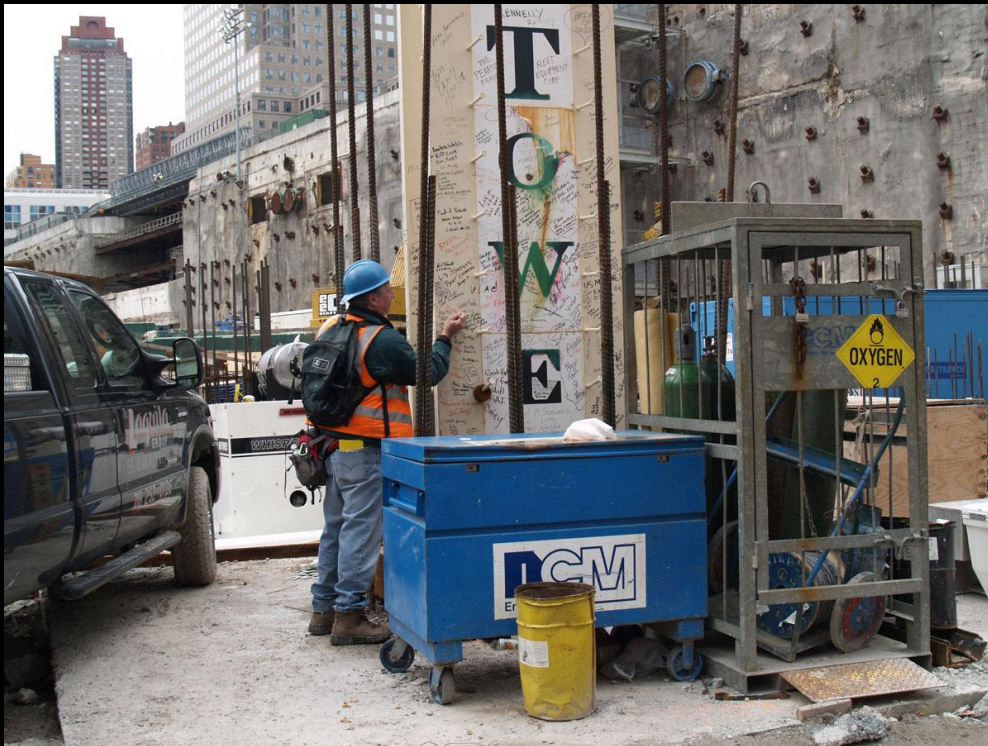


The World Trade Center Site

New Perspectives on the Geology of New York City

Charles Merguerian

Hofstra University Geology Dept.



Thanks To:

Cheryl Moss

Bob Reina

Pablo Lopez

Jim Tantalla



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
Laboratory in Westbury



"We're Not Good But We're Slow"



The Mom Unit



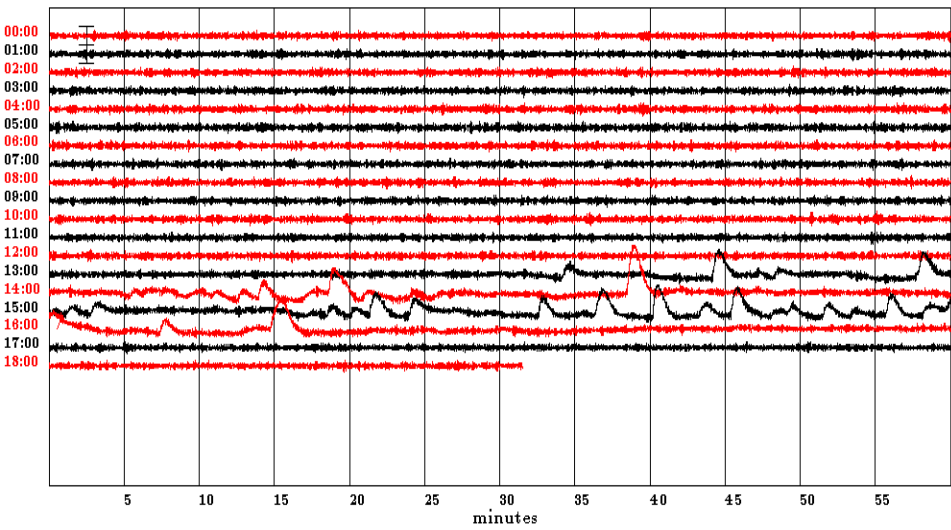
Hman VII

**Biting?
There's No
Biting in
the
Hamster
Industry!**





GMT 2 micrometer/s Station PAL, channel BHZ - Nov 1, 2001 gain 0.03 non-filtered



The New World Trade Center Plan



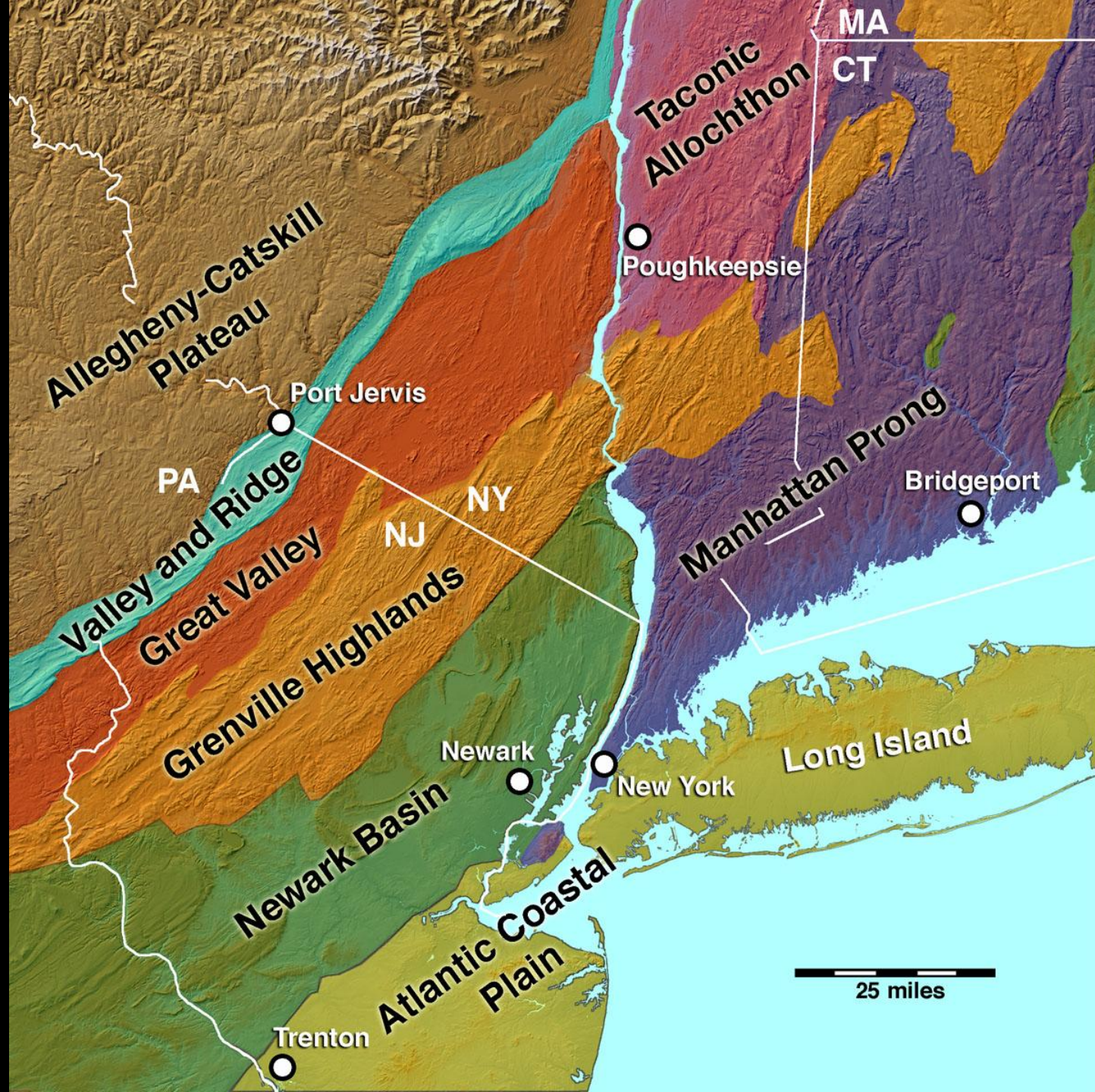
As Described by
Bela Lugosi in
“The Black Cat”
(1934)



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

**Hollywood Fat Cat Merguerian and Business Manager at Geology Dept.
“Hammy” Awards Presentation (2008)**







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



**Club Med
Conditions**

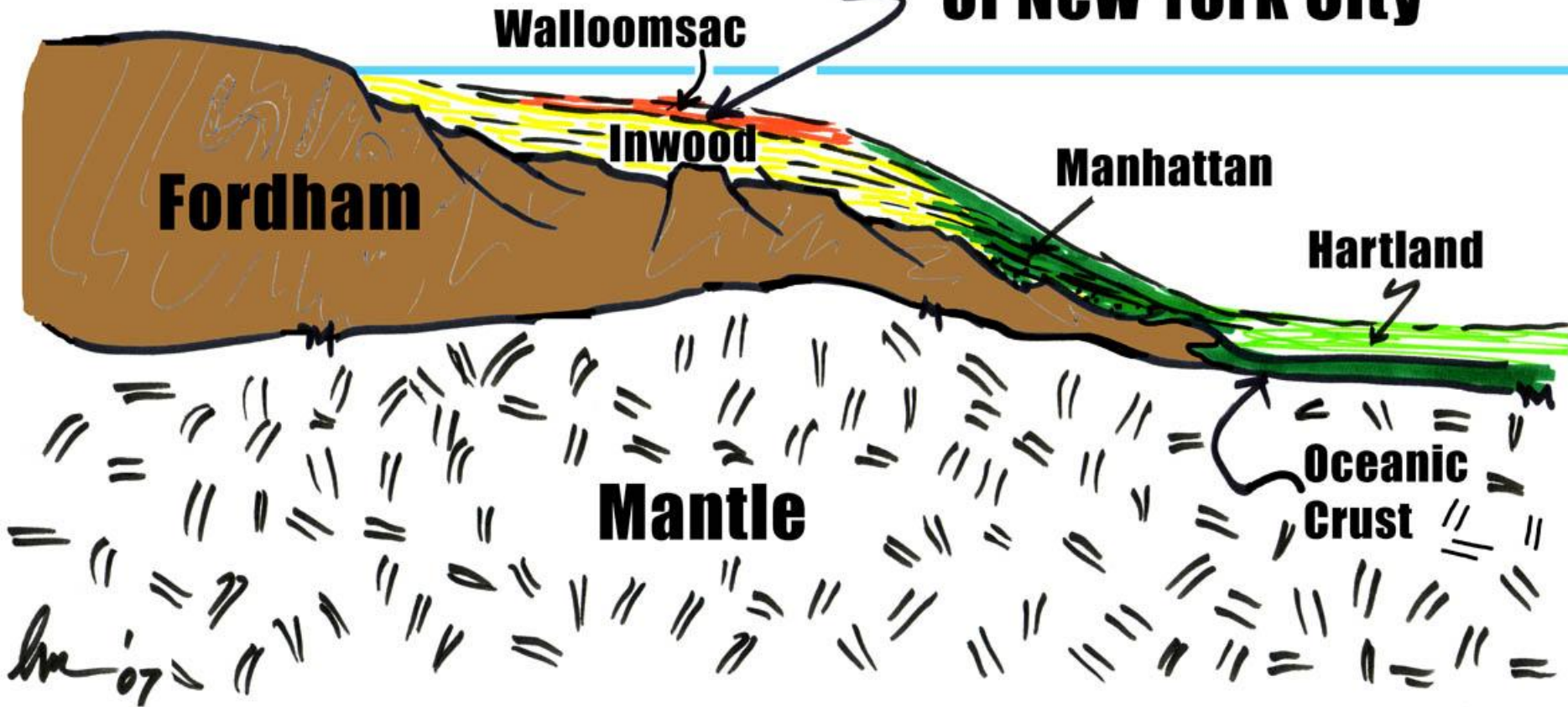
Miles

Paleo-equator

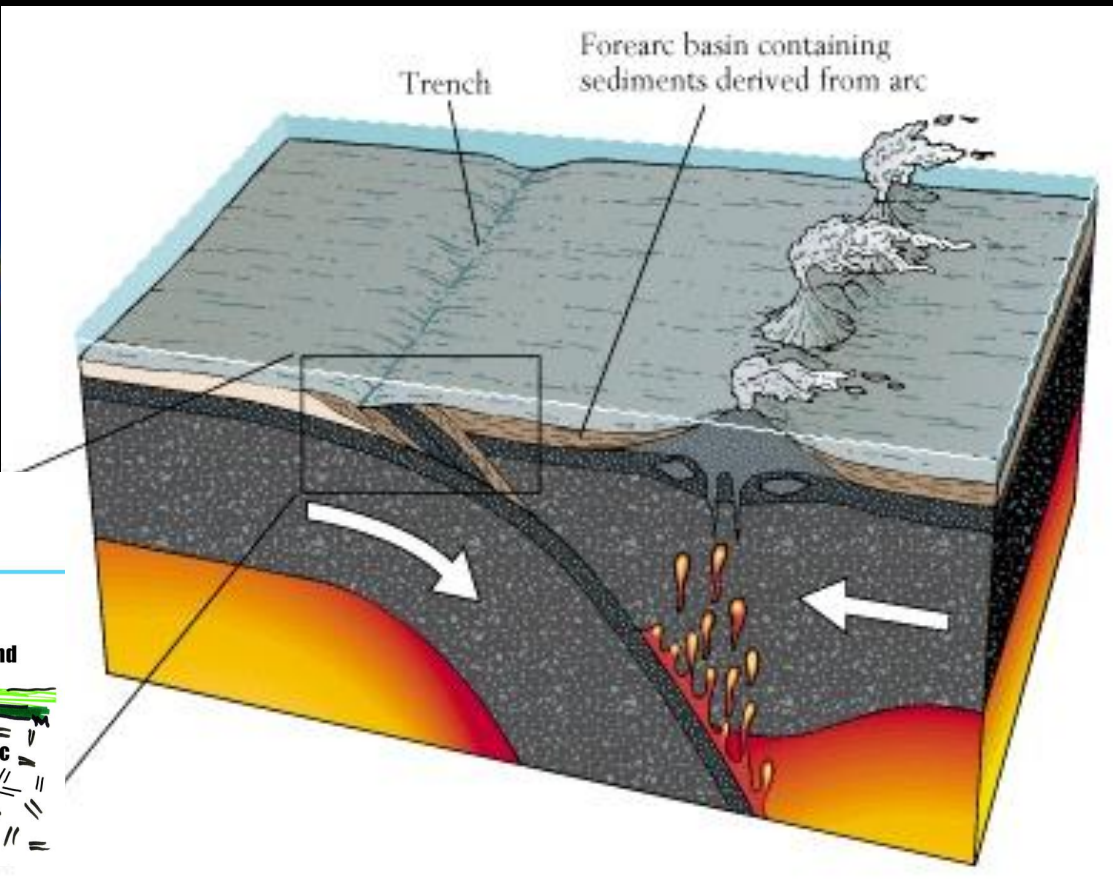
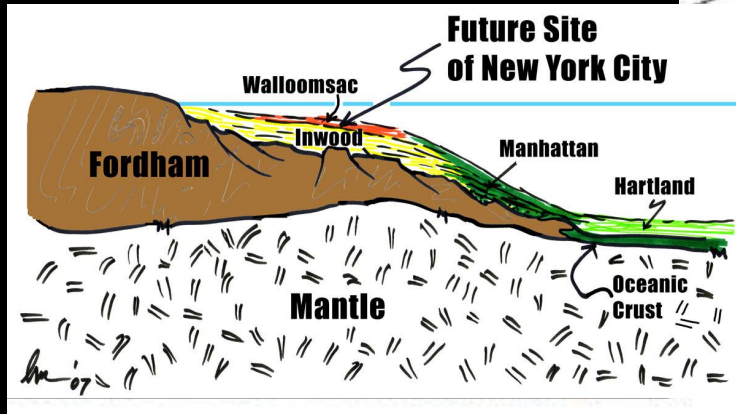
after Kay, 1951

Seas with bottoms of argillaceous muds and volcanic rocks on eugeosynclines

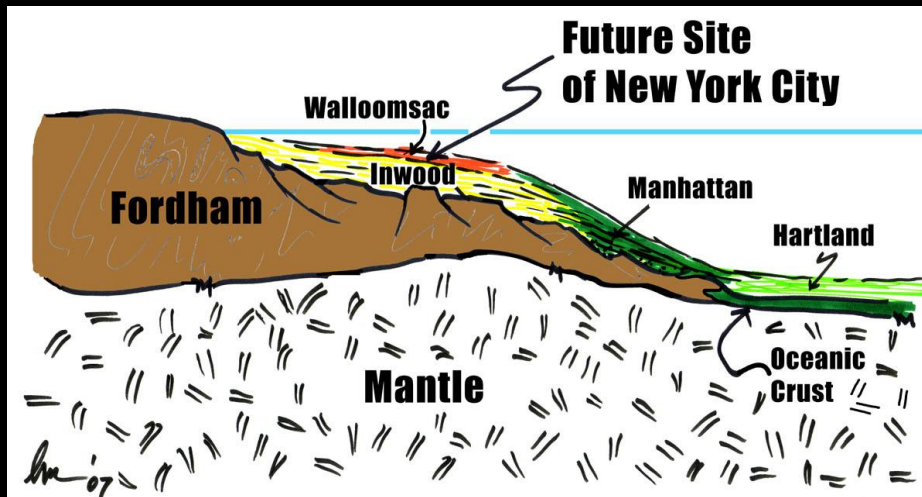
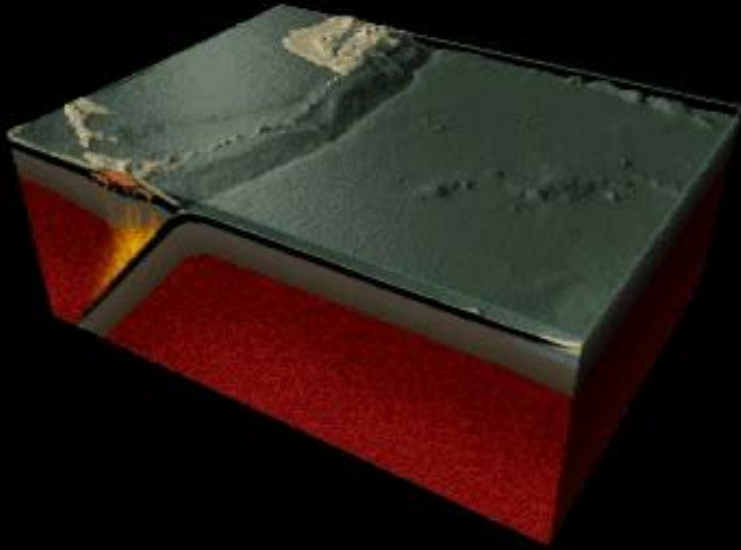
Future Site of New York City

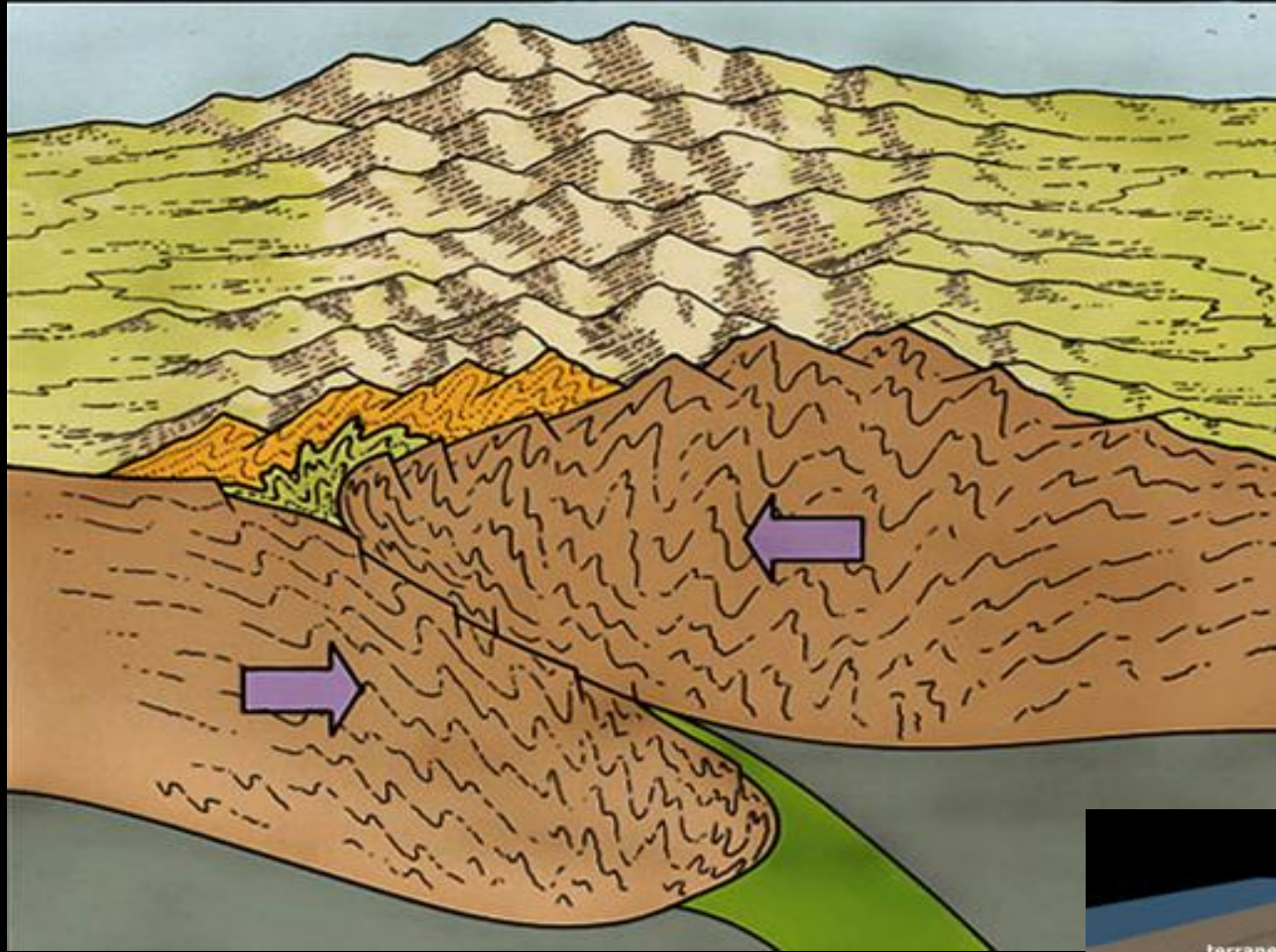


~ 450 Ma Taconic Arc – Passive Margin Collision

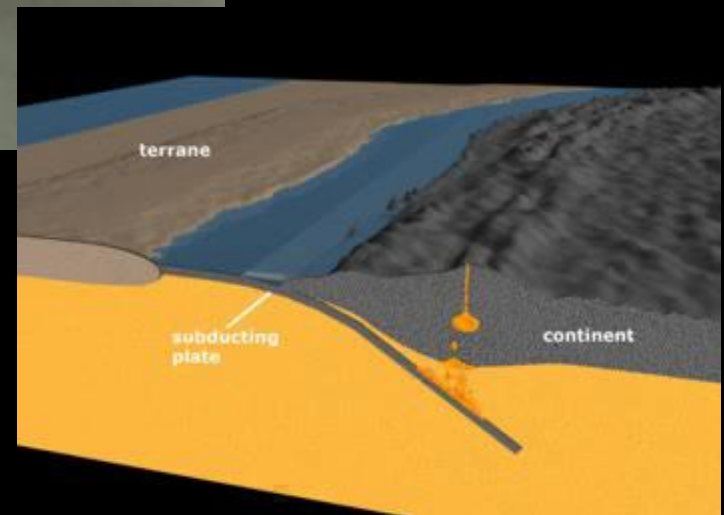


~ 450 Ma Taconic Arc – Passive Margin Collision

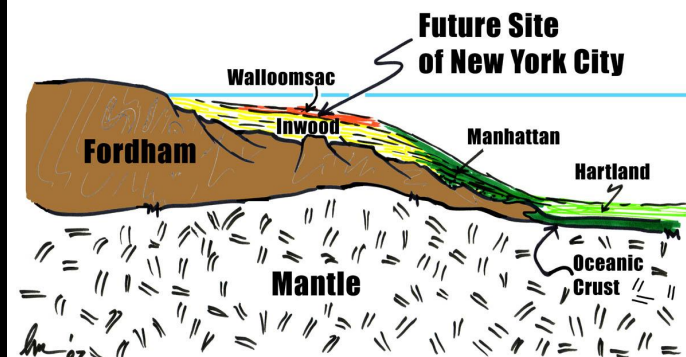
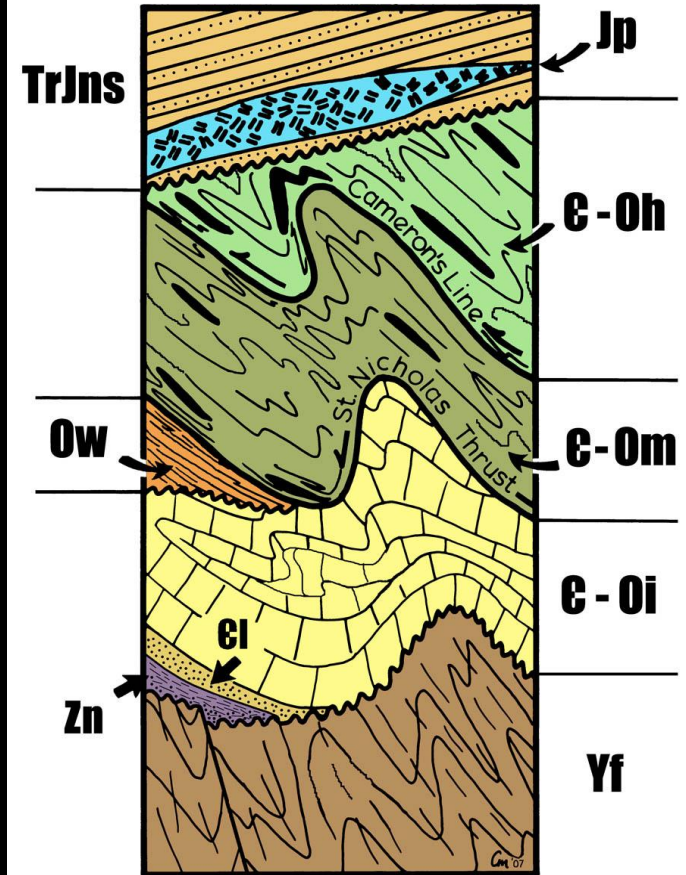
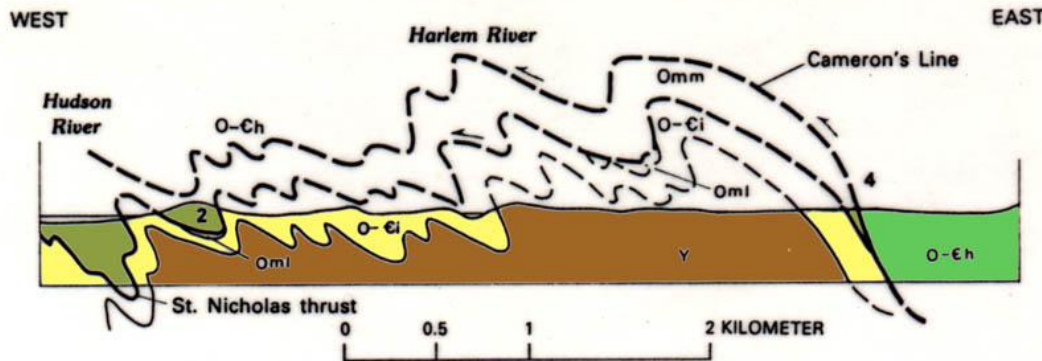
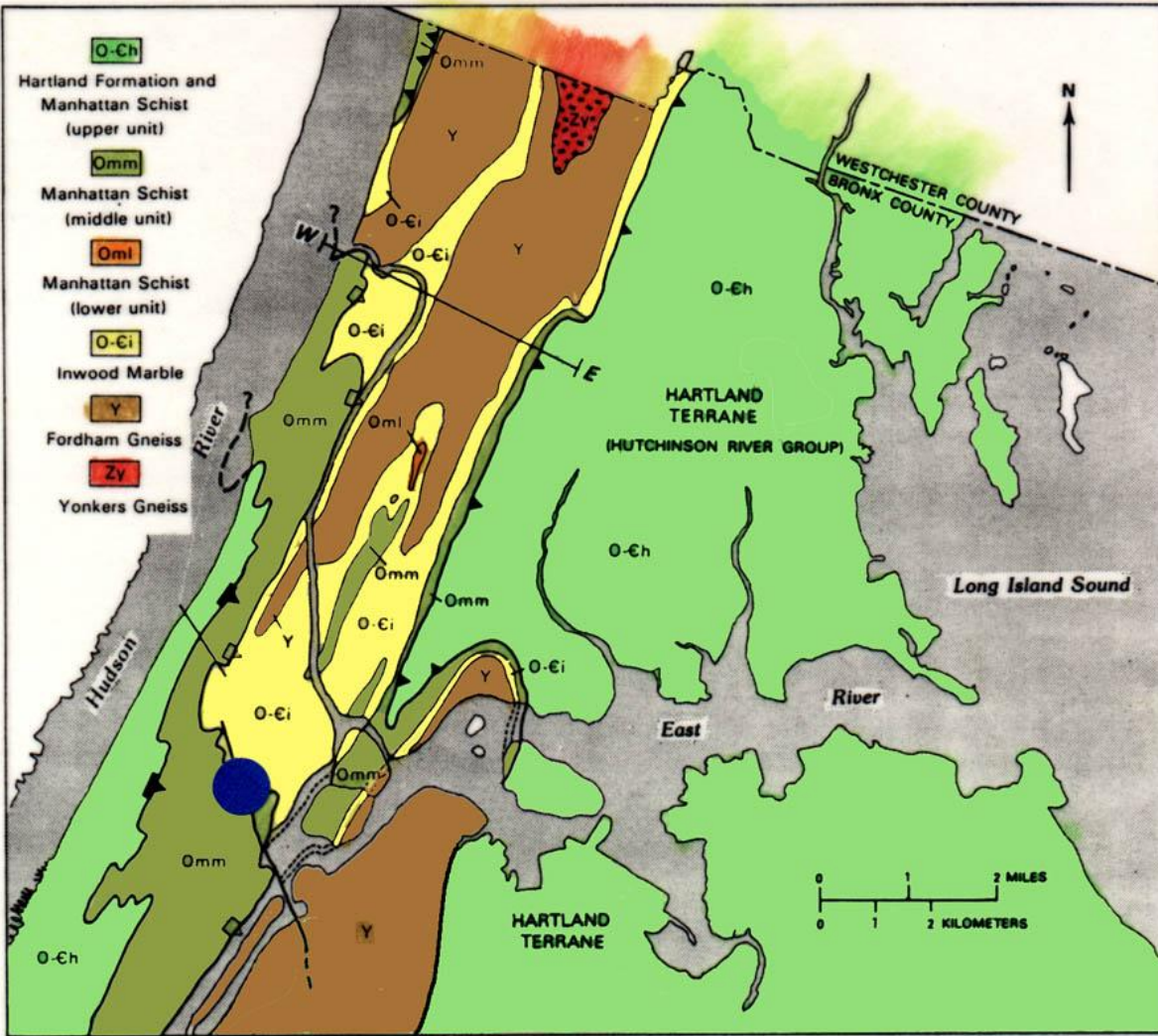




450 Ma to 250 Ma
Protracted Plate Collisions
Produce the Appalachians

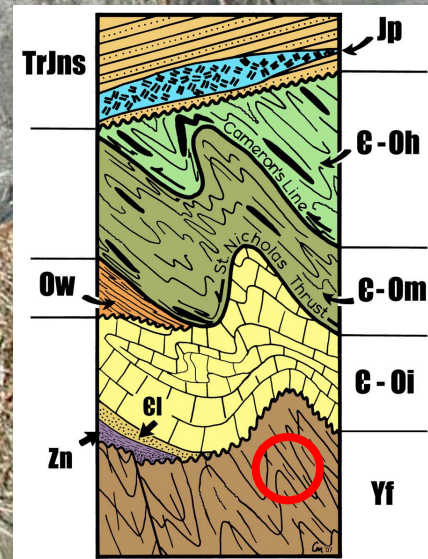


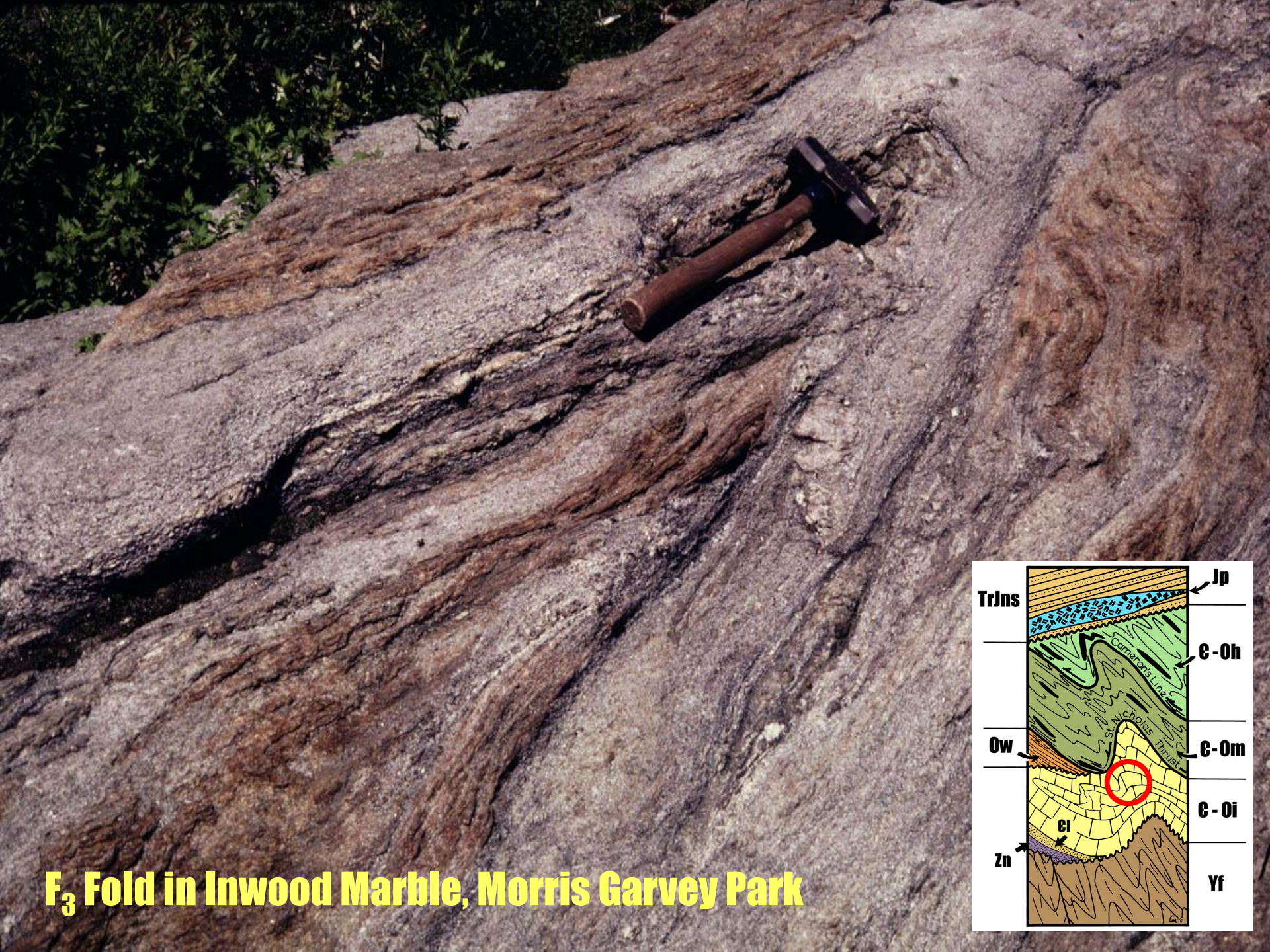
New York City



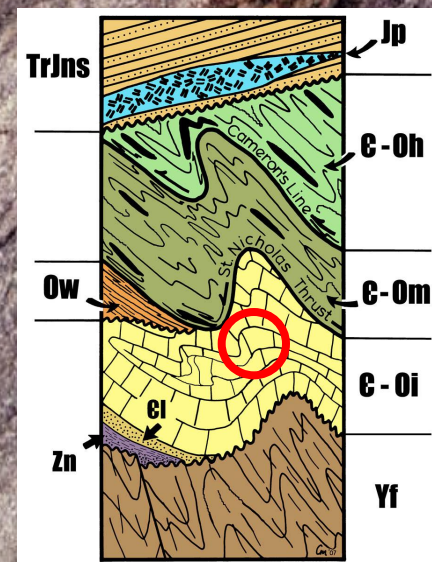


Fordham Gneiss, Echo Park



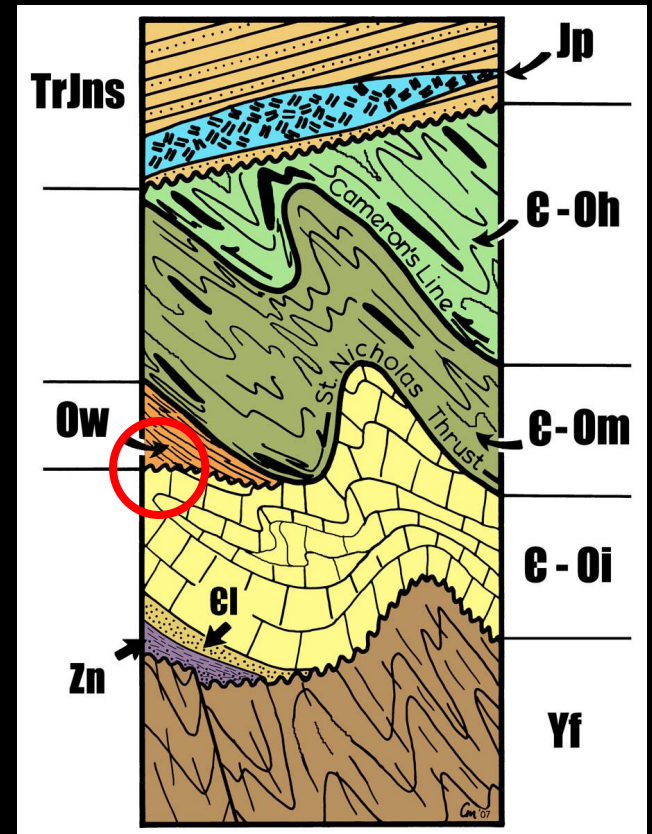


F₃ Fold in Inwood Marble, Morris Garvey Park

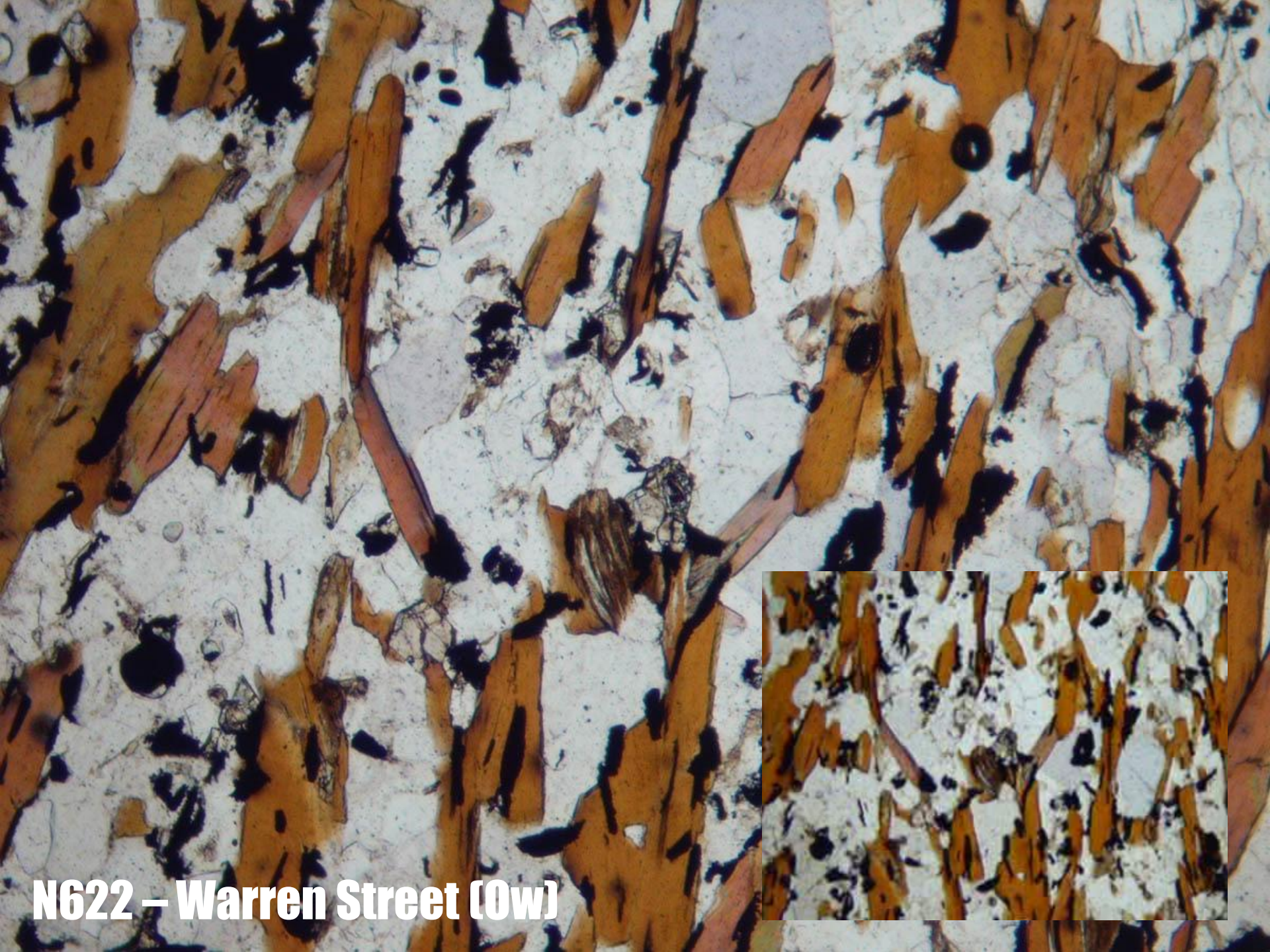




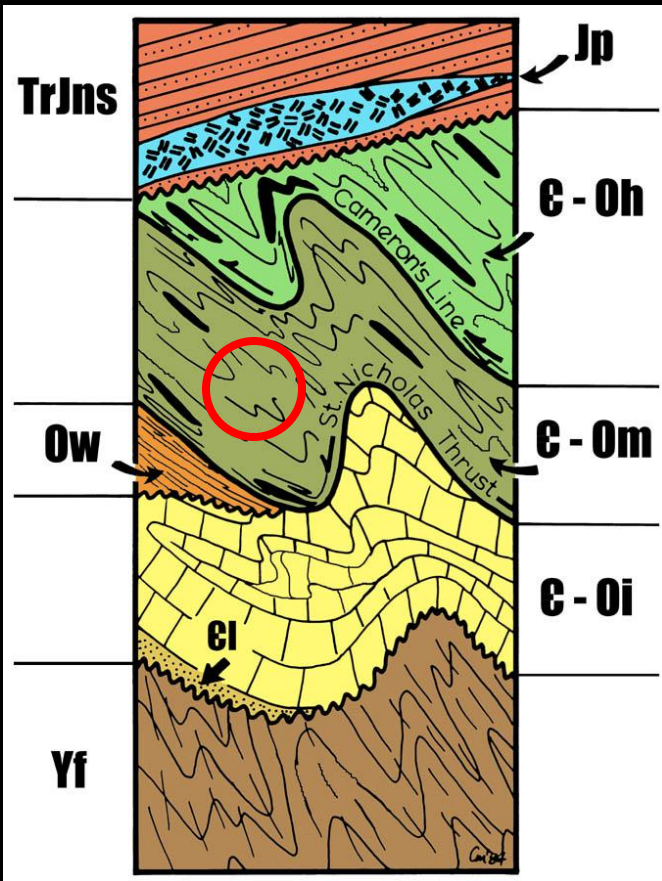
N631 – Warren Street (0w)



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

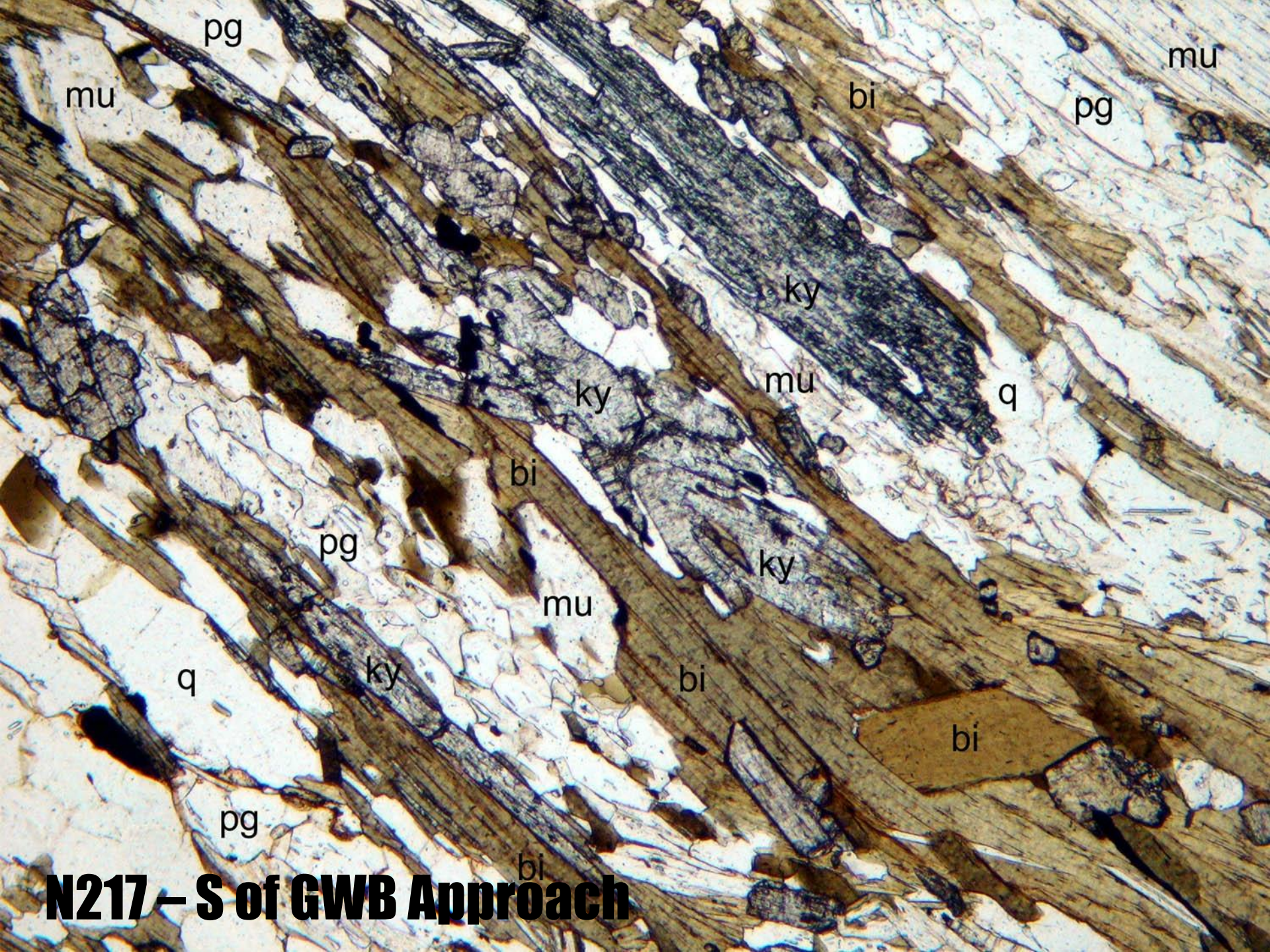


N622 – Warren Street (Ow)



Manhattan Schist
F₃ Folds of S₂
Central Park, NYC

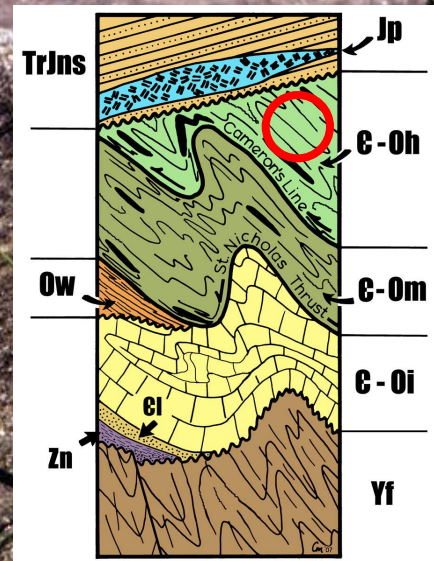


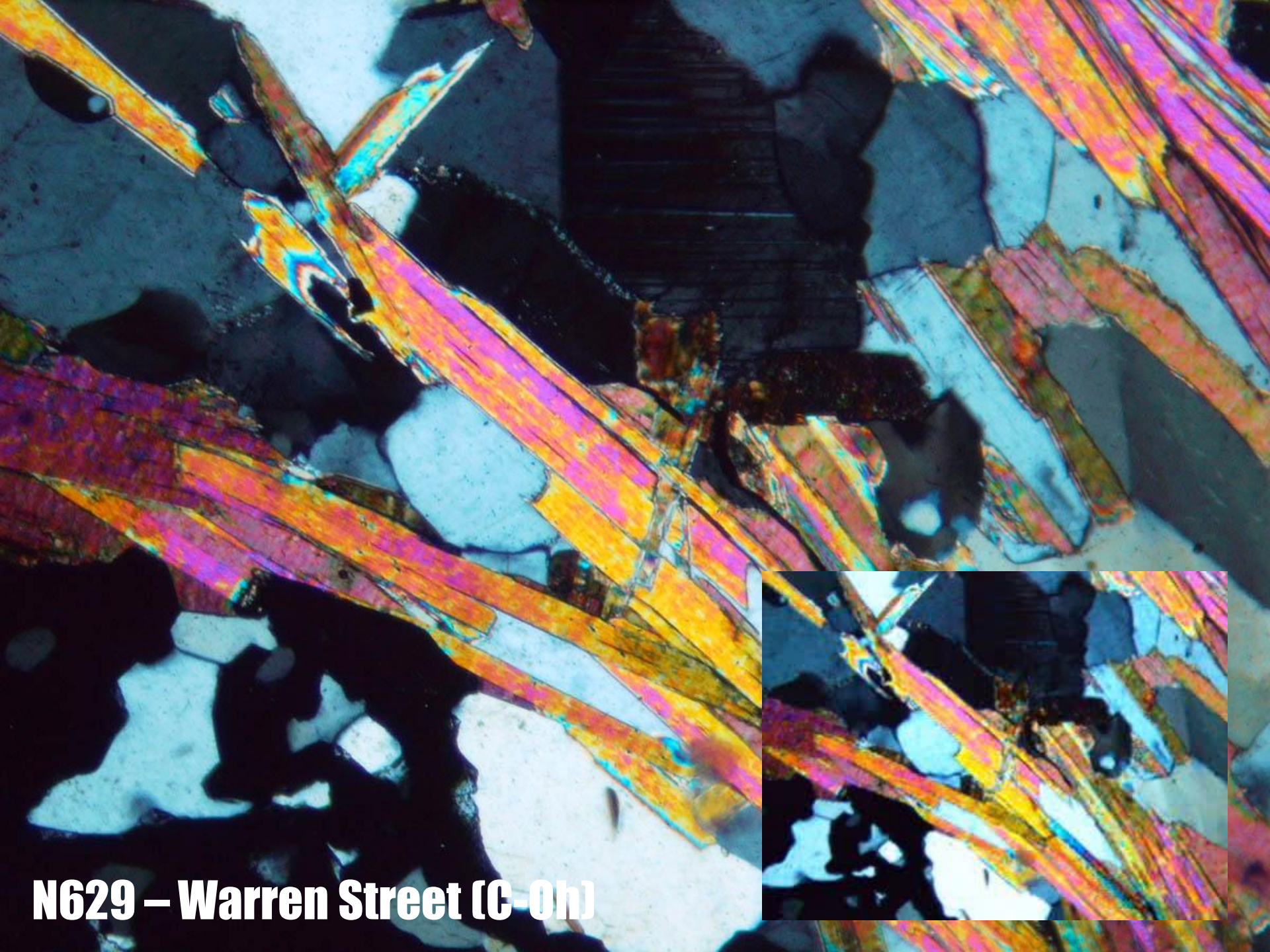


N217 – S of GWB Approach

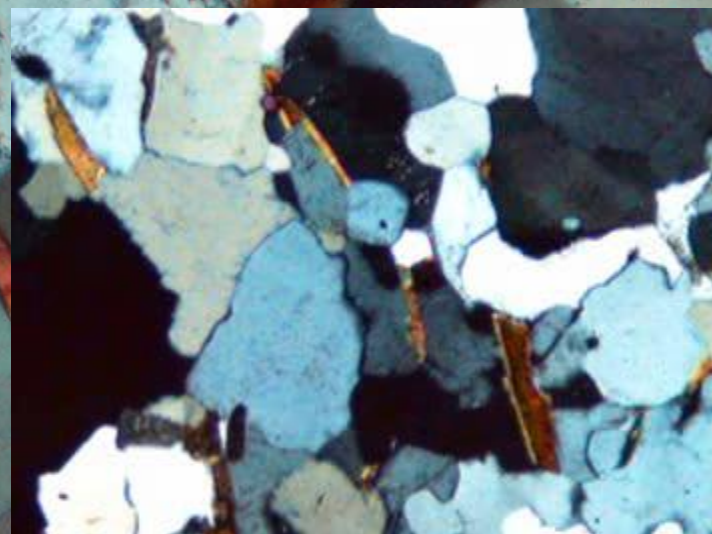
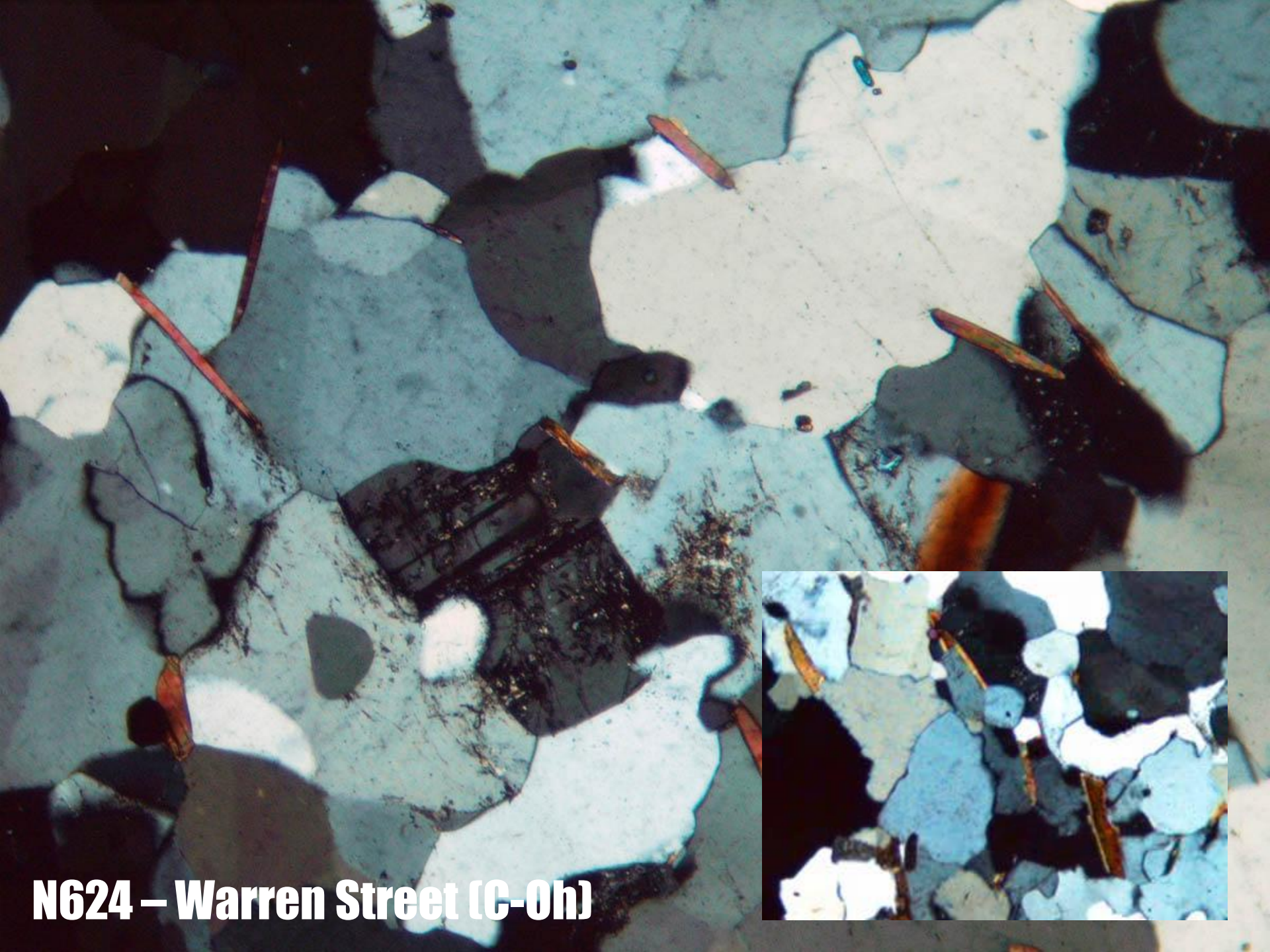


Hartland Schist, Riverside Park

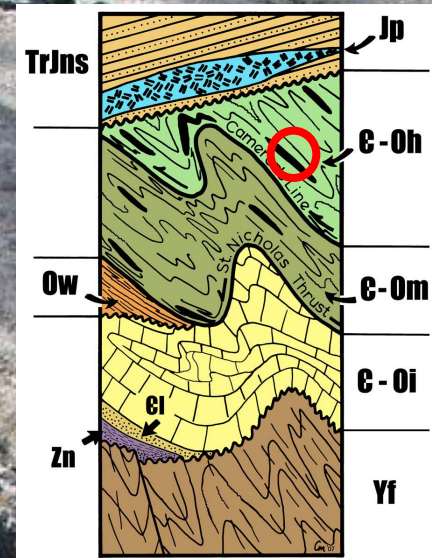




N629 – Warren Street (C-0h)

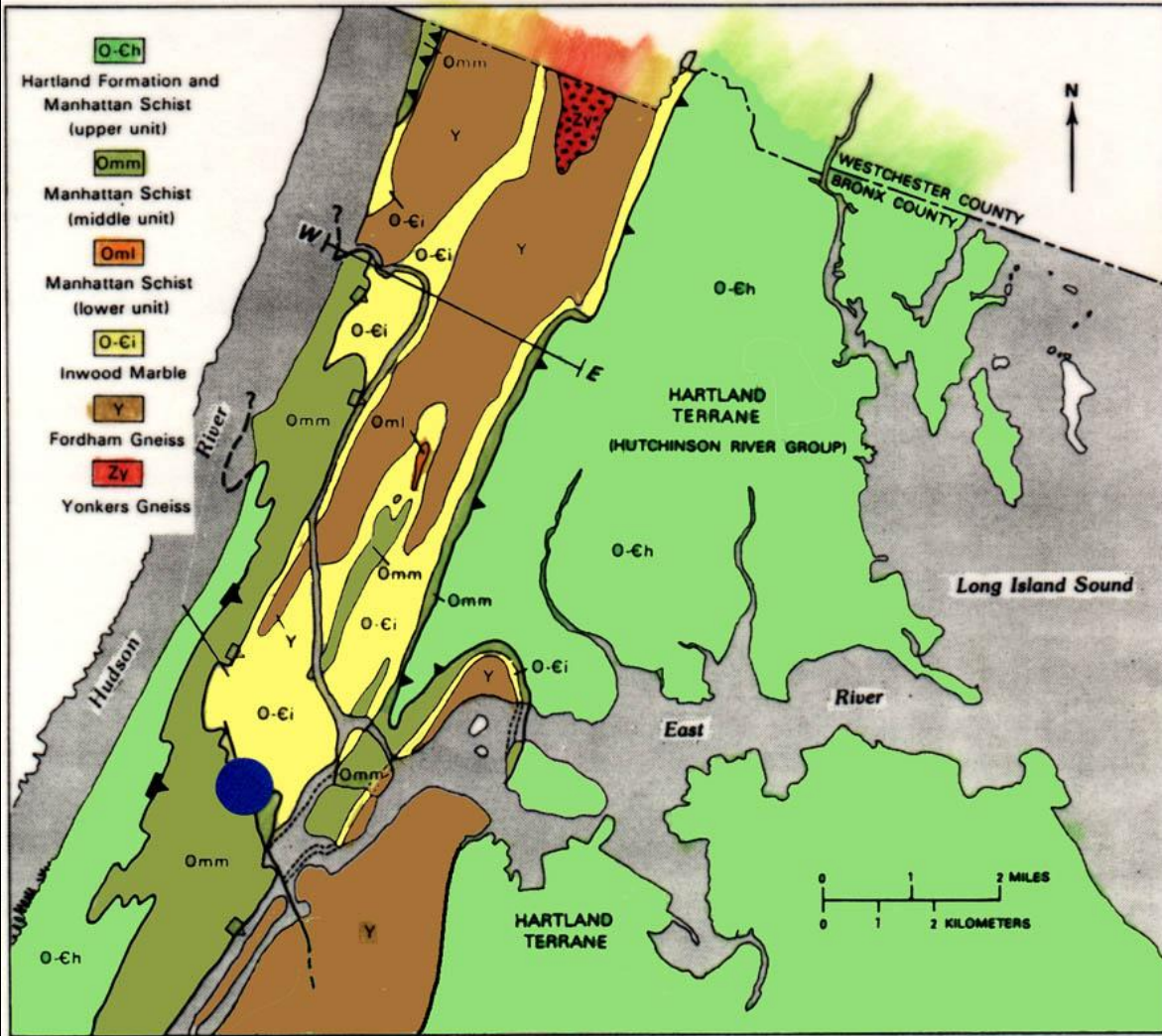


N624 – Warren Street (C-Oh)

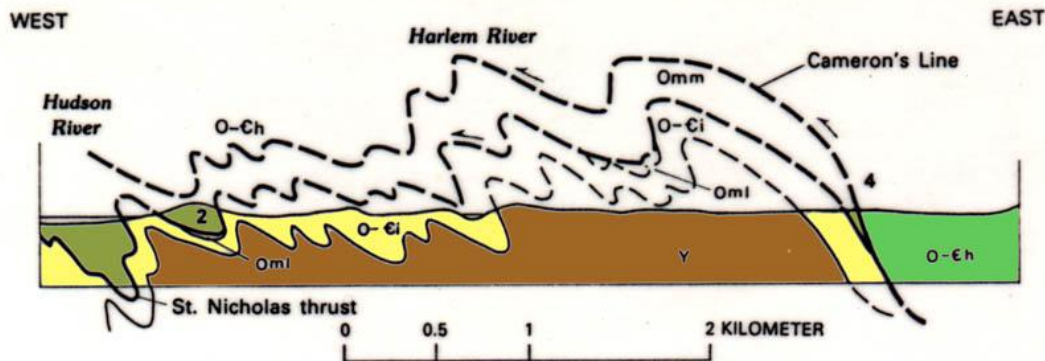
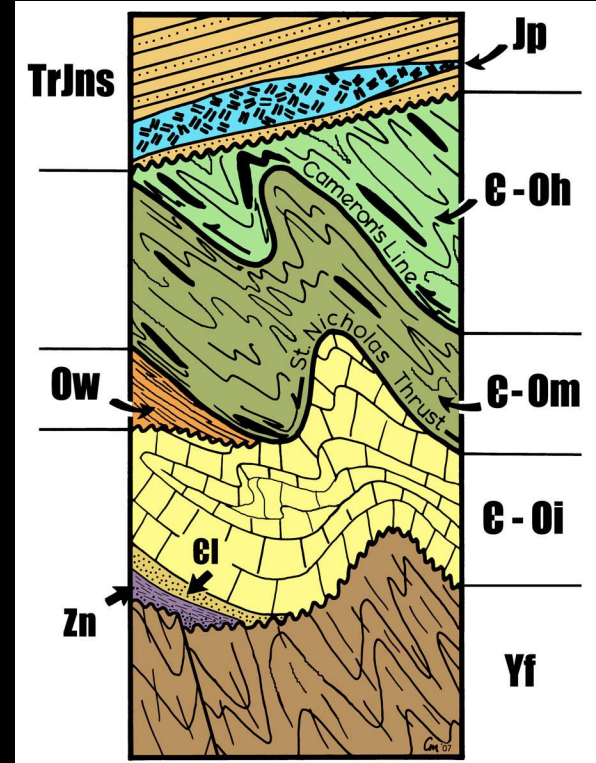


Hartland Amphibolite N567





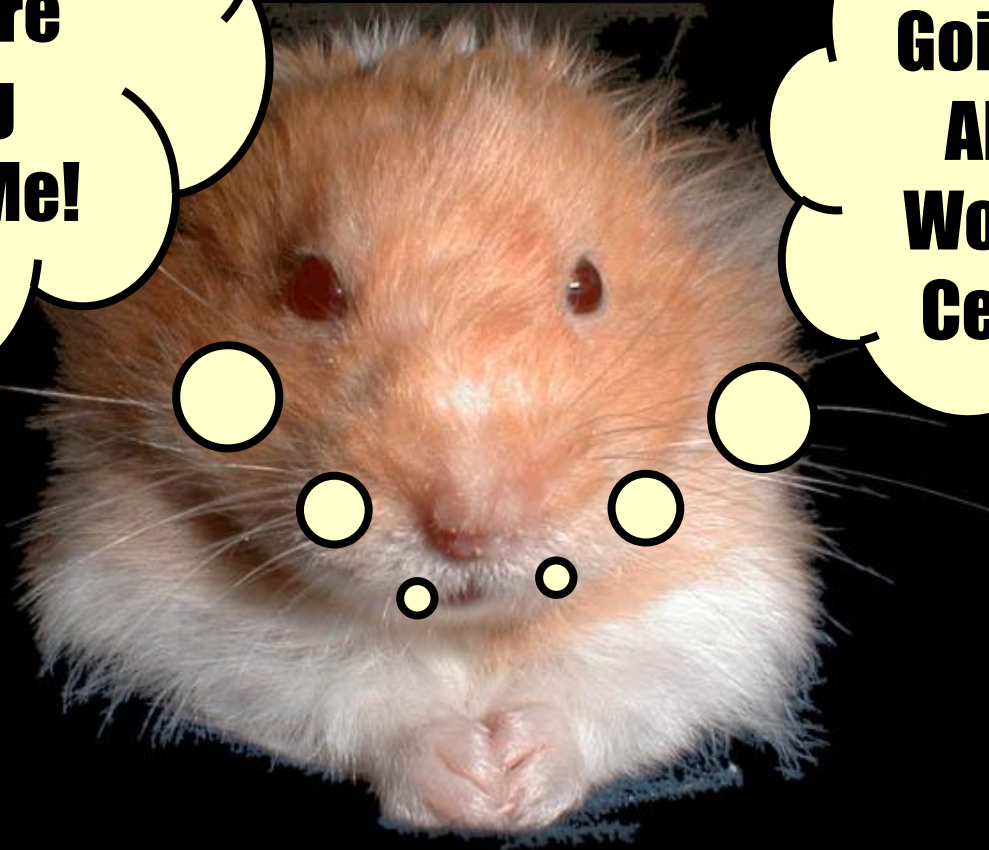
New York City



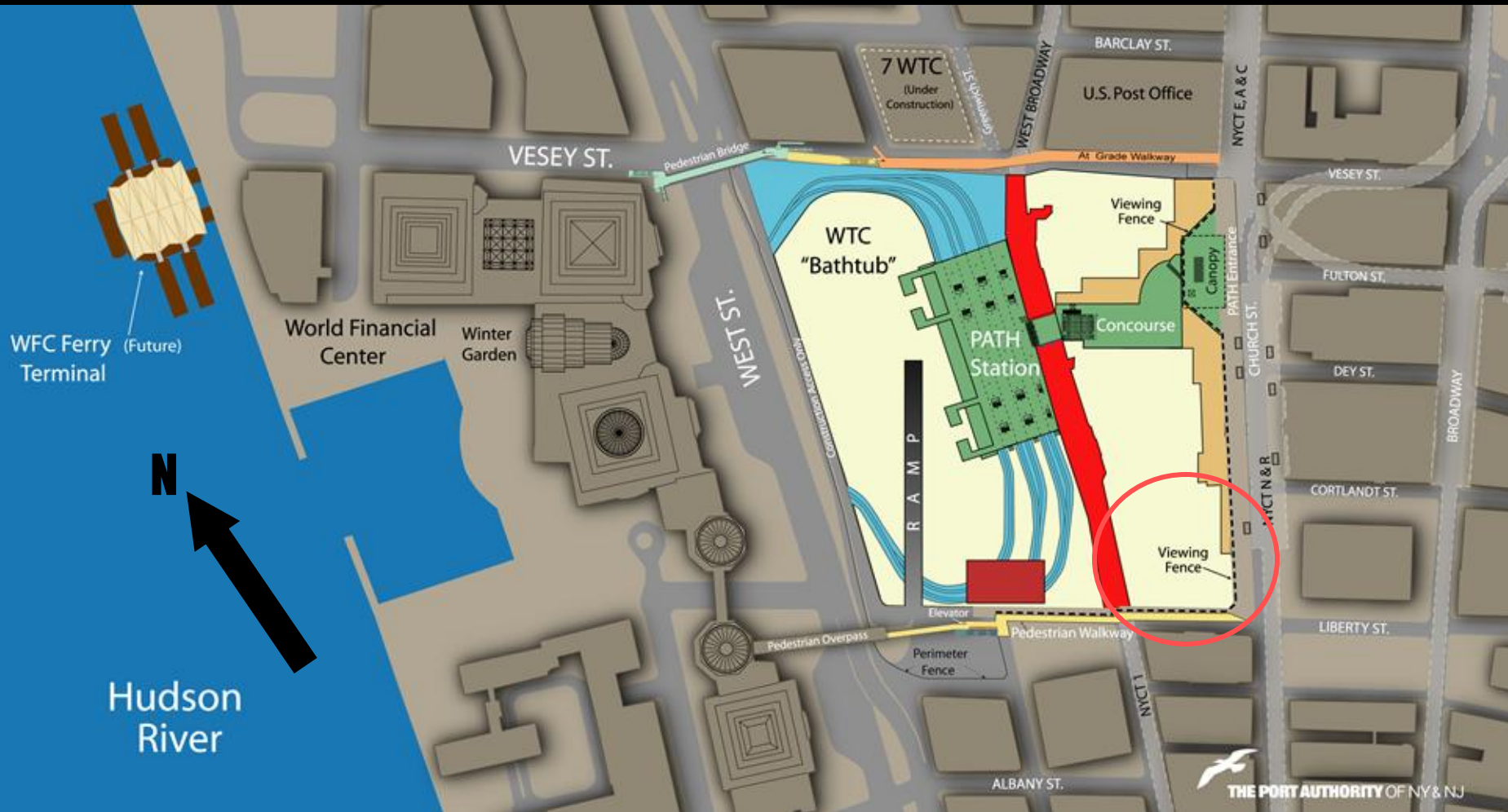
Merguerian and Merguerian, 2004

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

**Finally! He's
Going to Talk
About the
World Trade
Center Site**



The World Trade Center Site



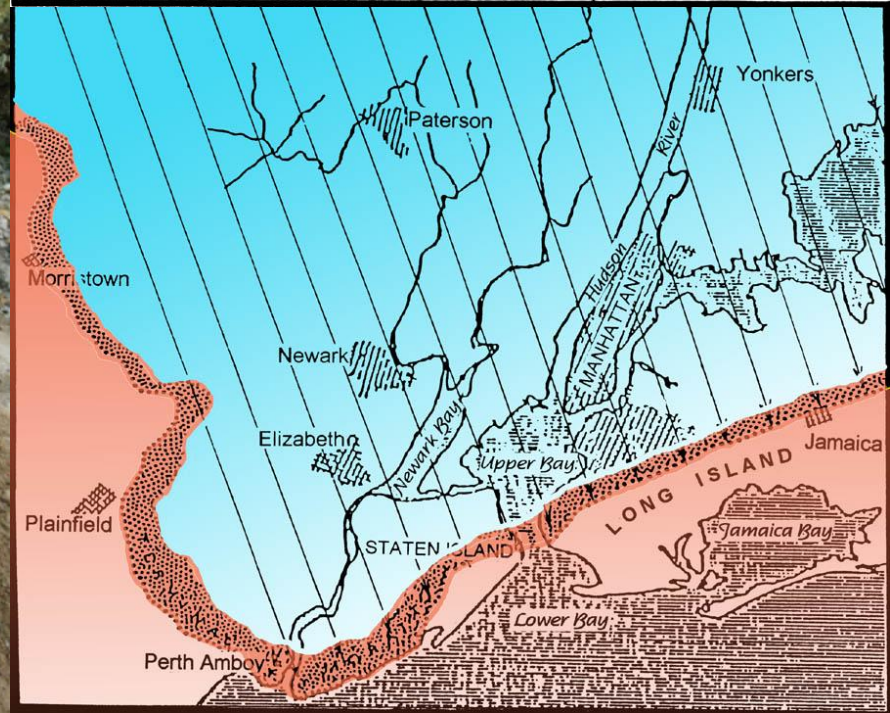
NYC Glaciation





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**



World Trade Center Plunge Pools



Movie Clip - C. Moss



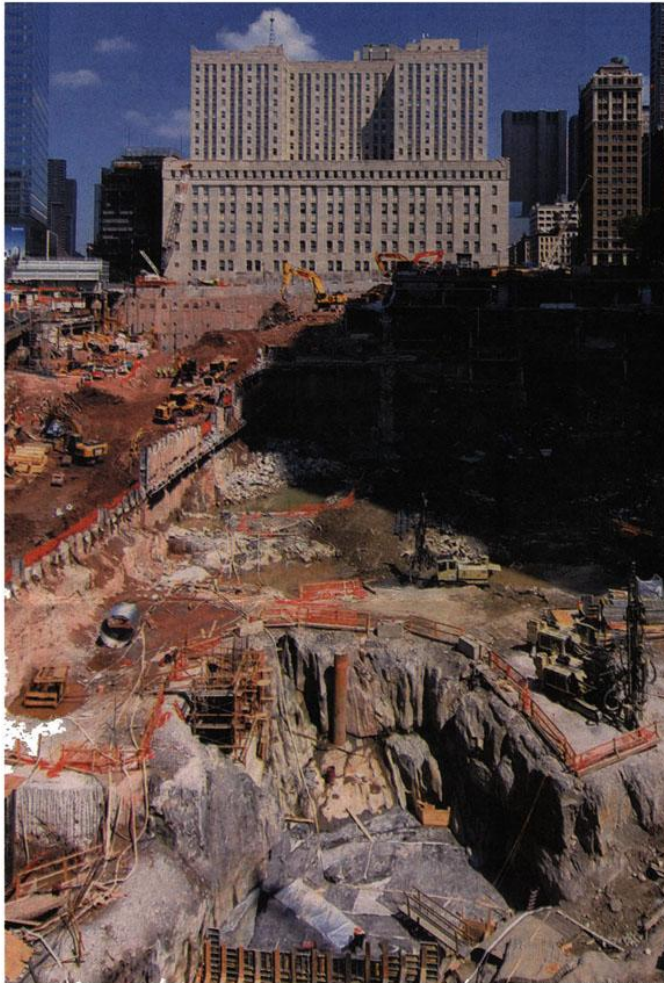
The Metro Section

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



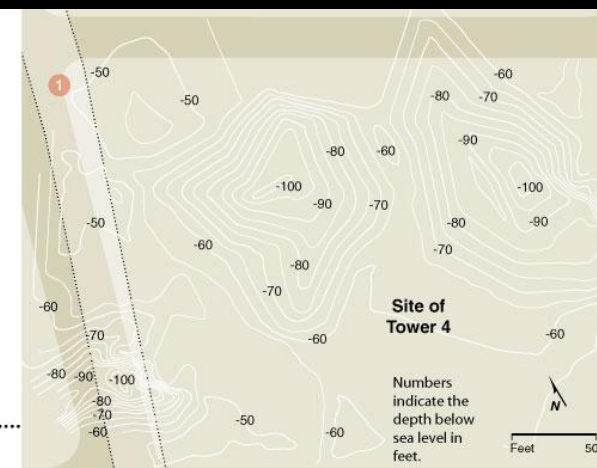
DAVID W. DUNLAP/THE NEW YORK TIMES

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.

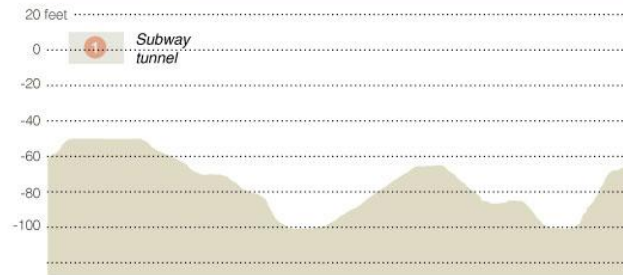
Glacial Terrain At Ground Zero

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 is 10 to 20 feet below street level. That means the bottoms of the potholes (-100) are about 110 feet to 120 feet below the street.



THE NEW YORK TIMES



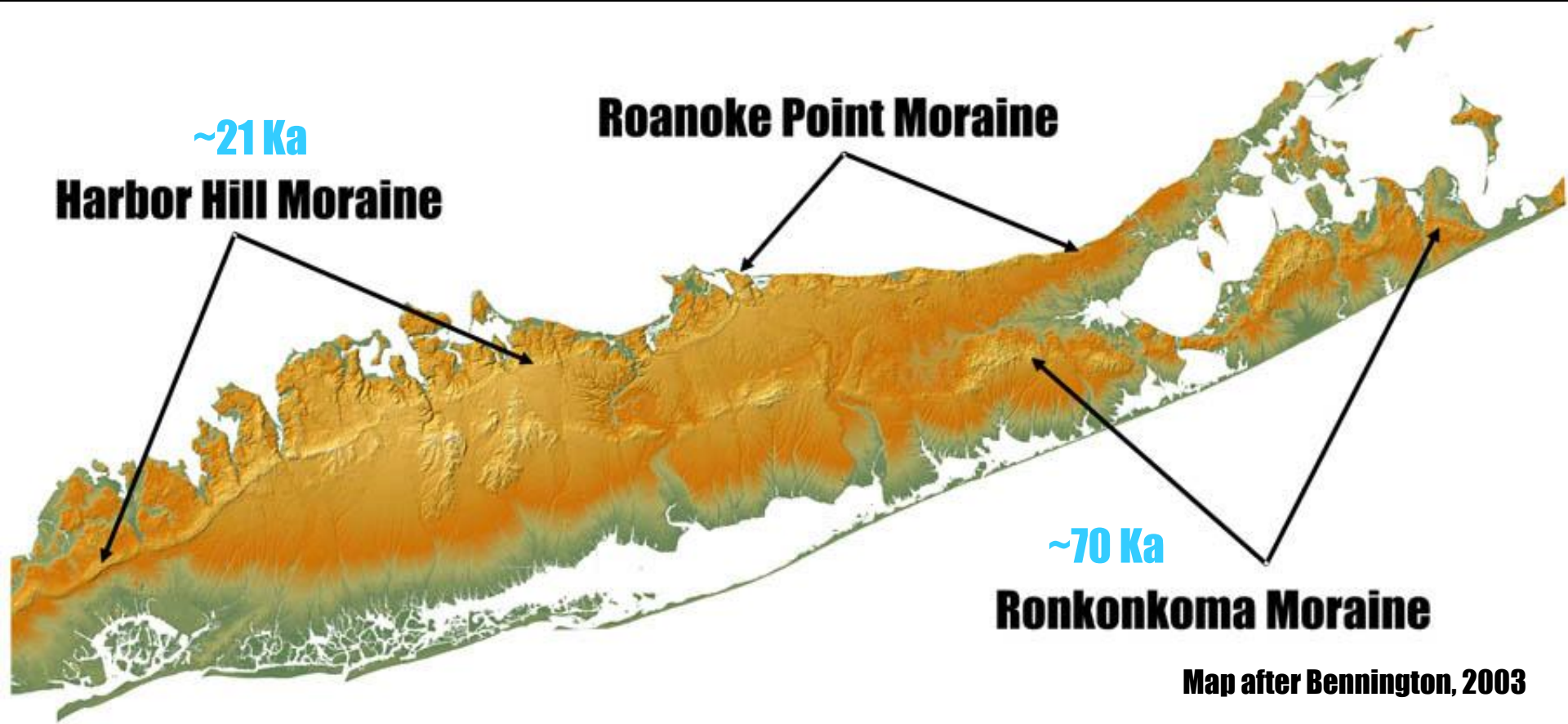




From Moss and Merguerian 2009



Long Island's Glacial Moraines



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

Existing caisson

Location Where Wood Was Found

X

Silt Lens

Surrounding Till





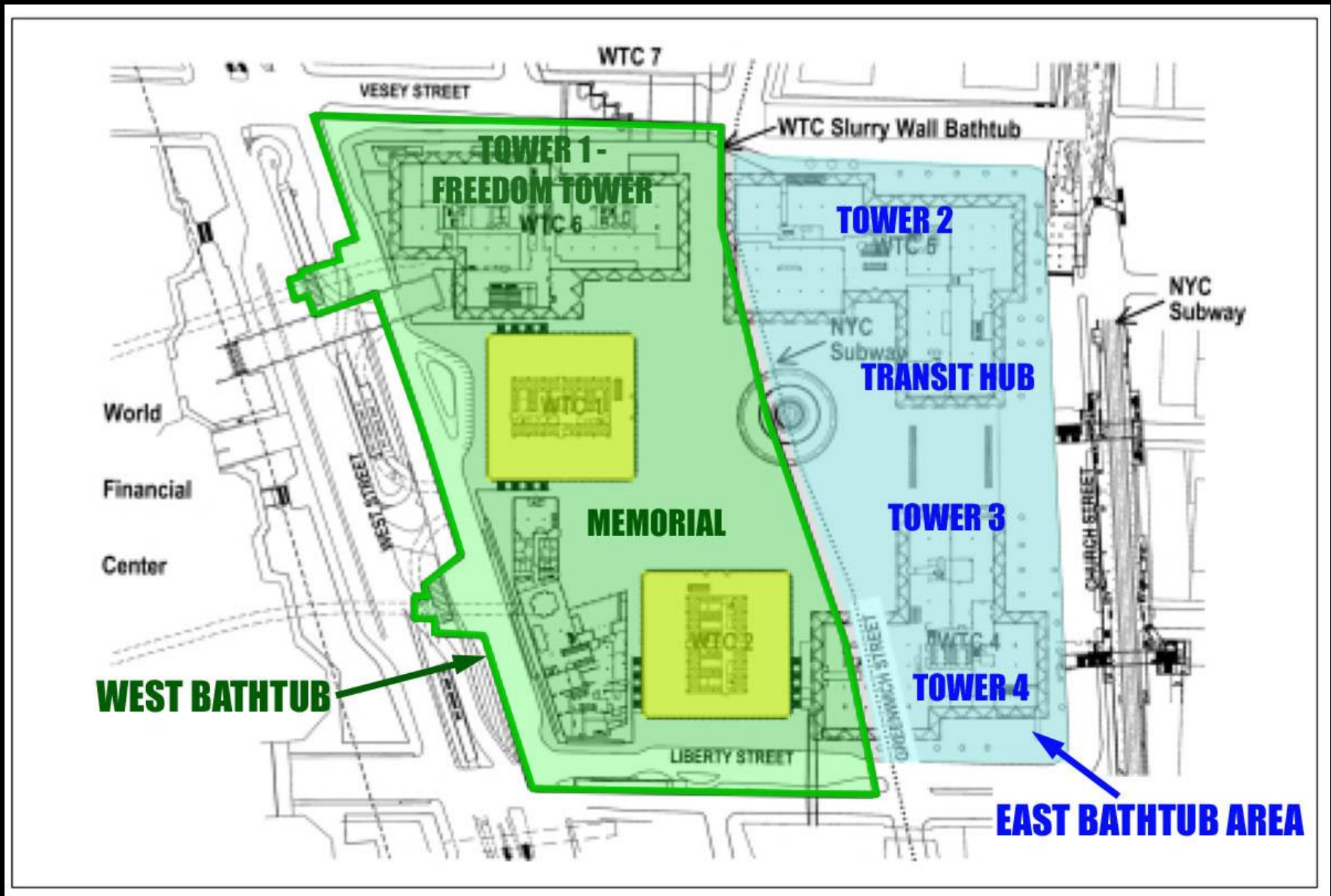
FRDG Funding = 49,500 BP +3050/-2205

Harbor Hill 25 - 19 Ka

Ronkonkoma ~70 Ka

Question is: WHICH GLACIATION?

World Trade Center Site



World Trade Center



On The Rocks

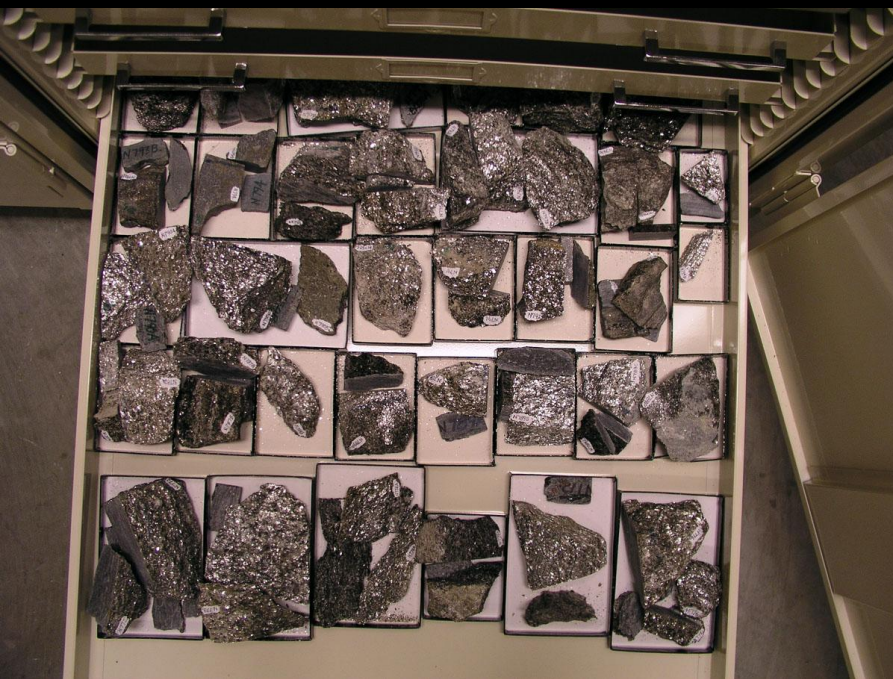


2004



Geology Department

**New York City
Rock Sample Archive
Gittleson Hall**



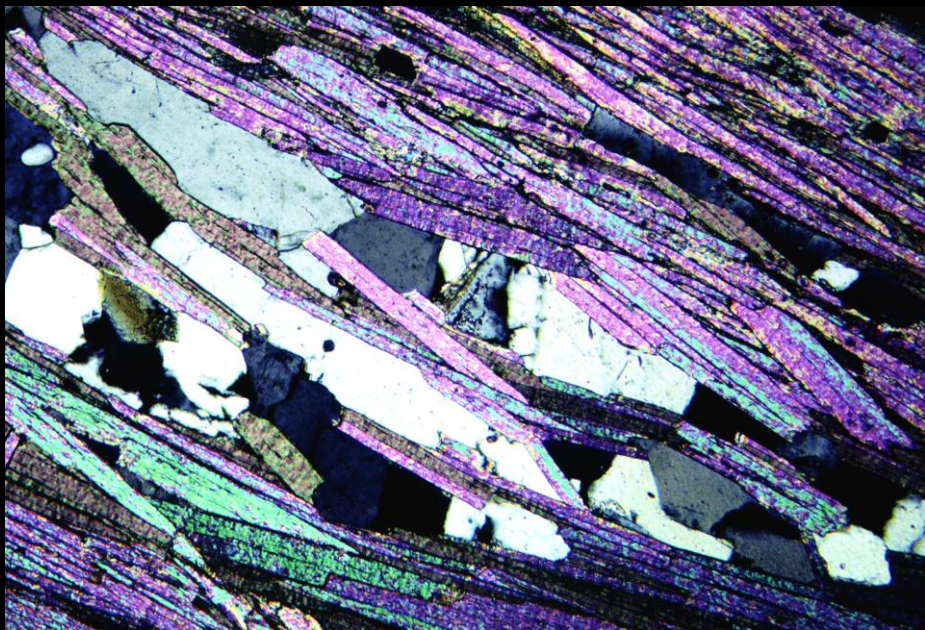
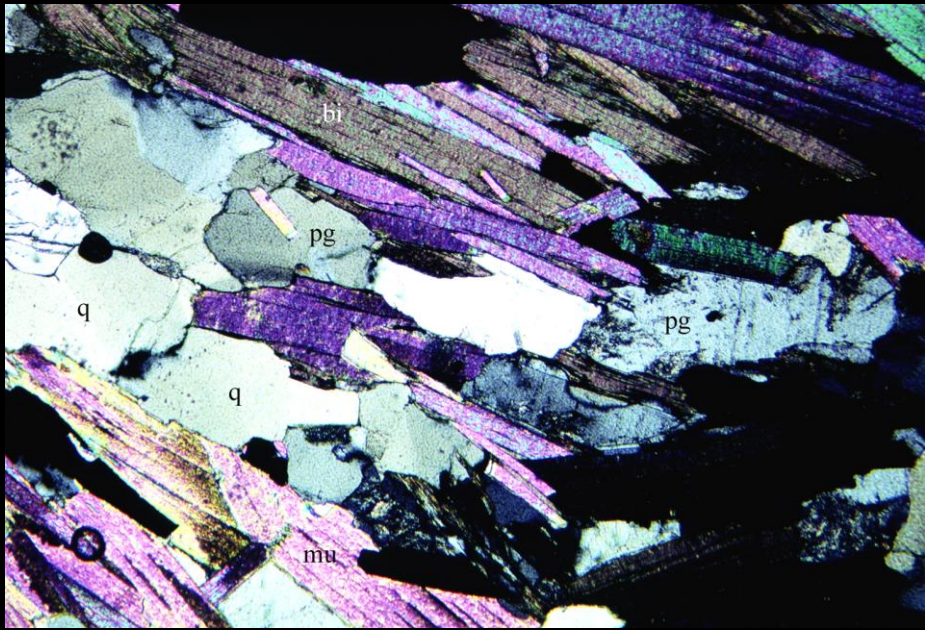
Hofstra Geology Petrography Lab





**So, Let's Take a Peek
at Some Rocks**

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



Stop 6



COh

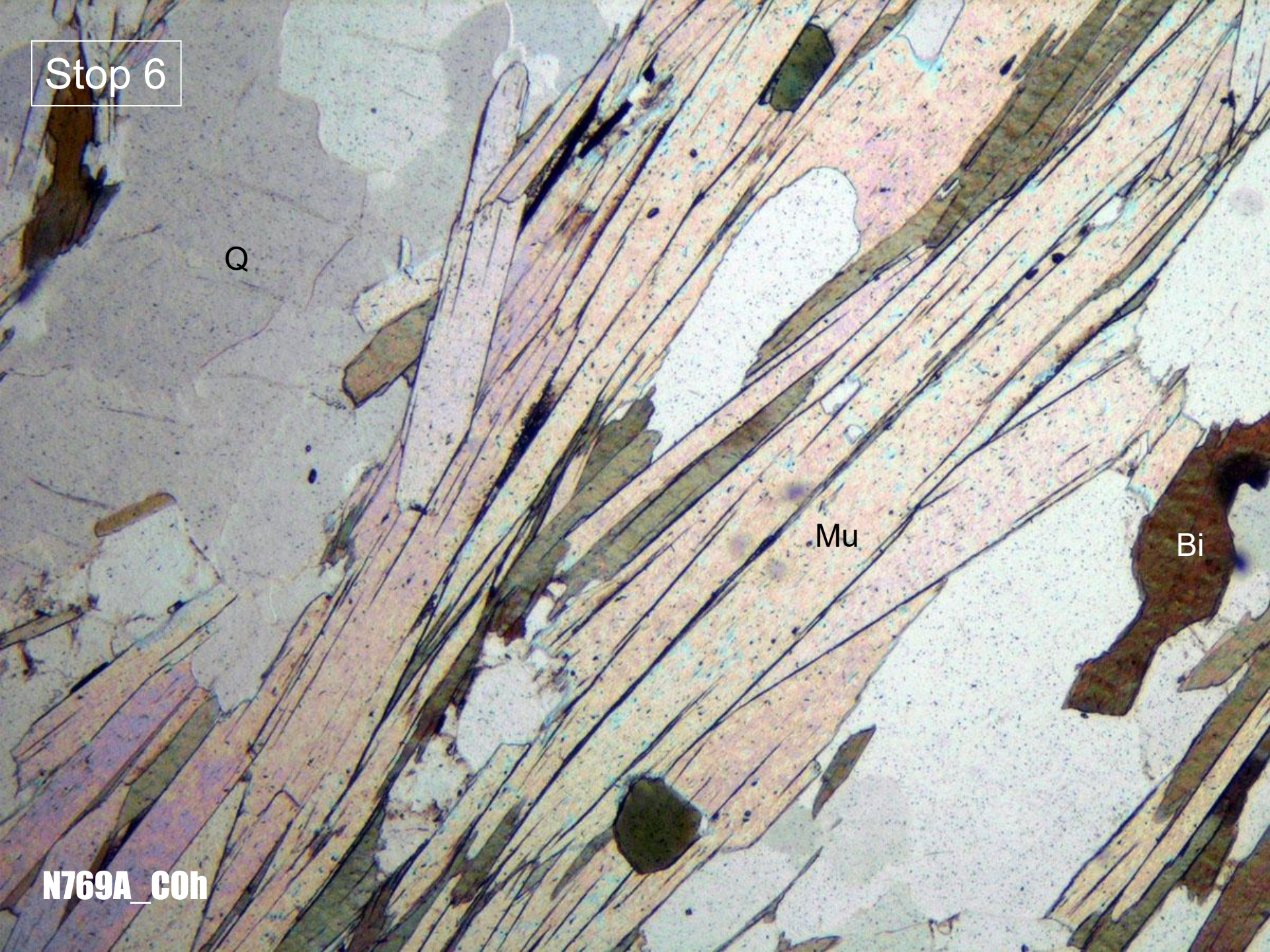
Stop 6

Q

Mu

Bi

N769A_c0h



Stop 6

Q

Mu

Bi

N769A_c0h

Stop 6

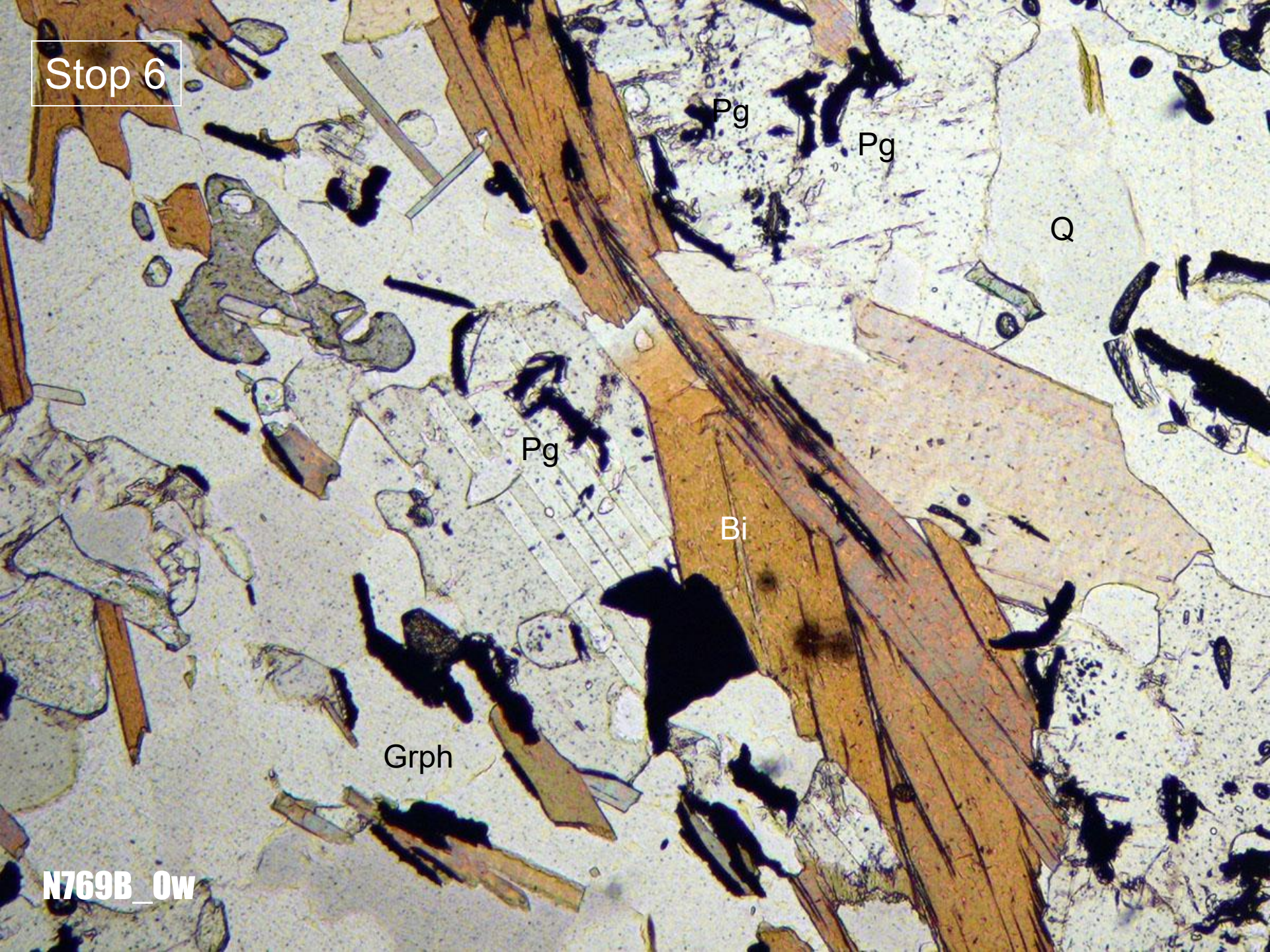


Ow

COh

COh+Ow

Stop 6



N769B_0w

Stop 6

Pg

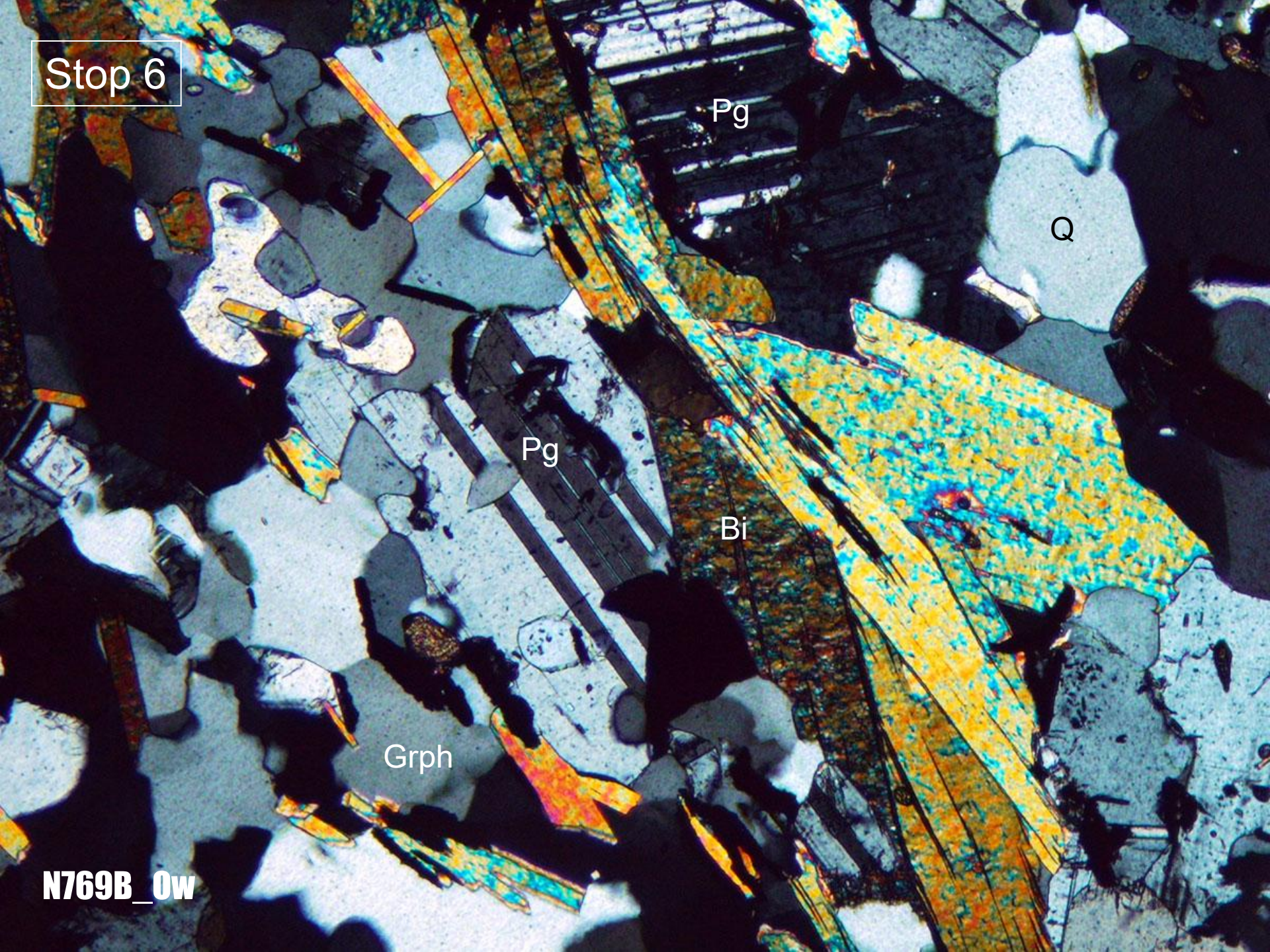
Q

Pg

Bi

Grph

N769B_0w

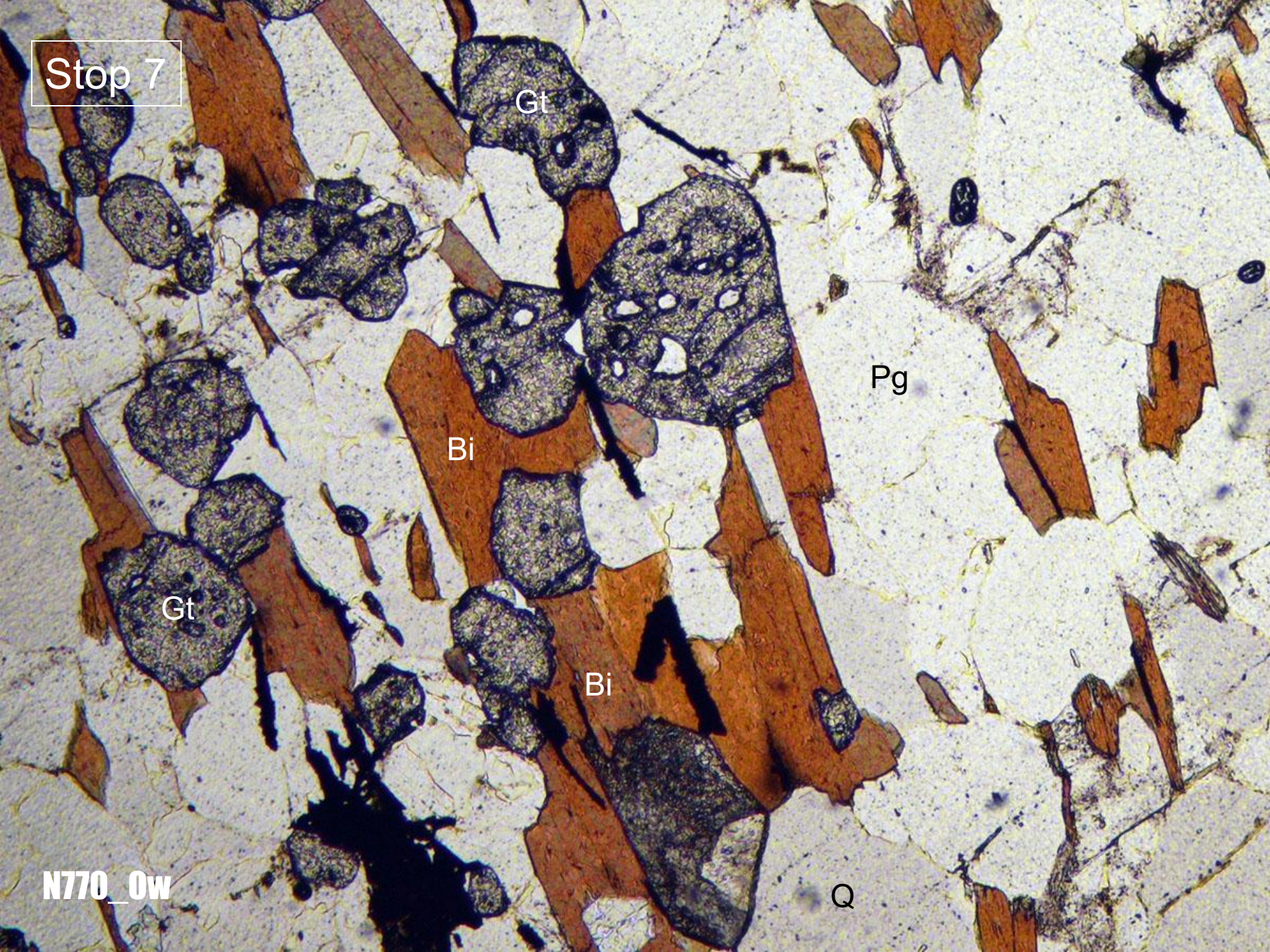


Stop 7



0w

Stop 7



Gt

Pg

Bi

Gt

Bi

Q

N770_0w

Stop 7

Gt

Pg

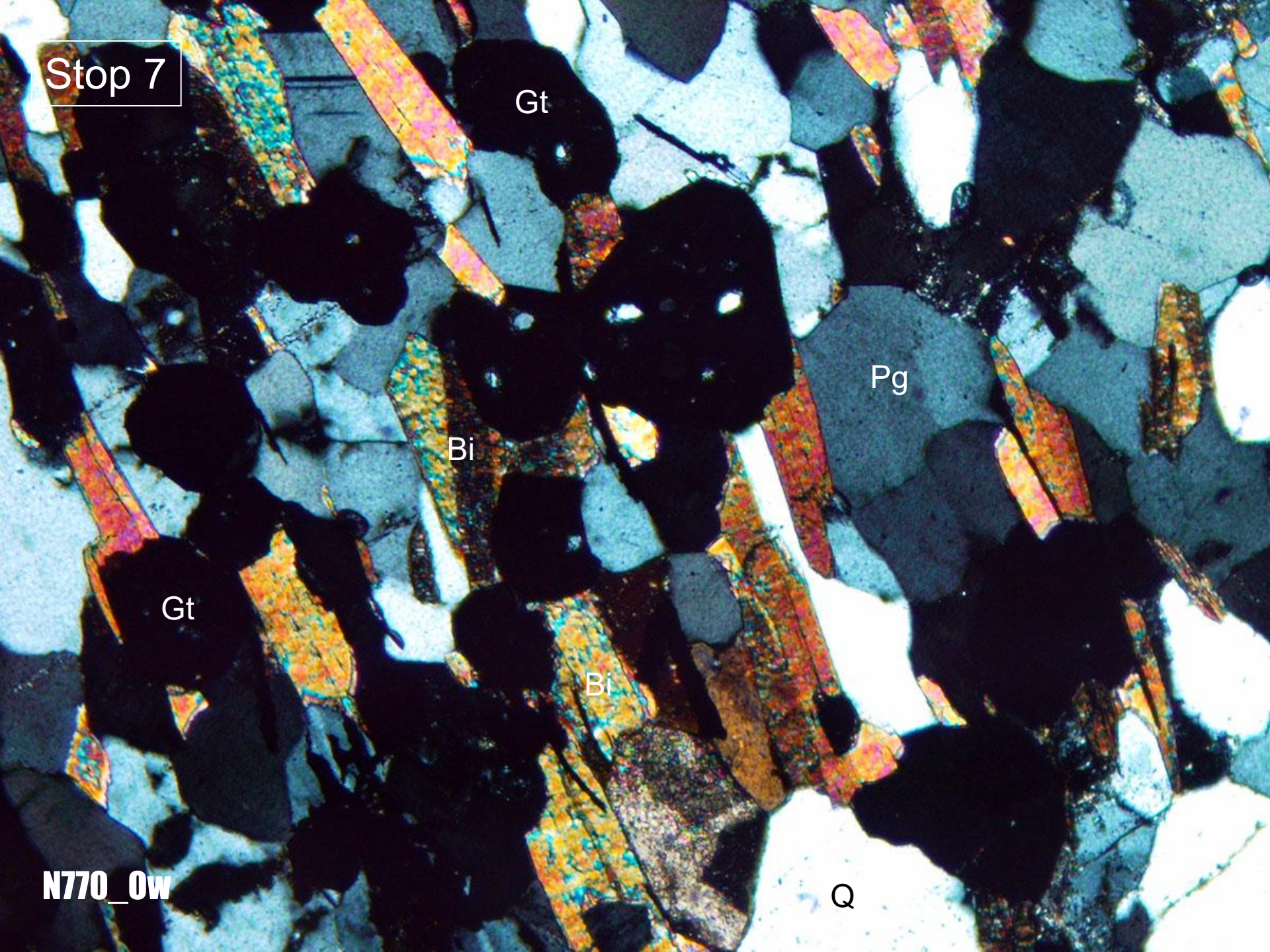
Bi

Gt

Bi

N770_0w

Q



Stop 13



COH

Stop 13

Gt

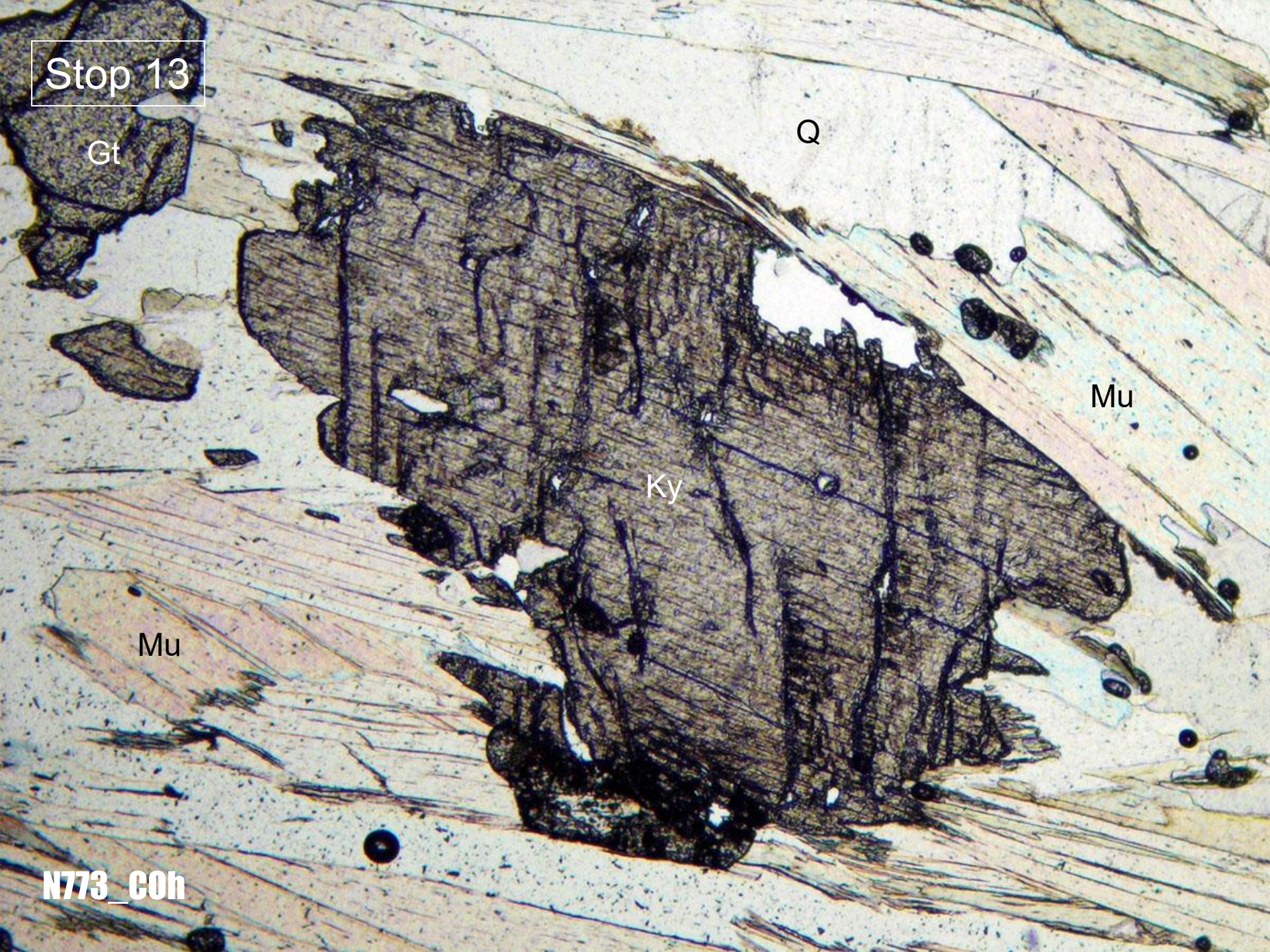
Q

Mu

Ky

Mu

N773_c0h



Stop 13

Gt

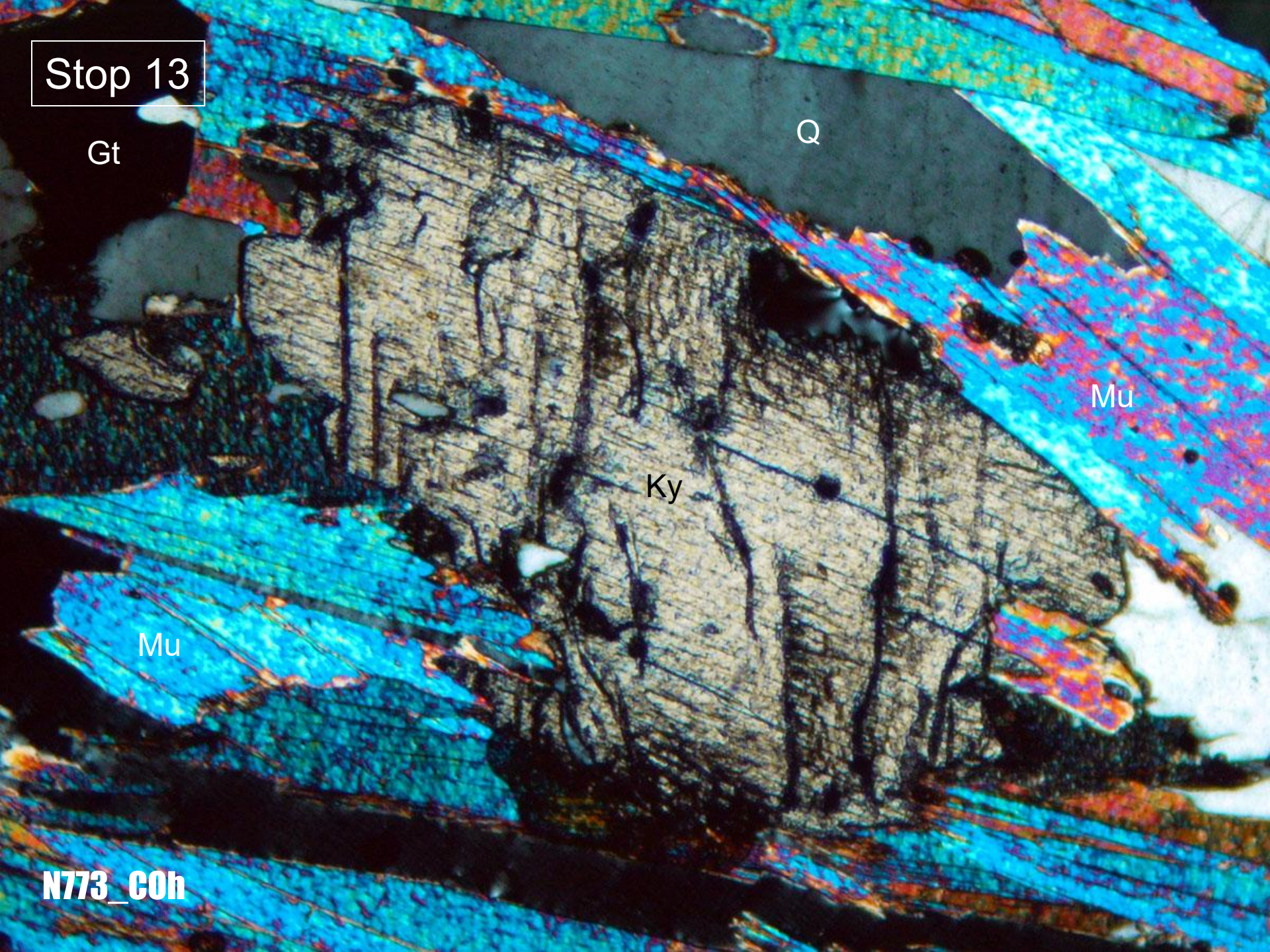
Q

Mu

Ky

Mu

N773_C0h

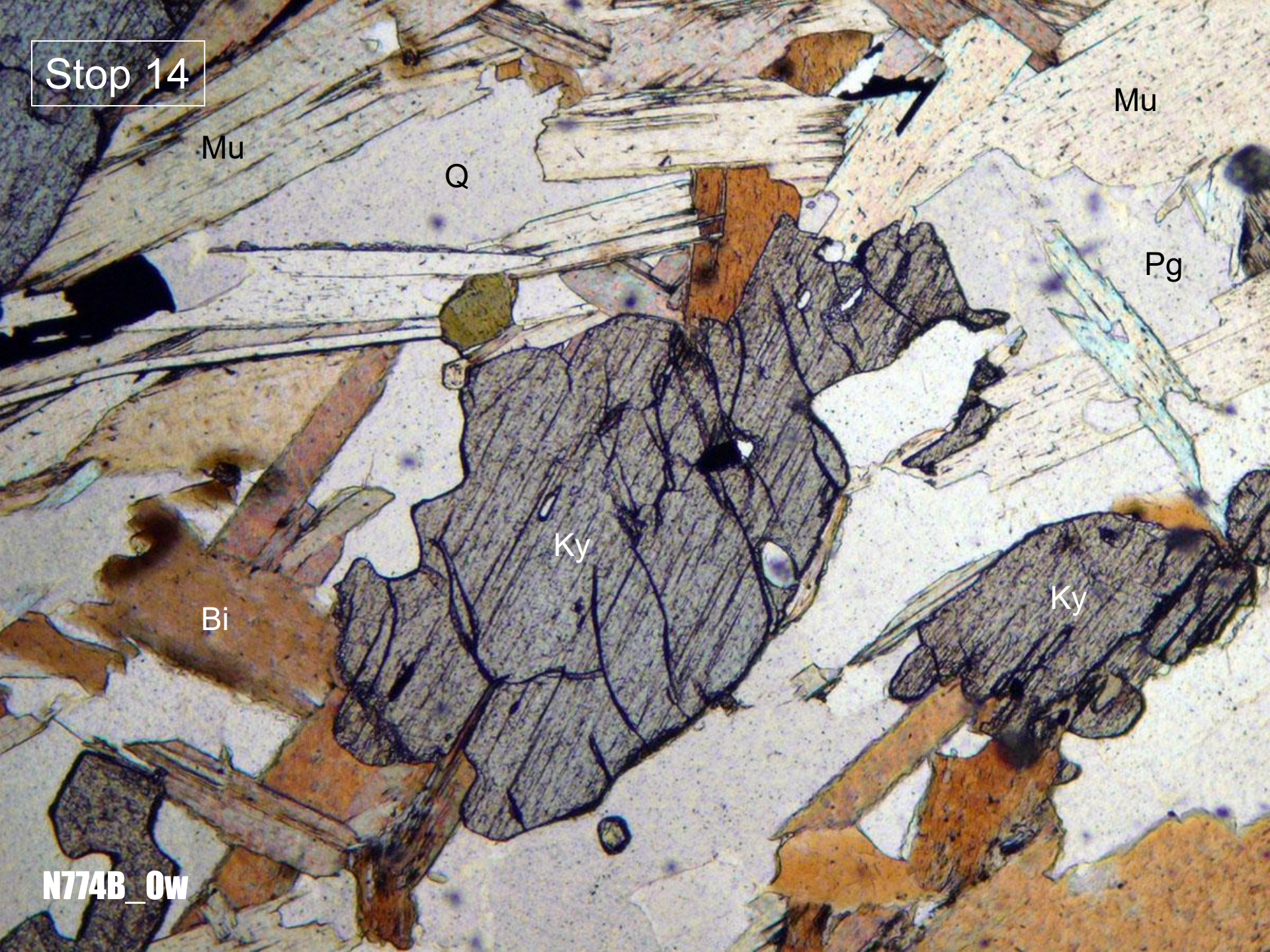


Stop 14



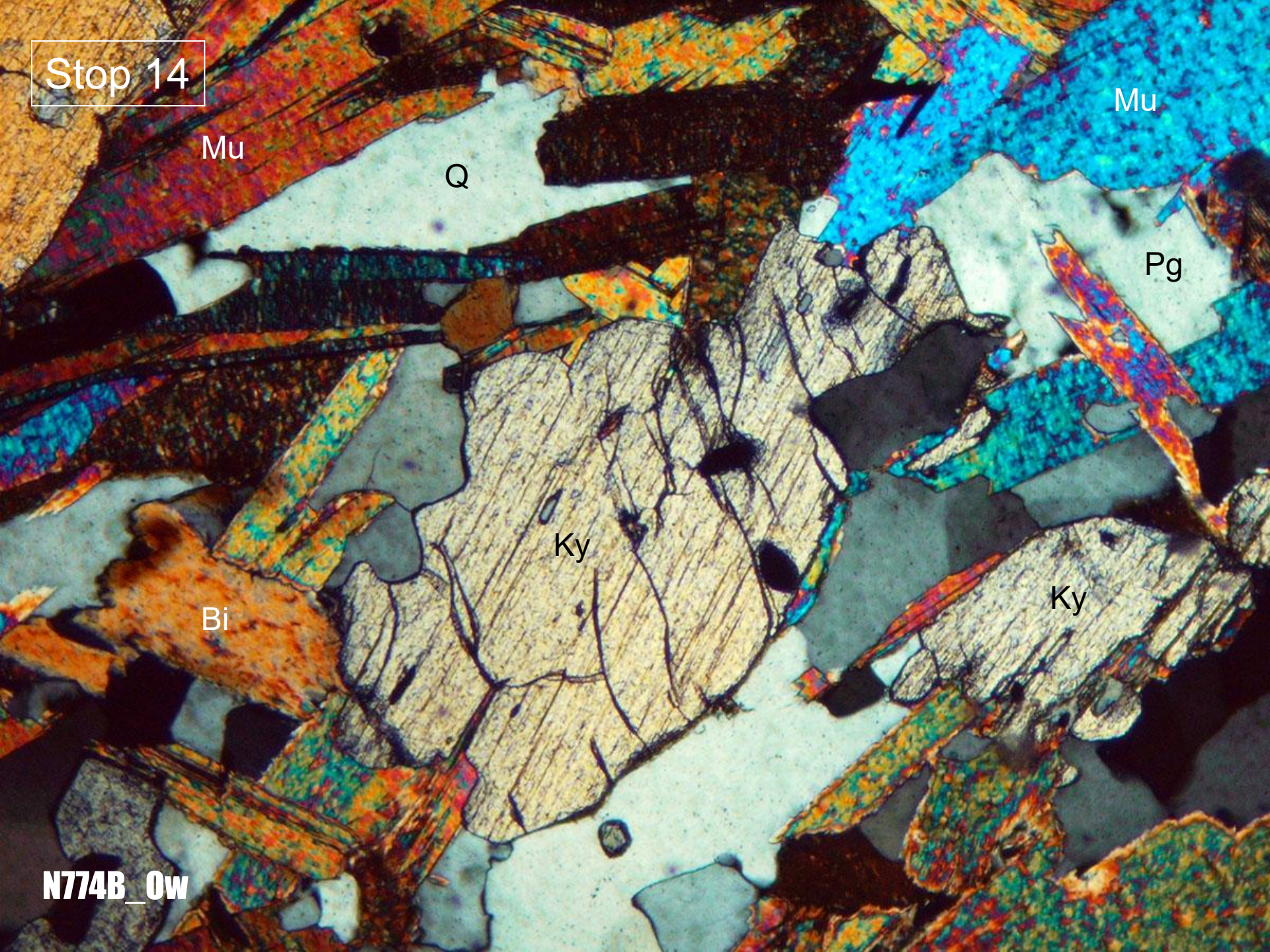
0w

Stop 14



N774B_0w

Stop 14



Mu

Mu

Q

Pg

Ky

Bi

Ky

N774B_0w







Stop 21



COh

Stop 21



N787A_C0hPL

Stop 21

Gt

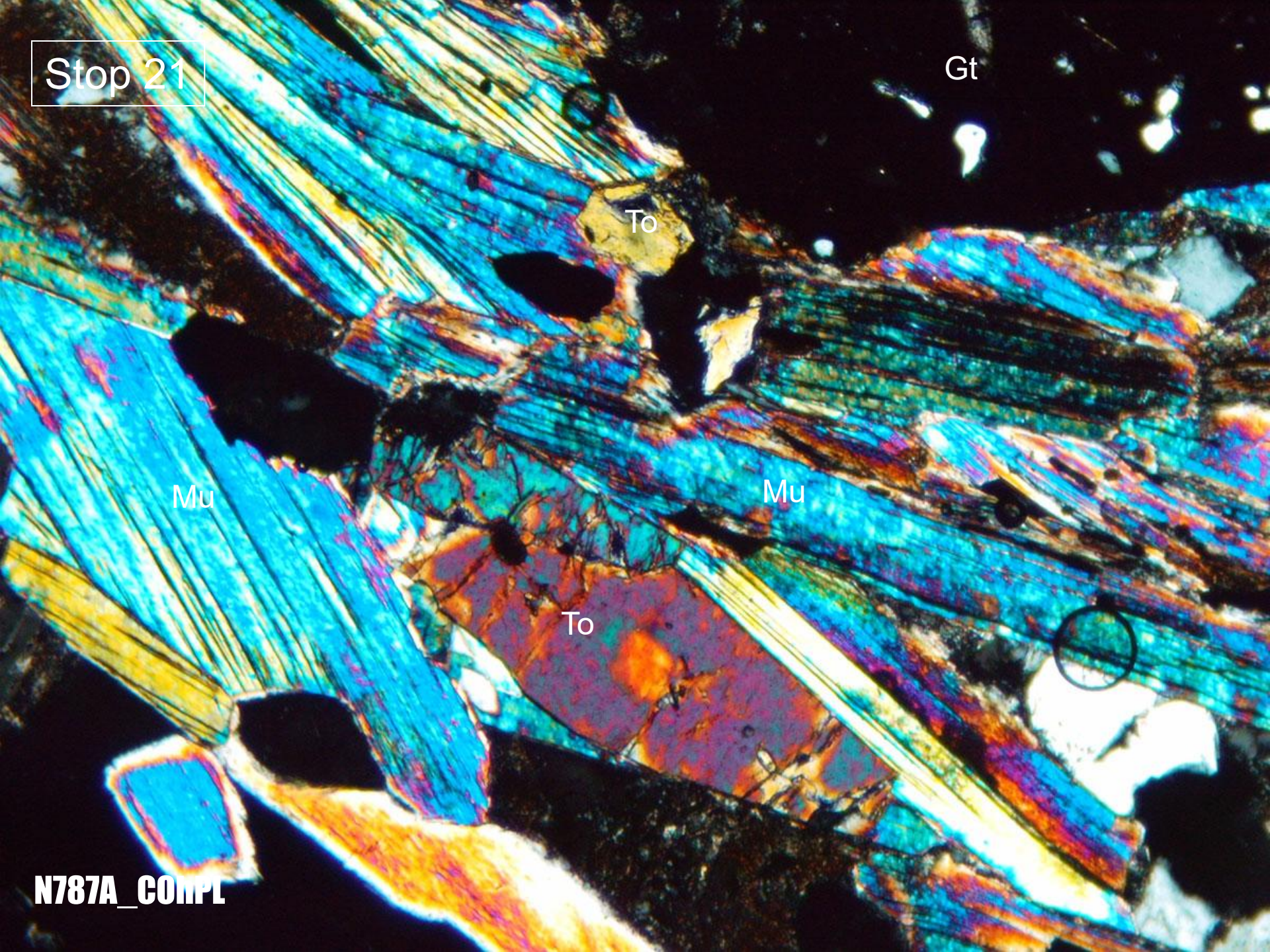
To

Mu

Mu

To

N787A_COMPL

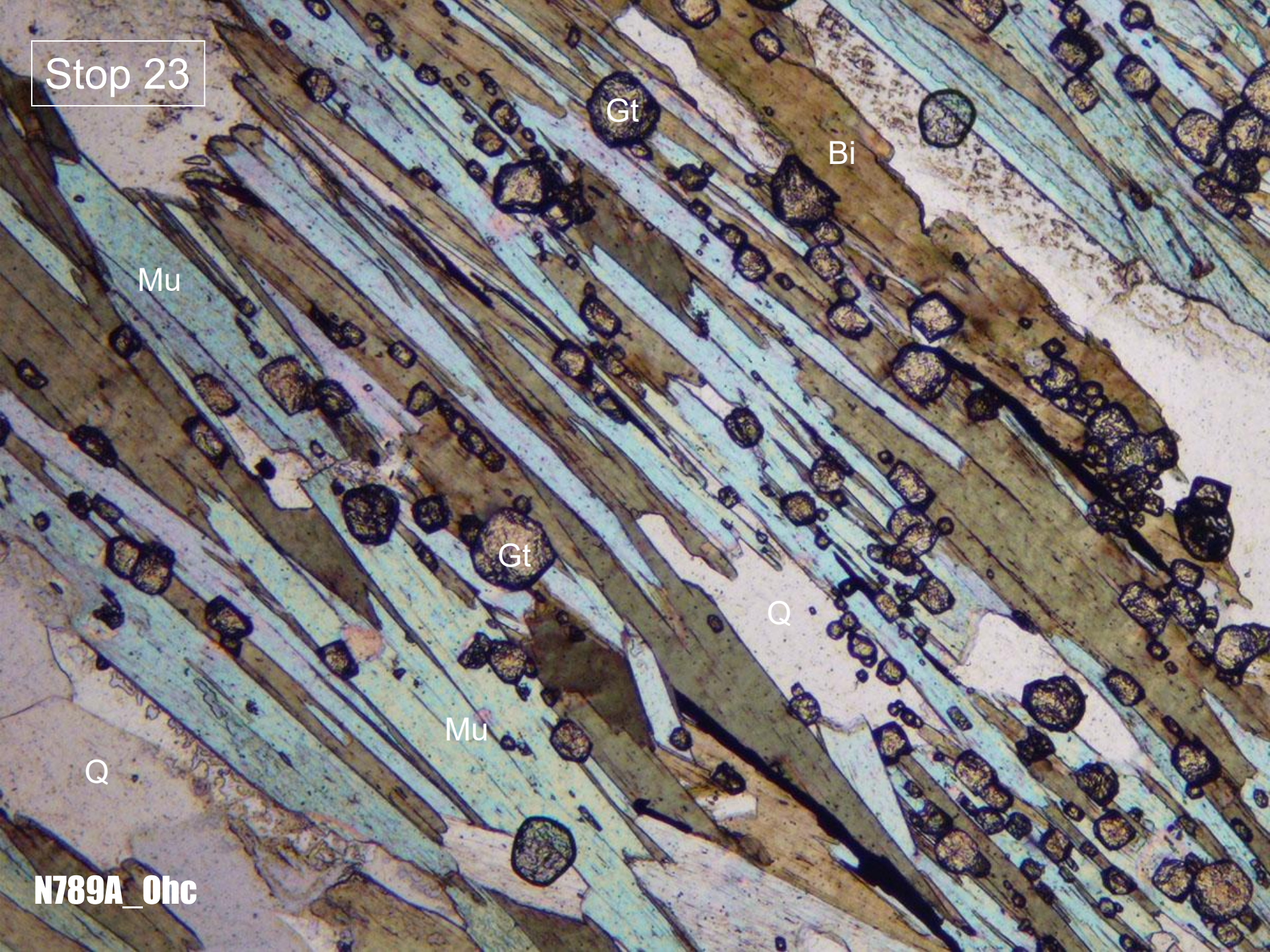


Stop 23



Con

Stop 23



Gt

Bi

Mu

Gt

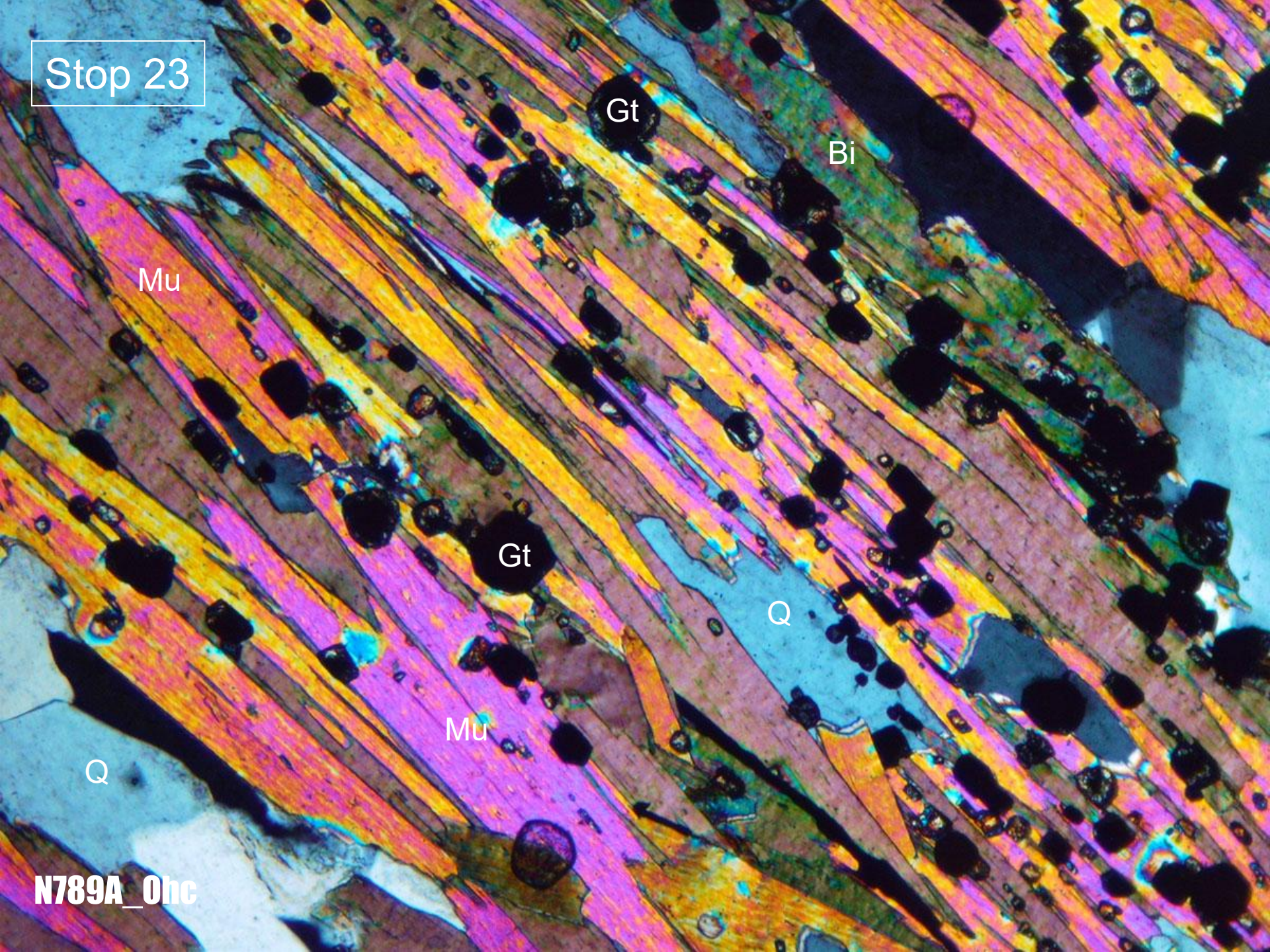
Q

Mu

Q

N789A_0hc

Stop 23



Gt

Bi

Mu

Gt

Q

Mu

Q

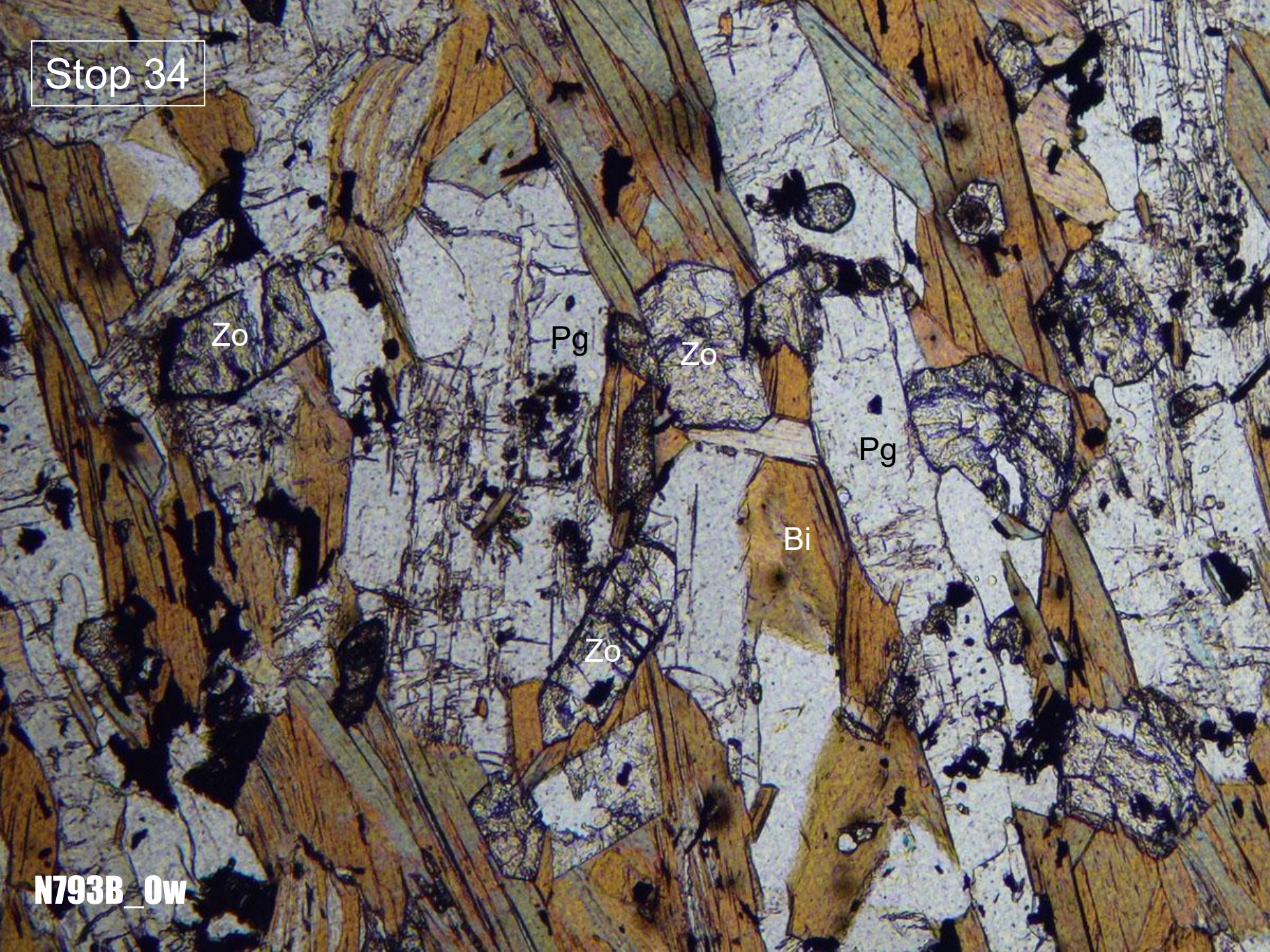
N789A_0hc

Stop 34

0w



Stop 34



N793B_0w

Stop 34

Zo

Pg

Zo

Pg

Bi

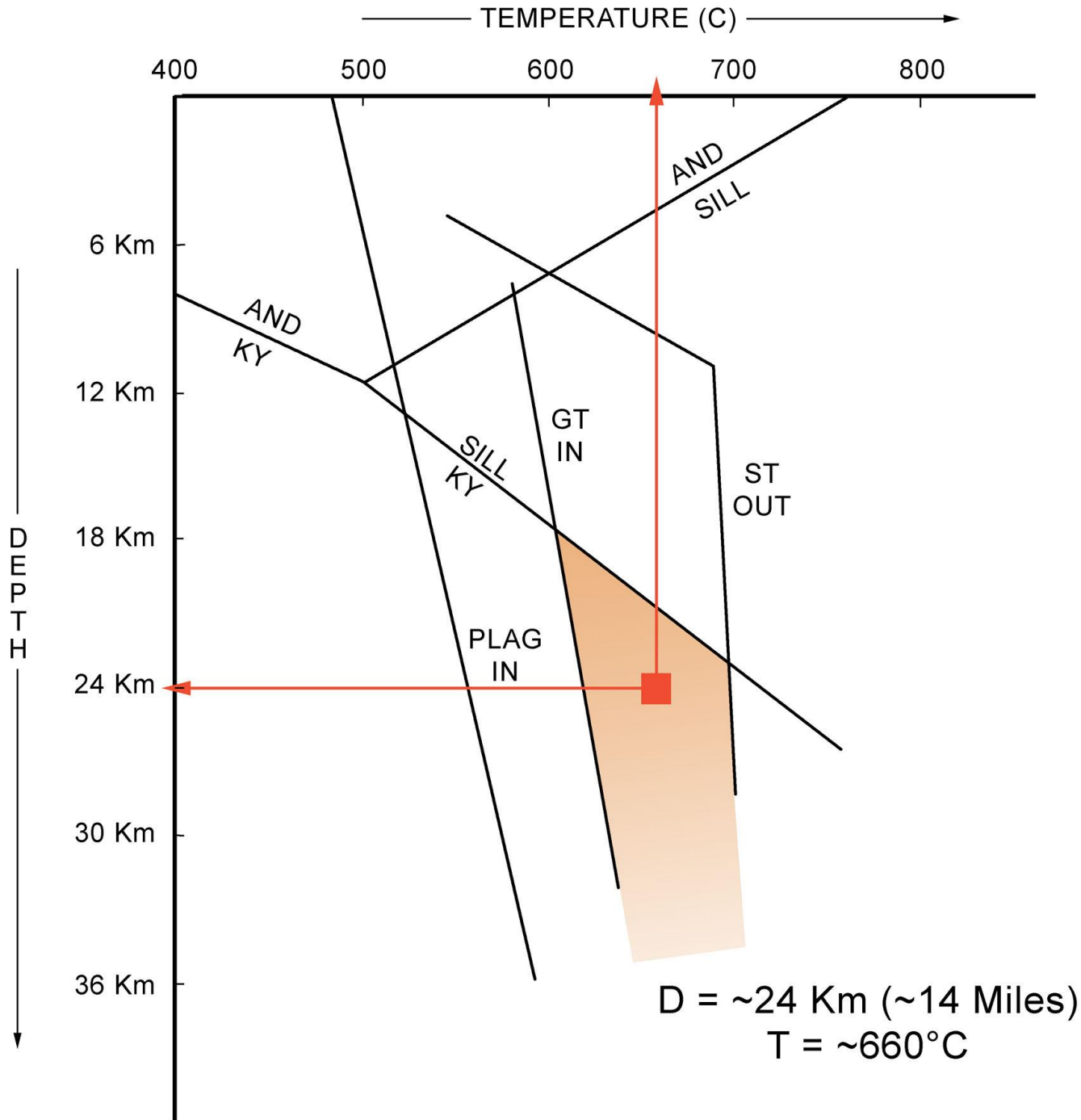
Zo

N793B_0w

**Minerals Are
Your Pals!**

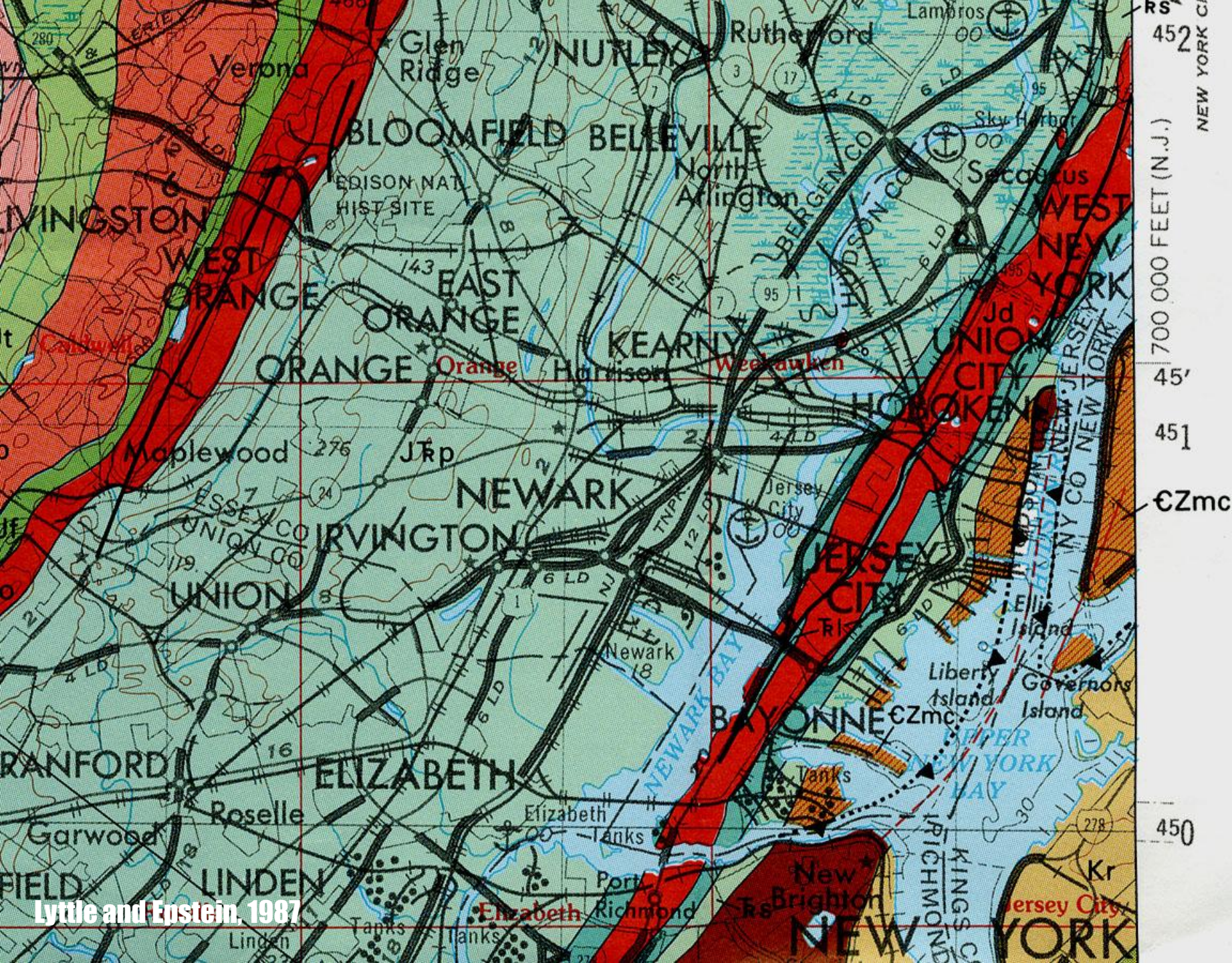
WTC Minerals

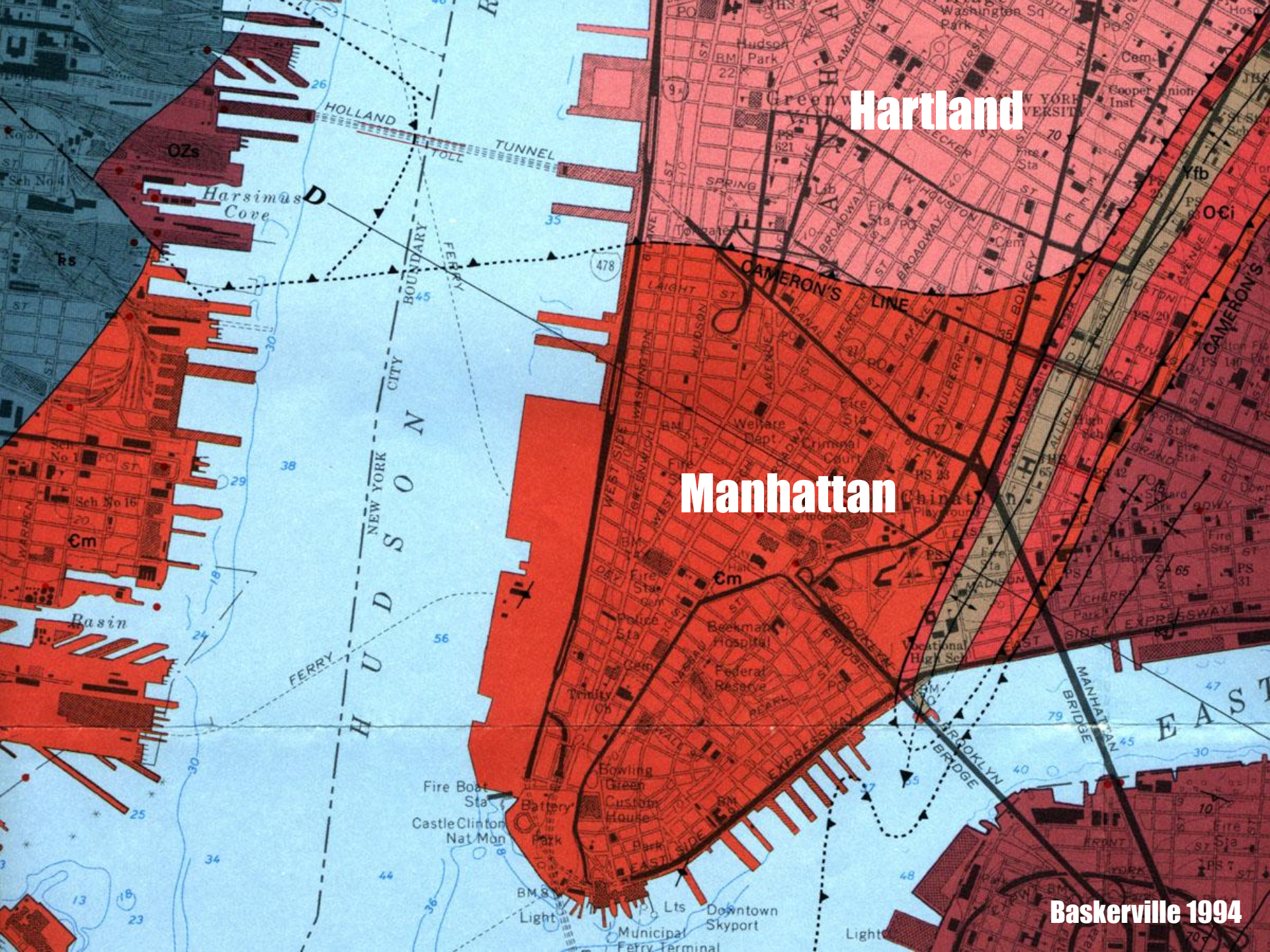
**Plagioclase
Garnet
Staurolite
Kyanite**





Berkey, 1911

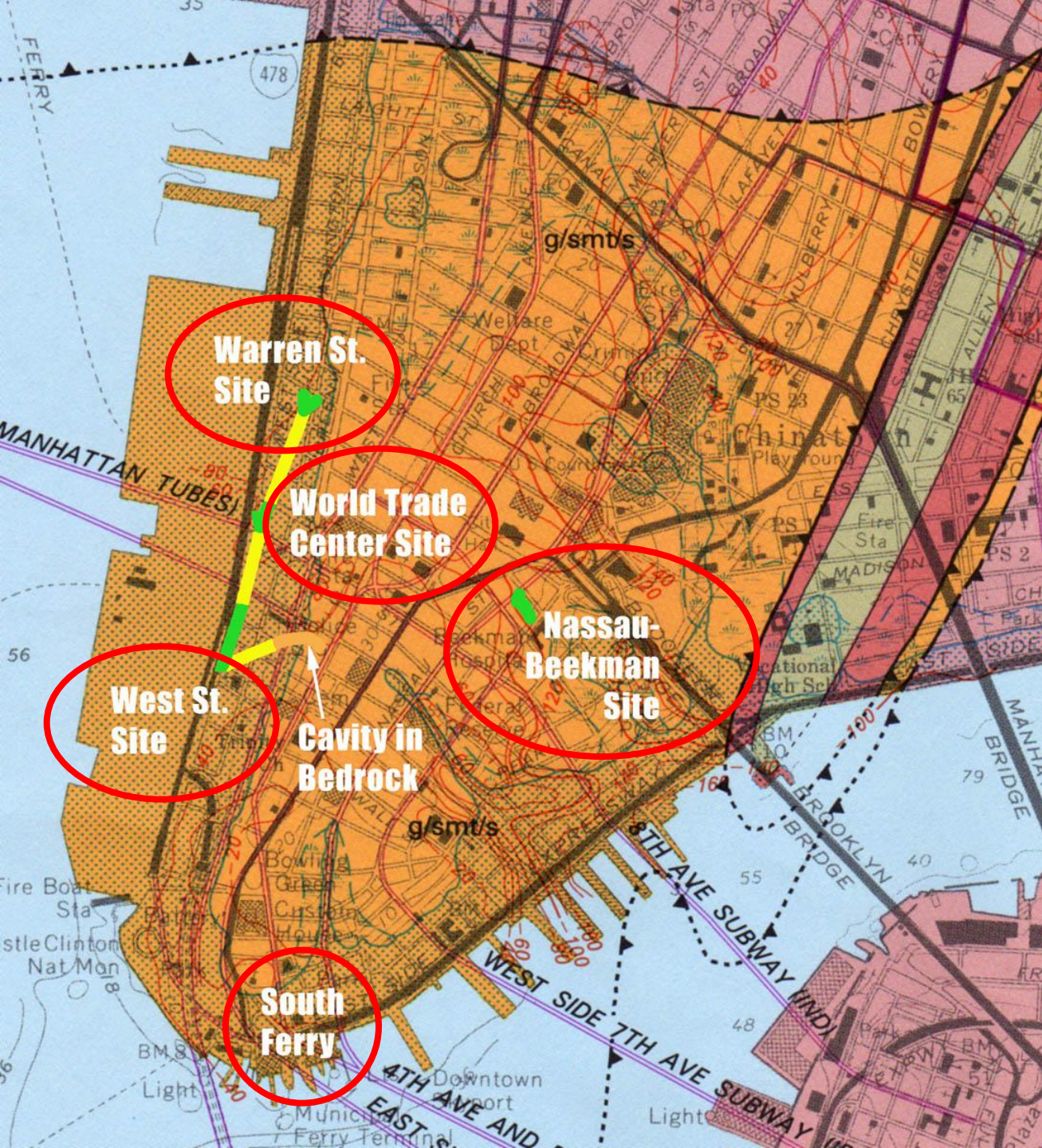




Hartland

Manhattan

Baskerville 1994



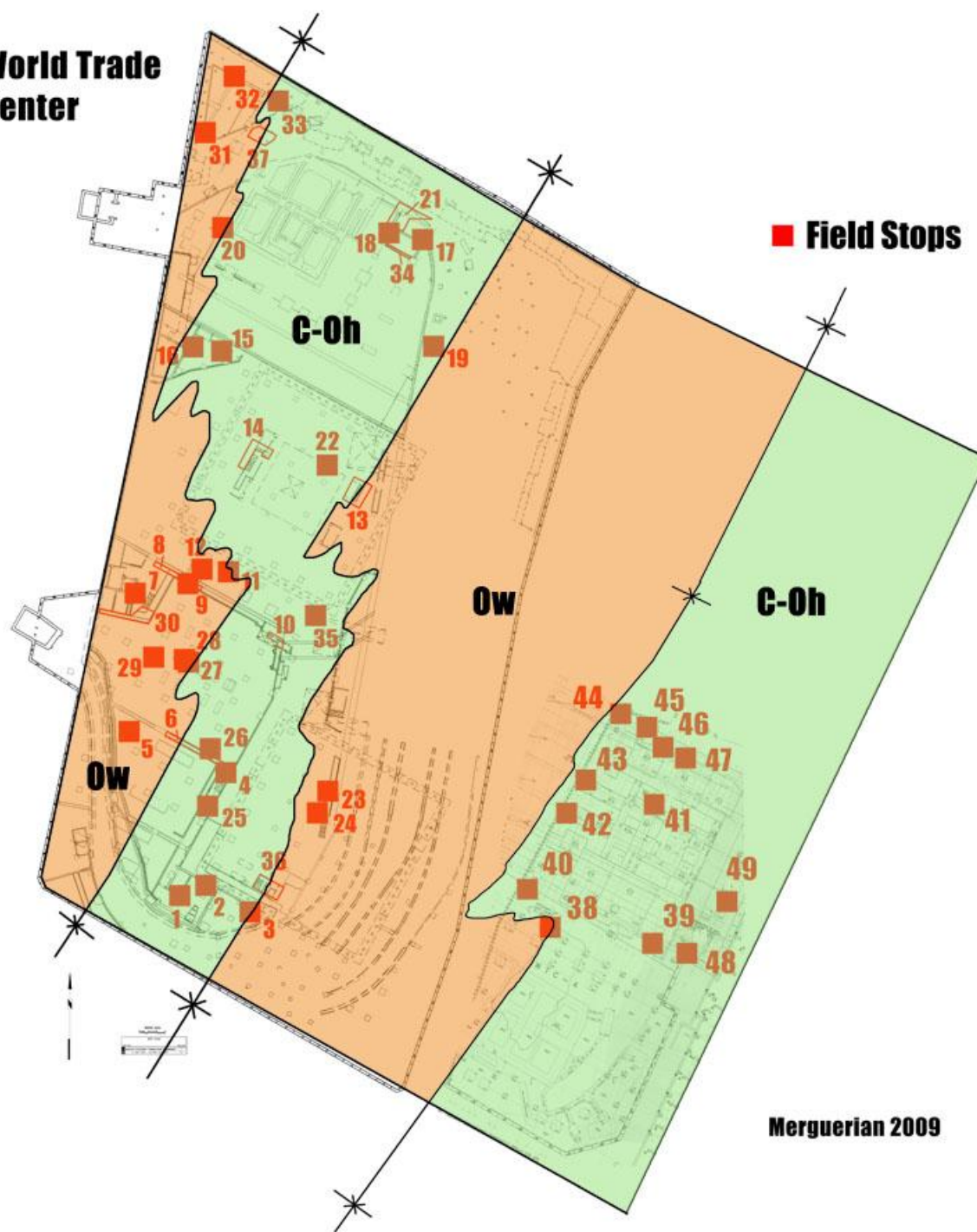
Five Localities South of Canal Street Display Sheared Manhattan, Hartland, and Walloomsac Rocks!

after Baskerville 1994,
Merguerian and Moss 2007

World Trade Center



World Trade Center



Field Stops

C-Oh

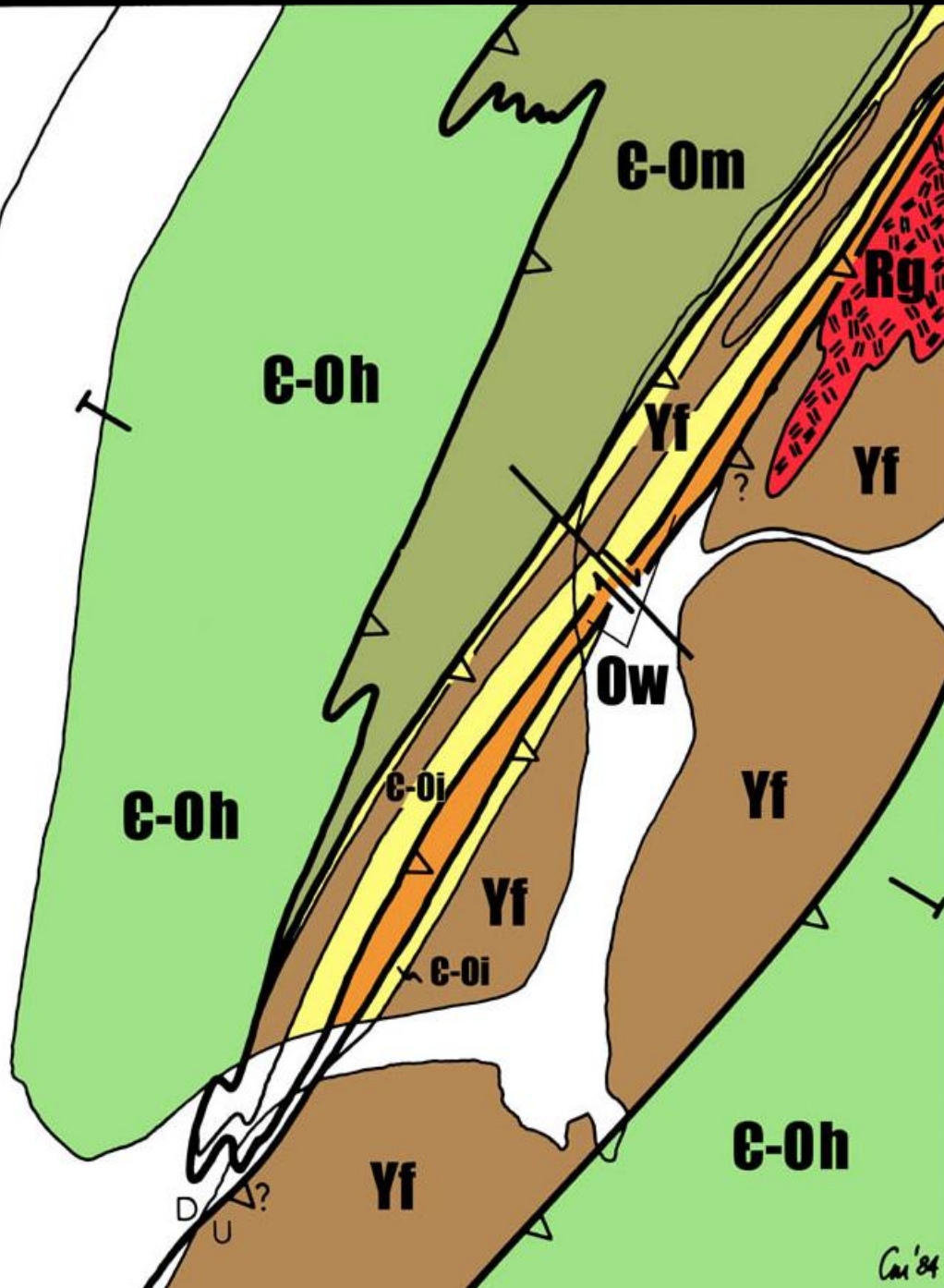
Ow

C-Oh

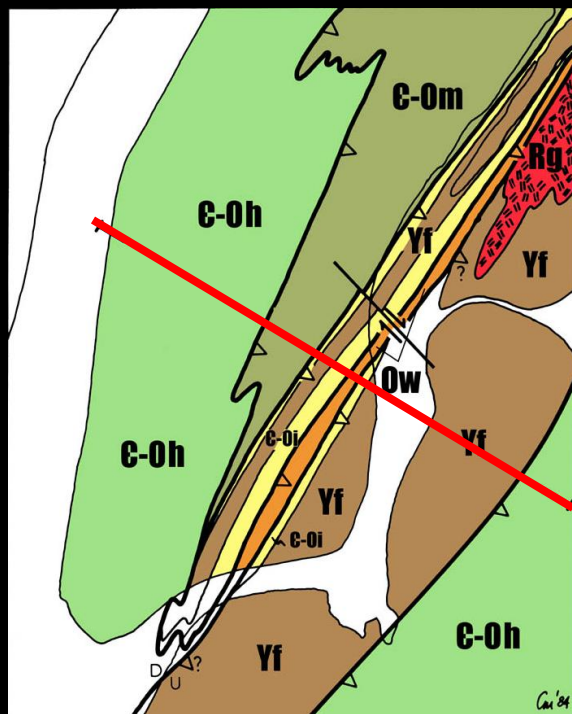
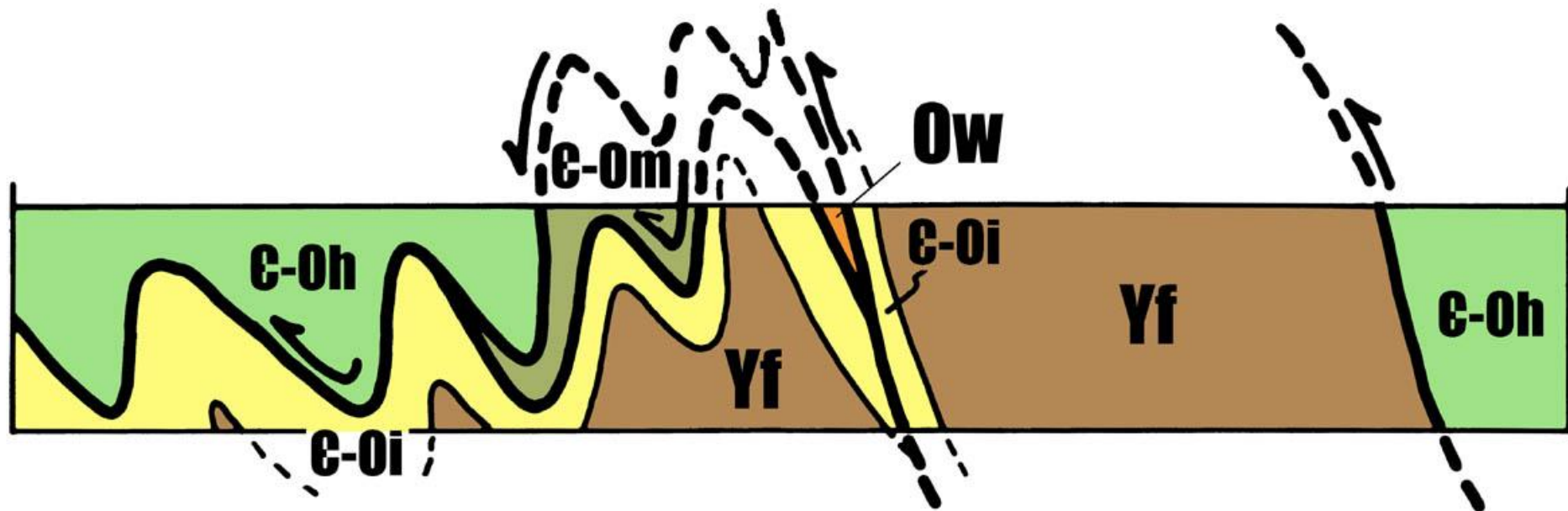
Ow

Merguerian 2009

Interpretive Geologic Map of SE Manhattan, Brooklyn, and Queens Based on Borings of Berkey (1910)



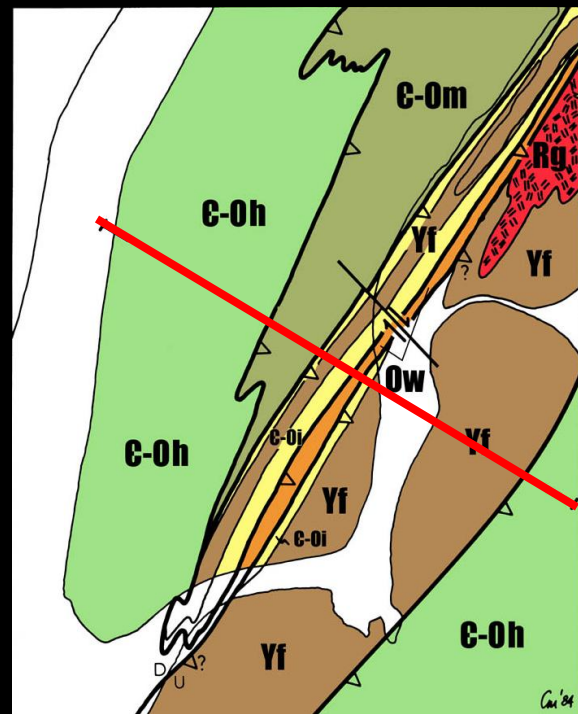
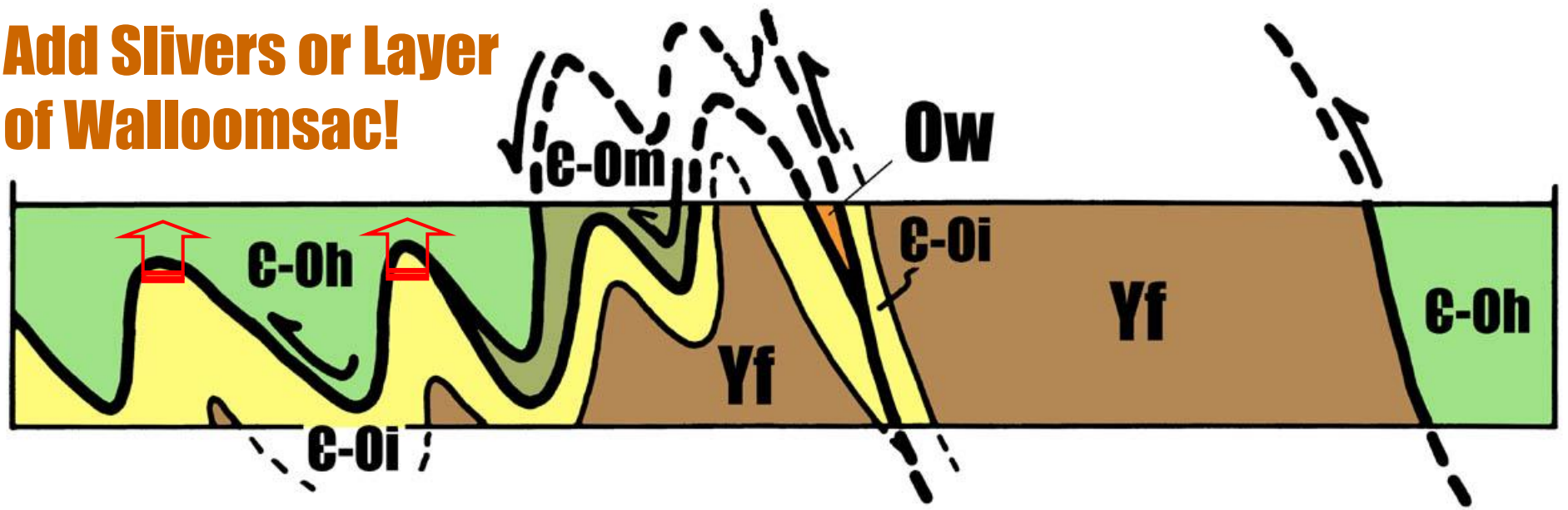
Merguerian, 1984



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

Merguerian, 1984

Add Slivers or Layer of Walloomsac!

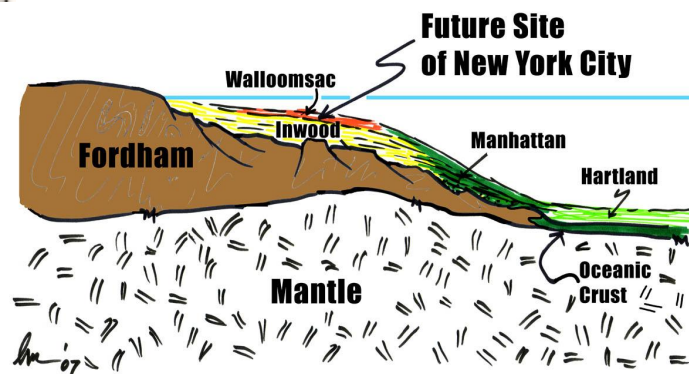
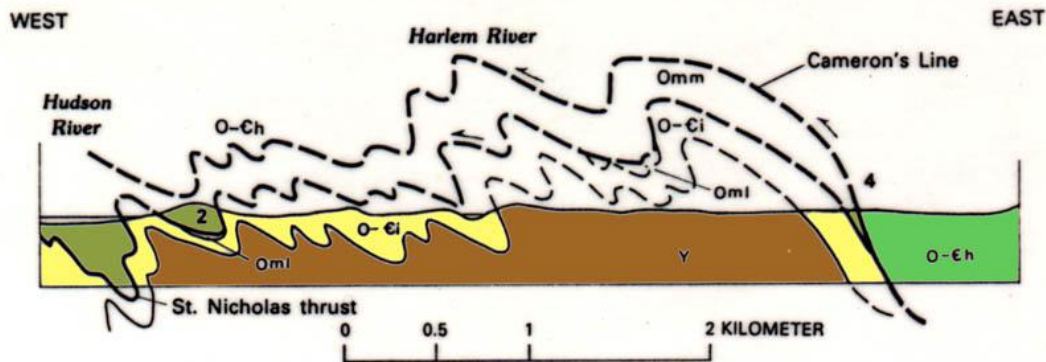
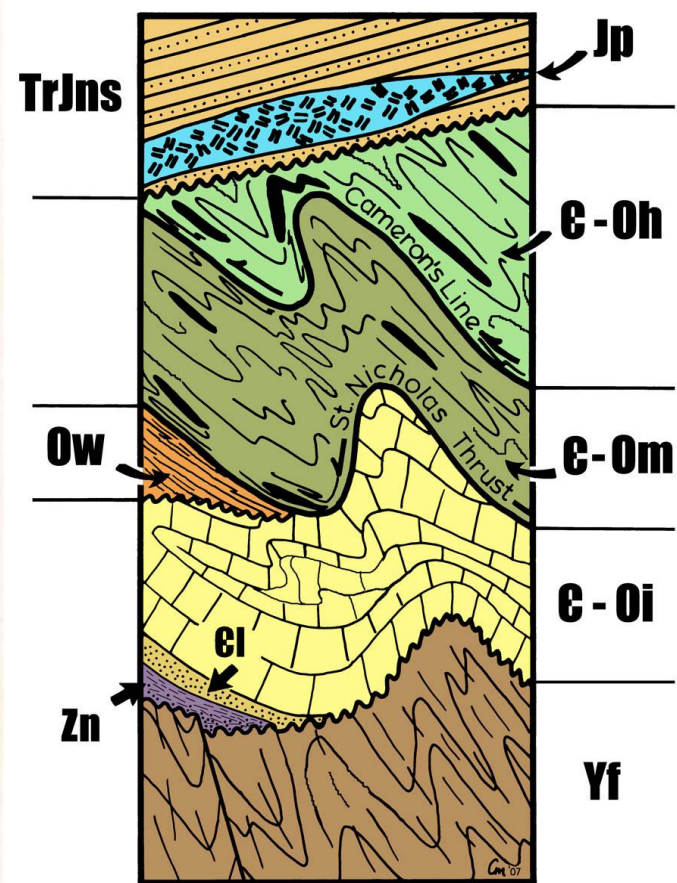
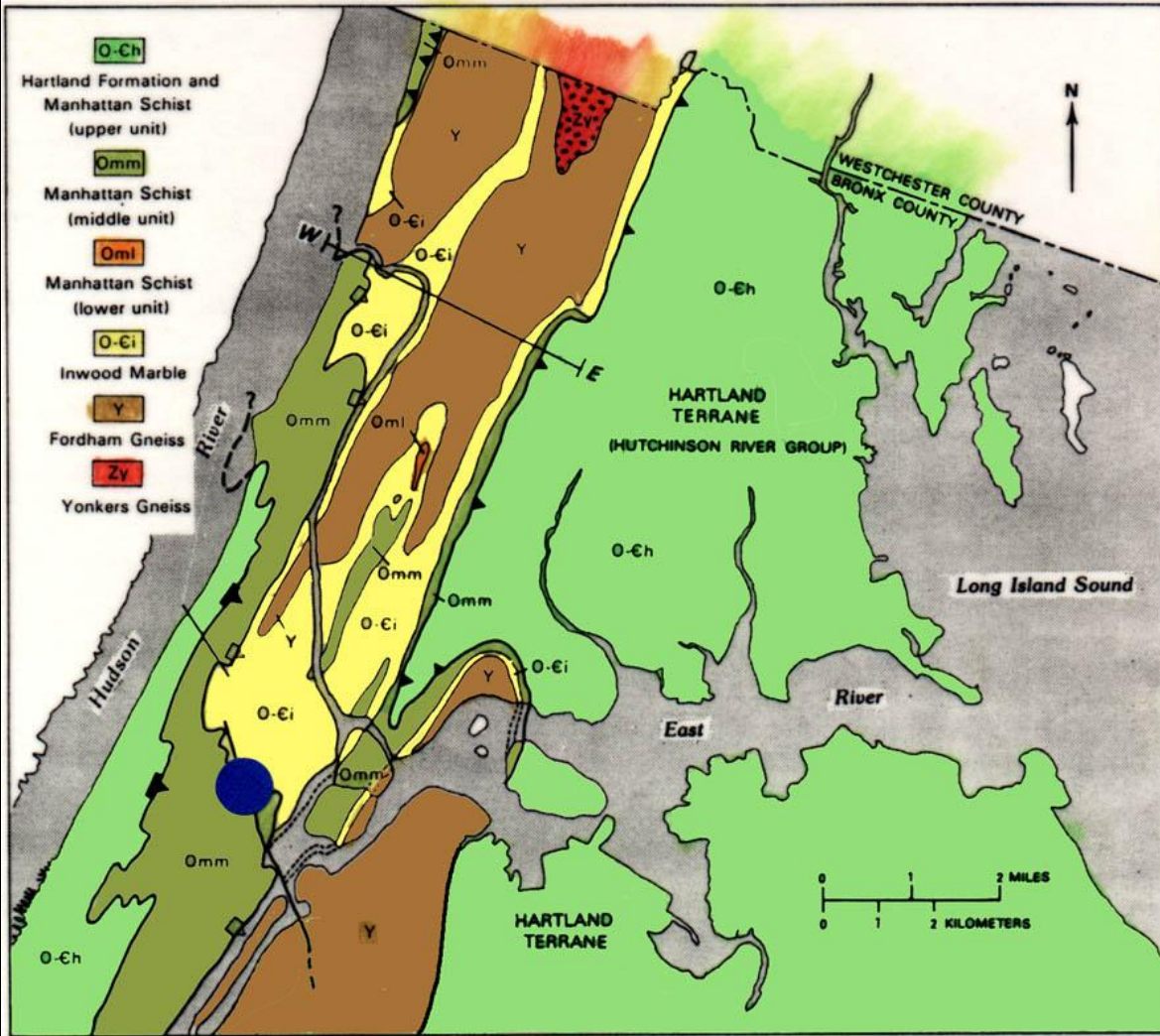


**Interpretive NW-SE
Geologic Section Based
on Berkey 1910 Boring Data**

Merguerian, ~~1984~~ (2006)



WTC



Merguerian, 2001

Future WTC Research at Hofstra Geology :



**Refine Map
Mineralogy
Petrography
X-Ray Microprobe
XRF**



