Road cuts on West Fourth Street, west of McCarran Boulevard and east of Mayberry Drive, in Reno

Nevada Bureau of Mines and Geology

Jonathan G. Price
State Geologist and Director

Photo 1

What do you see?

What kind of rock is it?

What structure do you see?

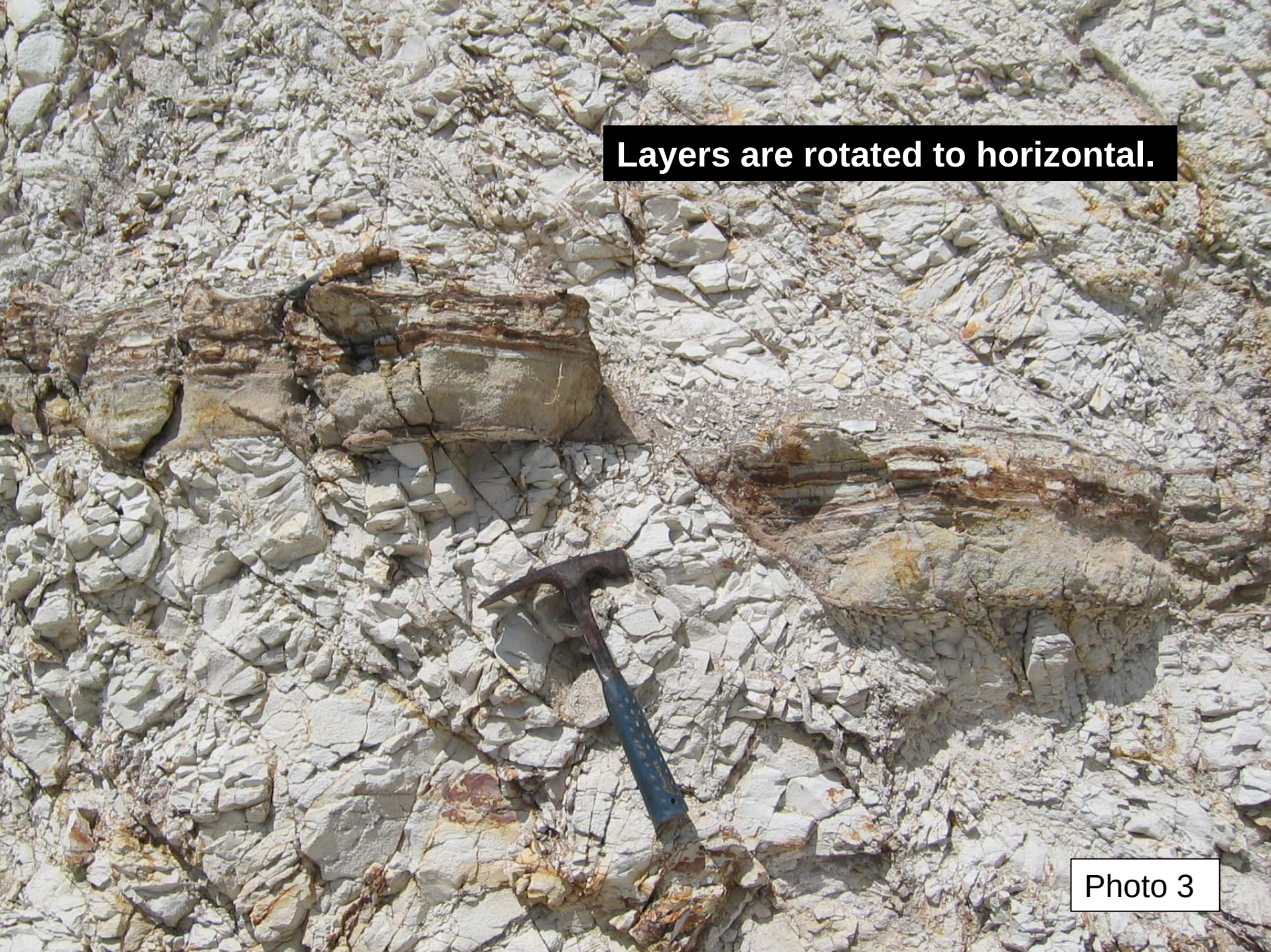
How did it form?


Layers are rotated to horizontal in this picture.

Photo 2


NEVADA BUREAU OF MINES AND GEOLOGY
CENTIMETER

Why are the layers not continuous?


Layers are rotated to horizontal.
Photo 3

Take a look at the rocks and the photographs.

Road cuts on West Fourth Street, west of McCarran Boulevard and east of Mayberry Drive, in Reno

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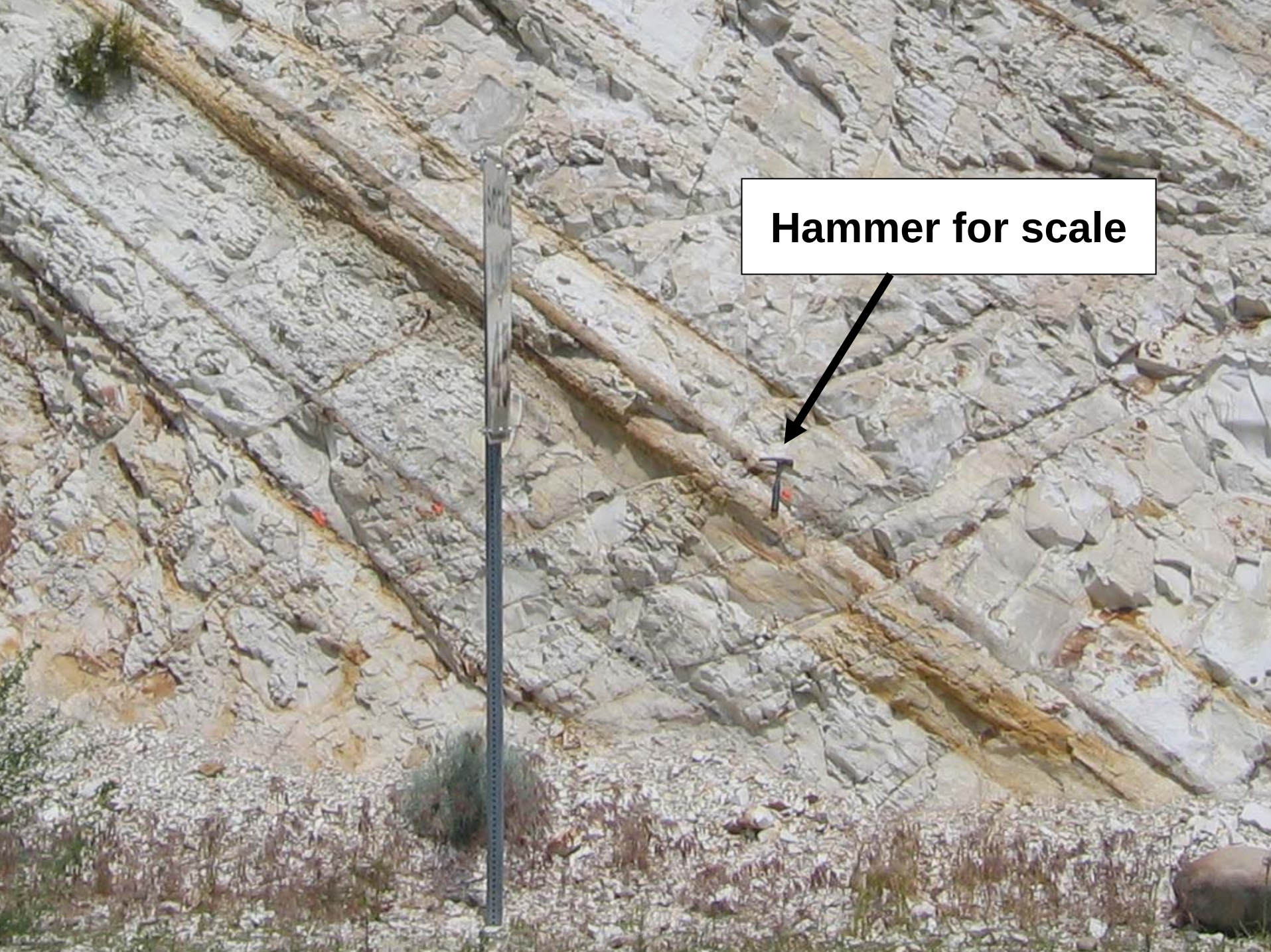
Jonathan G. Price
State Geologist and Director

How did the faults form?

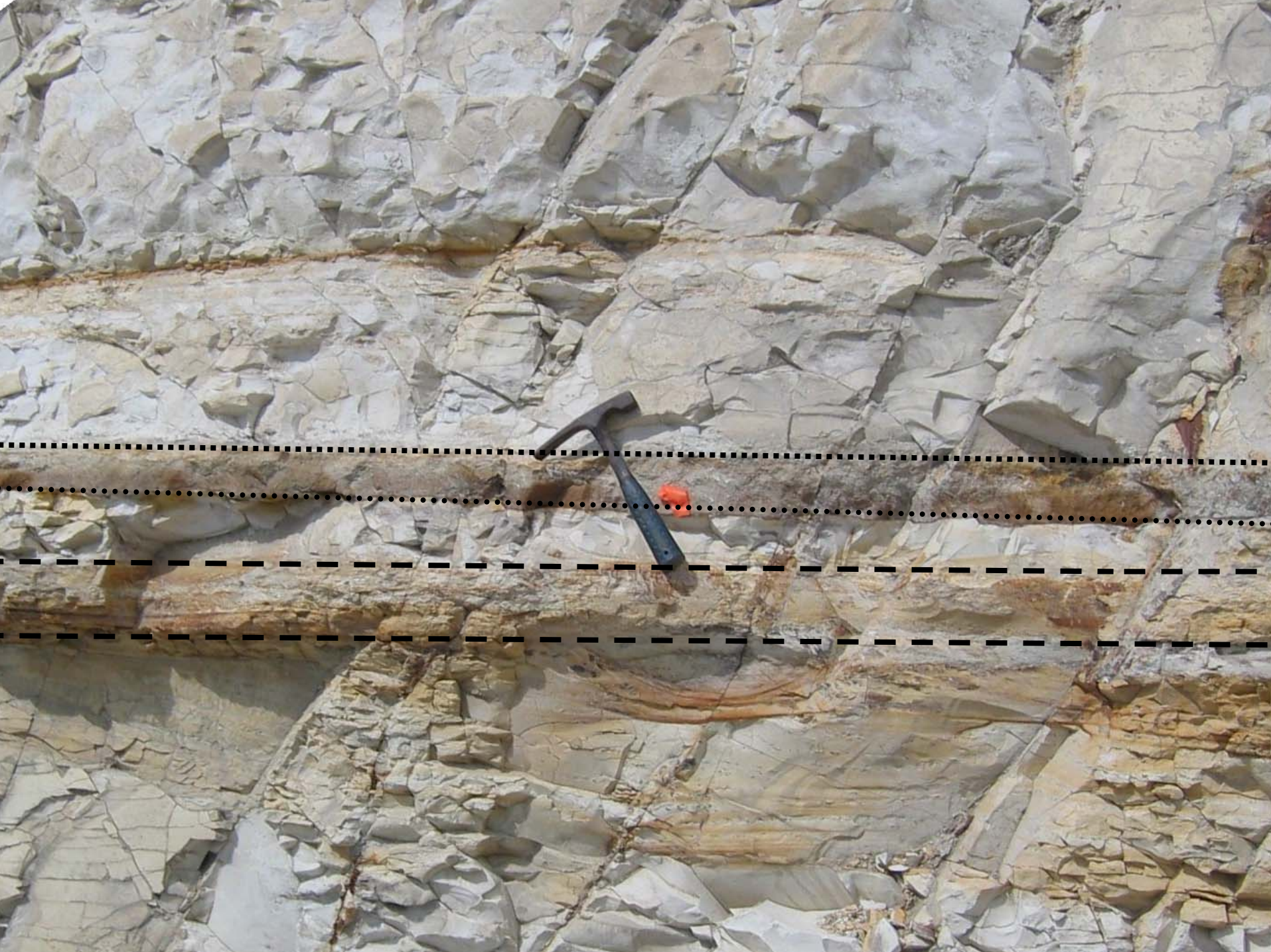
What forces acted on the rocks to form the faults?

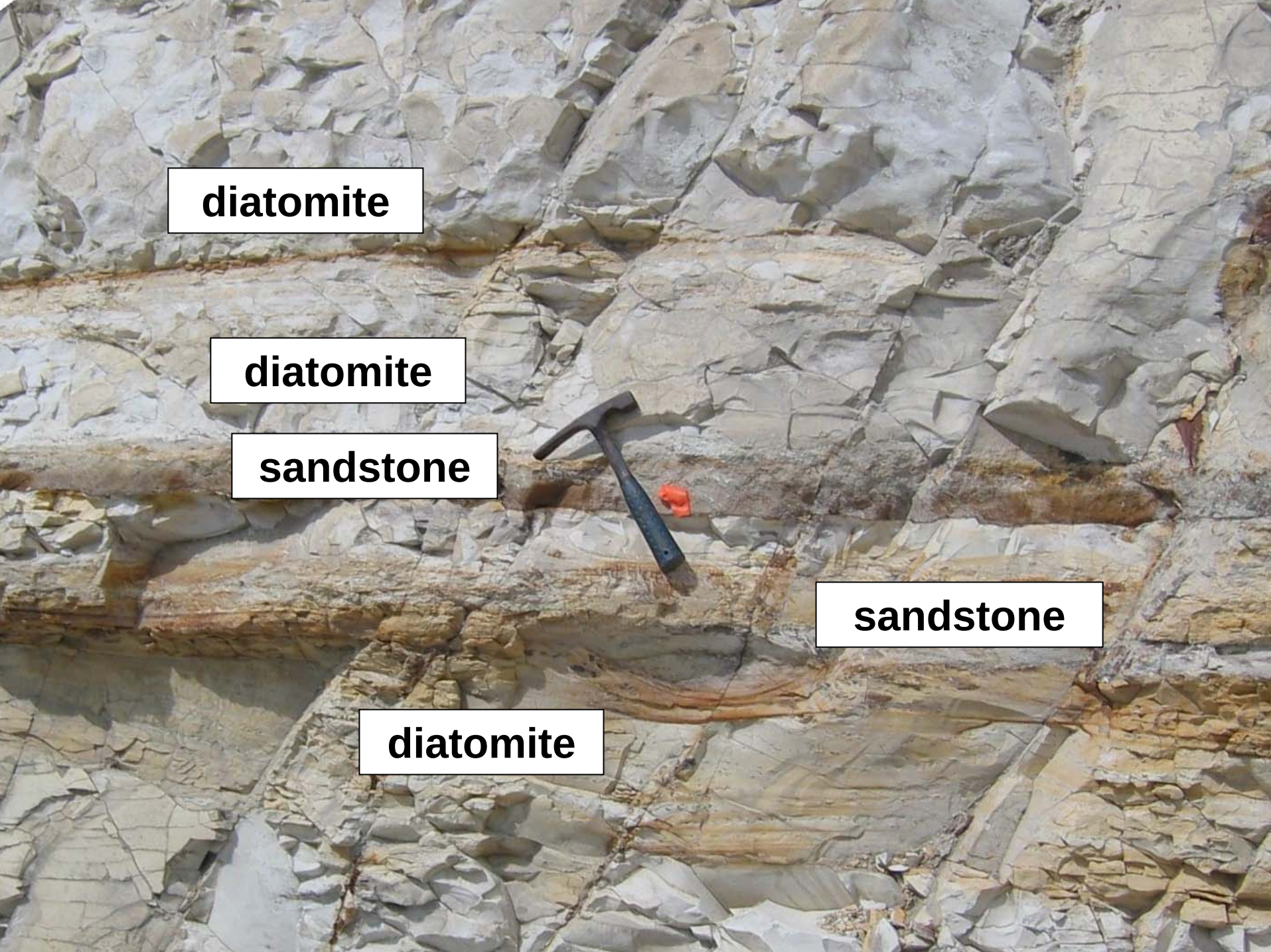
Did the mountains in Nevada form by compression or extension?

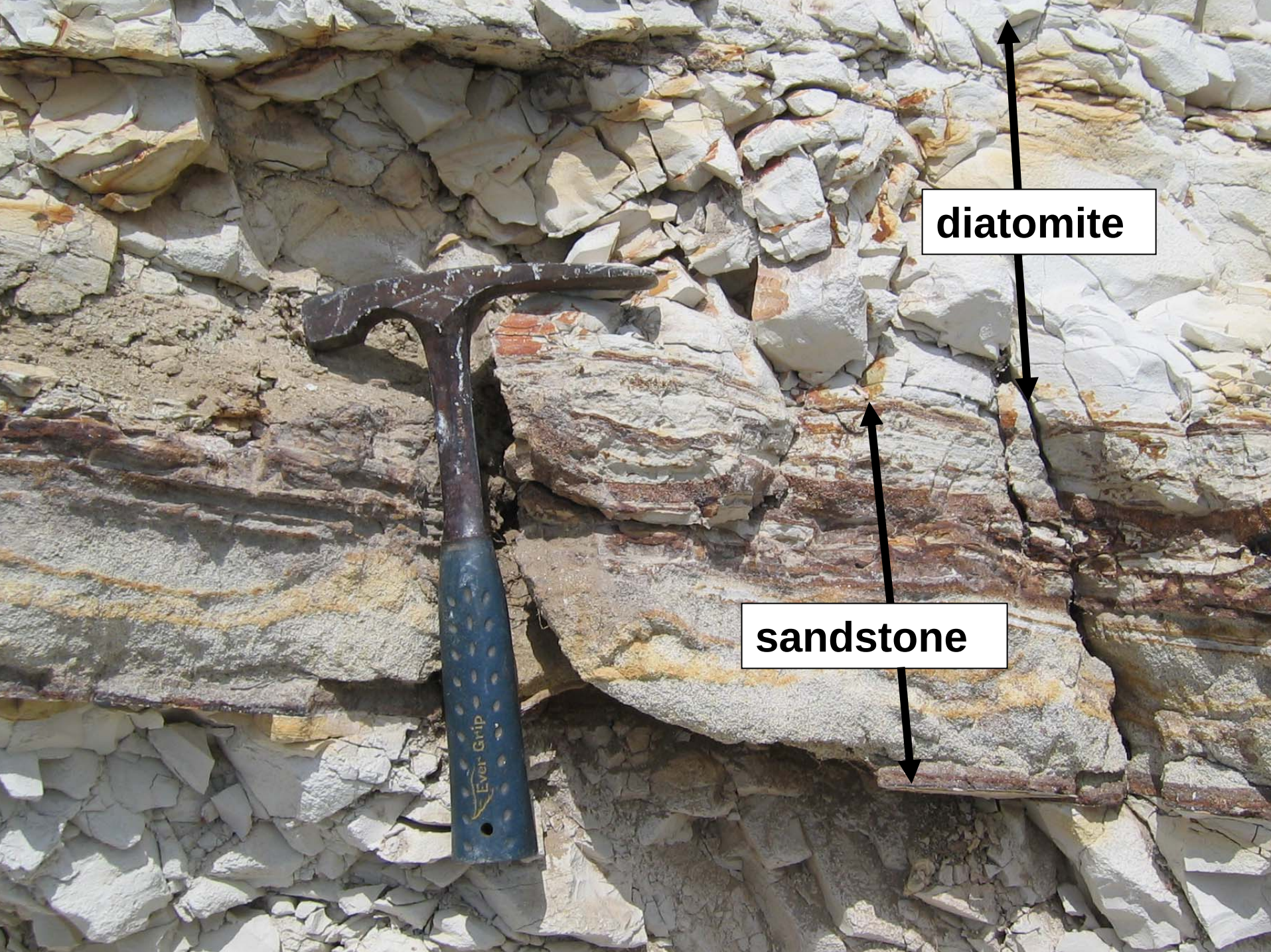
What kind of rock is it?

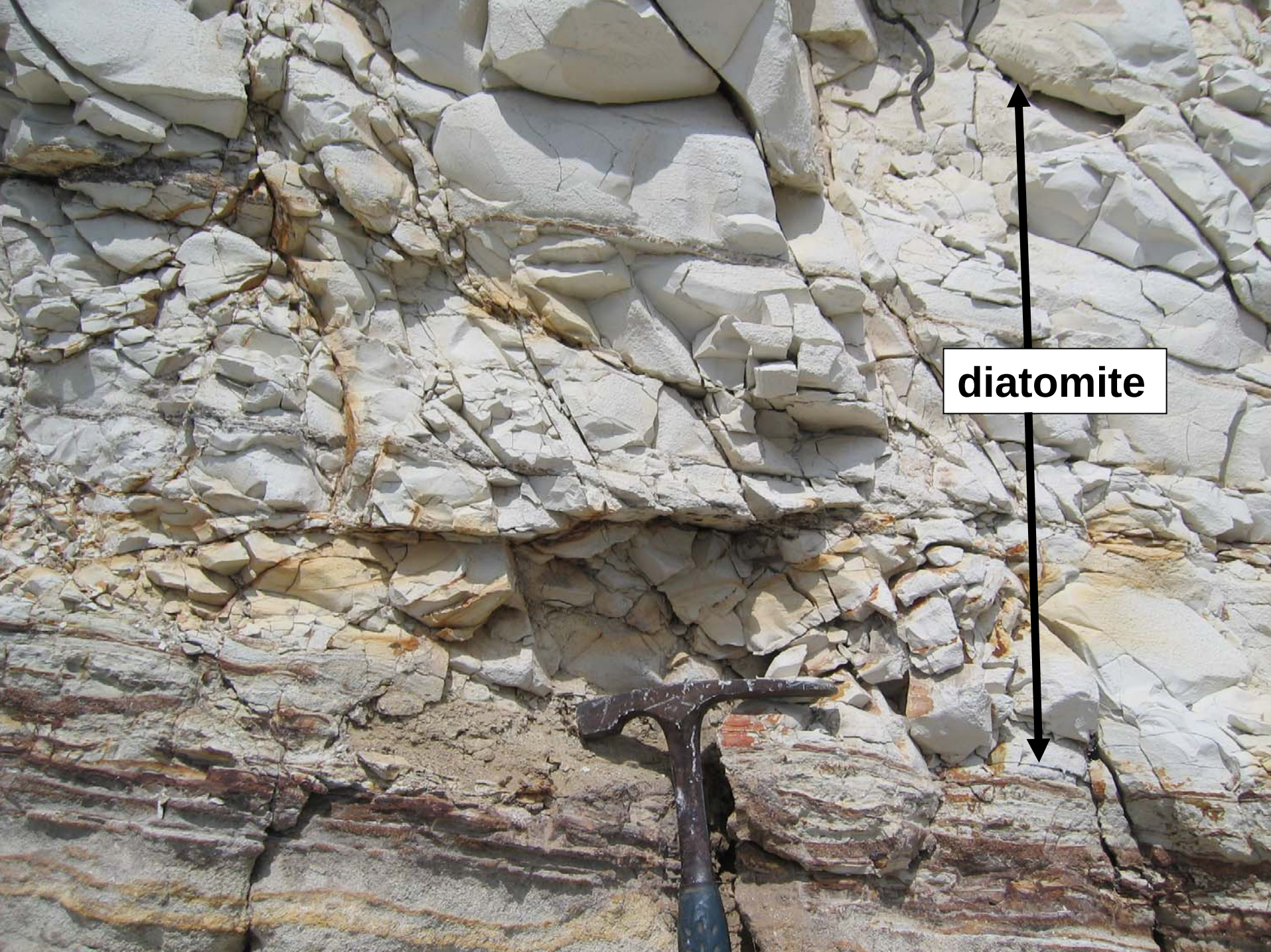

Hammer for scale

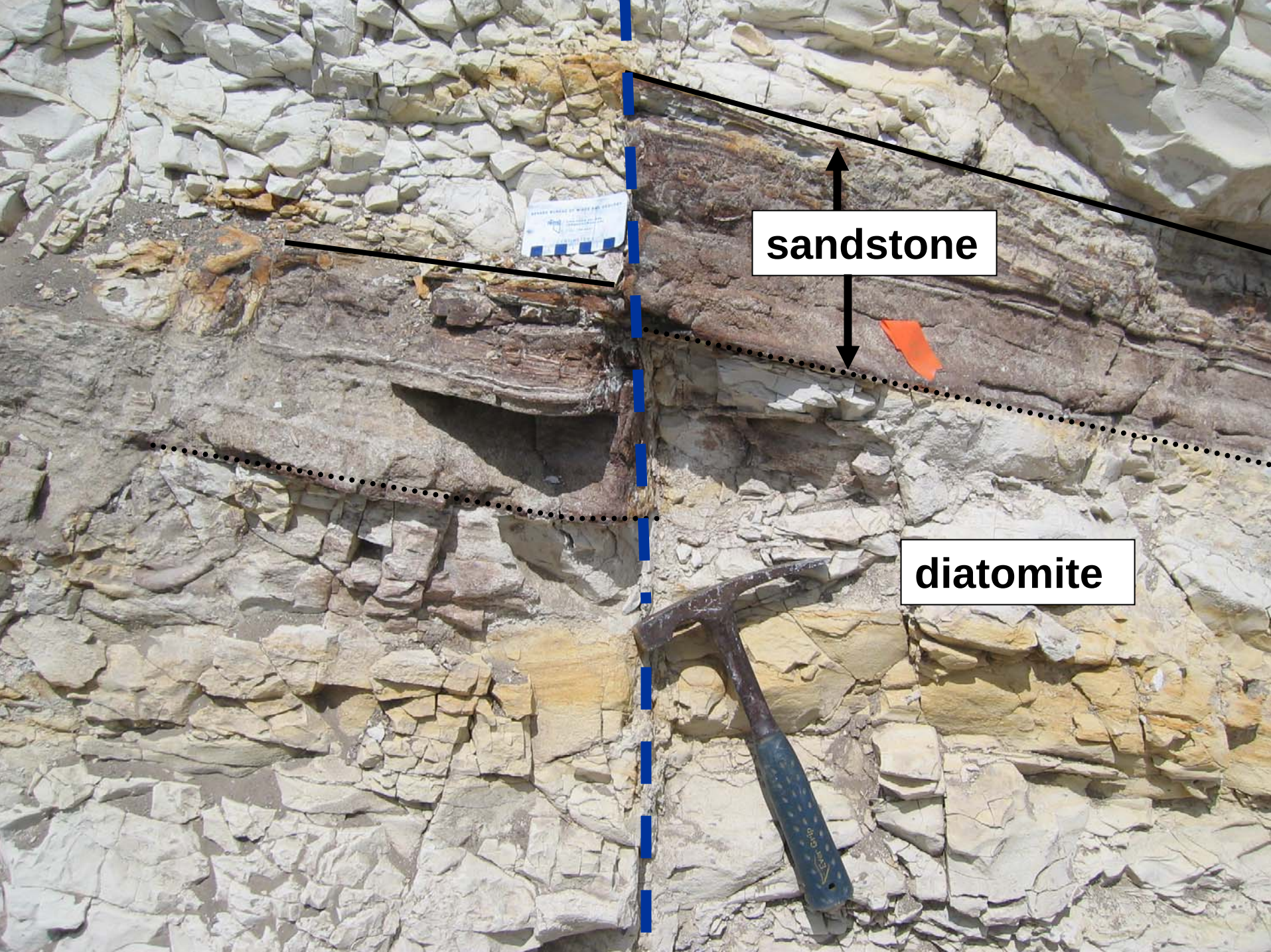

Strata are rotated to horizontal in this picture.




diatomite
diatomite
sandstone
sandstone
diatomite


diatomite
sandstone
Ever Grip


diatomite


sandstone
diatomite


NEVADA BUREAU OF MINES AND GEOLOGY
CENTIMETER

Why are the strata not continuous?

Photo 3

How did the faults form?

What forces acted on the rocks to form the faults?

Did the mountains in Nevada form by compression or extension?


If you drilled a hole here, where the heavy red line is, you would miss the sandstone, which is “faulted out” by the normal fault, a fault formed by extension.


Strata in current position.


Strata rotated to horizontal
Photo 4

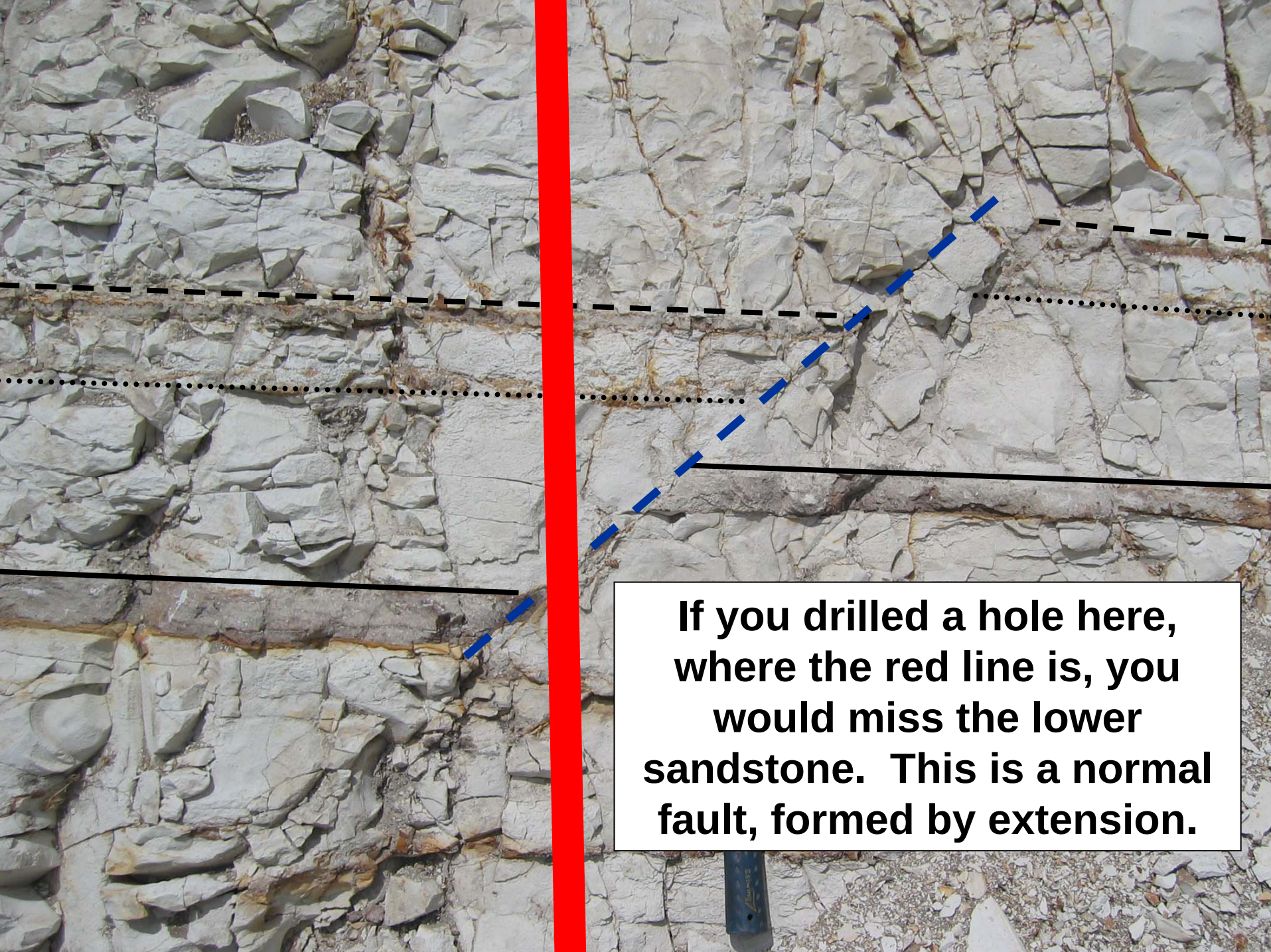

If you drilled a hole here, where the red line is, you would miss the lower sandstone. This is a normal fault, formed by extension.


Photo 5

Strata are rotated to horizontal.

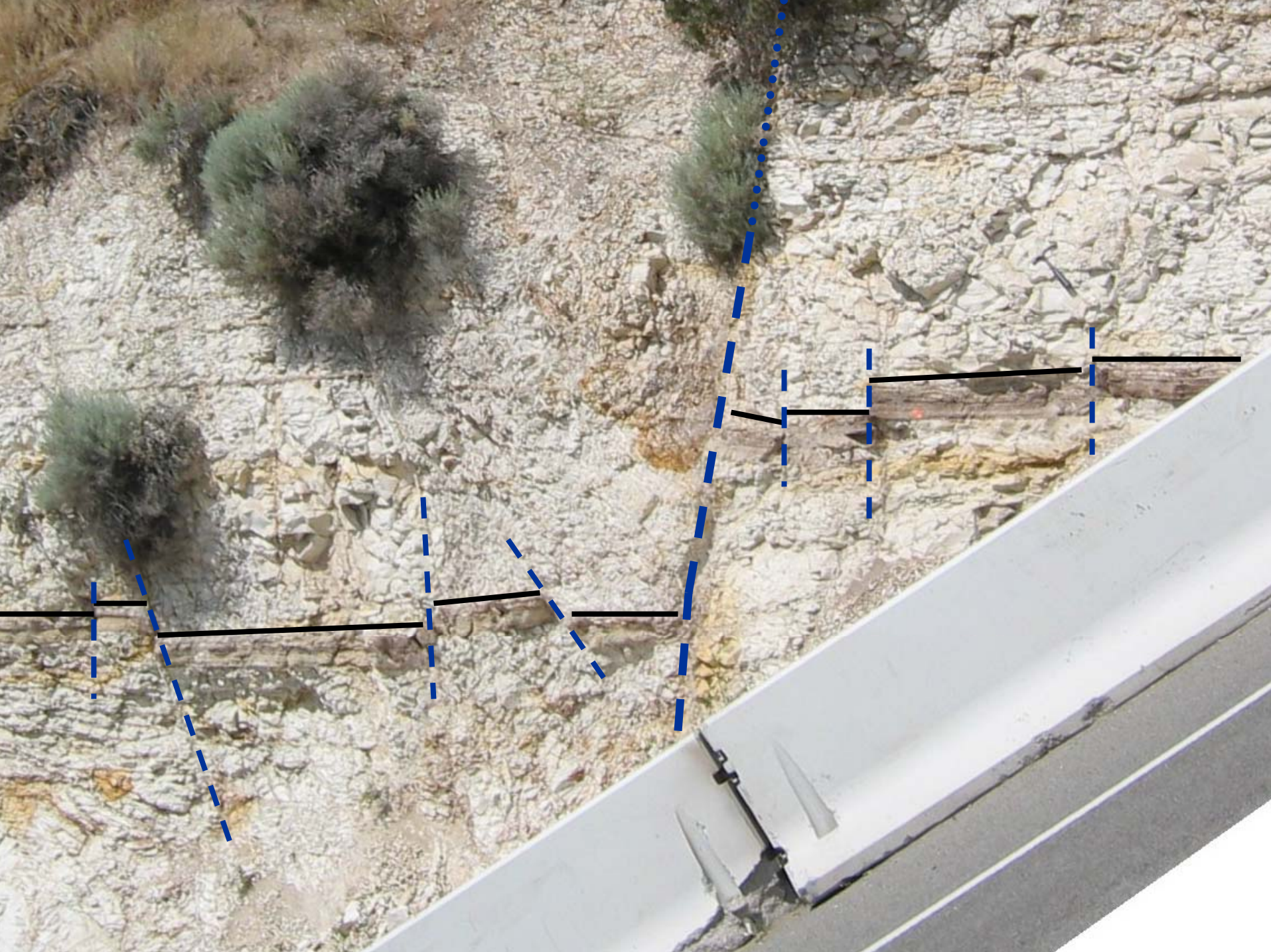
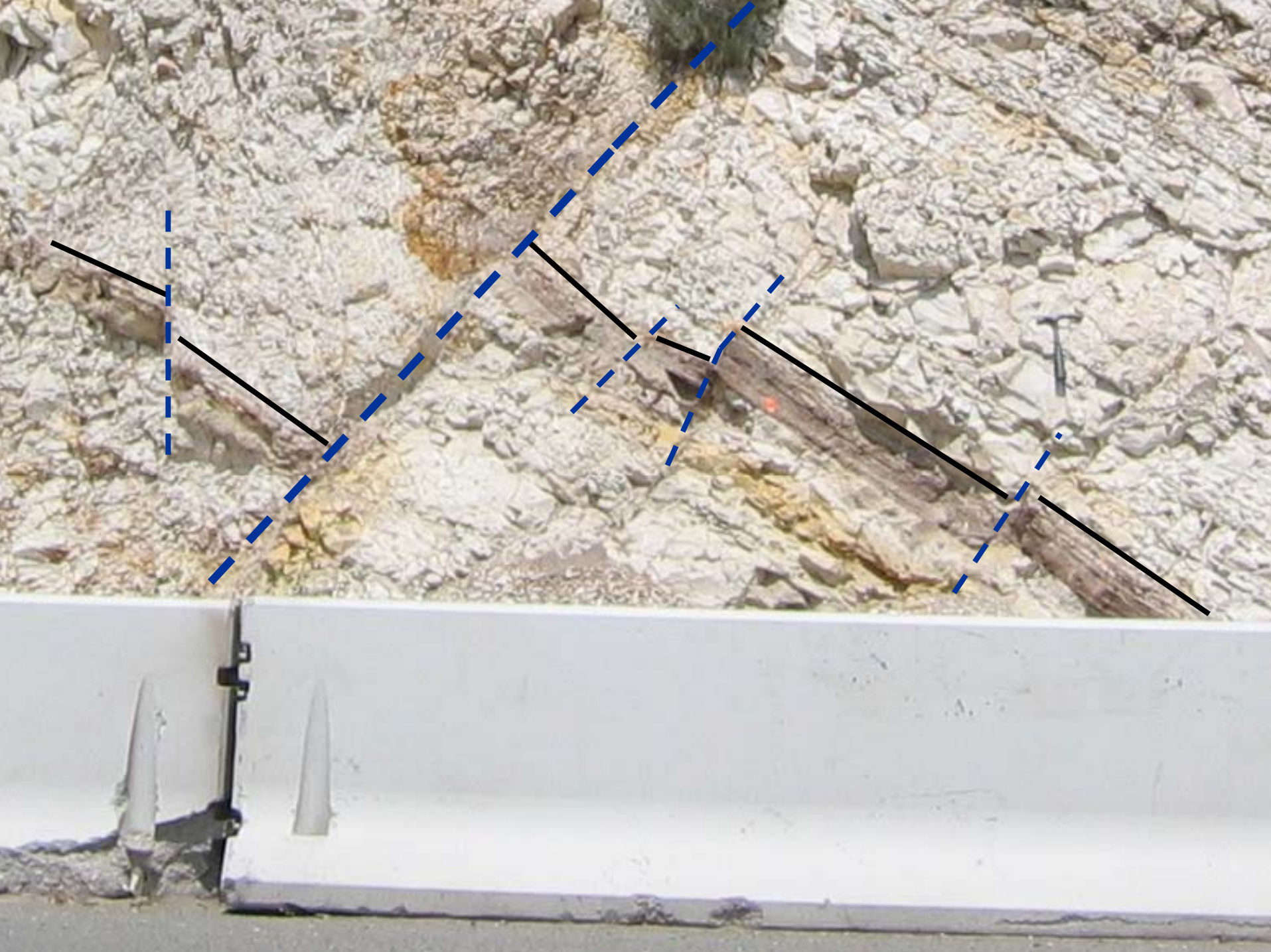
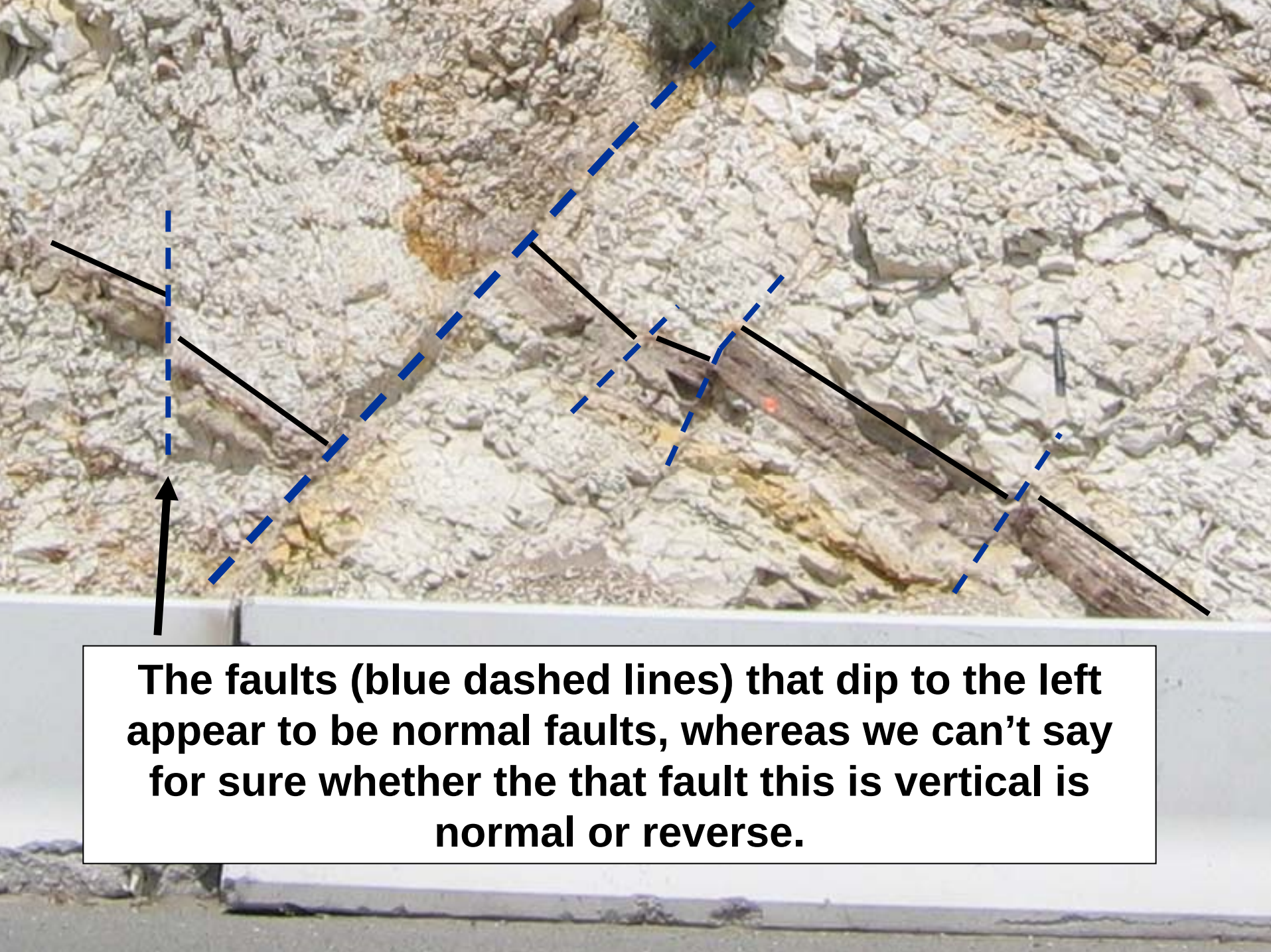



Photo 5

Photo 5, close up



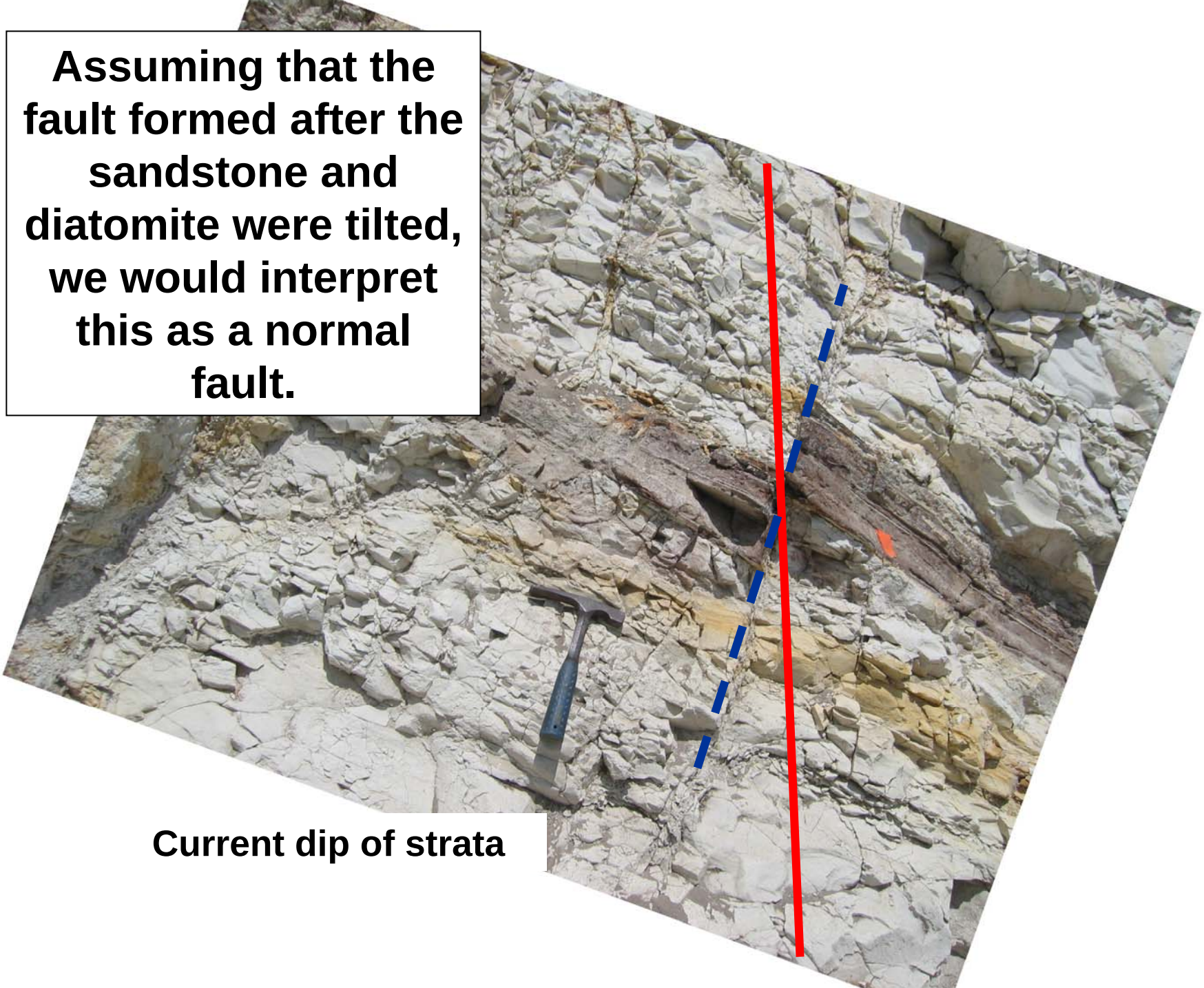


The faults (blue dashed lines) that dip to the left appear to be normal faults, whereas we can't say for sure whether the that fault this is vertical is normal or reverse.


The next few slides are close ups of this fault.

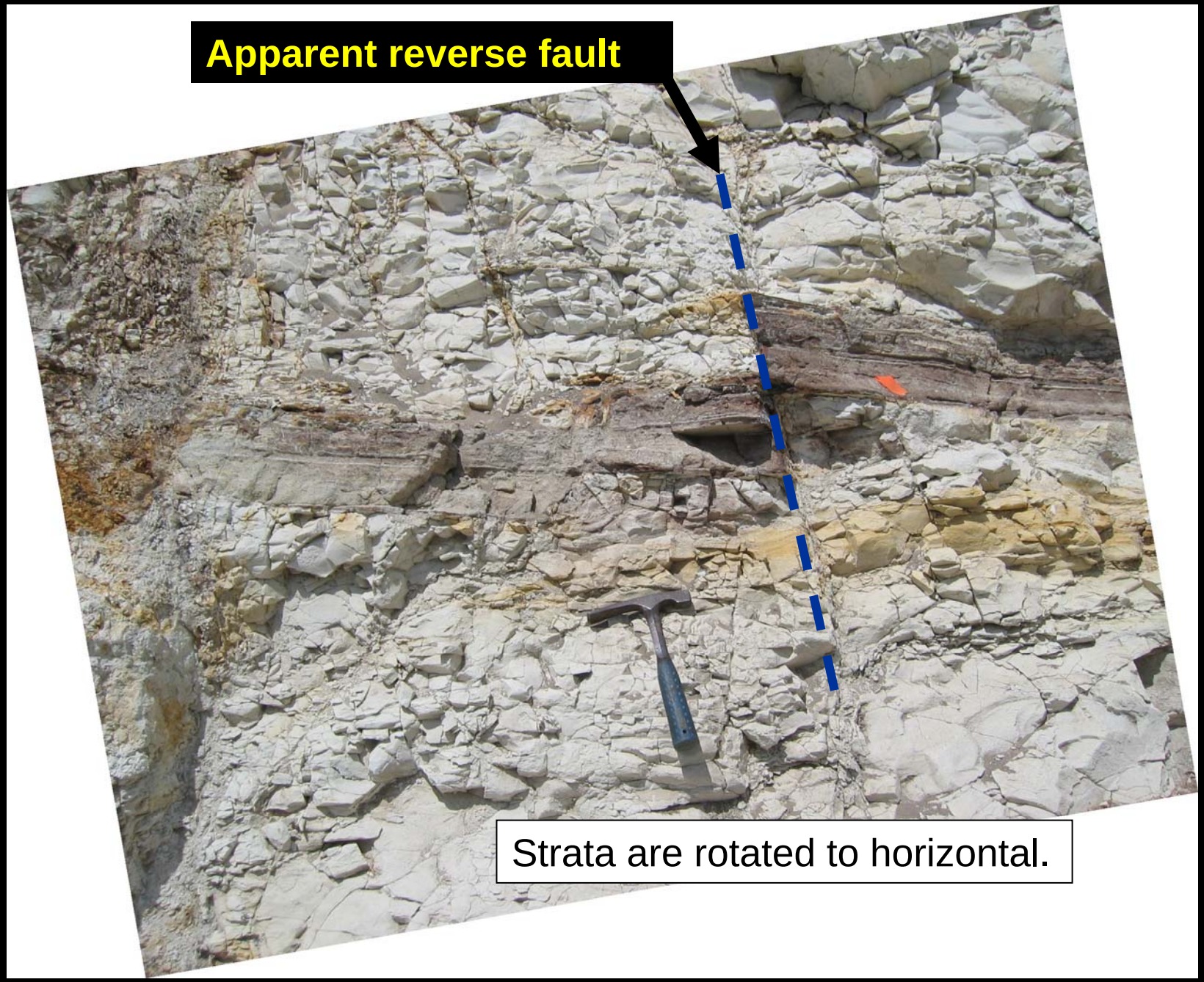
Current dip of strata

Assuming that the fault formed after the sandstone and diatomite were tilted, we would interpret this as a normal fault.



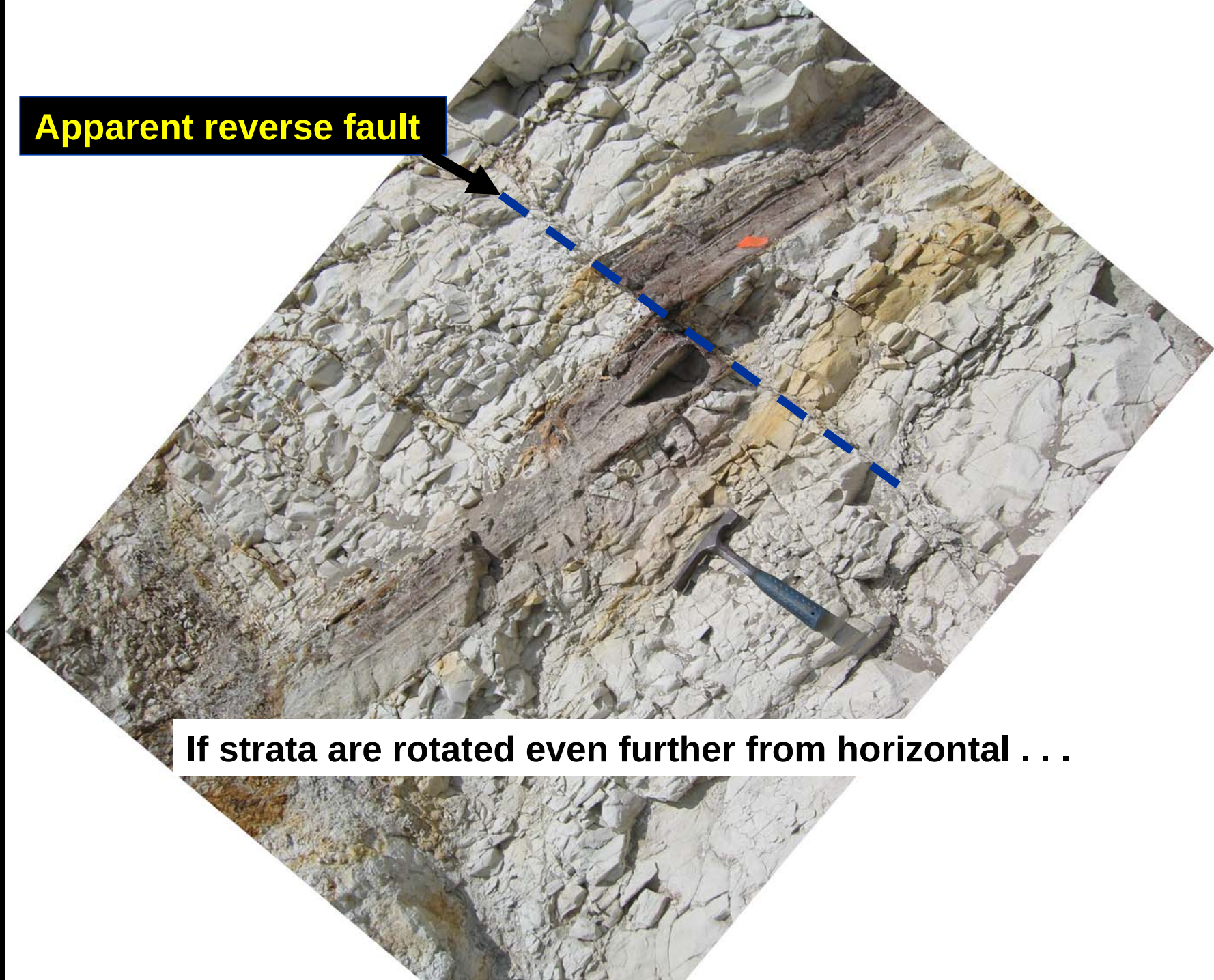
Rotating strata to horizontal . . .

Strata are rotated to horizontal.

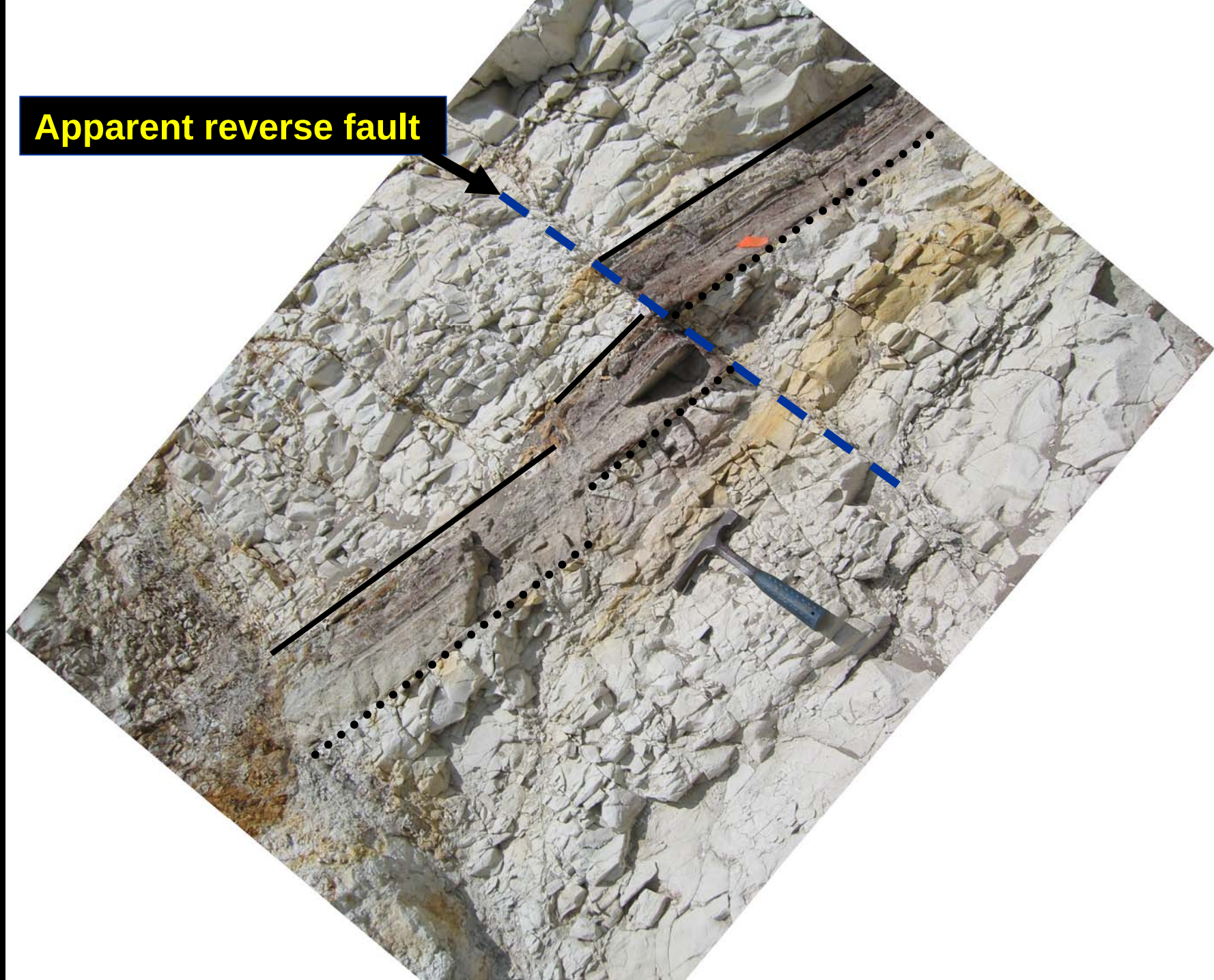

Apparent reverse fault
Strata are rotated to horizontal.

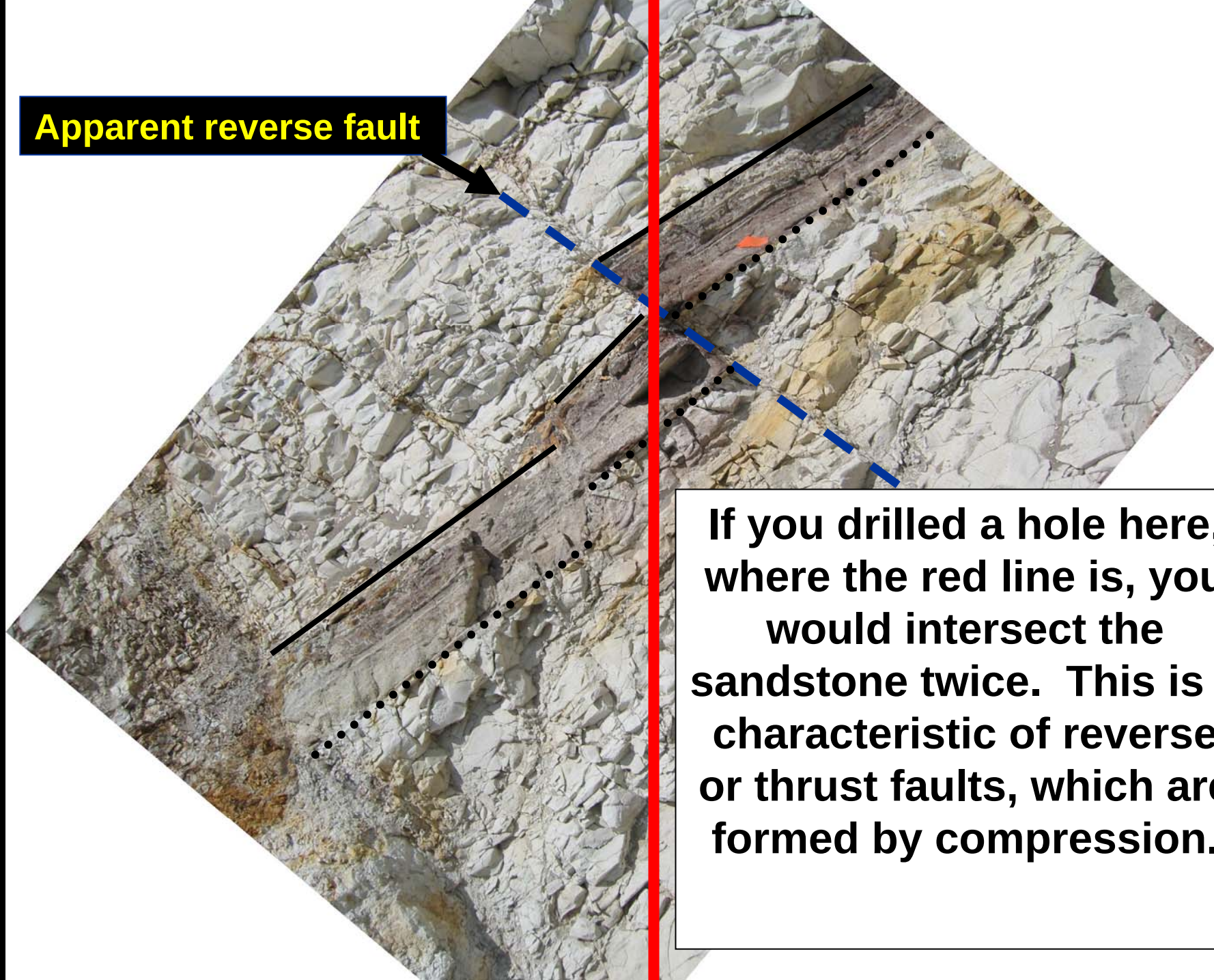
If strata are rotated even further from horizontal . . .

If strata are rotated even further from horizontal . . .



If strata are rotated even further from horizontal . . .


Apparent reverse fault



If you drilled a hole here, where the red line is, you would intersect the sandstone twice. This is a characteristic of reverse or thrust faults, which are formed by compression.

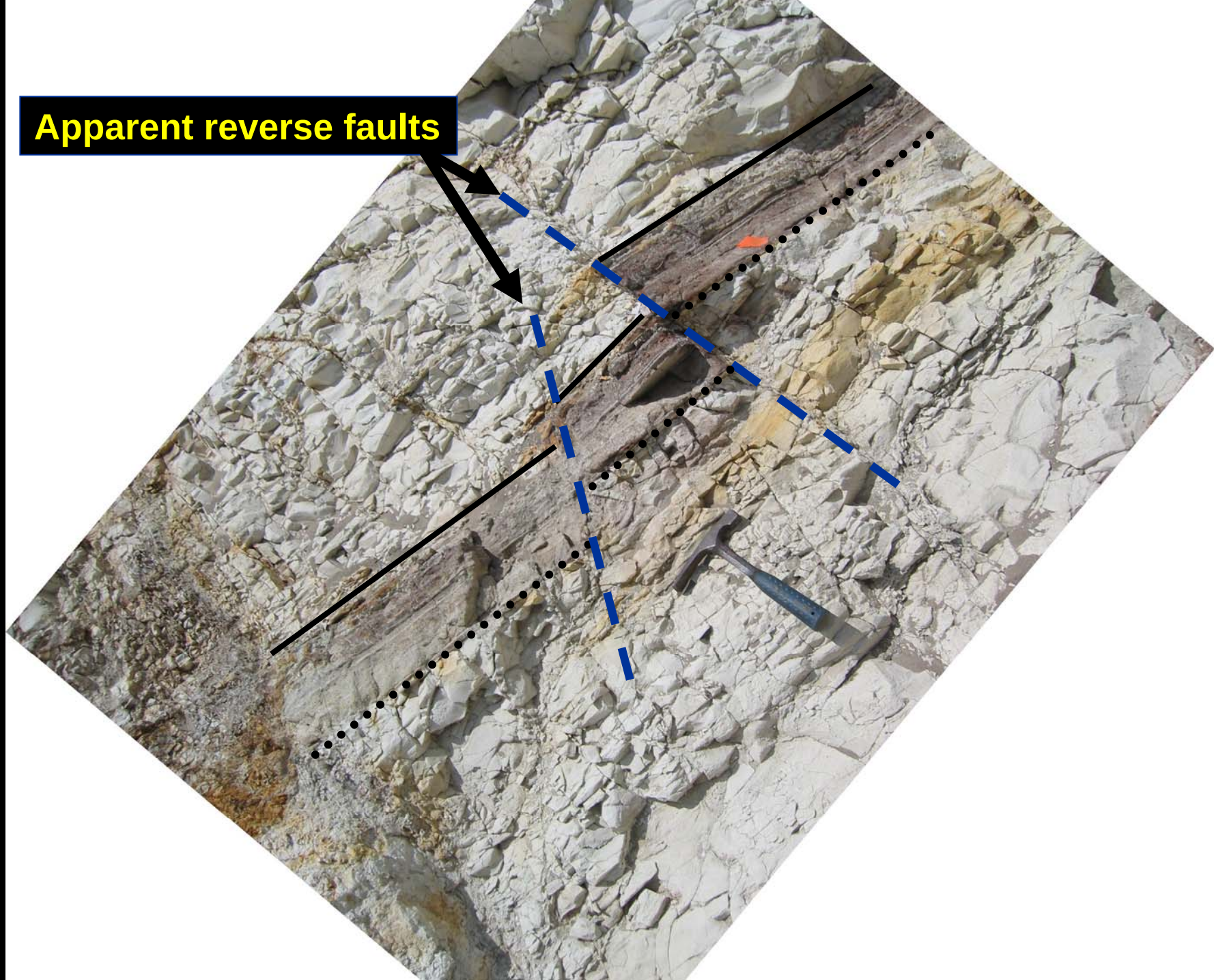
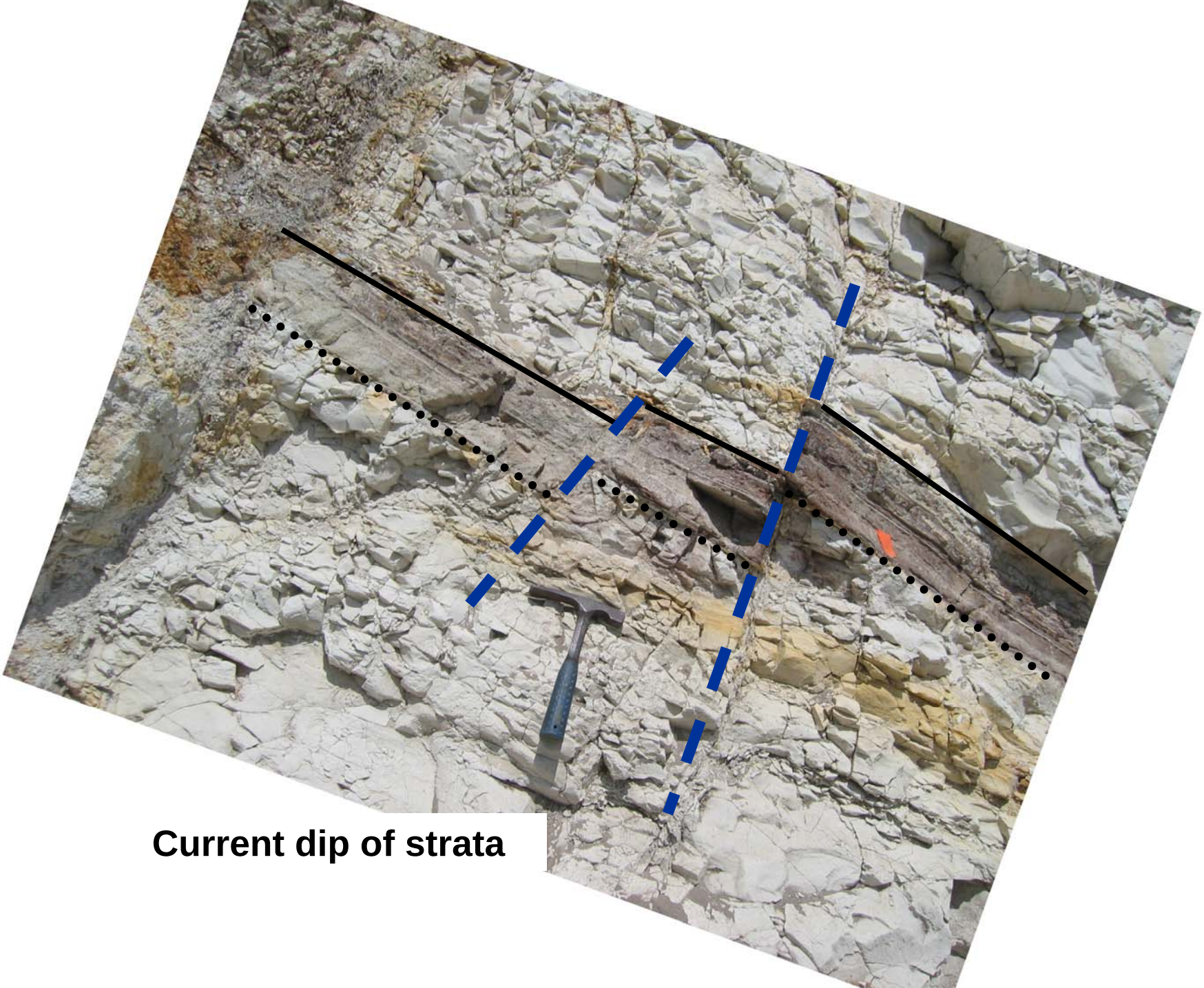

Apparent reverse faults

Photo 6

Current dip of strata


Current dip of strata

Because most of the faults at this road cut are unambiguously normal faults rather than reverse faults, the fact that this fault would be interpreted to have been a reverse fault had it formed when the strata were horizontal implies that these faults formed after the strata were tilted.

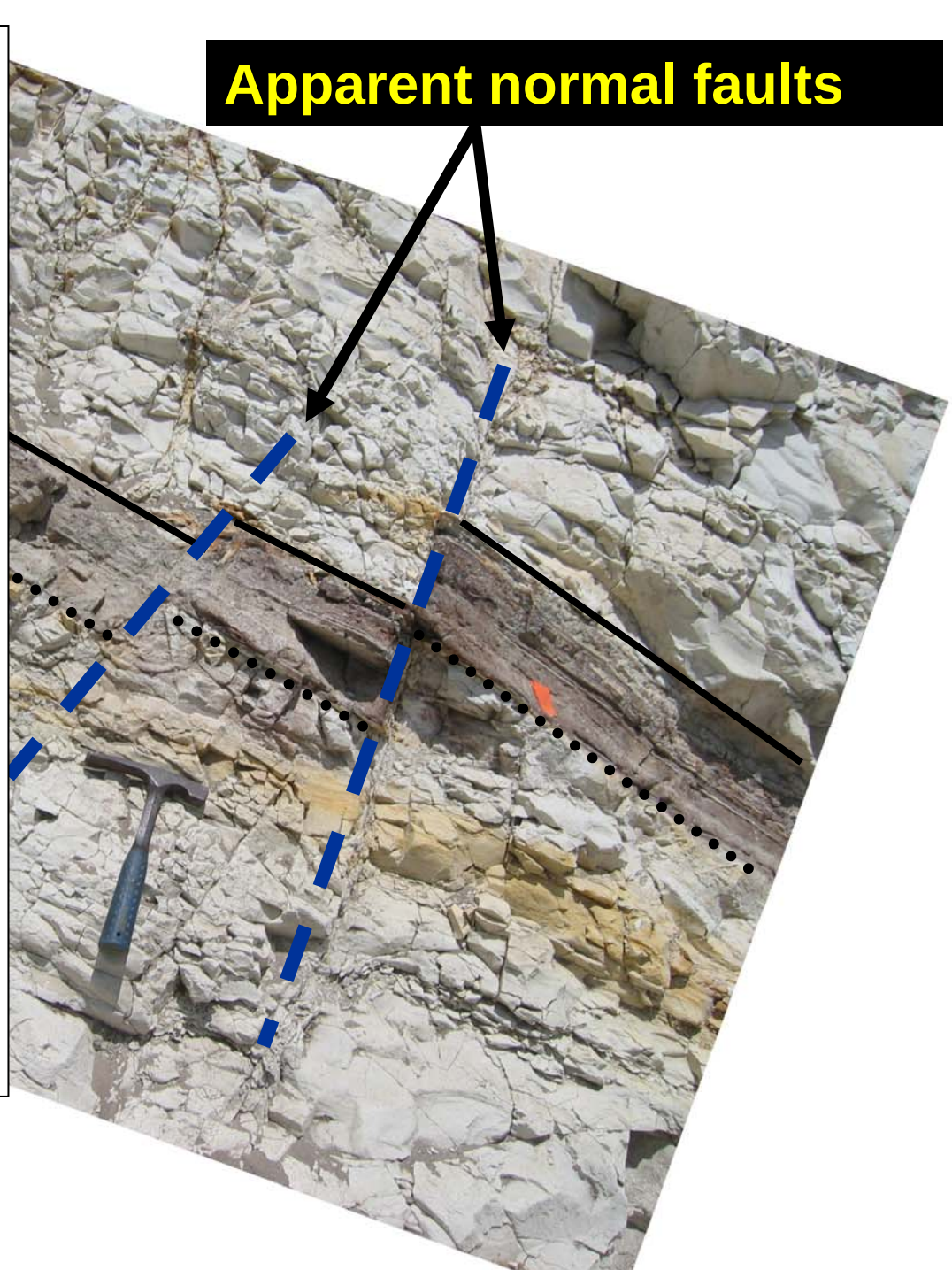



Photo 7

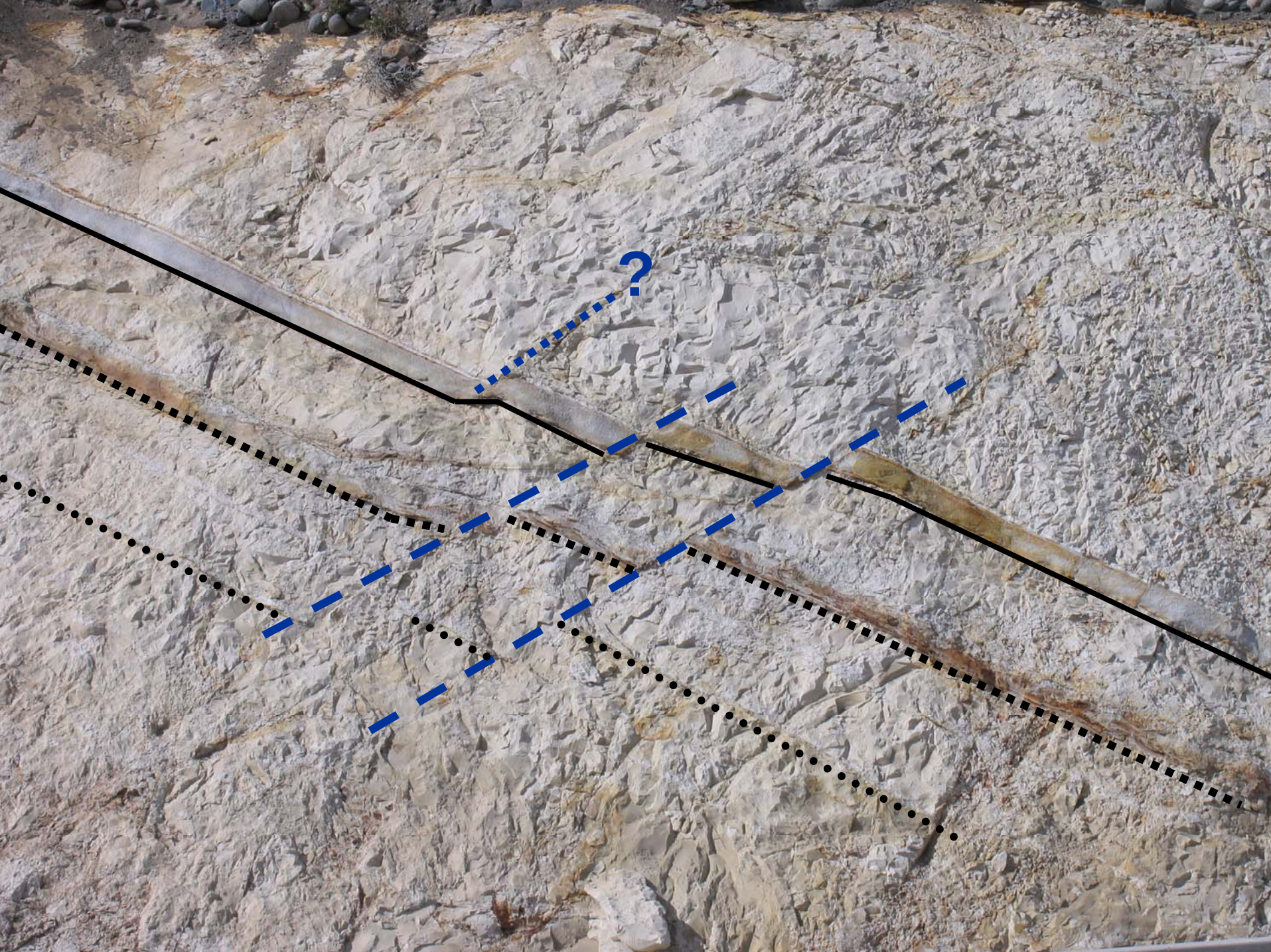
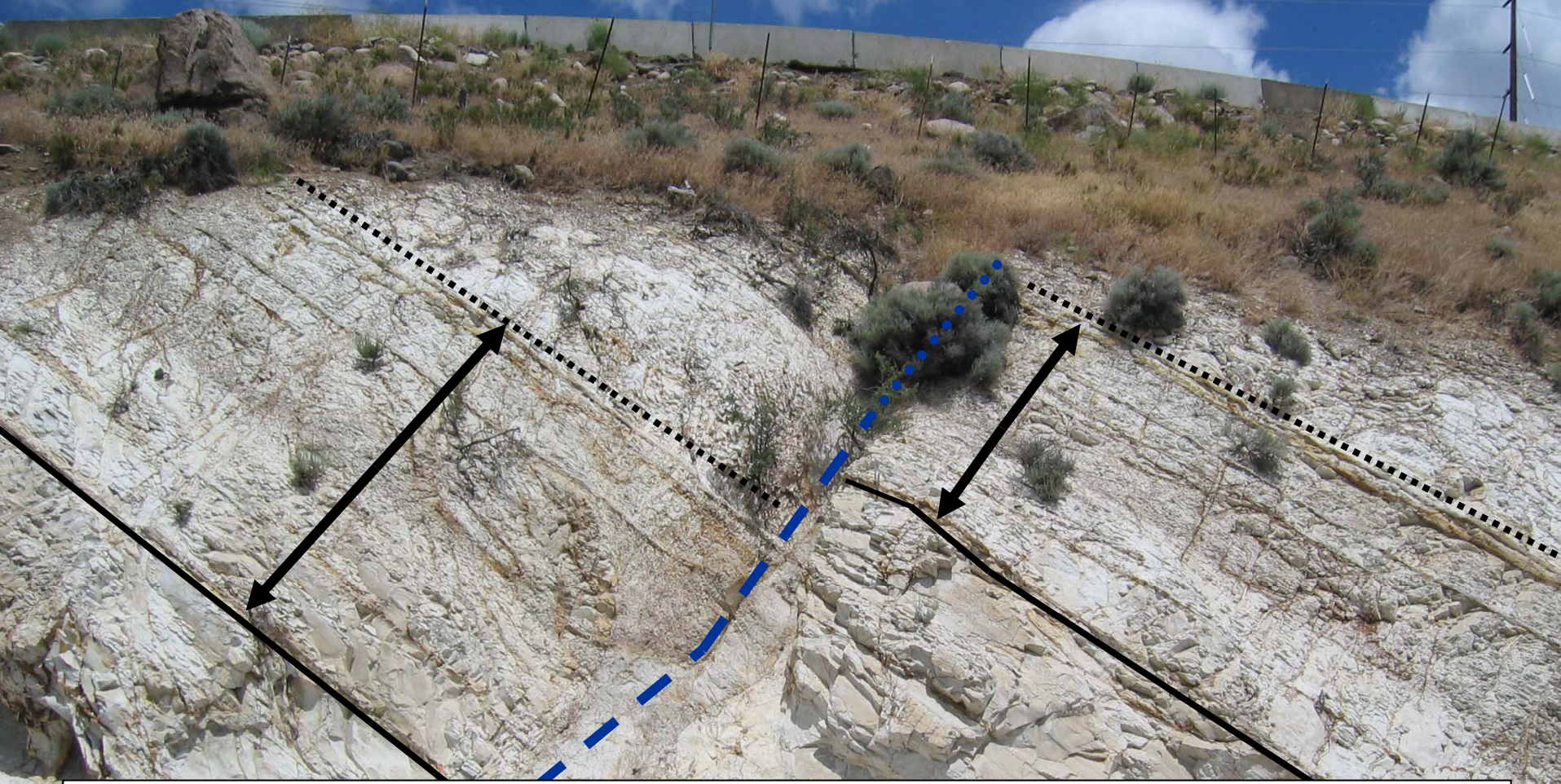
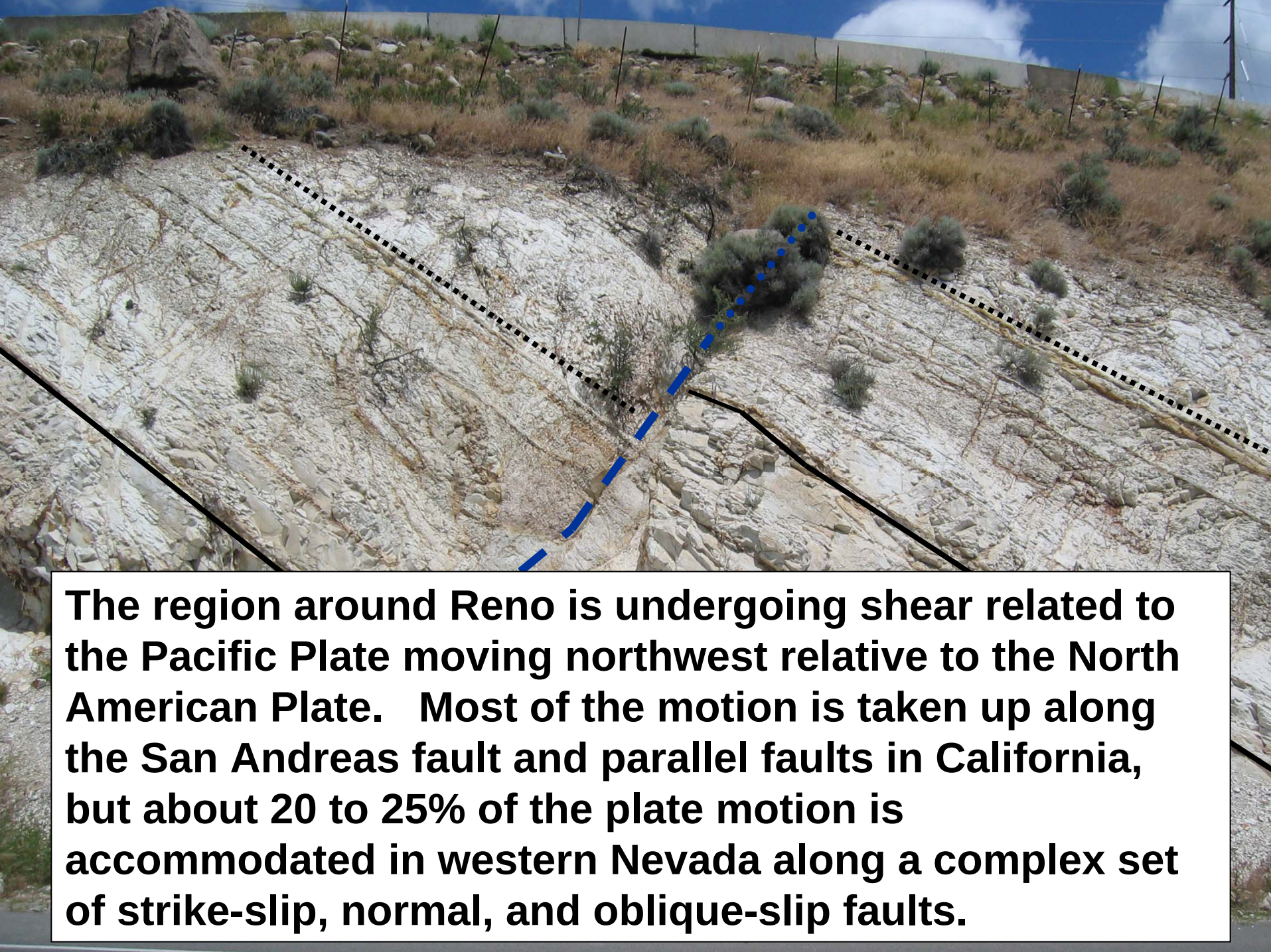


Photo 1


Photo 8



Note that the package of rocks bounded by the marked sandstones on the left hand side of the fault appears to be thicker than the package on the right hand side. This implies that there is some component of strike slip on the fault – that all the motion is not "normal."



The region around Reno is undergoing shear related to the Pacific Plate moving northwest relative to the North American Plate. Most of the motion is taken up along the San Andreas fault and parallel faults in California, but about 20 to 25% of the plate motion is accommodated in western Nevada along a complex set of strike-slip, normal, and oblique-slip faults.

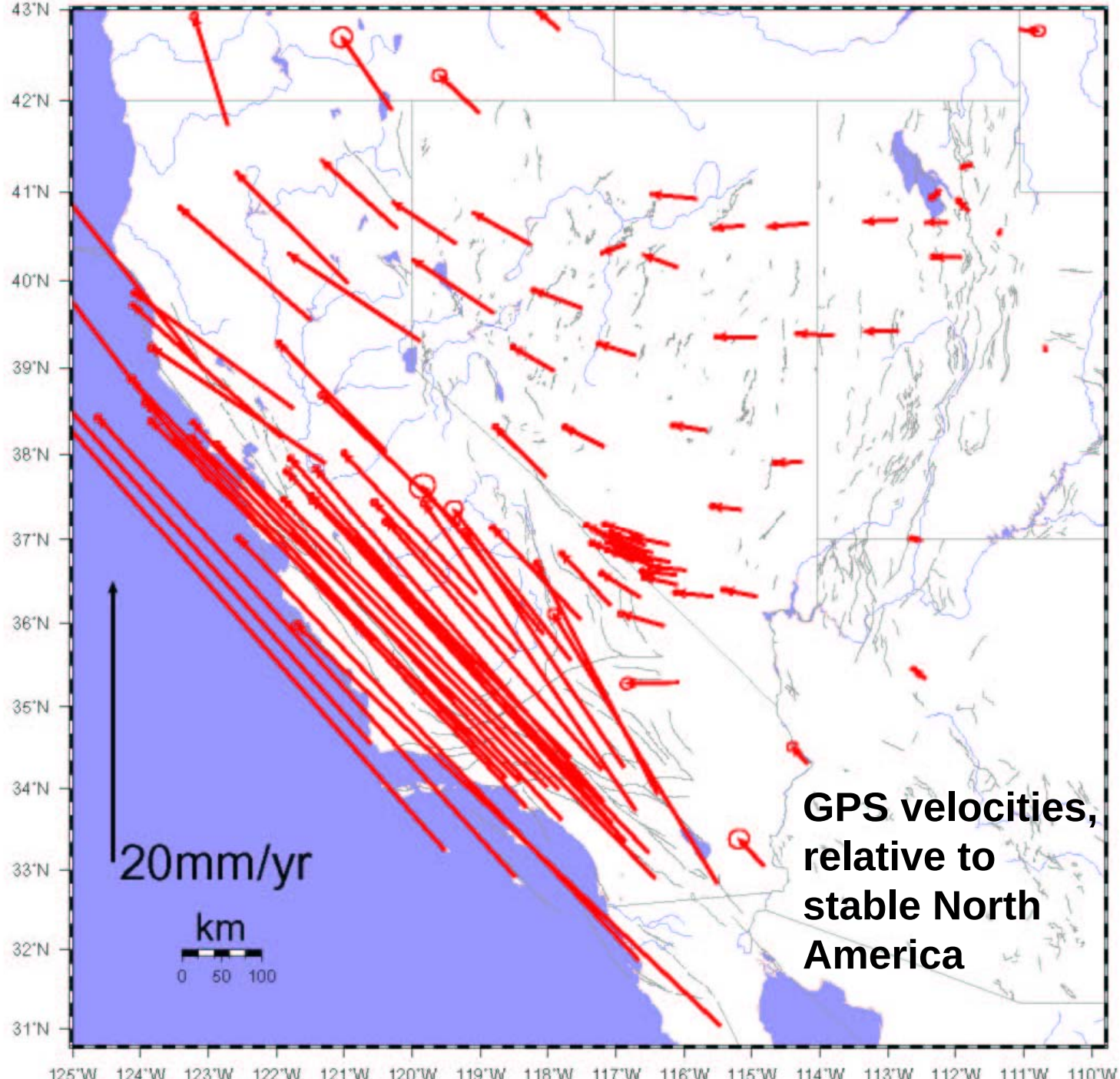
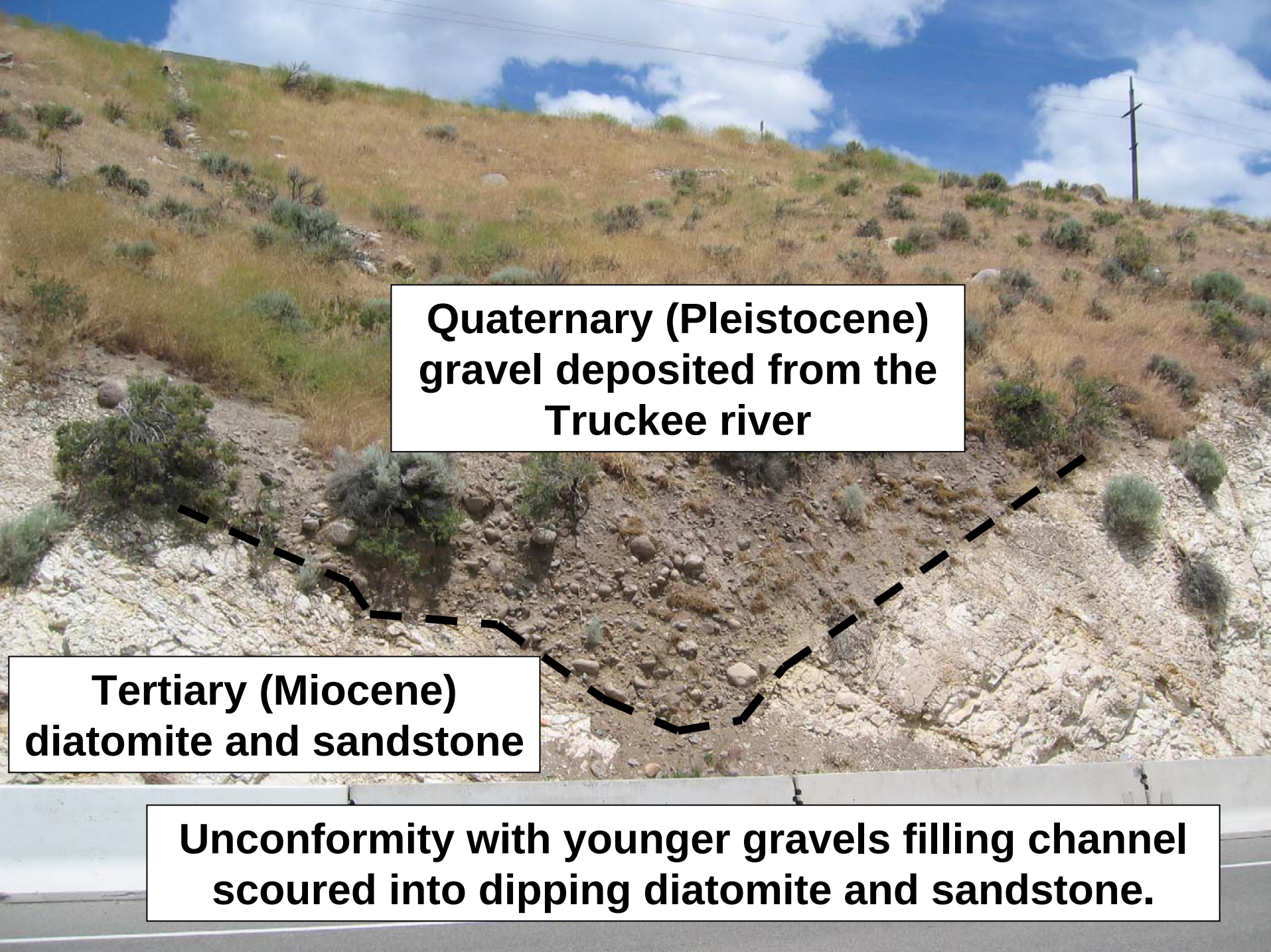

43°N
42°N
41°N
40°N
39°N
38°N
37°N
36°N
35°N
34°N
33°N
32°N
31°N
125°W
124°W
123°W
122°W
121°W
120°W
119°W
118°W
117°W
116°W
115°W
114°W
113°W
112°W
111°W
110°W
20mm/yr
km
0 50 100
GPS velocities, relative to stable North America


Photo 9

Unconformity with younger gravels filling channel scoured into dipping diatomite and sandstone.


Quaternary (Pleistocene) gravel deposited from the Truckee river
Tertiary (Miocene) diatomite and sandstone
Unconformity with younger gravels filling channel scoured into dipping diatomite and sandstone.


Ever Grip
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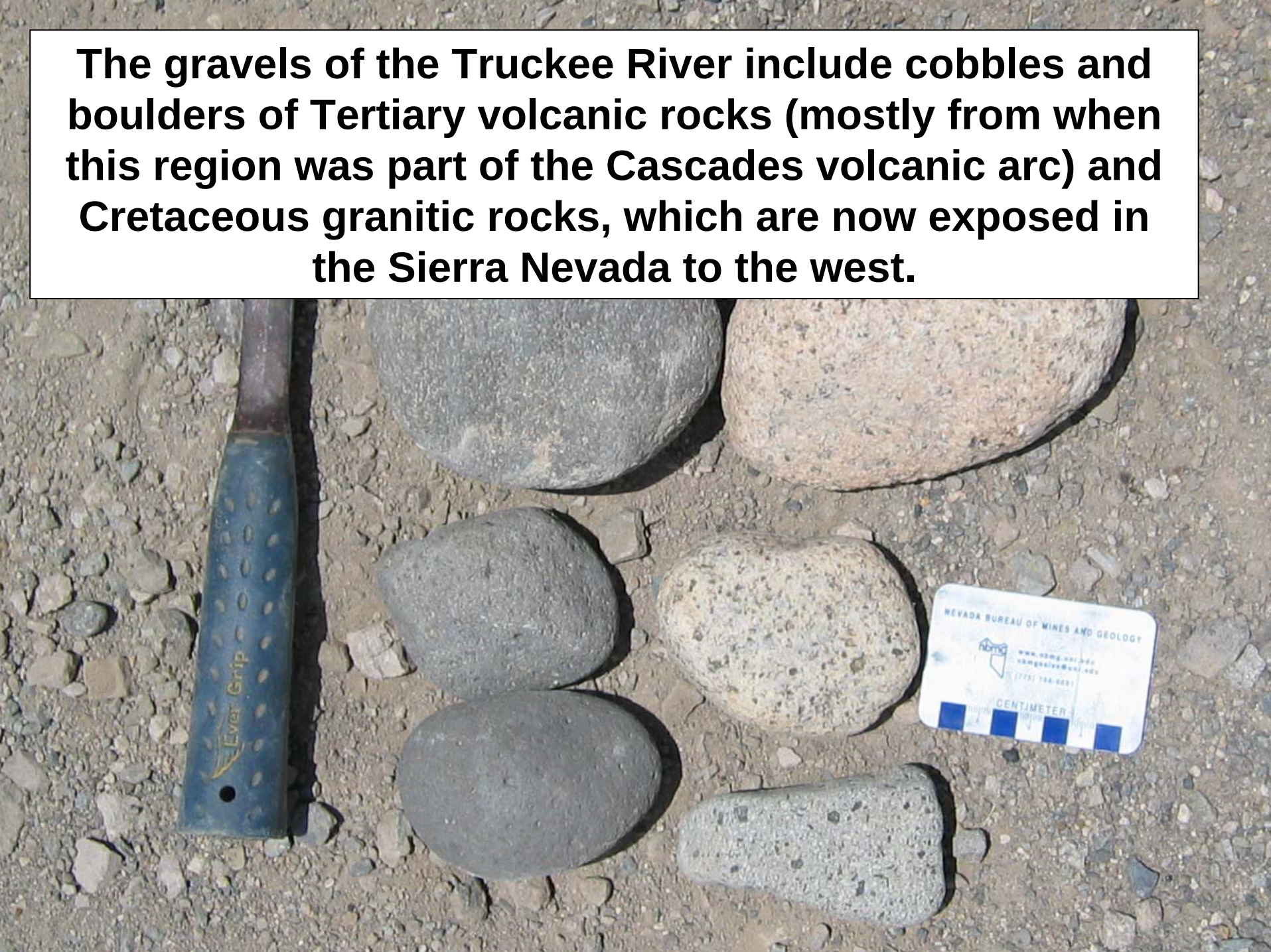
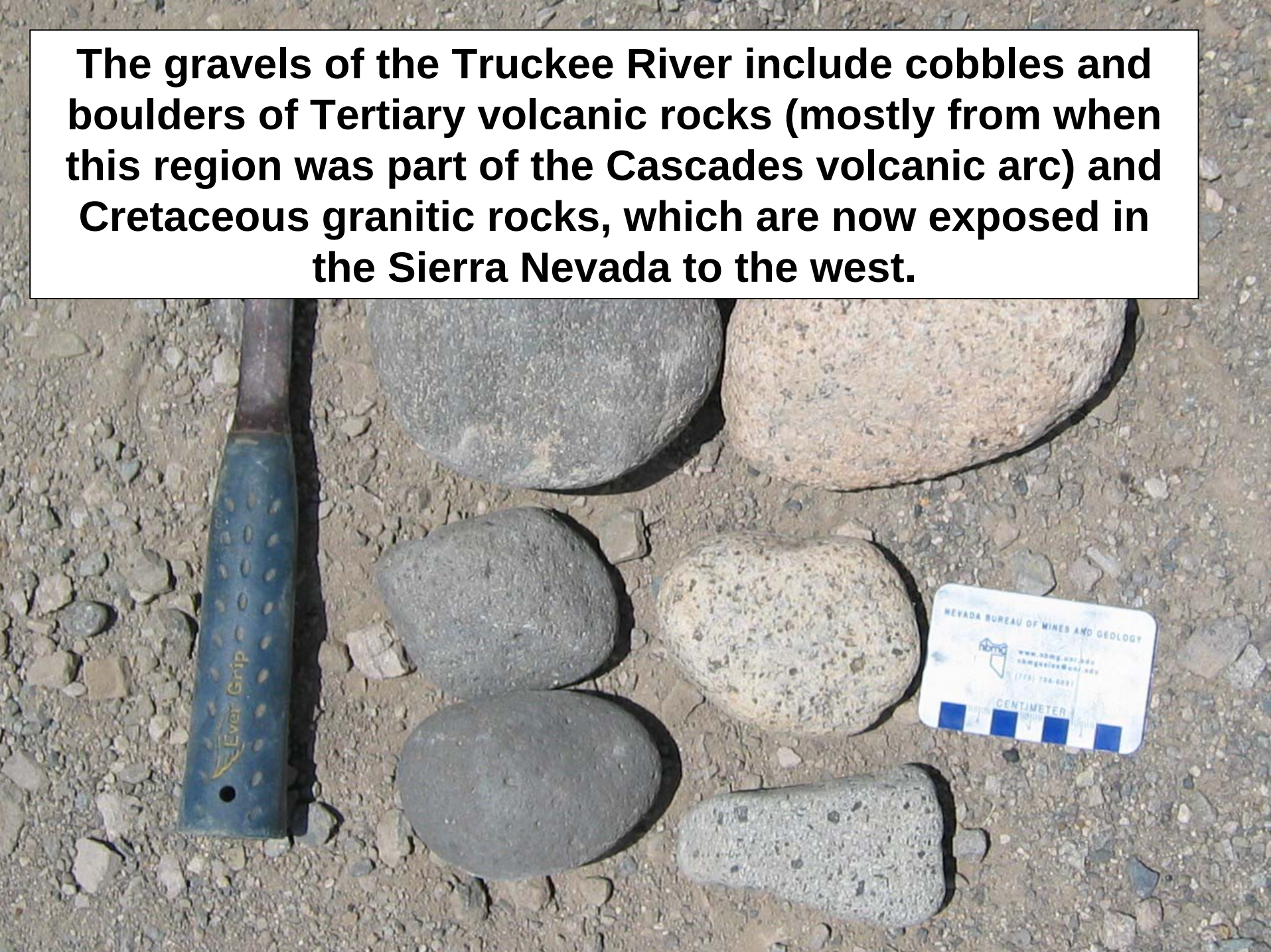


The gravels of the Truckee River include cobbles and boulders of Tertiary volcanic rocks (mostly from when this region was part of the Cascades volcanic arc) and Cretaceous granitic rocks, which are now exposed in the Sierra Nevada to the west.



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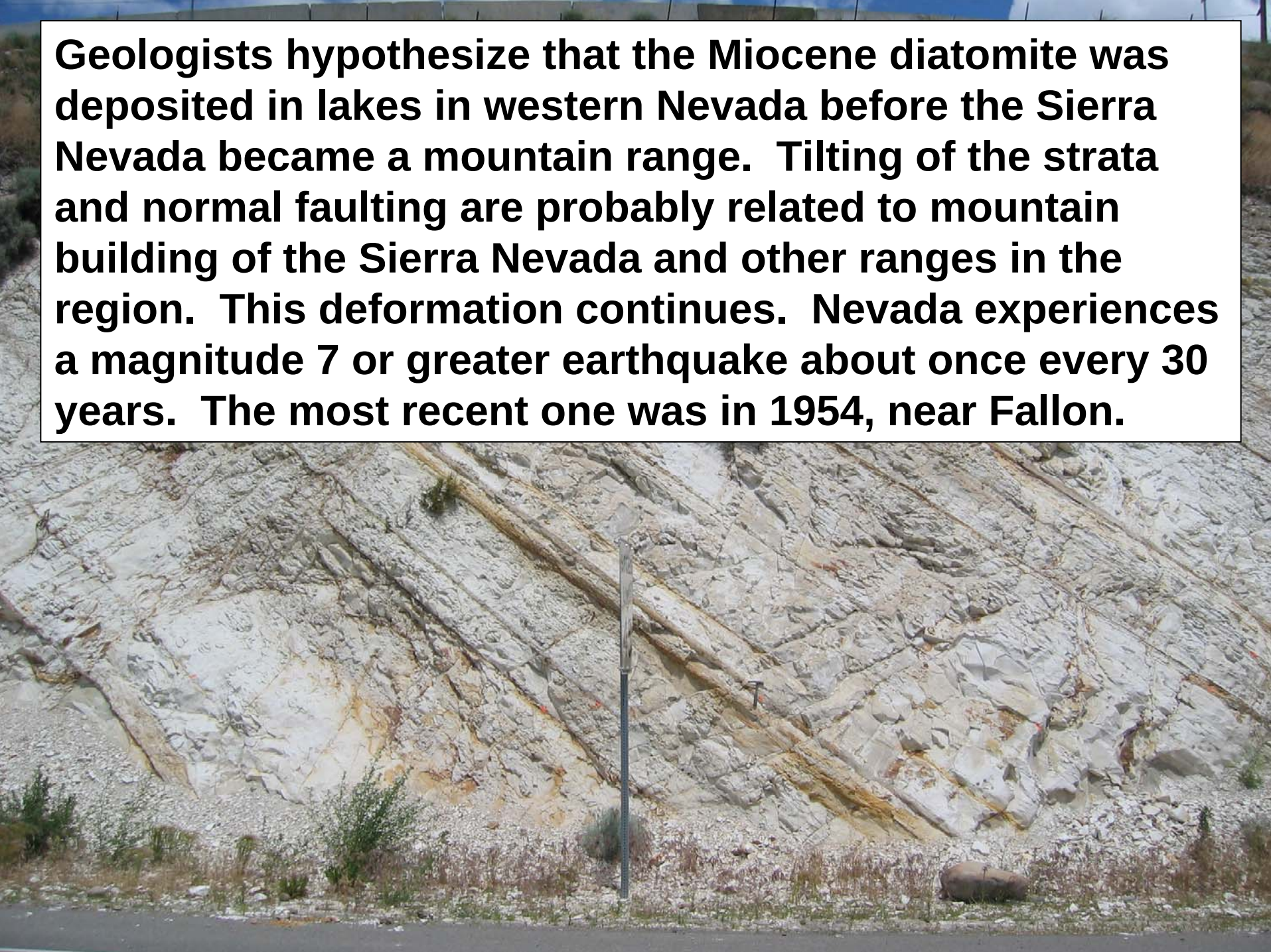
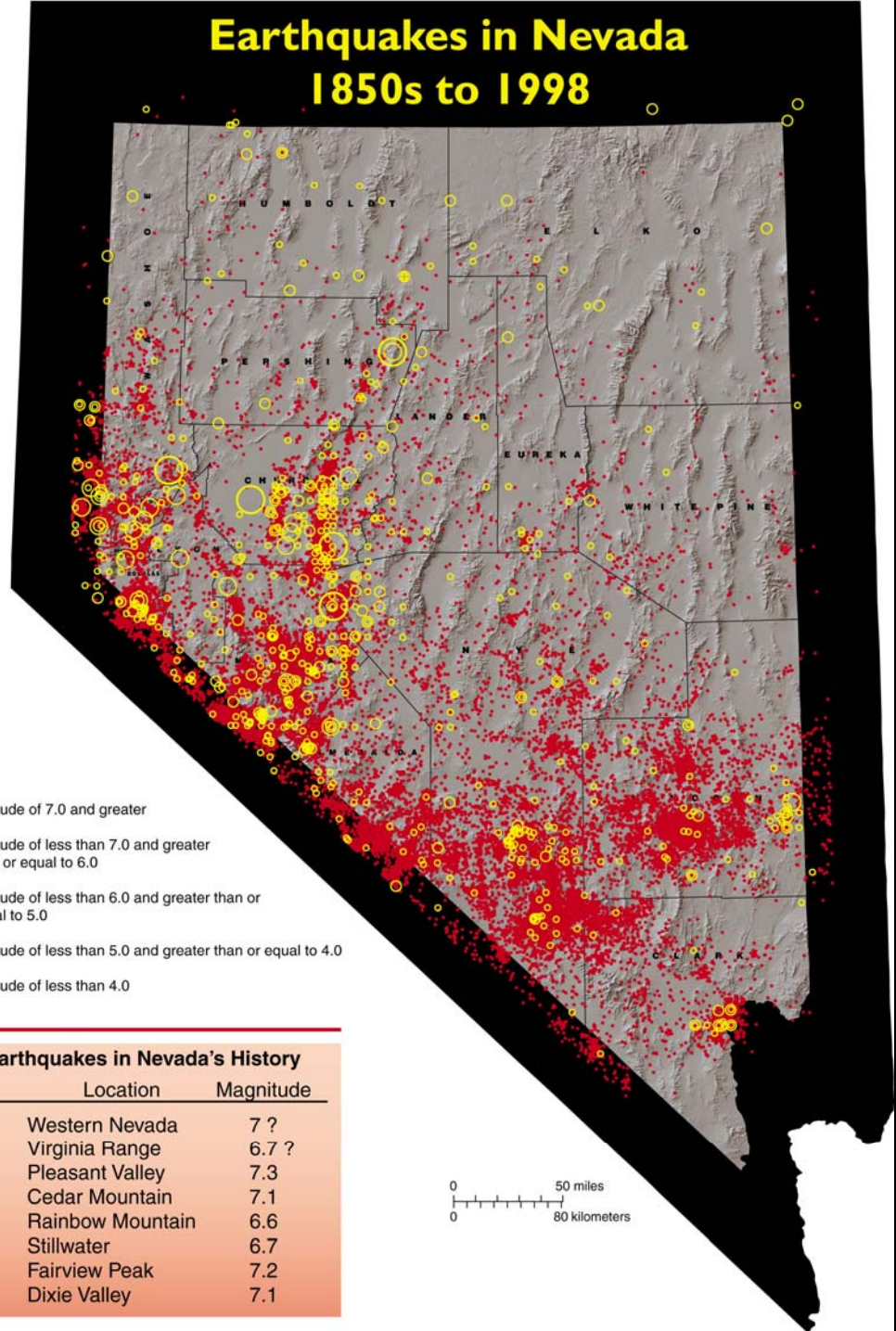


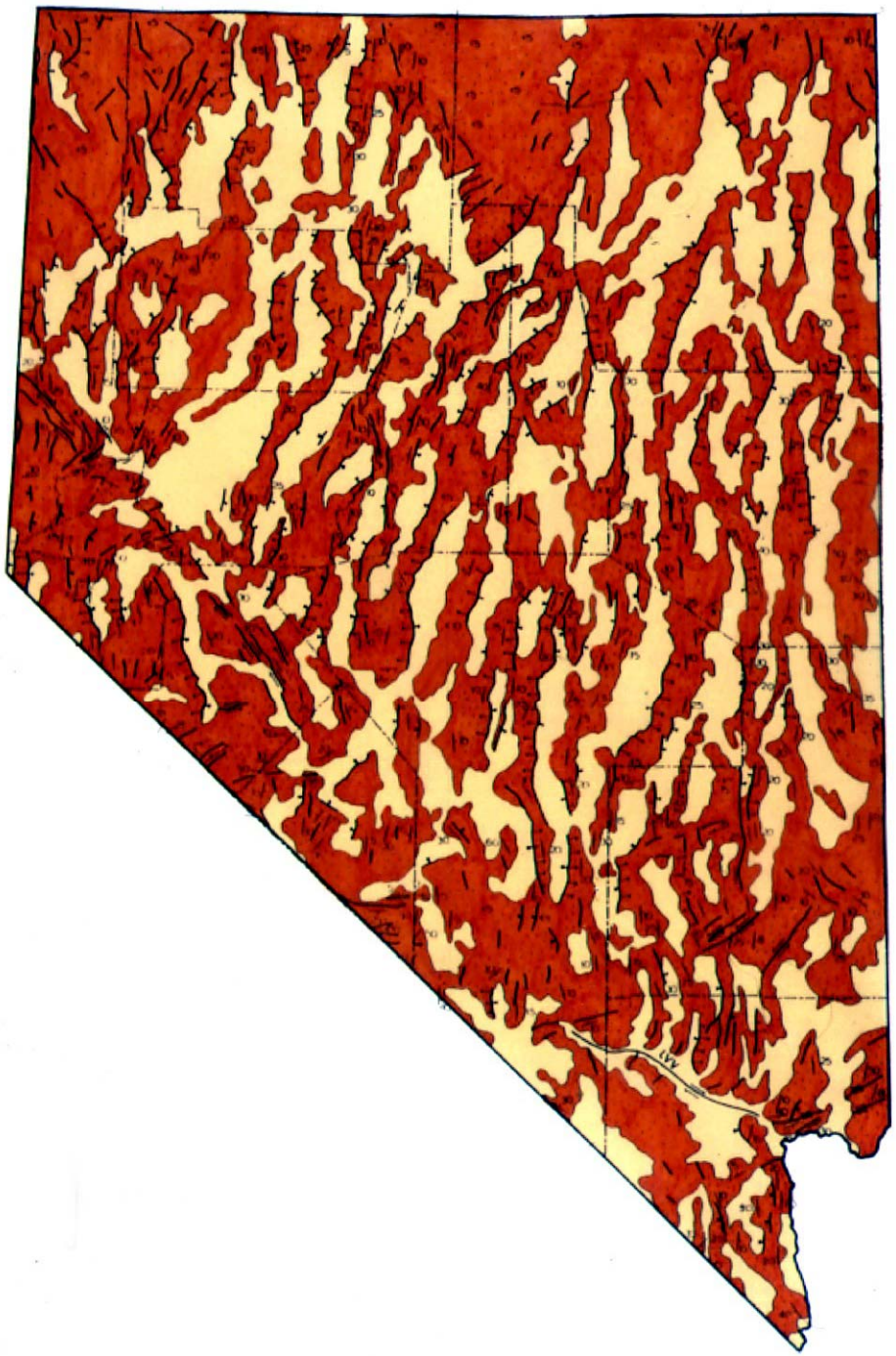
Geologists hypothesize that the Miocene diatomite was deposited in lakes in western Nevada before the Sierra Nevada became a mountain range. Tilting of the strata and normal faulting are probably related to mountain building of the Sierra Nevada and other ranges in the region. This deformation continues. Nevada experiences a magnitude 7 or greater earthquake about once every 30 years. The most recent one was in 1954, near Fallon.

Earthquakes in Nevada
1850s to 1998



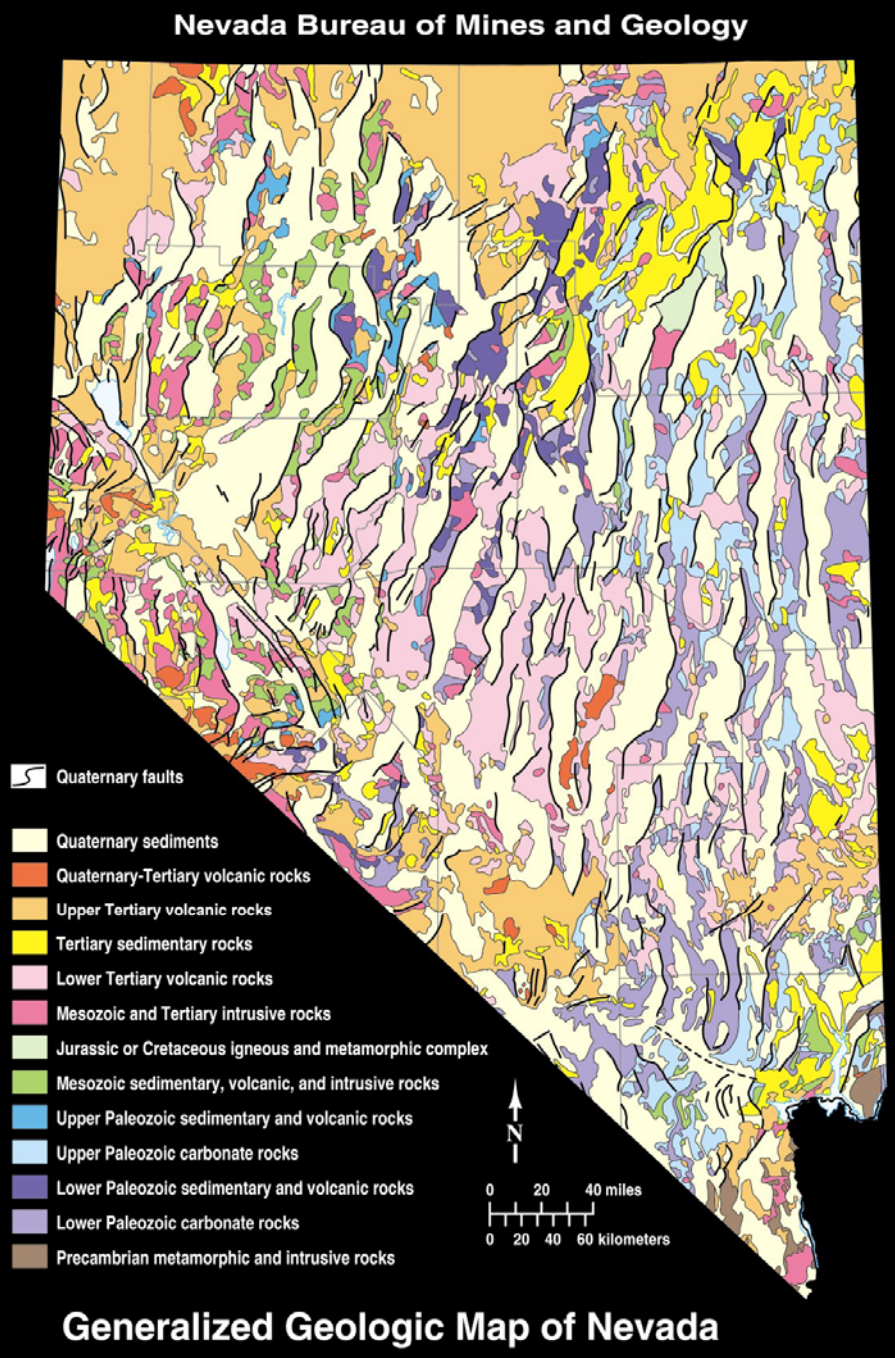
Big Earthquakes in Nevada's History

Date	Location	Magnitude
1860	Western Nevada	7 ?
1869	Virginia Range	6.7 ?
1915	Pleasant Valley	7.3
1932	Cedar Mountain	7.1
1954	Rainbow Mountain	6.6
1954	Stillwater	6.7
1954	Fairview Peak	7.2
1954	Dixie Valley	7.1

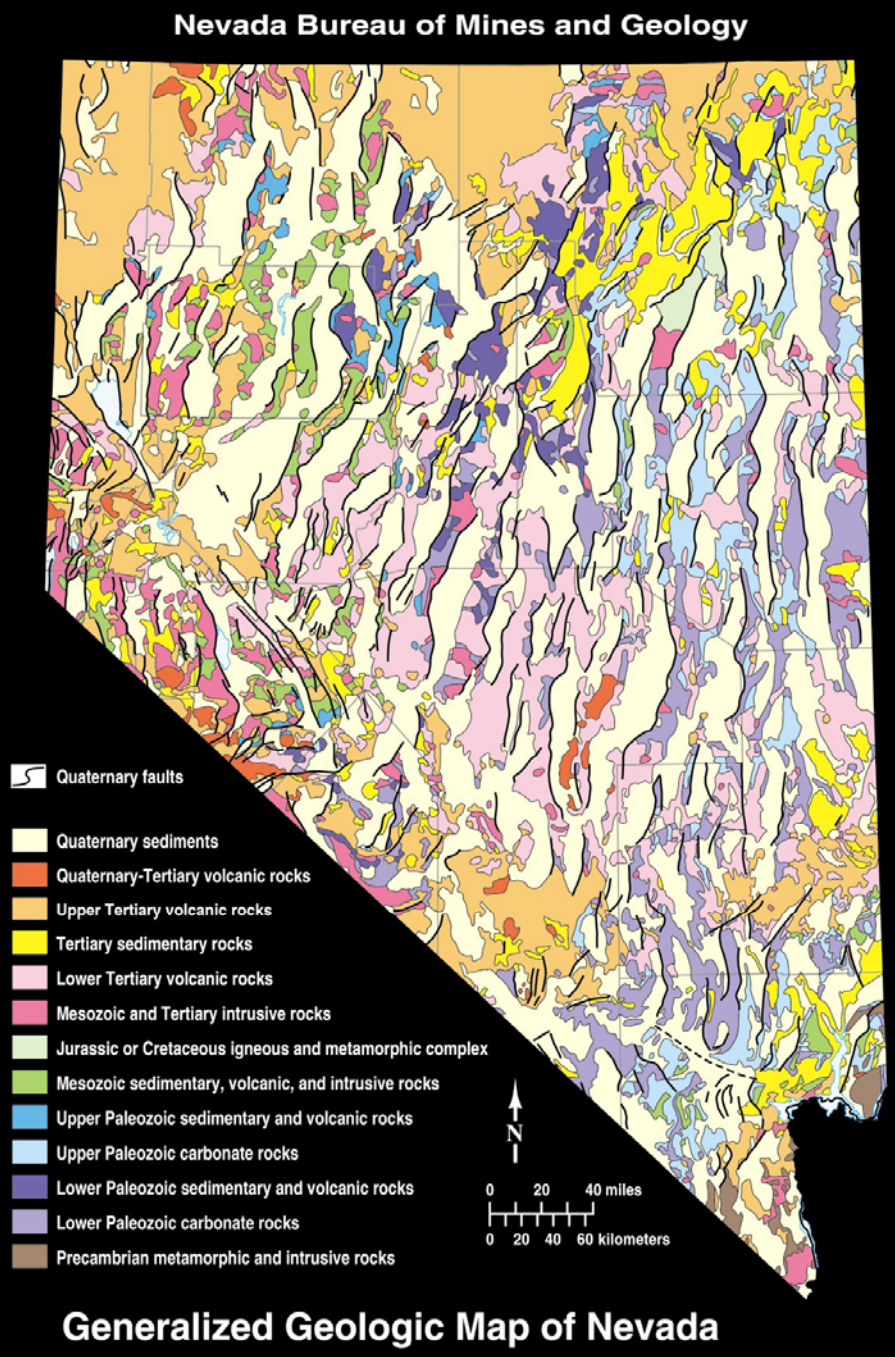


Nearly every mountain range in Nevada is bounded by a Quaternary fault.

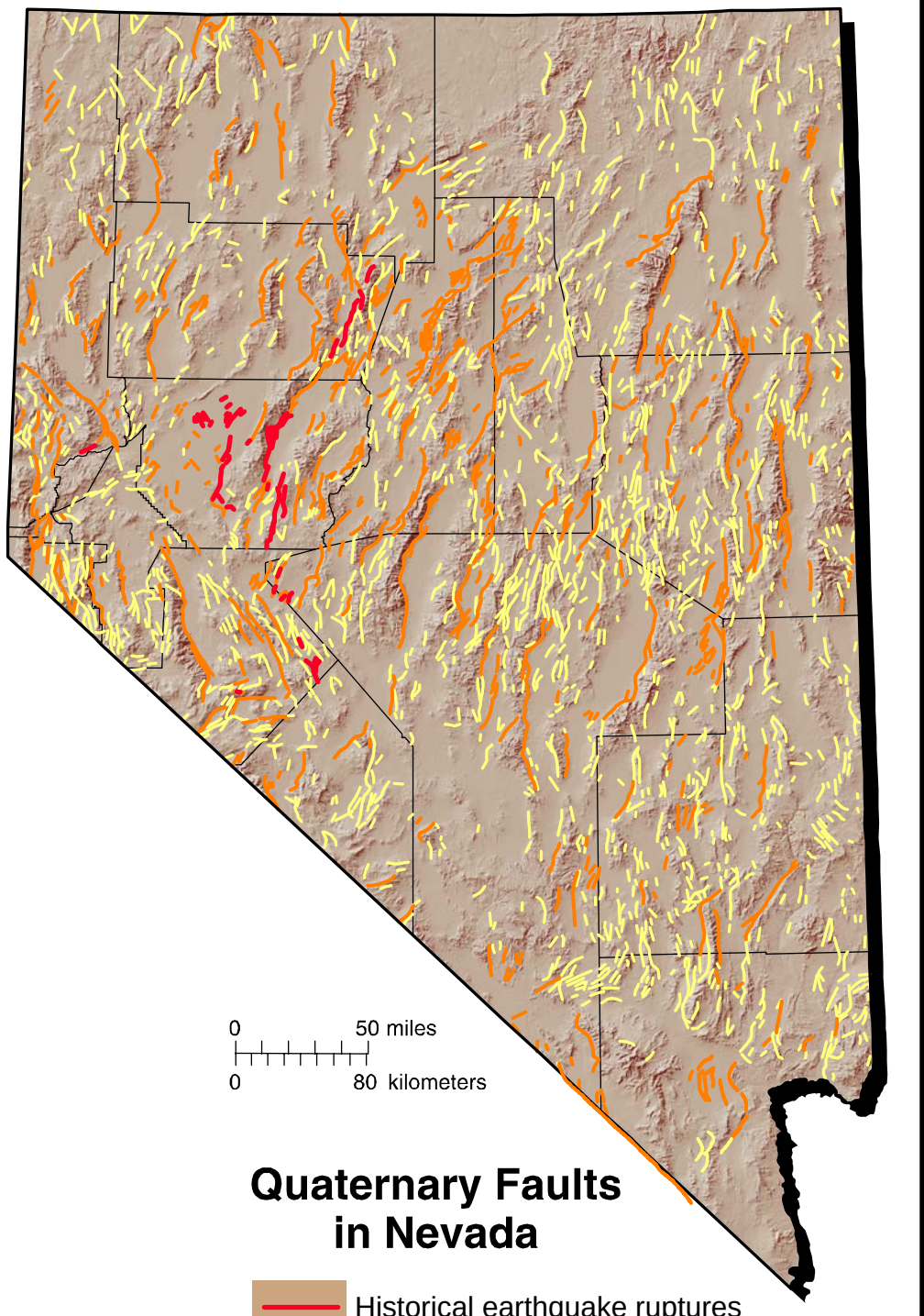
Quaternary fault at the Bald Mountain mine, southern Ruby Mountains



Large earthquakes have occurred near what are now urban areas. Faults that have moved during earthquakes in the last 10,000 years occur in urbanized areas of Reno, Carson City, and several other communities. Faults also occur in and around Las Vegas Valley, but we do not think that these faults have had earthquakes as frequently as those in the Reno-Carson City area.

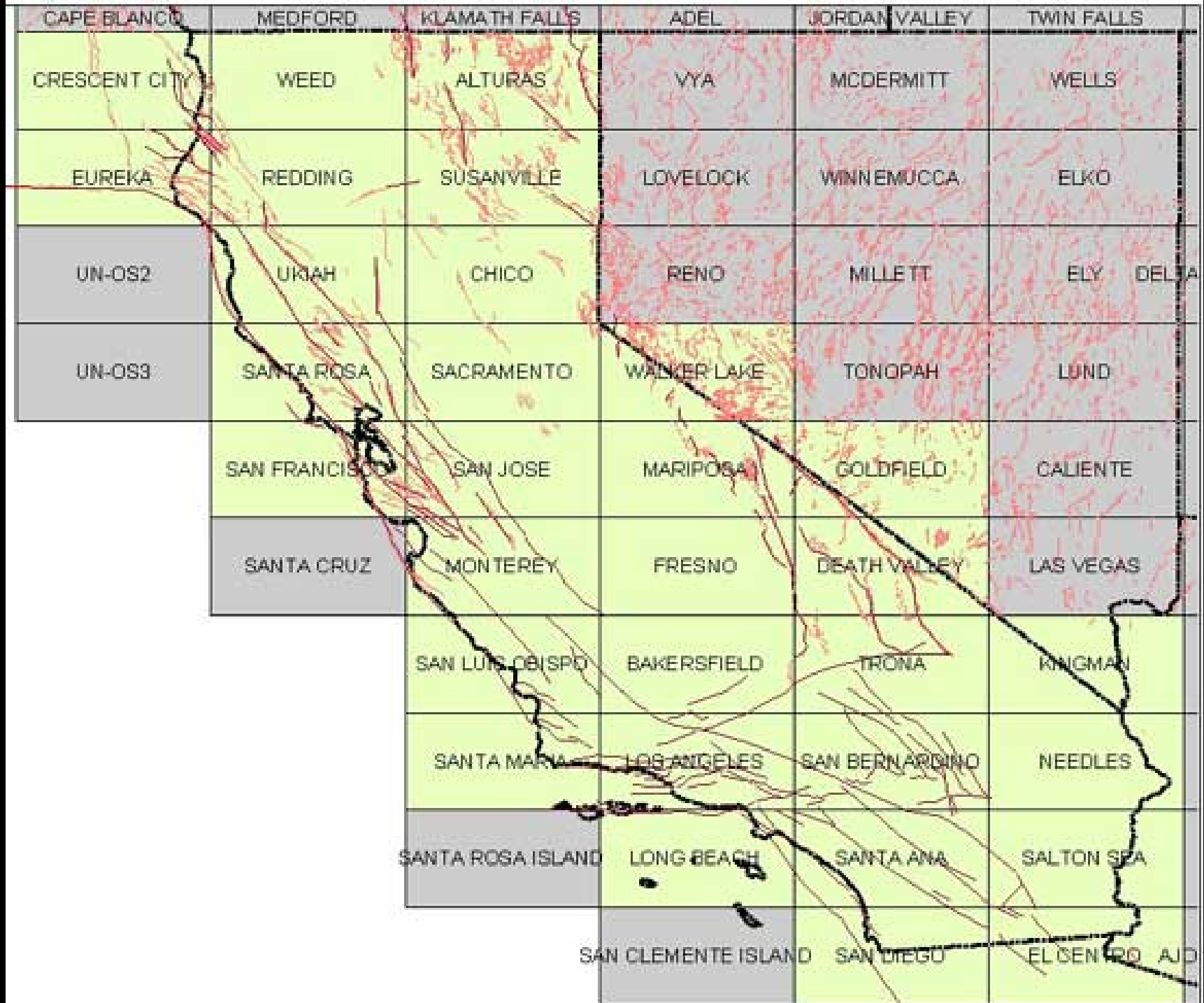


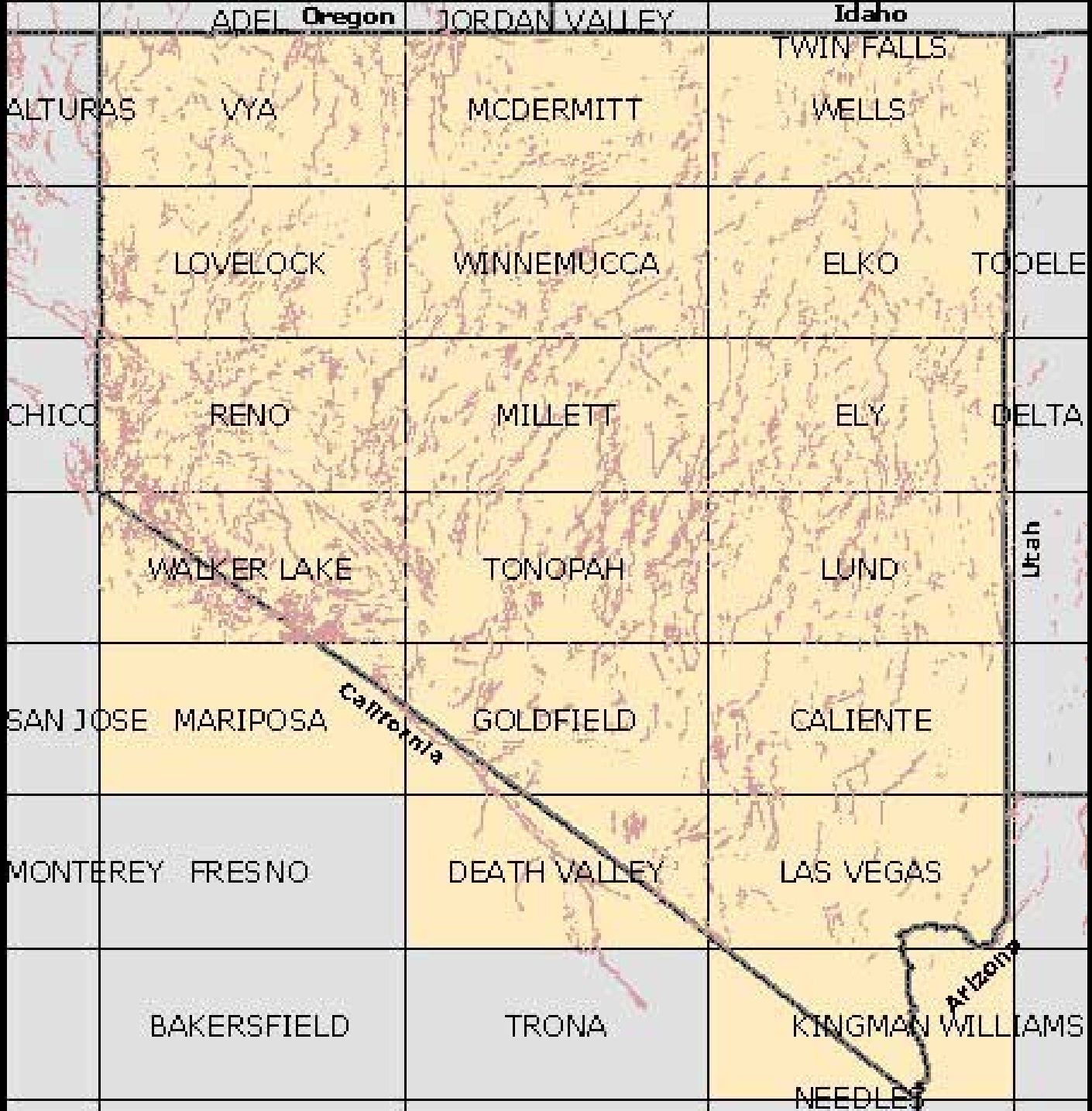
Generally NW-striking faults, which are roughly parallel to the San Andreas fault, have right-lateral displacement, and NE-striking faults have left-lateral displacement, as does the Garlock fault. About 20% of the North America – Pacific plate motion is taken up along NW-striking faults in Nevada.

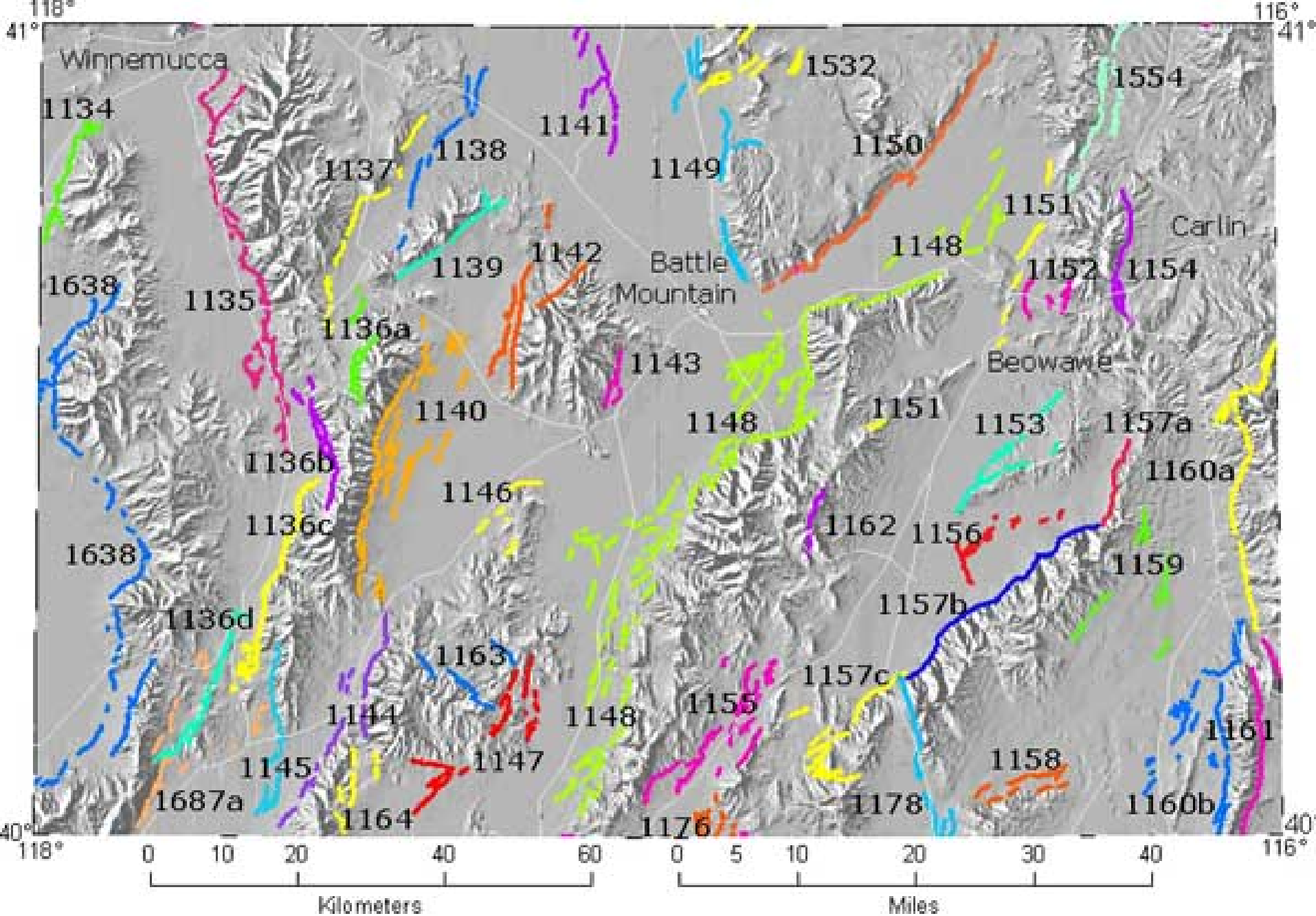

0
50 miles
0
80 kilometers
Quaternary Faults
in Nevada
Historical earthquake ruptures

Quaternary Fault and Fold Database for the United States

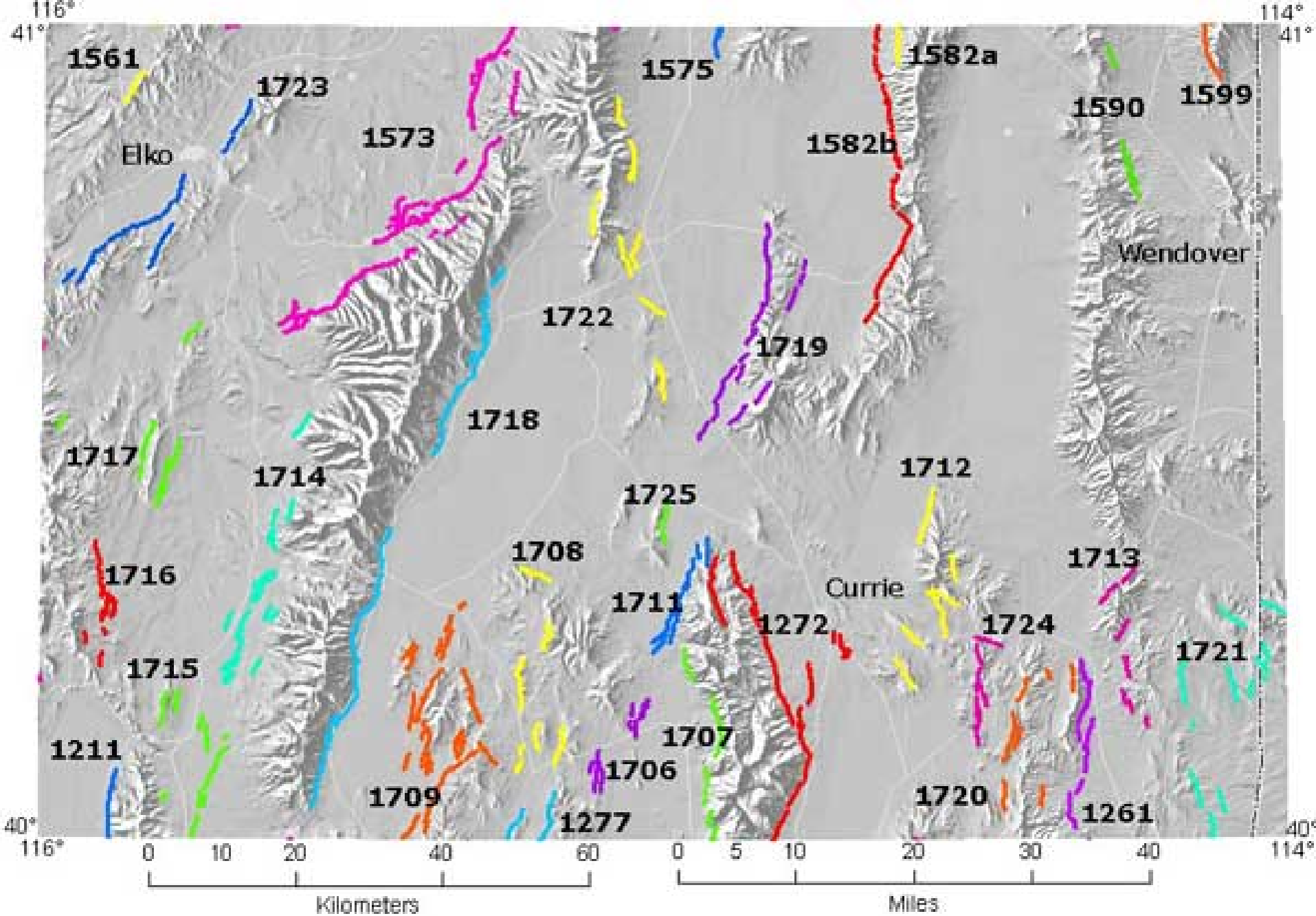
http://qfaults.cr.usgs.gov/


CAPE BLANCO
MEDFORD
KLAMATH FALLS
ADEL
JORDAN VALLEY
TWIN FALLS
CRESCENT CITY
WEED
ALTURAS
VYA
MCDERMITT
WELLS
EUREKA
REDDING
SUSANVILLE
LOVELOCK
WINNEMUCCA
ELKO
UN-OS2
UKIAH
CHICO
RENO
MILLETT
ELY
DELTA
UN-OS3
SANTA ROSA
SACRAMENTO
WALKER LAKE
TONOPAH
LUND
SAN FRANCISCO
SAN JOSE
MARIPOSA
GOLDFIELD
CALIENTE
SANTA CRUZ
MONTEREY
FRESNO
DEATH VALLEY
LAS VEGAS
SAN LUIS OBISPO
BAKERSFIELD
TRONA
KINGMAN
SANTA MARIA
LOS ANGELES
SAN BERNARDINO
NEEDLES
SANTA ROSA ISLAND
LONG BEACH
SANTA ANA
SALTON SEA
SAN CLEMENTE ISLAND
SAN DIEGO
EL CENTRO
AJO

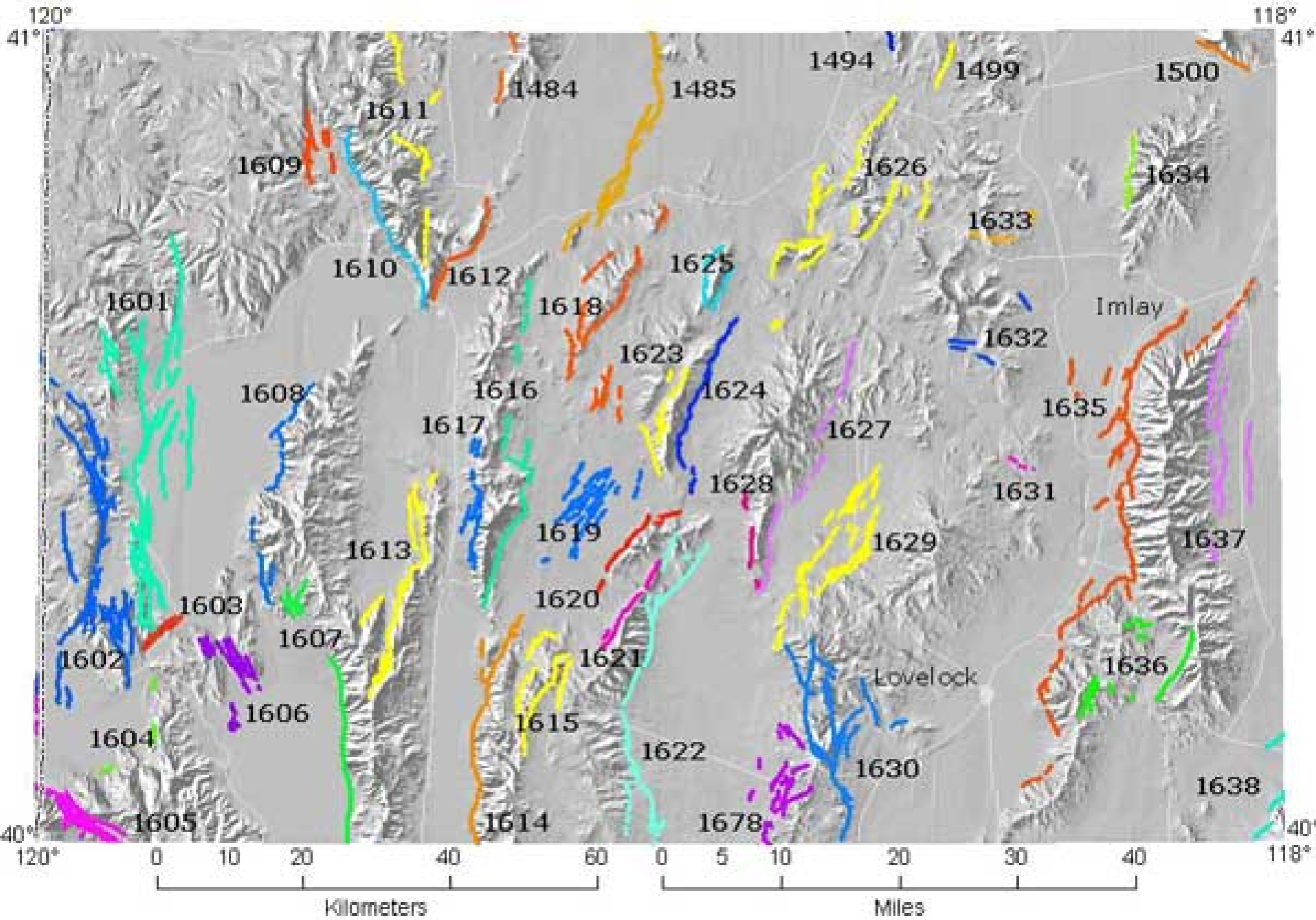

ADEL
Oregon
JORDAN VALLEY
Idaho
TWIN FALLS
ALTURAS
VYA
MCDERMITT
WELLS
LOVELOCK
WINNEMUCCA
ELKO
TOOELE
CHICO
RENO
MILLETT
ELY
DELTA
WALKER LAKE
TONOPAH
LUND
Utah
SAN JOSE
MARIPOSA
California
GOLDFIELD
CALIENTE
MONTEREY
FRESNO
DEATH VALLEY
LAS VEGAS
Arizona
BAKERSFIELD
TRONA
KINGMAN
WILLIAMS
NEEDLES



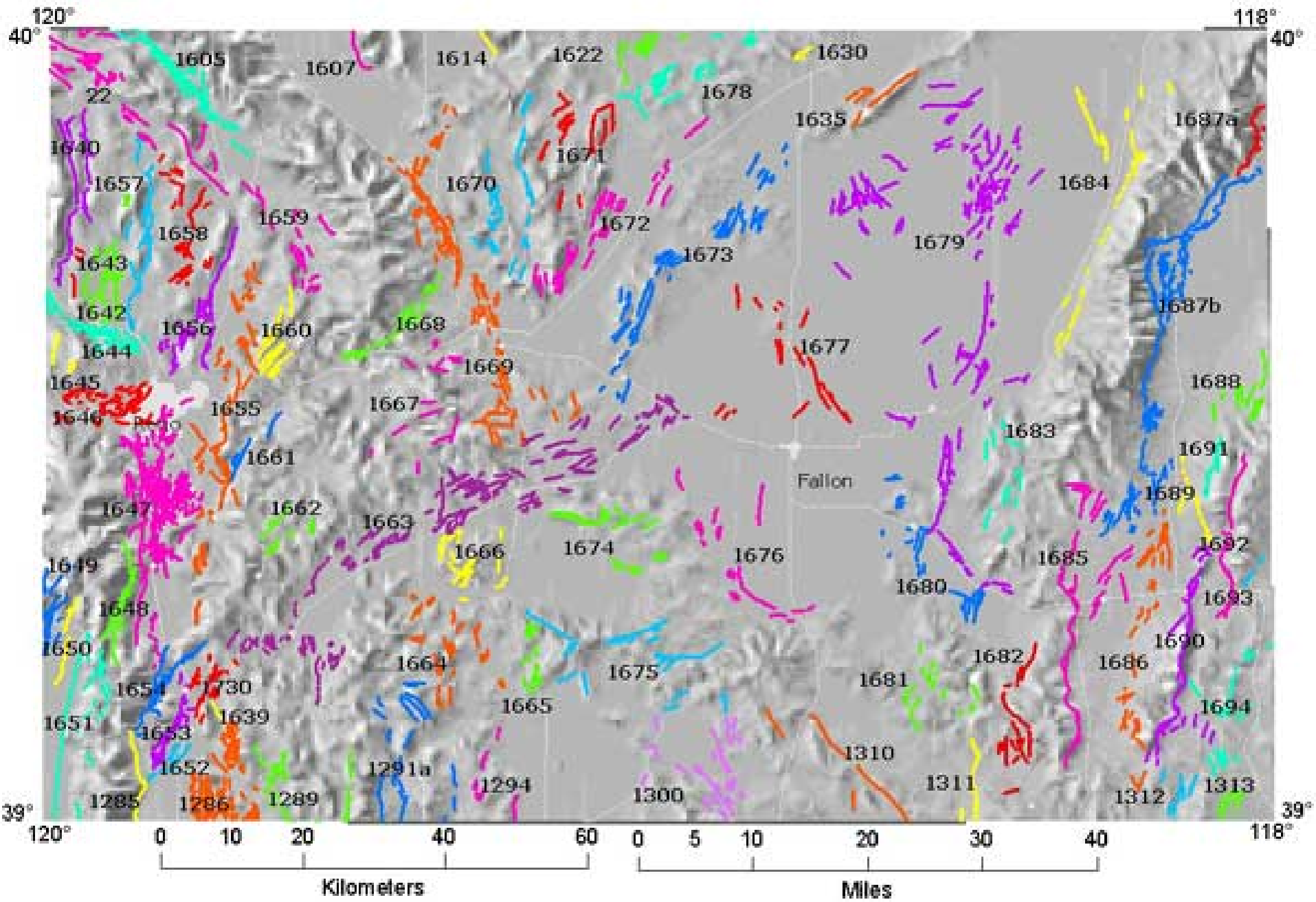
Winnemucca – Battle Mountain – Carlin sheet



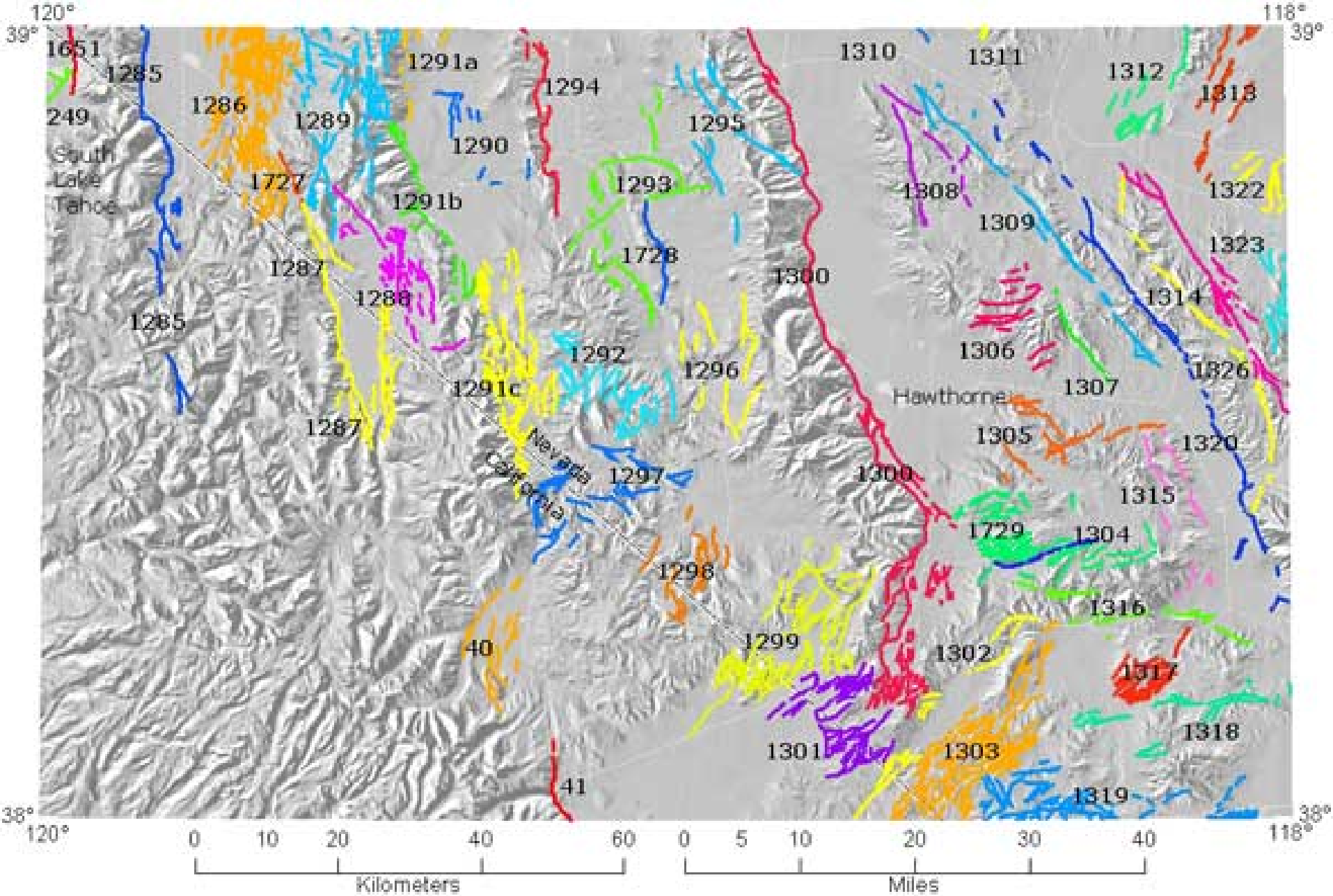
Elko – Wendover sheet



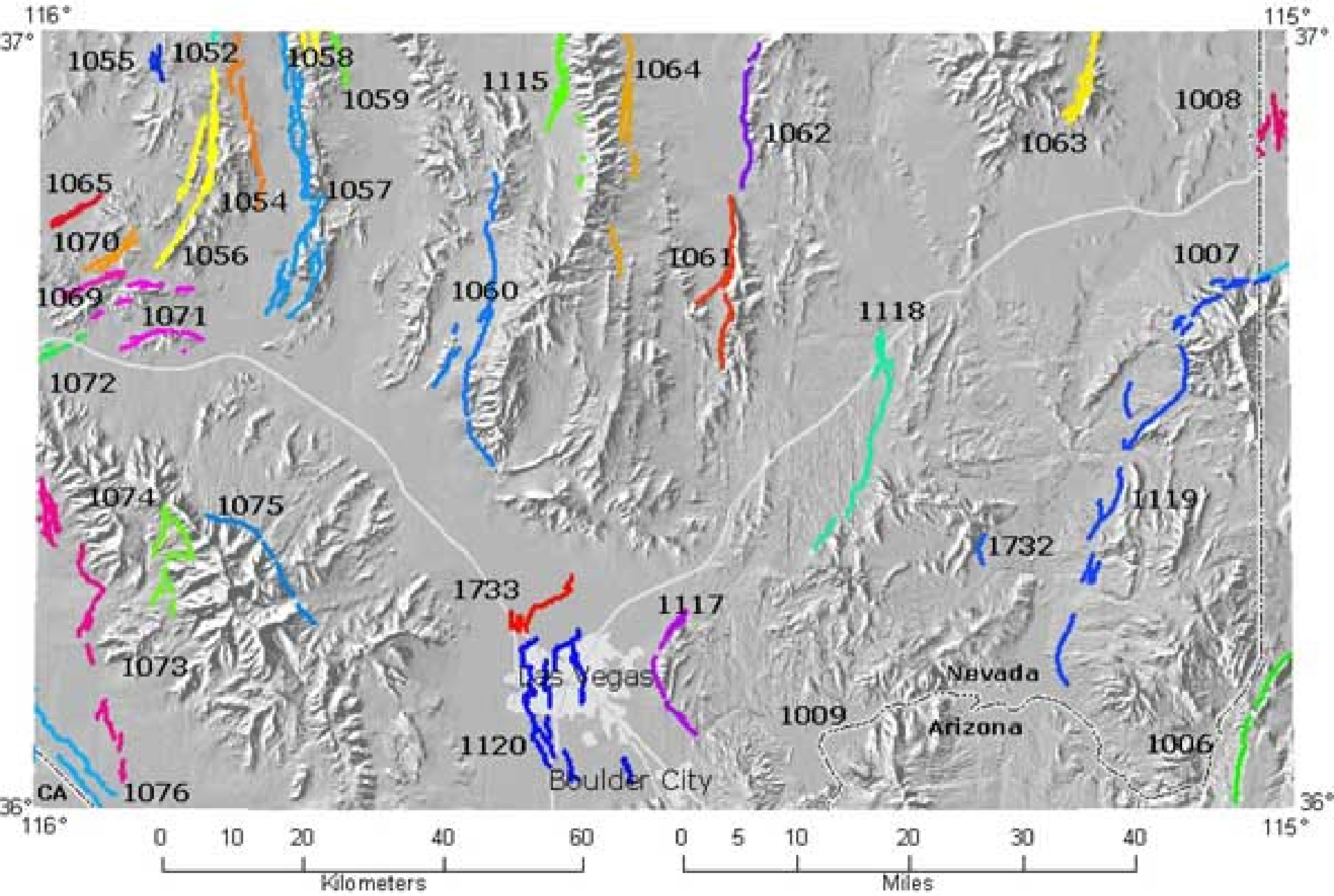
Lovelock – Imlay sheet



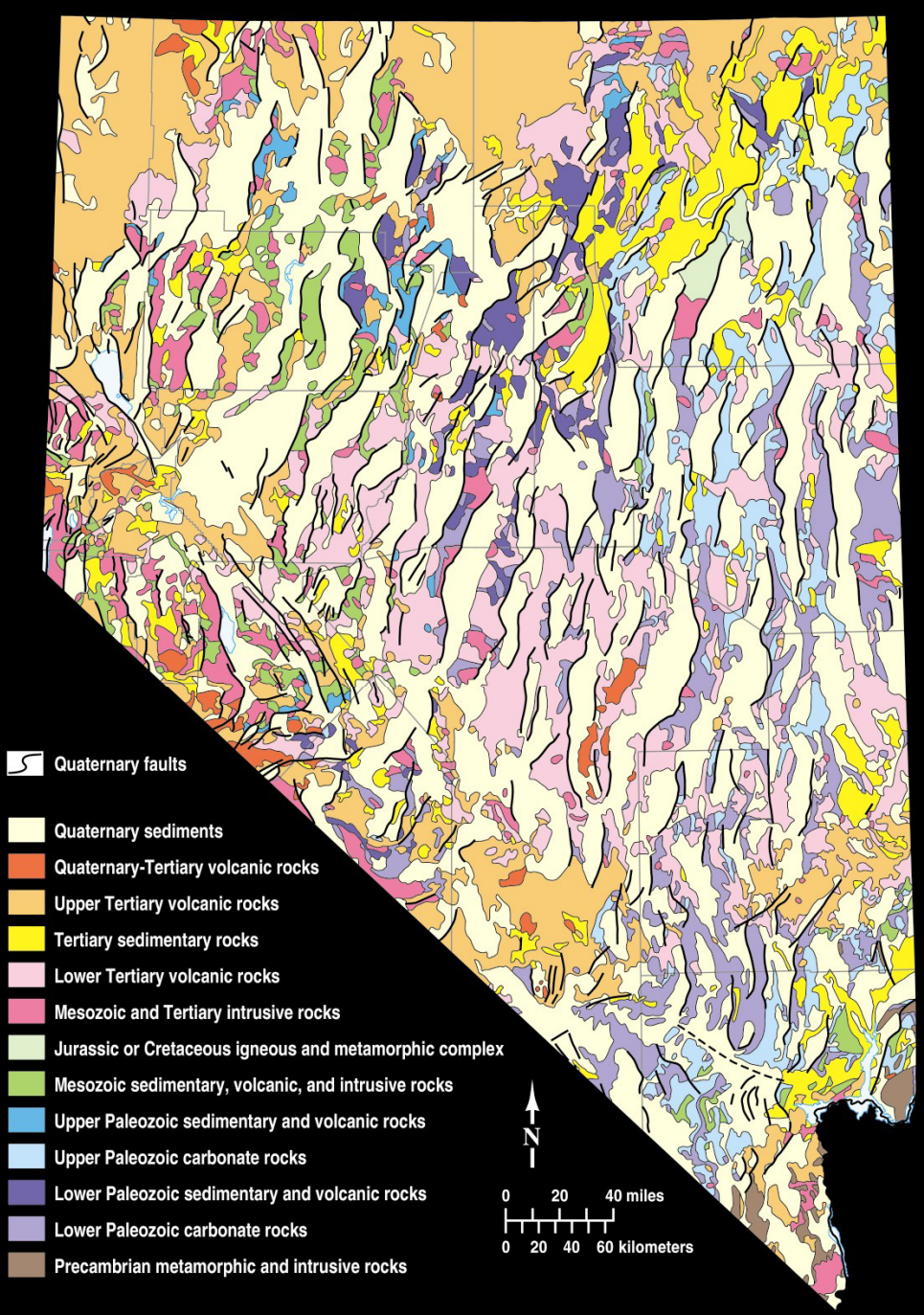
Reno – Carson City – Fernley – Fallon sheet



Walker Lake – Minden – Gardnerville – Hawthorne sheet



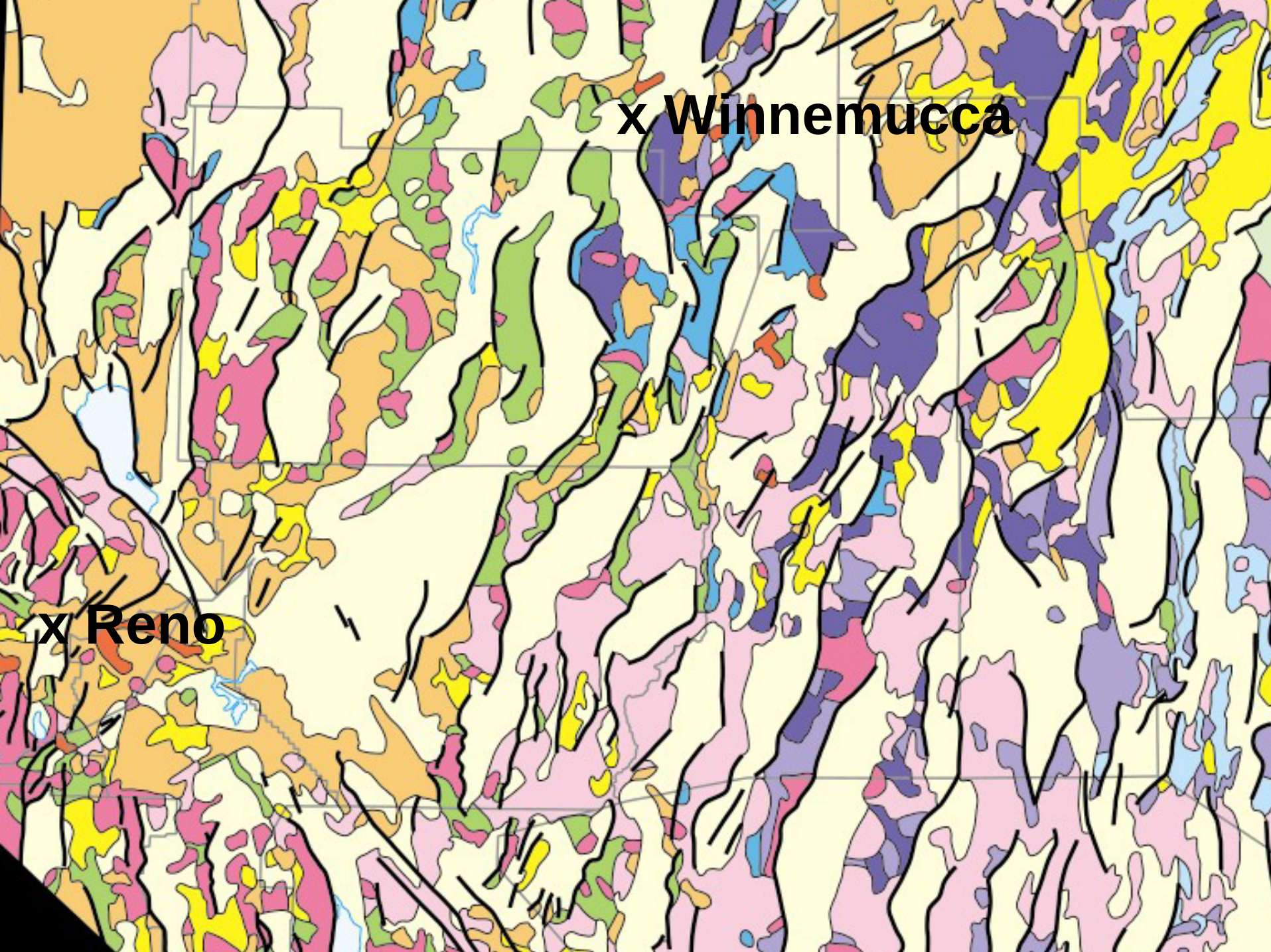
Las Vegas sheet



Generalized Geologic Map of Nevada

This map includes most of the largest, most important fault zones in Nevada. It is available on line, along with many other free items, as Nevada Bureau of Mines and Geology Educational Series E-30.

www.nbmg.unr.edu


x Winnemucca
x Reno

http://eqint.cr.usgs.gov/eq/html/eqprob.html

nbmg.unr.edu

Links

USGS Seismic Hazard Maps

Earthquake Probability Mapping

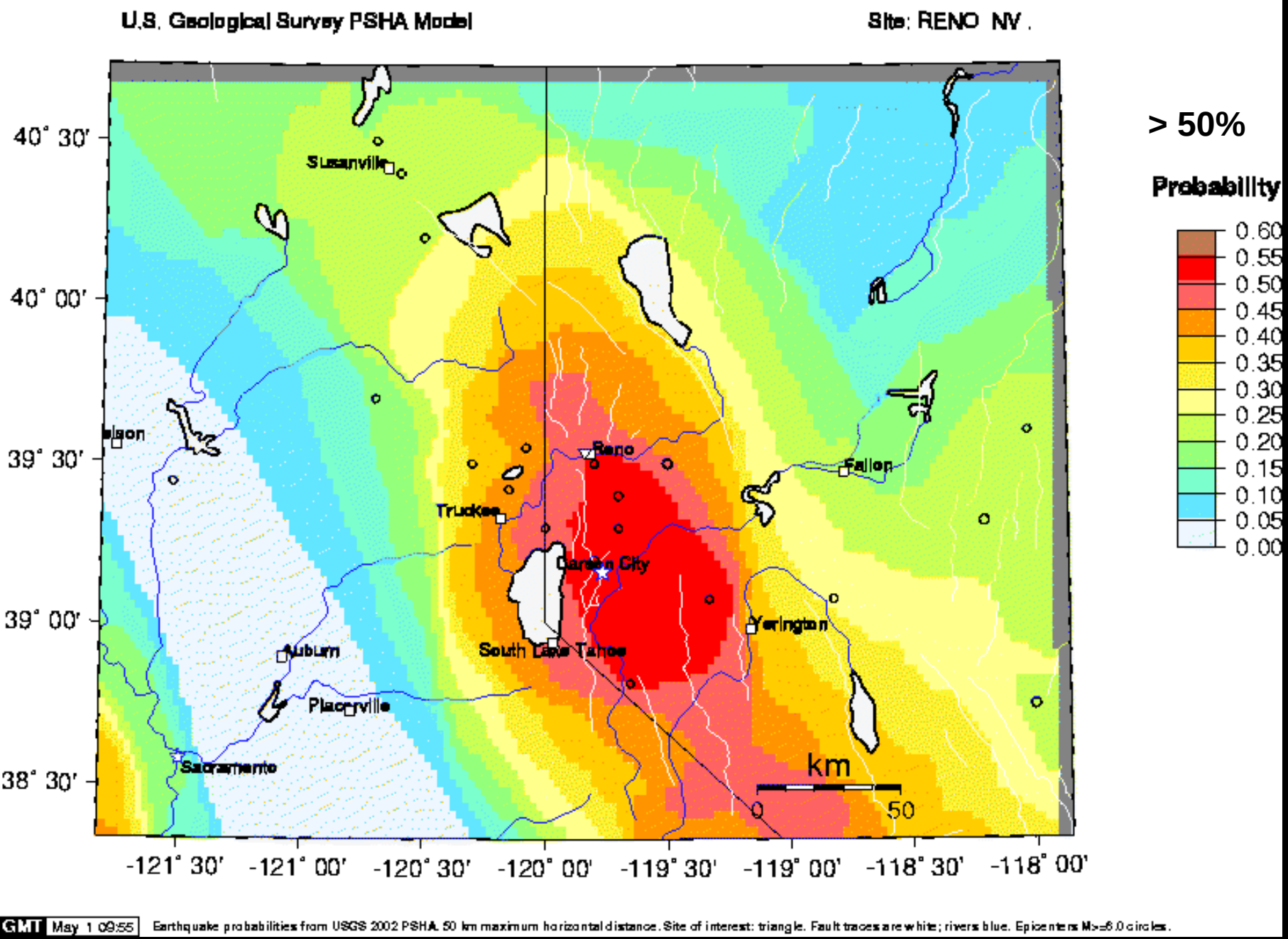
Choose a location (by Zip Code or Longitude and Latitude)

Select a timeframe (50 years or less)

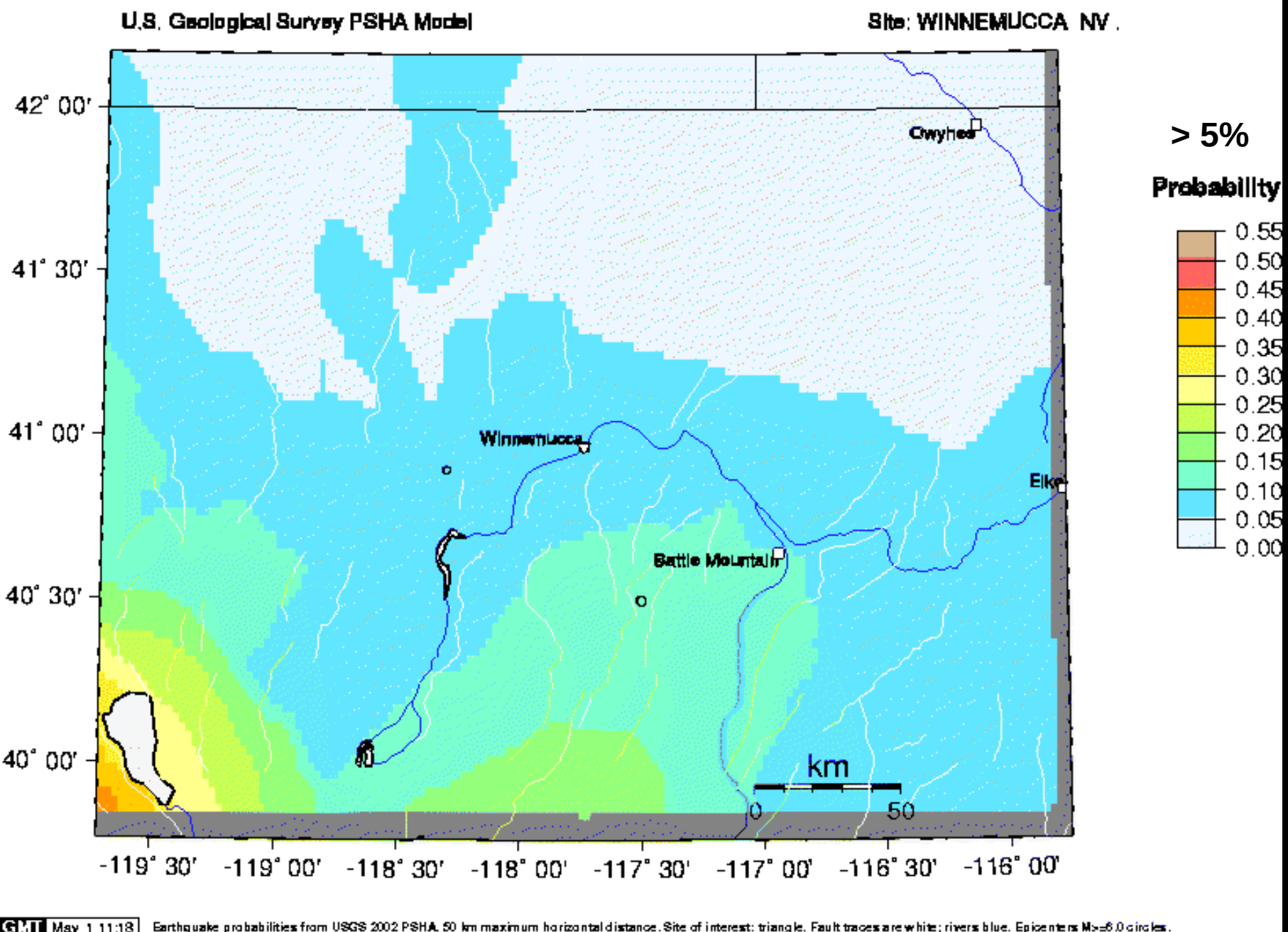
Select a magnitude (5.0, 6.0, 6.5, 7.0 is appropriate for Nevada)

Default distance = 50 km

Probability of earthquake with M ≥ 6.5 within 50 years & 50 km

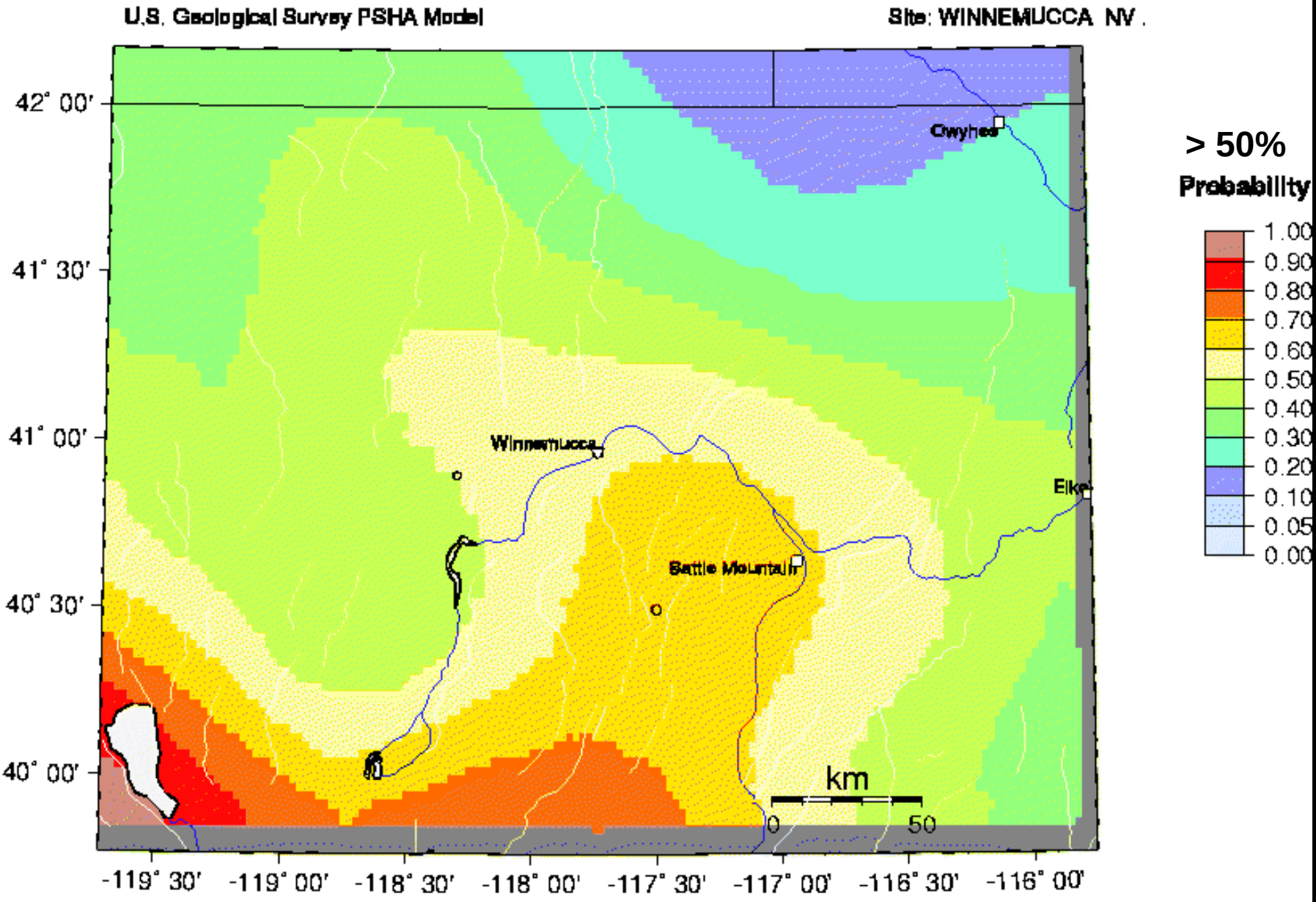


Probability of earthquake with M ≥ 6.5 within 50 years & 50 km



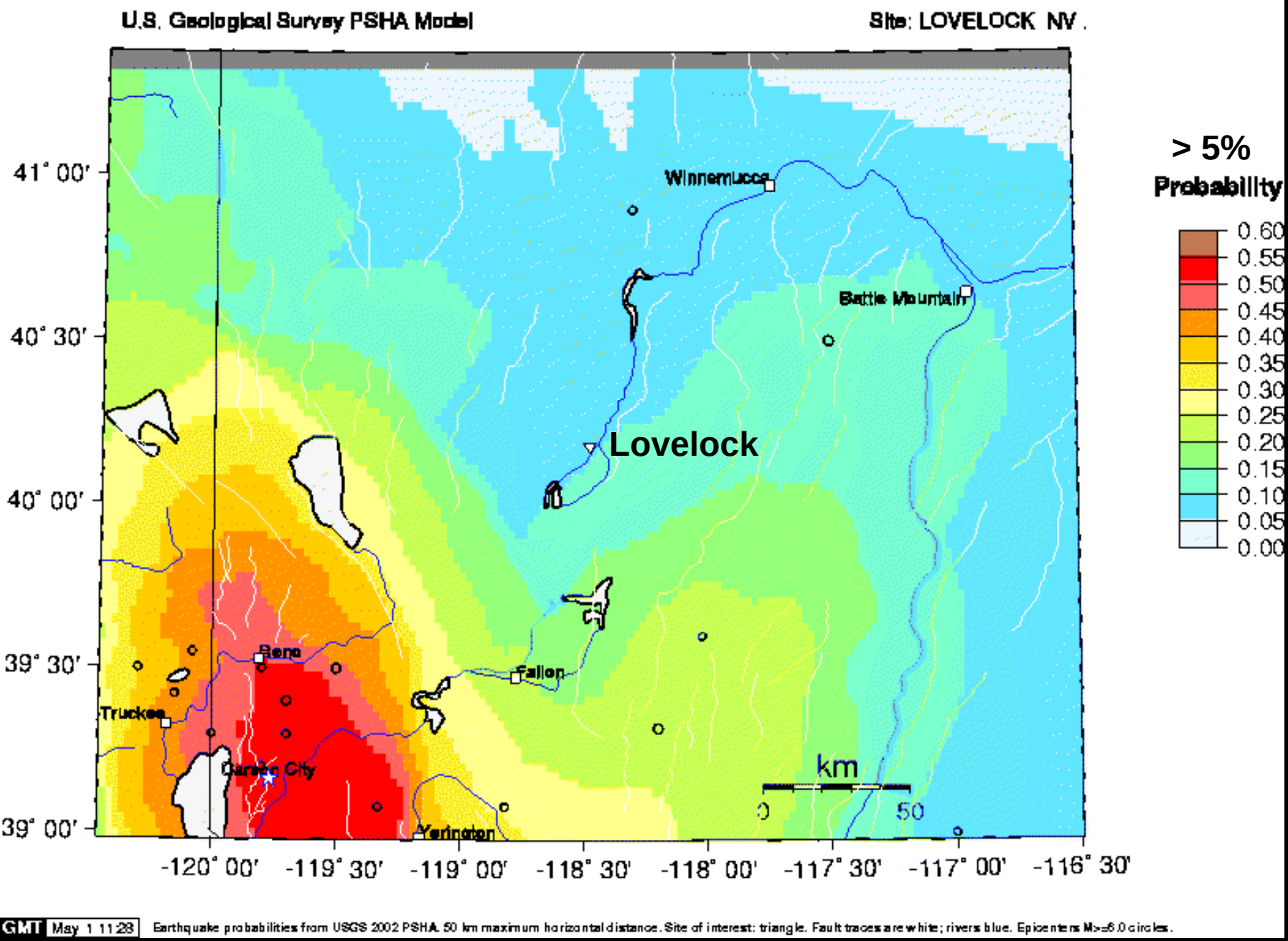
GMT May 1 11:18 Earthquake probabilities from USGS 2002 PSHA. 50 km maximum horizontal distance. Site of interest: triangle. Fault traces are white; rivers blue. Epicenters M>=6.0 circles.

Probability of earthquake with M ≥ 5.0 within 50 years & 50 km



GMT May 1 11:17 Earthquake probabilities from USGS 2002 PSHA. 50 km maximum horizontal distance. Site of interest: triangle. Fault traces are white; rivers blue. Epicenters M>=6.0 circles.

Probability of earthquake with M ≥ 6.5 within 50 years & 50 km



GMT May 1 11:23 Earthquake probabilities from USGS 2002 PSHA. 50 km maximum horizontal distance. Site of interest: triangle. Fault traces are white; rivers blue. Epicenters M>=6.0 circles.

The main points:

1. Nevada is earthquake country.

2. We can do something about it.

   a. Be prepared to respond.

   b. Mitigate structural risks, largely through building codes.

   c. Mitigate non-structural risks.

Photo 10, Steamboat Ditch east of McCarran Boulevard in Reno, looking south


Fortunately, these faults
appear to be inactive.

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

Nevada Earthquake Safety Council
www.nbmg.unr.edu/nesc

Nevada Seismological Laboratory
www.seismo.unr.edu

Nevada Division of Emergency Management
dem.state.nv.us

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

Earthquakes in Nevada and How to Survive Them
= Educational Series E-16 (pamphlet)

Earthquakes in Nevada, 1852-1998
= Map 119 (1:1,000,000 scale)

Living with Earthquakes in Nevada
= Special Publication 27 (booklet)