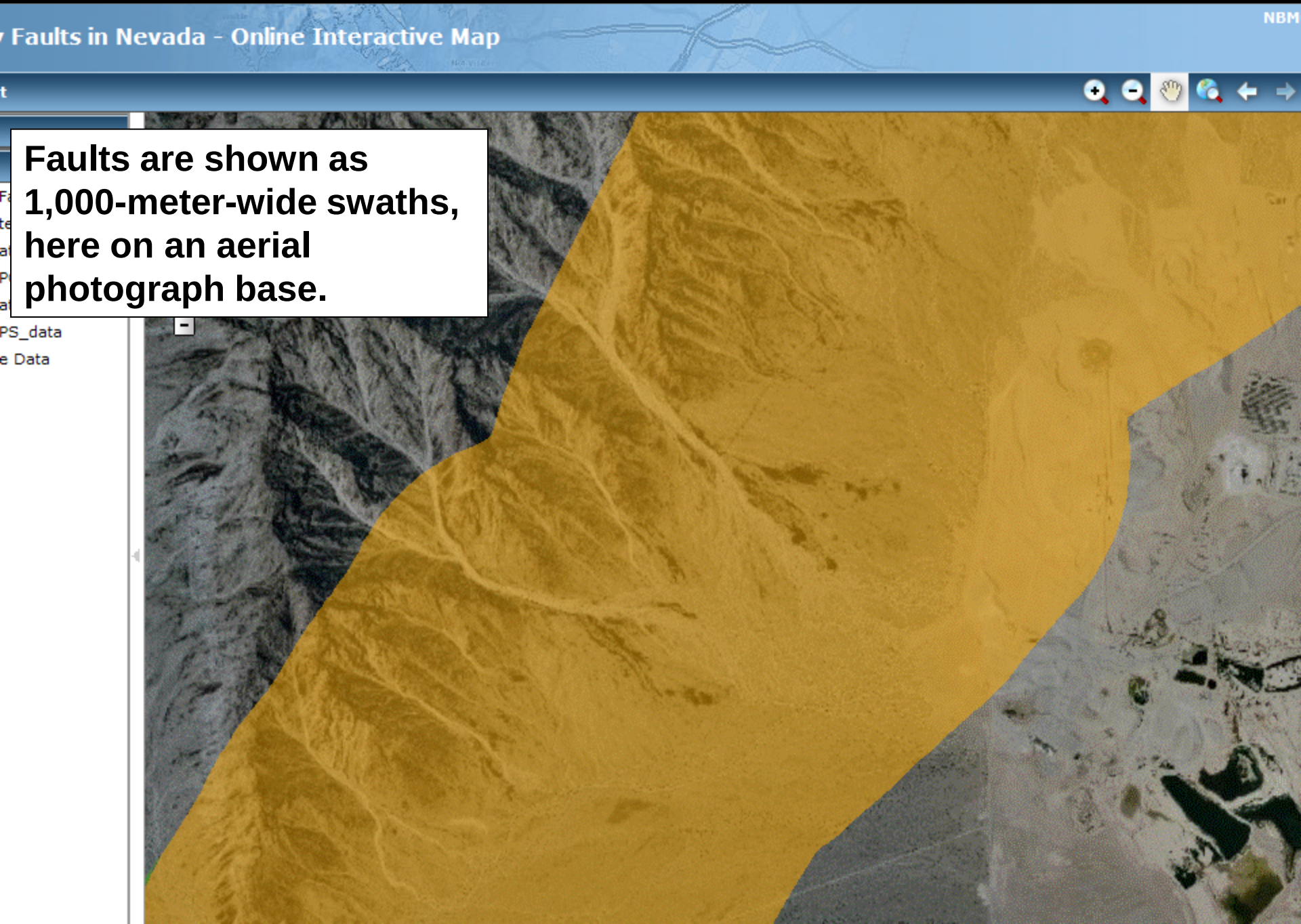
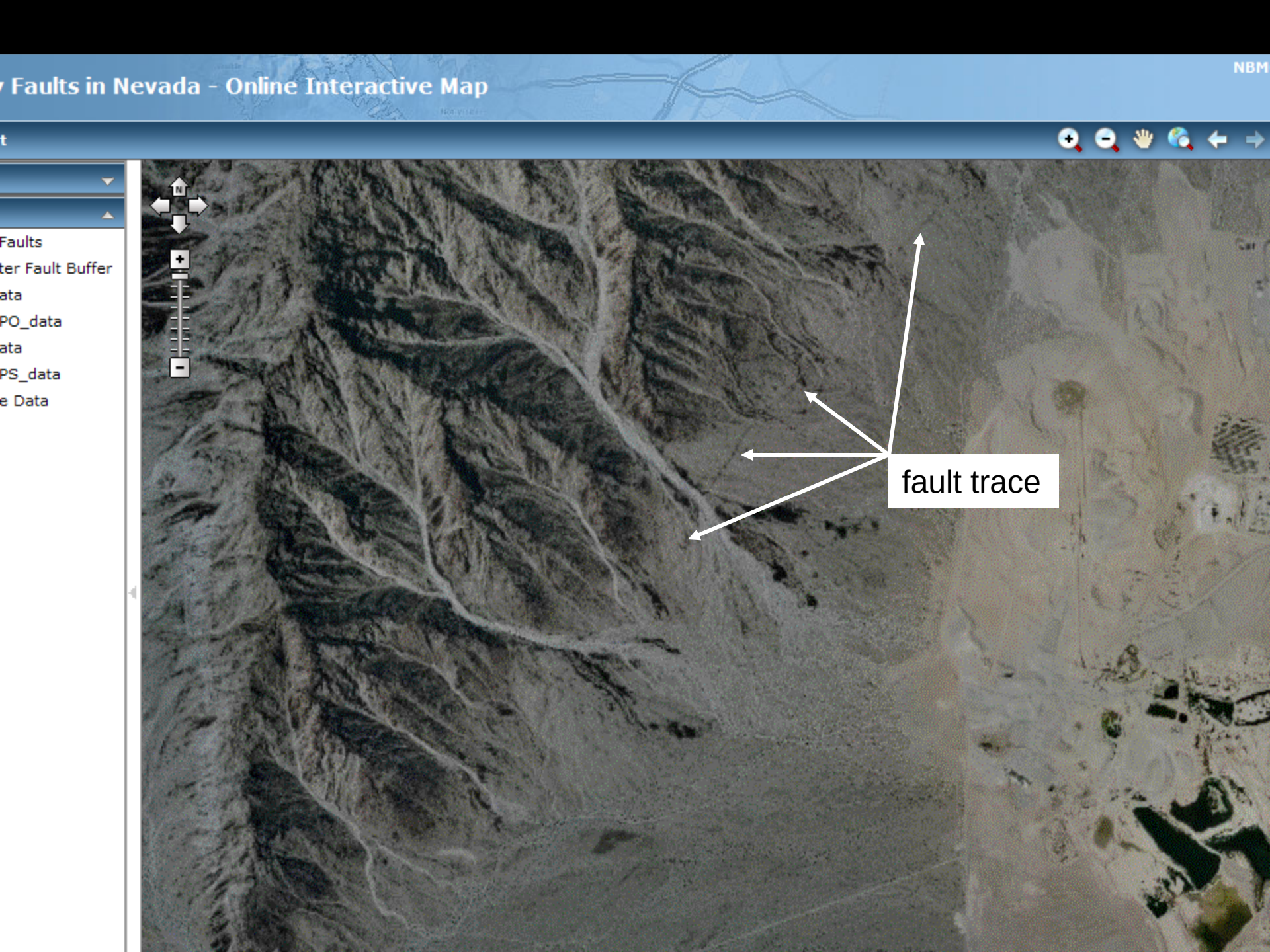
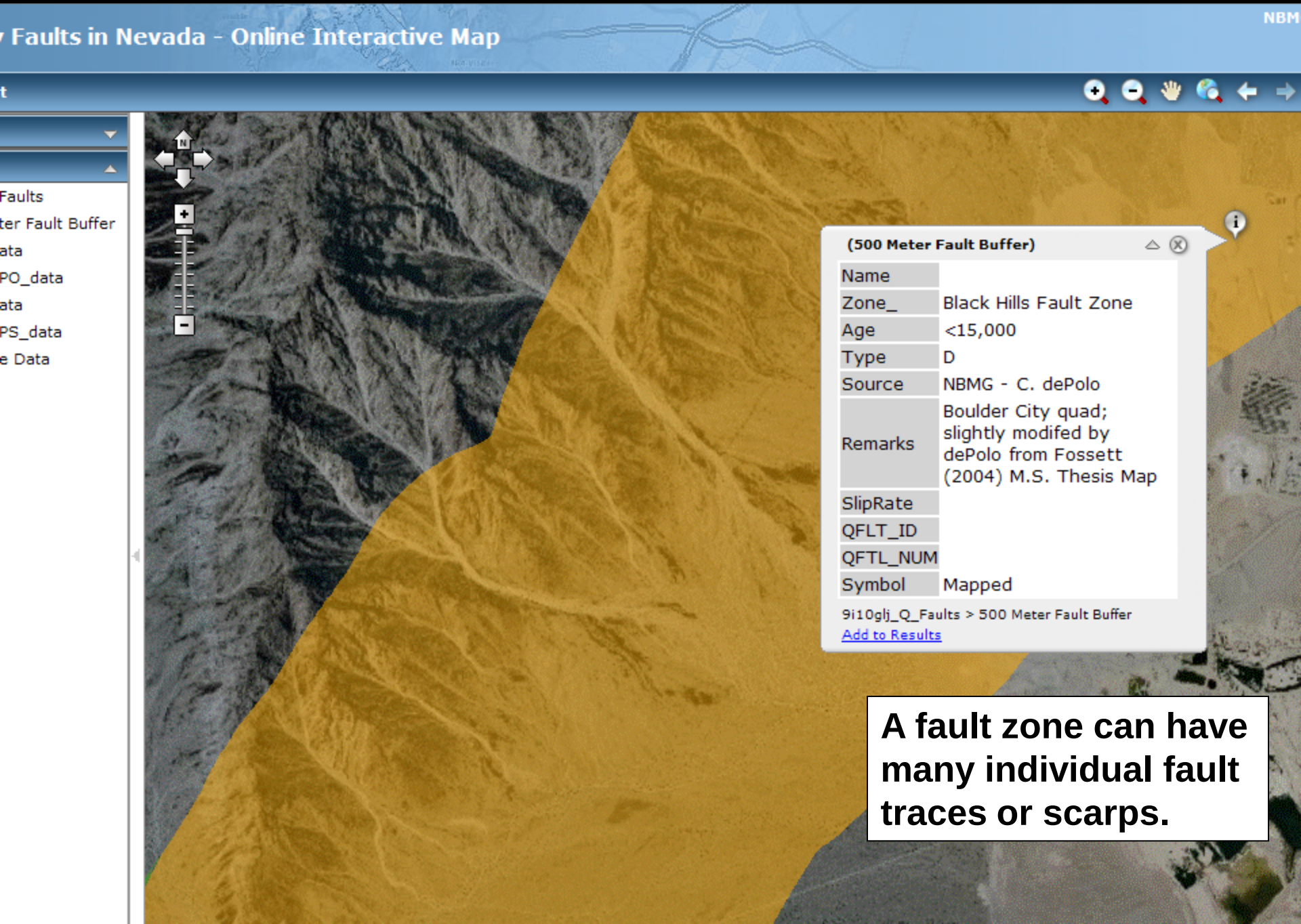
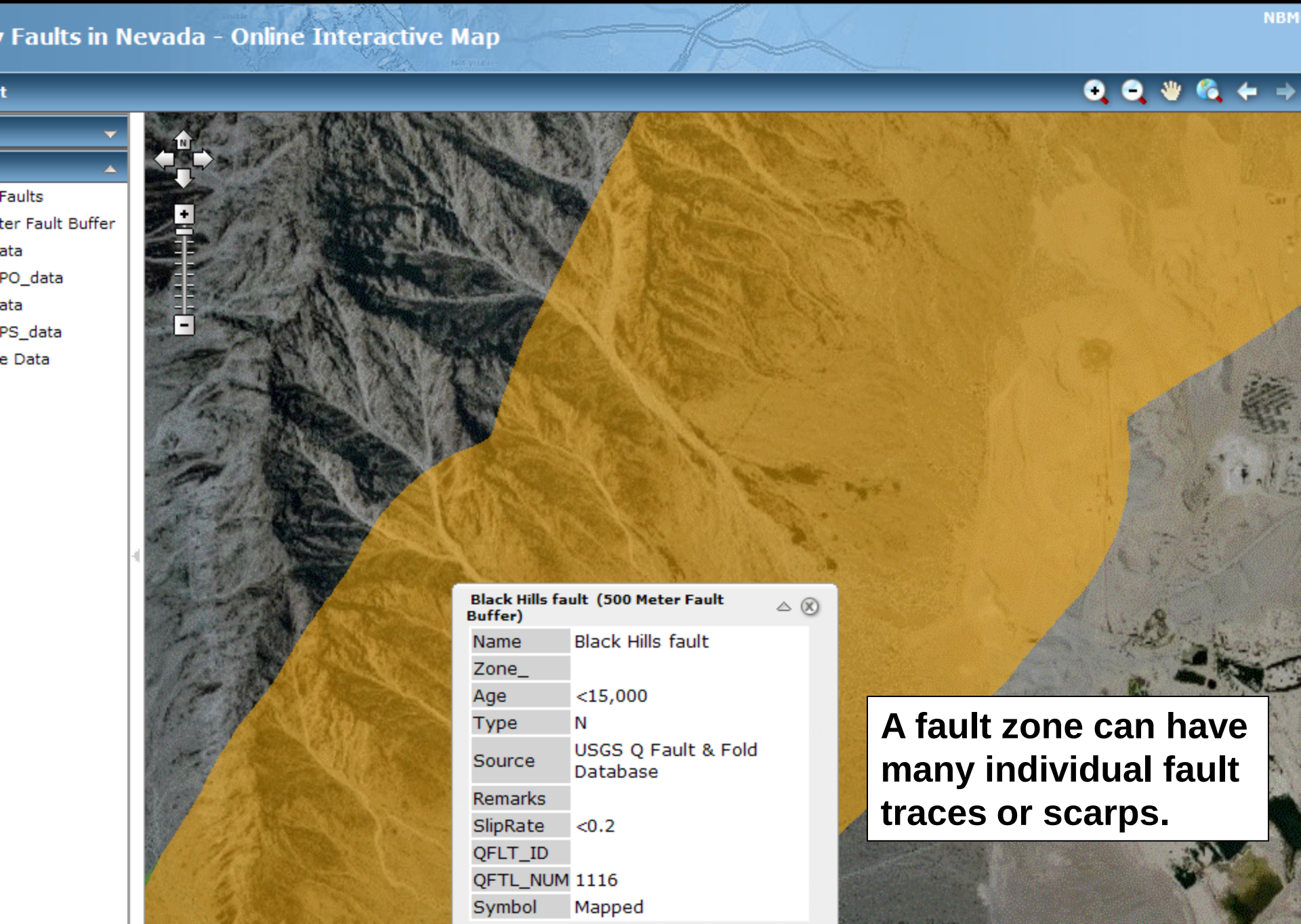
PS_data
e Data


Faults in Nevada - Online Interactive Map
NBM
Faults are shown as 1,000-meter-wide swaths, here on a topographic map base.
PS_data
e Data
21
22
2000
2200
2400
1800
3200


Faults in Nevada - Online Interactive Map
NBM
Faults are shown as 1,000-meter-wide swaths, here on an aerial photograph base.

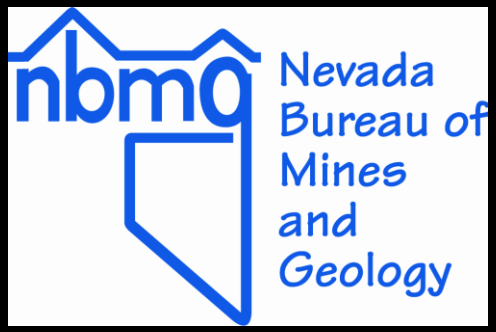

Faults in Nevada - Online Interactive Map
NBM
Faults
ter Fault Buffer
ata
PO_data
ata
PS_data
e Data
fault trace


Faults in Nevada - Online Interactive Map
NBM
Faults
ter Fault Buffer
ata
PO_data
ata
PS_data
e Data
(500 Meter Fault Buffer)
Name
Zone_ Black Hills Fault Zone
Age <15,000
Type D
Source NBMG - C. dePolo
Remarks Boulder City quad; slightly modifed by dePolo from Fossett (2004) M.S. Thesis Map
SlipRate
QFLT_ID
QFTL_NUM
Symbol Mapped
9i10glj_Q_Faults > 500 Meter Fault Buffer
Add to Results
A fault zone can have many individual fault traces or scarps.


Faults in Nevada - Online Interactive Map
NBM
Faults
ter Fault Buffer
ata
PO_data
ata
PS_data
e Data
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.

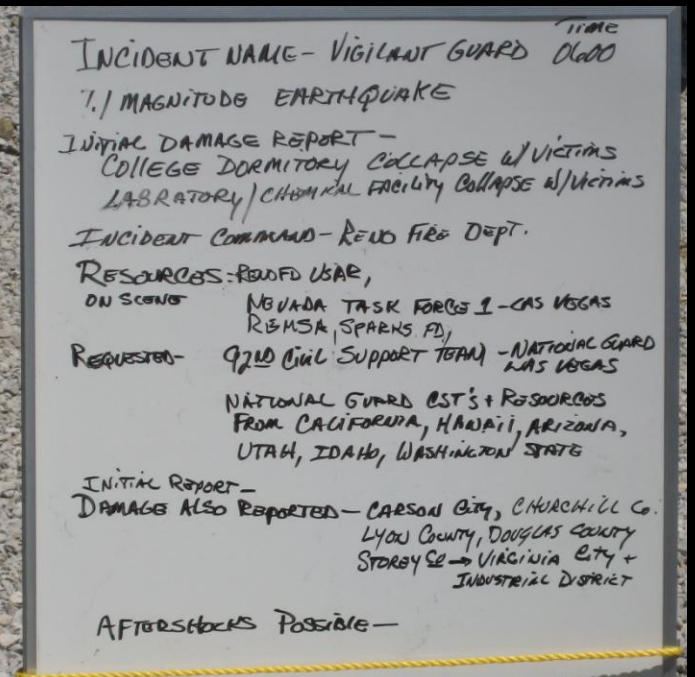
Earthquake faults occur throughout Nevada, and potential losses from earthquakes are high for many communities.

NBMG Open-File Report 09-8, *Estimated Losses from Earthquakes near Nevada Communities*, demonstrates that the consequences of earthquakes can be huge in Nevada, particularly if individuals are not prepared.



Earthquake risks in Nevada are assessed by the Nevada Bureau of Mines and Geology using the Federal Emergency Management Agency's loss-estimation model, HAZUS-MH, and the U.S. Geological Survey's probabilistic seismic hazard analysis.

These loss estimates are useful in hazard-mitigation planning, in building scenarios for emergency response and recovery exercises, and in helping emergency managers and the Governor make decisions on official disaster declarations after an actual earthquake.



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
Stateline	>90	~80	60-70	40-50	10
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.

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.

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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
Stateline	>90	~80	60-70	40-50	10
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).

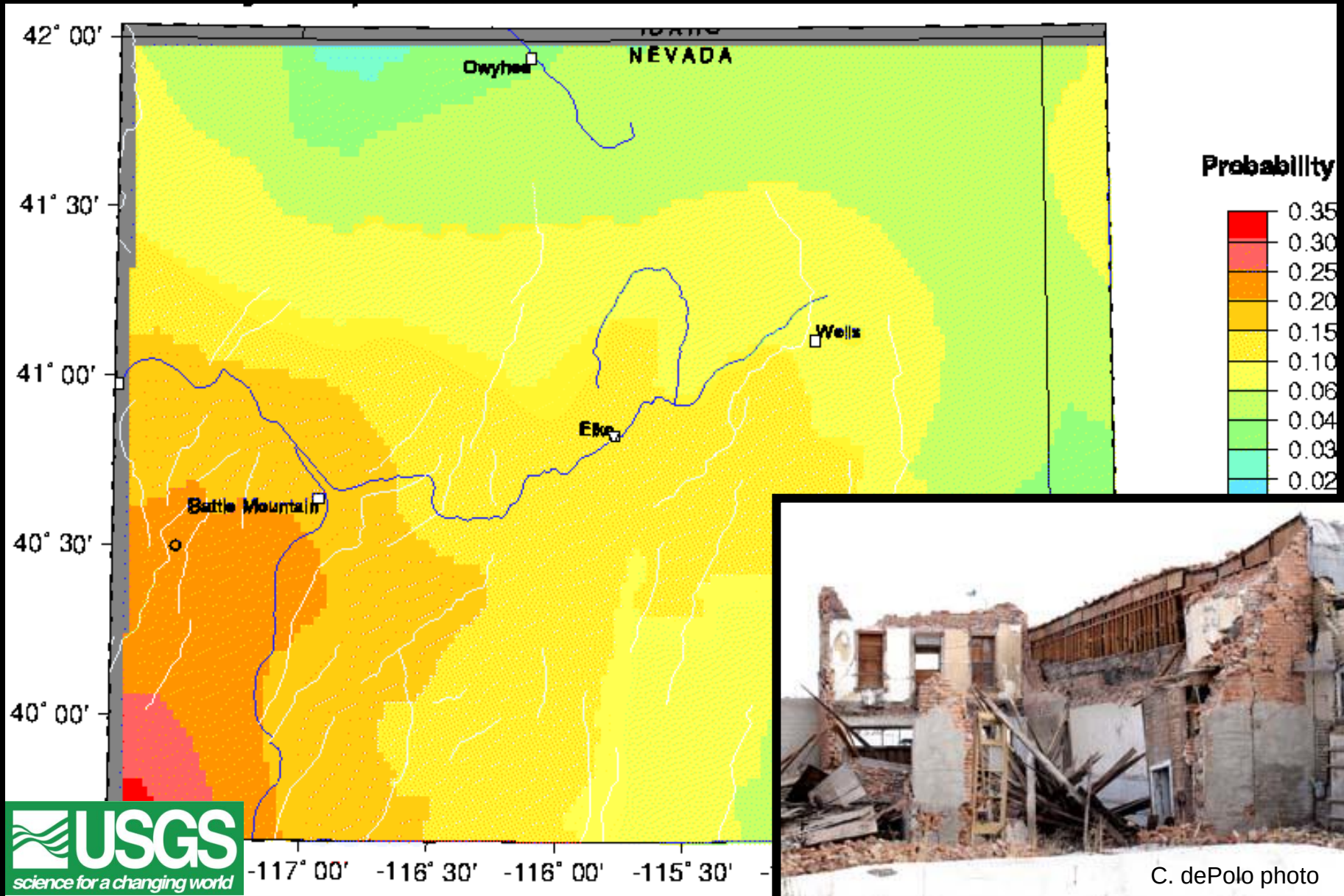
HAZUS estimates for total economic loss from a magnitude 6.0 earthquake and probability of an earthquake of this magnitude or greater occurring within 50 years and within 50 km of the community.

Community	Total Economic Loss	Probability in 50 years within 50 km
Las Vegas	$7.2 billion	12%
Reno	$1.9 billion	67%
Stateline	$590 million	60 to 70%
Elko	$160 million	10 to 15%
Wells	$30 million	9%

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%.

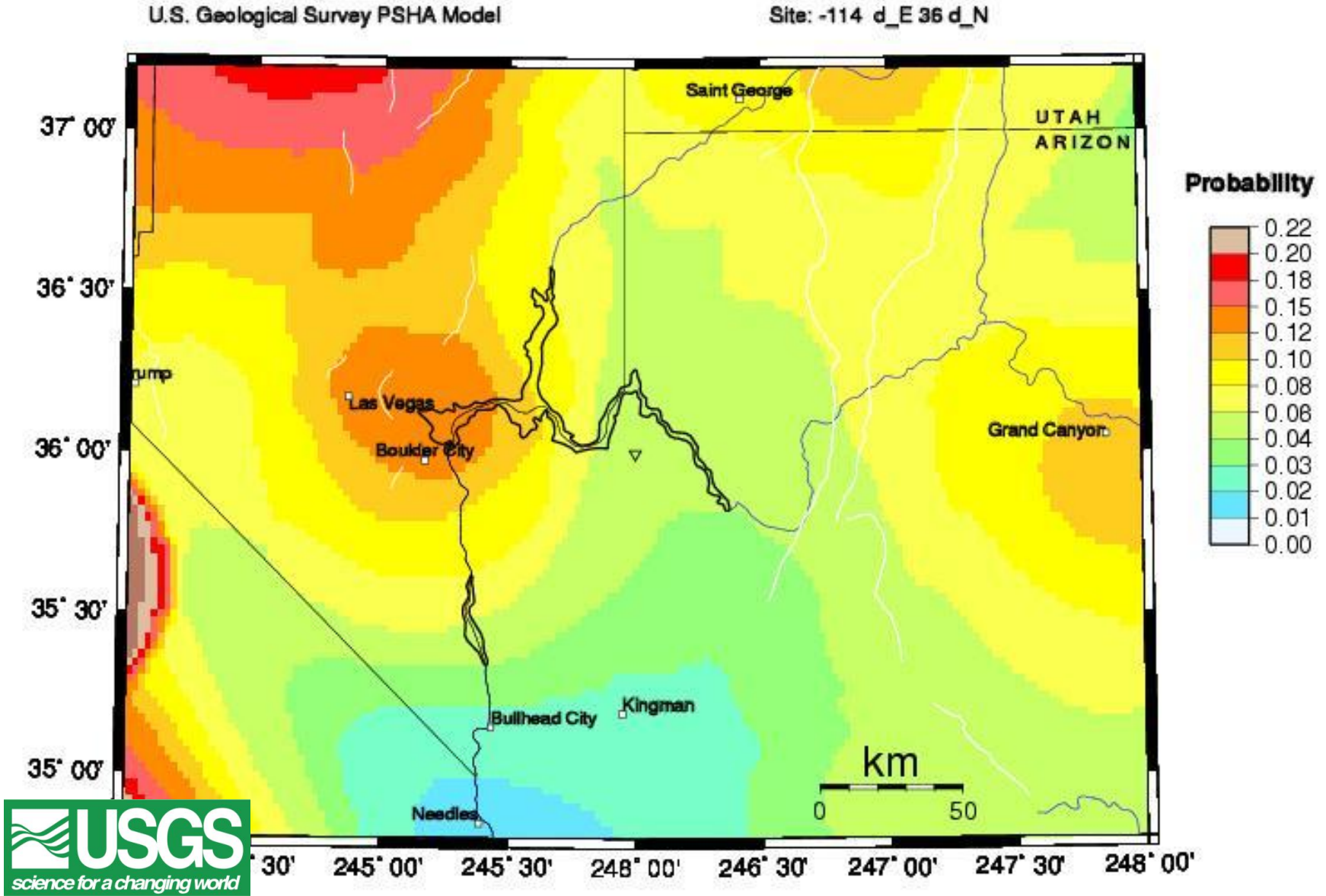
It happened on 21 February 2008.



C. dePolo photo

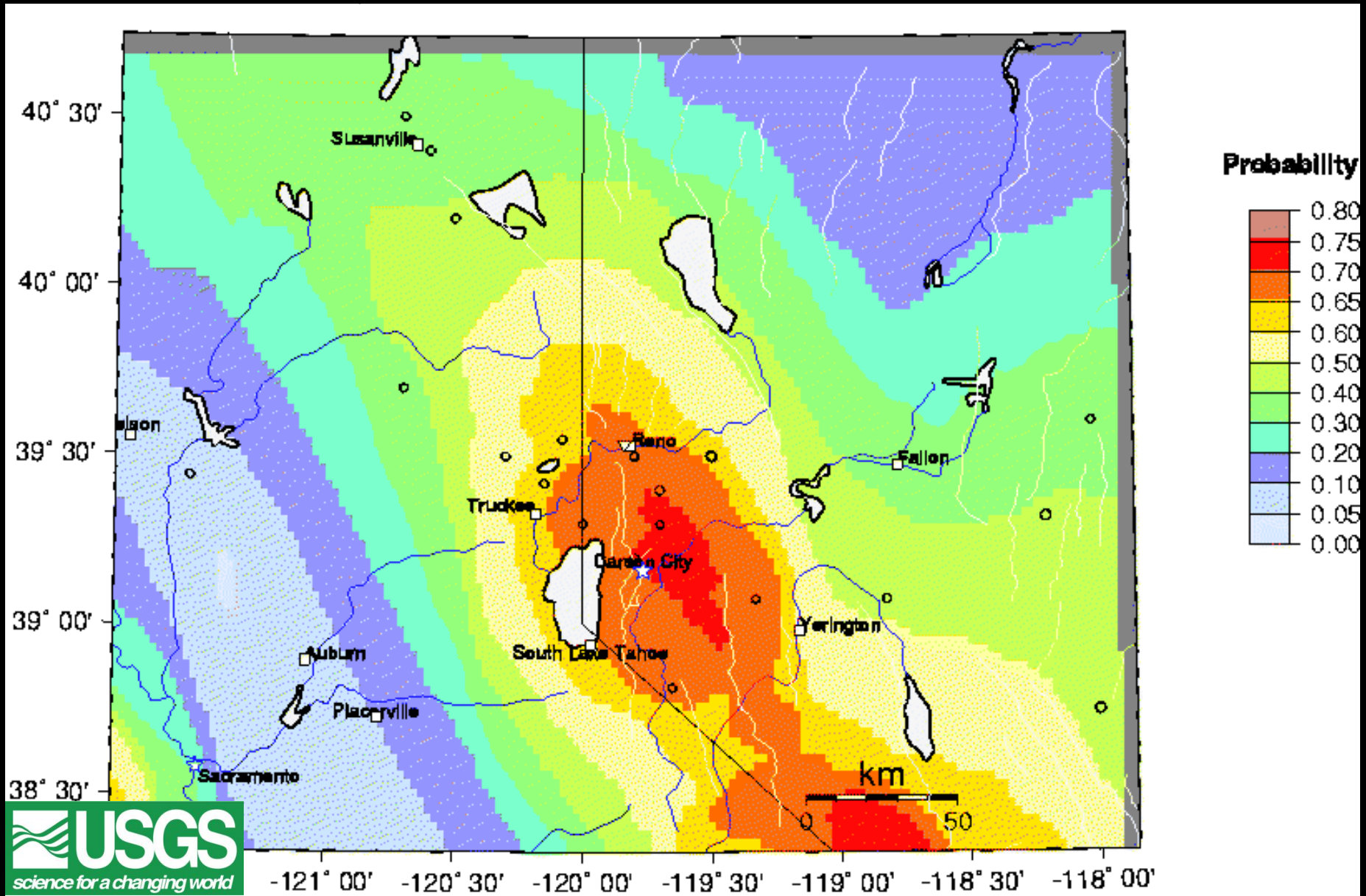
USGS science for a changing world

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.



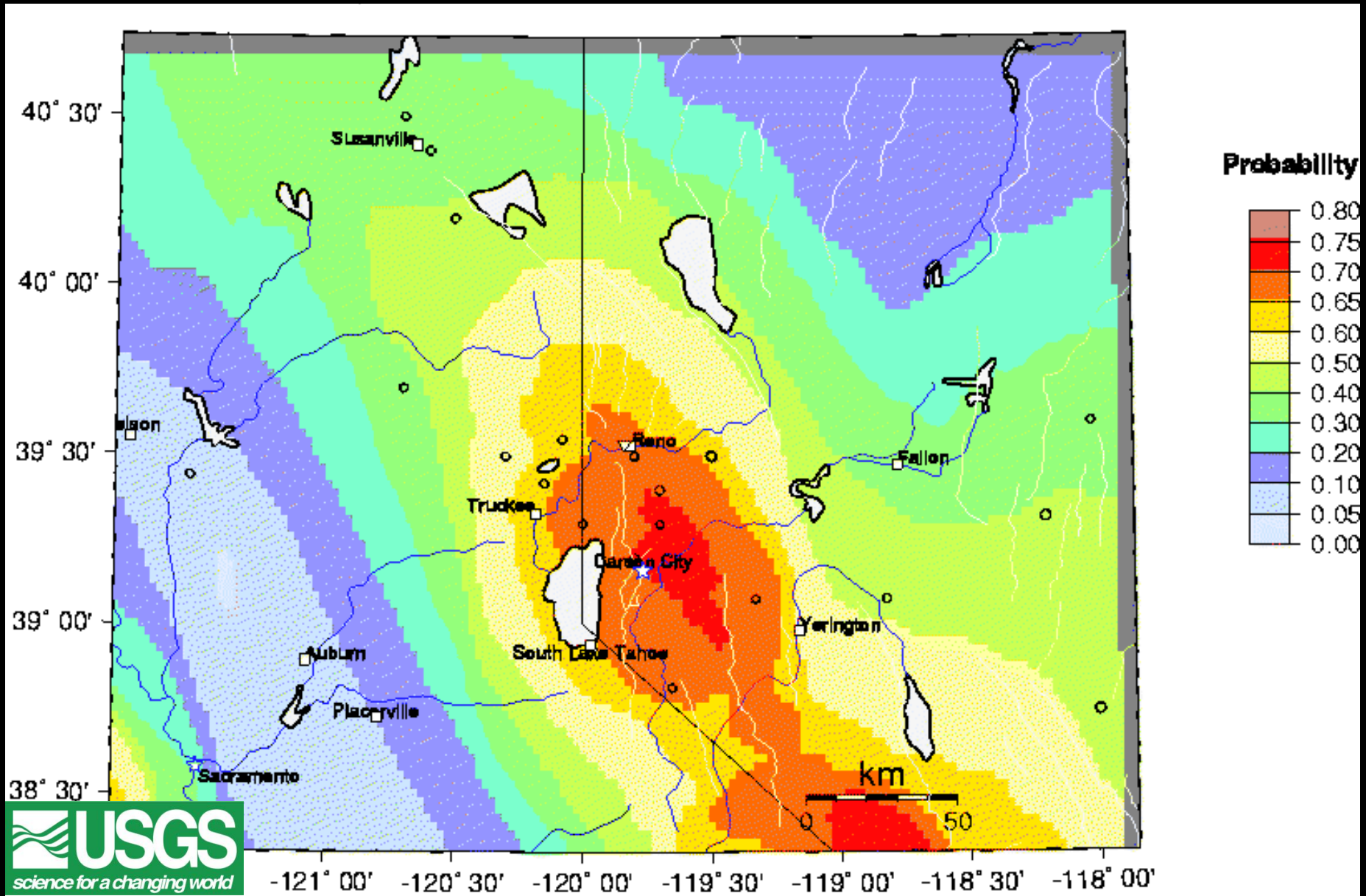
USGS
science for a changing world

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



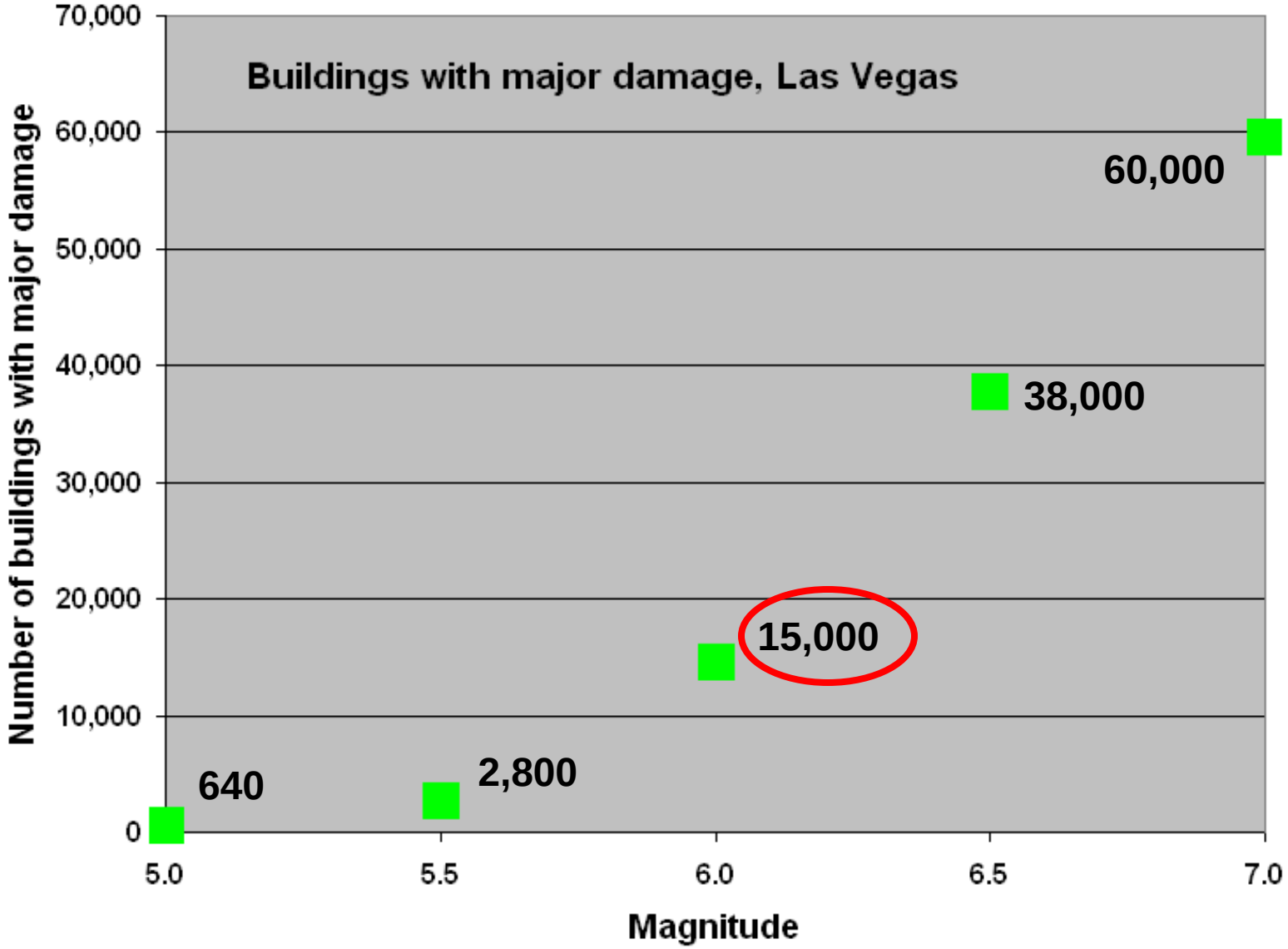
USGS science for a changing world

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.



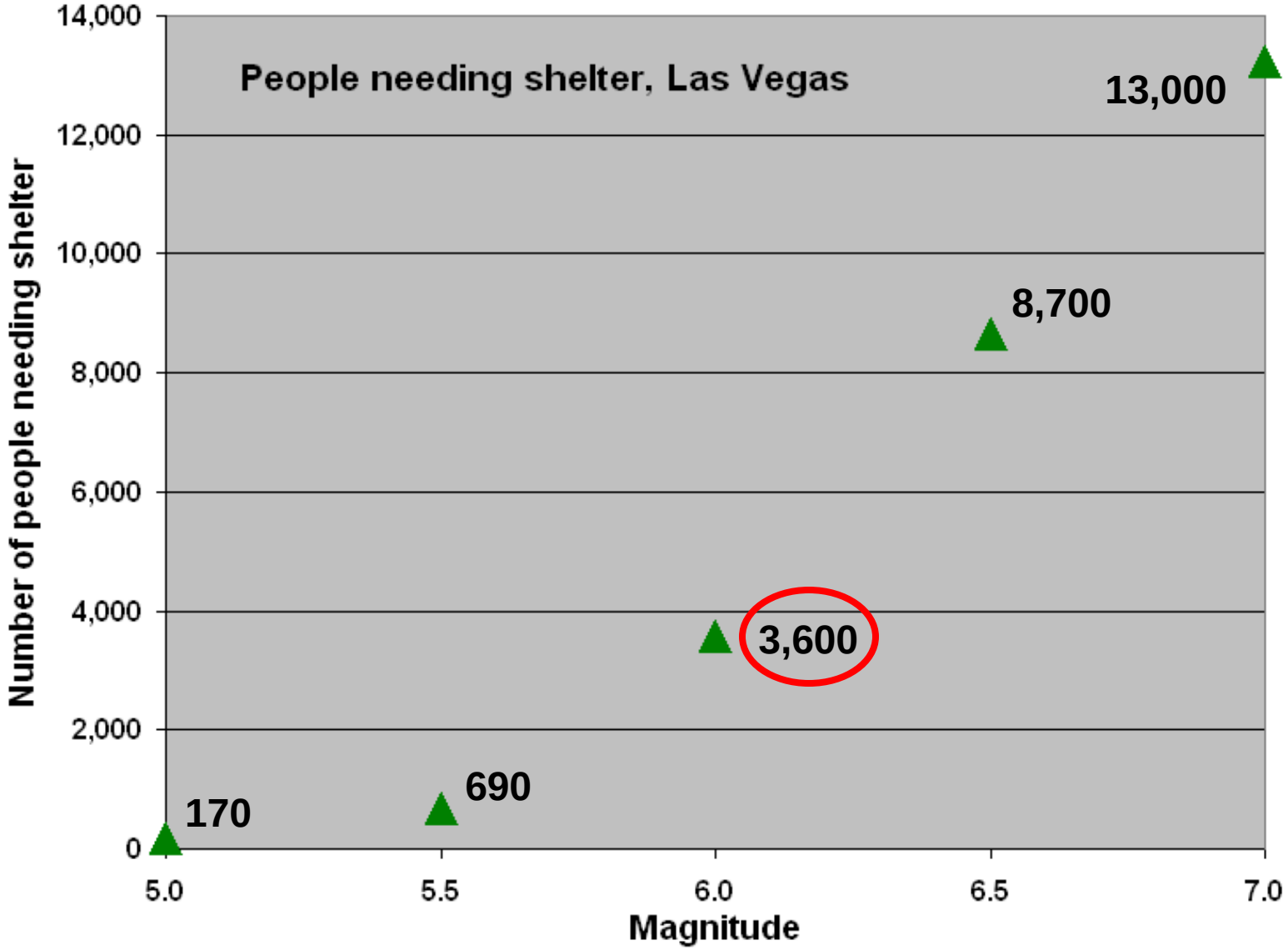
USGS science for a changing world

HAZUS estimates building damage:



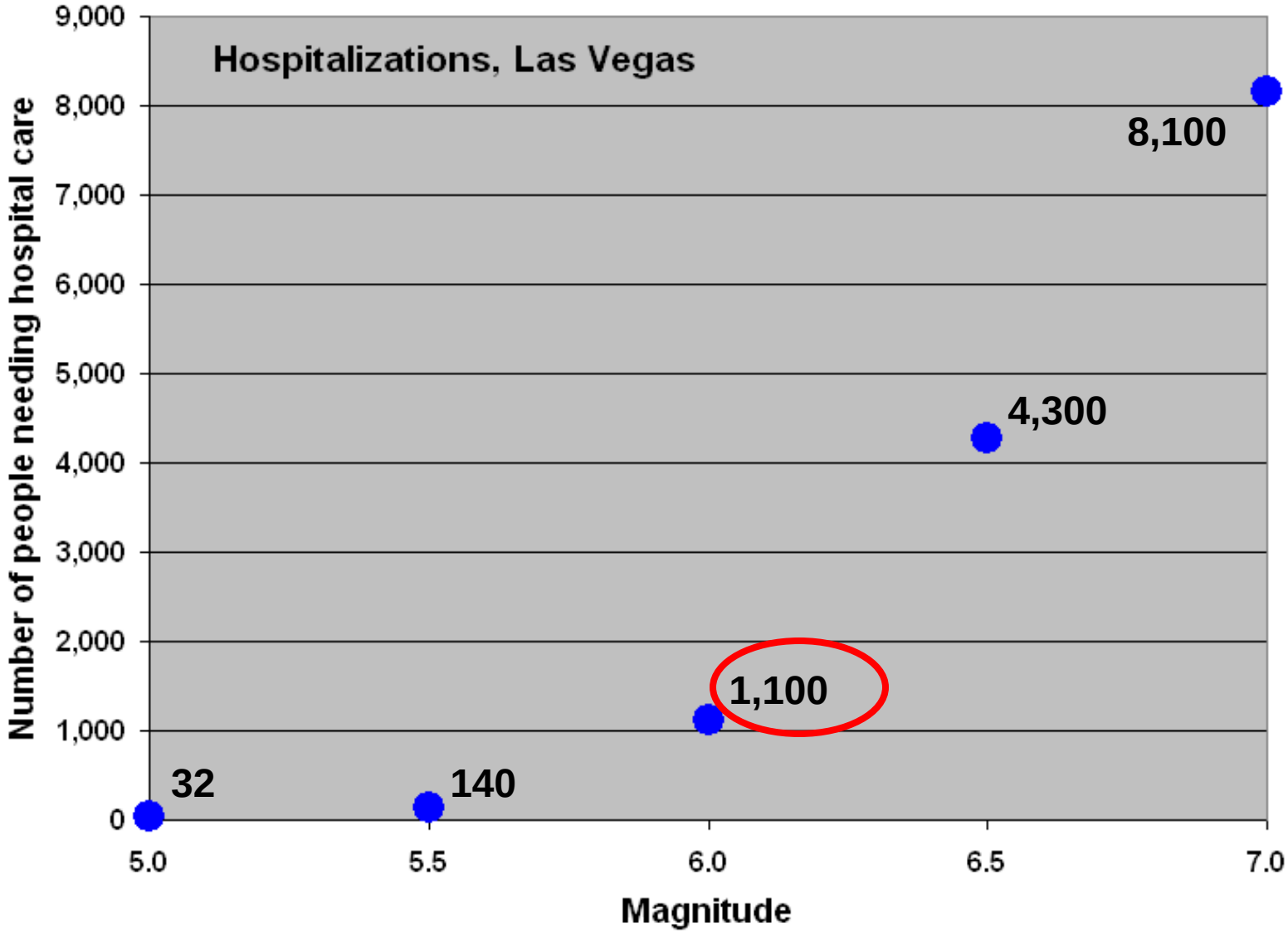
Note that the graphs are similar, but the scale changes with what is at risk.

HAZUS estimates public shelter needs:



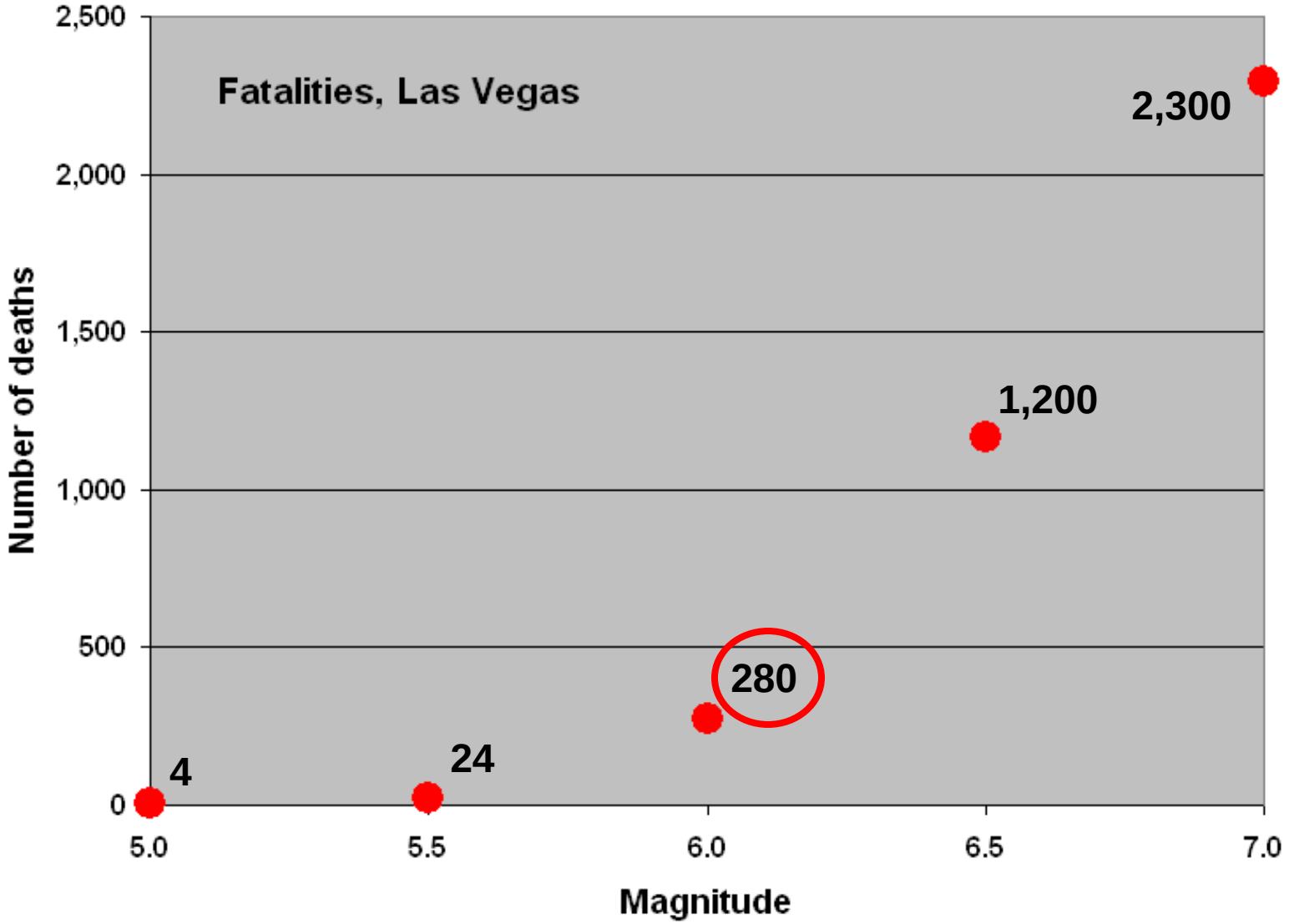
Note that the graphs are similar, but the scale changes with what is at risk.

HAZUS estimates hospital needs:



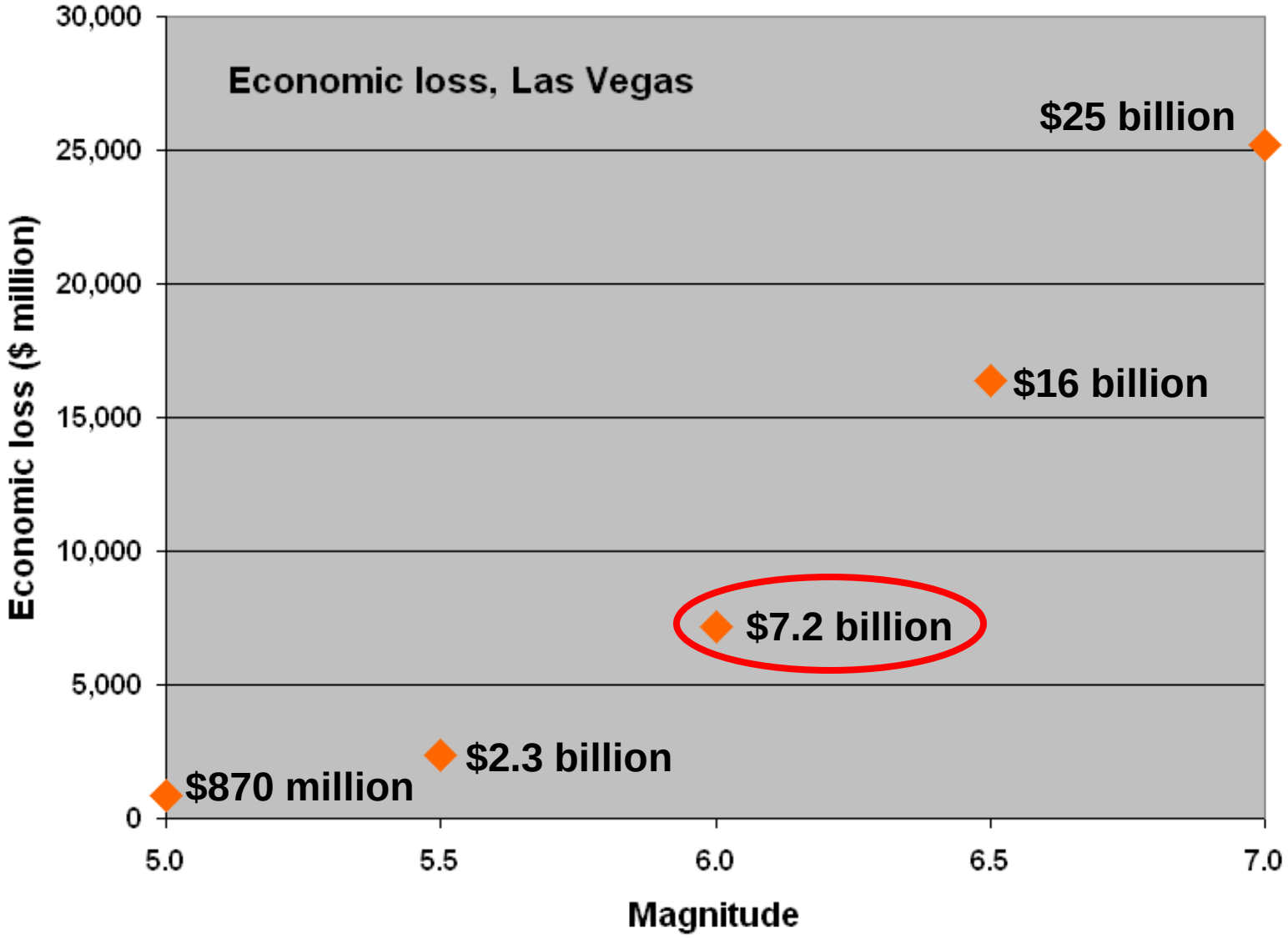
Note that the graphs are similar, but the scale changes with what is at risk.

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.

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

View from back, 20 May 2009

View from front, 20 May 2009

Nonstructural damage often can be easily prevented.

Earthquake-secure bookshelves in the office of the State Geologist

Secured computers at the Clark County Building Department

Thank you!

And thanks to Gary Johnson, Christine Ballard, Heather Armeno, Irene Seeley, Linda D. Goar, and Jordan T. Hastings for their work on the open-file reports (OF 09-8 and 09-9), which are available as online documents at www.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 Bureau of Mines and Geology

University of Nevada, Reno
Statewide • Worldwide

FEMA

Nevada Department of Public Safety
Division of Emergency Management

Nevada Earthquake Safety Council

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University of Nevada, Reno

on the Campus of the Desert Research Institute
2175 Raggio Parkway, Reno, NV 89512

Cuttings from oil, gas, and geothermal exploration and production wells
6 May 2009

Seismic base isolation for storage racks in the warehouse section, 6 May 2009


RIDG-U-RAK®
Seismic Base Isolation System
Patent No's. 7,249,442 & 7,263,806

4 May 2009