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.

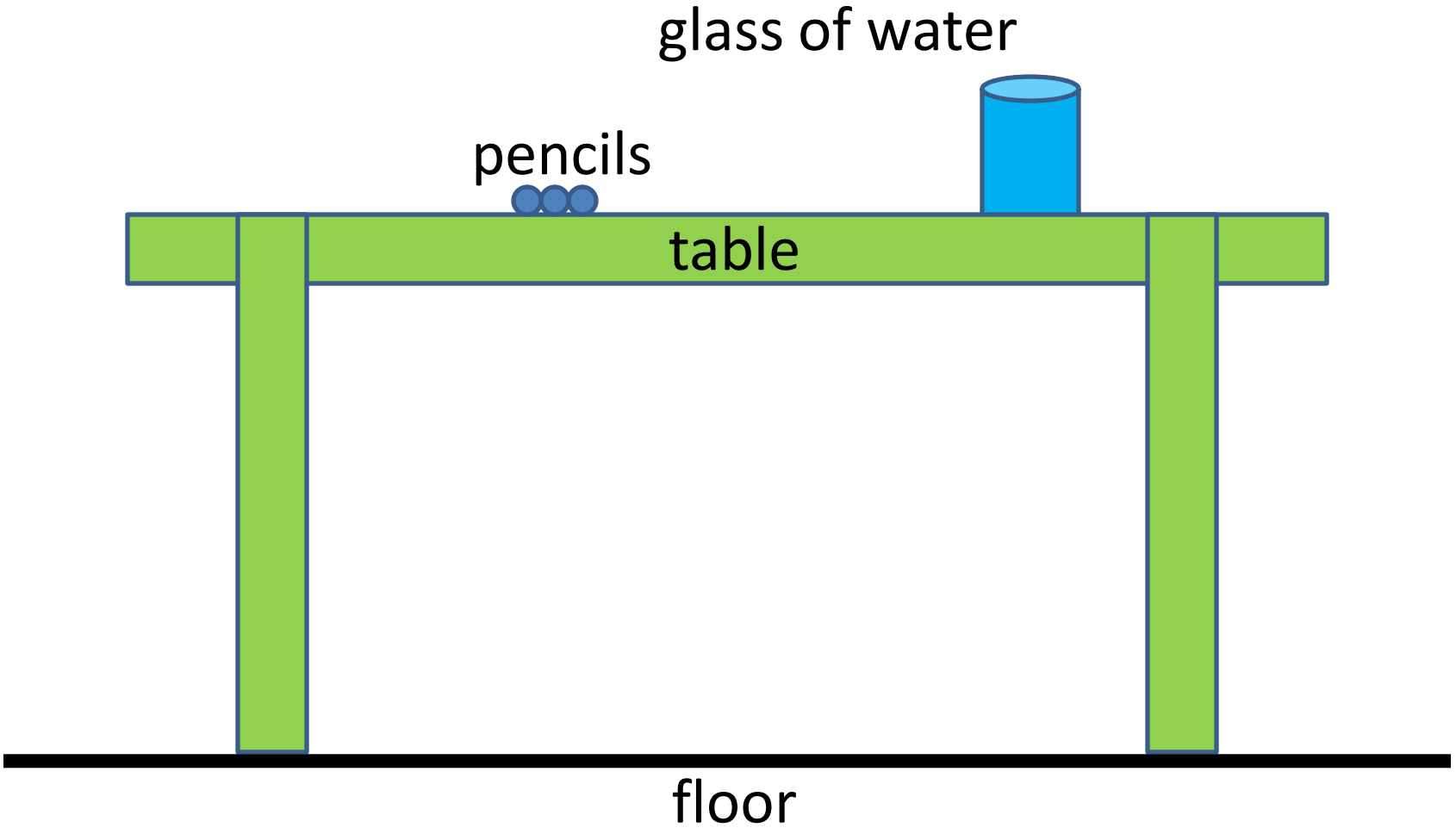
"I was upstairs on my computer, and **all of a sudden I hear a boom, boom, boom**, then a bang, bang, bang. My monitor almost fell off of my computer desk," said resident Stephen Garcia. "So I immediately went downstairs to check on my grandma and ask her if she was alright or if she fell."

earthquake = shaking of the ground

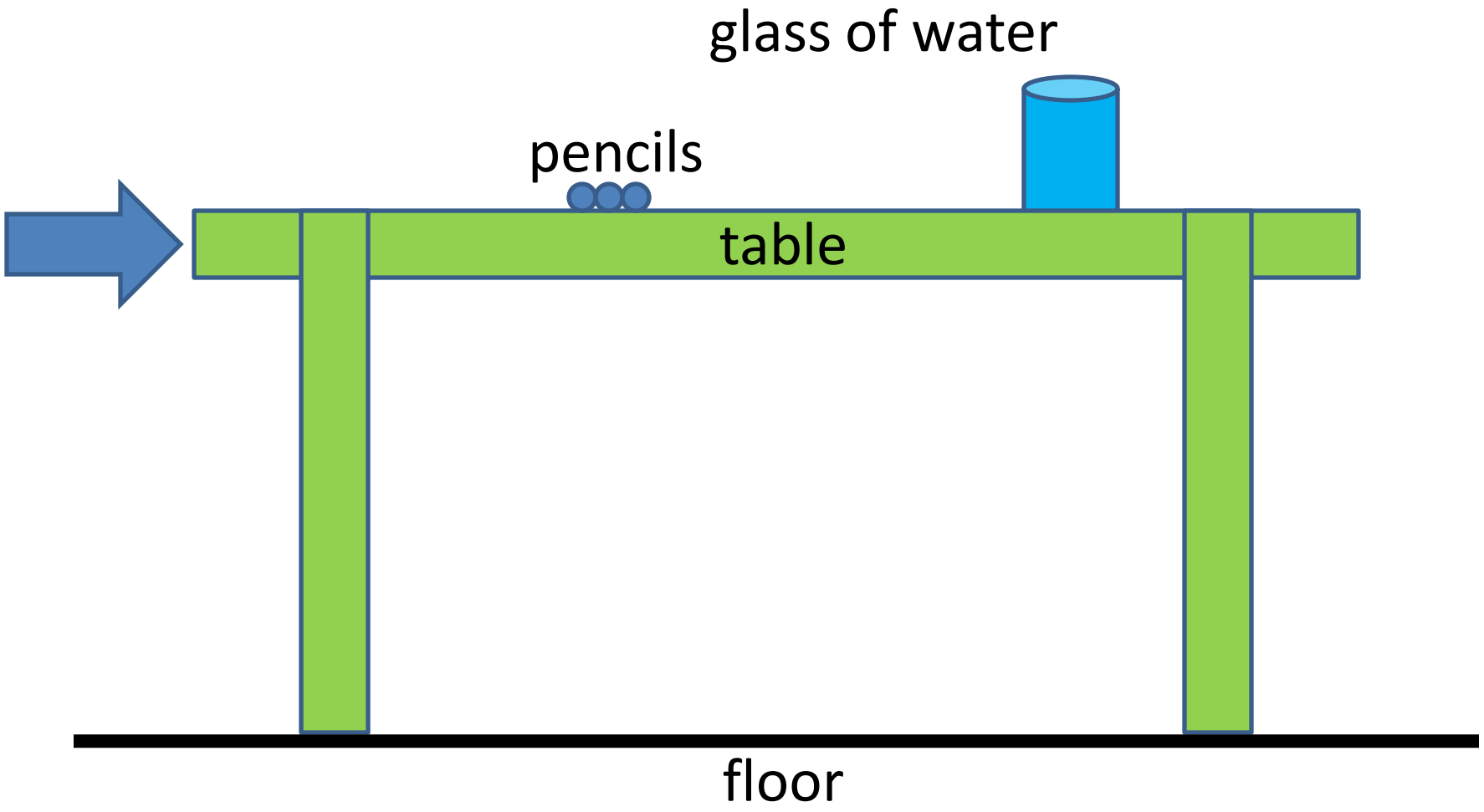
due to slip on a fault

fault = crack in the ground

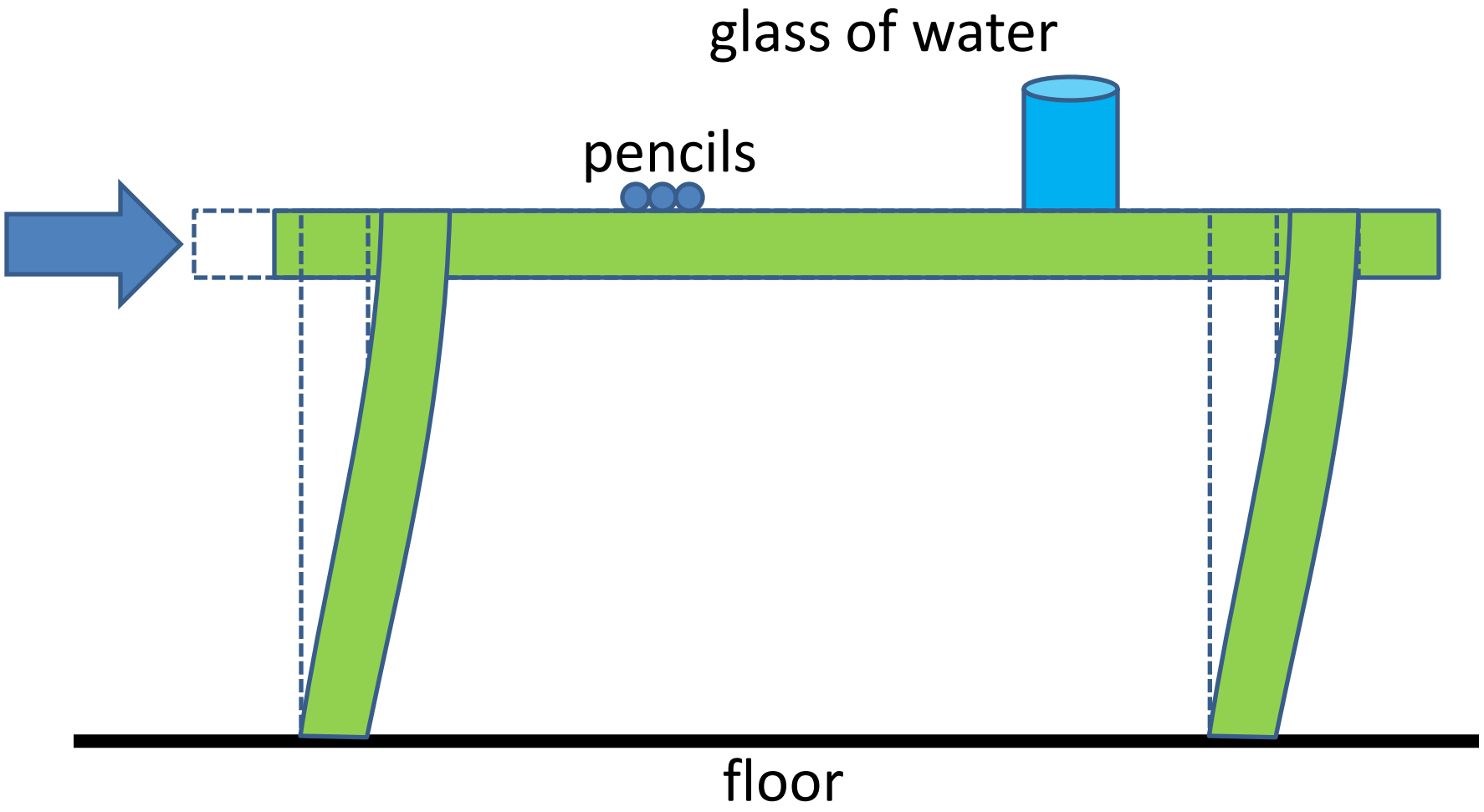
across which motion occurs


glass of water
pencils
table
floor

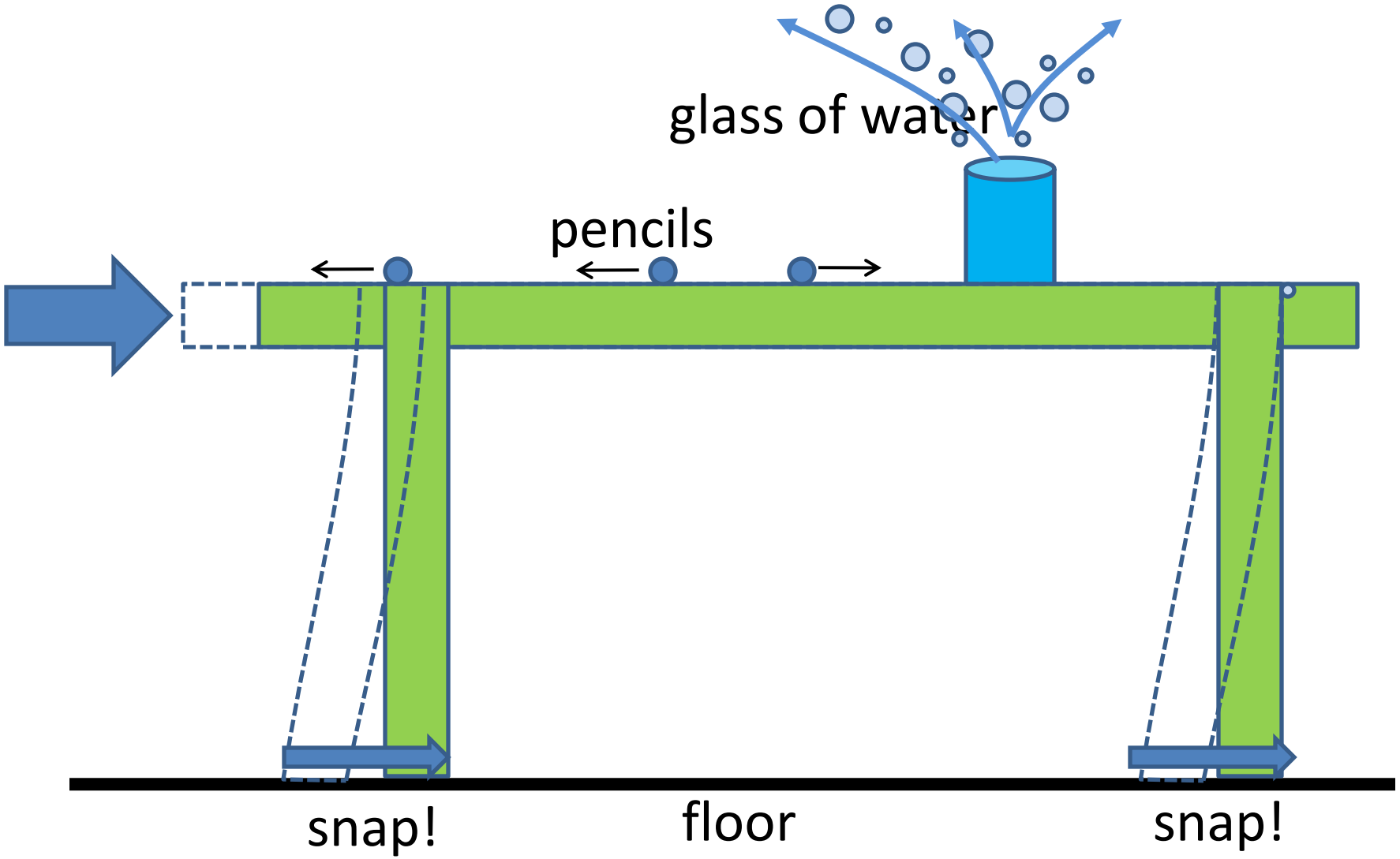
push the table

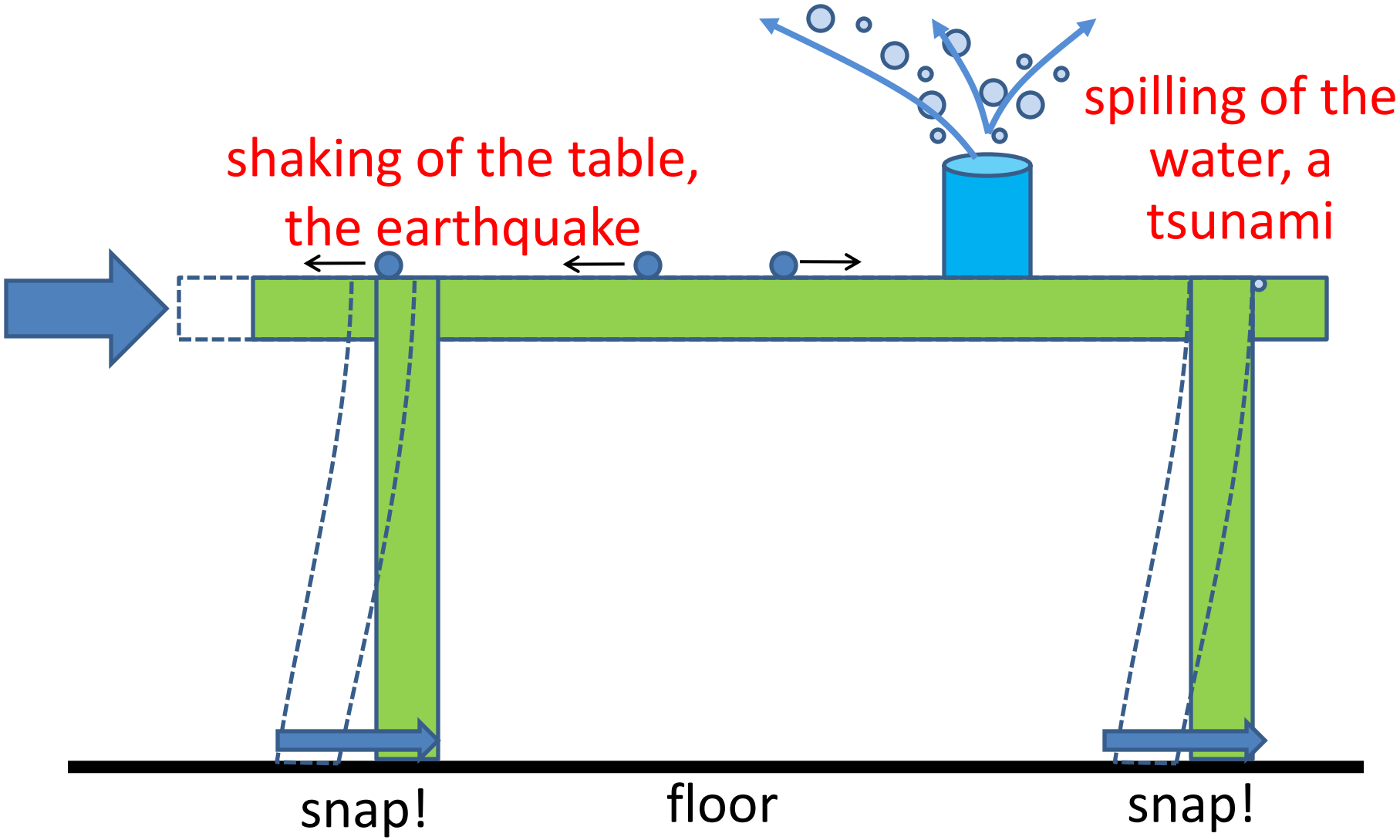


the legs slowly bend



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

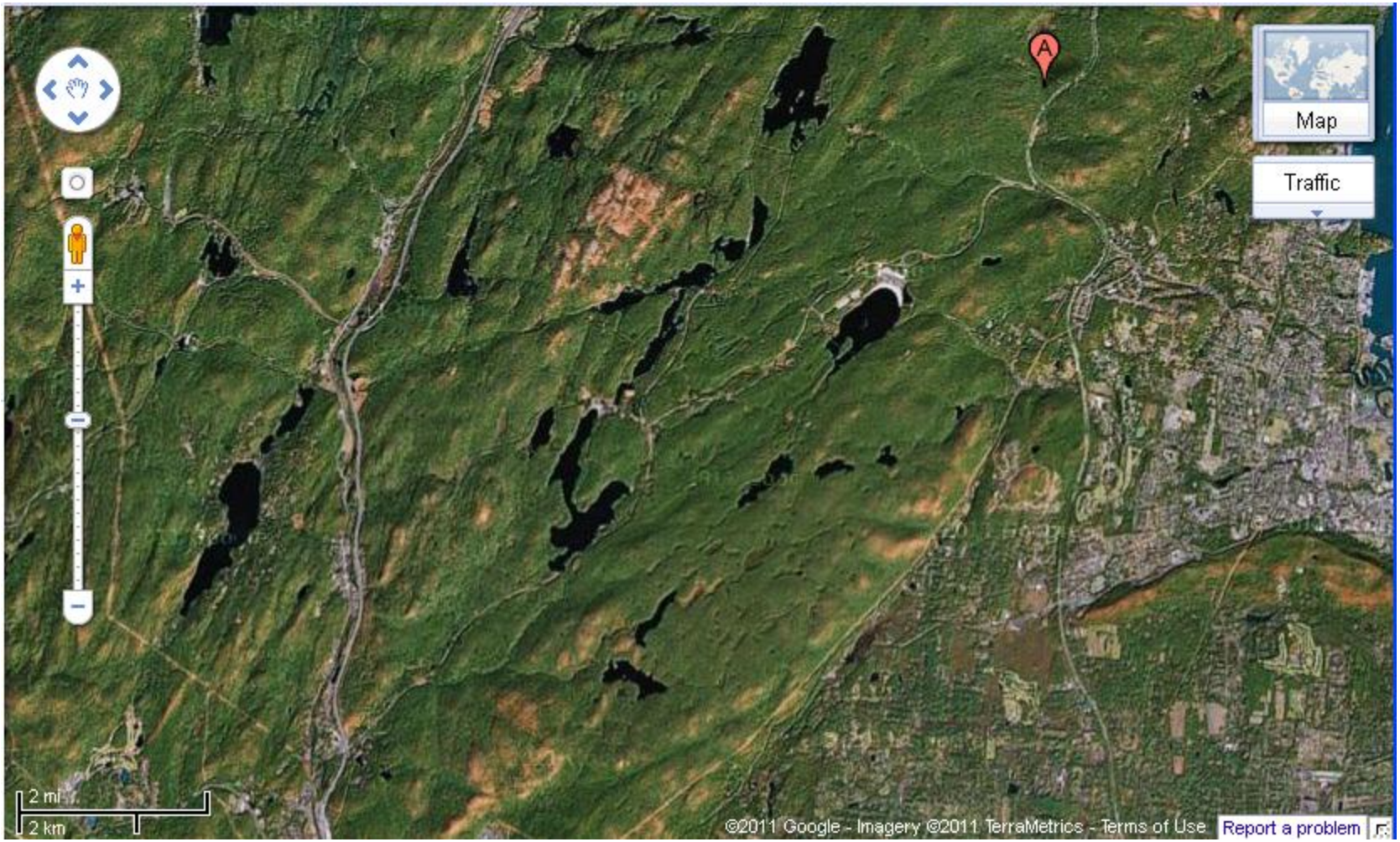
a fault never goes away unless the rock is heated almost to its melting point

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


A
Map
Traffic
2 mi
2 km
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Report a problem


Lake Tiorati
Lake Welch
Stony Point
Tuxedo Park
ACA
Pomona
Sloatsburg
Map
Traffic
2 mi
2 km
©2011 Google - Imagery ©2011 TerraMetrics - Terms of Use
Report a problem


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Map
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Report a problem


A
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RAMAPO FAULT
2 mi
2 km
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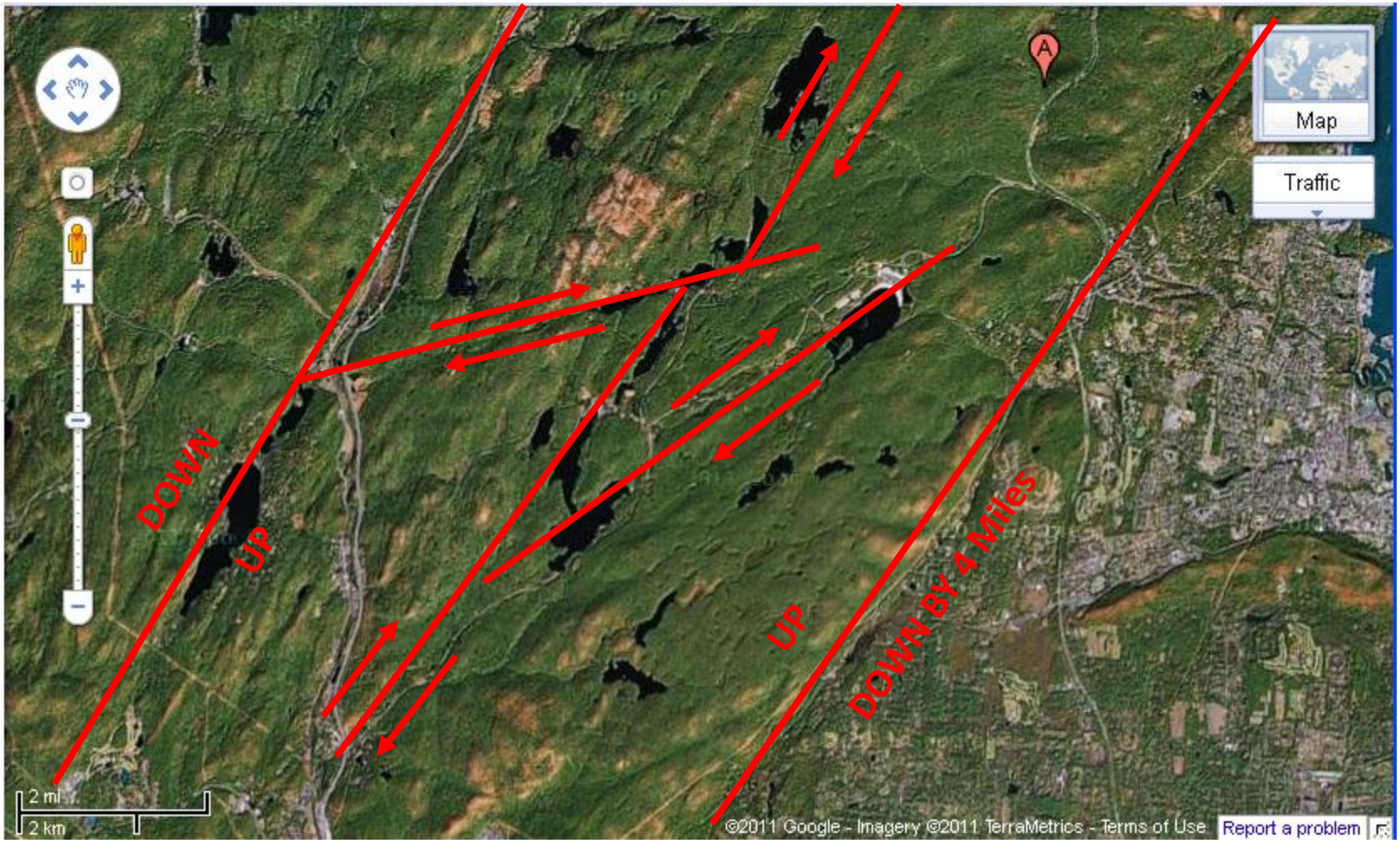
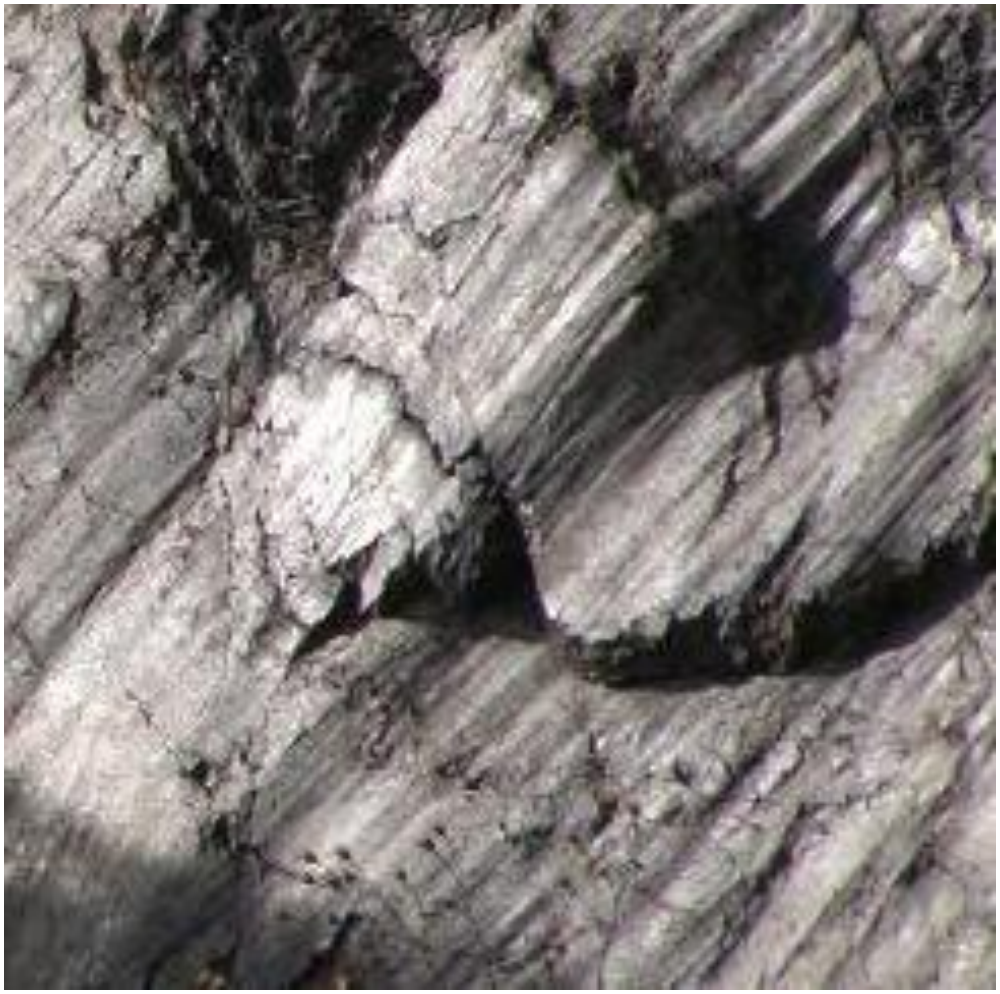
Report a problem


DOWN
UP
UP
DOWN BY 4 Miles
Map
Traffic
2 mi
2 km
©2011 Google - Imagery ©2011 TerraMetrics - Terms of Use
Report a problem

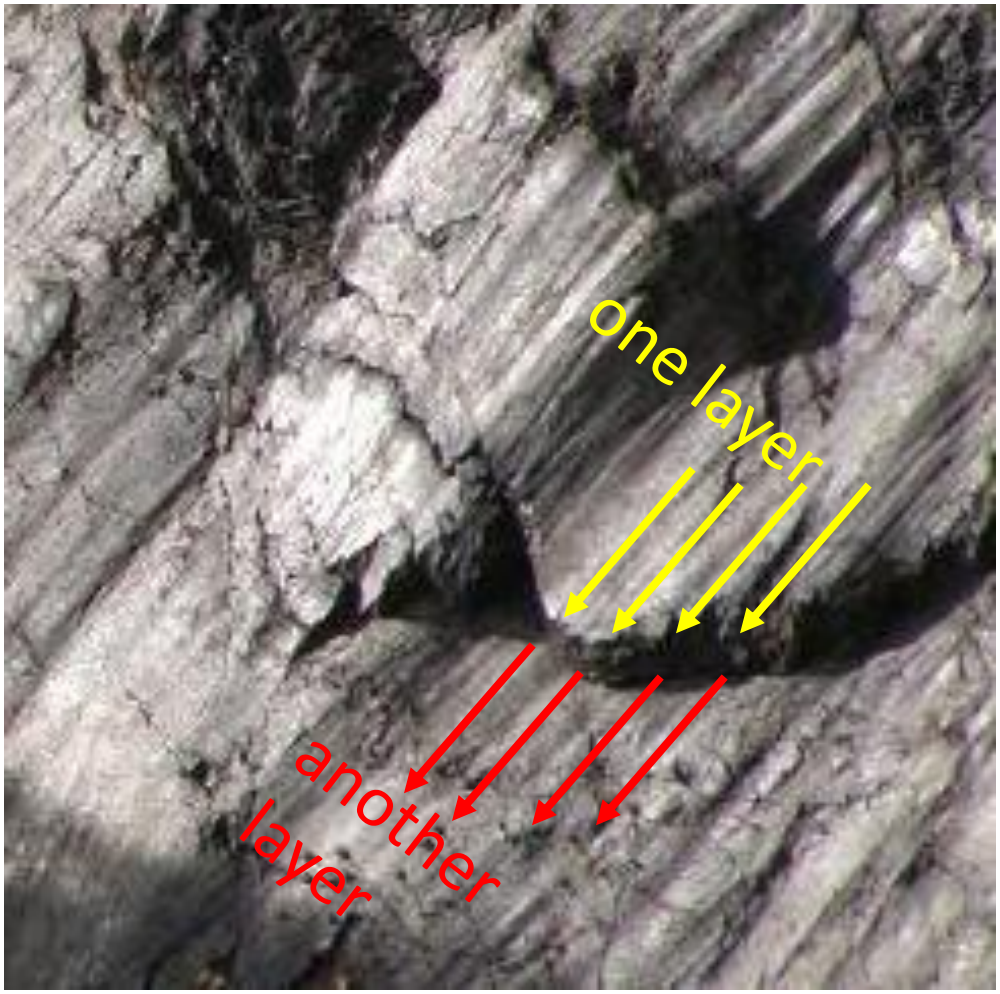
what a fault looks like up close


Pavilion Road, Suffern NY


slickenslides = 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 …

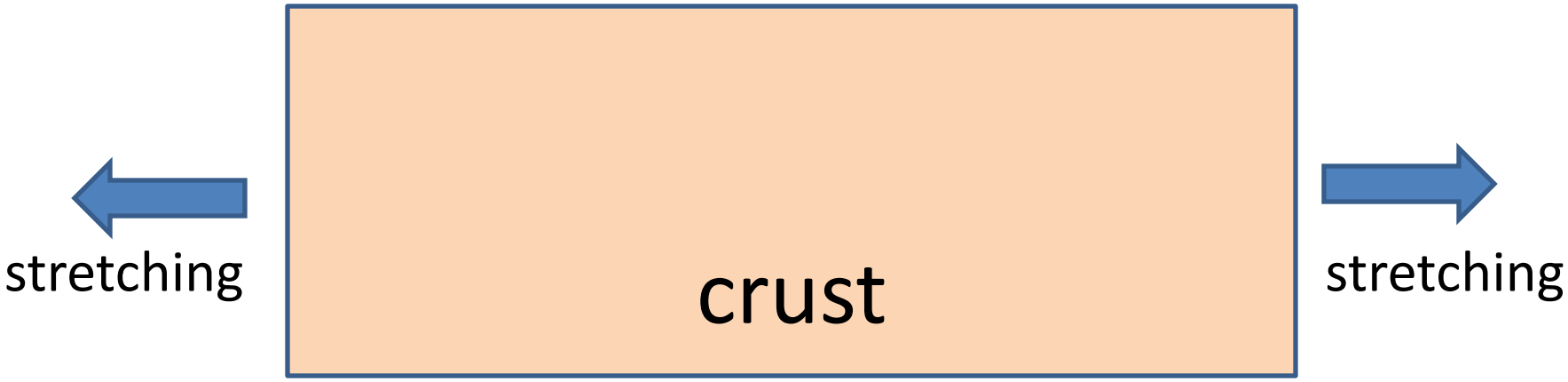
why do faults slip?

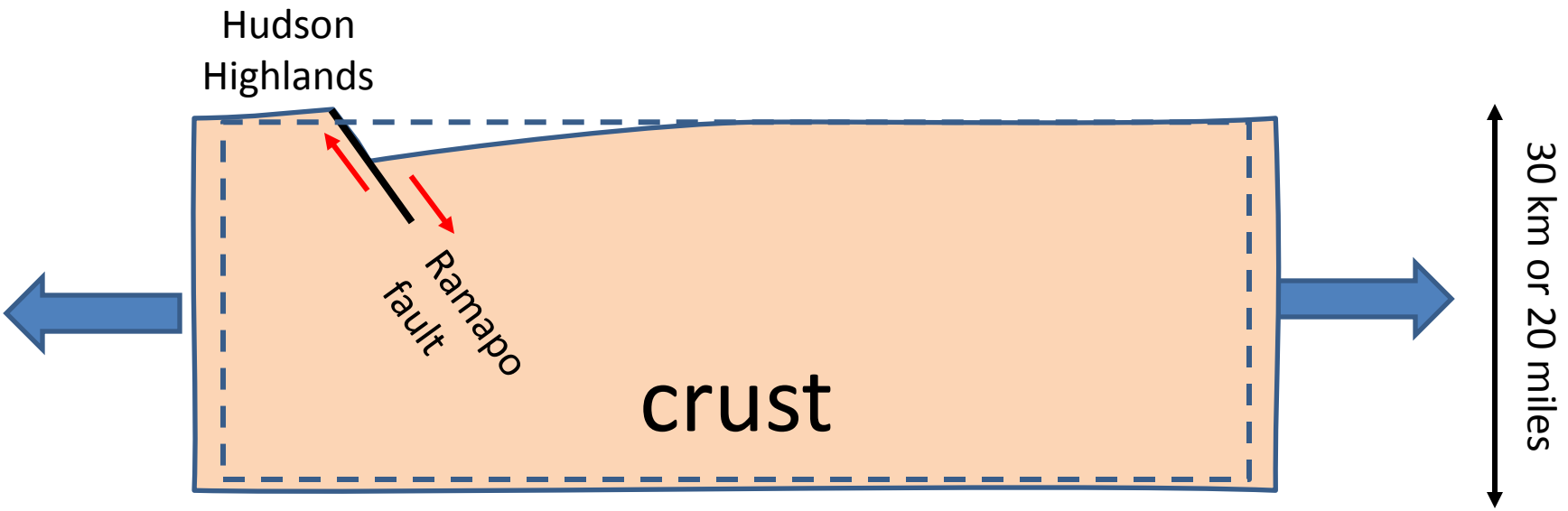
the surface of the earth is being squeezed and stretched by slow motions of the interior driven by the slow cooling of the earth

220 million years ago

(age of the dinosaurs)

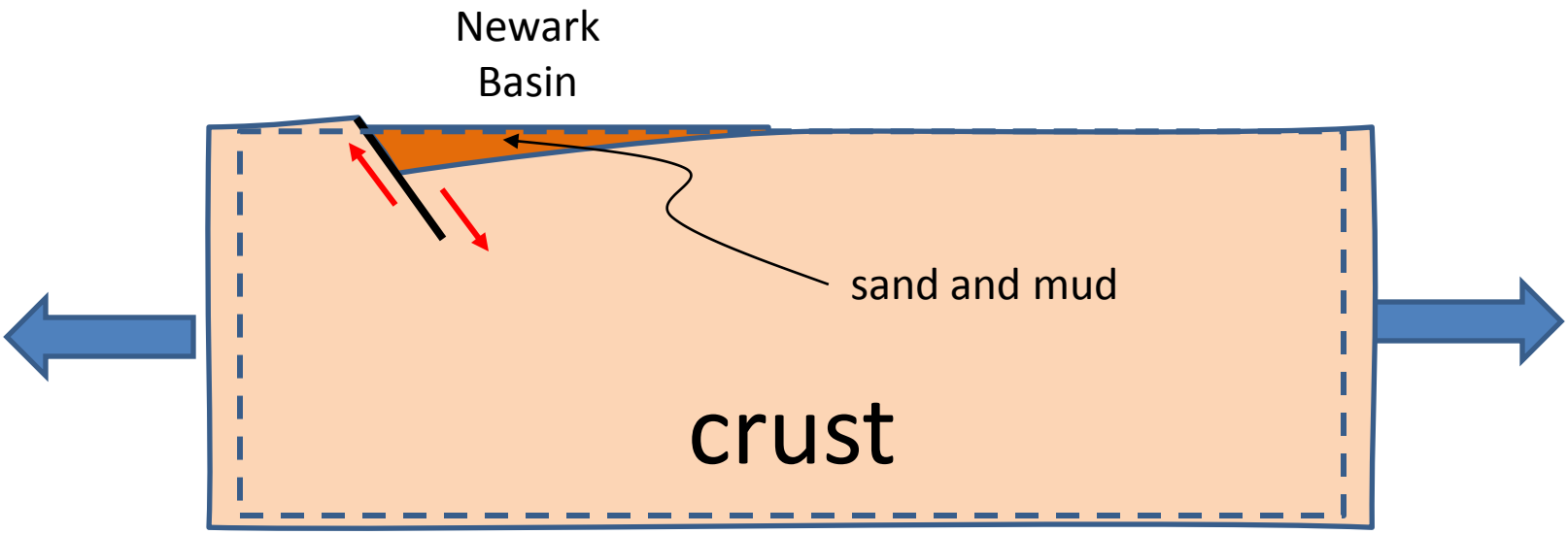
period of stretching that ultimately led to the formation of the Atlantic Ocean




Hudson
Highlands
Ramapo
fault
crust
30 km or 20 miles

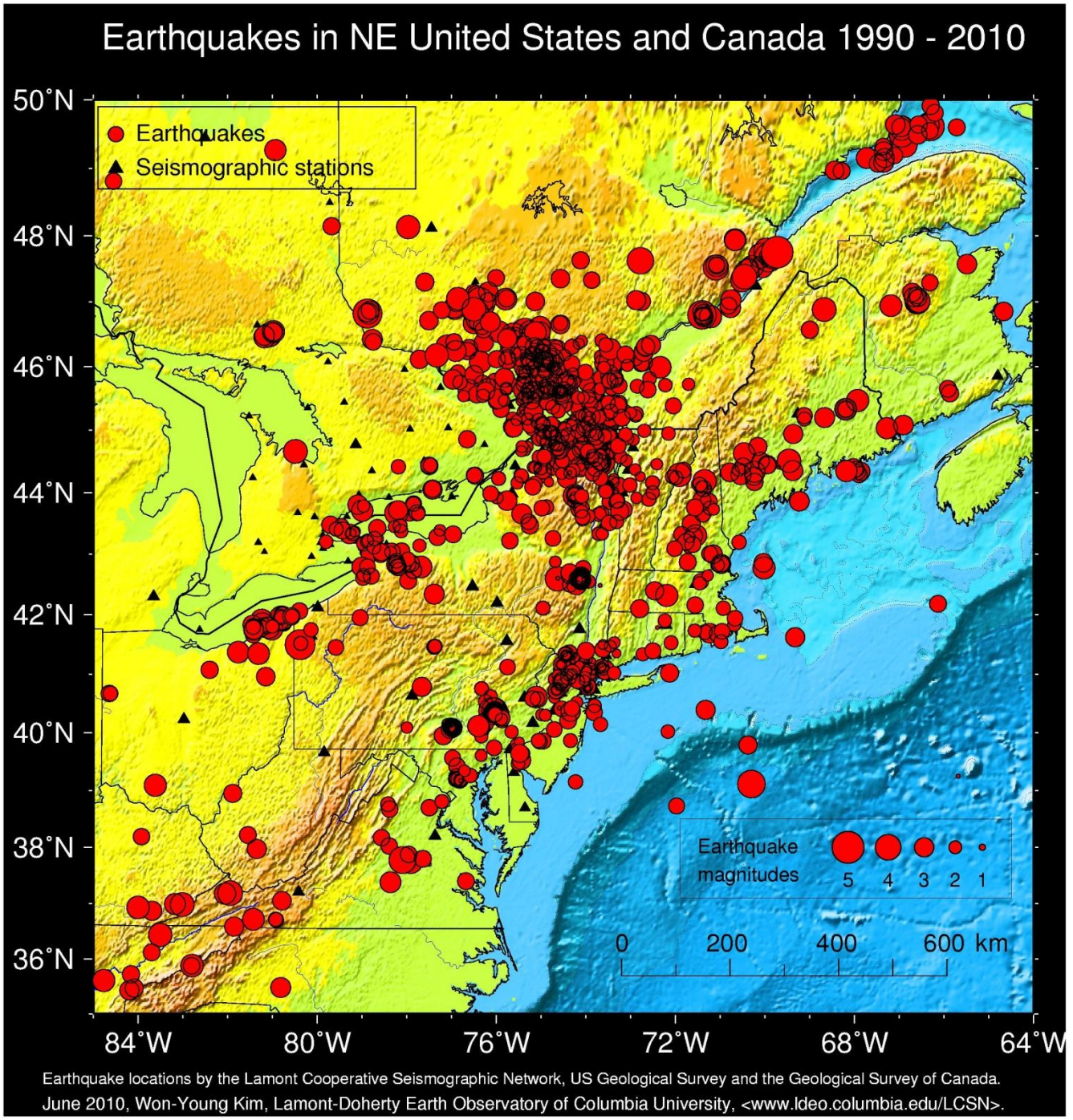
180 million years ago

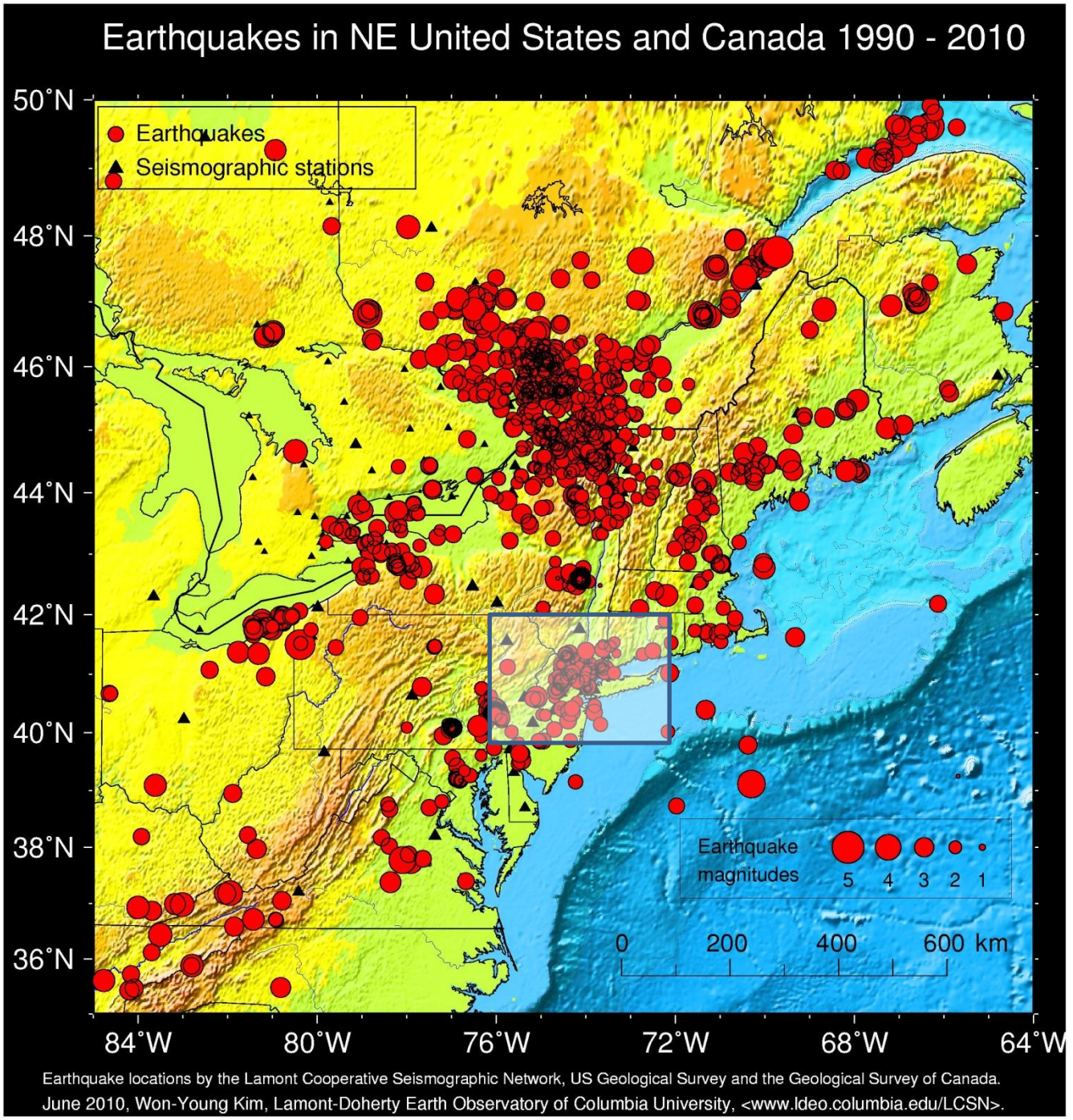
(still the age of the dinosaurs)
period of stretching ended



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
Earthquakes
Seismographic stations
50°N
48°N
46°N
44°N
42°N
40°N
38°N
36°N
84°W
80°W
76°W
72°W
68°W
64°W
Earthquake magnitudes
5 4 3 2 1
0 200 400 600 km
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>.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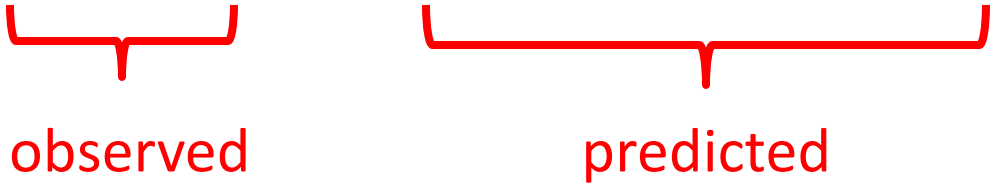
rate of earthquakes

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



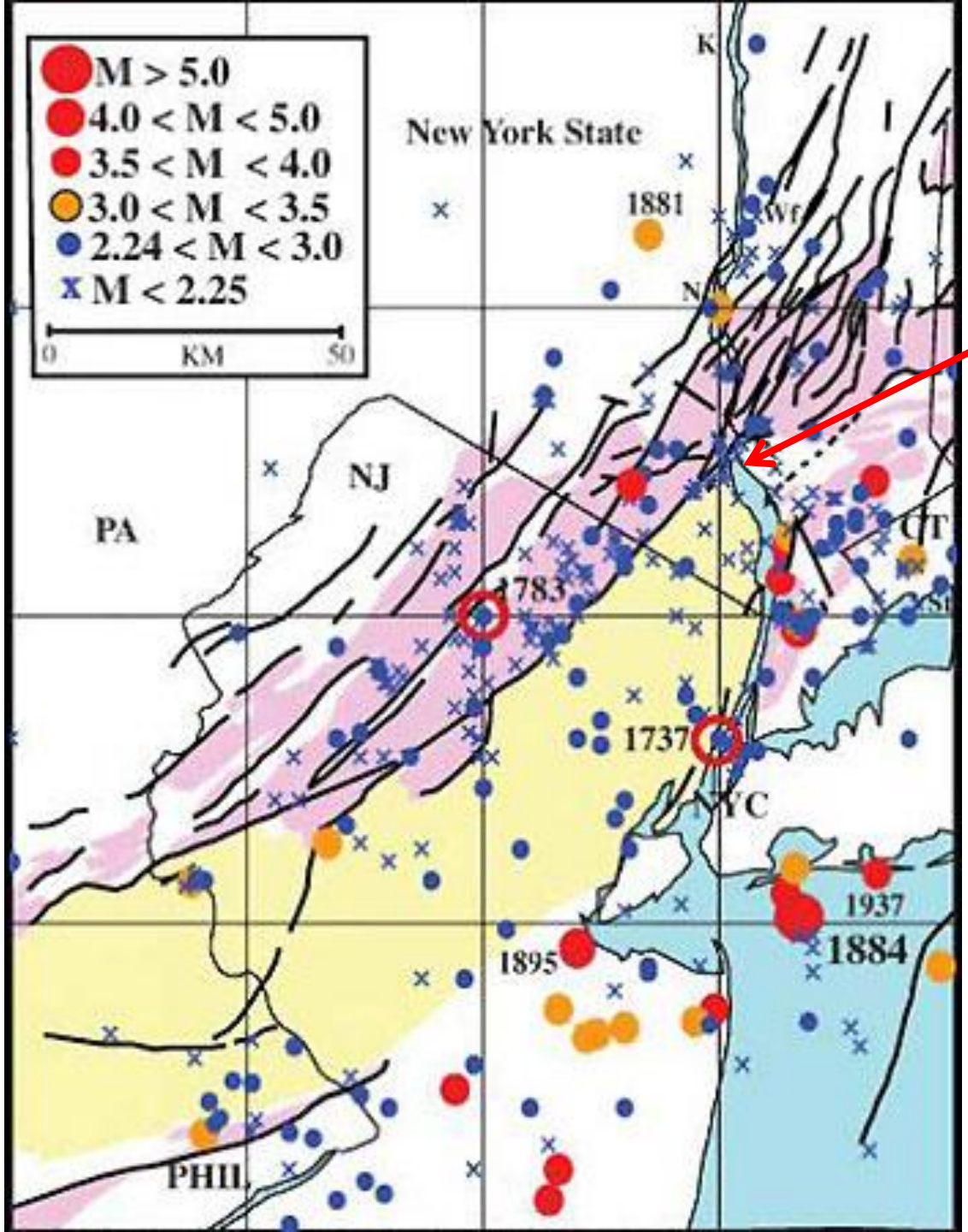
rate of earthquakes

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

this is the one that will cause real damage

observed

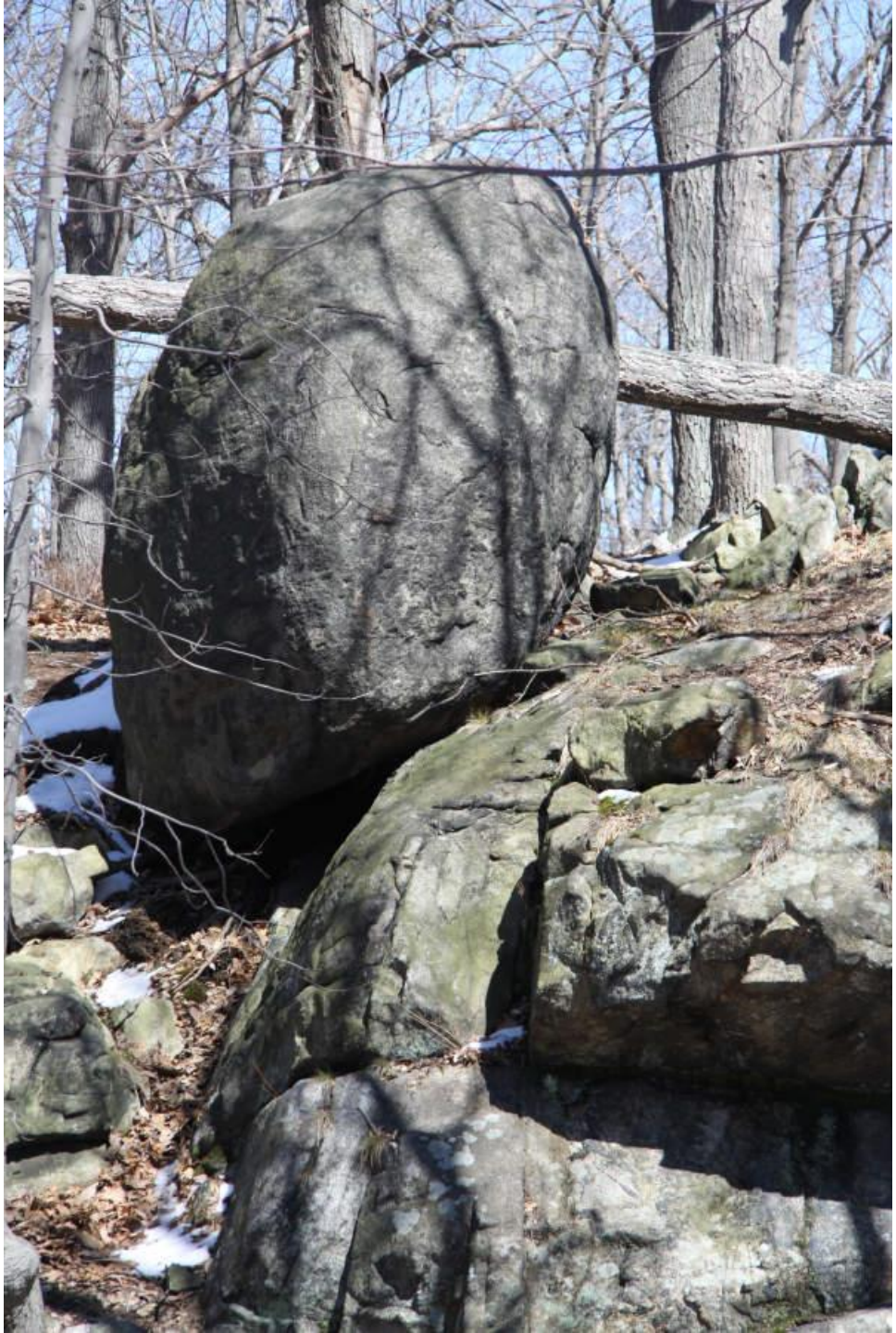
predicted


M > 5.0
4.0 < M < 5.0
3.5 < M < 4.0
3.0 < M < 3.5
2.24 < M < 3.0
M < 2.25
0
KM
50
New York State
1881
NJ
PA
1783
1737
NYC
1937
1884
1895
PHIL
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