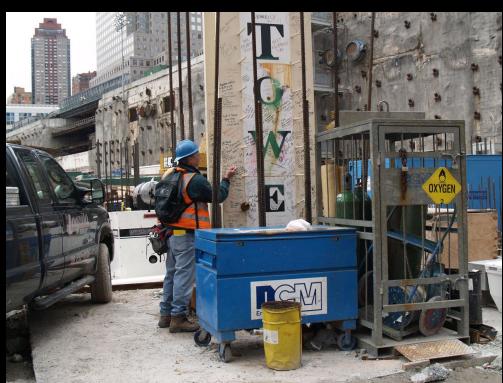
Geology of the World Trade Center

Perspectives on the Geology of New York City

Charles Merguerian
Hofstra University Geology Dept.







Thanks To:

Cheryl Moss Bob Reina Pablo Lopez Jim Tantella



Mueser Rutledge Consulting Engineers

Elizabeth Guise and Mickey Merguerian HCLAS FRDG Grants Many Students Over 29 Years at Hofstra

- Some Still With Us!





and, the "get-it-done" staff at Duke Geological Labs





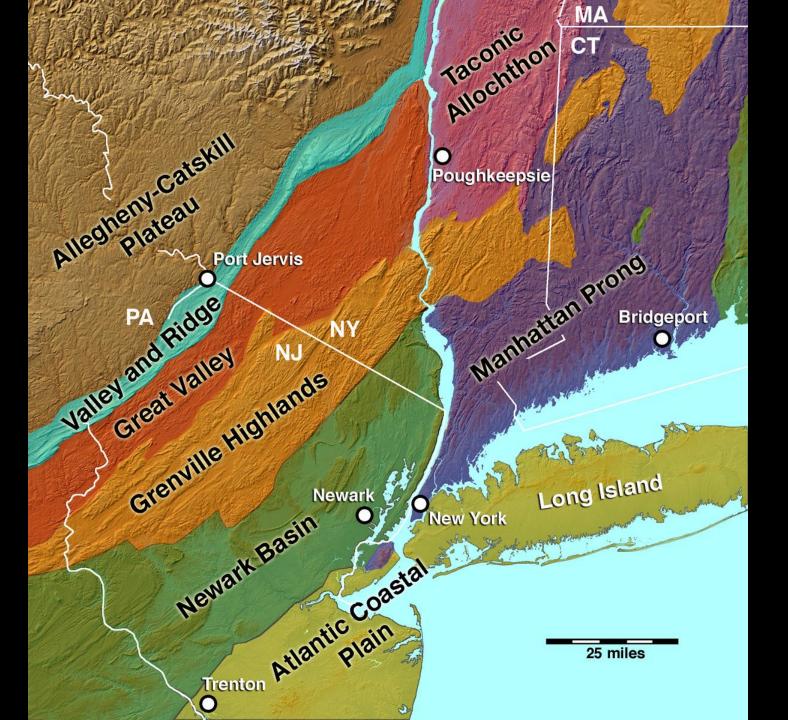




Perfectly
Described by
Bela Lugosi *in*The Black Cat
(1934)



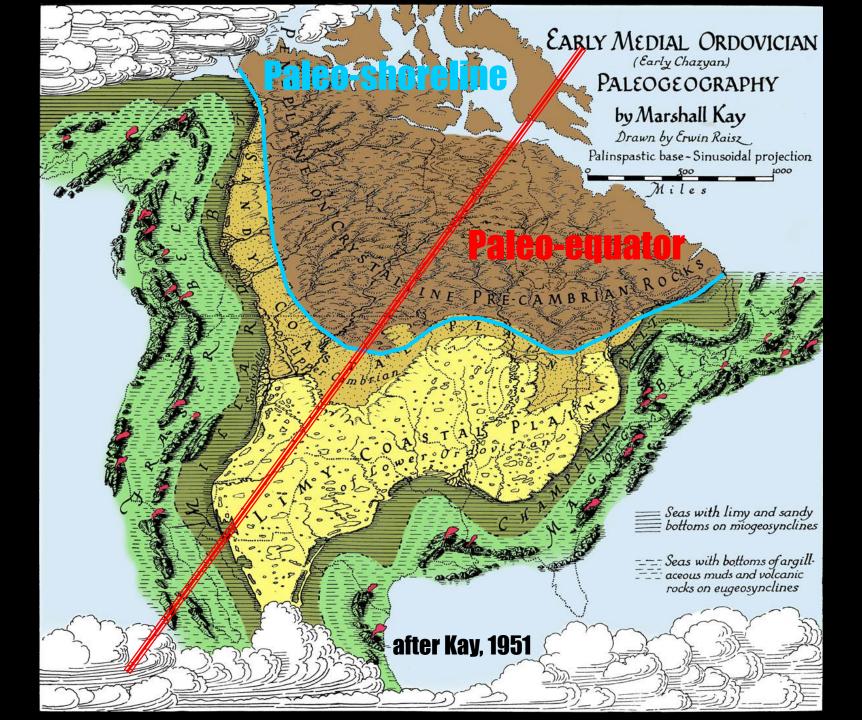
The History Channel: Super City – New York 22 September 2008

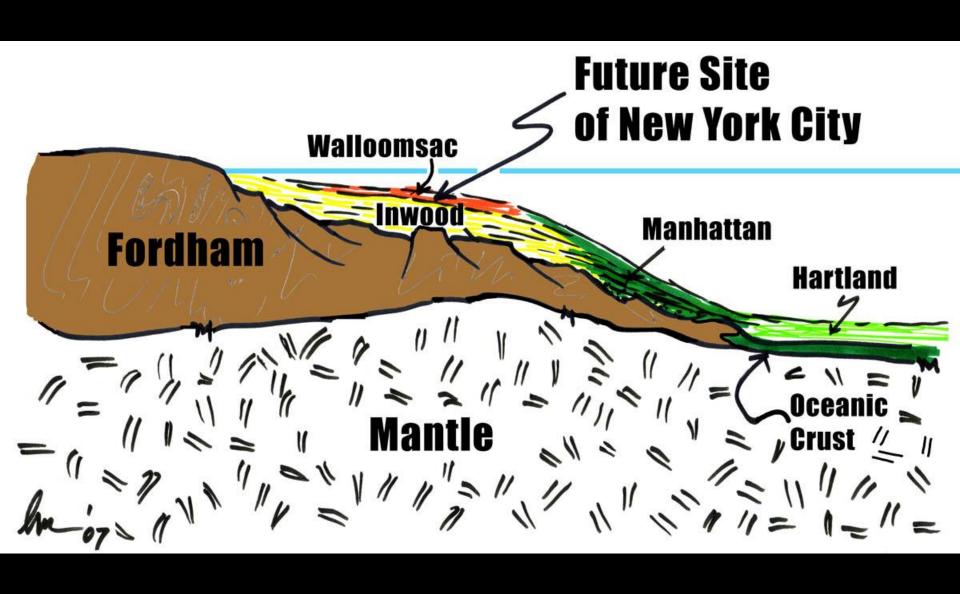




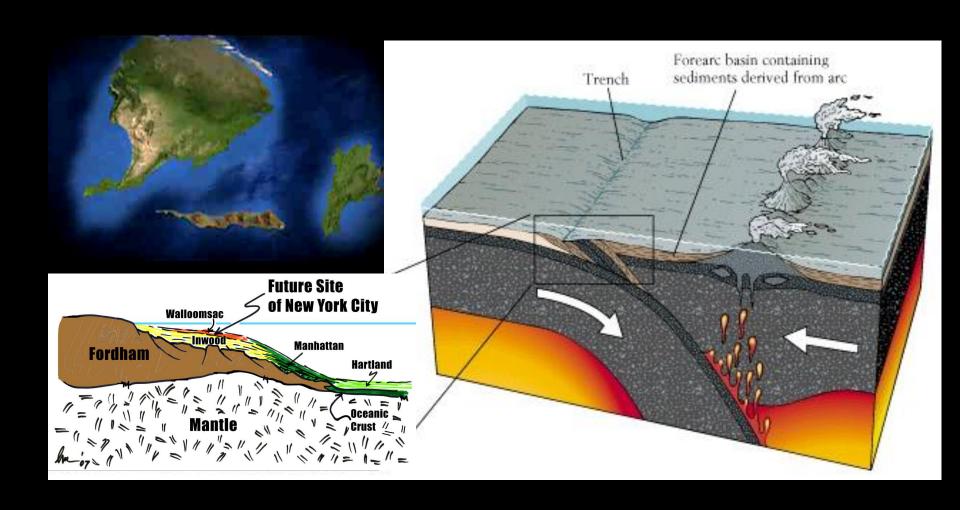
Let's Go Back In Time From Today to the Cambrian!



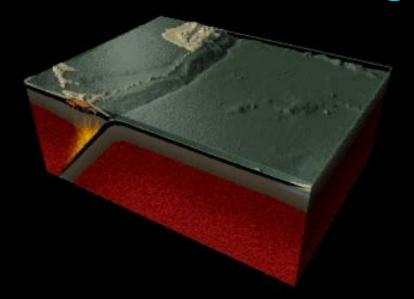


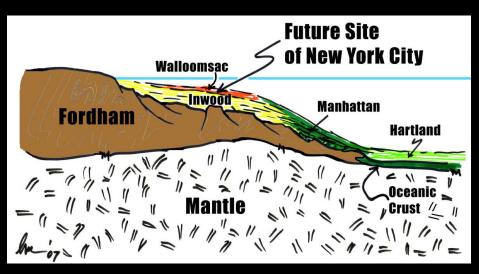


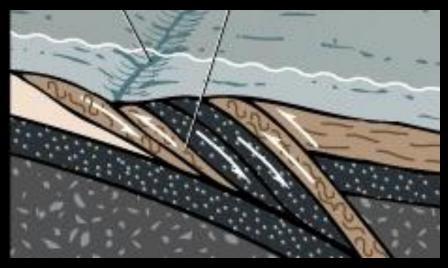
~ 450 Ma Taconic Arc – Passive Margin Collision

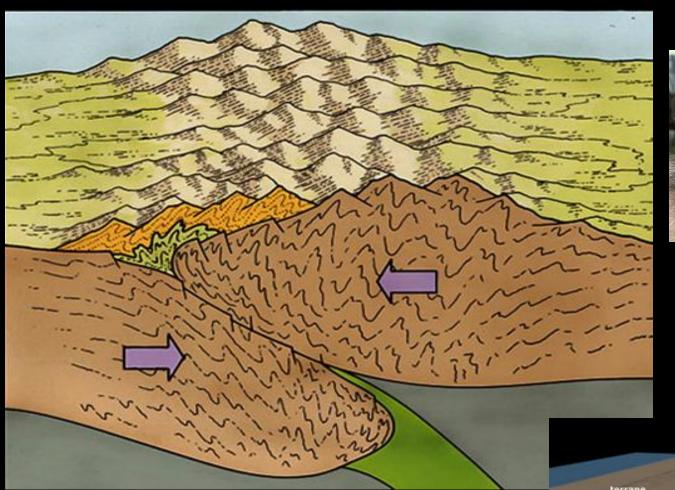


~ 450 Ma Taconic Arc – Passive Margin Collision



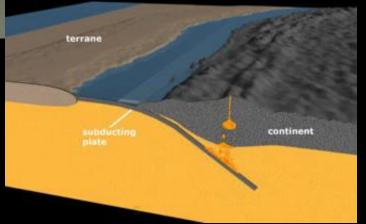








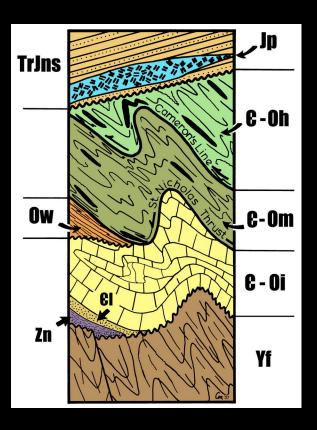
450 Ma to 250 Ma Protracted Plate Collisions Produce the Appalachians



O-Ch Hartland Formation and Manhattan Schist (upper unit) BRONK COUNTY Omm Manhattan Schist (middle unit) Oml Manhattan Schist 0-Eh (lower unit) 0-Ei Inwood Marble HARTLAND TERRANE Fordham Gneiss (HUTCHINSON RIVER GROUP Yonkers Gneiss 0-€h Long Island Sound River 0-€ East HARTLAND TERRANE 0-Eh

Hudson River O-Ch O-Ci O-Ci O-Ci O-Ci O-Ci O-Ci O-Ci O-Ch St. Nicholas thrust O 0.5 1 2 KILOMETER

New York City

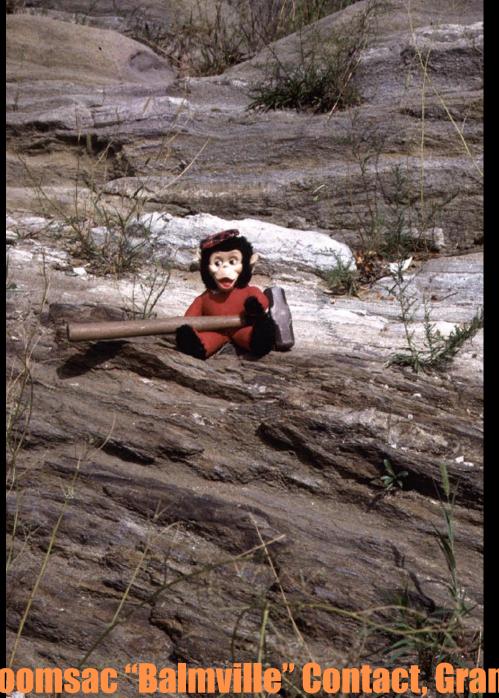


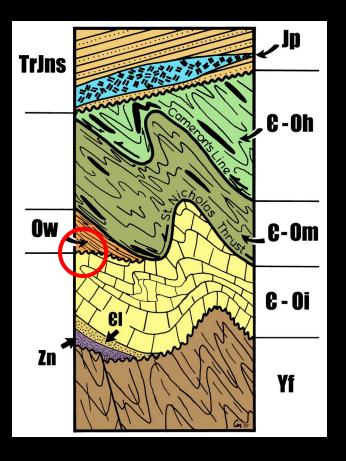
Merguerian, 2001





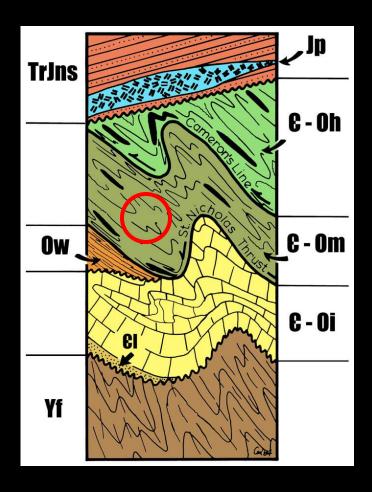






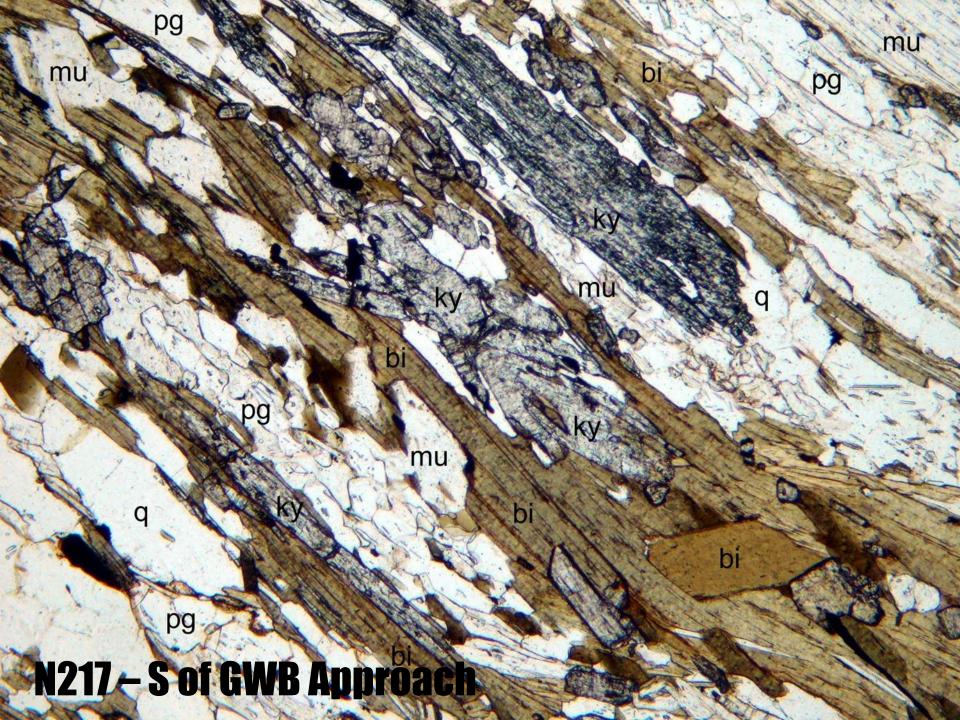
Nalloomsac "Balmville" Contact, Grand Concourse, Bronx, Ny



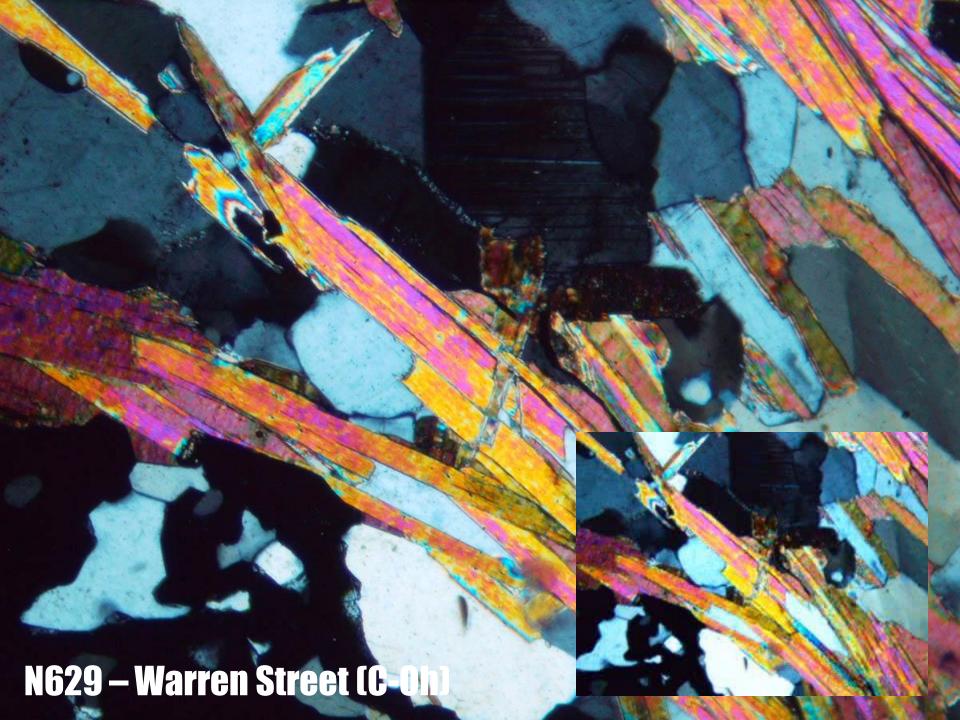


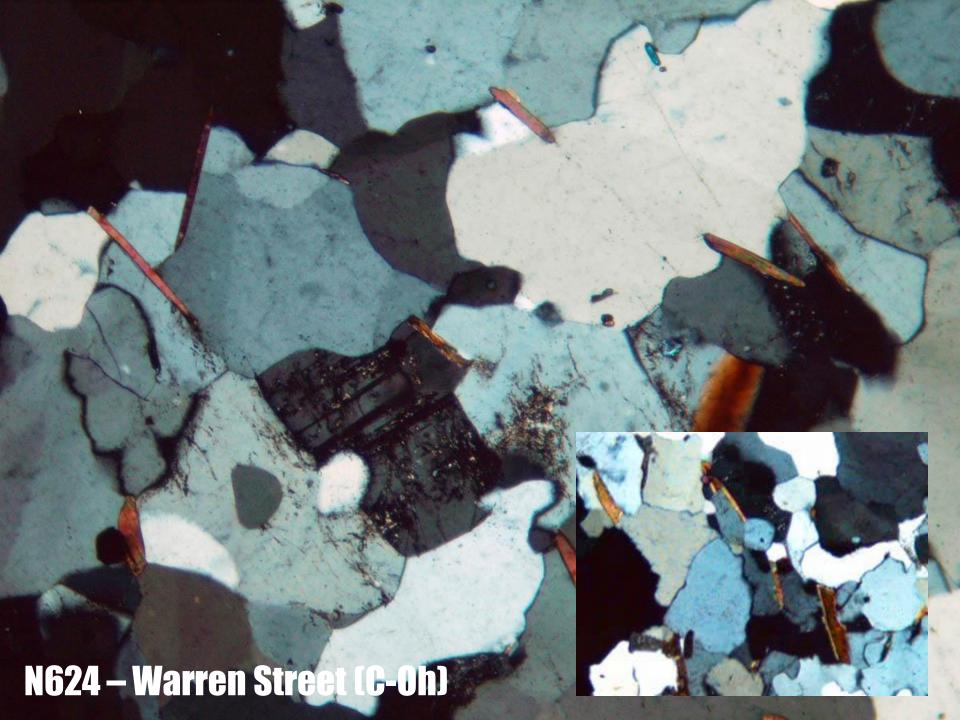
Manhattan Schist F₃ Folds of S₂ Central Park, NYC







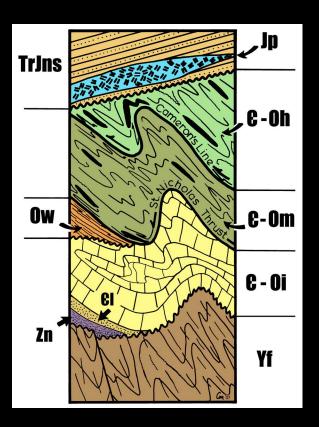






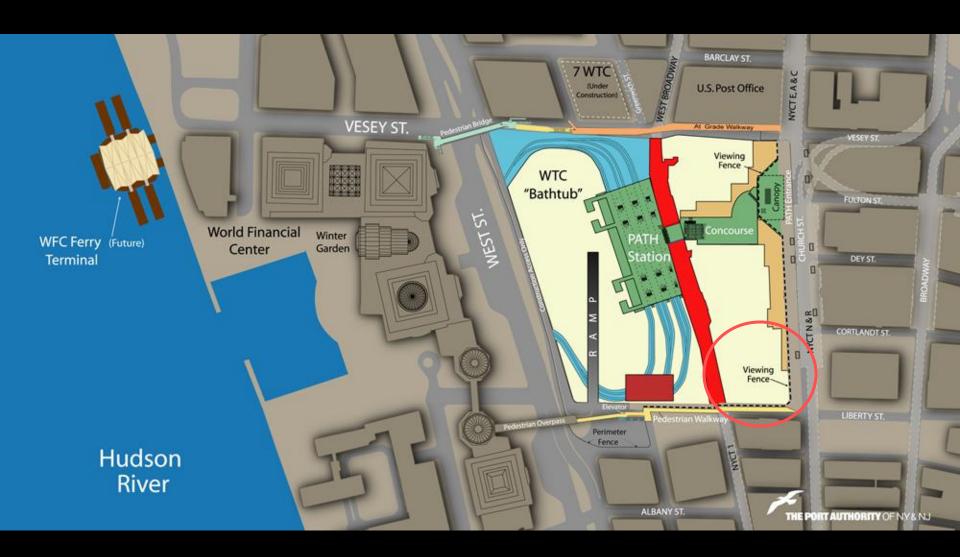
O-€h Hartland Formation and Manhattan Schist (upper unit) BRONX COUNTY Omm Manhattan Schist (middle unit) Oml Manhattan Schist 0-Eh (lower unit) 0-Ei Inwood Marble HARTLAND TERRANE Fordham Gneiss (HUTCHINSON RIVER GROUP Yonkers Gneiss 0-€h Long Island Sound River East TERRANE 0-Eh **Future Site** ST of New York City Walloomsac Inwood Manhattan Fordham Hartland

New York City



Merguerian and Merguerian, 2004



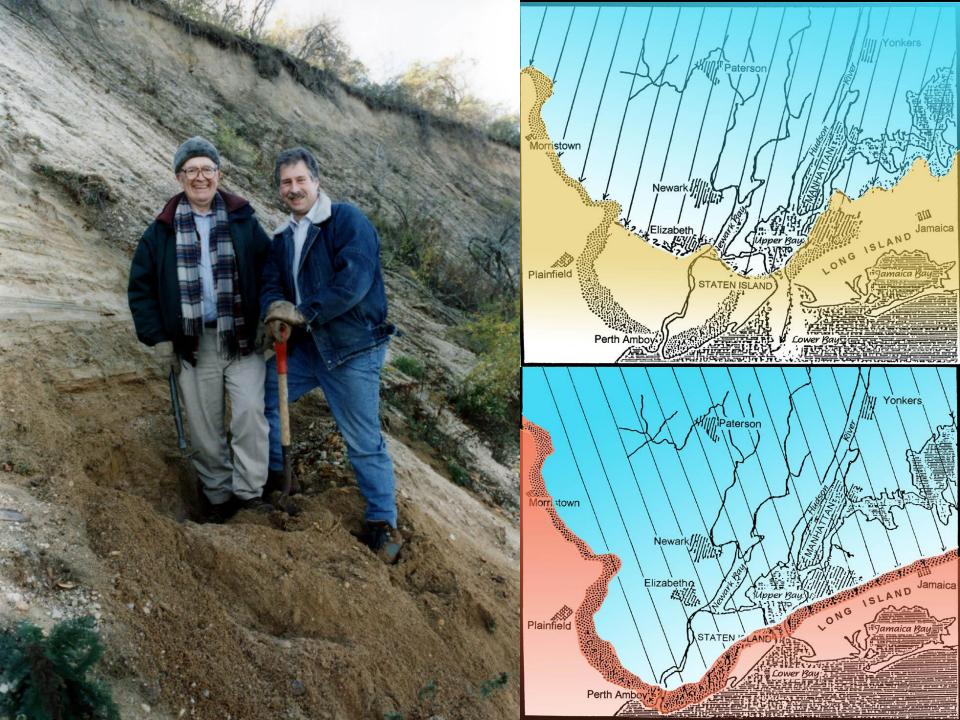






Pleistocene Glaciation



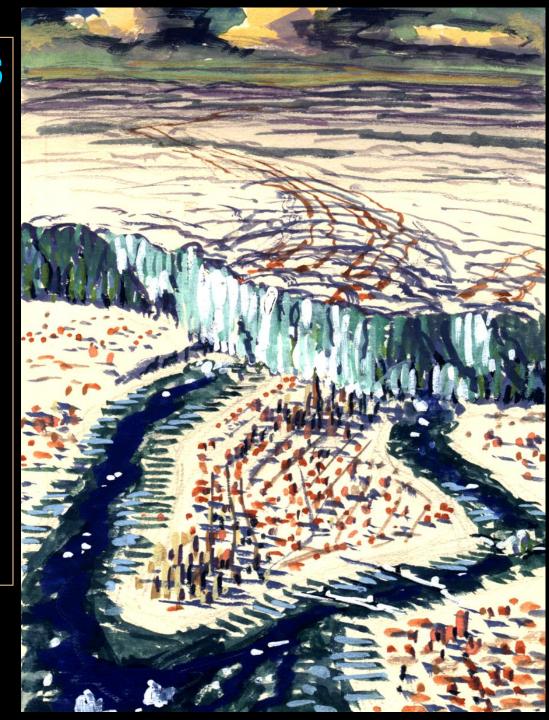


Rock - Paper - Scissors

Paper Covers Rock

Glacier Covers NYC

Not a One-Shot Deal!
Multiple Glaciers
Sculpted and Supplied
Sediment to the
NYC and LI Region





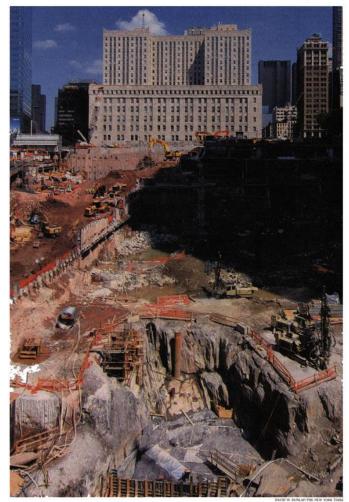
The Metro Section

The New York Times

MONDAY, SEPTEMBER 22, 2008

At Ground Zero, Scenes From the Ice Age

Trade Center Excavation Uncovers a Landscape Carved by Glaciers



A Glimpse of New York City, 18,000 B.C.
Excavation at the World Trade Center site has uncovered, among other geologic features, a 40-foot glacial pothole. Page B4.

Glacial Terrain At Ground Zero

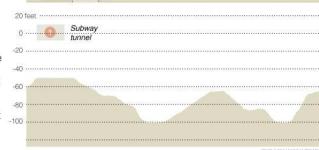
Excavations for Tower 4 at the southeast corner of the World Trade Center site uncovered a landscape carved by glaciers out of bedrock at least 20,000 years ago, with deep pools known as potholes.





BELOW CITY STREETS

Map at upper right shows bedrock contours of the Tower 4 site from above. At right is a cross section. In the measurement scale, 0 is close to sea level and is10 to 20 feet below street level. That means the bottoms of the potholes (-100) are about 110 feet to 120 feet below the street.



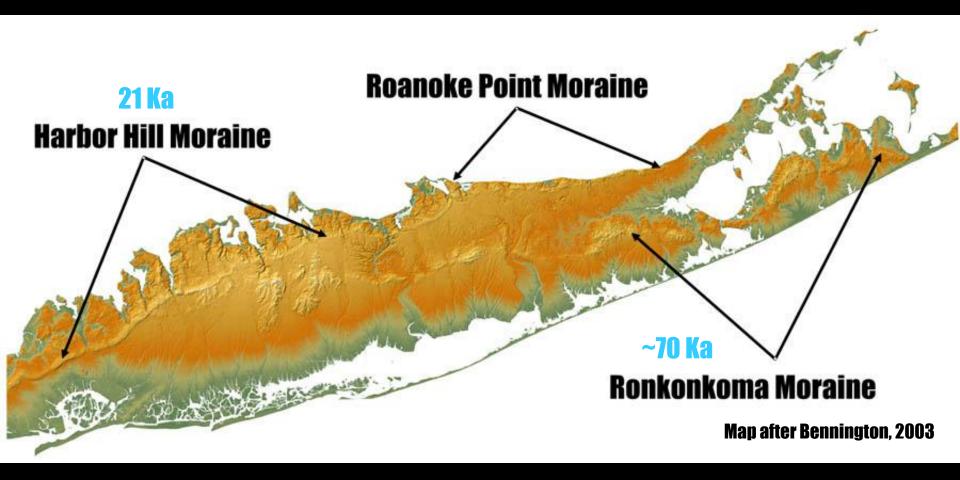








Long Island's Moraines



Most NY Area Glacial Features or Erosion and Deposition Are the Product of NW Advances







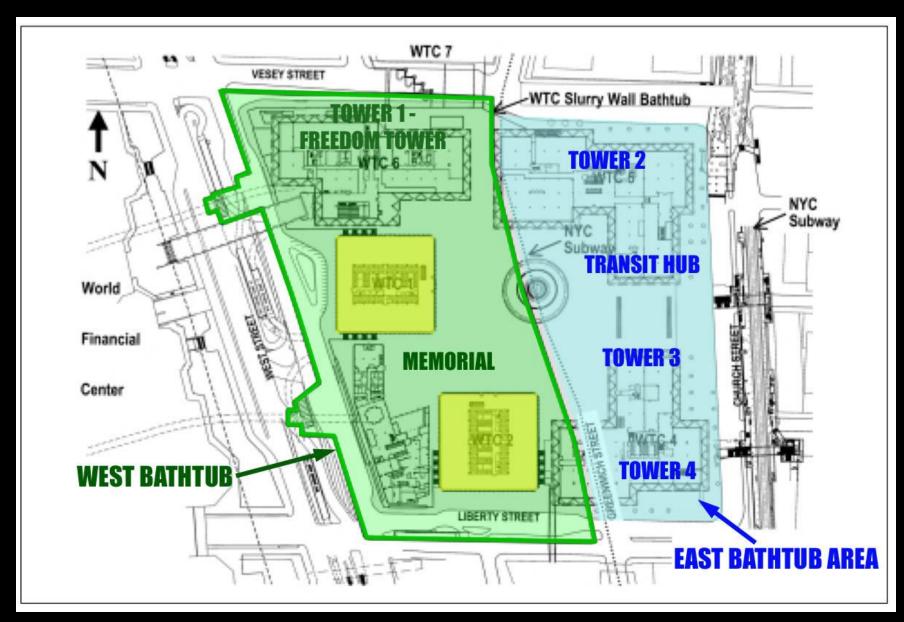
FRDG Funding = 49,500 BP +3050/-2205

Harbor Hill 25 - 19 Ka

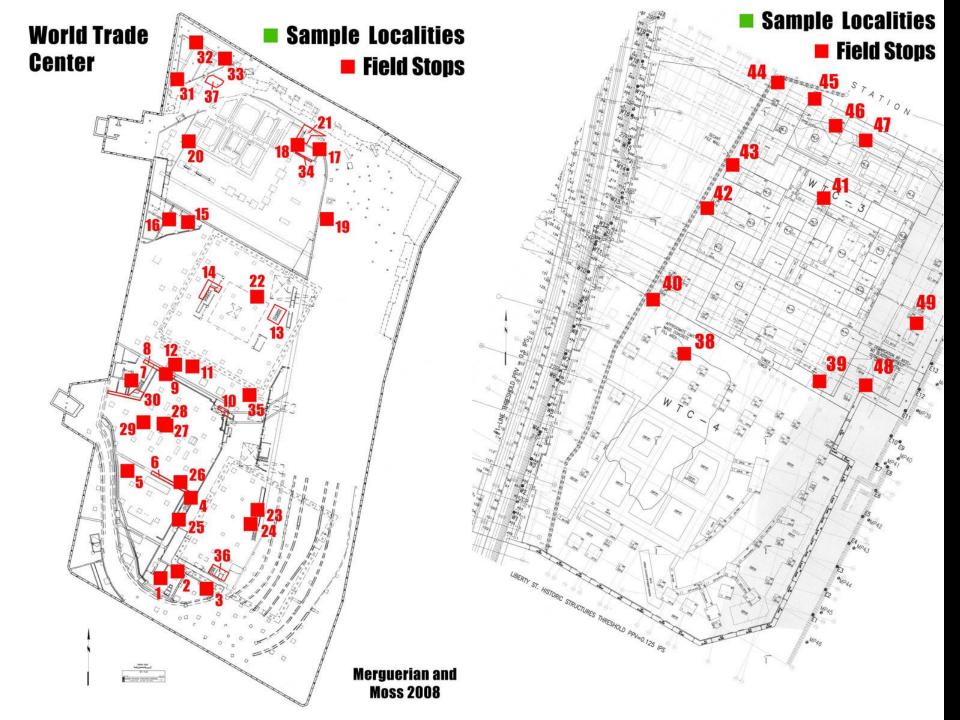
Ronkonkoma ~70 Ka

WHICH GLACIATION?

World Trade Center Site





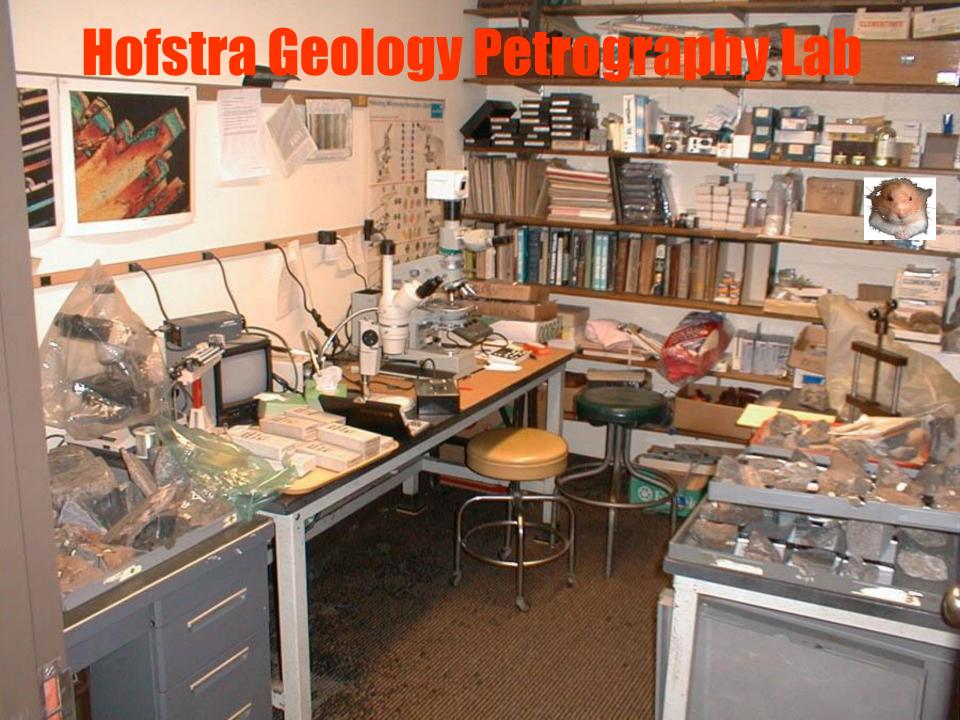




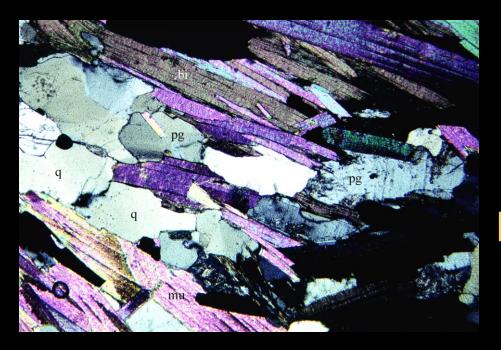
New York City Rock Sample Archive Gittleson Room 110



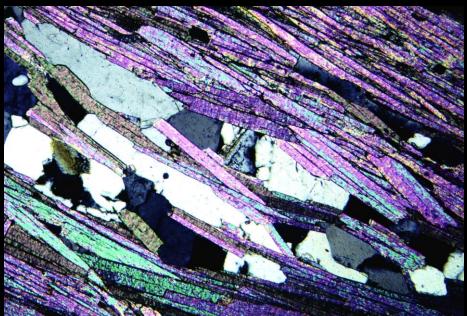








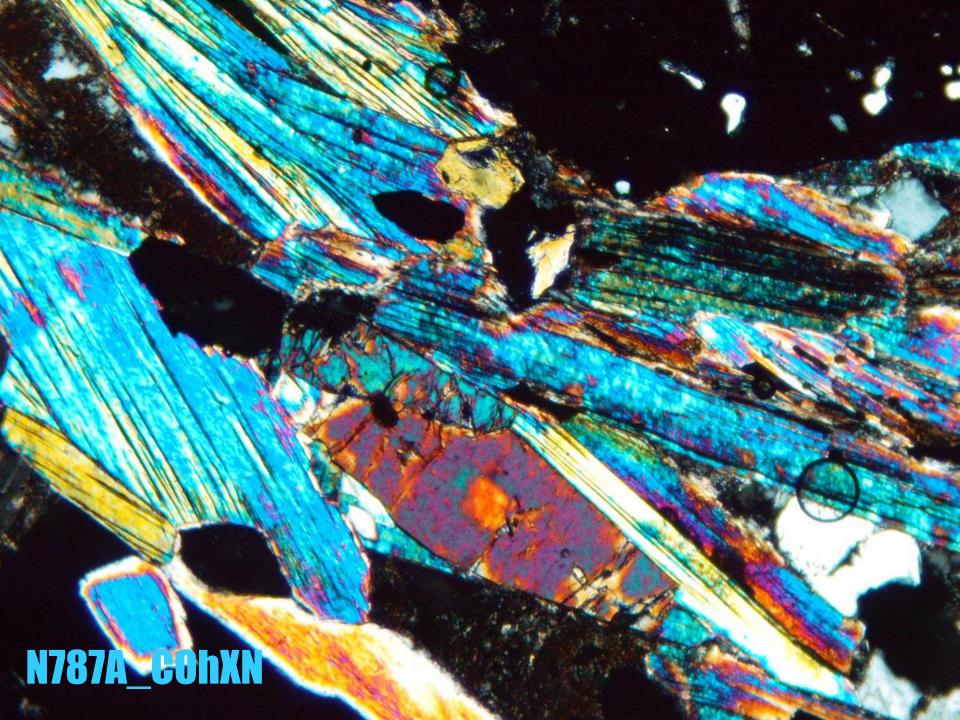
In Western and Central Manhattan:
Amphibolite Facies Schist Well-layered Hartland Fm.
Penetrative Foliated Textures
Great Rocks for Tunneling and Excavation!



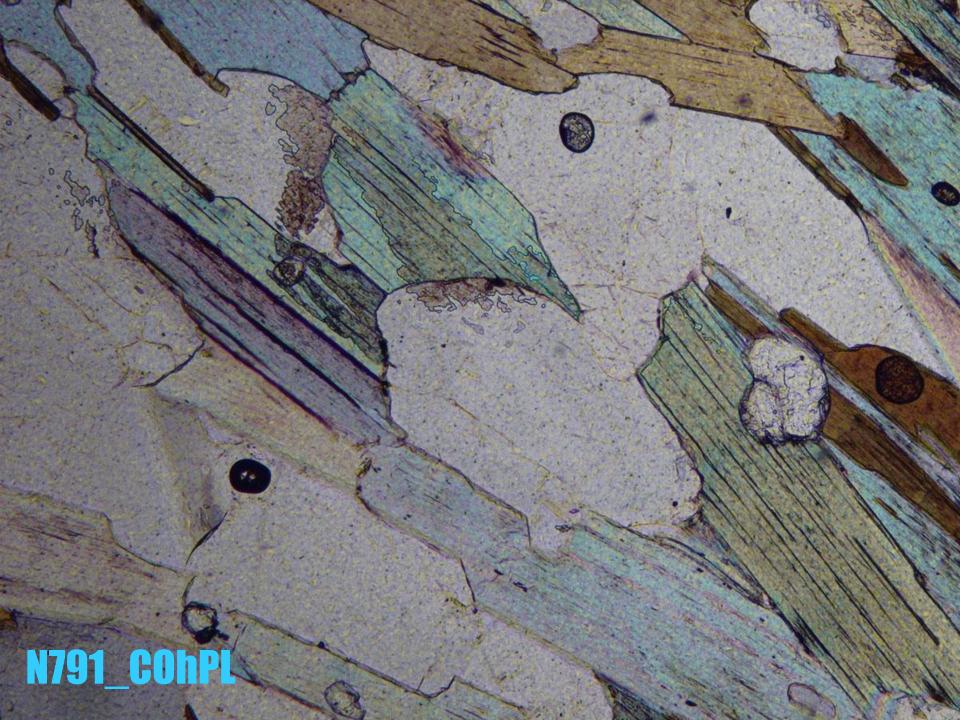


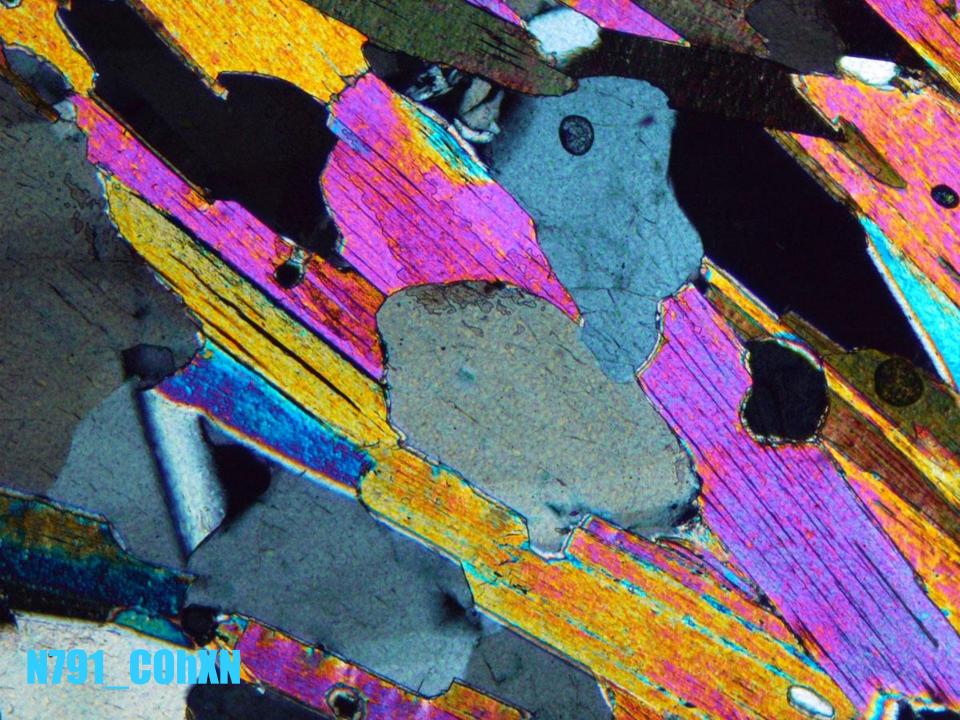




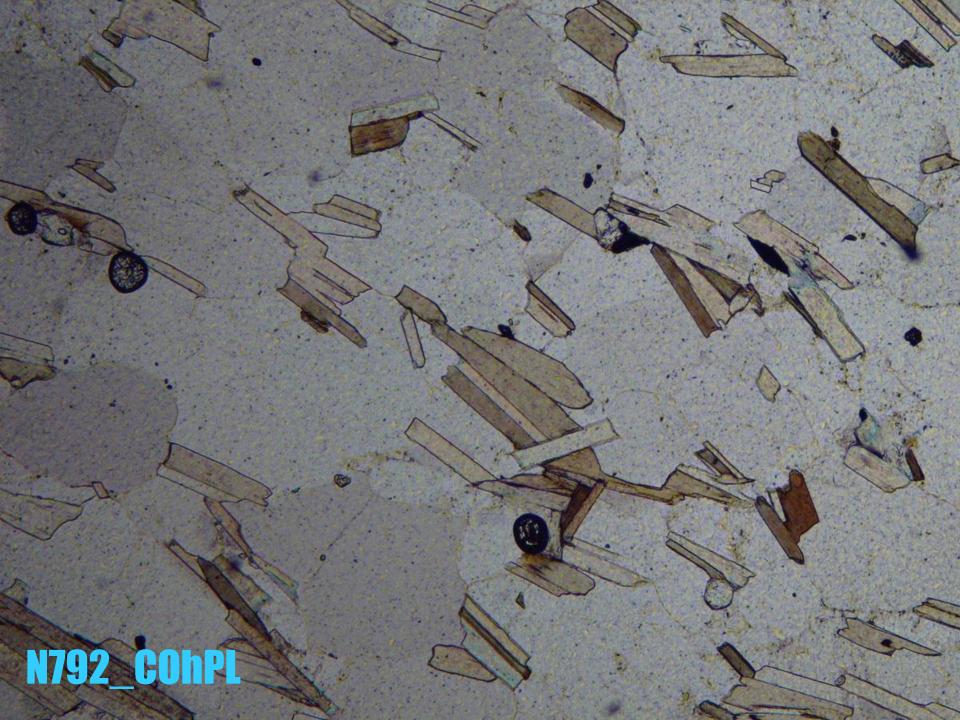


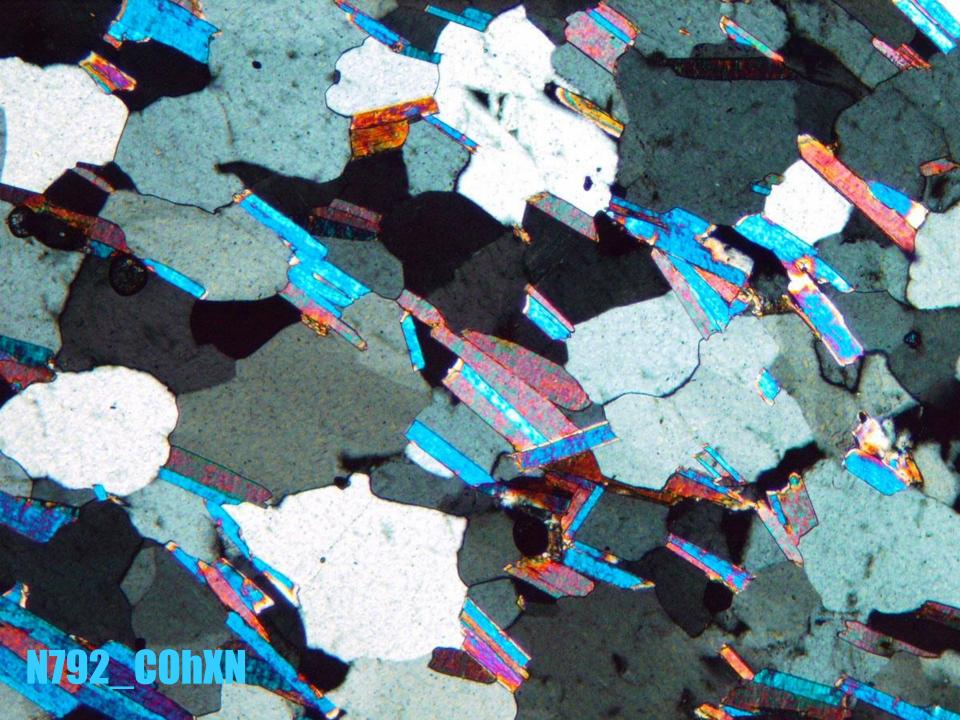






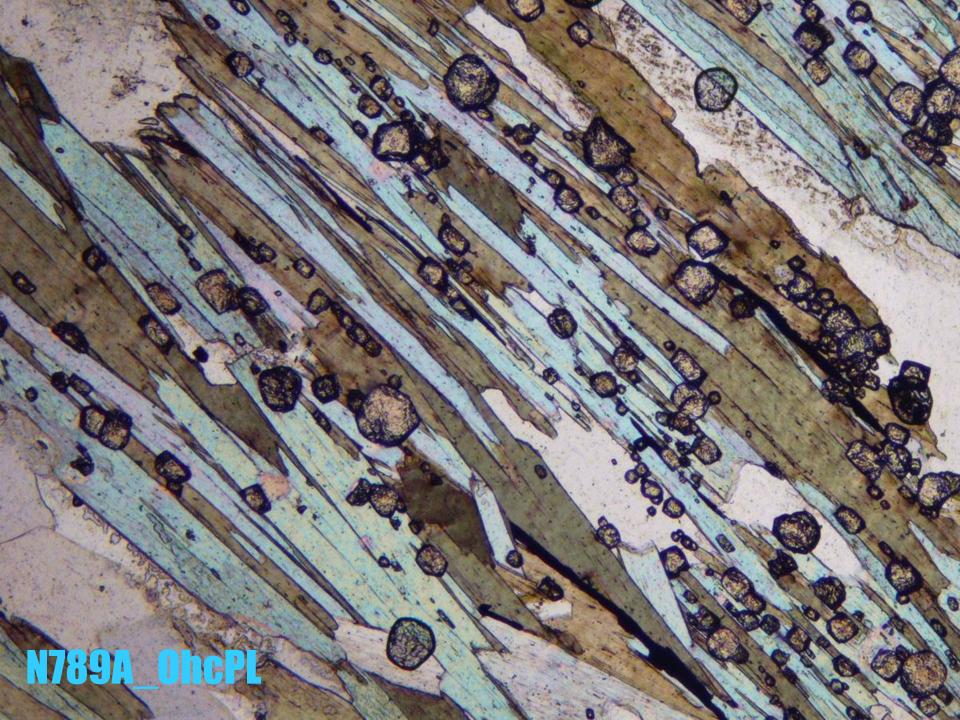


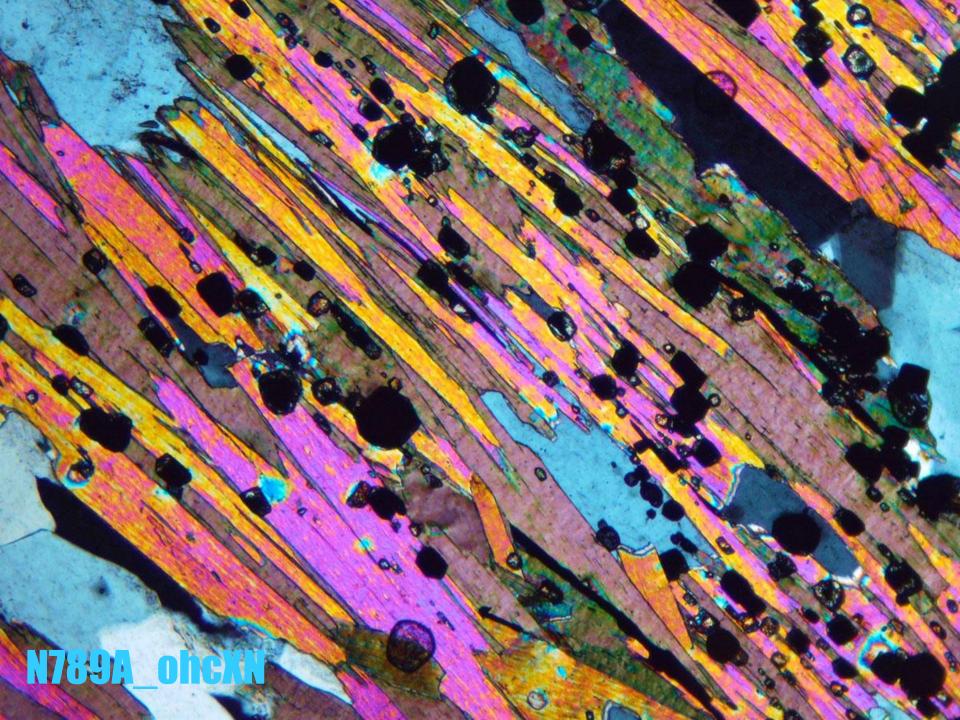


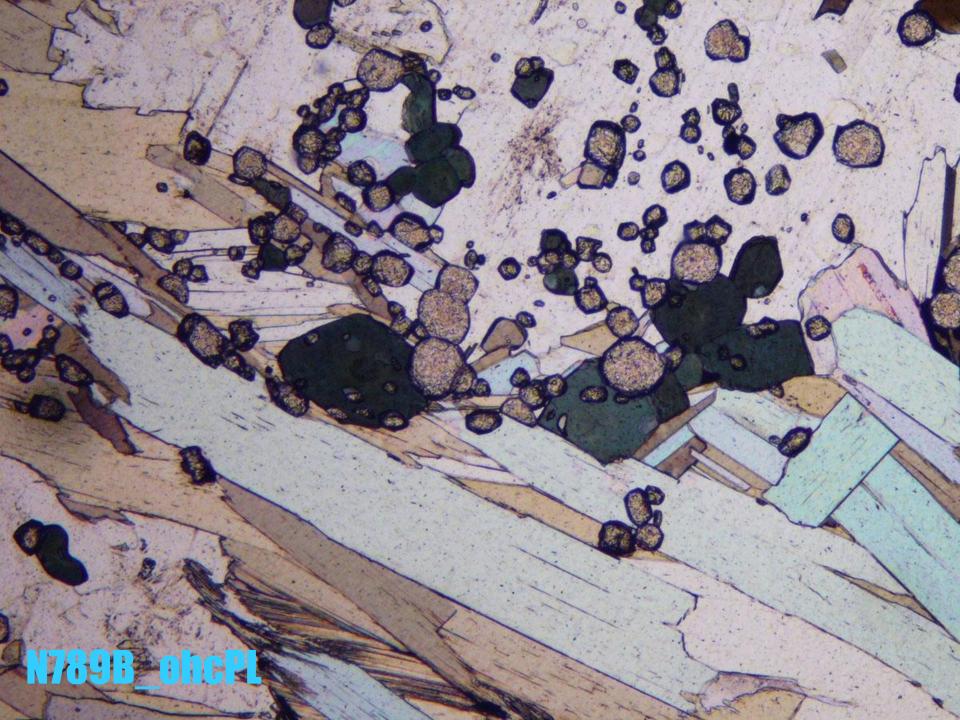


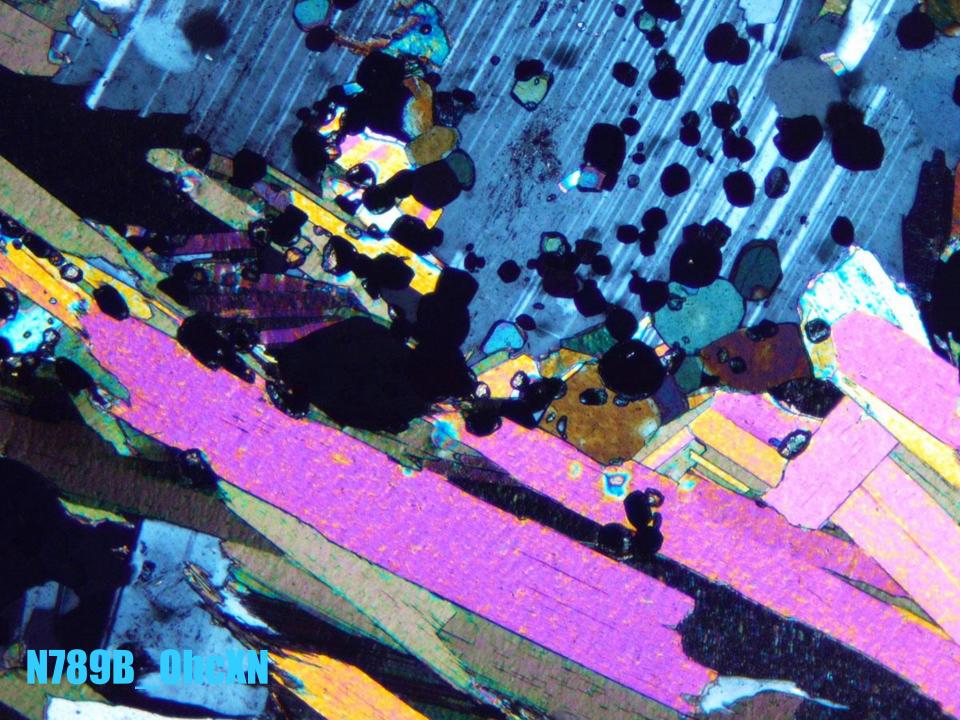


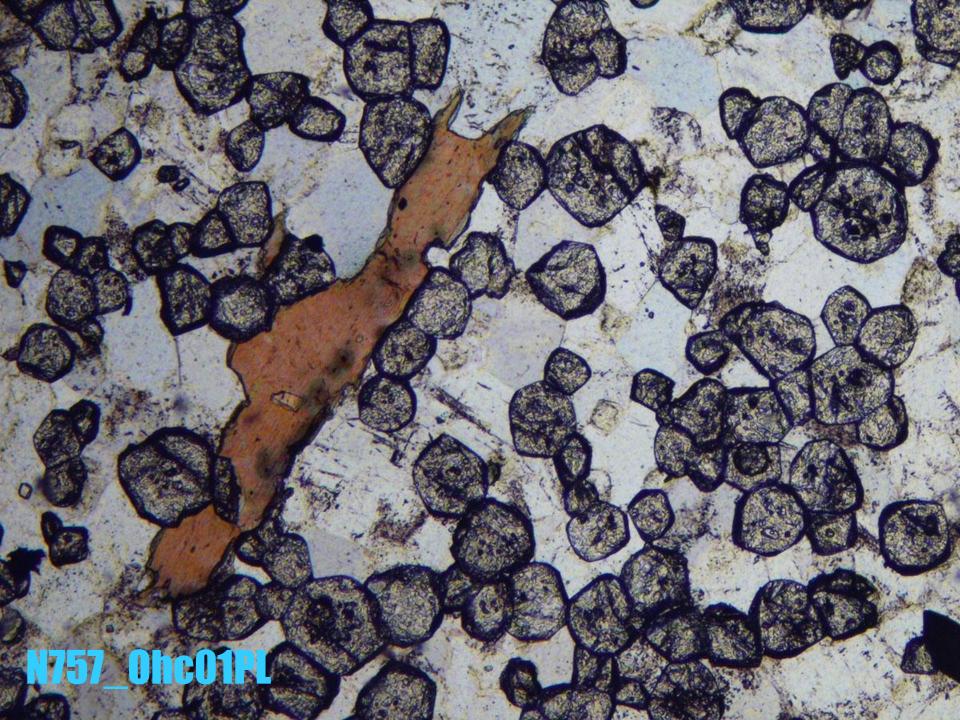


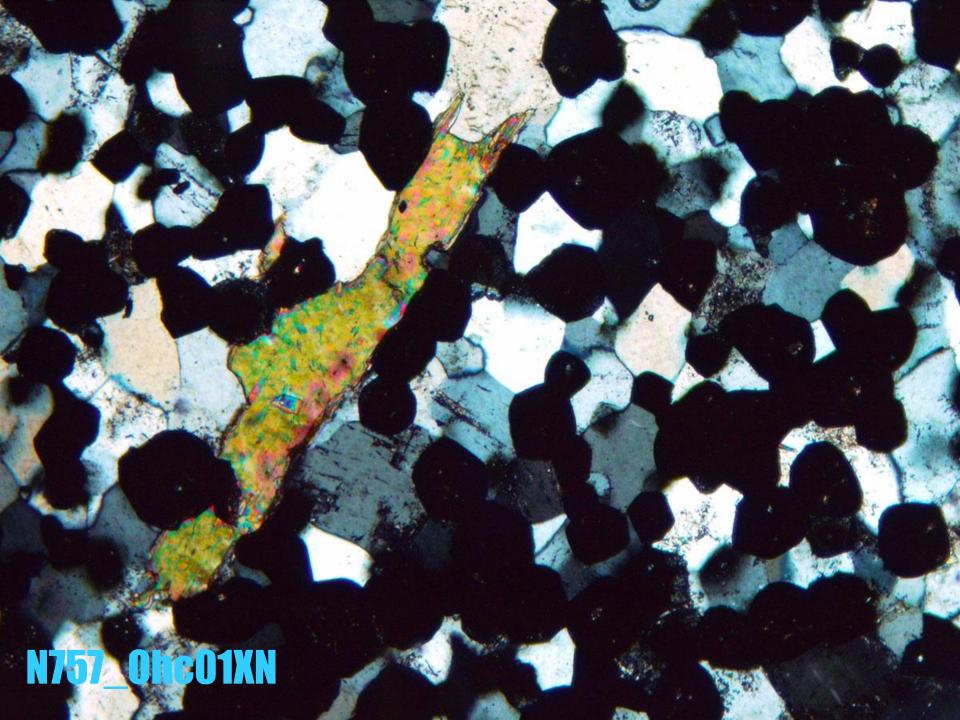




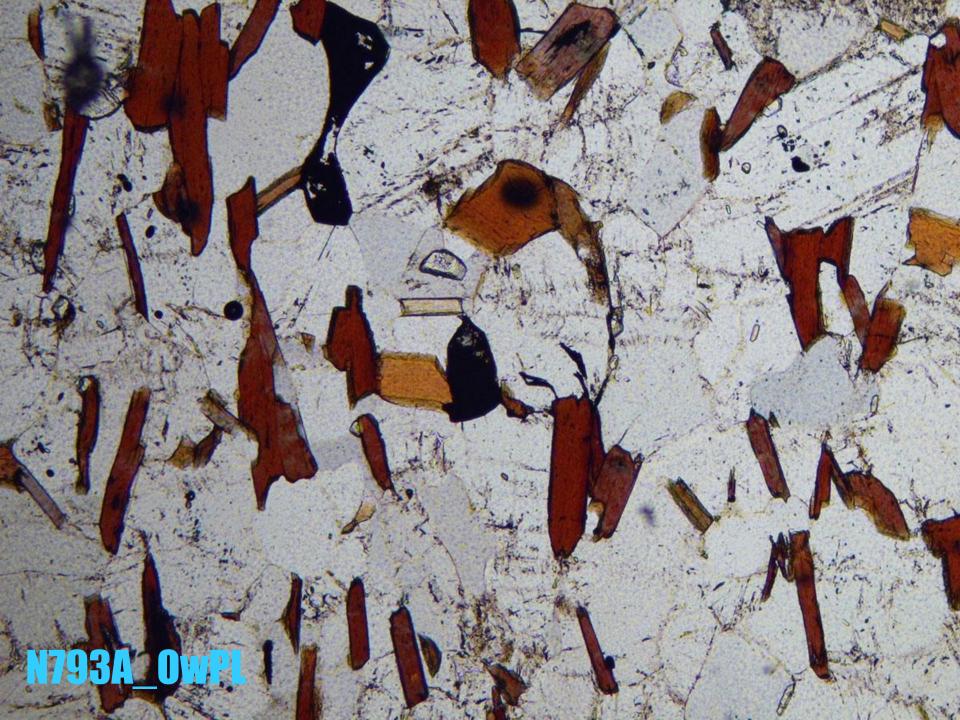


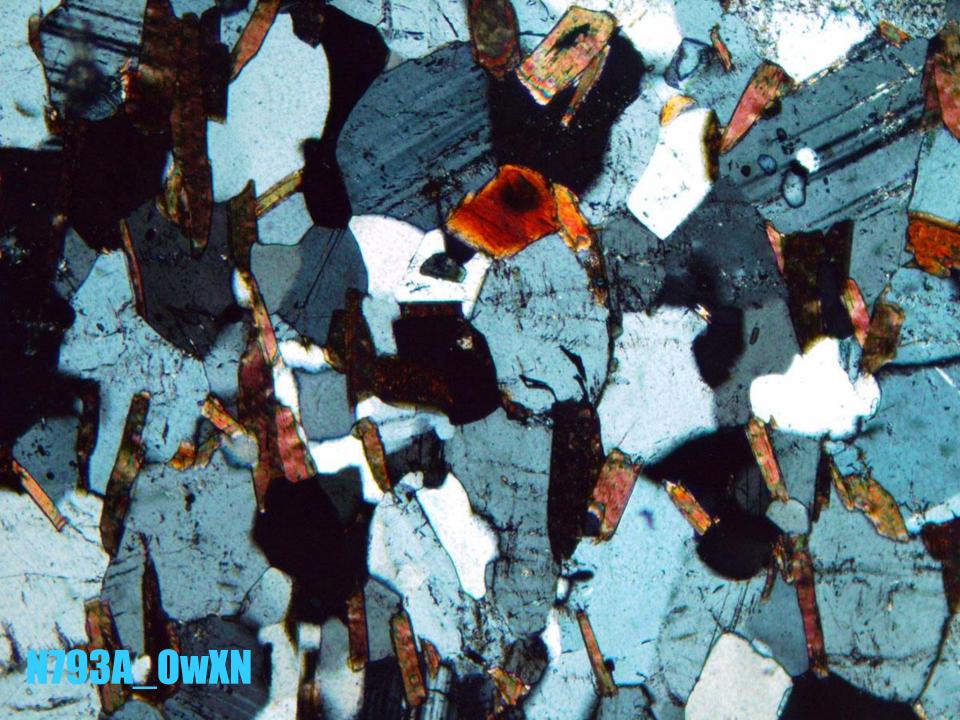




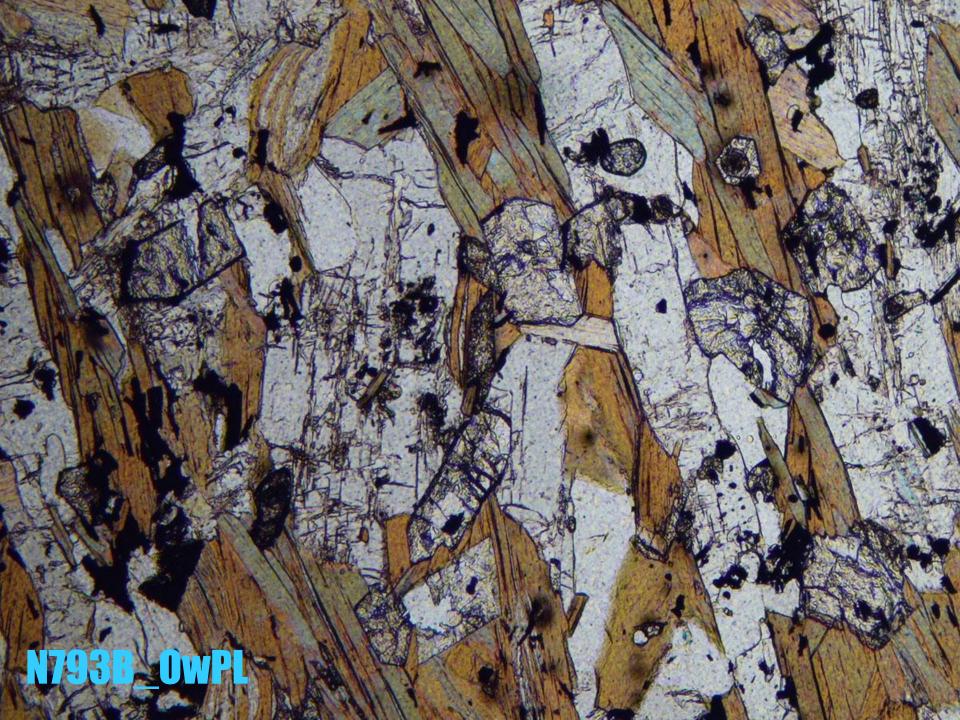


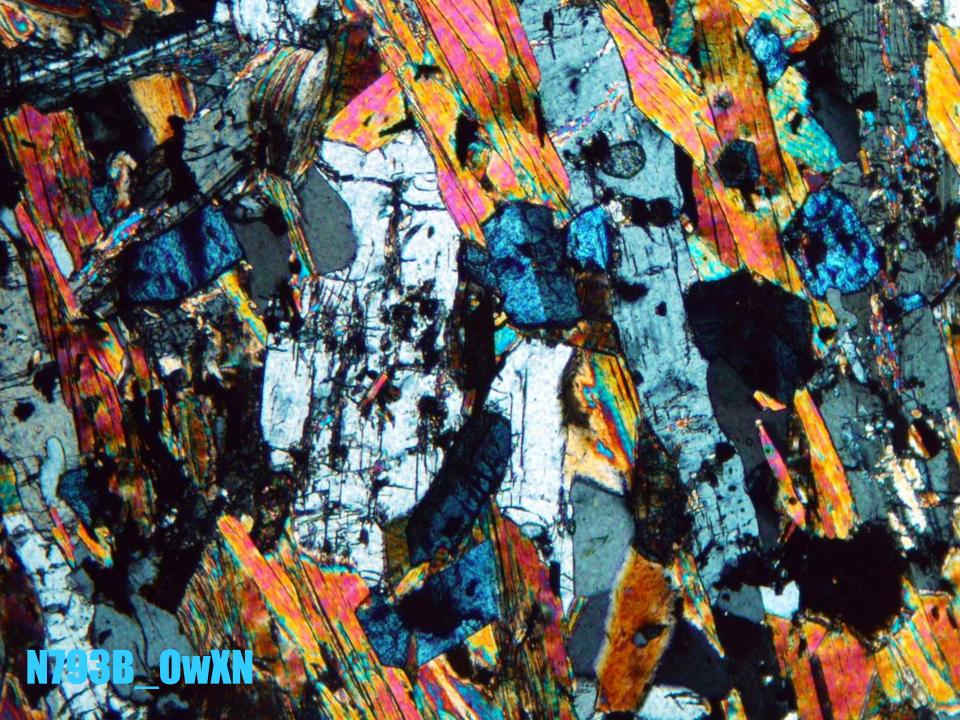


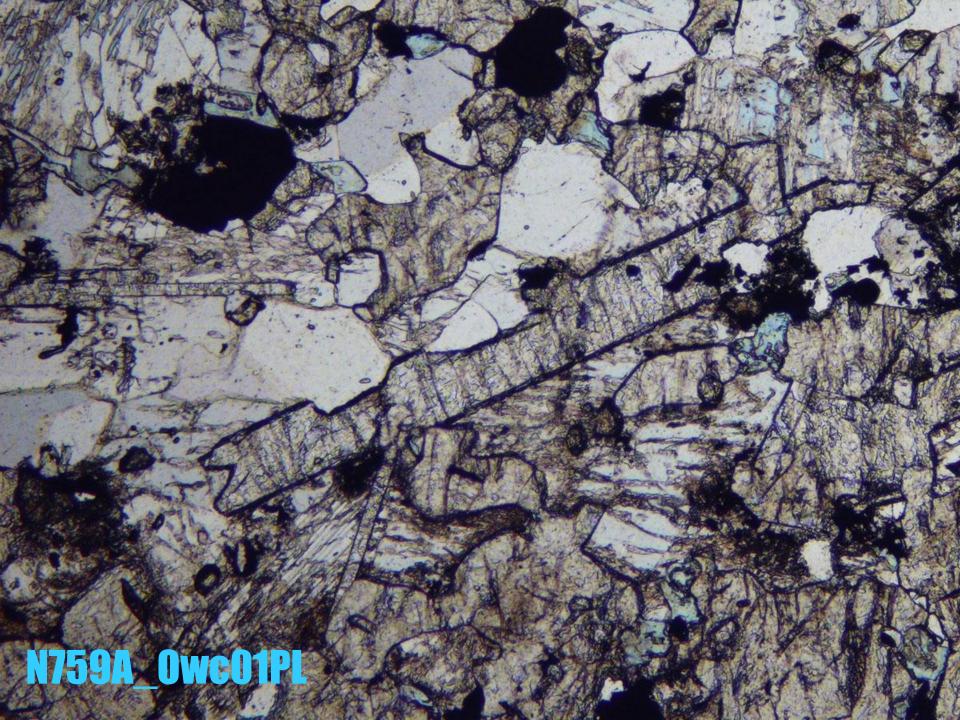


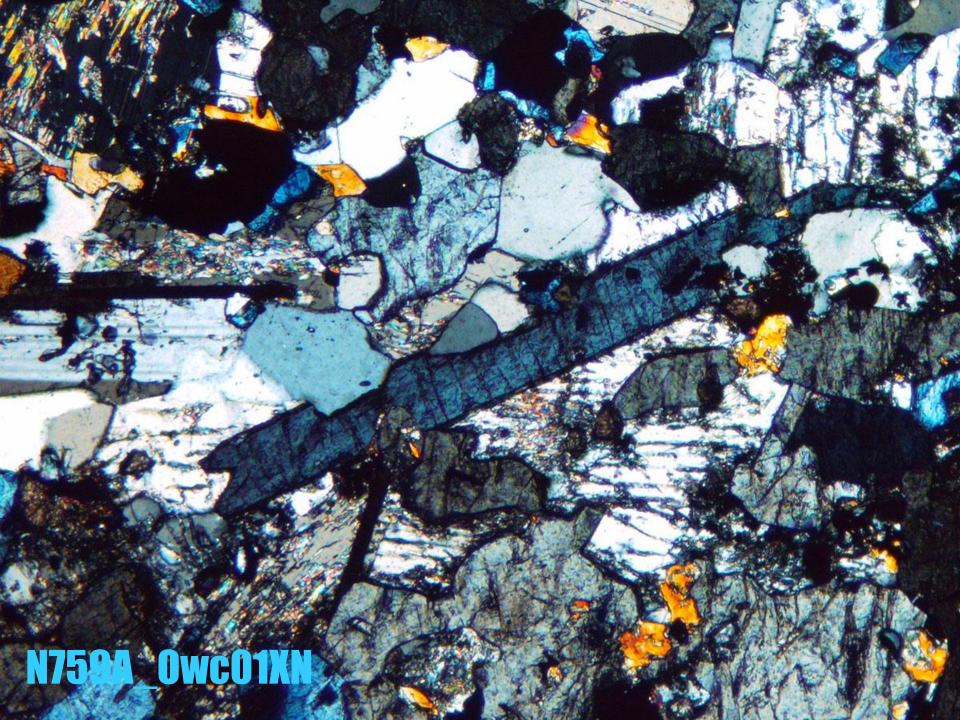












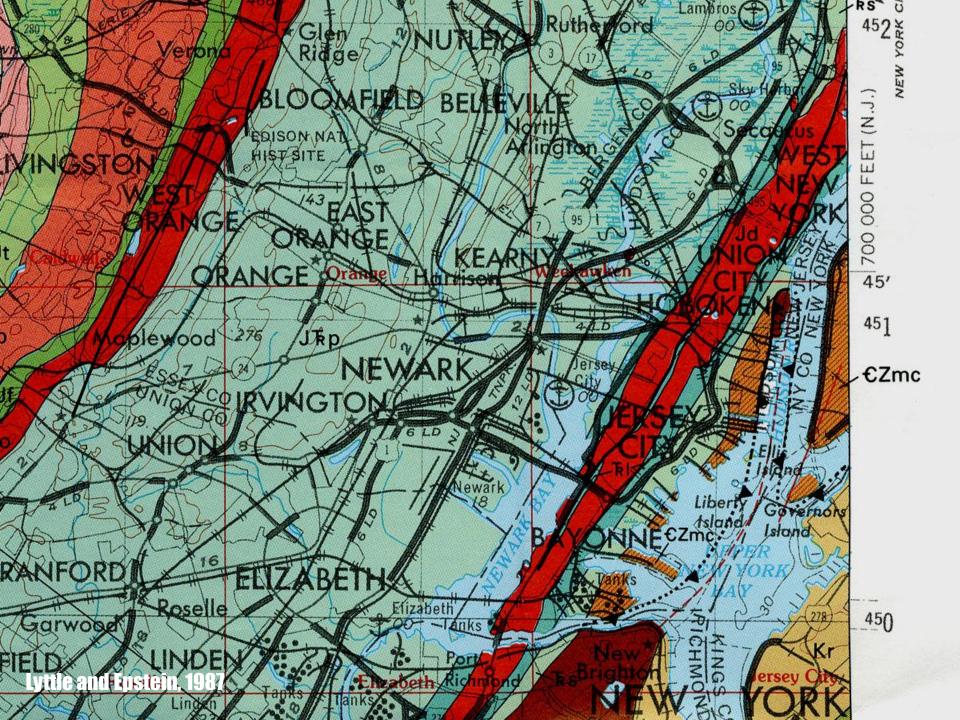


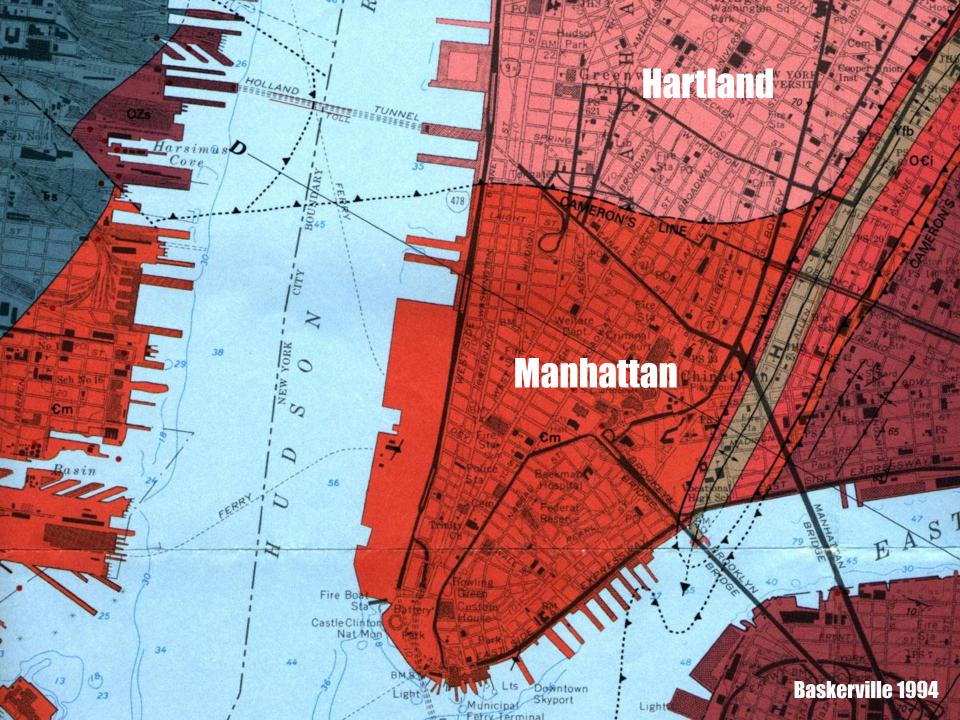


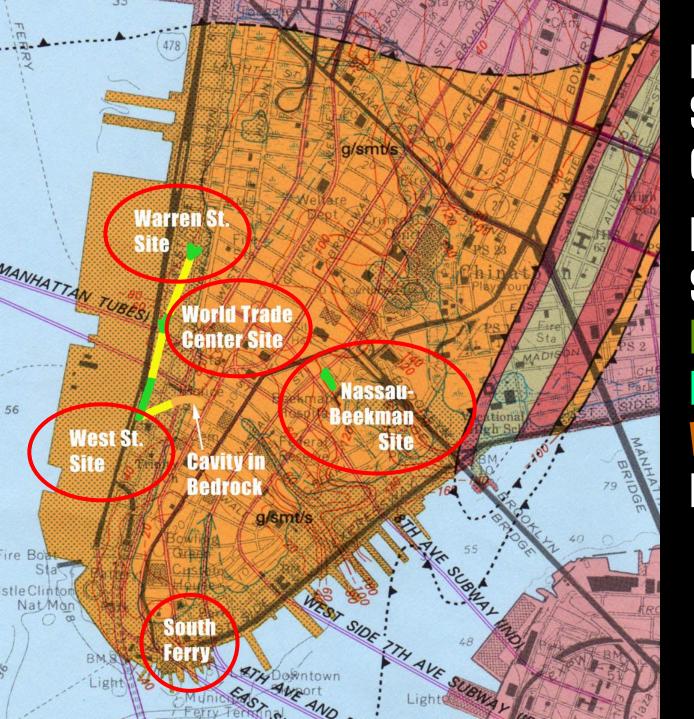








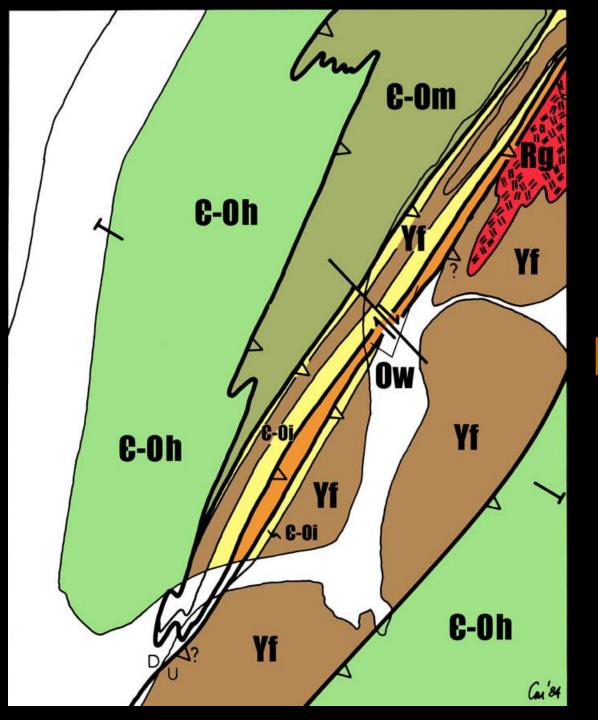




Five Localities South of Canal Street

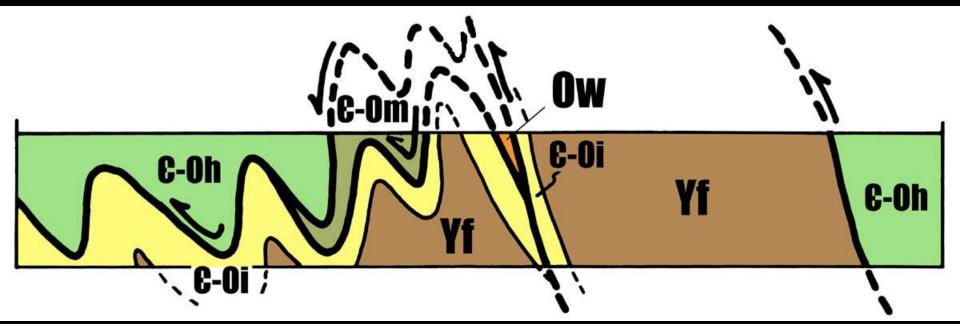
Display
Sheared
Manhattan,
Hartland, and
Walloomsac
Rocks!

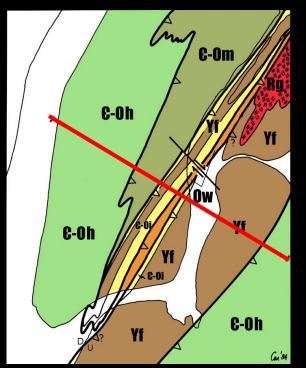
after Baskerville 1994, Merguerian and Moss 2007



of Berkey (1910)

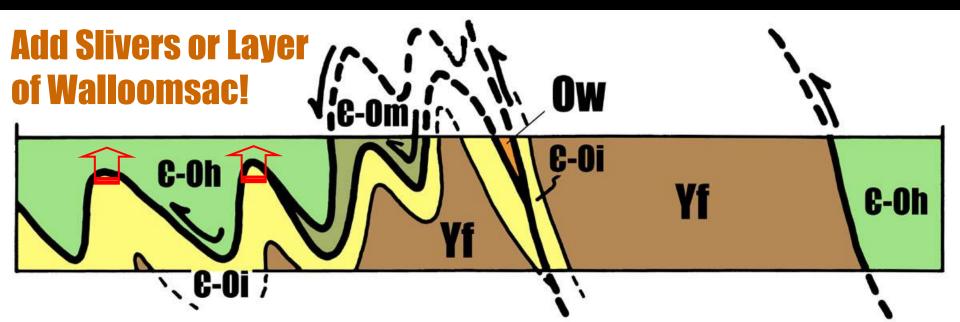
Merguerian, 1984

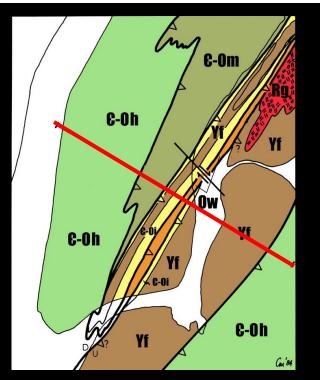




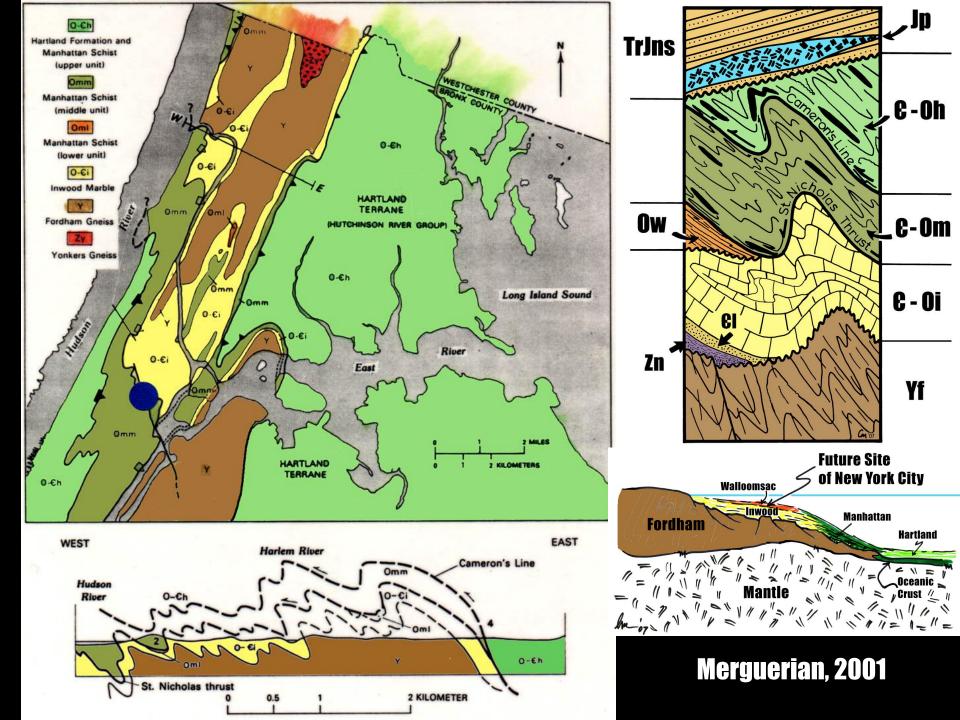
Interpretive NW-SE Geologic Section Based on Berkey 1910 Boring Data

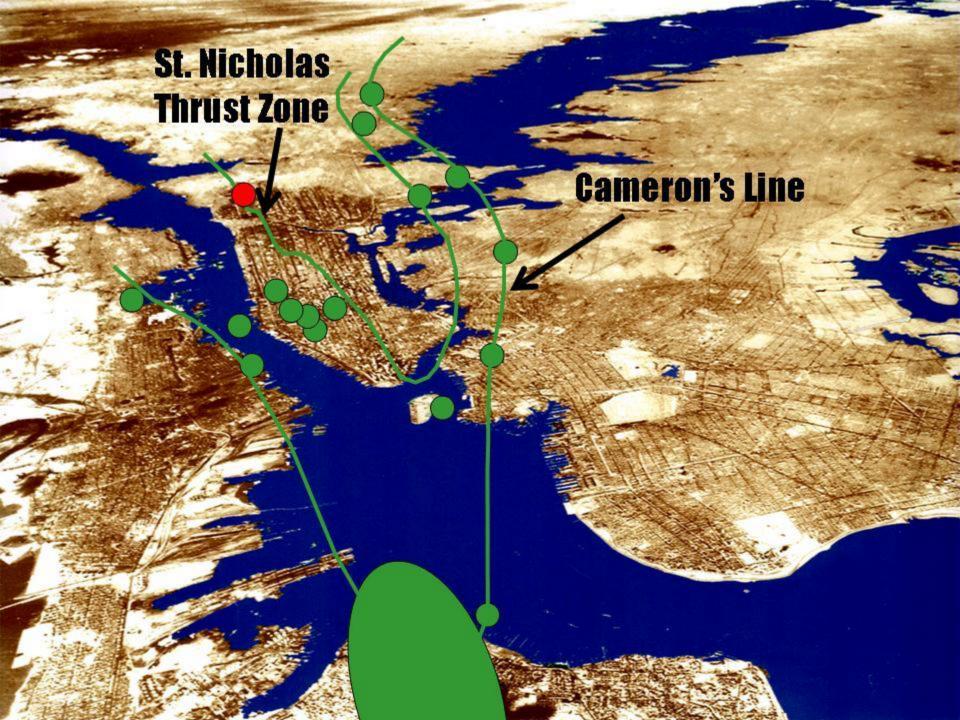
Merguerian, 1984





Interpretive NW-SE Geologic Section Based on Berkey 1910 Boring Data





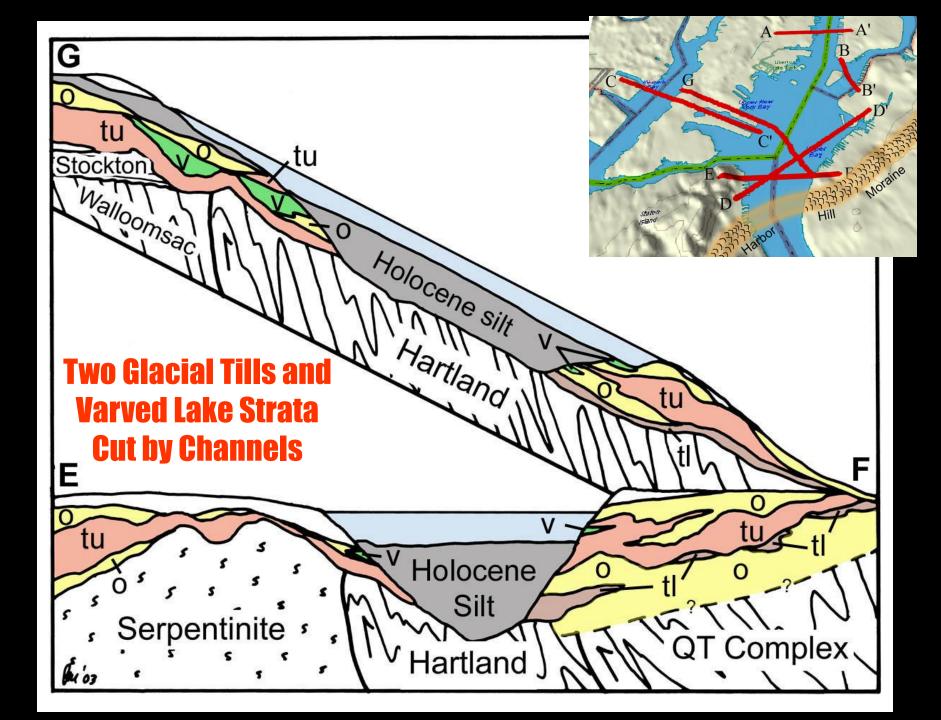
Future WTC Research at Hofstra Geology:



Refine Maps Mineralogy Petrography X-Ray Microprobe



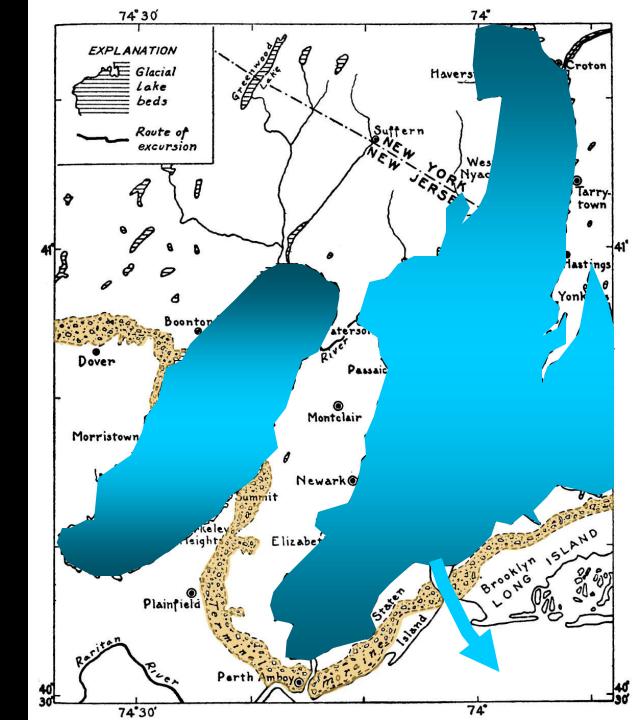
Extra Slides

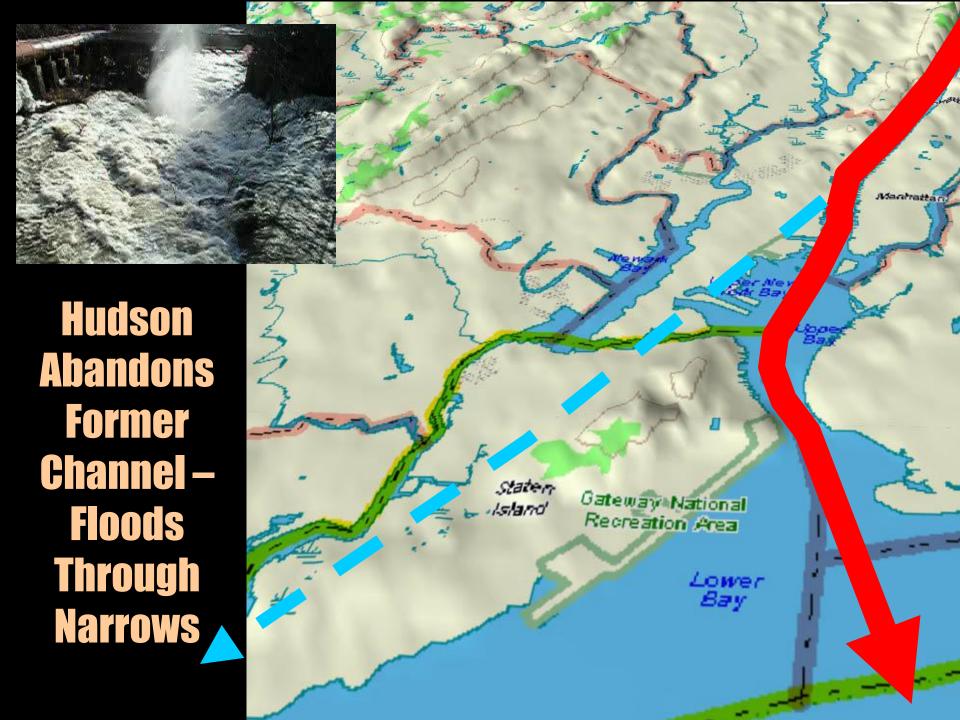


Glacial Lake Strata and the Harbor Hill Moraine

Woodfordian
Drainage
Through
The Narrows

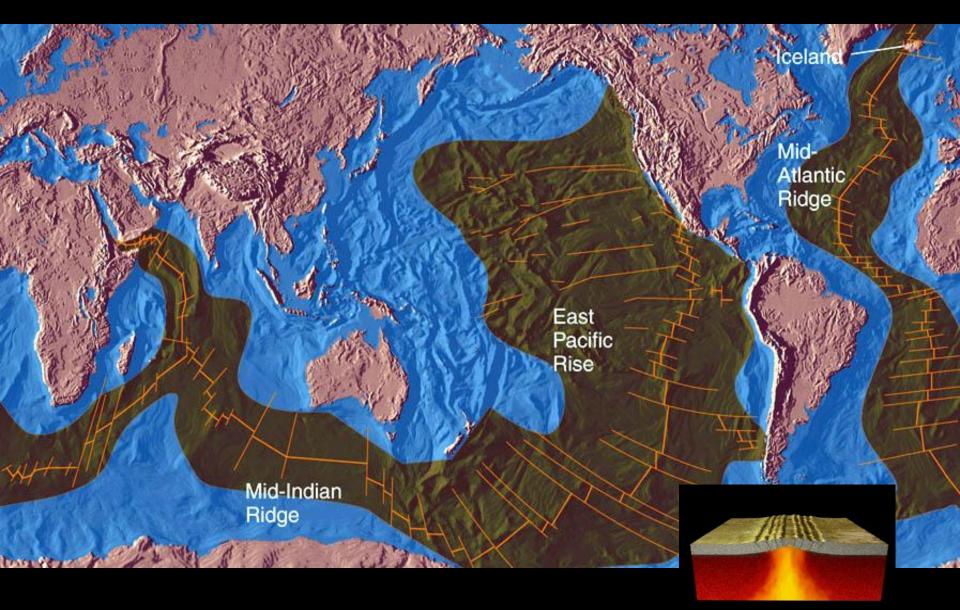
Berkey (1933)

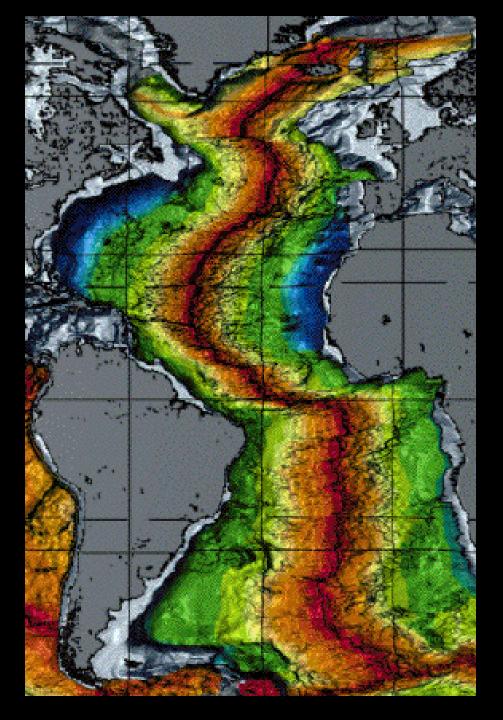






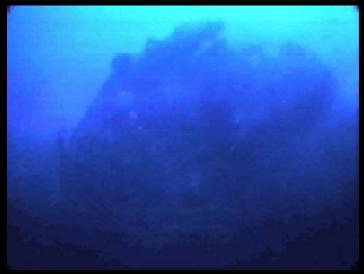
Ocean Ridge System



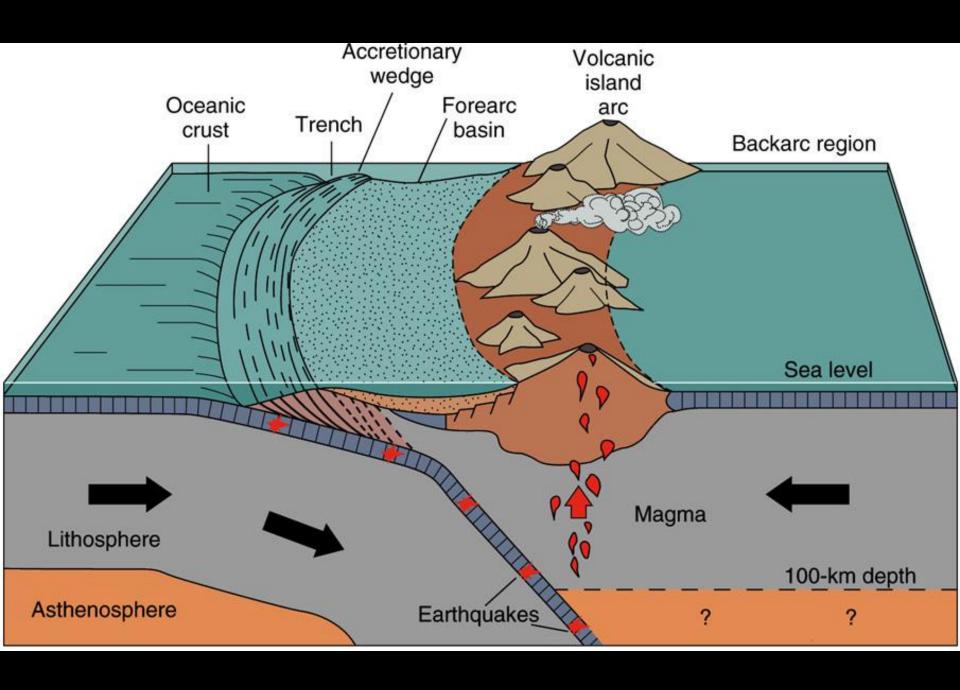


Ocean Floor Environment

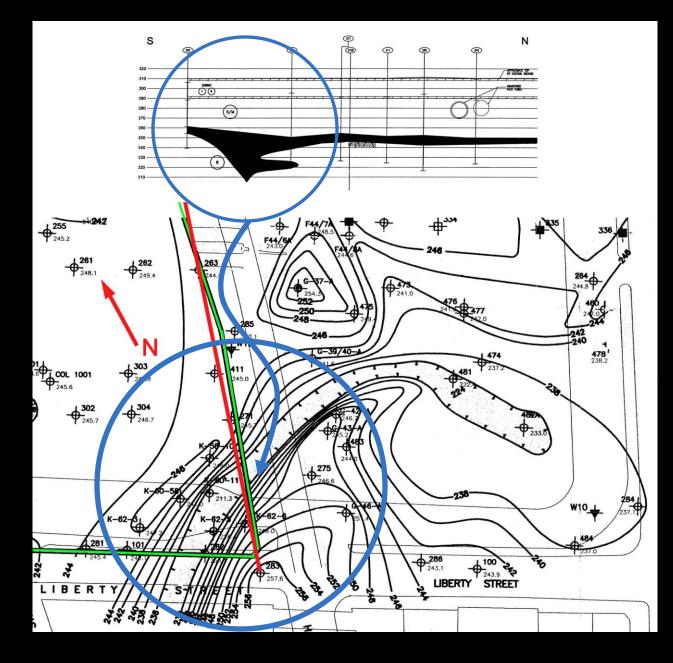






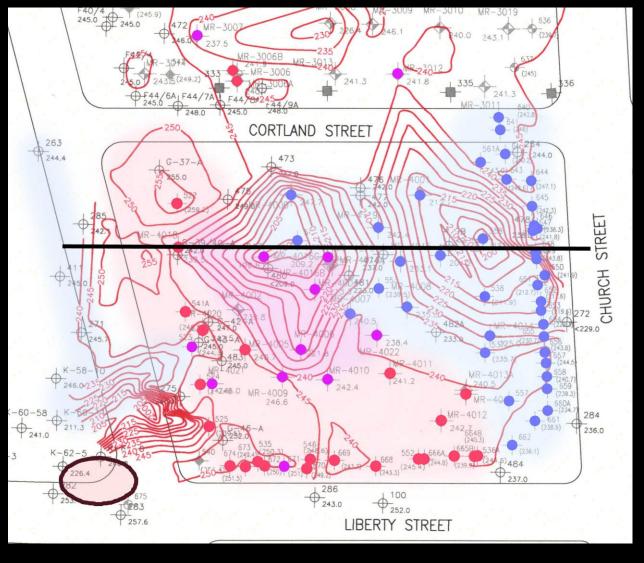


Bedrock Ledge Over Boulder Filled Valley









Bedrock Contour Of SE Corner Of Site

SCHIST

Depressions in Schist To The North

PEGMATITE

High Ground in Pegmatite To The West And South

Differential Erosion