



New York City Earthquakes - Can It Happen There?

Charles Merguerian

**Duke Geological Lab
Stone Ridge, NY**





A New York City Earthquake When Will it Happen There?

1737 **5.2**

1783 **4.9**

1884 **5.2**

2031 **?**

EARLY MEDIAL ORDOVICIAN

(Early Chazyan)

PALEOGEOGRAPHY

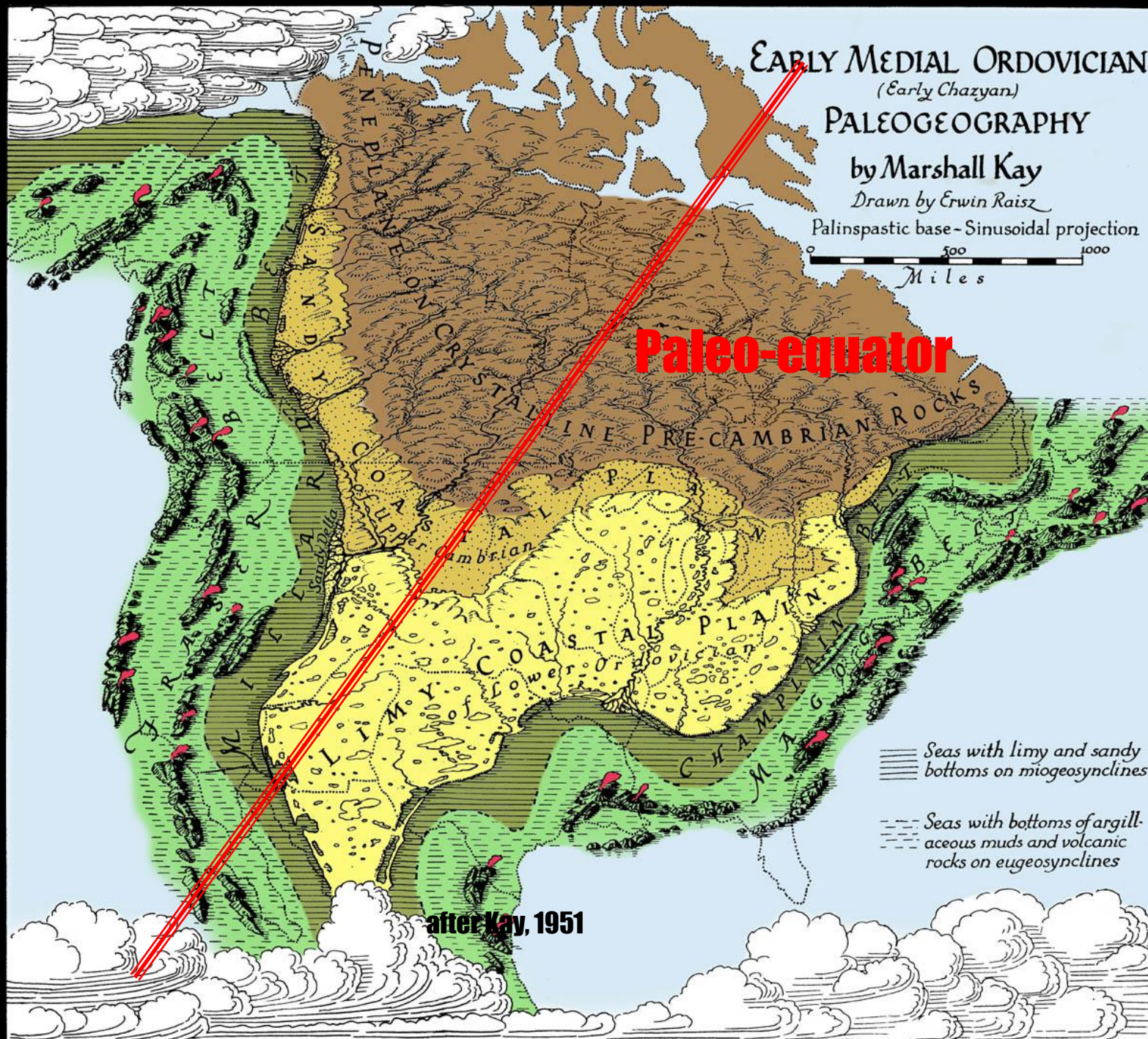
by Marshall Kay

Drawn by Erwin Raisz

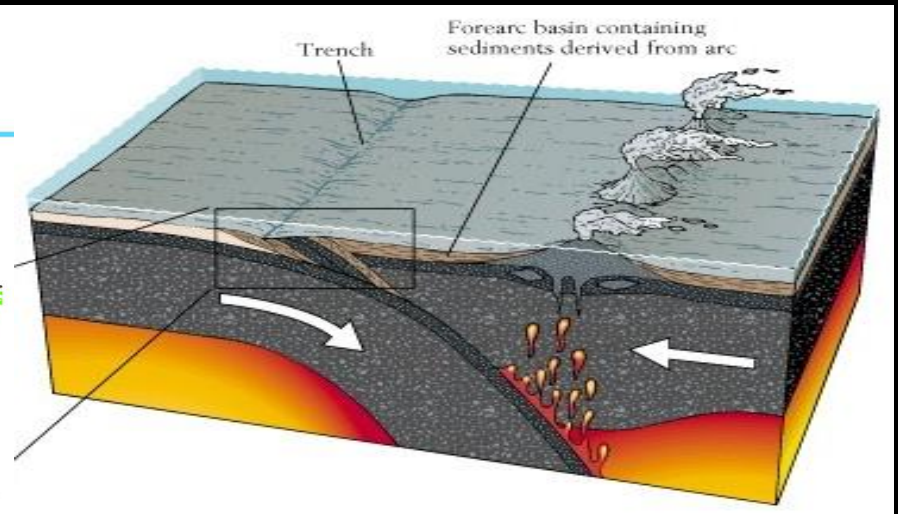
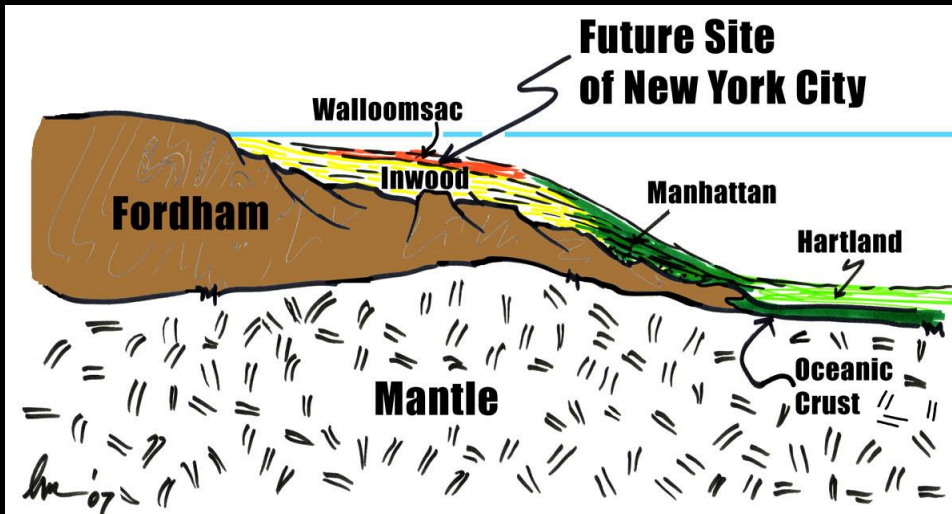
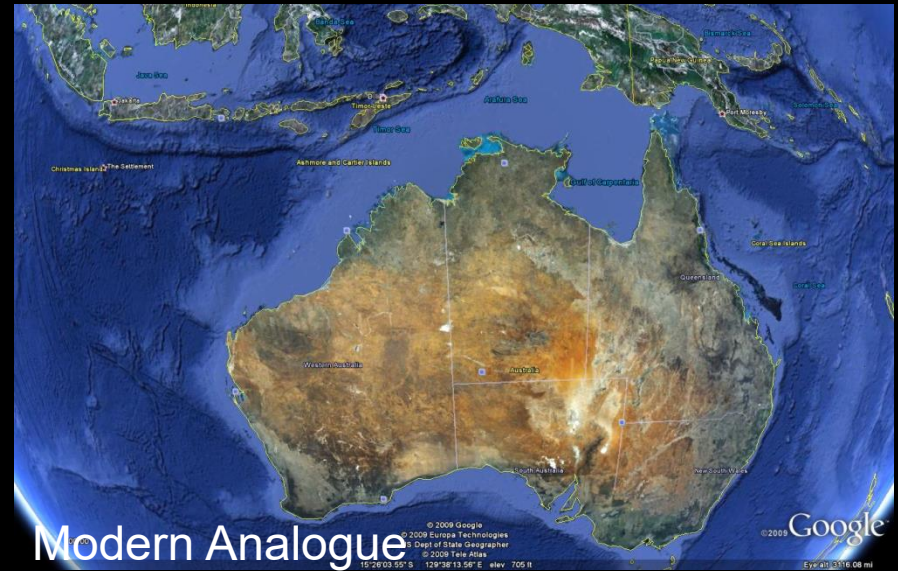
Palinspastic base - Sinusoidal projection

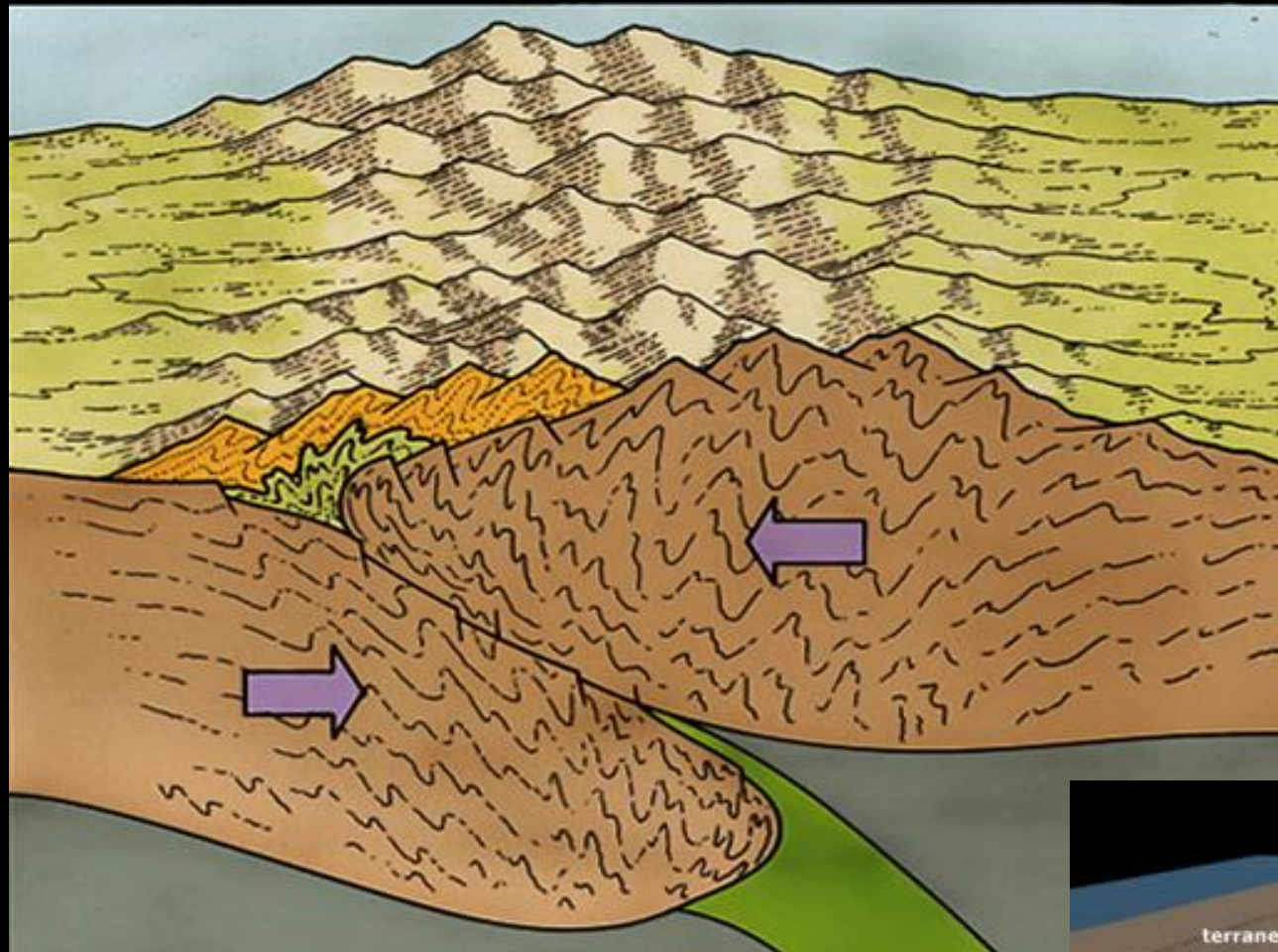
0 500 1000
Miles

Paleo-equator



~ 450 Ma Taconian Arc – Passive Margin Collision

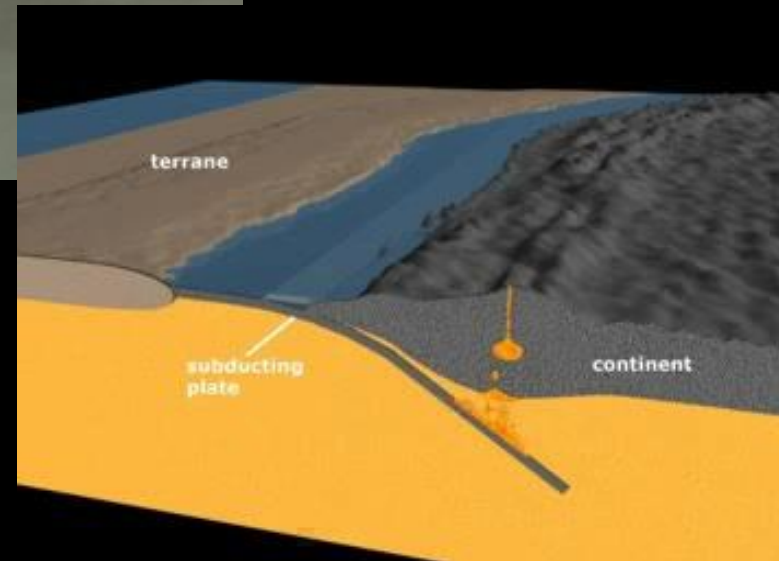


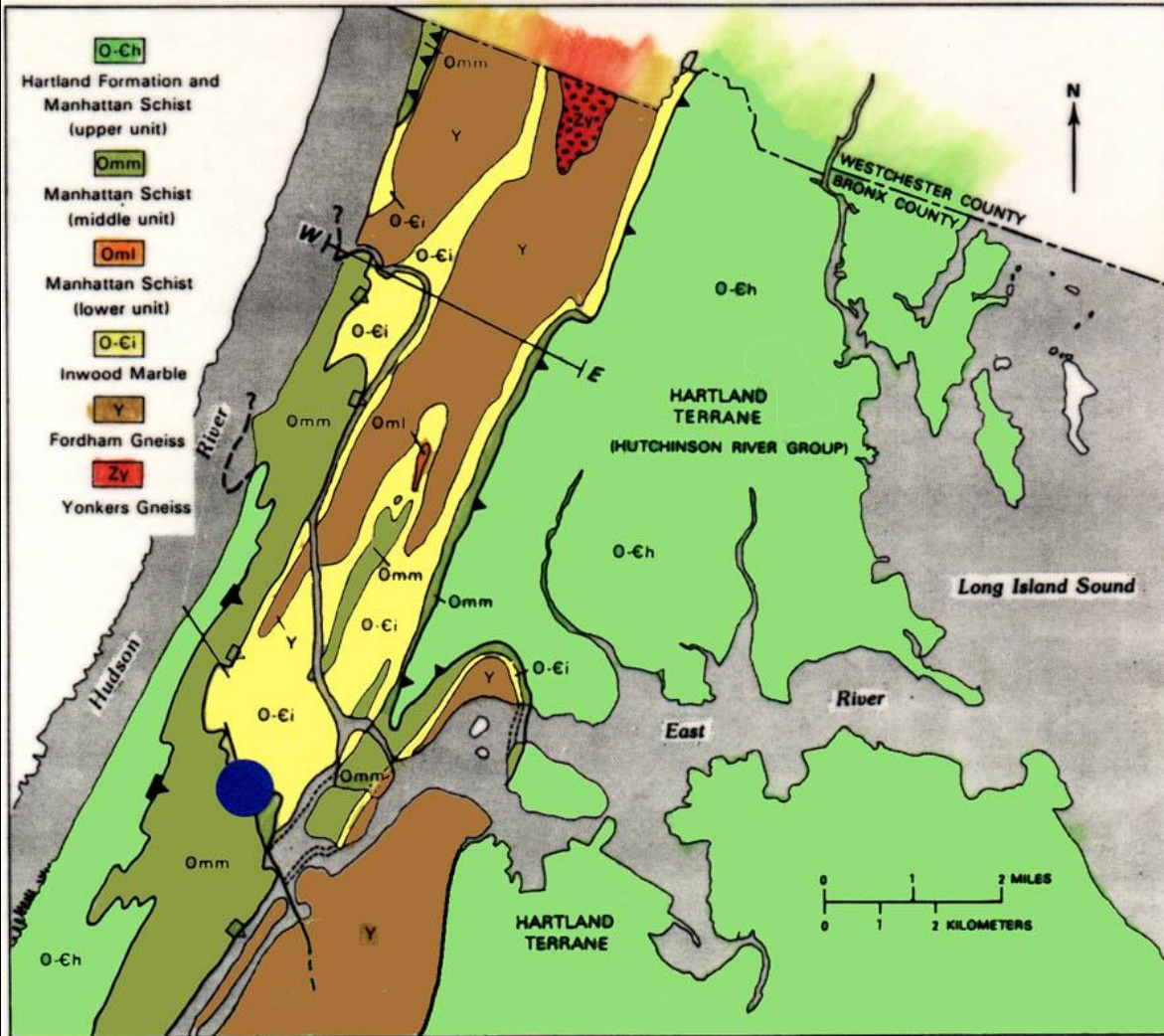


**Beautiful!
Beau-ti-ful!**

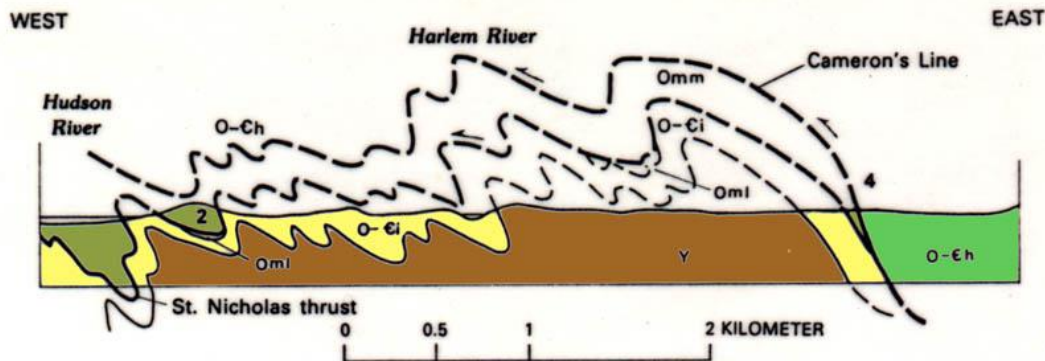
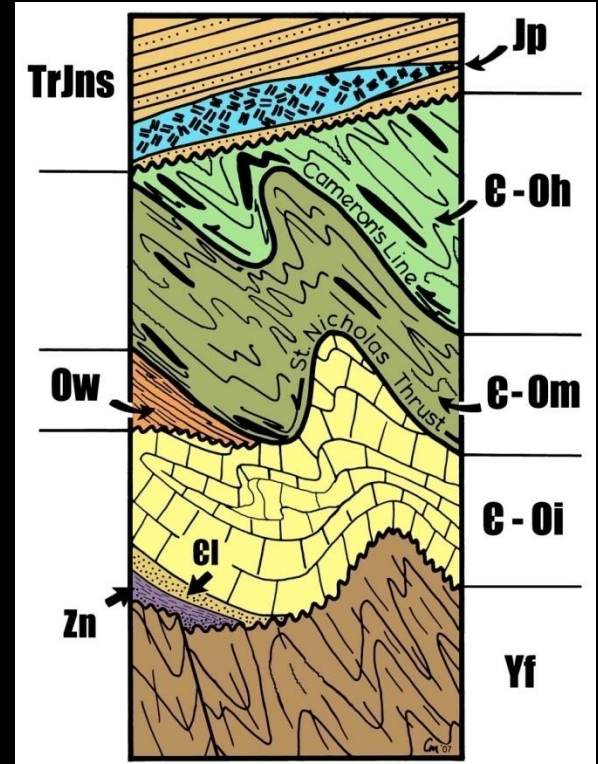


Plate Collisions

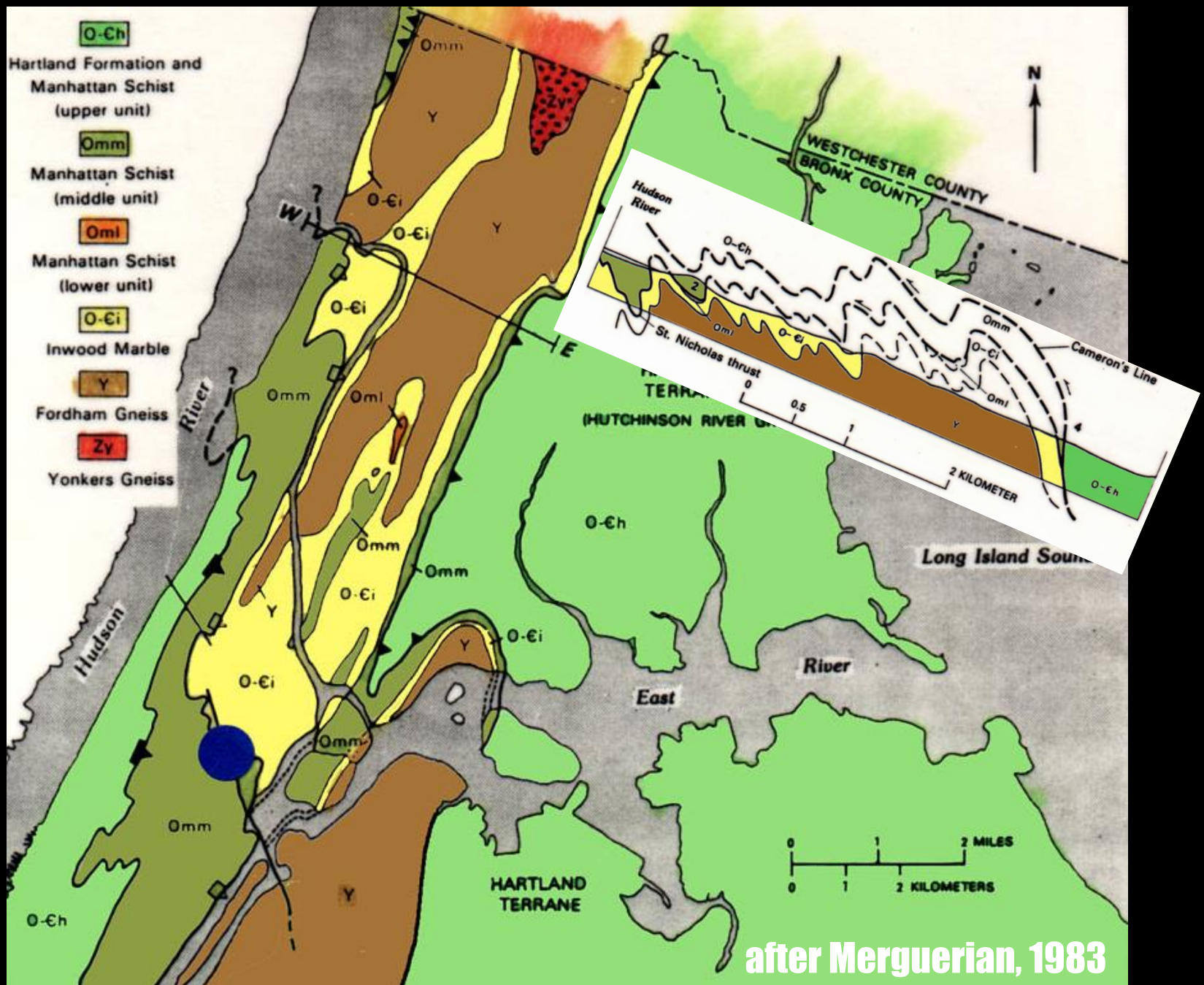




New York City

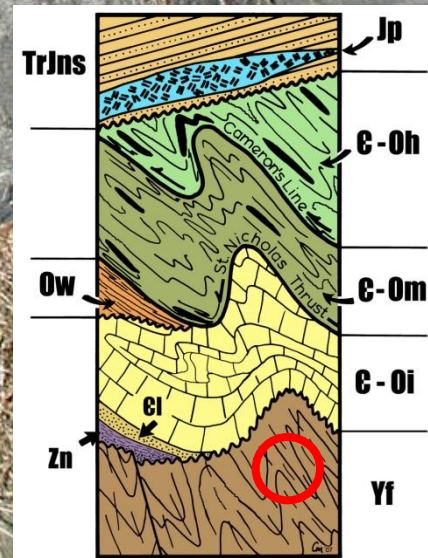


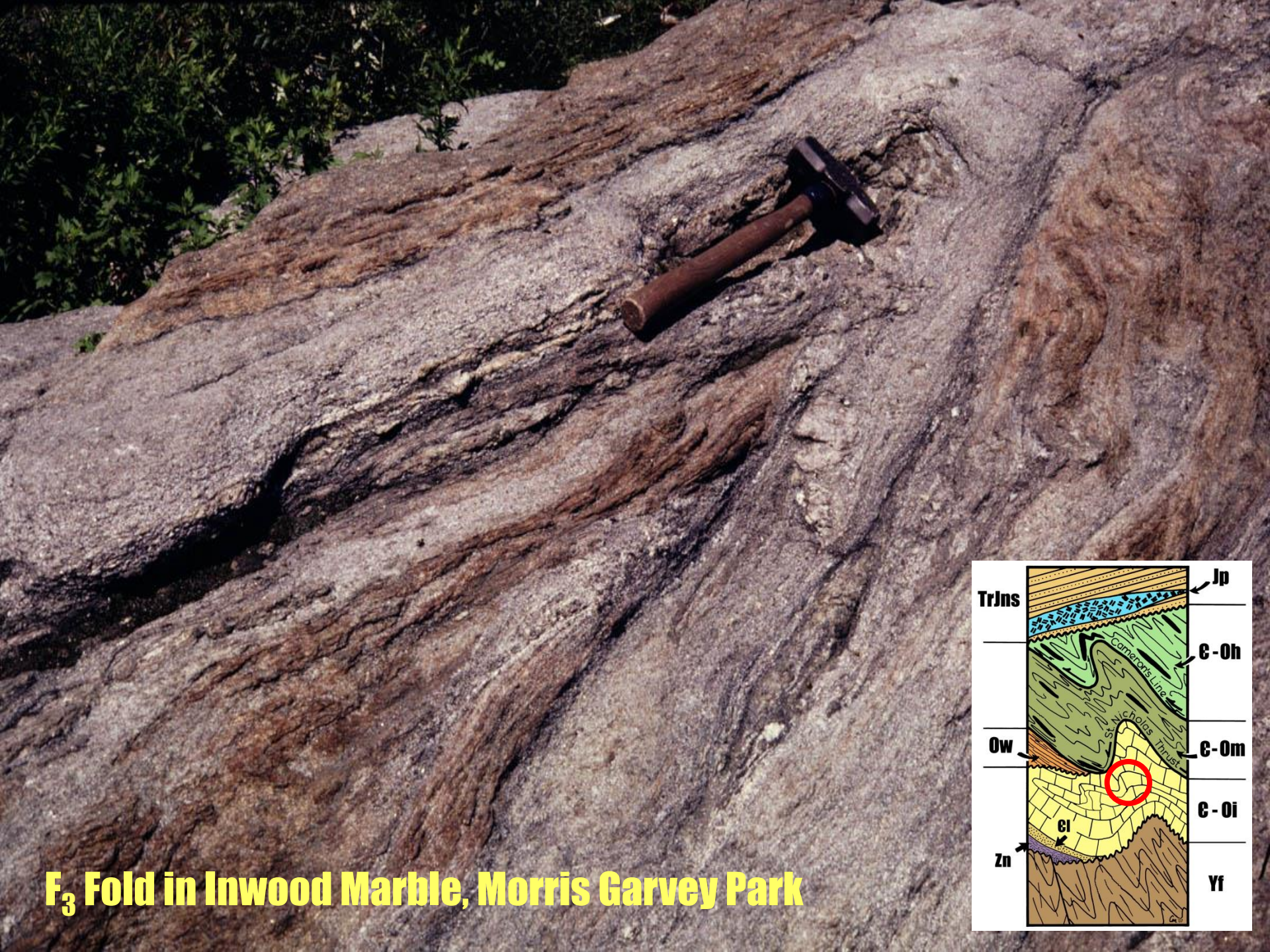
Merguerian, 2001



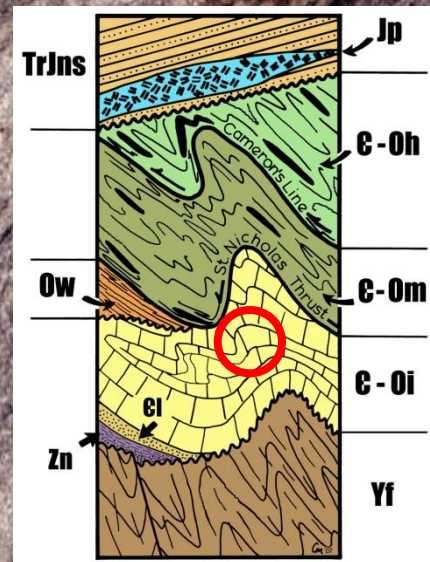


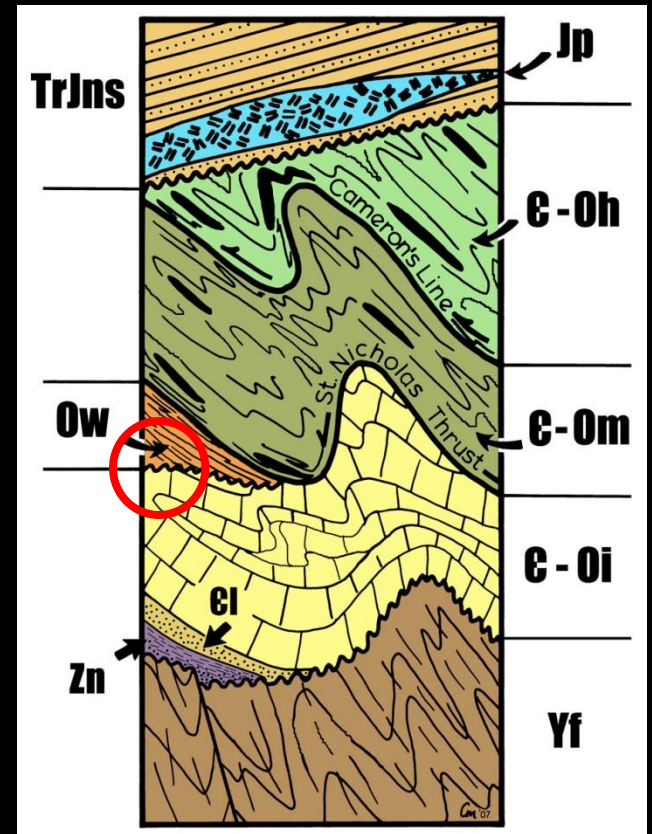
Fordham Gneiss, Echo Park





F₃ Fold in Inwood Marble, Morris Garvey Park

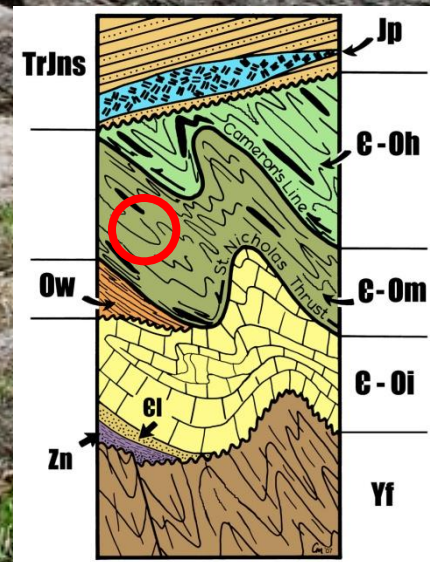




Walloomsac "Balmville" Contact, Grand Concourse, Bronx, NY

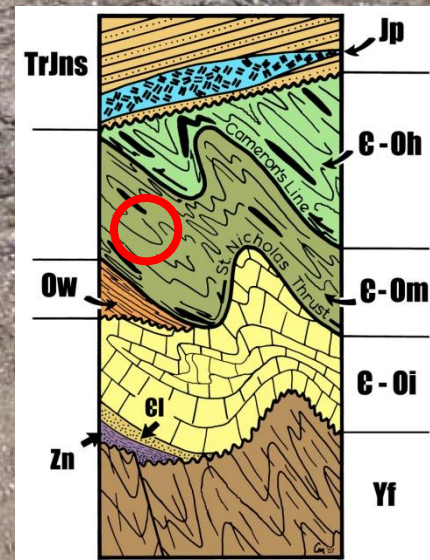


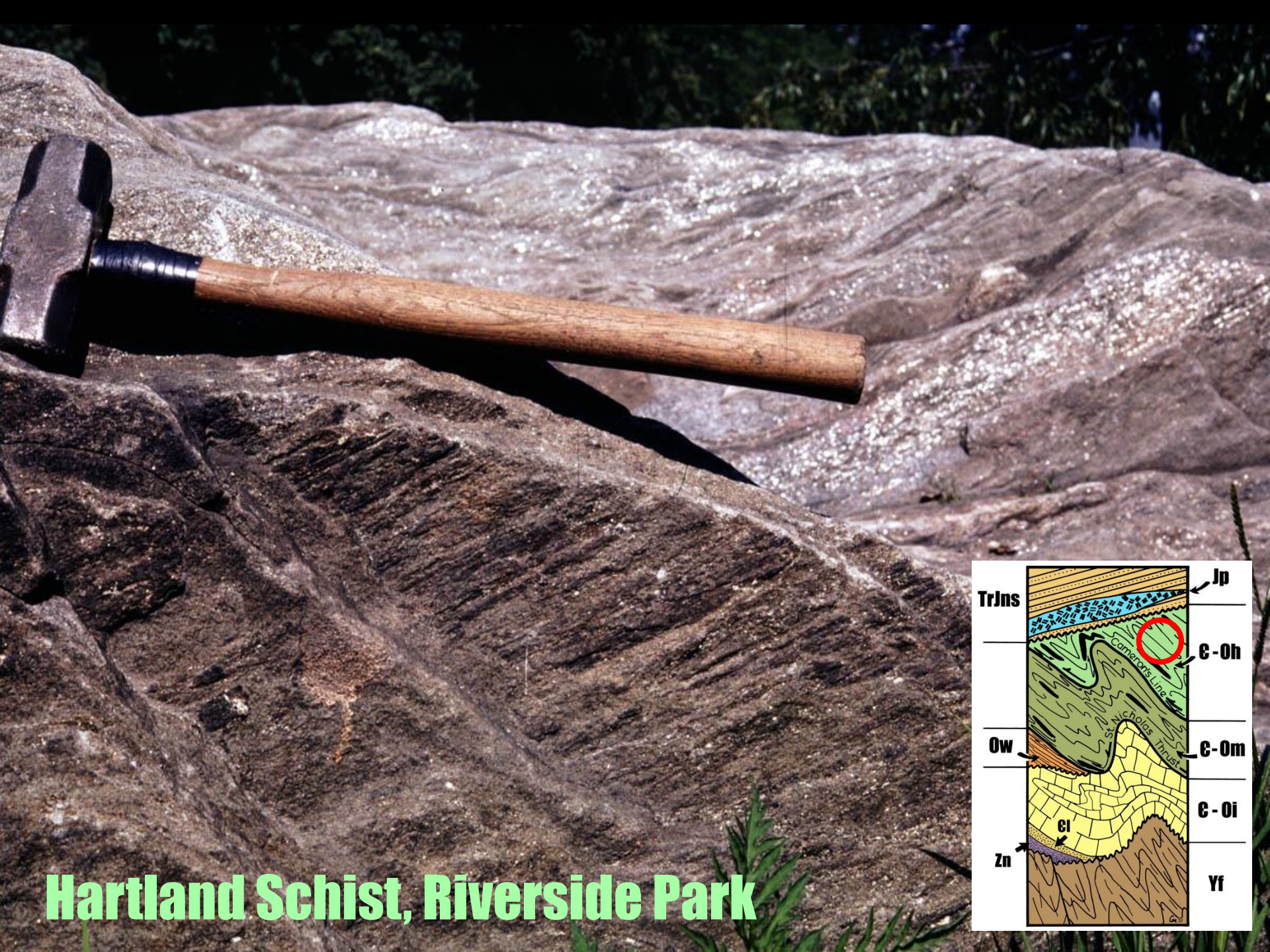
Manhattan Schist, Central Park



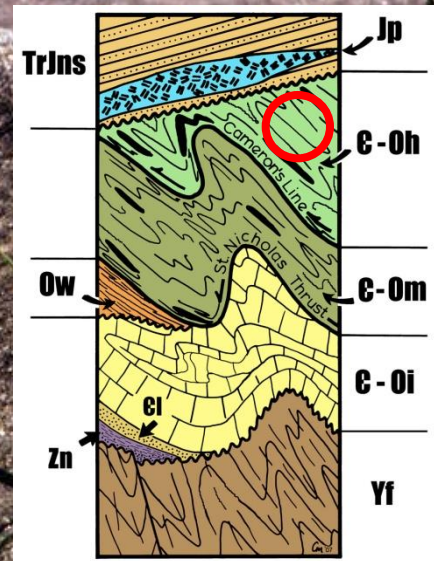


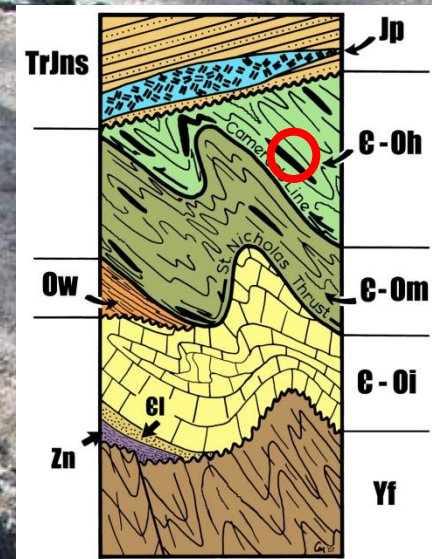
Retrograde Muscovite after Kyanite





Hartland Schist, Riverside Park





Hartland Amphibolite N567

**Merguerian's Early
Field Work on
Manhattan
Island**

**In The Days
When He Was
Young and Limber**

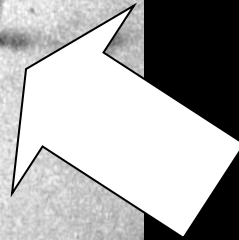






**Merguerian Has Spent
(Wasted?)**

**Most of his Career
Mapping the Surface
and Subsurface
Geology of NYC**



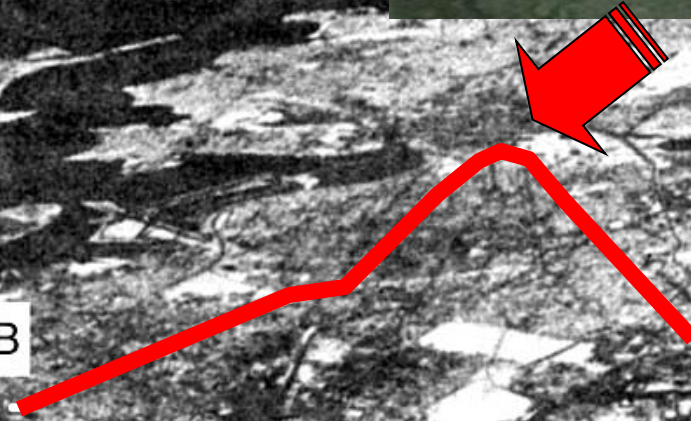
**Proper Field Attire
For NYC**

Long Island Sound



16B

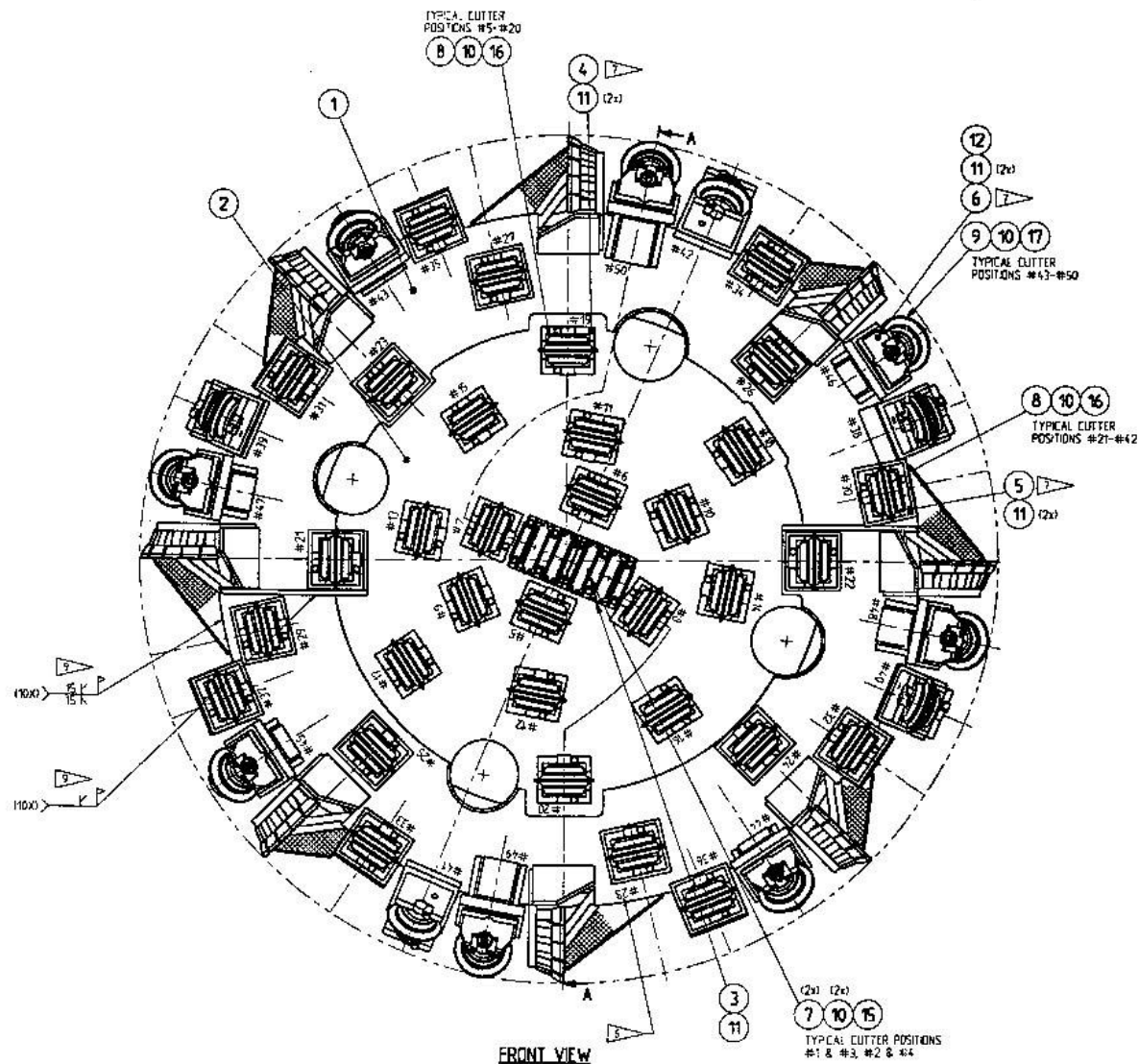
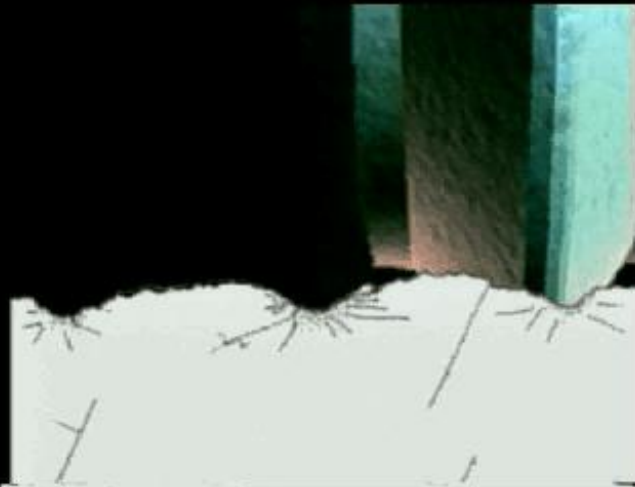
19B

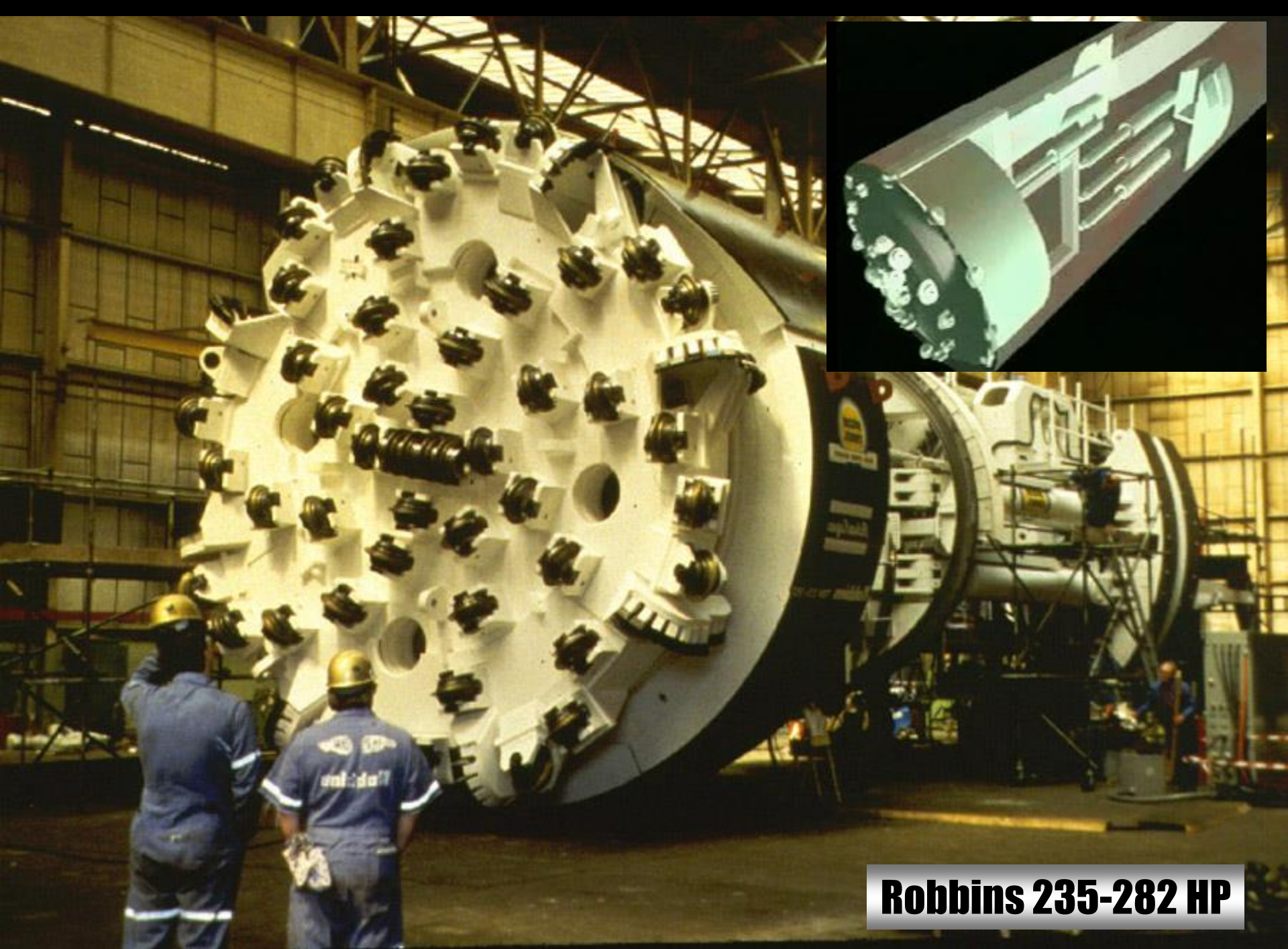




Robbins 235-282 HP TBM







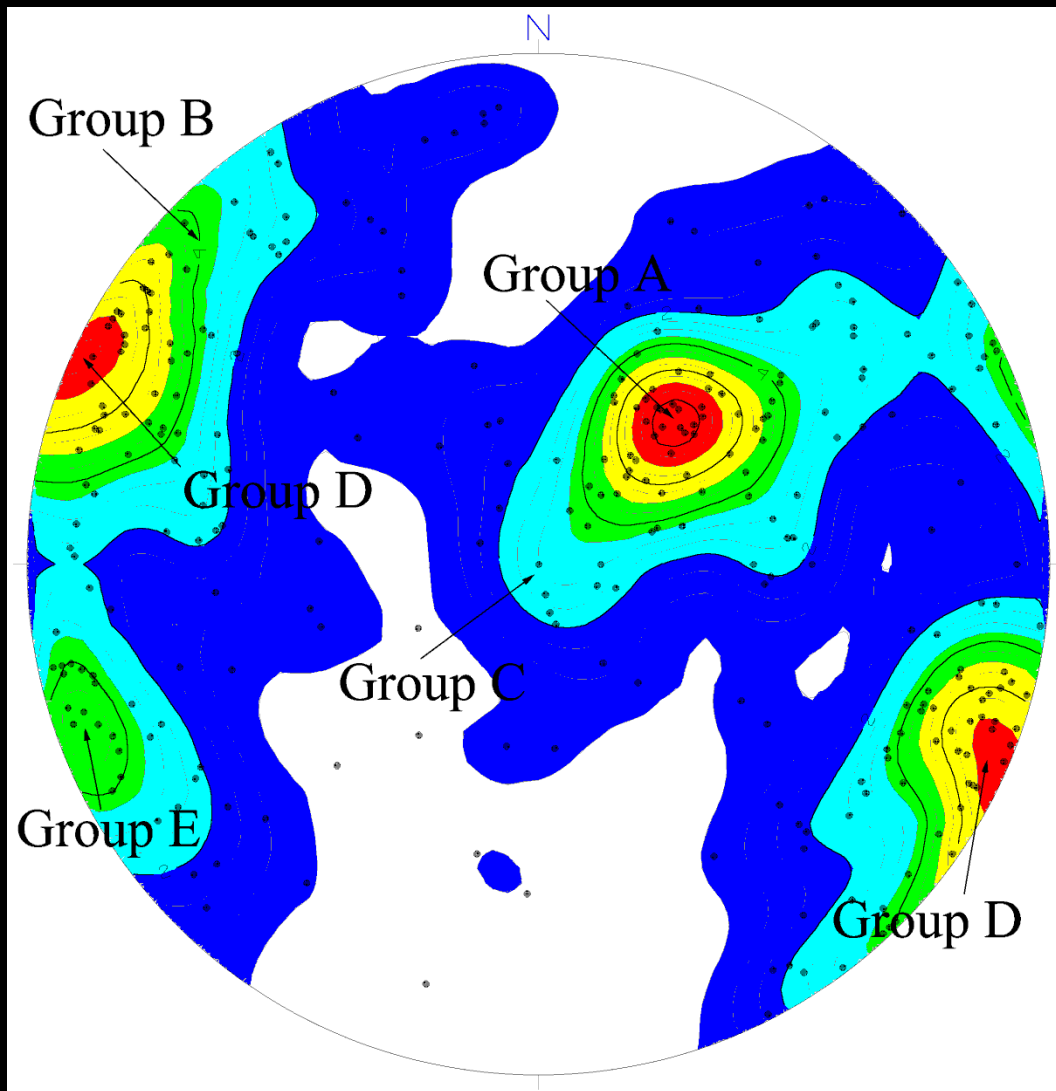
Robbins 235-282 HP



**Merguerian's Queens
Tunnel Field Office**

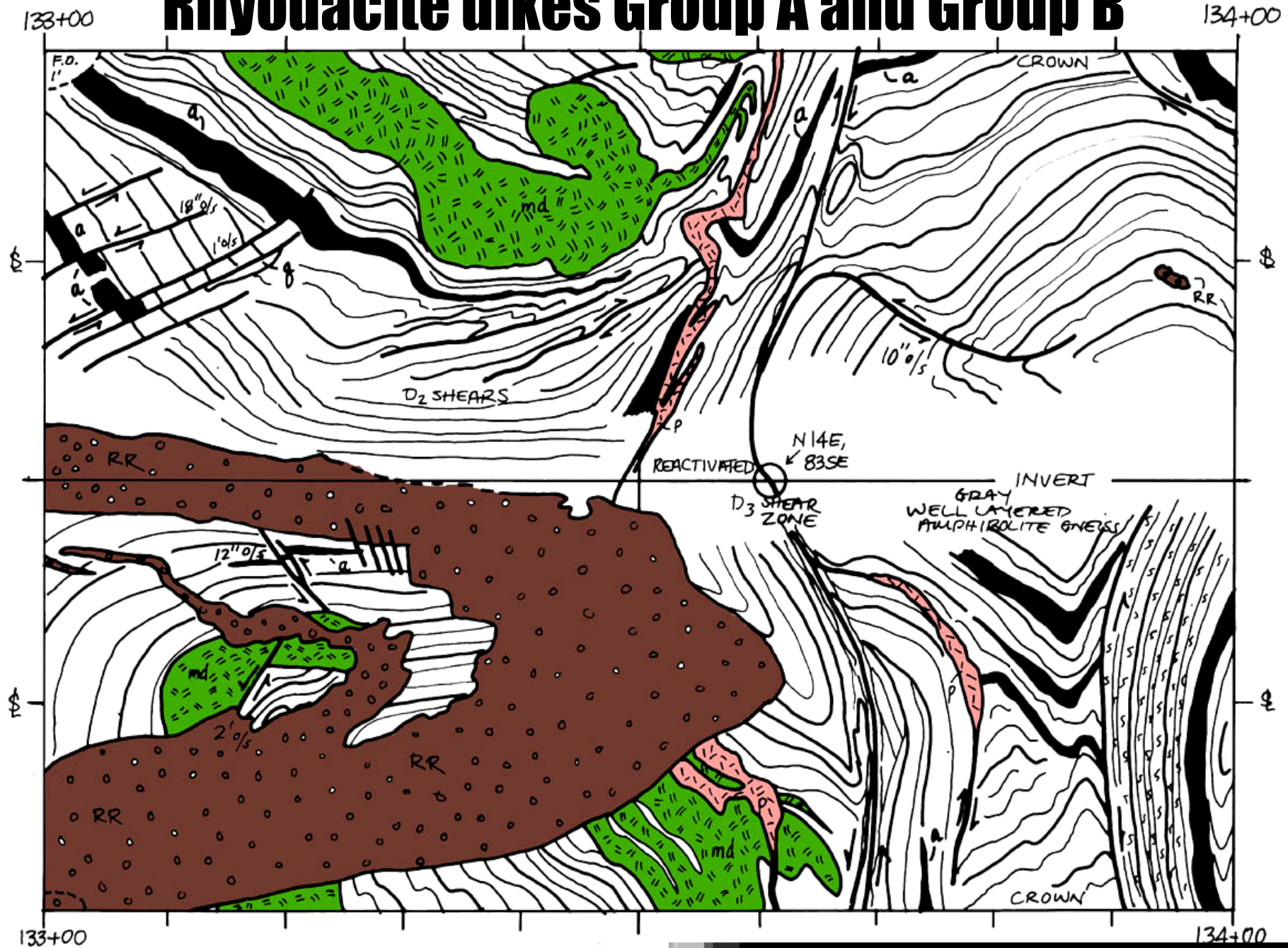


**Dukelabs
Administrative
Assistant**



Queens Tunnel Faults

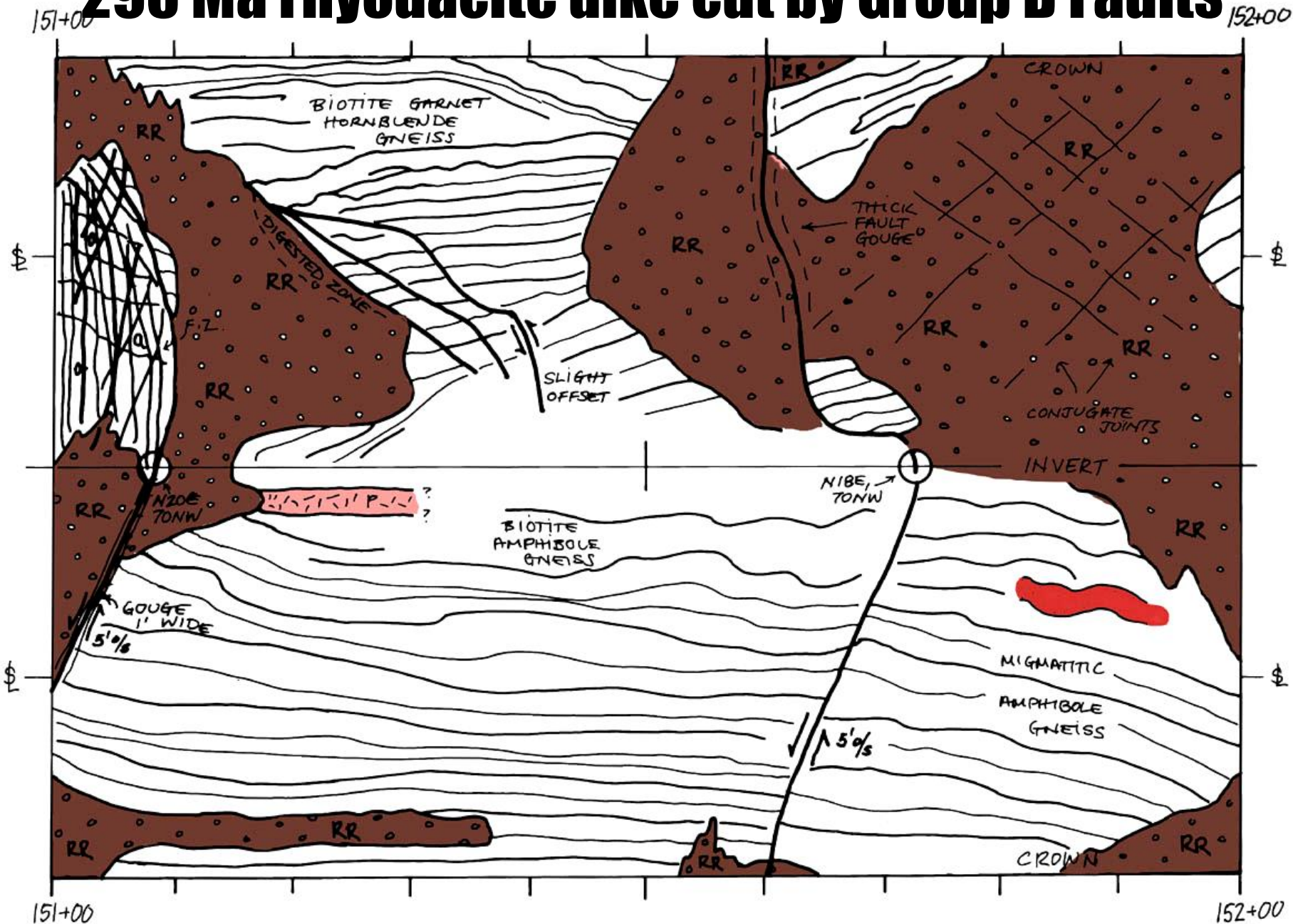
Rhyodacite dikes Group A and Group B



Group B Faults



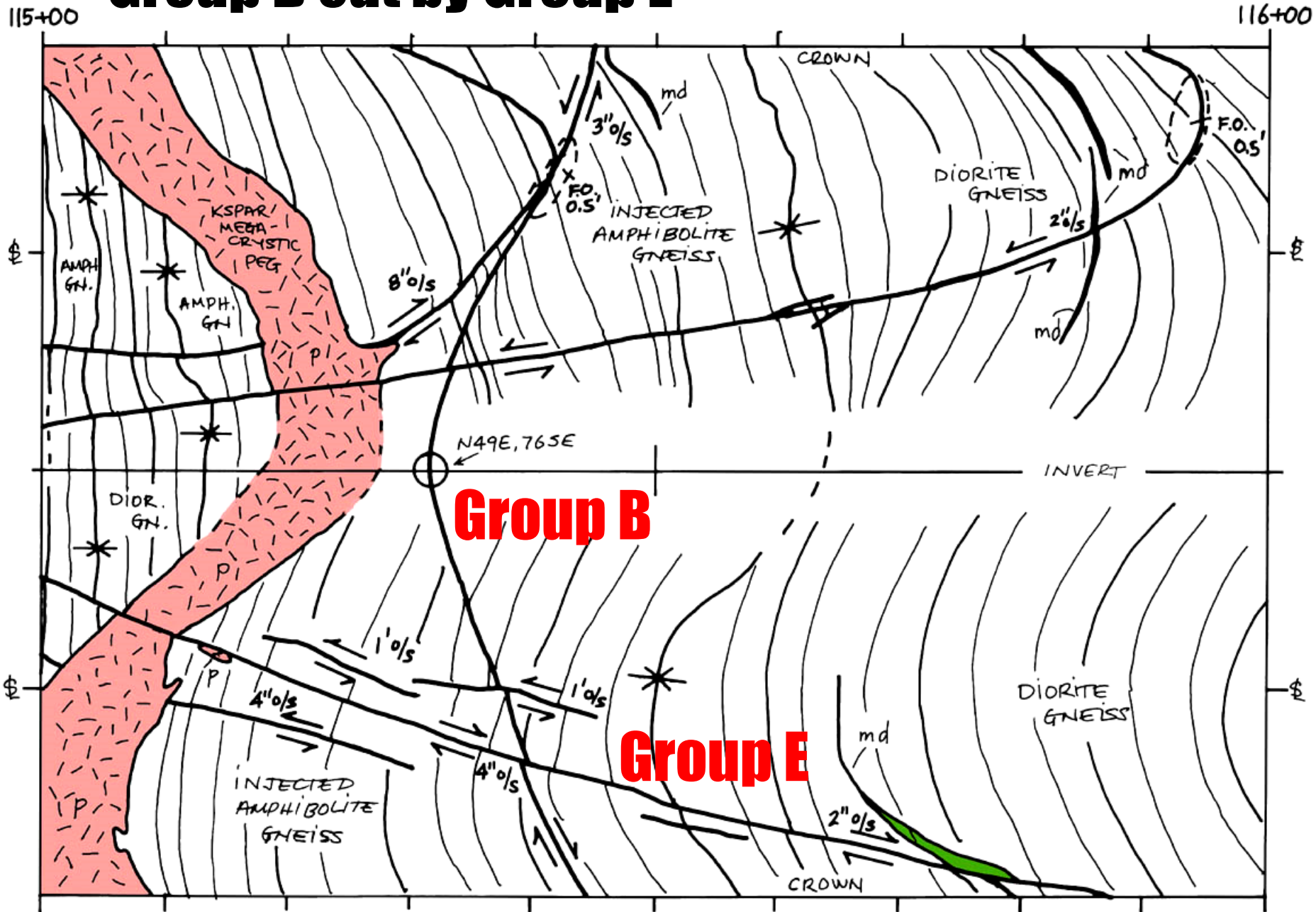
295 Ma rhyodacite dike cut by Group D Faults



NNW-Trending Fault System of Group E

- **NNW strike and steep dips**
- **R/L and L/L strike-slip offset**
- **Follow S_4 traces of open cross folds (F_4)**
- **Commonly healed with quartz +/- pyrite**
- **Youngest fault group – they cut all tunnel structures**
- **Reactivate many older faults**
- **Persistent features in NW-leg of tunnel**
- **Associated with areas of stress relief**
- **Produce wet zones in areas of fault convergence**

Group B cut by Group E



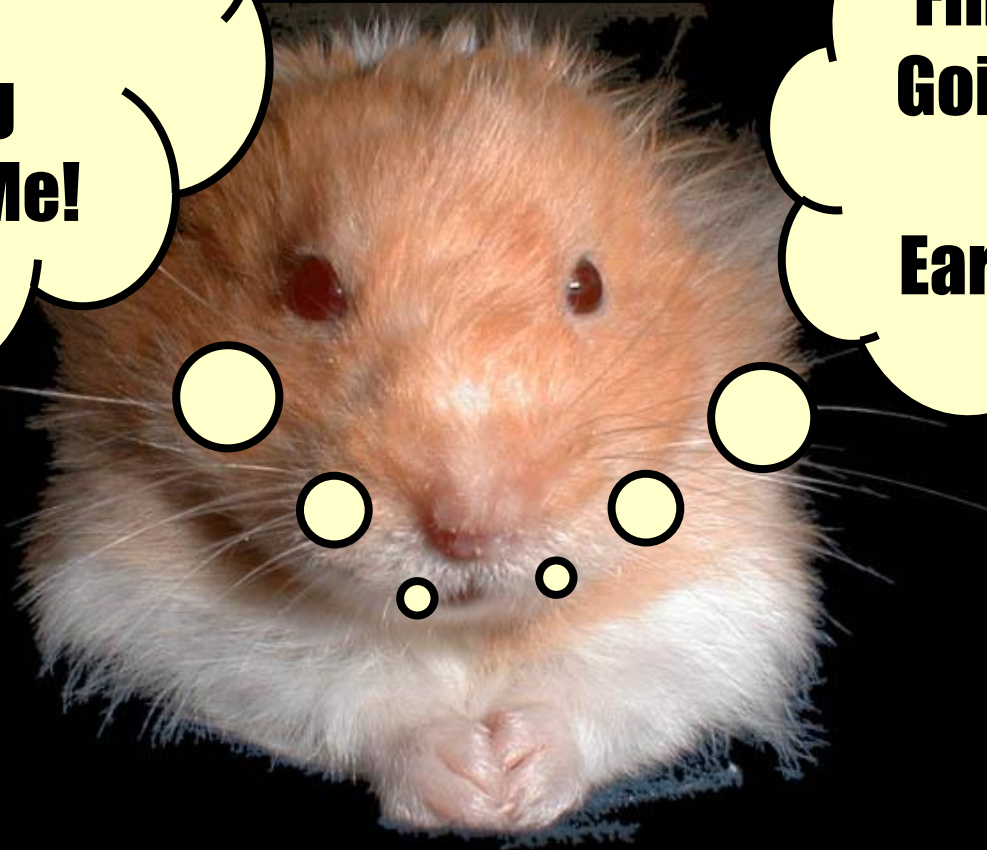
Crown Failure in Overstressed Rock

Queens Tunnel Sta. 253+40



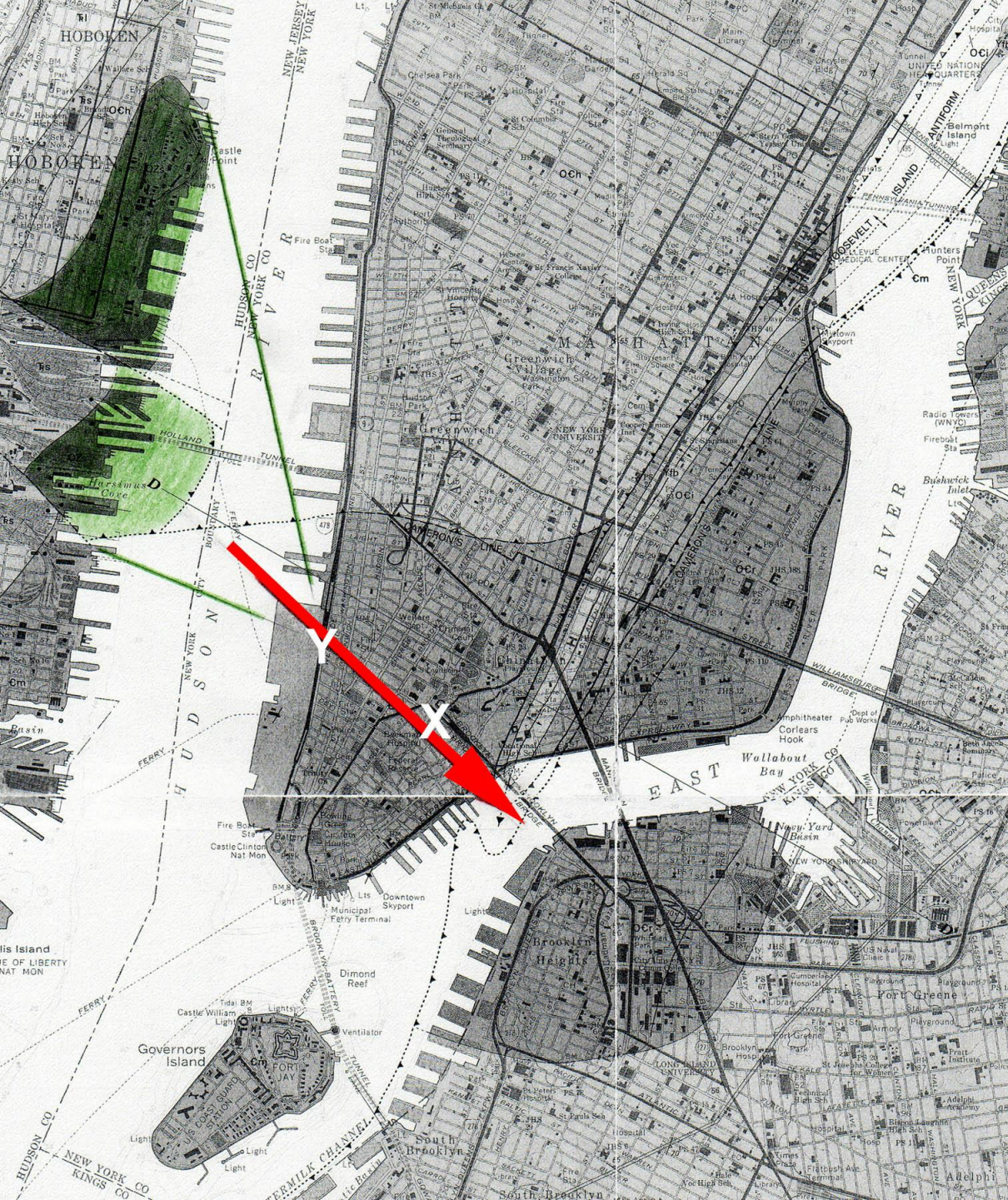
**Remember,
You're
Nothing
Without Me!**

**Finally, He's
Going to Talk
About
Earthquakes**









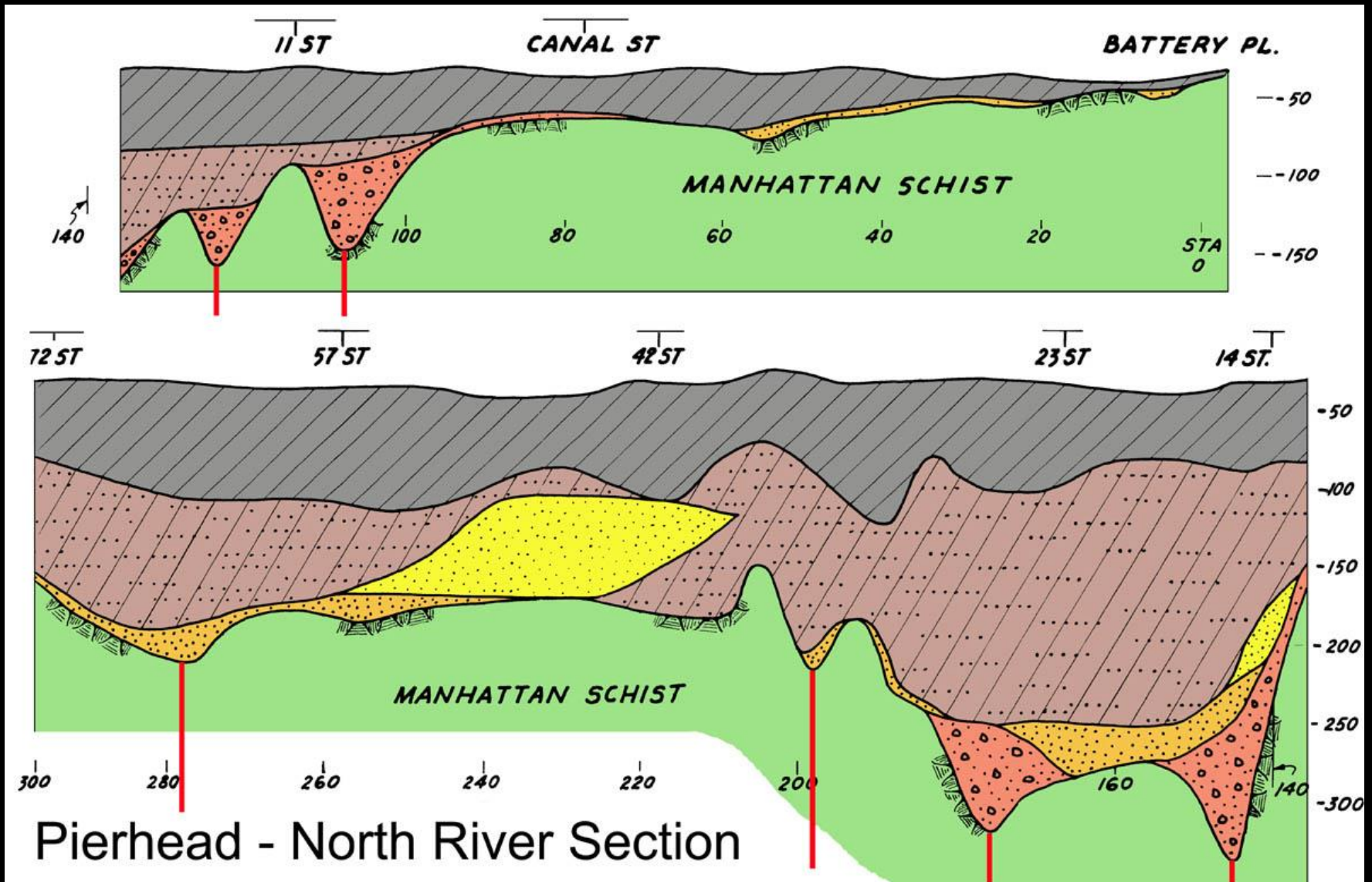
Buried Valley

Carved By Old
Glacier

Backfilled by
Younger
Glaciers

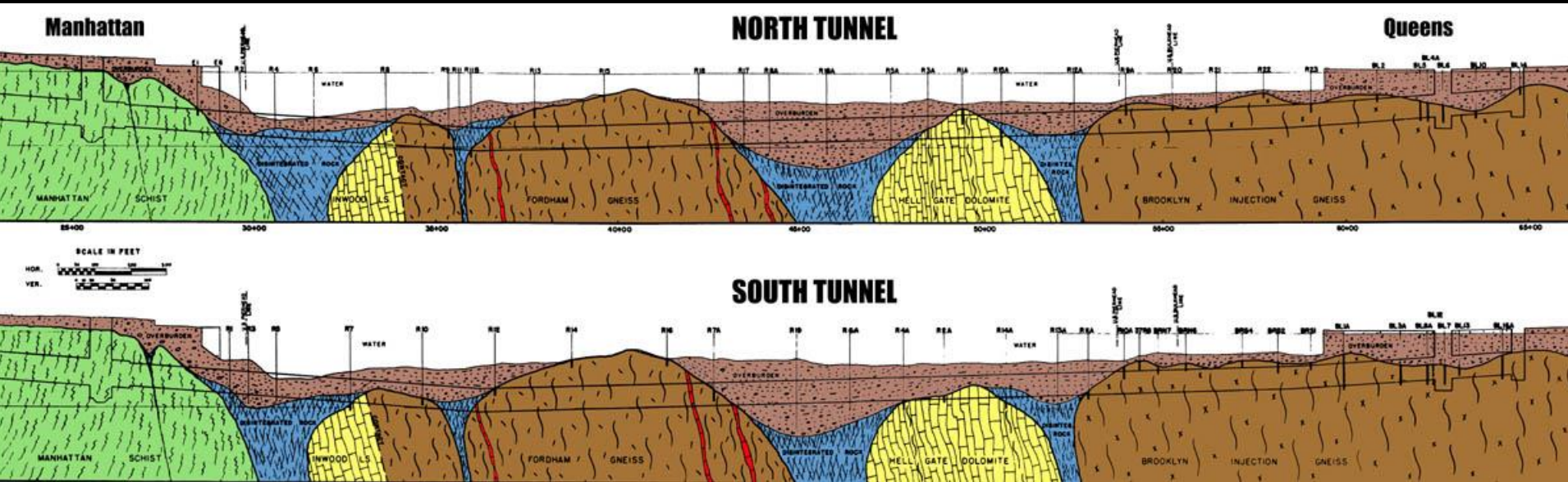
Sites in Valley
Contain NJ
Serpentinite
In Till; Wood
Found in Till at
WTC (49 Ka)

Longitudinal Profile - Manhattan



Base diagram after Mueser-Rutledge Consultants

Queens Midtown Tunnel

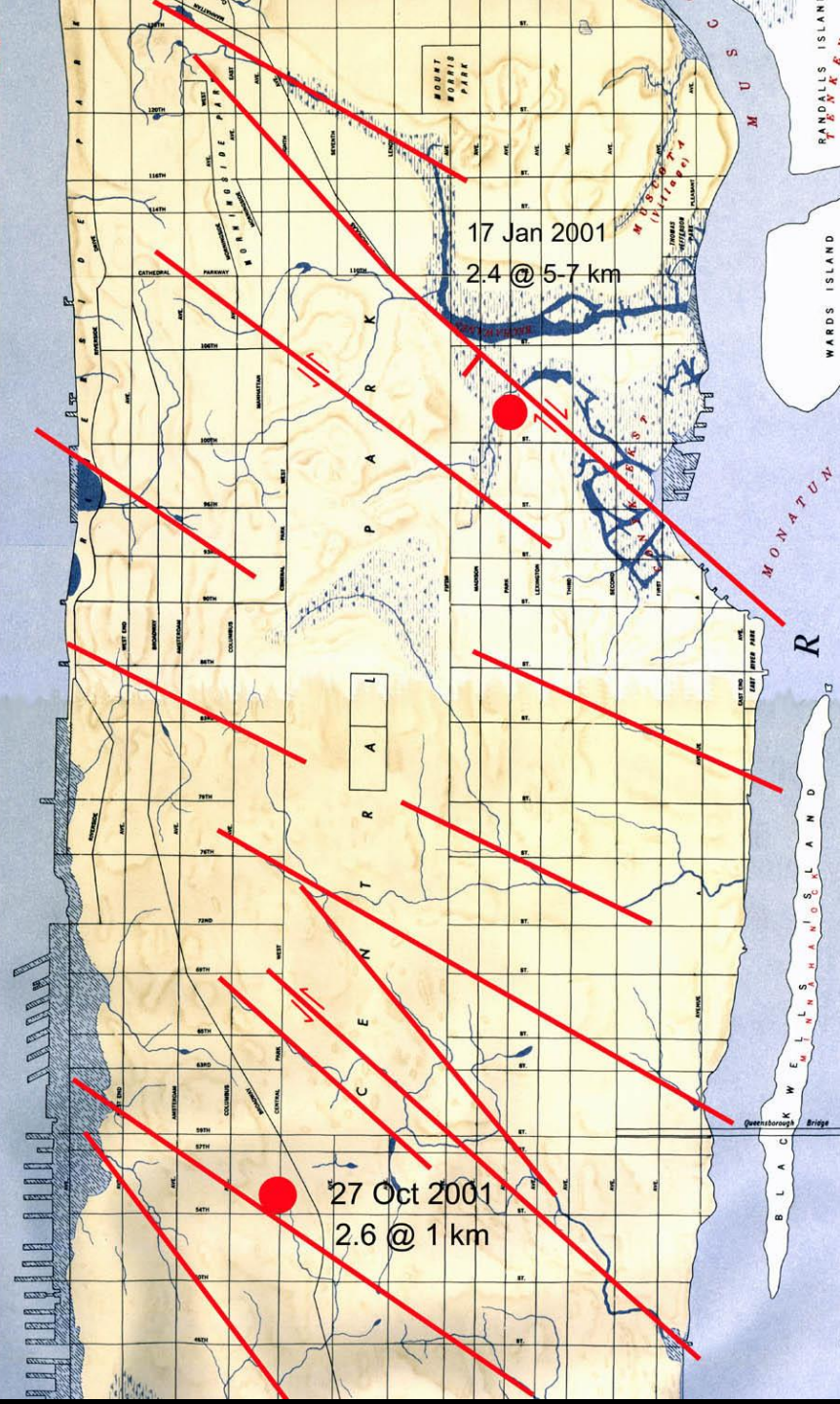


Built 1936-1940

after Berkey, 1948



McCoun (1609)



17 Jan 2001
2.4 @ 5-7 km

27 Oct 2001
2.6 @ 1 km

**Manhattan
Schist**

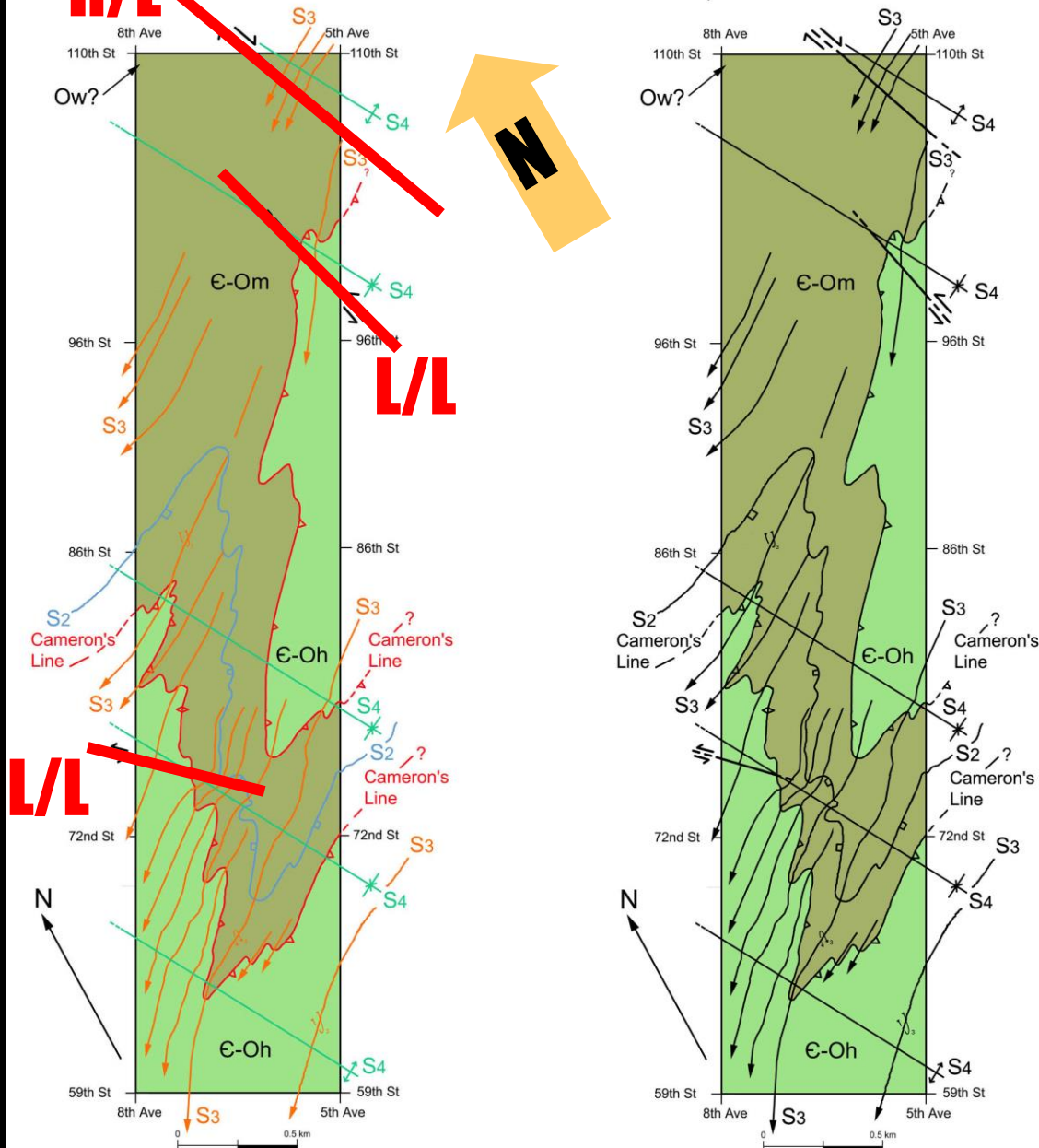
**Offsets F_3
Syncline**

N537

Group E - N12°W, L/L Fault



PRELIMINARY GEOLOGICAL MAP OF CENTRAL PARK, NYC



Group E Faults In Central Park

Merguerian and
Merguerian, 2004

Group E - N45°W, 80°S L/L Fault

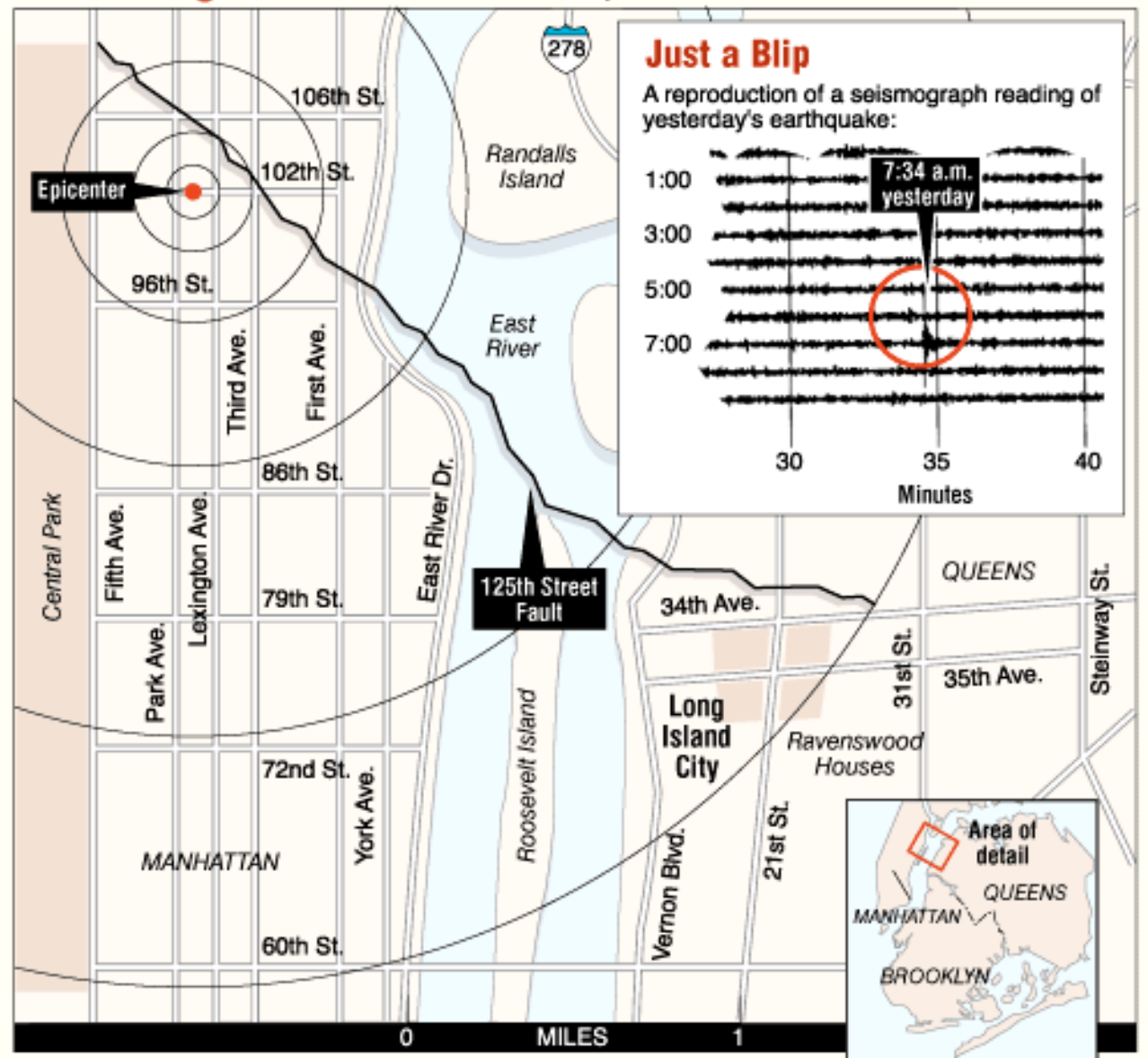


N296 Hartland Fm

17 January 2001, M = 2.4

A Morning Jolt

The epicenter of yesterday's earthquake and a look at the 125th Street fault; believed to be where the quake occurred.



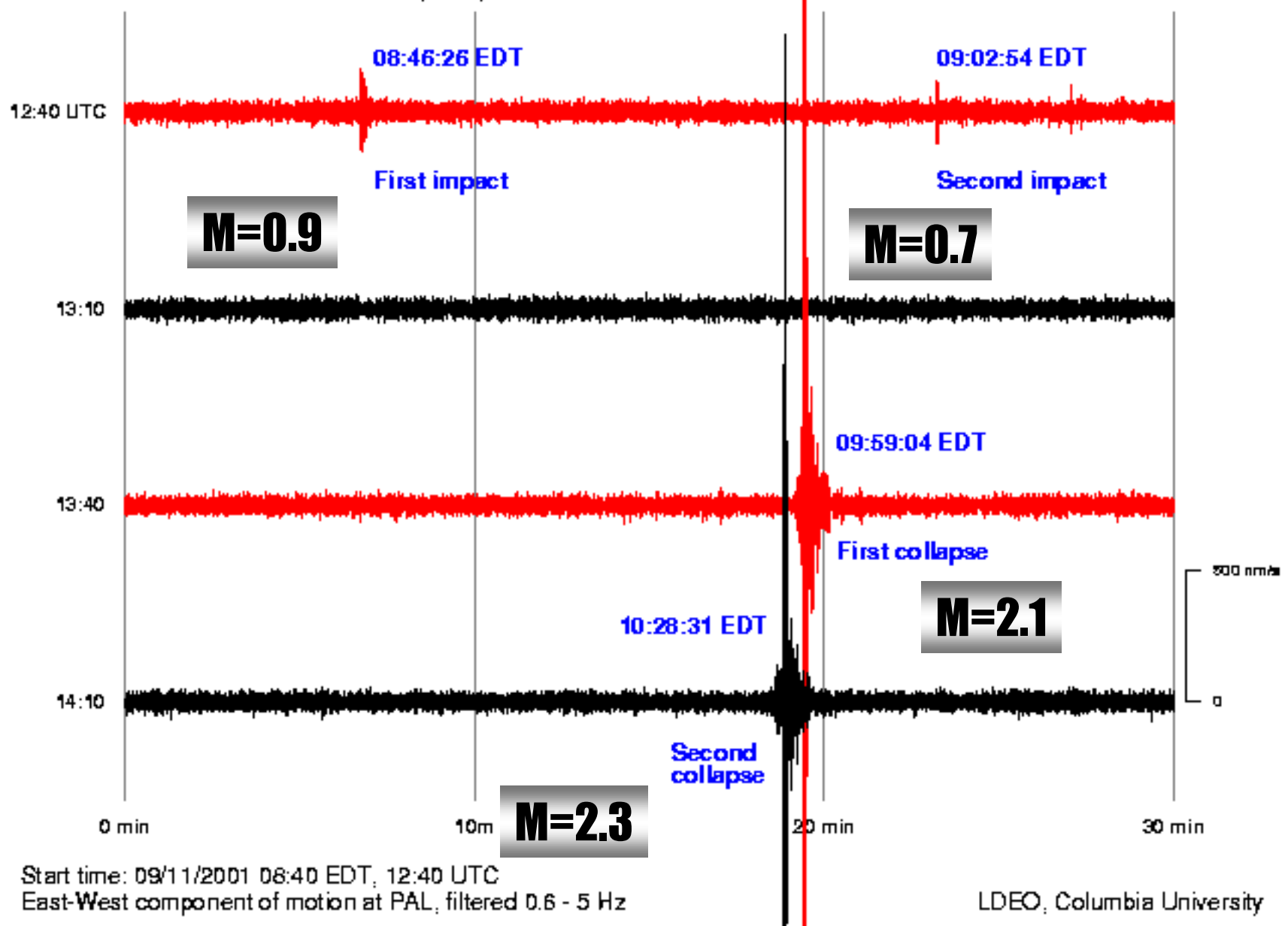
27 October 2001; M = 2.6



11 Sept 2001



Seismic Record at Palisades, NY, 34 km North of the World Trade Center Disaster





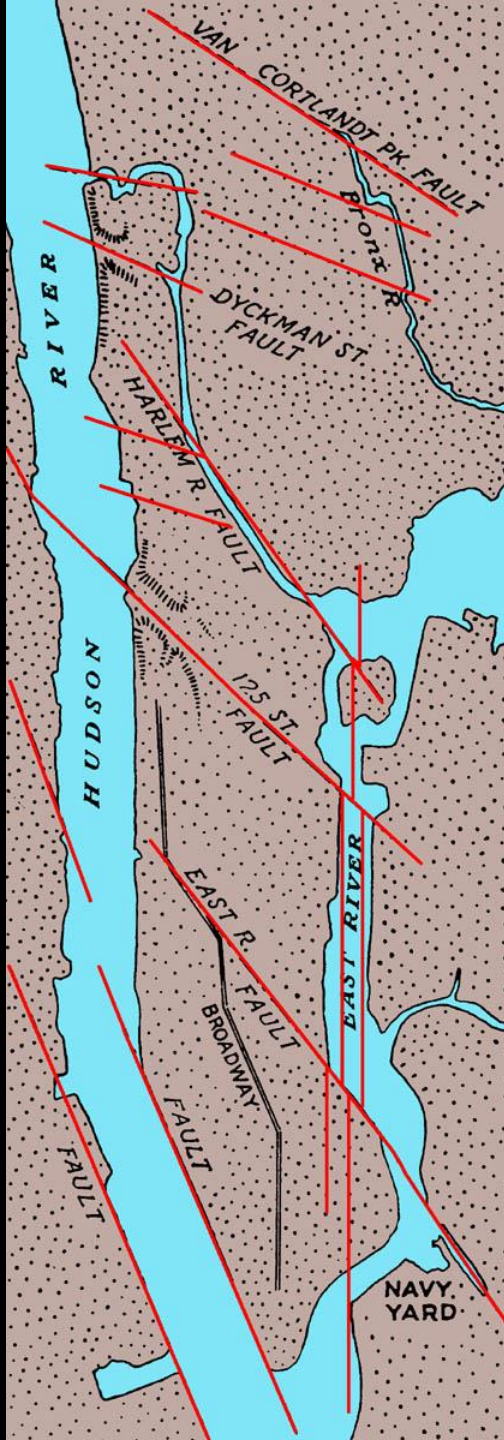
It's Not My Fault! He put me up to this!

125th Street Manhattanville Fault



Charles Merguerian

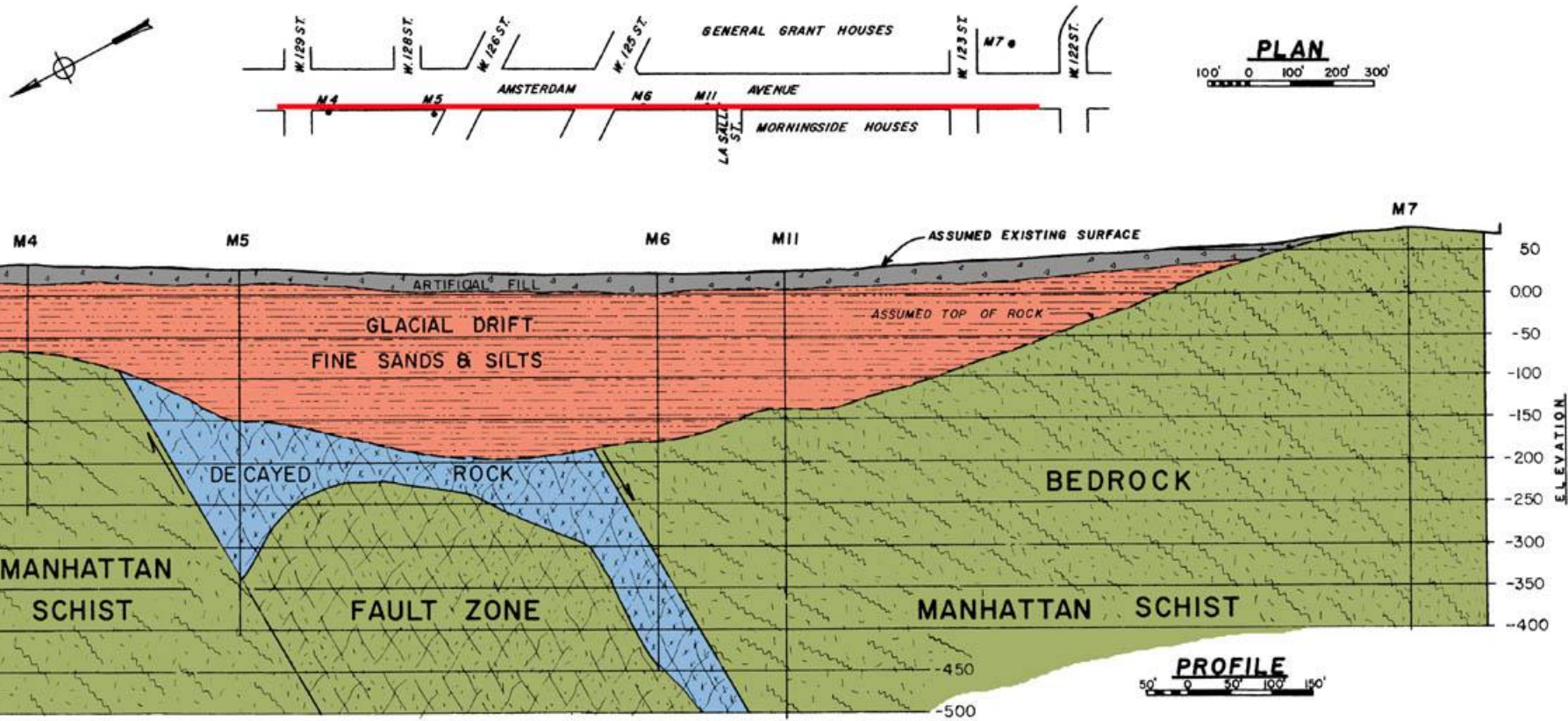
Group E Faults

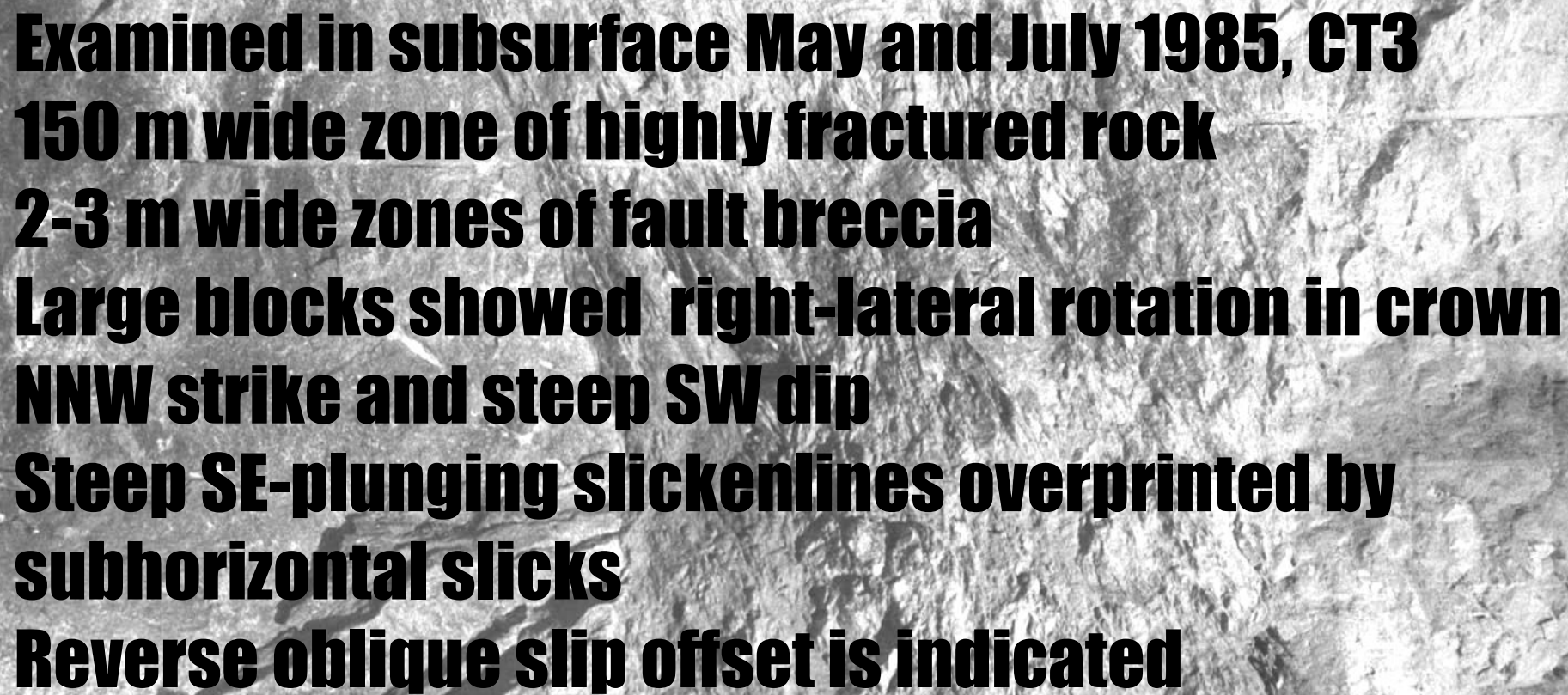




125th Street Fault, CT3, Stage 1

Manhattanville “125th Street” Fault Zone is 400’ in width

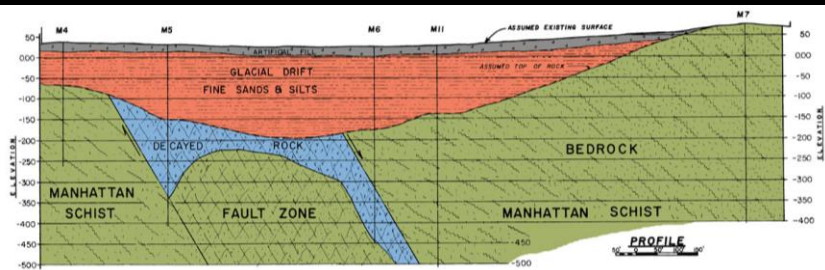


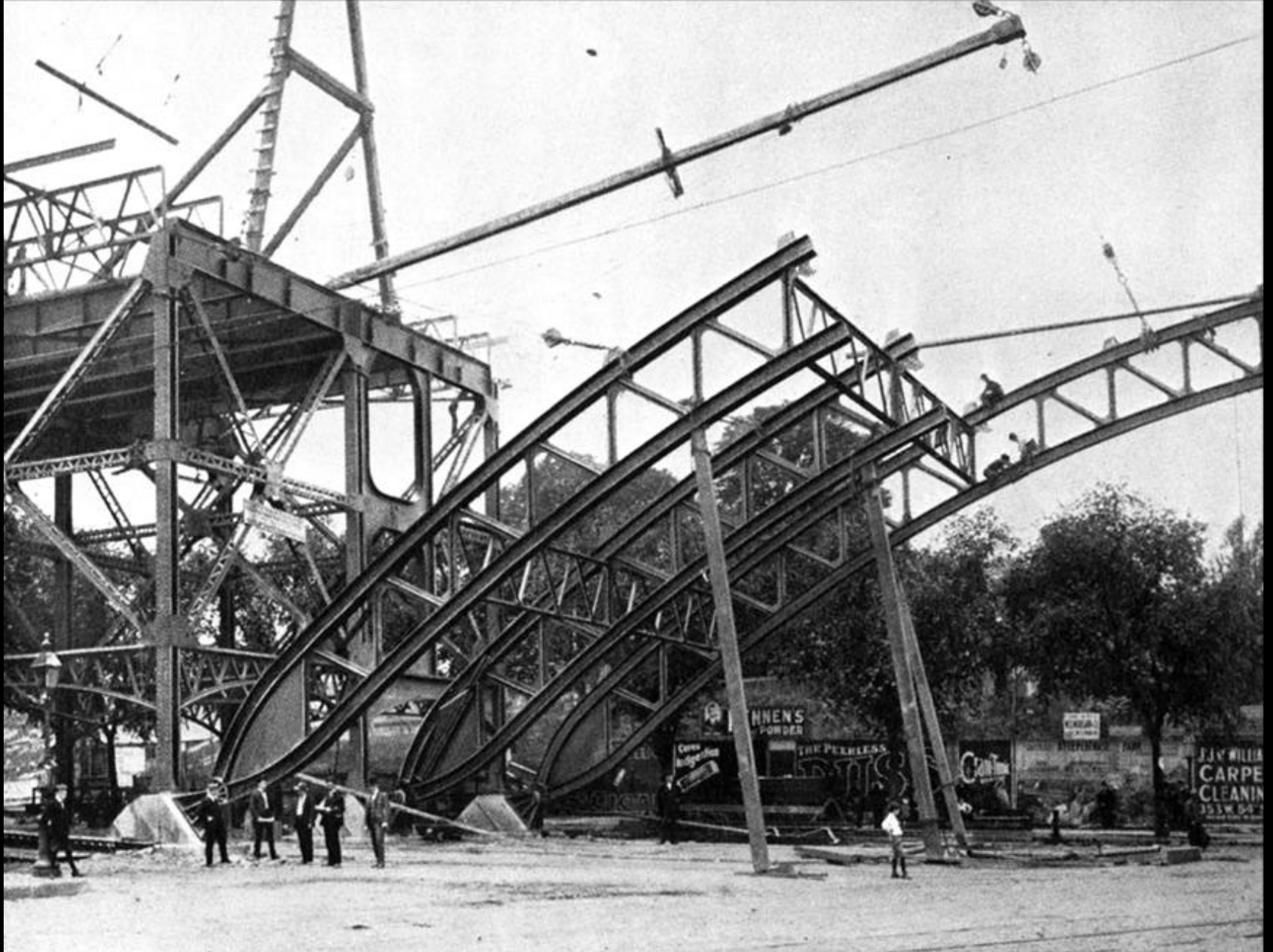


Examined in subsurface May and July 1985, CT3
150 m wide zone of highly fractured rock
2-3 m wide zones of fault breccia
Large blocks showed right-lateral rotation in crown
NNW strike and steep SW dip
Steep SE-plunging slickenlines overprinted by
subhorizontal slicks
Reverse oblique slip offset is indicated

125th Street Fault, CT3, Stage 1

View North on Amsterdam Avenue into 125th Valley





Manhattanville Bridge Construction, circa 1898

Manhattanville Bridge, circa 1900



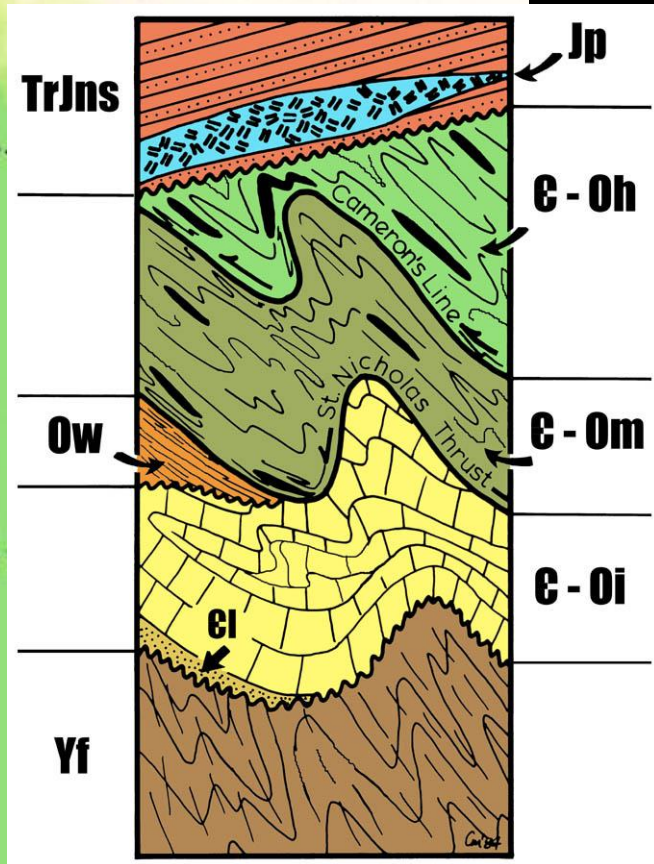
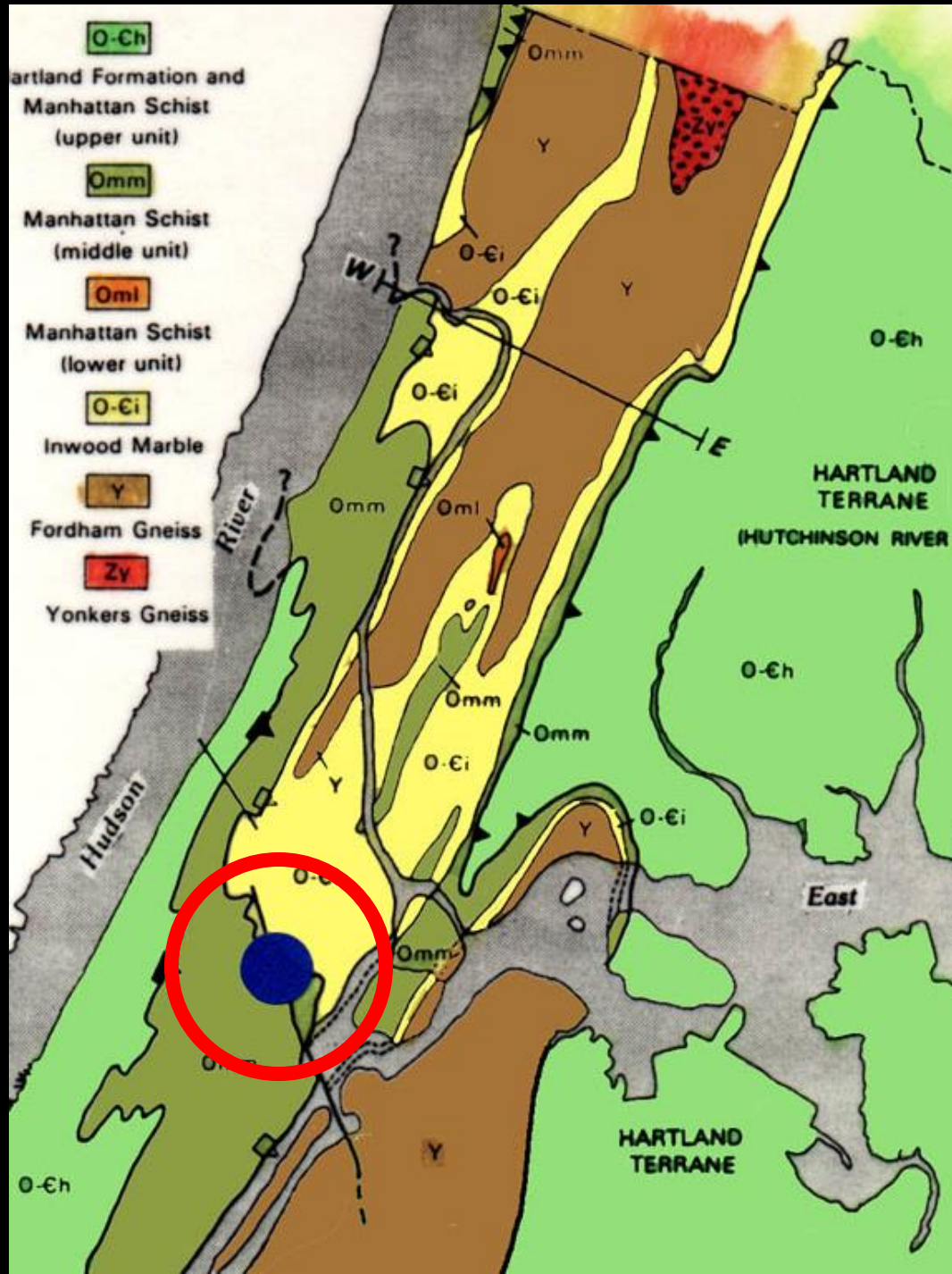


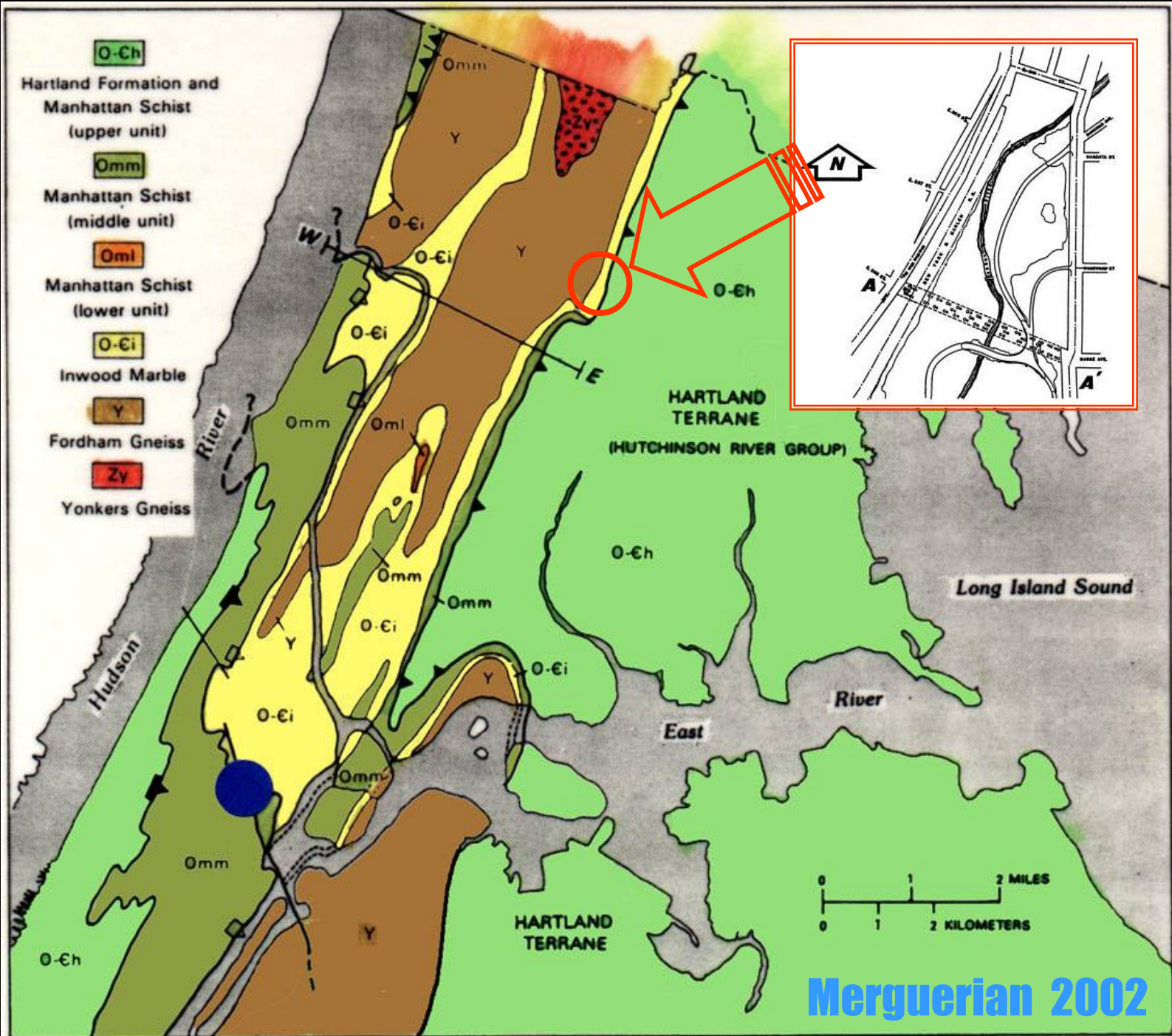


IRT 117th Street and Broadway



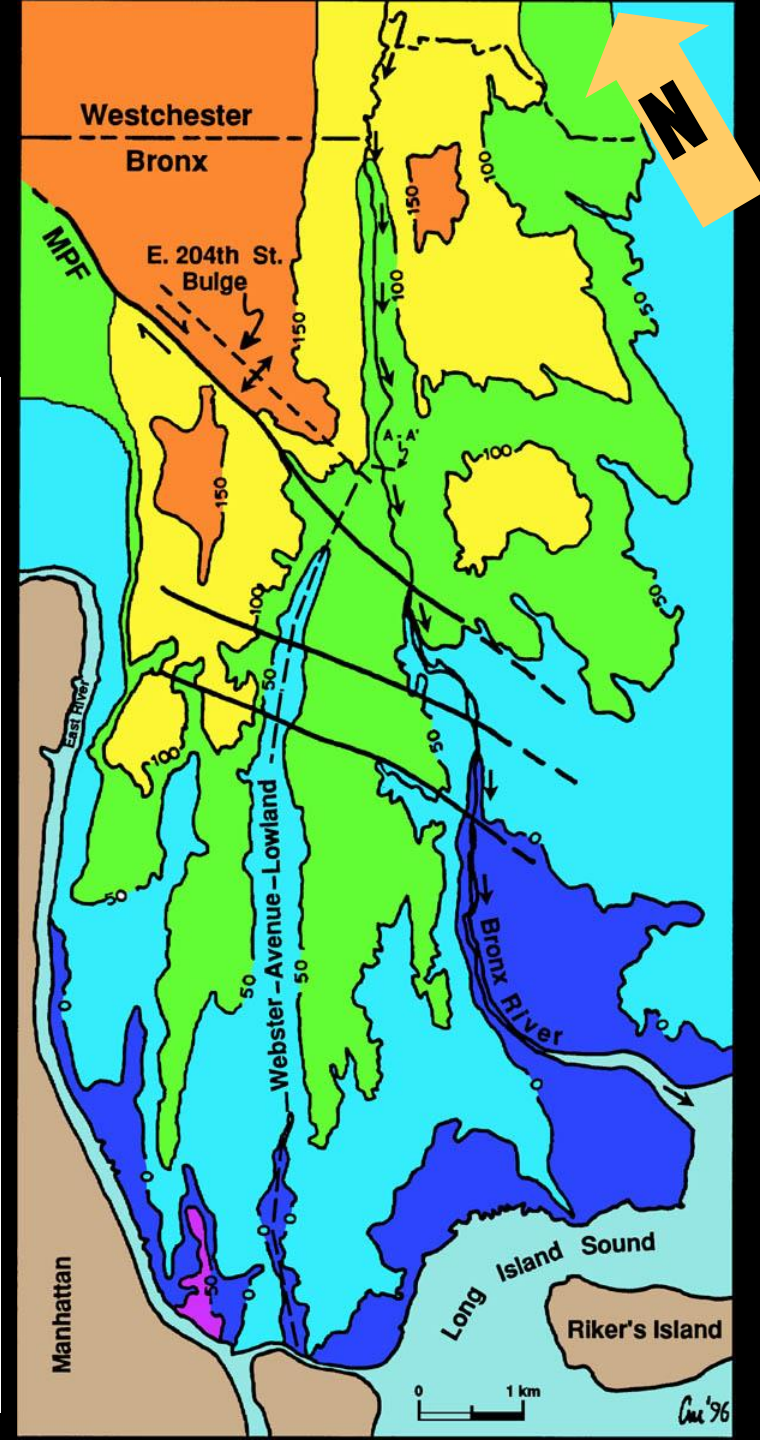
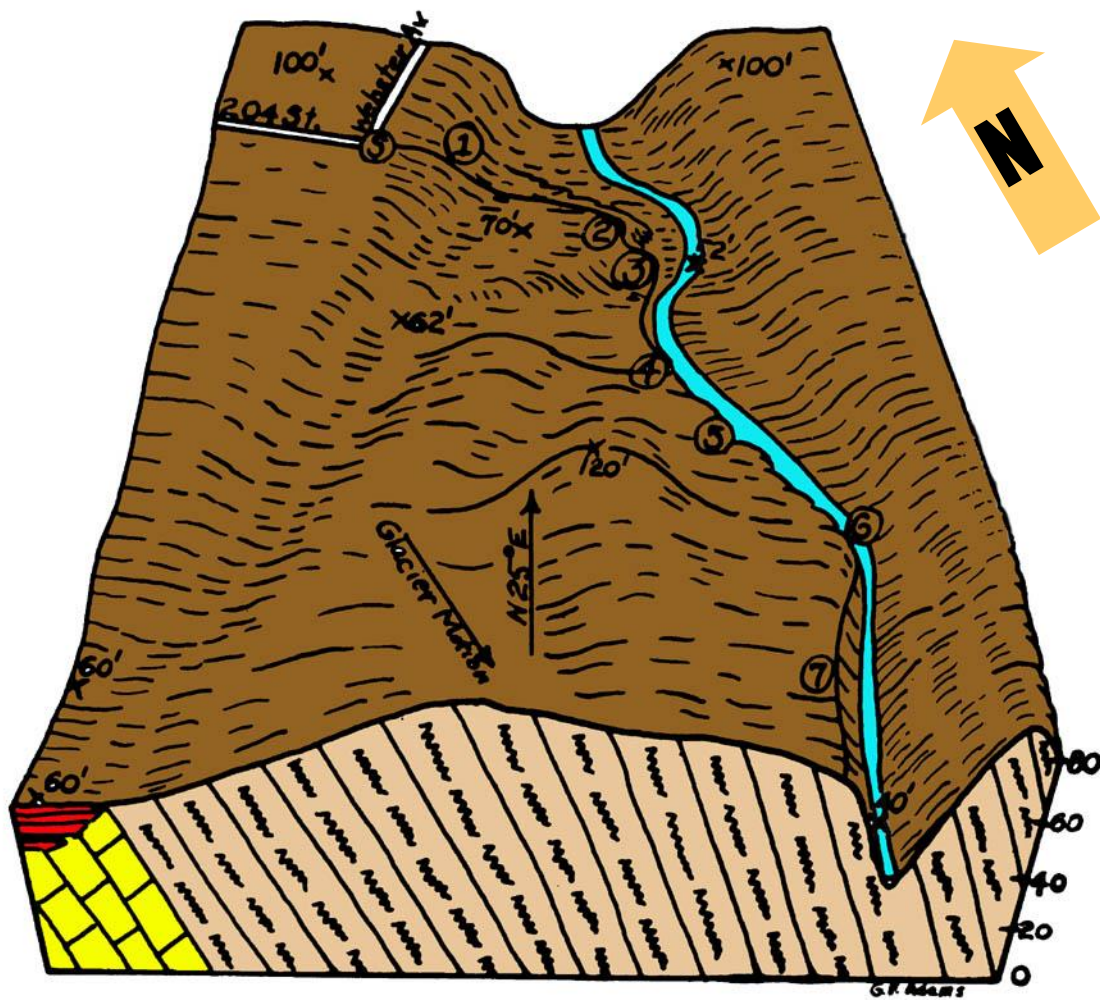




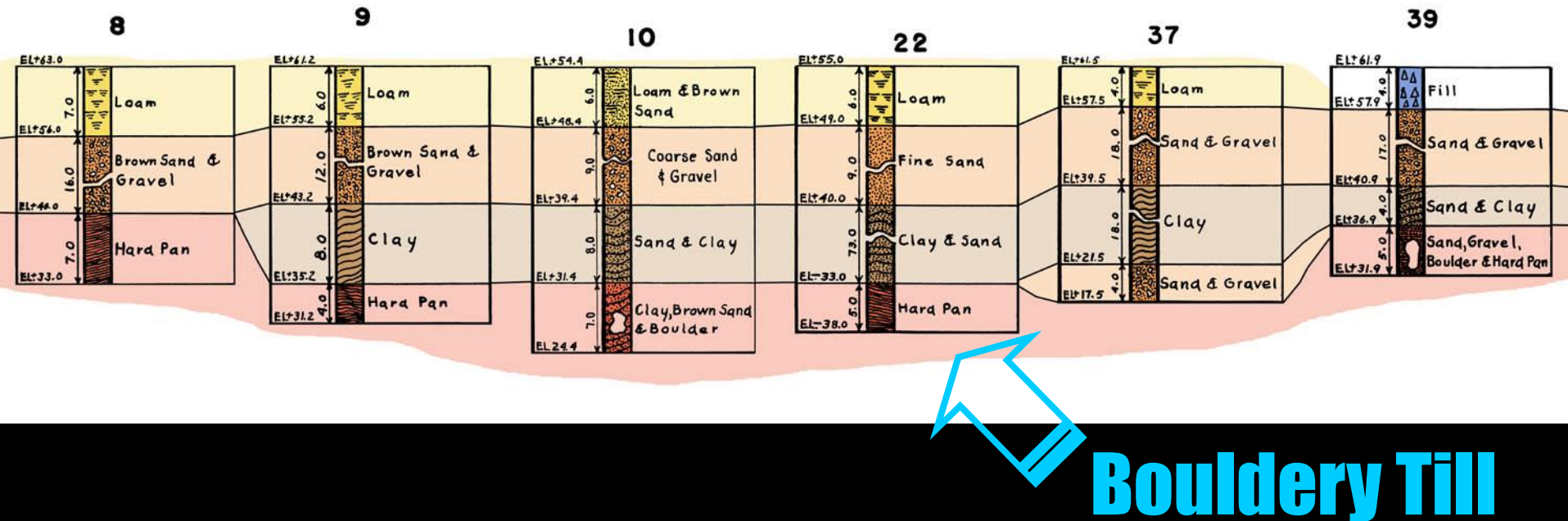


Merguerian 2002

Bronx River Drainage Anomaly



Burke Avenue Profile – Bronx WPA

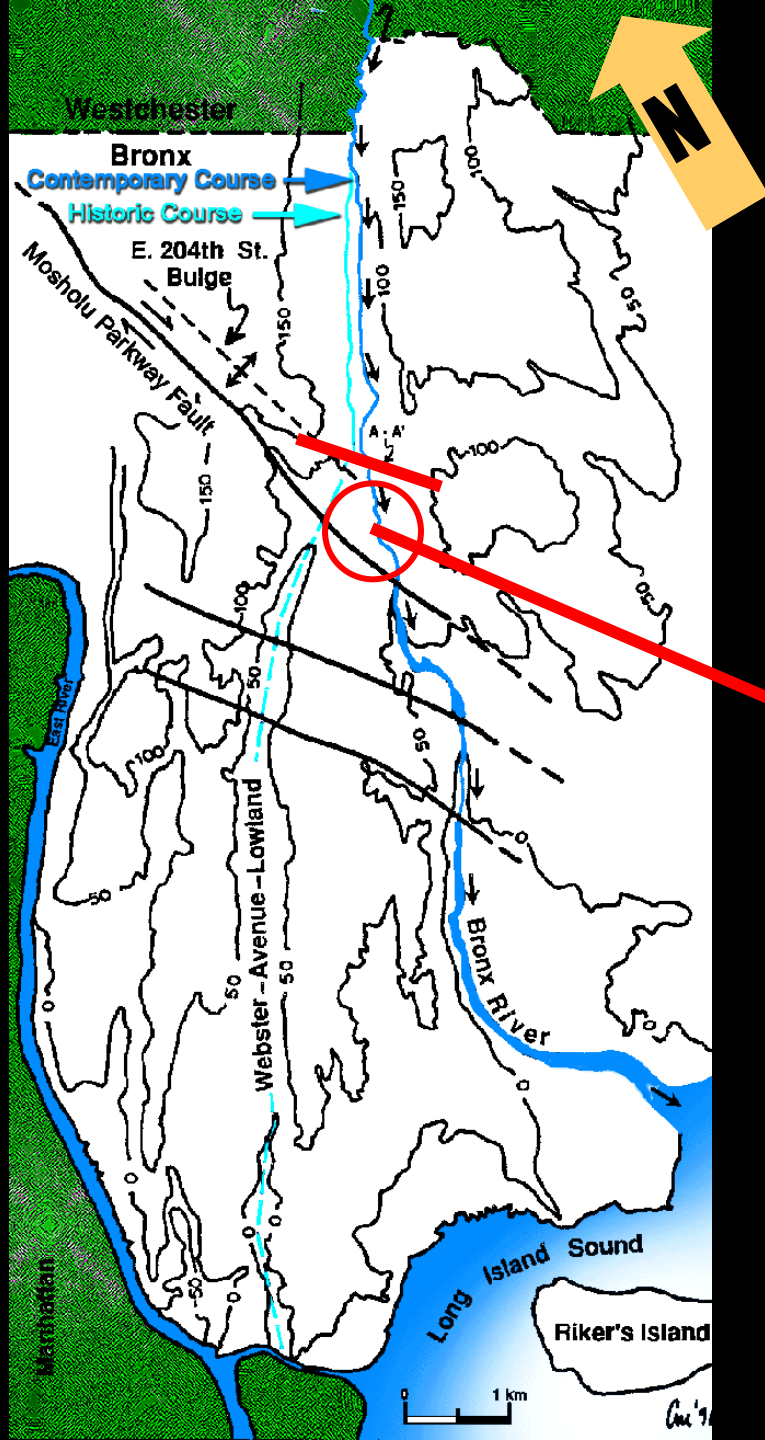


Stratified Lake Sediment Overlie Glacial Drift
Supports Hypothesis that Damming of Bronx River
was Post-Glacial

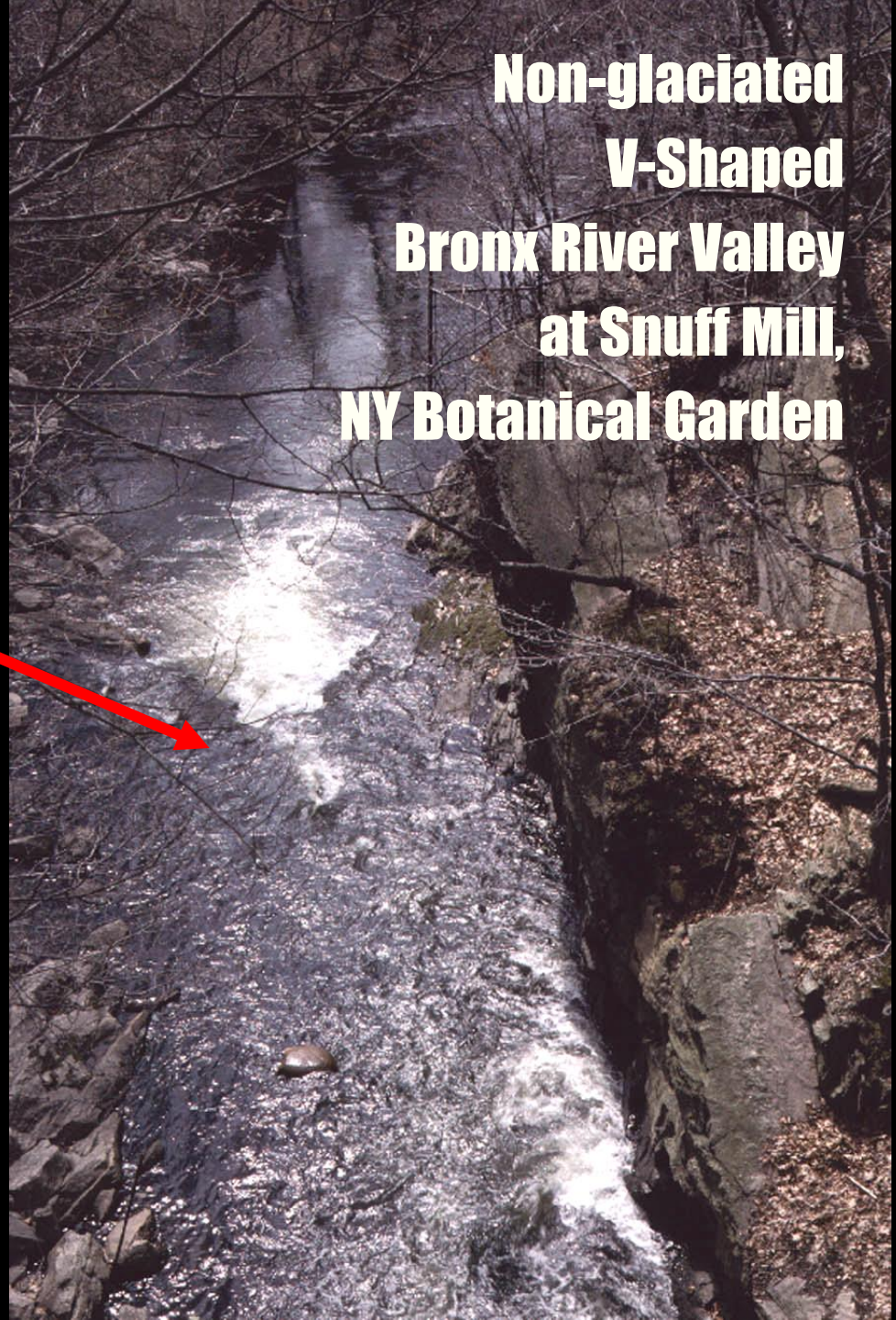


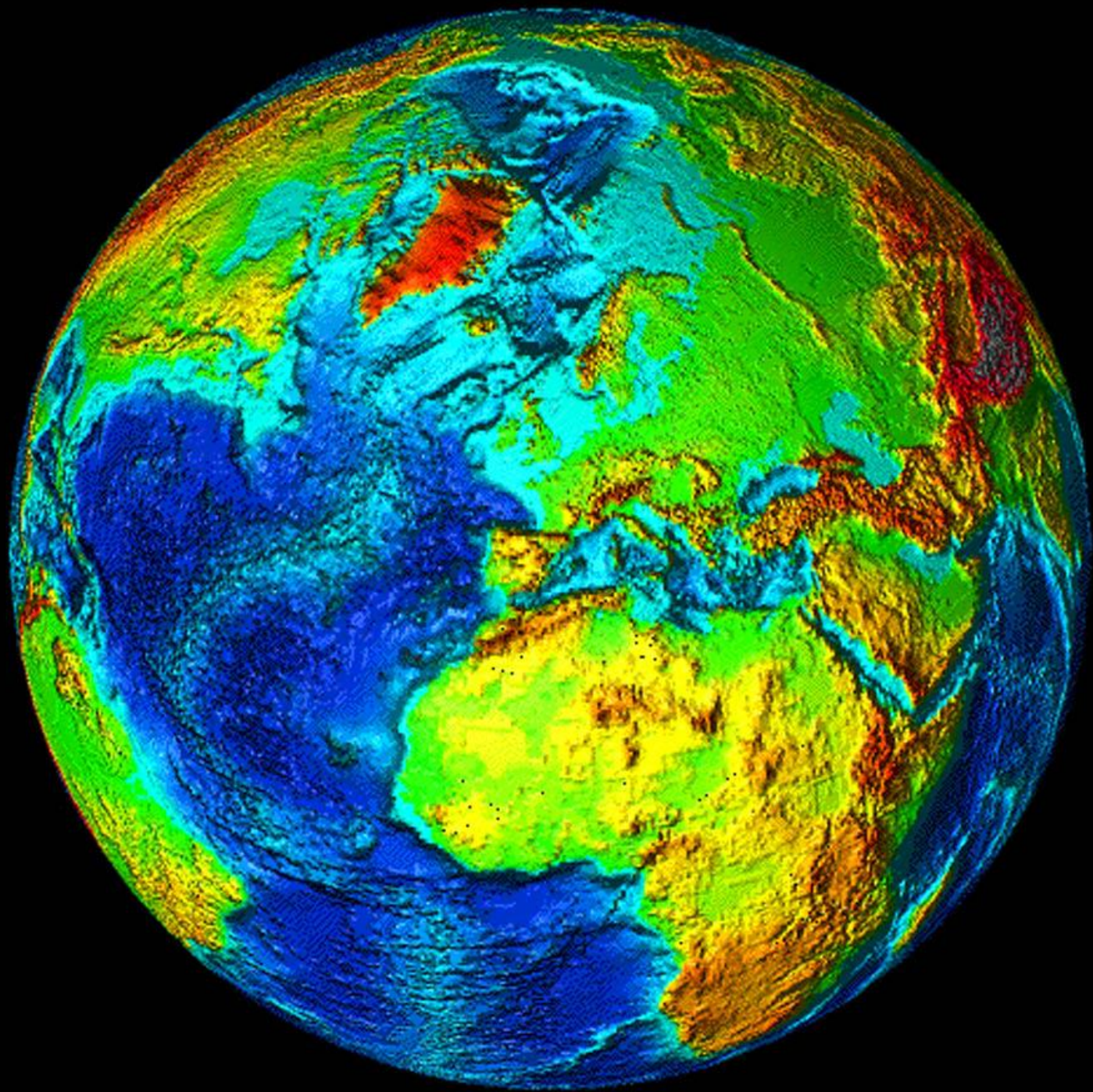
**NW-Trending
Joints**

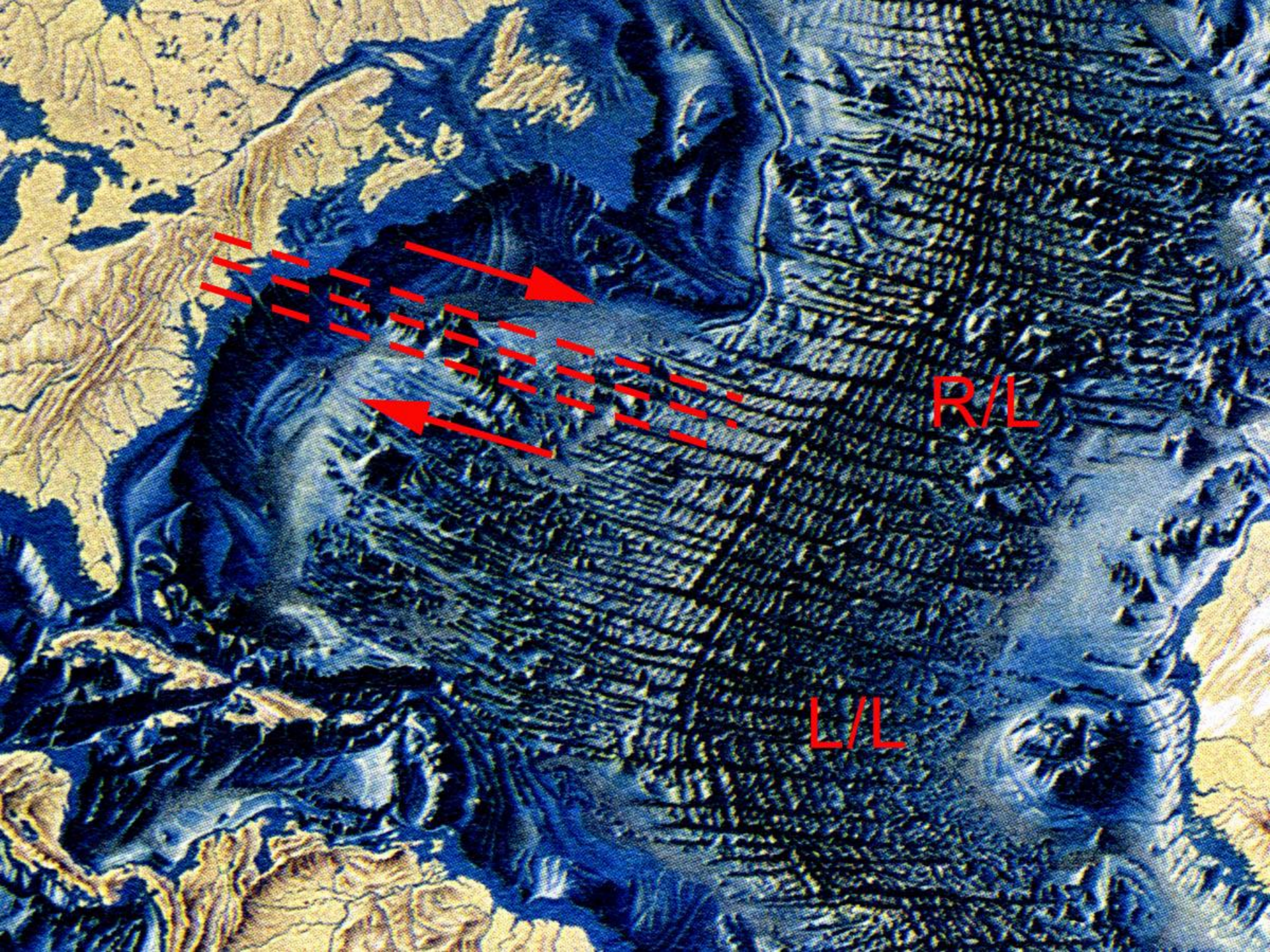
NW Joints, Moshulu Fault, Bronx, NY



**Non-glaciated
V-Shaped
Bronx River Valley
at Snuff Mill,
NY Botanical Garden**









New York City Earthquake Can it Happen Here?

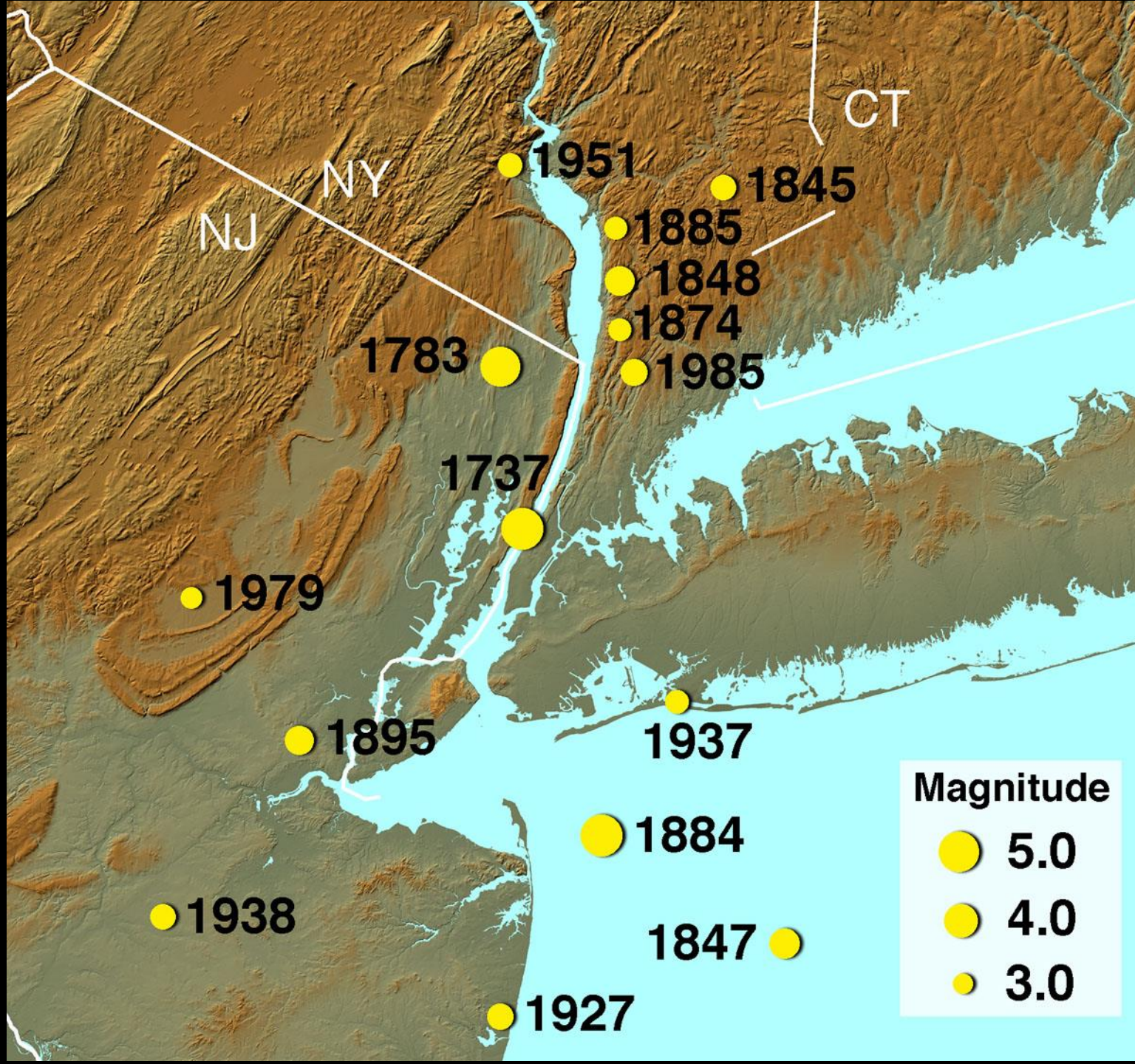
1737 5.2

1783 4.9

1884 5.2

2031 ?







**How Well Will
NYC Withstand
A Moderate
Earthquake?**

How is NYC Built?

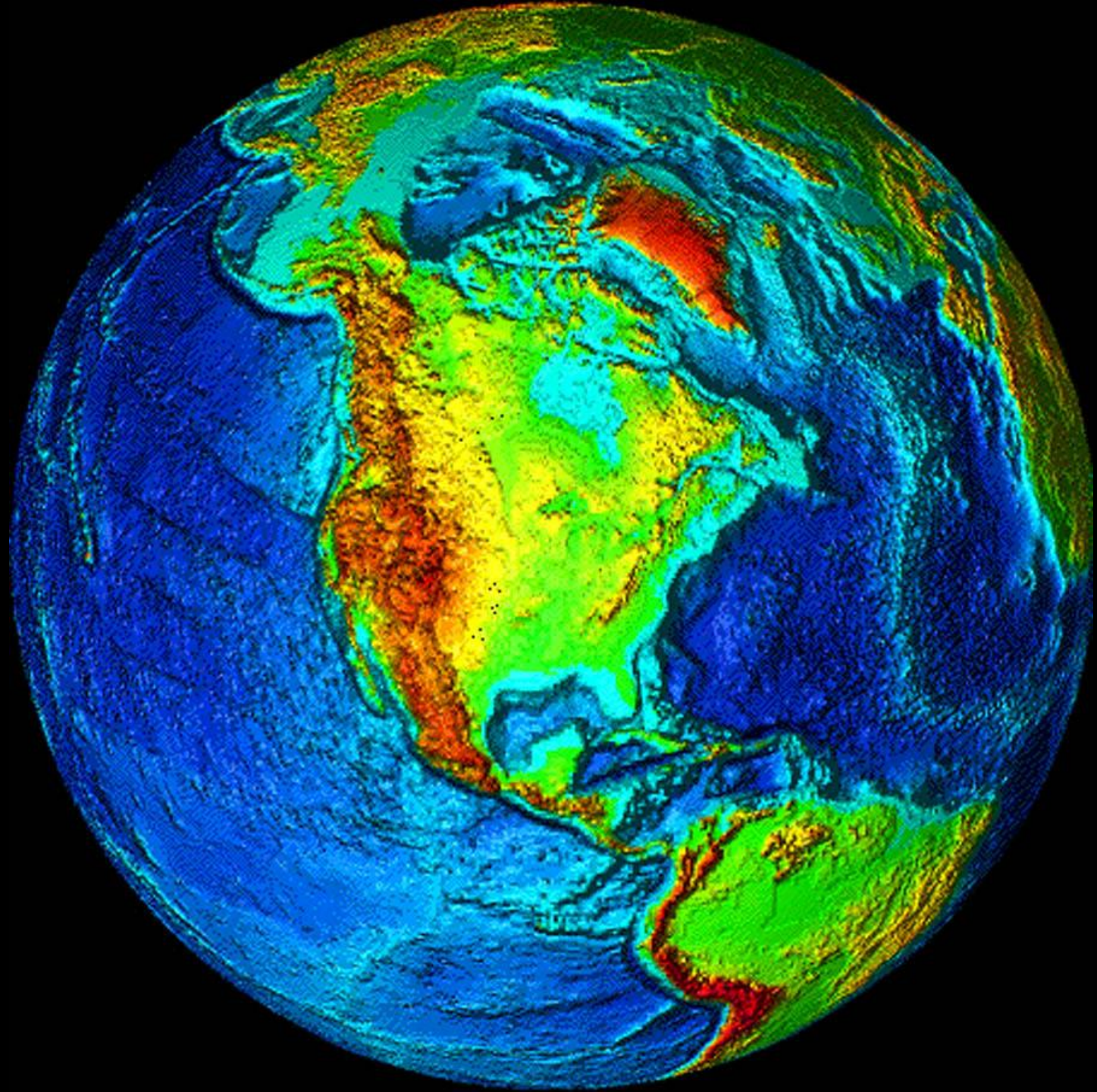


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CharlesM@

**What's All
That
Shaking?**



EXTRA SLIDES



A photograph of a stream bed composed of dark, wet rocks. Numerous sharp, conical rock features, known as hoodoos or spires, are scattered across the bed, particularly in the center and right side. The water in the stream is shallow and clear, reflecting the surrounding green foliage and the dark rocks. The background shows a dense forest with green leaves, suggesting a temperate or tropical environment. The overall scene is a natural, geological landscape.

Late Paleozoic Bedrock Features

NW Joints, Mosholu Fault, Bronx, NY

NW-Trending
Joints



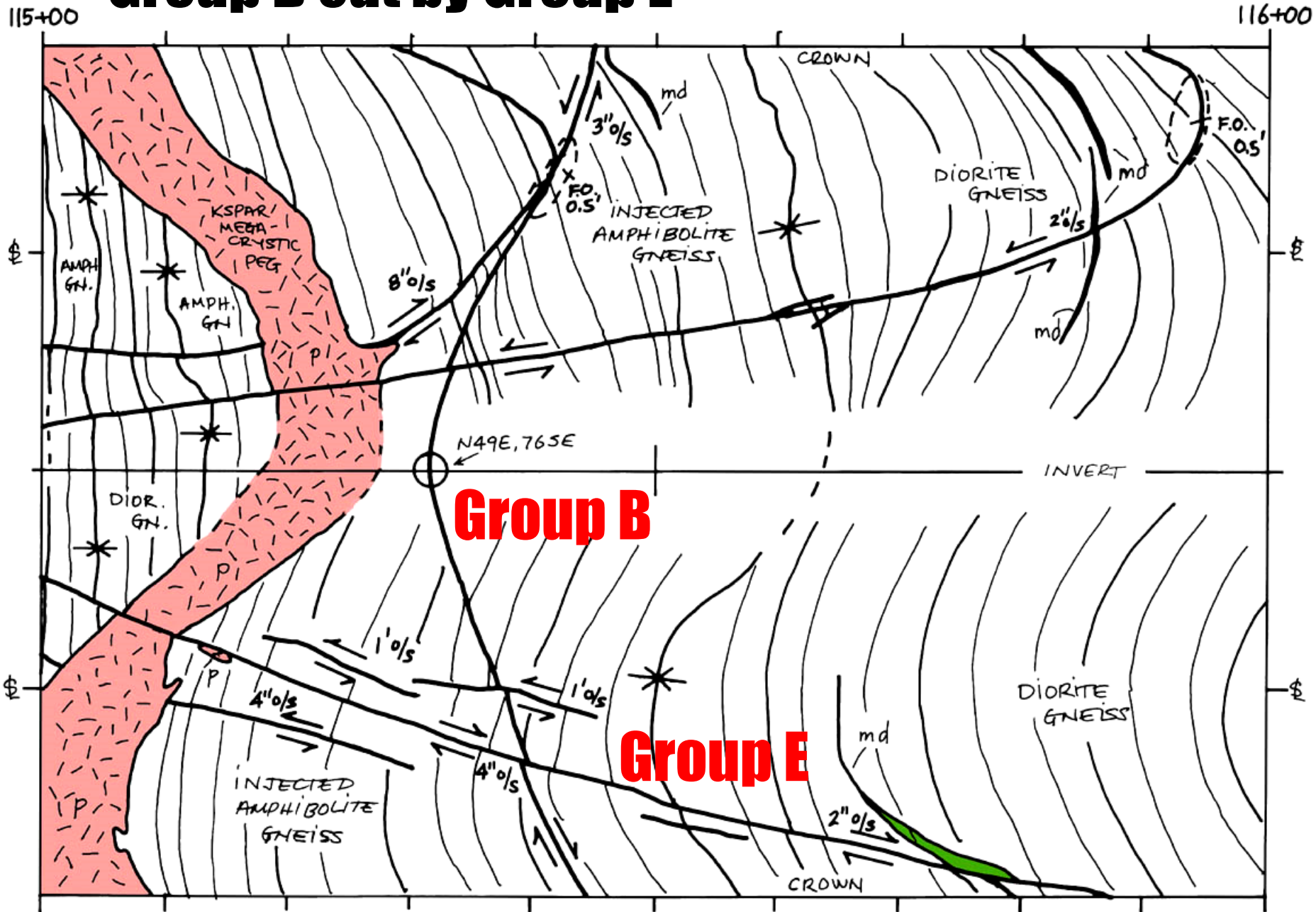
NNW-Trending “Manhattanville” Strike-Slip Faults

**Splays and Conjugate
Joints**

Queens Tunnel Sta. 75+85



Group B cut by Group E



Crown Failure in Overstressed Rock

Queens Tunnel Sta. 253+40

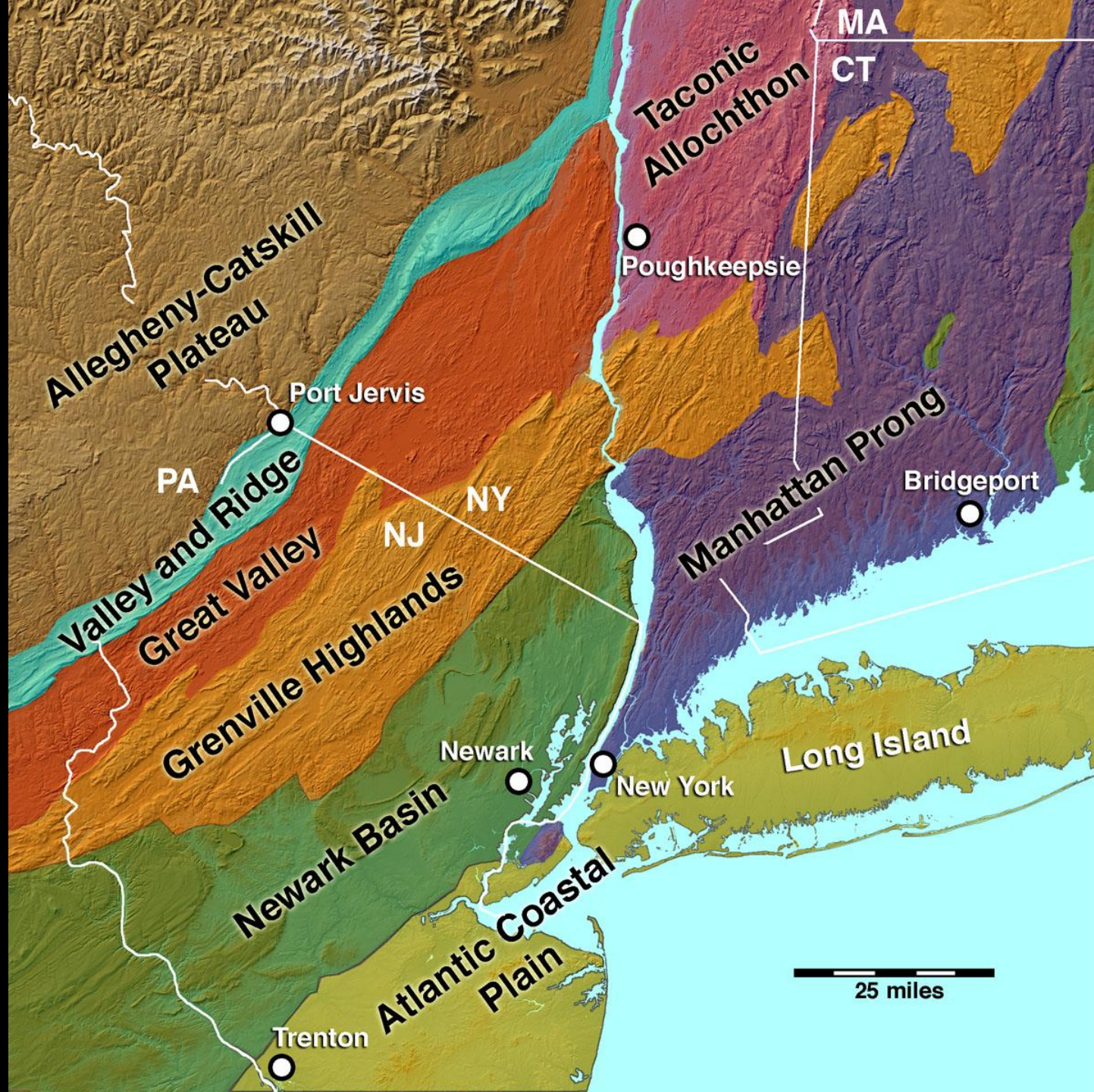




N569 Mylonitic C0m



Retrograde Muscovite after Kyanite



N42°E-Trending Left-Lateral Fault, South Twin Is., NY





N66°W R/L Fault, So. Twin Is., NY