

# Earthquakes in Harriman Park

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Public Lecture  
American Canoe Association  
Hilltop Facility  
4PM Saturday May 21 2011

## Another Small Earthquake Rattles Central N.J.

WCBS-TV | Feb 15, 2009

MORRISTOWN, N.J. (CBS) -- For the second time in two weeks, a small earthquake has rattled an area of central New Jersey.

The latest earthquake, with a magnitude of 2.2, was recorded shortly before 5:30 p.m.

...

**"It sounded like an explosion and the house shook,"** resident Dan Servidio said.

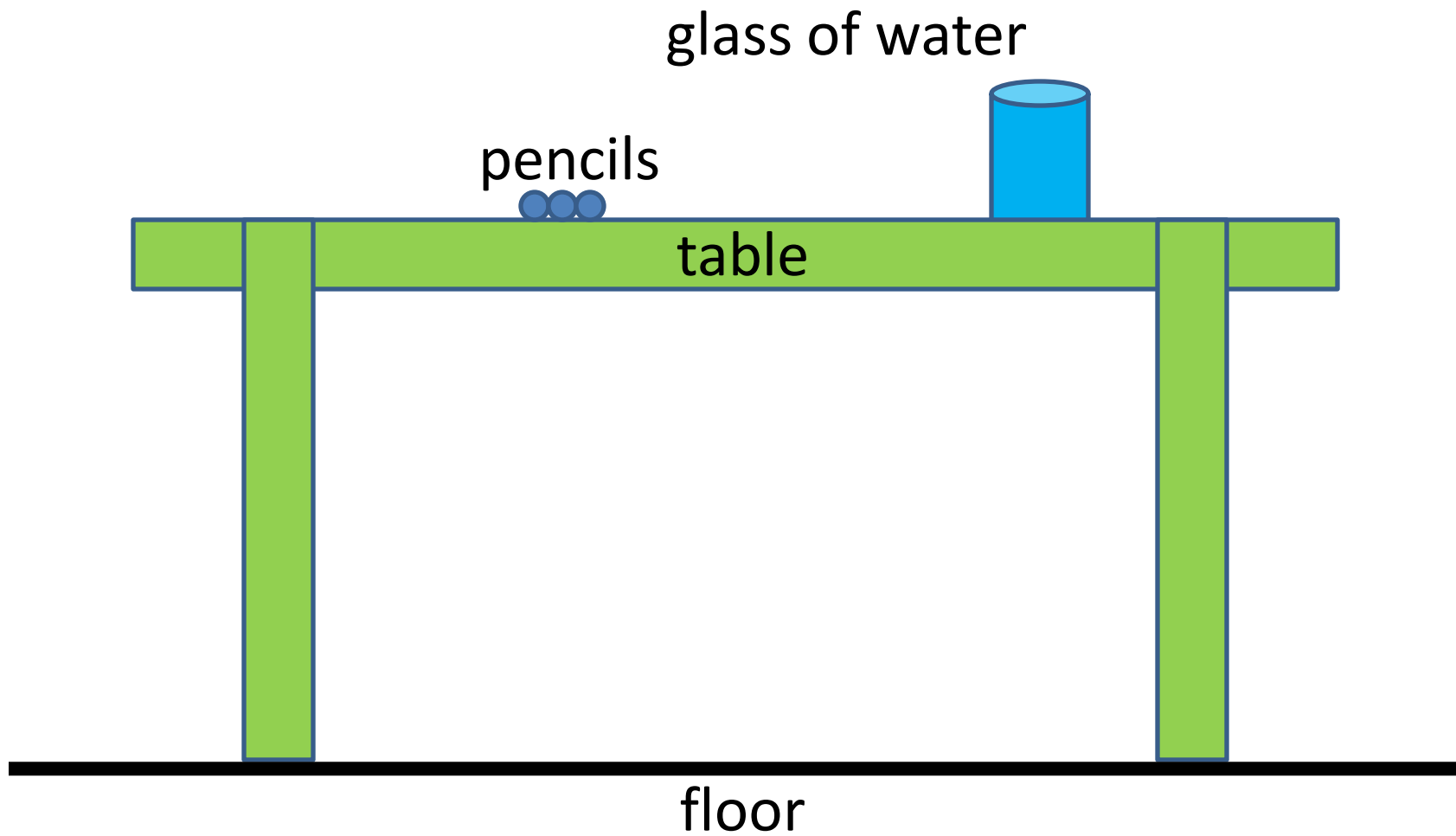
The epicenter was five miles west-northwest of Morristown, along the Ramapo fault. It could be felt in Rockaway, Dover and Morris Plains as far as 30 miles away.

"We felt rumbling and thought something fell off a shelf," resident Lisa Cheek said.

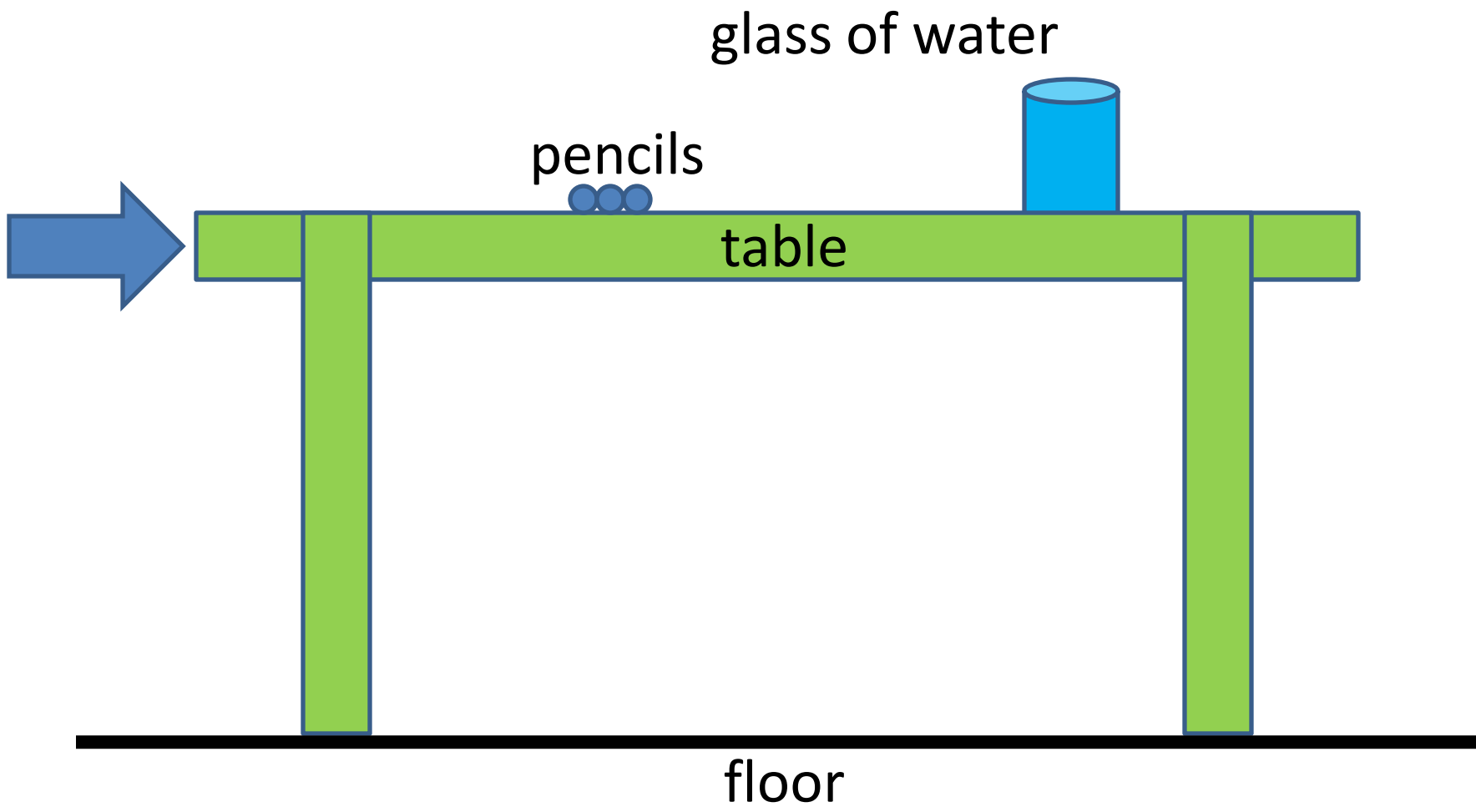
"I was upstairs on my computer, and **all of a sudden I hear a boom, boom, boom,** then a bang, bang, bang. My monitor almost fell off of my computer desk," said resident Stephen Garcia. "So I immediately went downstairs to check on my grandma and ask her if she was alright or if she fell."

earthquake = shaking of the ground  
due to slip on a fault

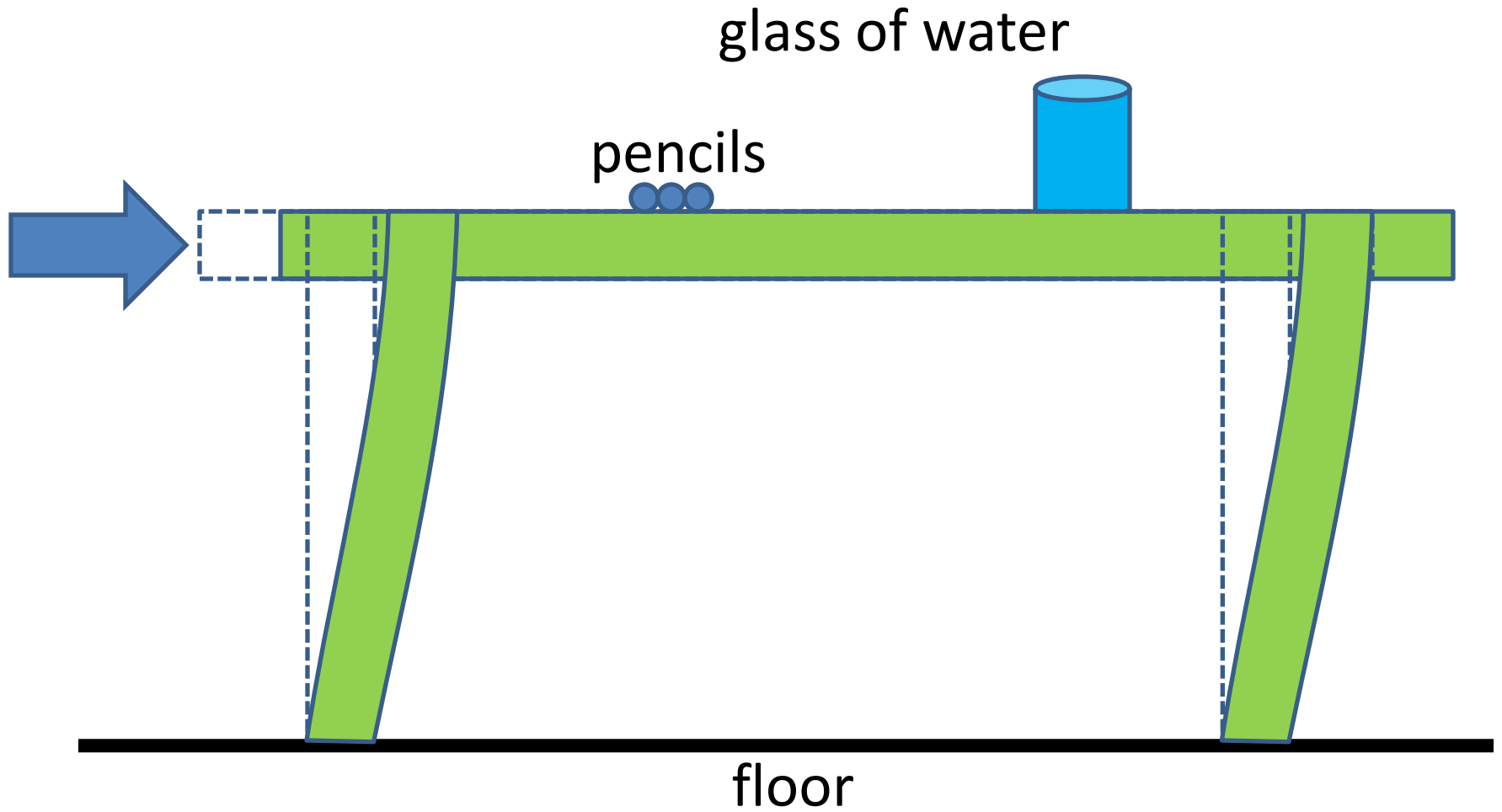
fault = crack in the ground  
across which motion occurs



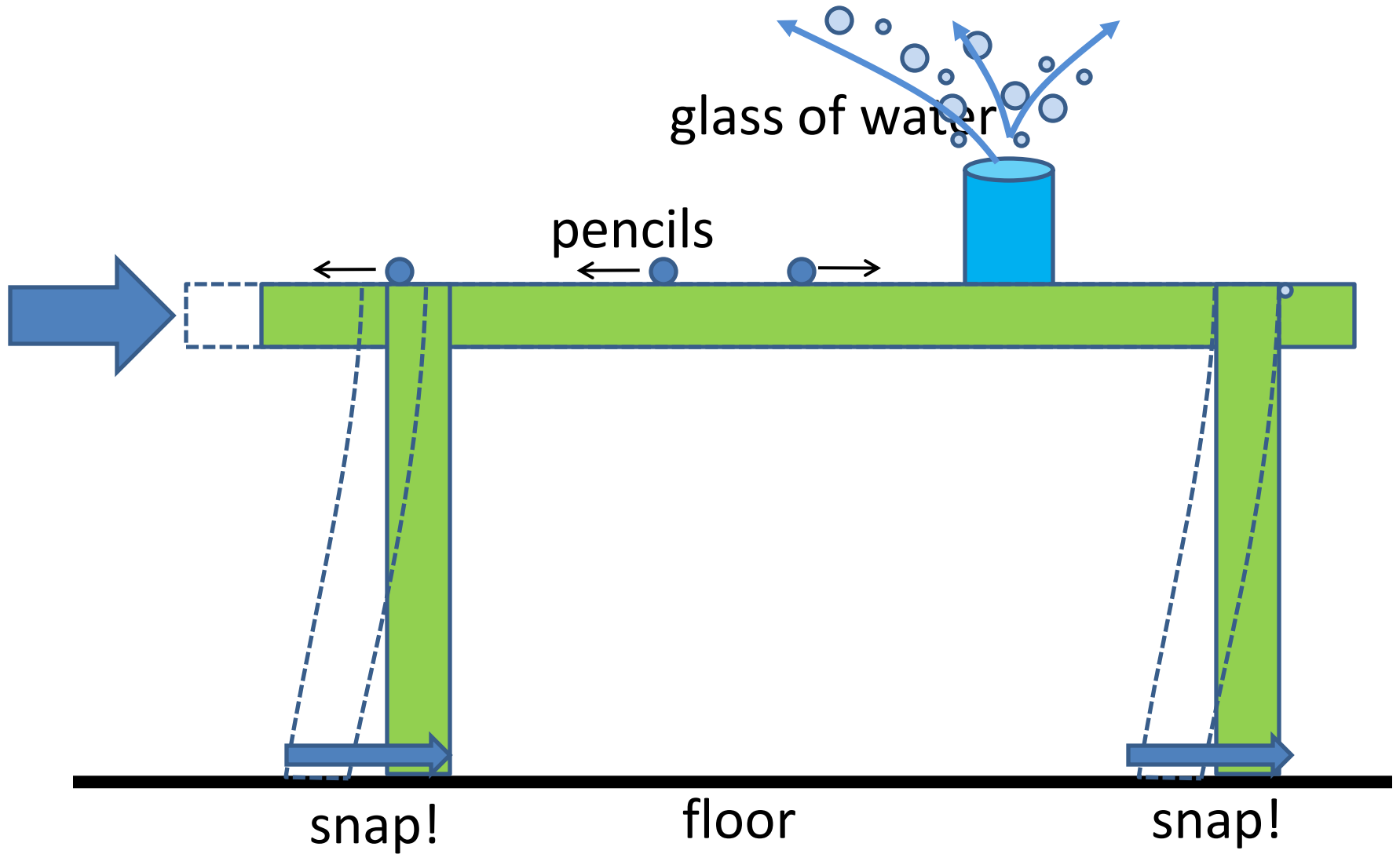
push the table

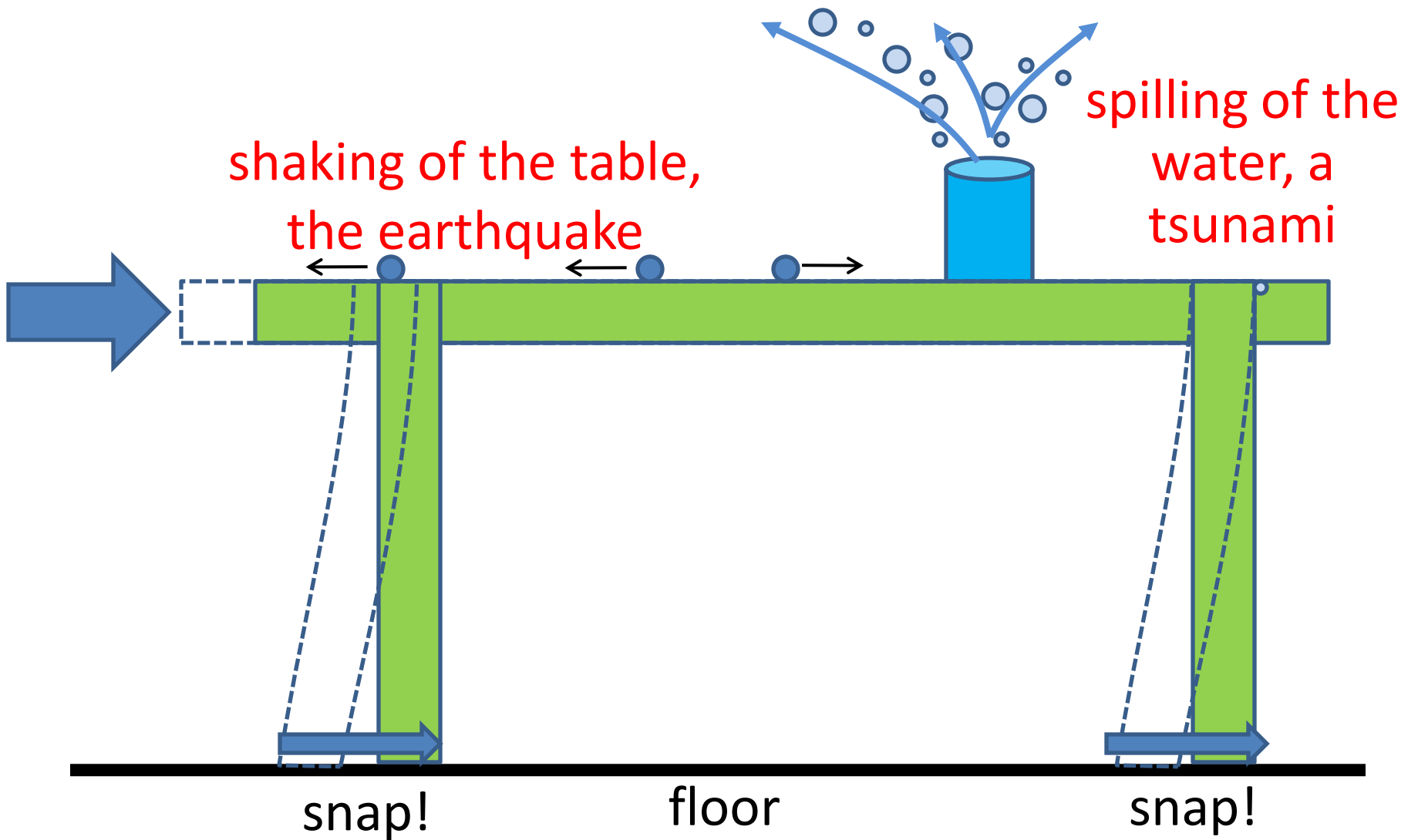


the legs slowly bend



the legs snap back straight





shaking of the table,  
the earthquake

spilling of the  
water, a  
tsunami

snap!

floor

snap!

leg sliding on the floor, the faulting

# The World is Riddled With Faults

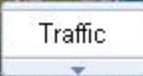
a fault never goes away unless the rock is heated almost to its melting point

the earth is very old and so has had lots of opportunity to accumulate faults

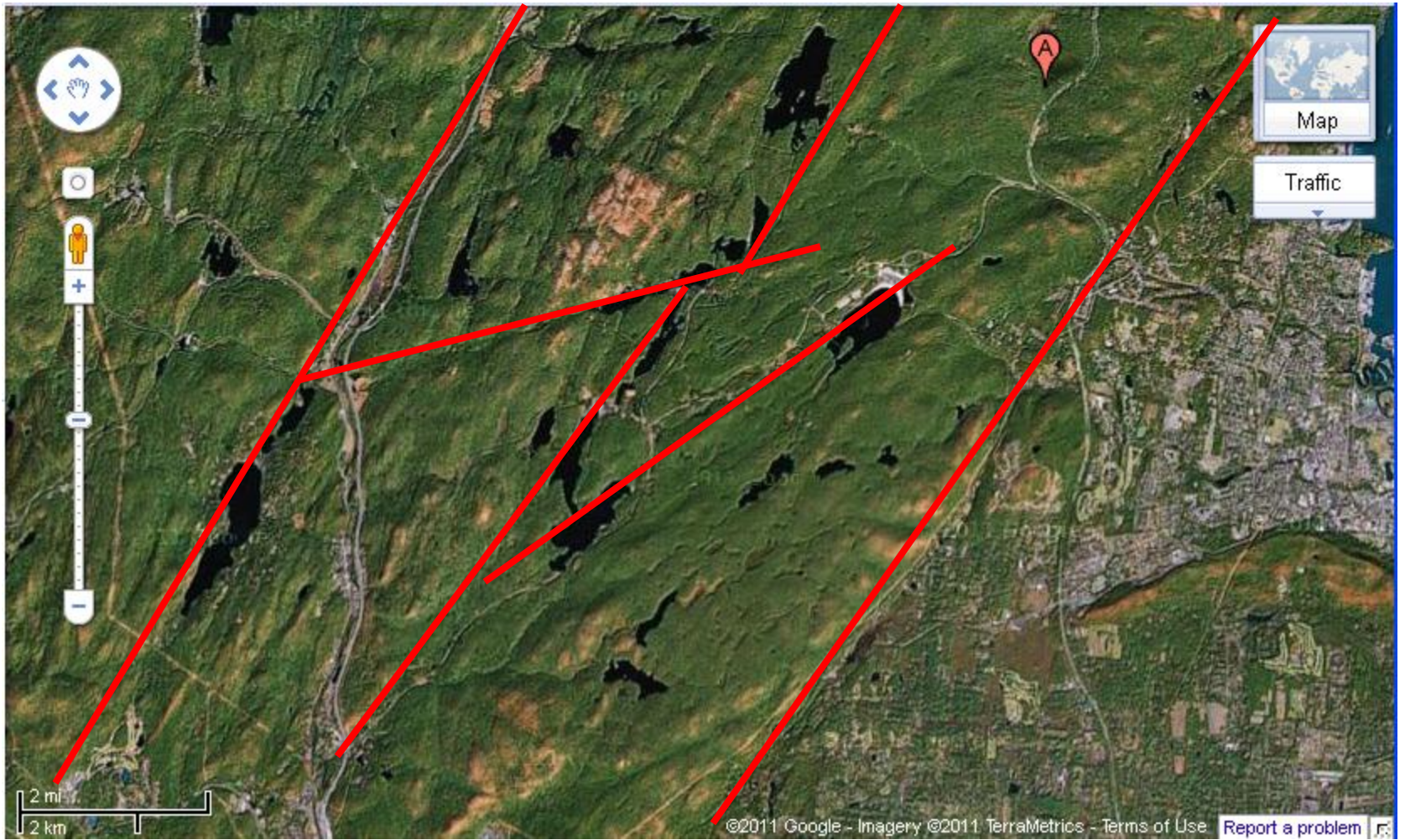
# faults break up the rock

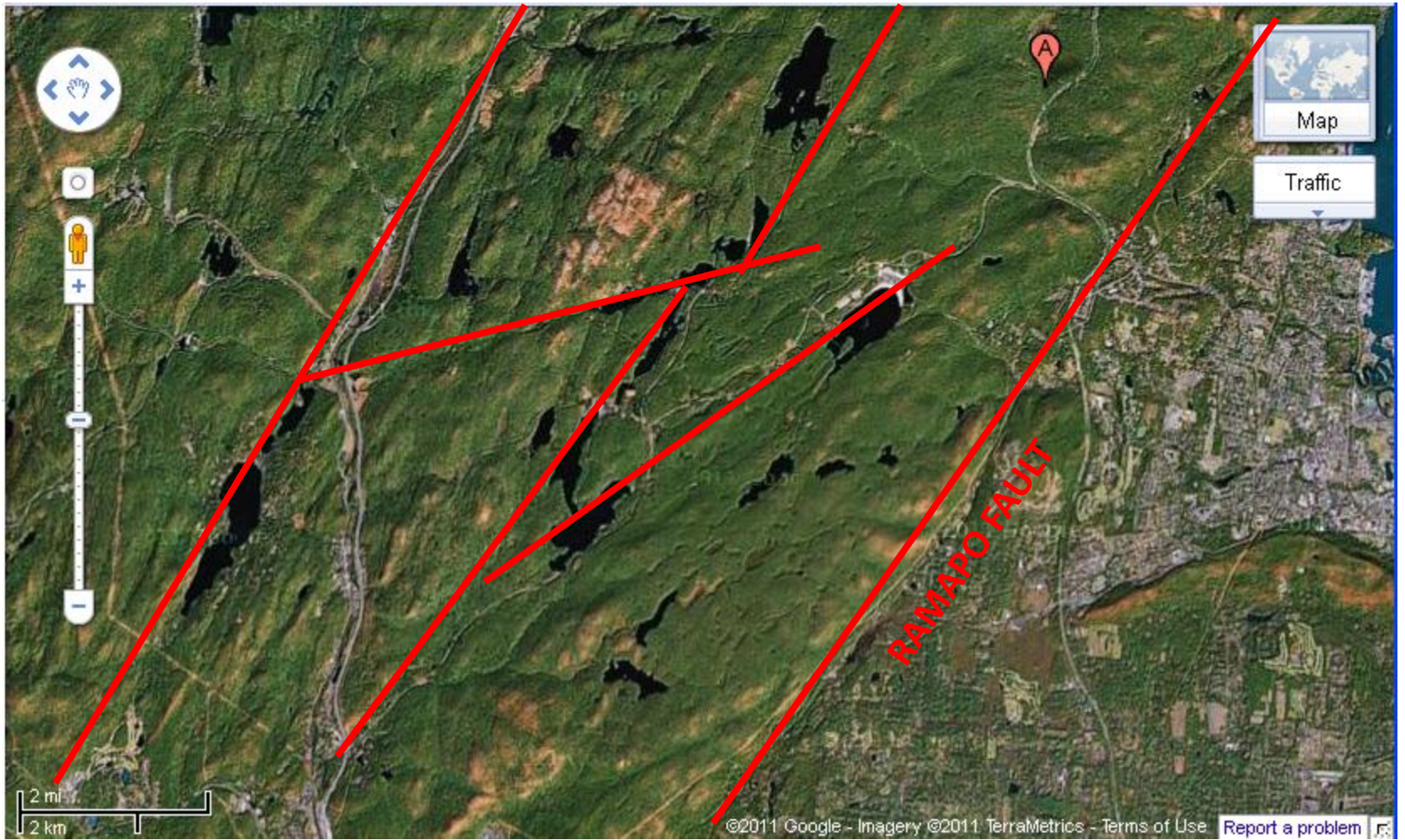
faulted rock is easily washed away

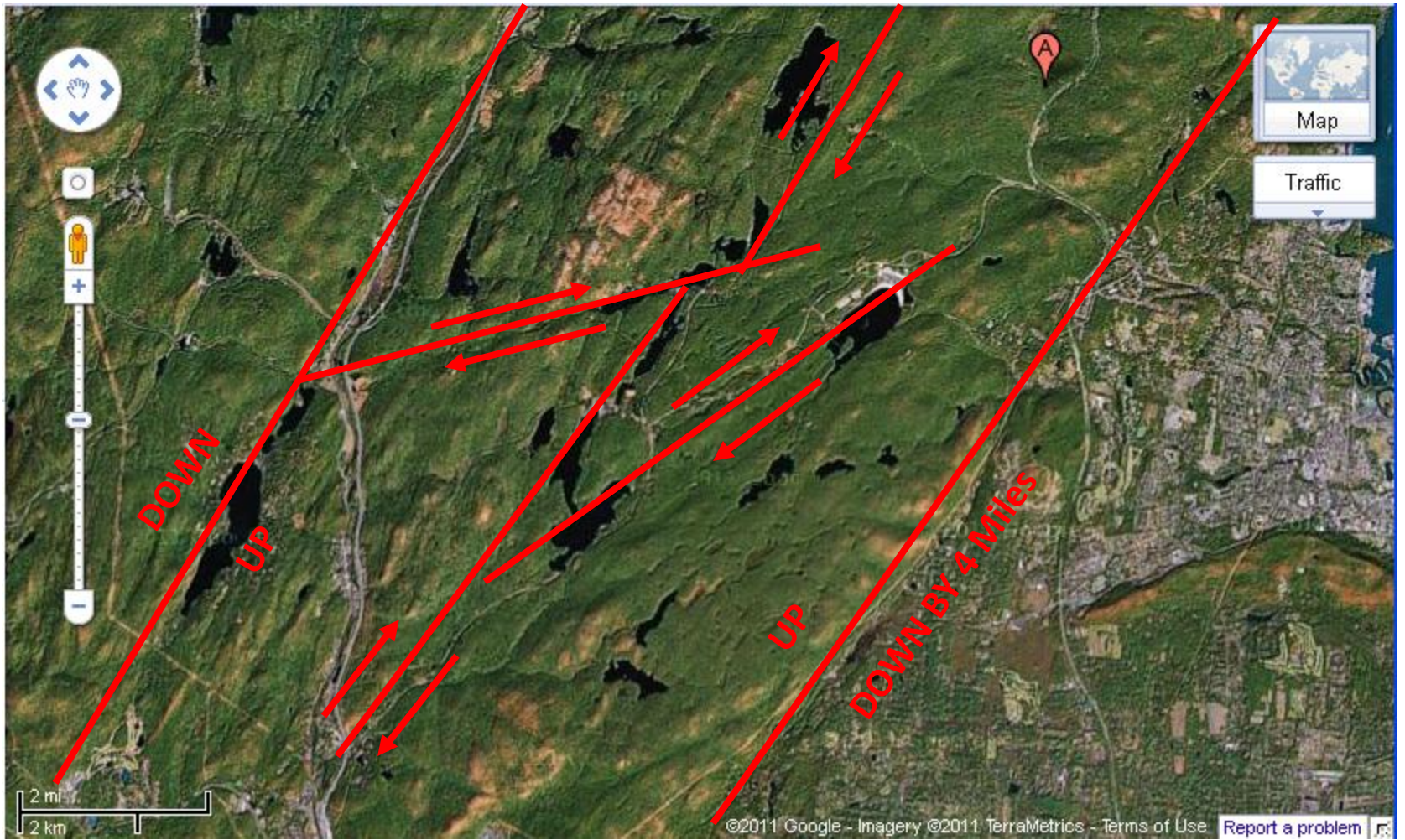
rivers often follow faults











what a fault looks like up close



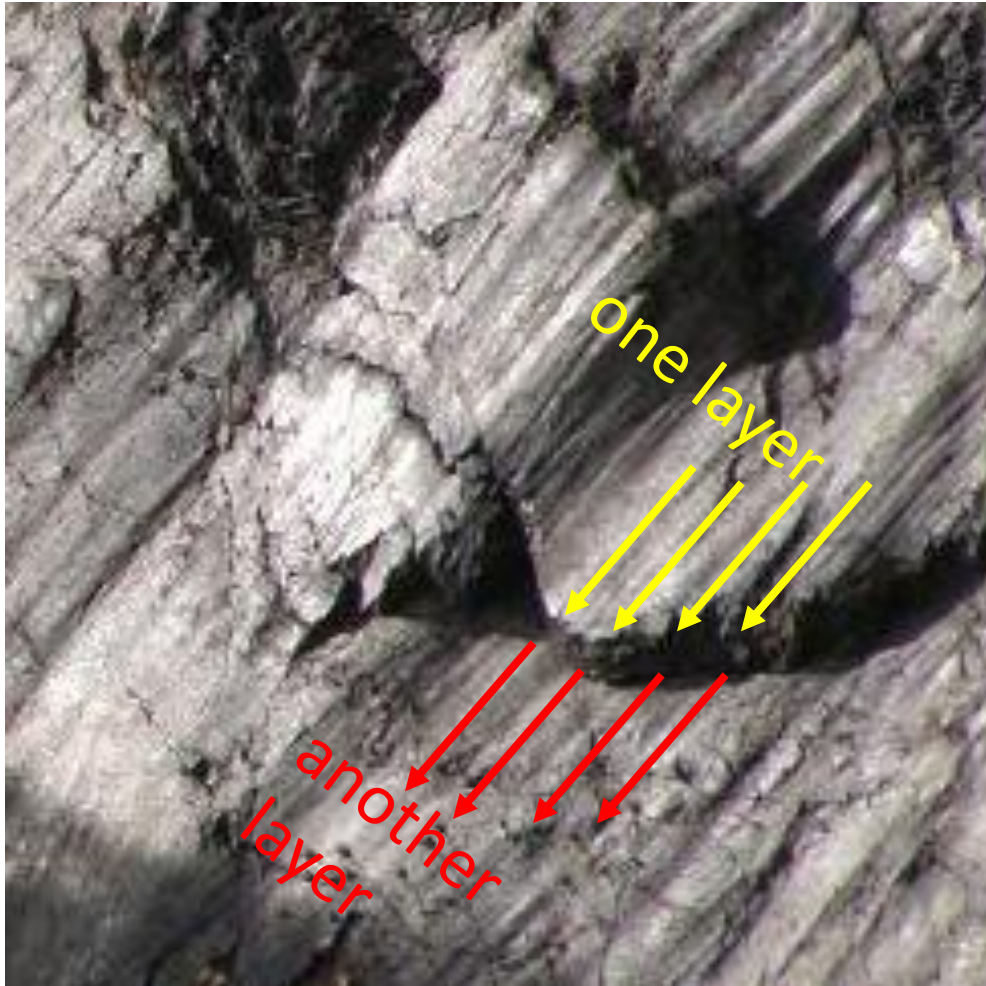
Pavilion Road, Suffern NY



slickensides = fault scratches



Note that there are multiple layers of scratches, and that some extend into the rock – they are not just on the surface



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sizes ...

length of a fault

how much it slipped

magnitude of the resulting earthquake

sizes ...

length of a fault

faults come in all lengths

how much it slipped

magnitude of the resulting earthquake

sizes ...

length of a fault

how much it slipped

usually only a portion of the fault slips

slip about  $1/10000$  of the portion's length

magnitude of the resulting earthquake

sizes ...

length of a fault

how much it slipped

magnitude of the resulting earthquake

magnitude depends on length *and* slip

tiny earthquake

1.3 mm of slip

on a fault 100 meters long and 100 meters wide

**magnitude 2.2**

moderate earthquake

1.3 meters of slip

on a fault 10 km long and 10 km wide

**magnitude 6.3**

huge earthquake

130 meters of slip

on a fault 1000 km long and 200 km wide

**magnitude 9.8**

tiny earthquake  
1/20 inch of slip  
on a fault 300 feet long and 300 feet wide  
**magnitude 2.2**

moderate earthquake  
4.3 feet of slip  
on a fault 6 mi long and 6 mi wide  
**magnitude 6.3**

huge earthquake  
500 feet of slip  
on a fault 600 mi long and 120 mi wide  
**magnitude 9.8**

# suppose the whole Ramapo Fault slipped

40 meters of slip  
on a fault 300 km long and 20 kilometers wide  
magnitude 8.4

128 feet of slip  
on a fault 185 miles long and 12 miles wide  
magnitude 8.4

very unlikely scenario now

undoubtedly happened very few centuries when that  
fault was active 220 million years ago  
in the  
Age of the Dinosaurs

still, you can see why the  
Ramapo Fault  
is a concern ...

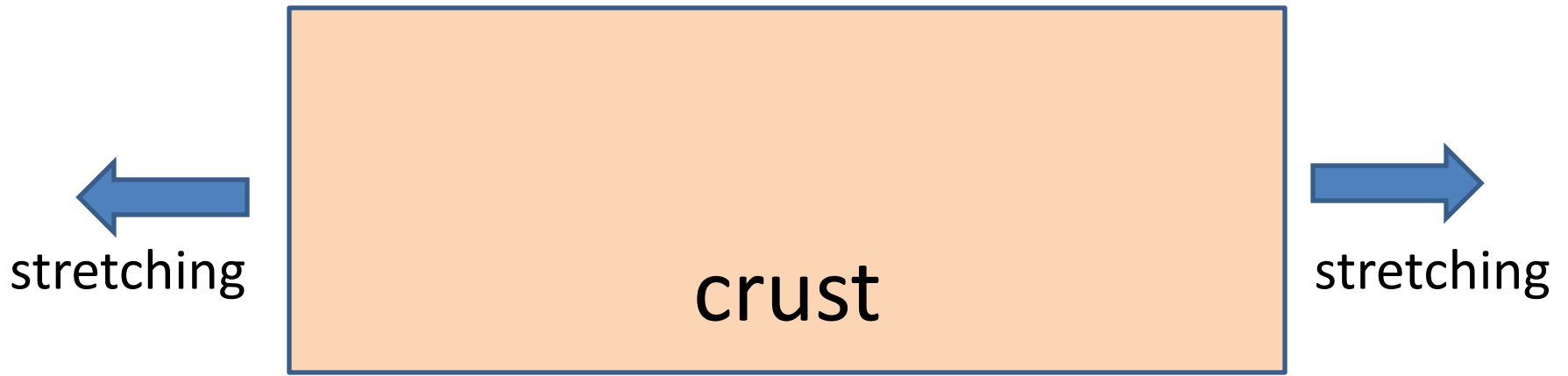
why do faults slip?

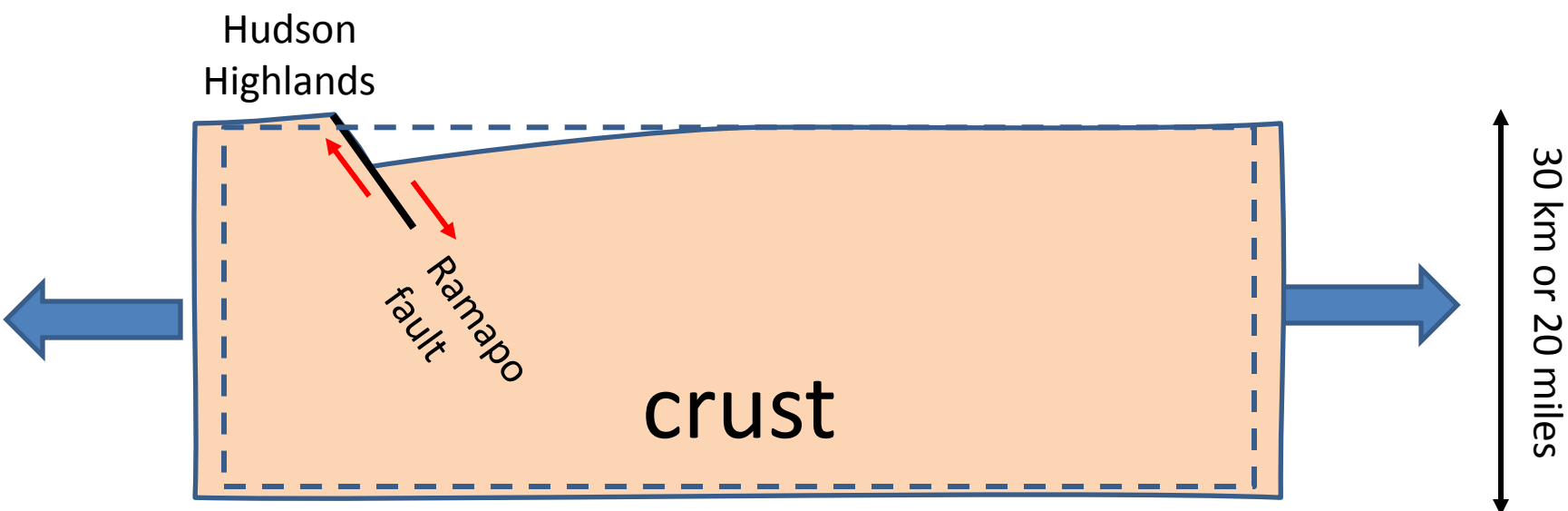
the surface of the earth is being squeezed and stretched by slow motions of the interior driven by the slow cooling of the earth

# 220 million years ago

(age of the dinosaurs)

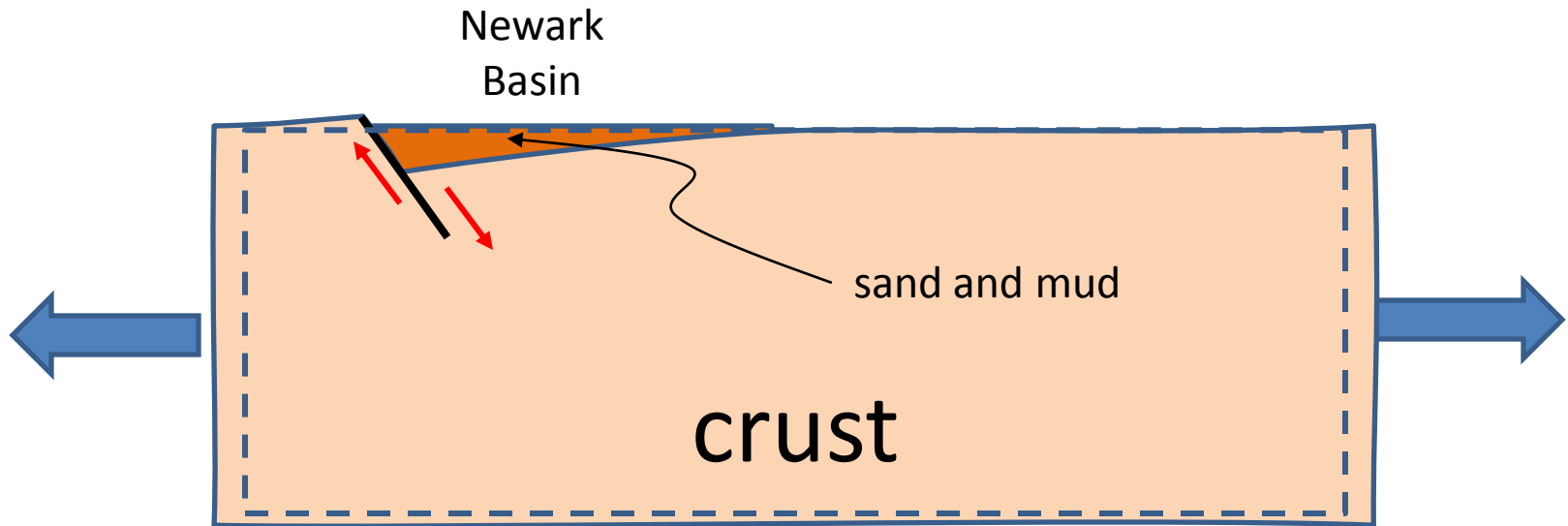
period of stretching that ultimately led to the formation of the Atlantic Ocean





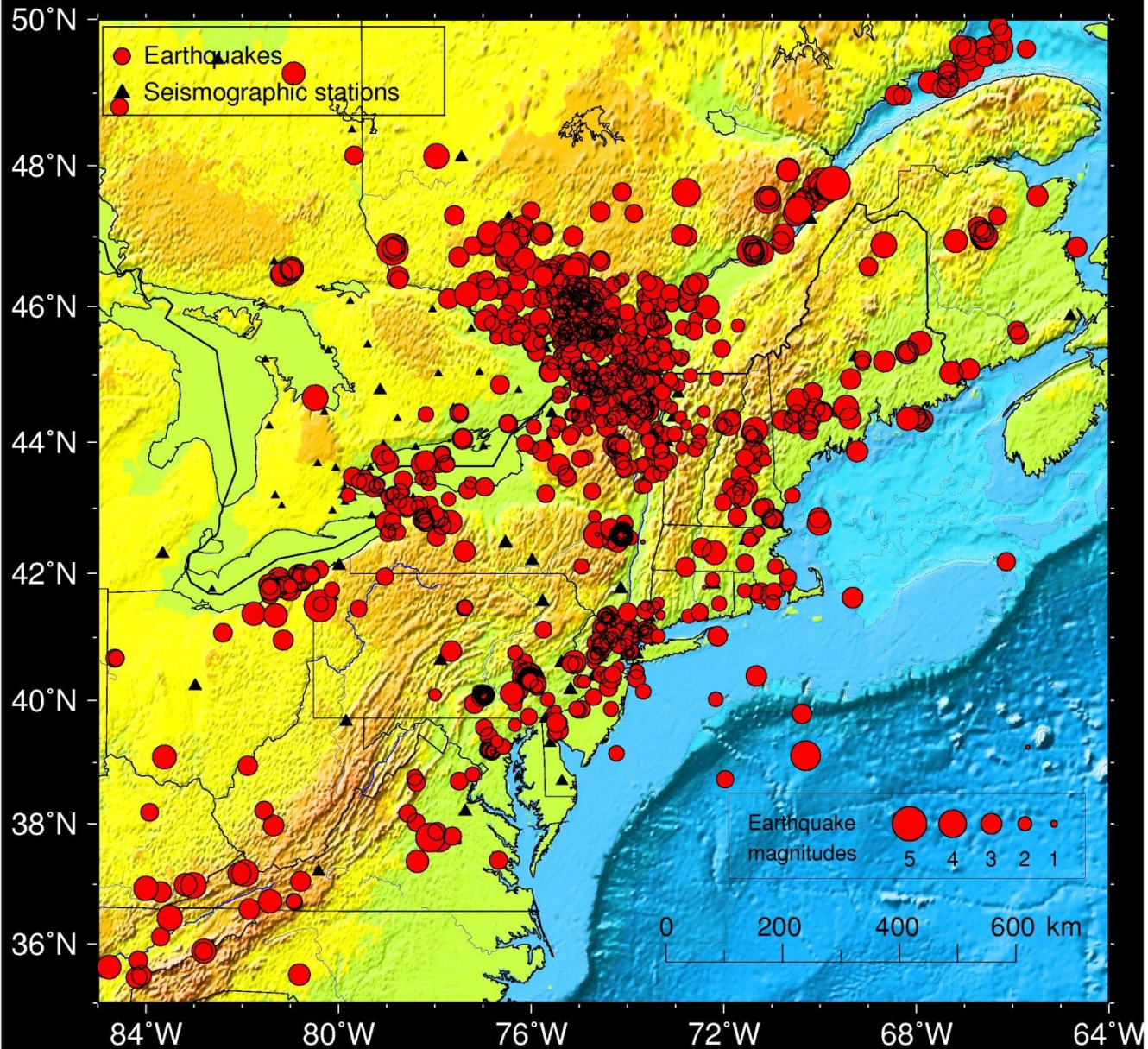
# 180 million years ago

(still the age of the dinosaurs)  
period of stretching ended



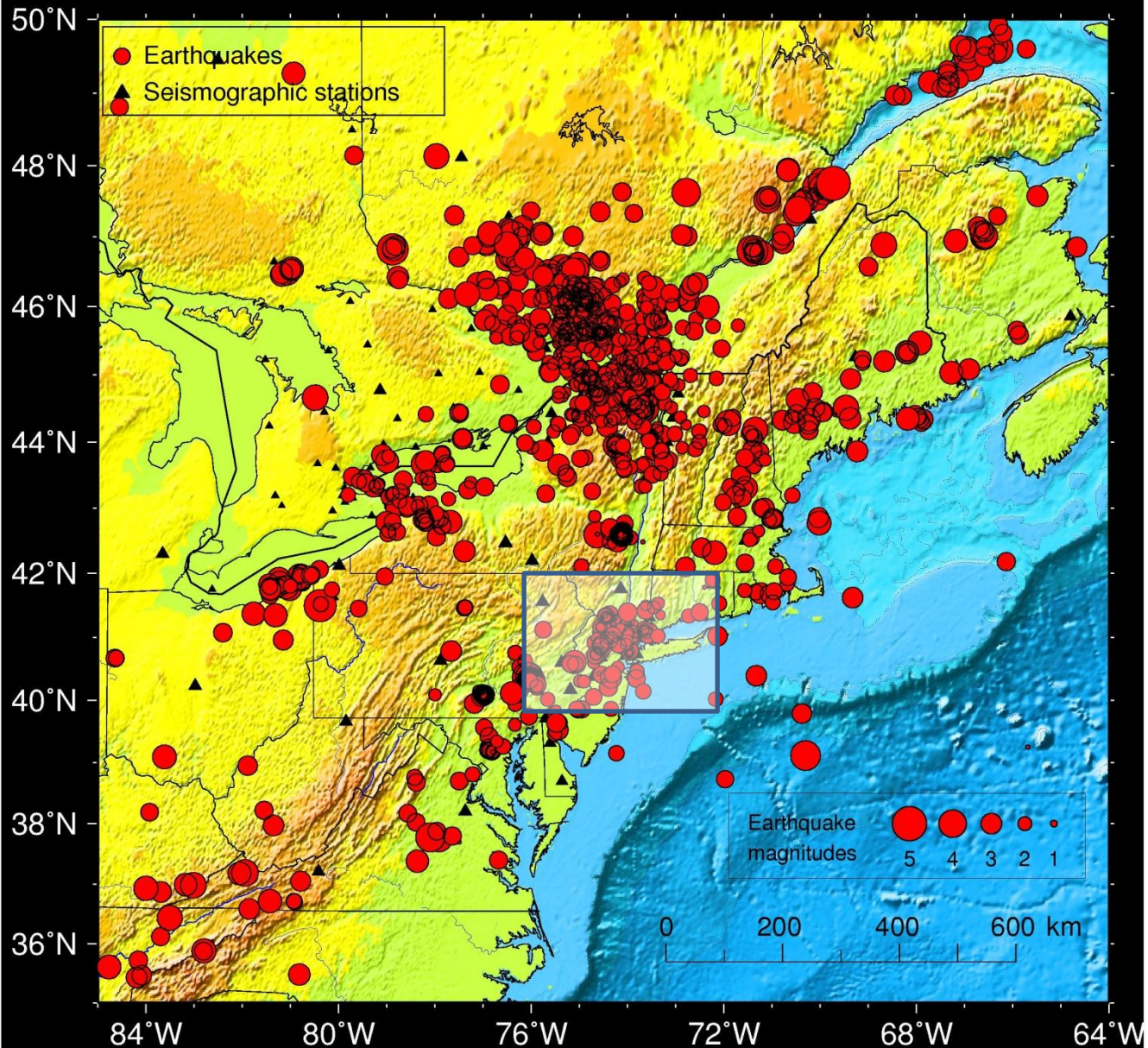
for the last 180 million years  
no major stretching or squeezing  
  
but still some minor deformation  
due to things happening far away  
and/or below us

# Earthquakes in NE United States and Canada 1990 - 2010



Earthquake locations by the Lamont Cooperative Seismographic Network, US Geological Survey and the Geological Survey of Canada.  
June 2010, Won-Young Kim, Lamont-Doherty Earth Observatory of Columbia University, <[www.ldeo.columbia.edu/LCSN](http://www.ldeo.columbia.edu/LCSN)>.

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# rate of earthquakes

magnitude	40 years	400 years	4000 years
2.0-2.9	93	1,000	10,000
3.0-3.9	10	100	1,000
4.0-4.9	1	10	100
5.0 to 5.9		1	10
6.0 to 6.9			1




observed



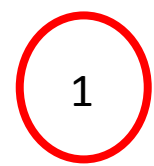
predicted

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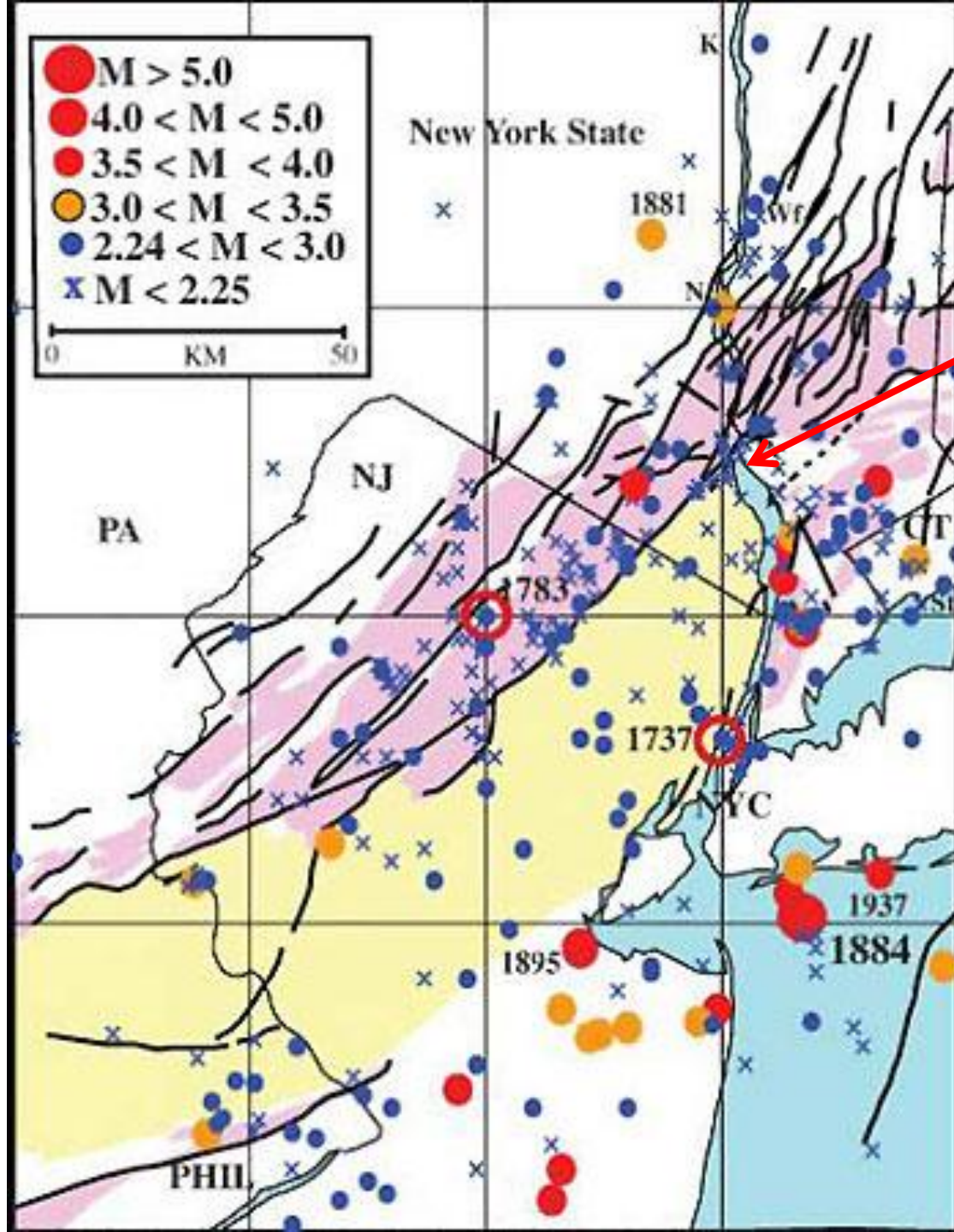
  
observed

  
predicted



this is the one  
that will cause  
real damage





Indian Point

end of the ice age – 20,000 years ago



smooth surfaces  
should be easy to detect fault offset





precariously  
perched  
glacial  
boulders

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could be used to  
place a limit on  
the amount of  
shaking

no evidence (yet) for really big  
earthquake  
in the last 20,000 years  
anywhere in the Harriman Park Area

*but we haven't looked very hard so far*