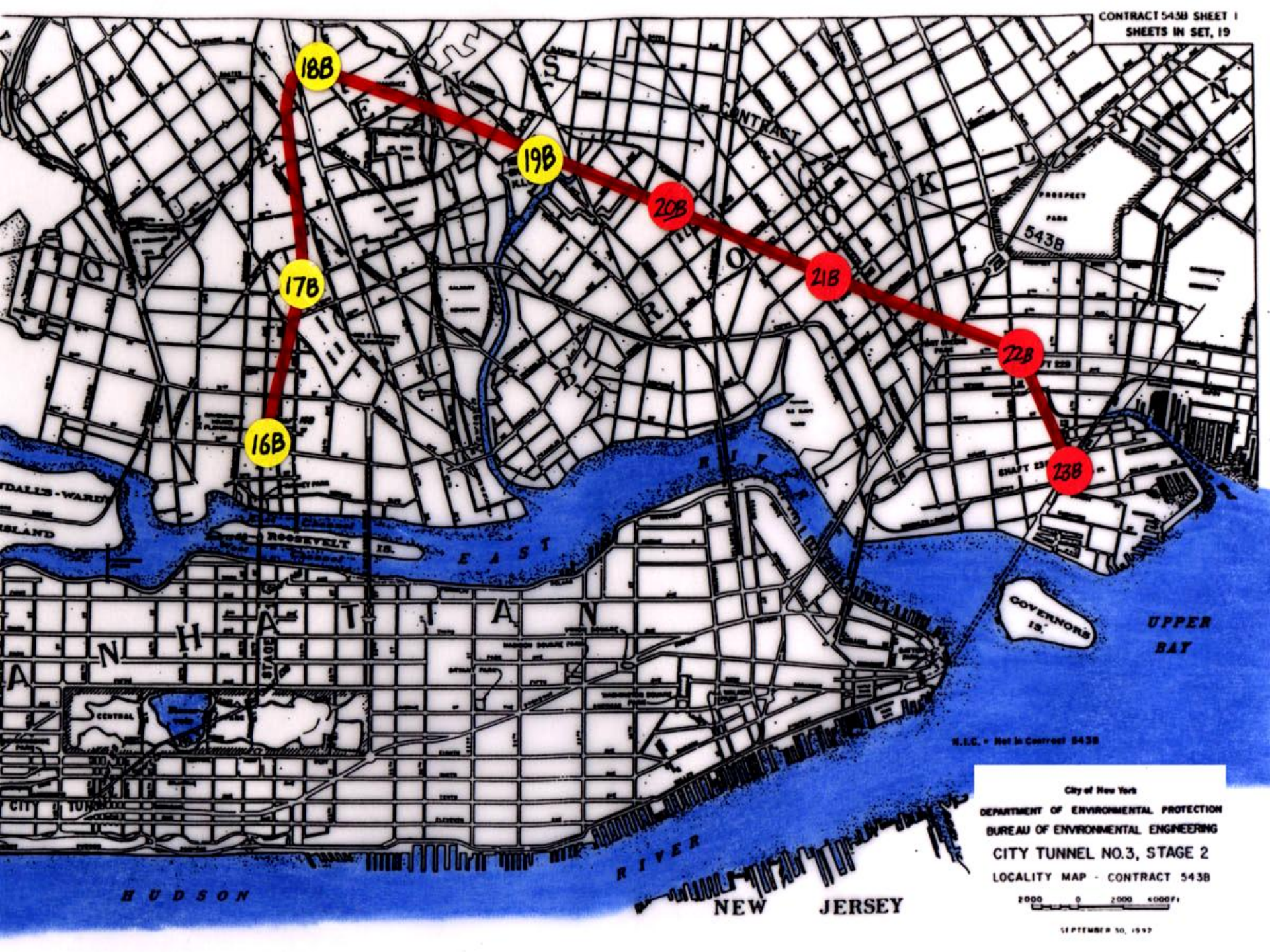
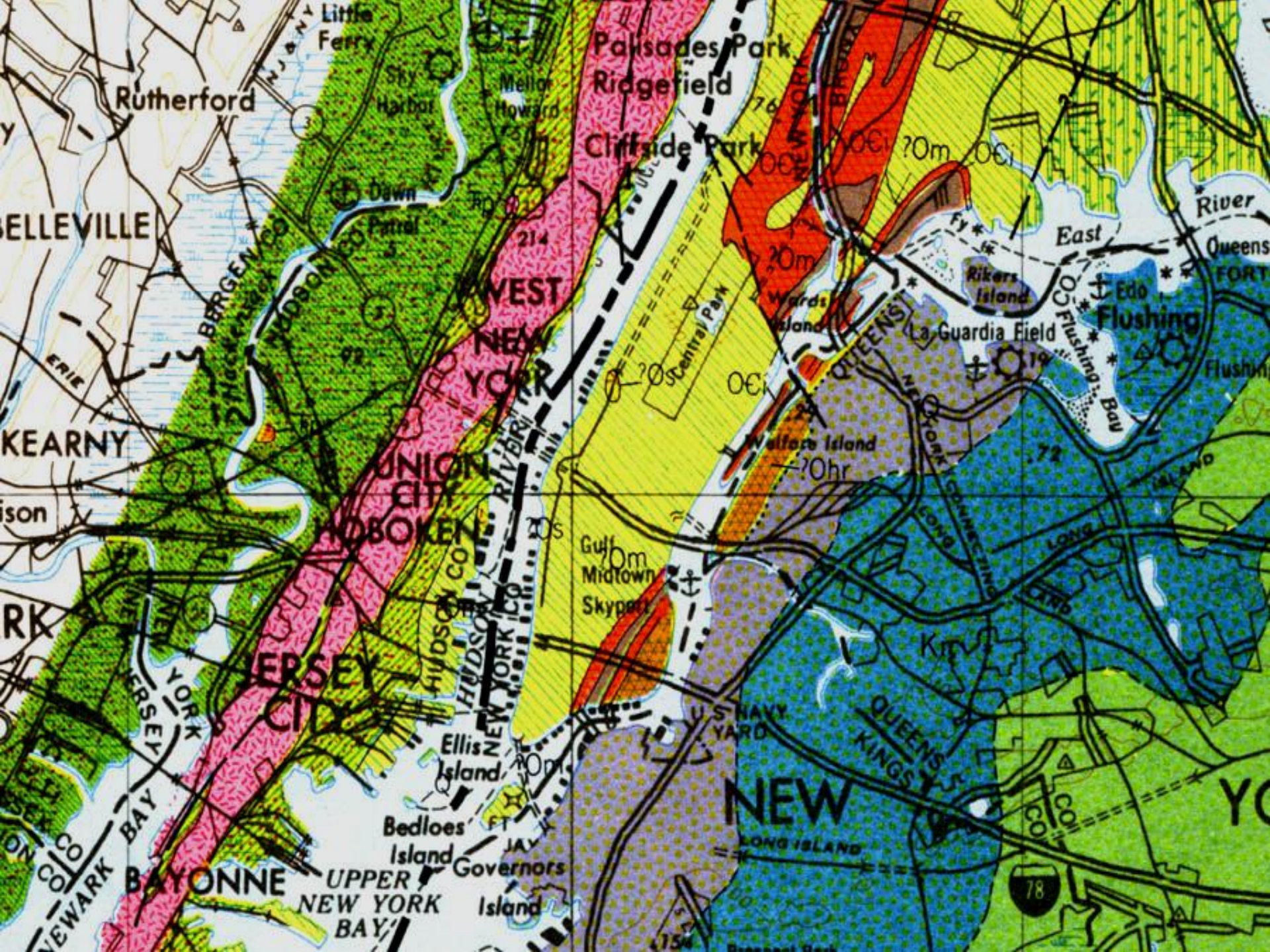
Brittle Faults of the Queens Tunnel Complex, NYC Water Tunnel #3

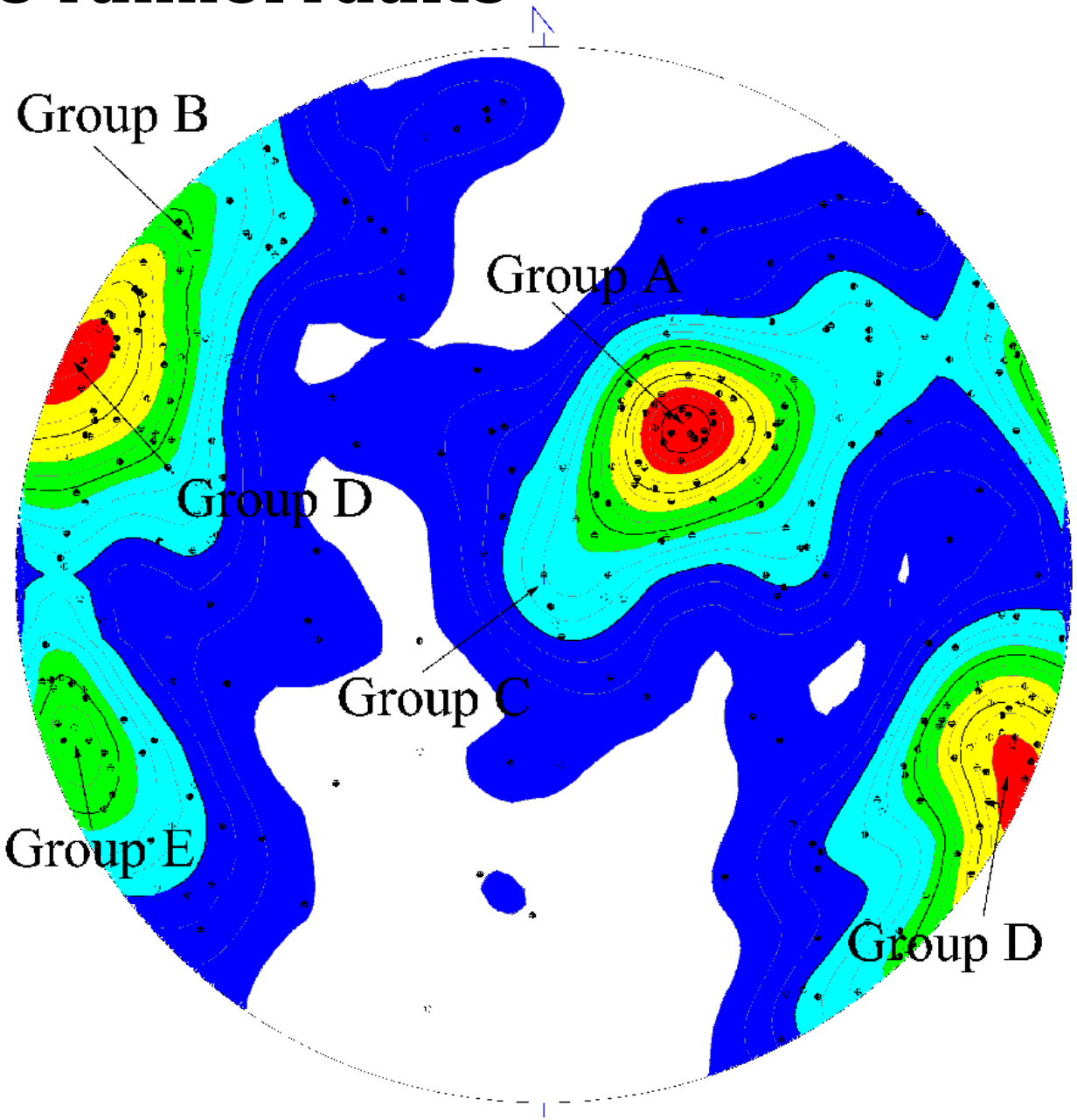
Charles Merguerian

HOFSTRA UNIVERSITY


CONTRACT 543B SHEET 1
SHEETS IN SET, 19
18B
19B
20B
21B
22B
23B
17B
16B
543B
CONTRACT
PROSPECT PARK
ROOSEVELT IS.
EAST RIVER
GOVERNORS IS.
UPPER BAY
MANHATTAN
STAGE 2
CENTRAL PARK
CITY TUNNEL
HUDSON RIVER
NEW JERSEY
N.I.C. = Not in Contract 543B
City of New York
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF ENVIRONMENTAL ENGINEERING
CITY TUNNEL NO.3, STAGE 2
LOCALITY MAP - CONTRACT 543B
2000 0 2000 4000FT
SEPTEMBER 30, 1992


Little Ferry
Rutherford
Sky Harbor
Mello Howard
Palisades Park
Ridgefield
Cliffside Park
Dawn Patrol
BELLEVILLE
WEST NEW YORK
KEARNY
UNION CITY
HOBOKEN
Gulf Midtown Skyport
Central Park
Wards Island
Rikers Island
La Guardia Field
East River
Flushing
Flushing Bay
Welfare Island
JERSEY CITY
Ellis Island
Bedloes Island
Governors Island
BAYONNE
UPPER NEW YORK BAY
U.S. NAVY YARD
NEW
LONG ISLAND
QUEENS
KINGS
?Om
?Ohr
?Os
OCi
78

Queens Tunnel Faults



Faults

- Hundreds of faults mapped in five major groups
- From oldest to youngest:

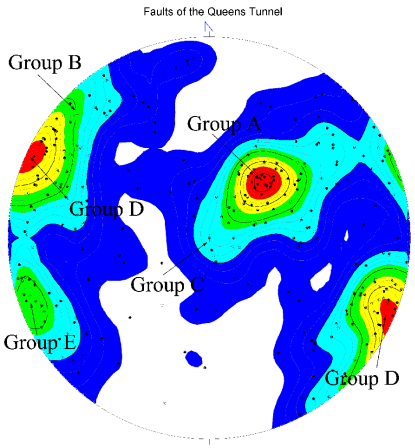
Group A = NW strike and gentle SW dip

Group B = ENE strike and steep dips

Group C = Subhorizontal fractures, faults, and shears

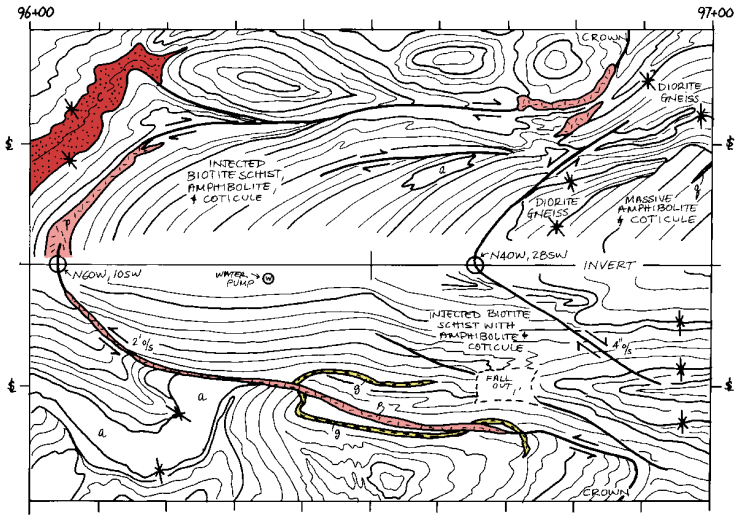
Group D = NNE-trending fault system (hitherto unknown)

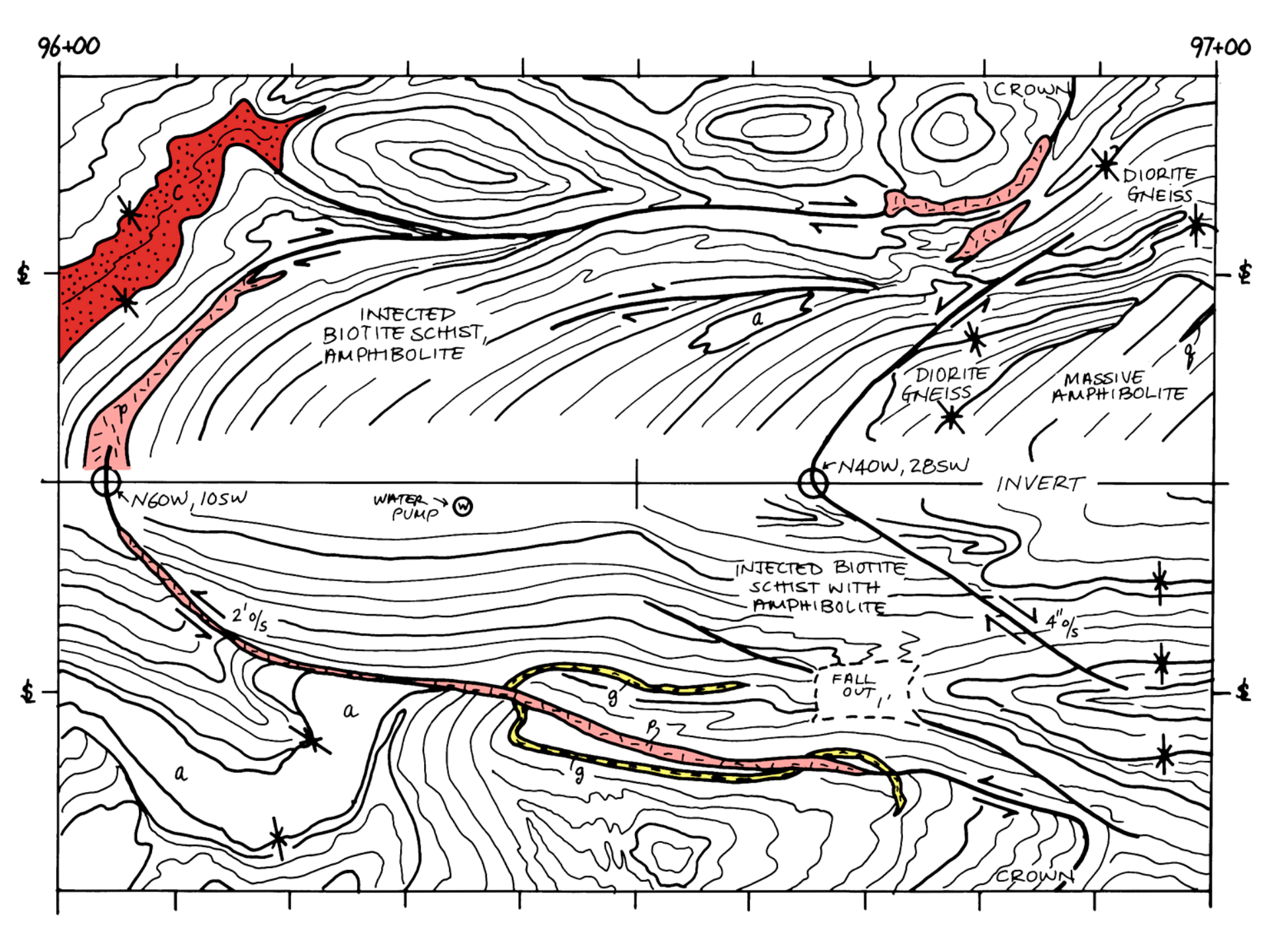
Group E = NNW-trending “Manhattanville” fault system

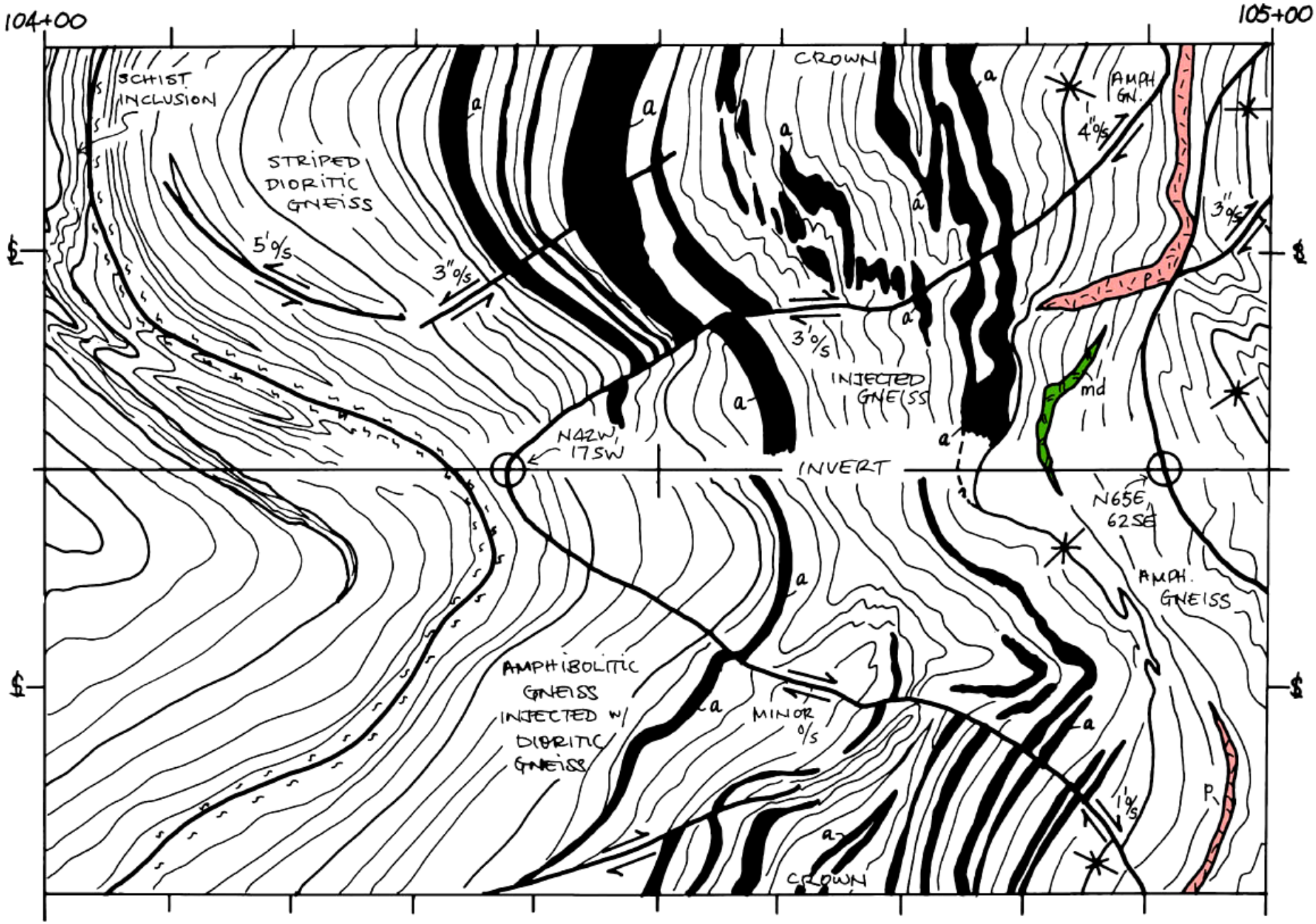


Gently-dipping Shear Zones of Group A

- NW strike and gentle SW dip
- Typically reactivate older ductile shears
- Thin zones of fault breccia and crush zones
- Commonly associated with sheared pegmatite intrusives
- Laterally extensive features that persist for 100s of feet
- Abruptly terminate by ramping steeply into crown and invert
- Wet features that resulted in collapsed tunnel heading



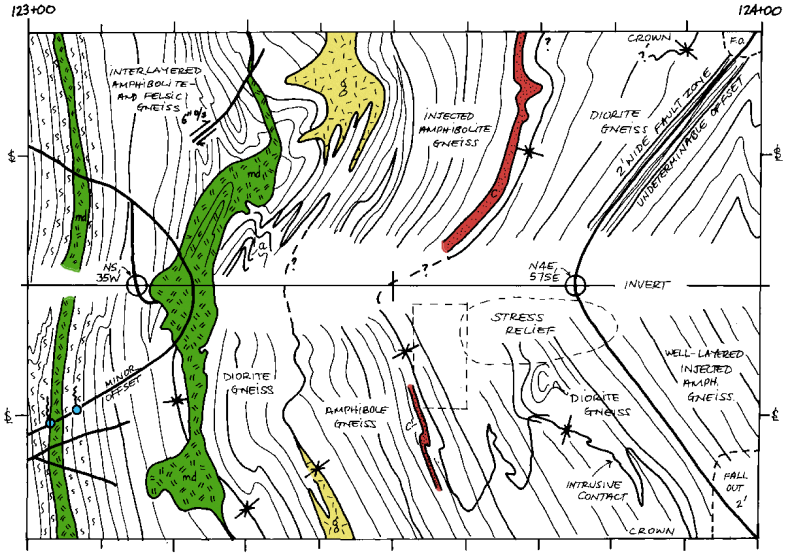

96+00
97+00
CROWN
DIORITE GNEISS
INJECTED BIOTITE SCHIST, AMPHIBOLITE
DIORITE GNEISS
MASSIVE AMPHIBOLITE
N60W, 10SW
WATER PUMP
N40W, 28SW
INVERT
INJECTED BIOTITE SCHIST WITH AMPHIBOLITE
2'0/s
4"0/s
FALL OUT
CROWN

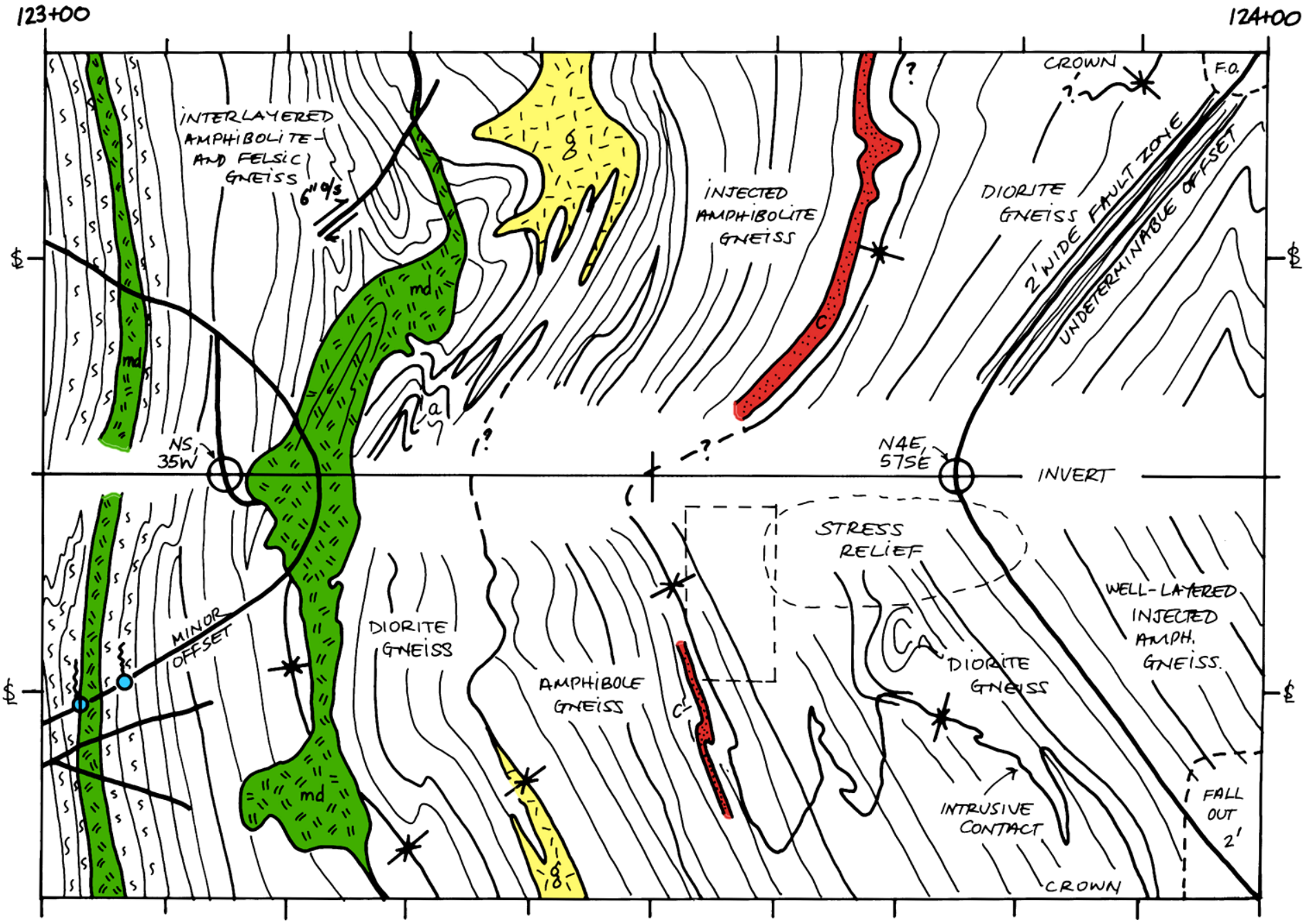

104+00
105+00
SCHIST INCLUSION
STRIPED DIORITIC GNEISS
5'0/S
3"0/S
CROWN
AMPH GN.
4"0/S
3"0/S
3'0/S
INJECTED GNEISS
md
N42W, 17SW
INVERT
N65E, 62SE
AMPH. GNEISS
AMPHIBOLITIC GNEISS INJECTED W/ DIORITIC GNEISS
MINOR 0/S
1'0/S
P
CROWN
a
$

Queens Tunnel Sta. 196+85

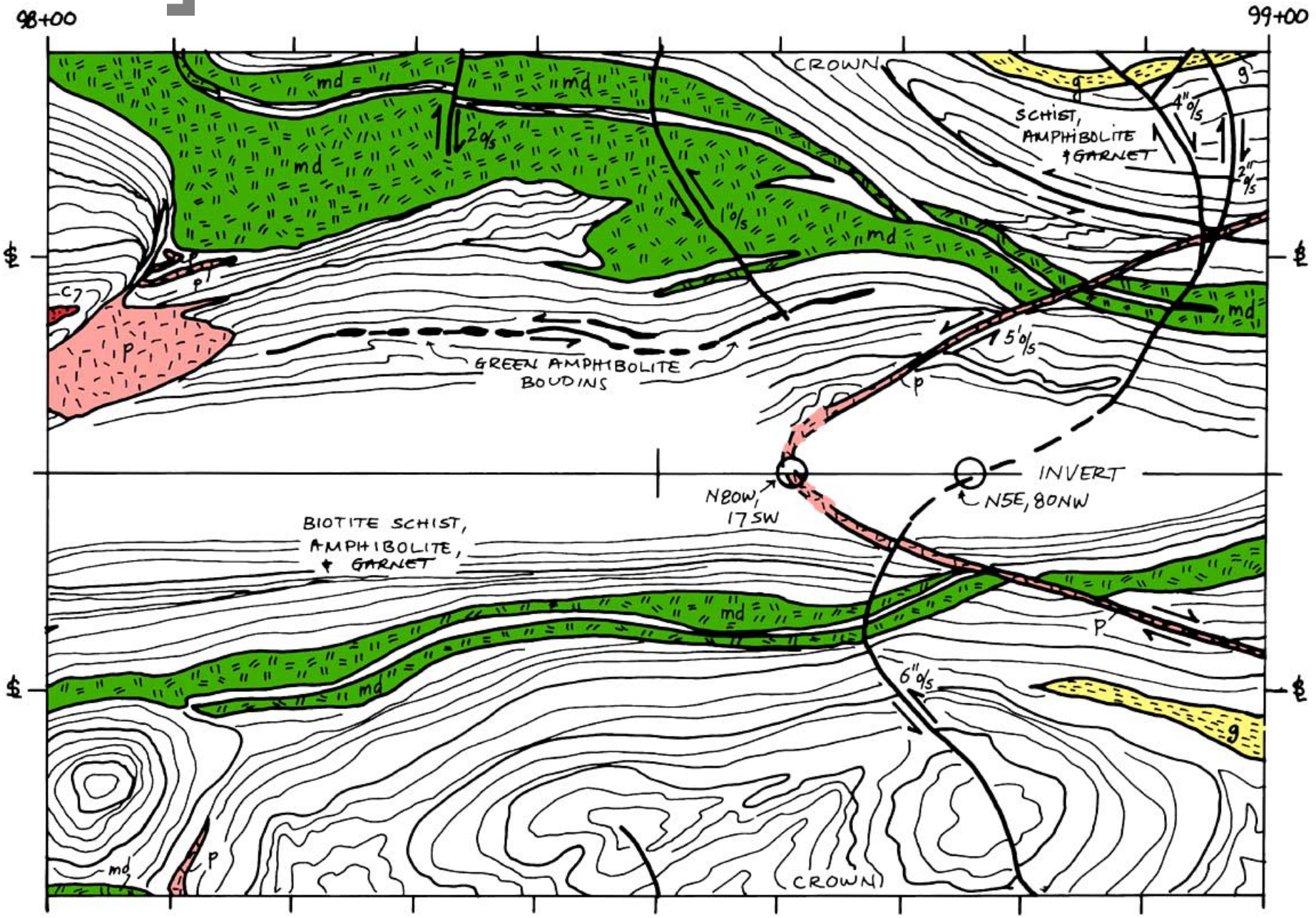
NNE-Trending Fault System of Group D

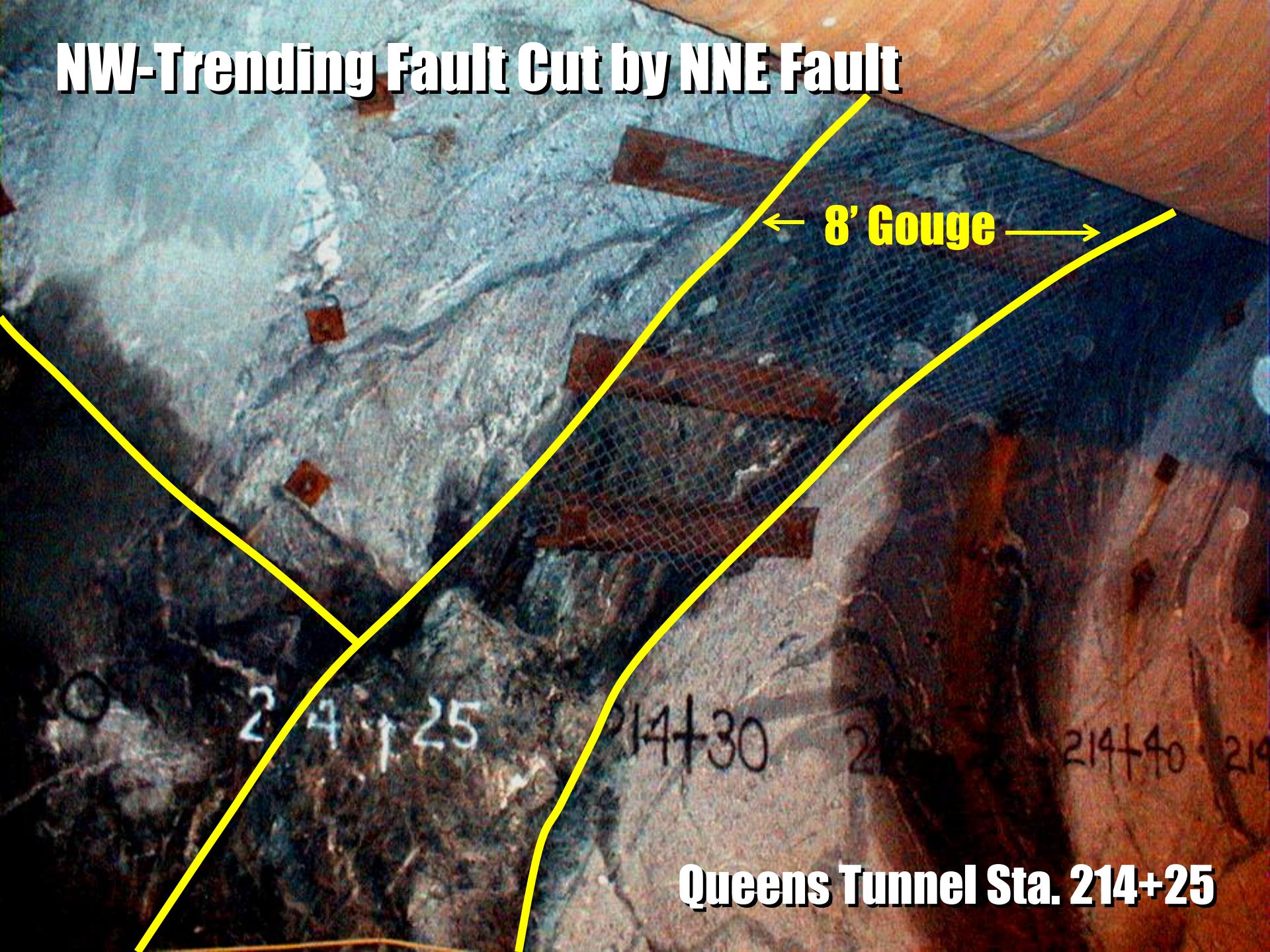
- NNE strike and steep dips; dip-slip mechanisms
- Thick zones of fault gouge and breccia
- Clay- and zeolite-rich gouge zones
- Relatively young – they cut 295 Ma rhyodacite dikes
- Reactivated by Group E “Manhattanville” faults
- Locally wet features in zones of fault convergence



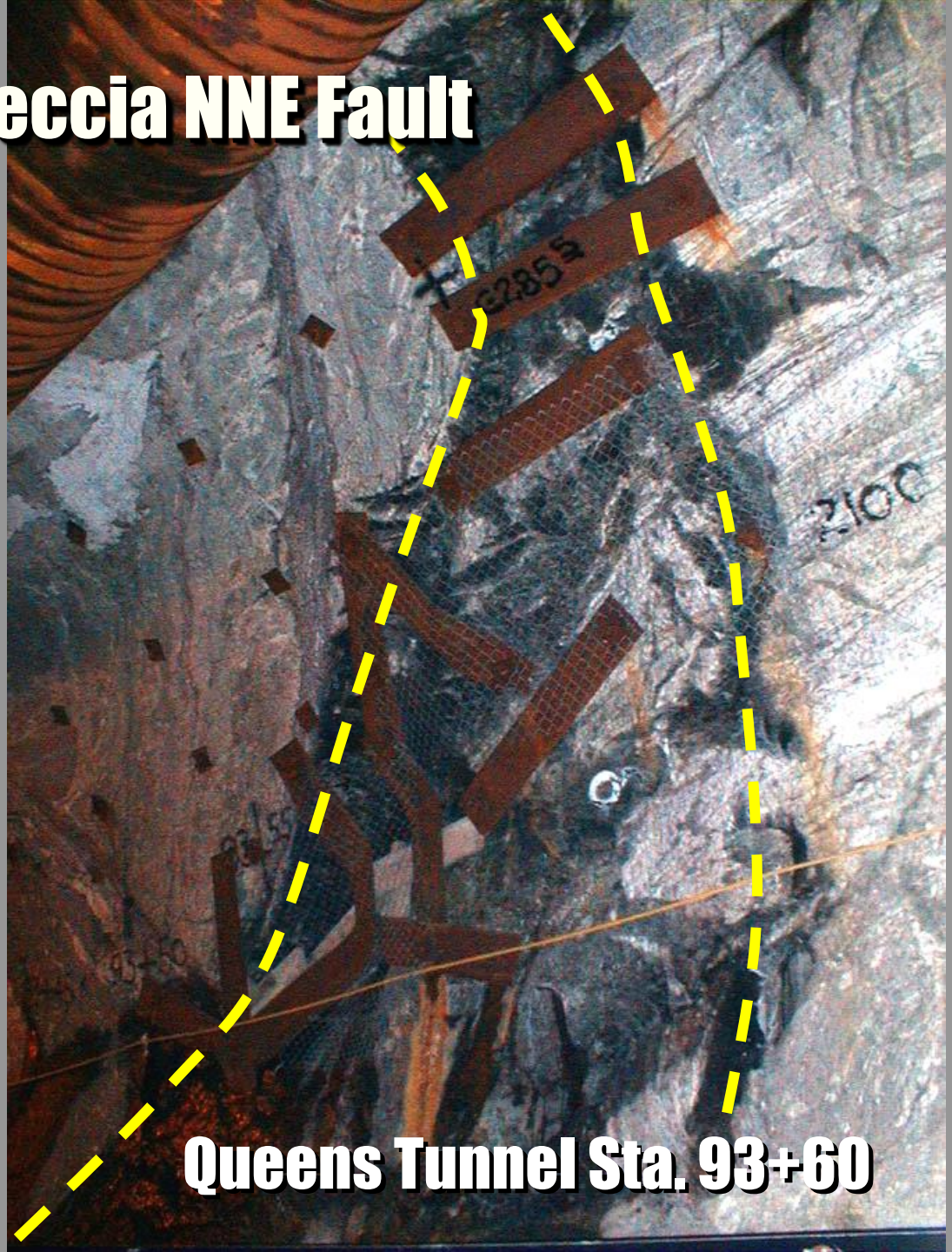

123+00
124+00
INTERLAYERED AMPHIBOLITE AND FELSIC GNEISS
6" o/s
md
g
INJECTED AMPHIBOLITE GNEISS
C
?
CROWN
F.O.
DIORITE GNEISS
2' WIDE FAULT ZONE
UNDETERMINABLE OFFSET
N5, 35W
N4E, 57SE
INVERT
STRESS RELIEF
CA
MINOR OFFSET
DIORITE GNEISS
AMPHIBOLE GNEISS
C'
DIORITE GNEISS
WELL-LAYERED INJECTED AMPH. GNEISS.
INTRUSIVE CONTACT
FALL OUT 2'
CROWN

Zone 046b - Support required because of intersecting faults and joints.

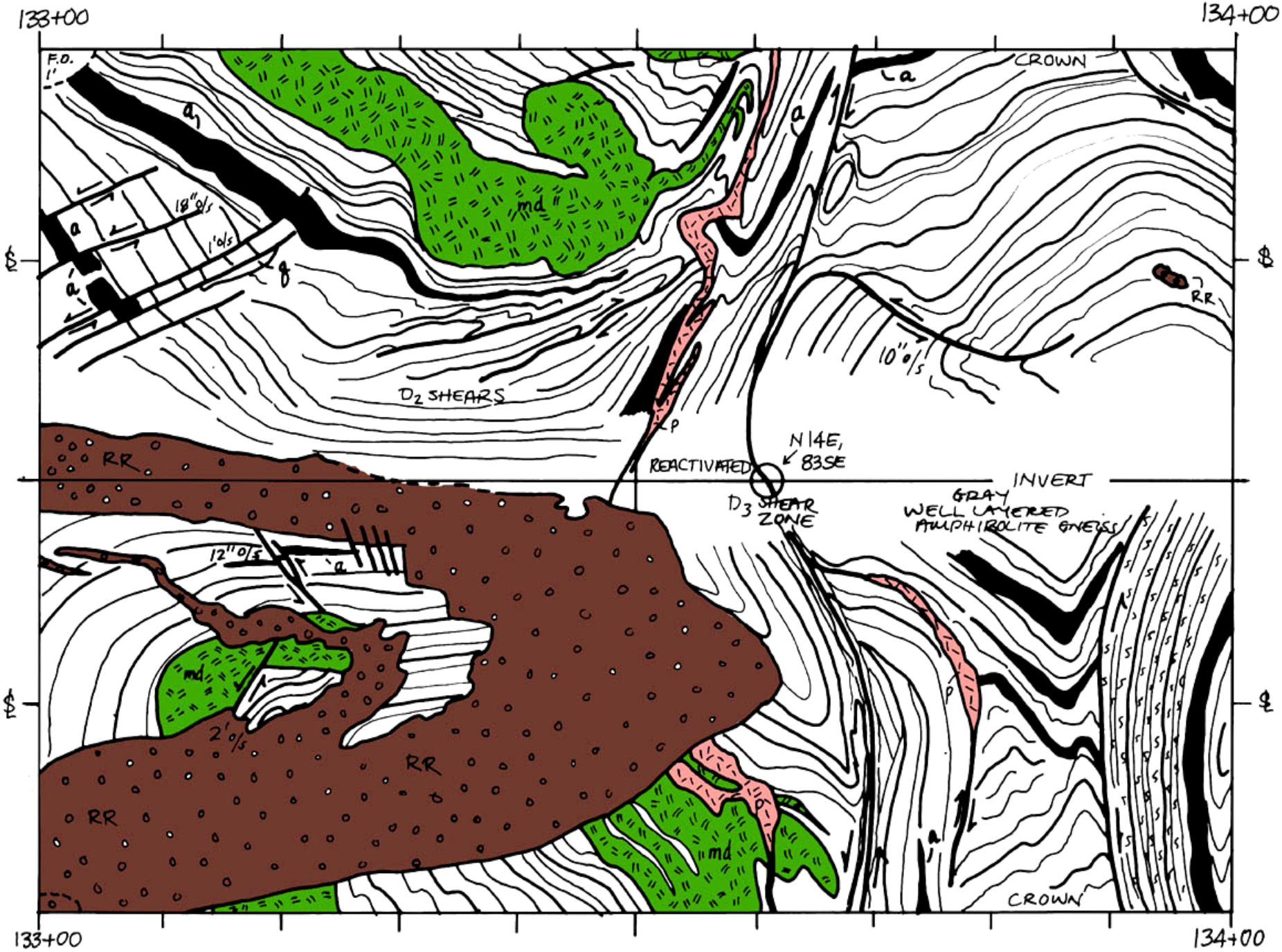

98+00
99+00
CROWN
SCHIST, AMPHIBOLITE & GARNET
4"o/s
2"o/s
1"o/s
2'o/s
15'o/s
6"o/s
md
p
g
GREEN AMPHIBOLITE BOUDINS
INVERT
N80W, 17SW
N5E, 80NW
BIOTITE SCHIST, AMPHIBOLITE, & GARNET
CROWN

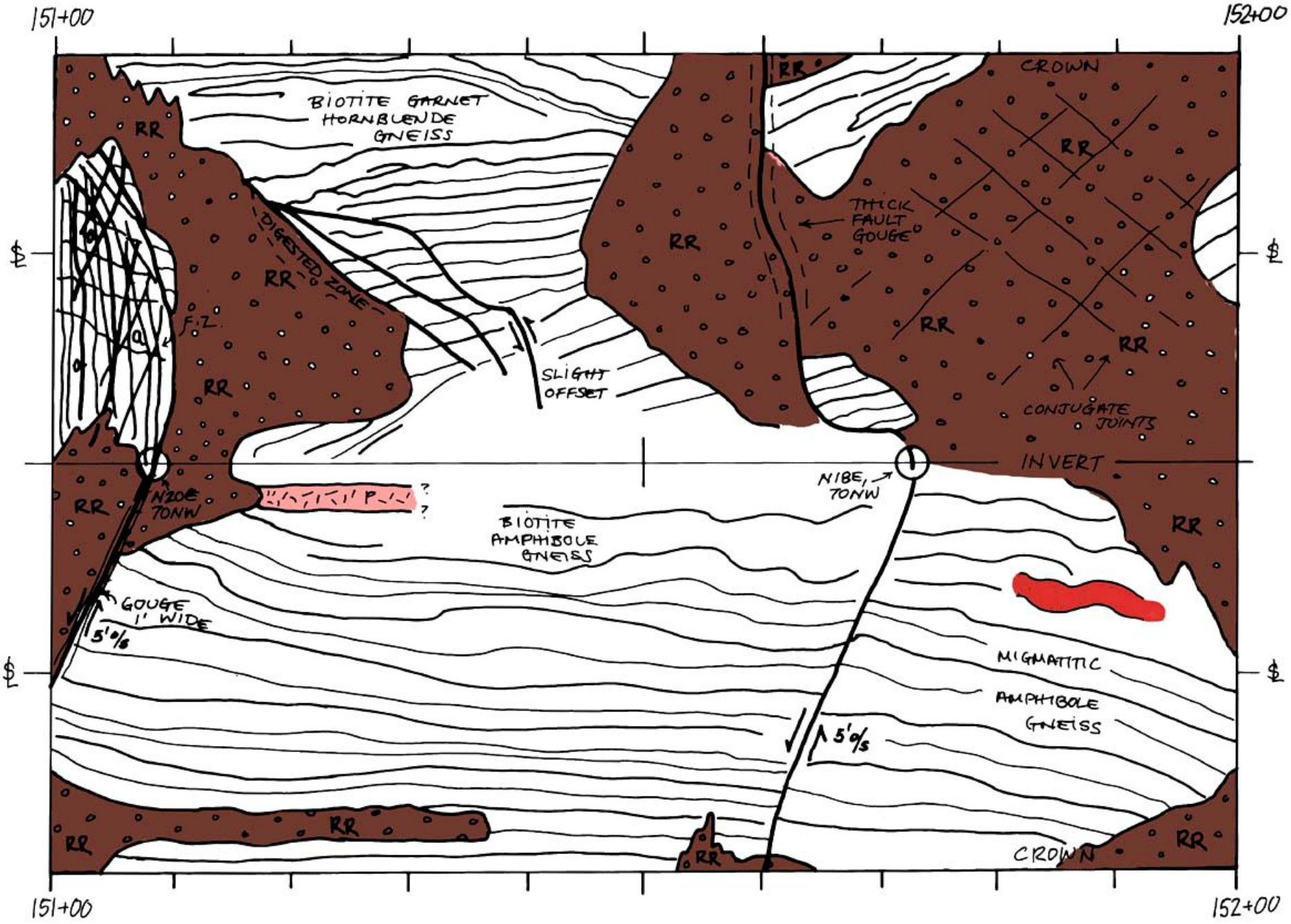

NW-Trending Fault Cut by NNE Fault
8' Gouge
214+25
214+30
214+40
Queens Tunnel Sta. 214+25

Crush Breccia NNE Fault



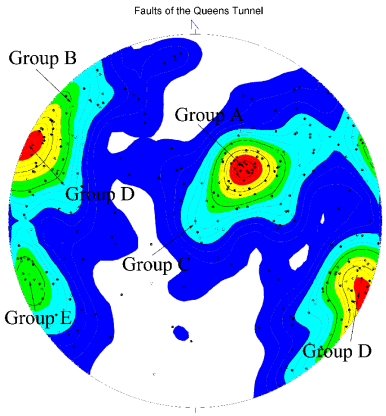

Station 130+40, Right Wall
Multidirectional cooling joints in rhyodacite

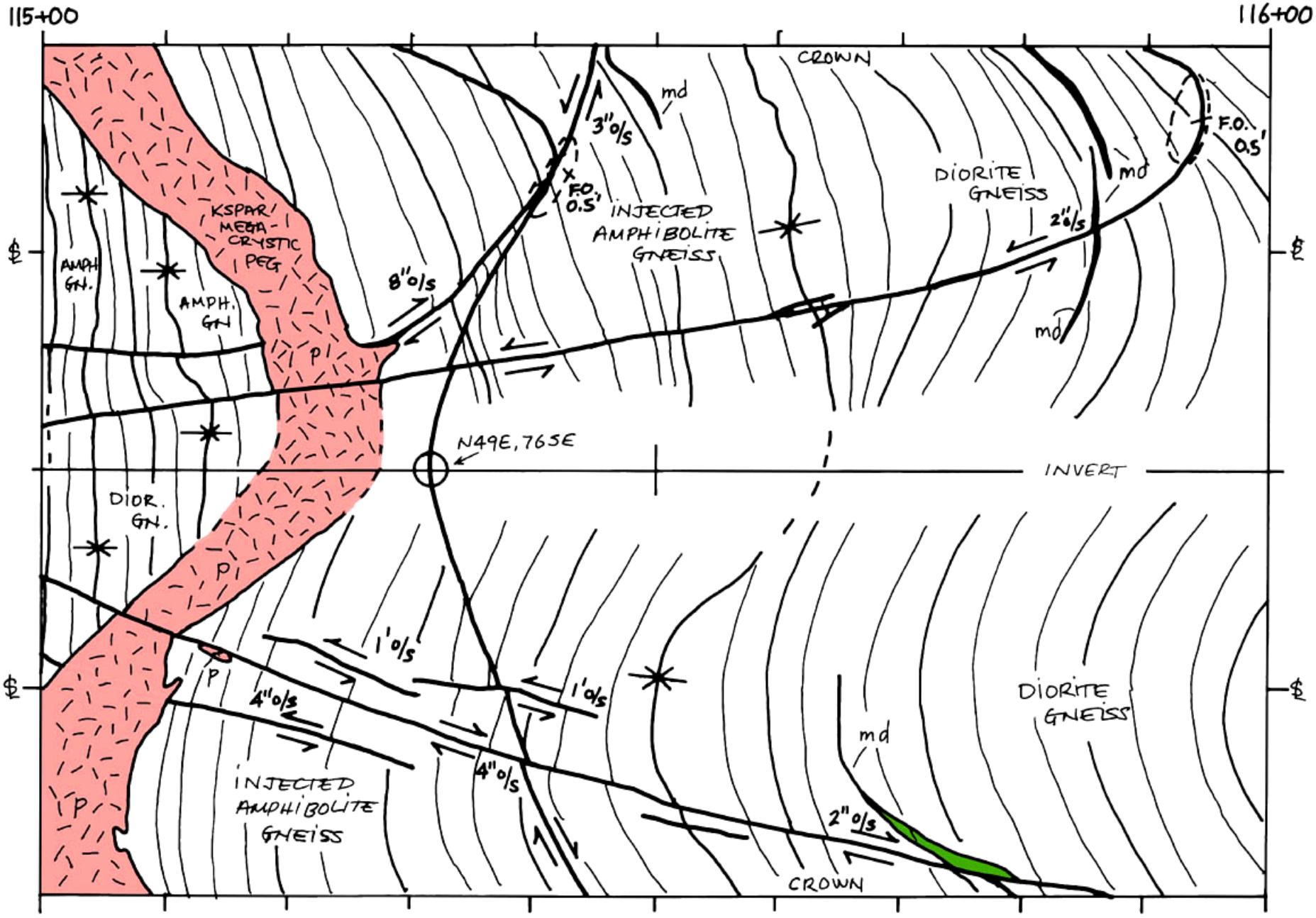

133+00
134+00
F.O.
CROWN
a
md
18"o/s
1'o/s
RR
10"o/s
D2 SHEARS
P
N14E,
83SE
REACTIVATED
D3 SHEAR ZONE
INVERT
GRAY
WELL LAYERED
AMPHIBOLITE GNEISS
12"o/s
2'o/s
RR
CROWN
133+00
134+00


151+00
152+00
BIOTITE GARNET HORNBLENDE GNEISS
RR
DIGESTED ZONE
F.Z.
SLIGHT OFFSET
THICK FAULT GOUGE
CROWN
CONJUGATE JOINTS
INVERT
N20E 70NW
N18E, 70NW
BIOTITE AMPHIBOLE GNEISS
GOUGE 1' WIDE
5'o/s
MIGMATITIC AMPHIBOLE GNEISS
151+00
152+00

NNW-Trending Fault System of Group E

- NNW strike and steep dips; strike-slip offset
- Highly fractured zones with quartz veining and pyrite
- Youngest fault group – they cut all tunnel structures
- Persistent features in NW-leg of tunnel
- Reactivate many older faults
- Overprint dip-slip slickensides
- Associated with areas of stress relief
- Produce wet zones in areas of fault convergence



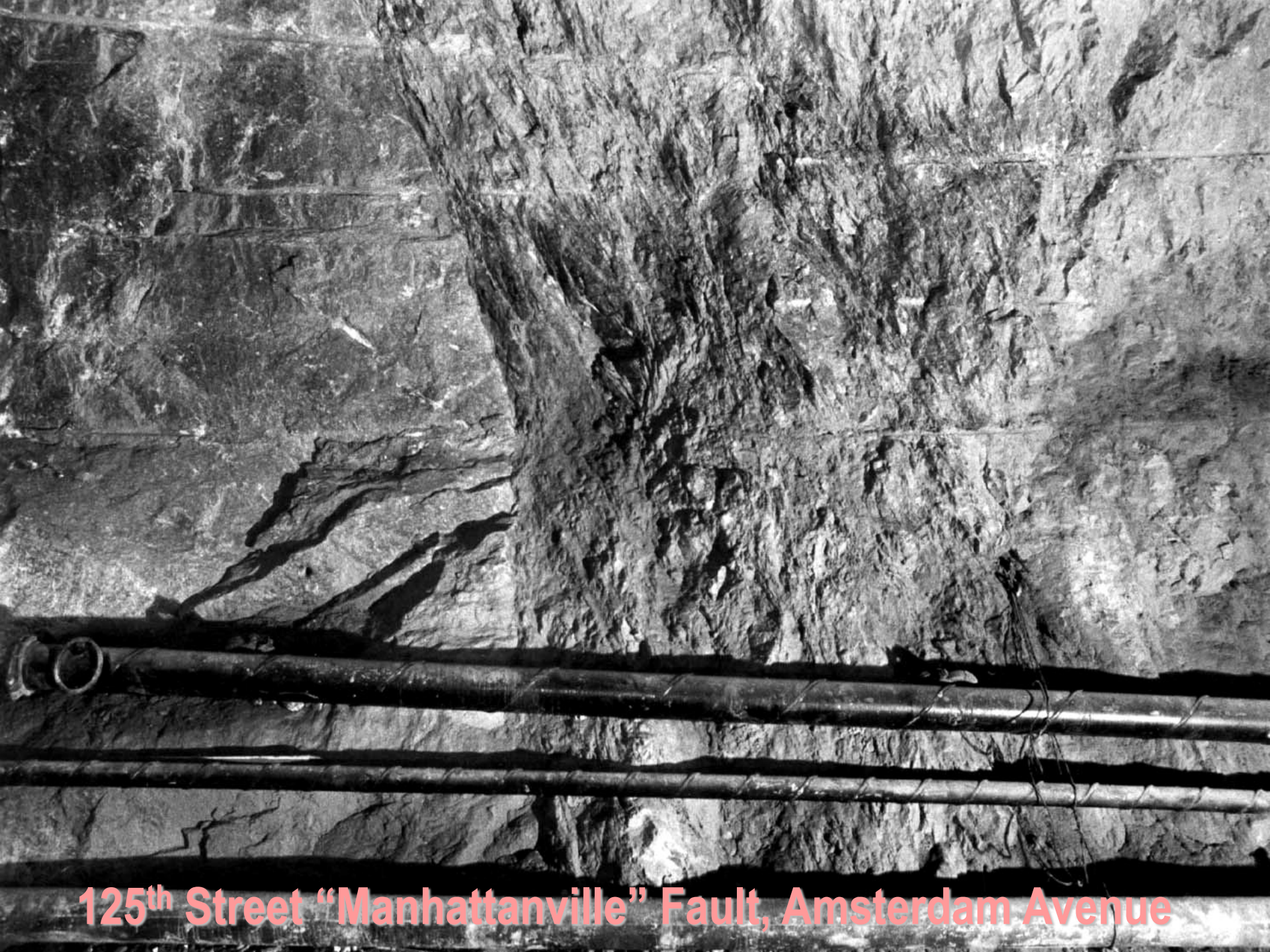

115+00
116+00
CROWN
md
3"o/s
F.O. 0.5'
INJECTED AMPHIBOLITE GNEISS
DIORITE GNEISS
2"o/s
KSPAR MEGA-CRYSTIC PEG
AMPH GN.
AMPH. GN
8"o/s
P
N49E, 765E
INVERT
DIOR. GN.
1'o/s
4"o/s
2" o/s


NNW-Trending "Manhattanville" Faults
Splays and Conjugate Joints
Fault Zone
156+40
156+35
156+30
156+20
Queens Tunnel Sta. 156+25

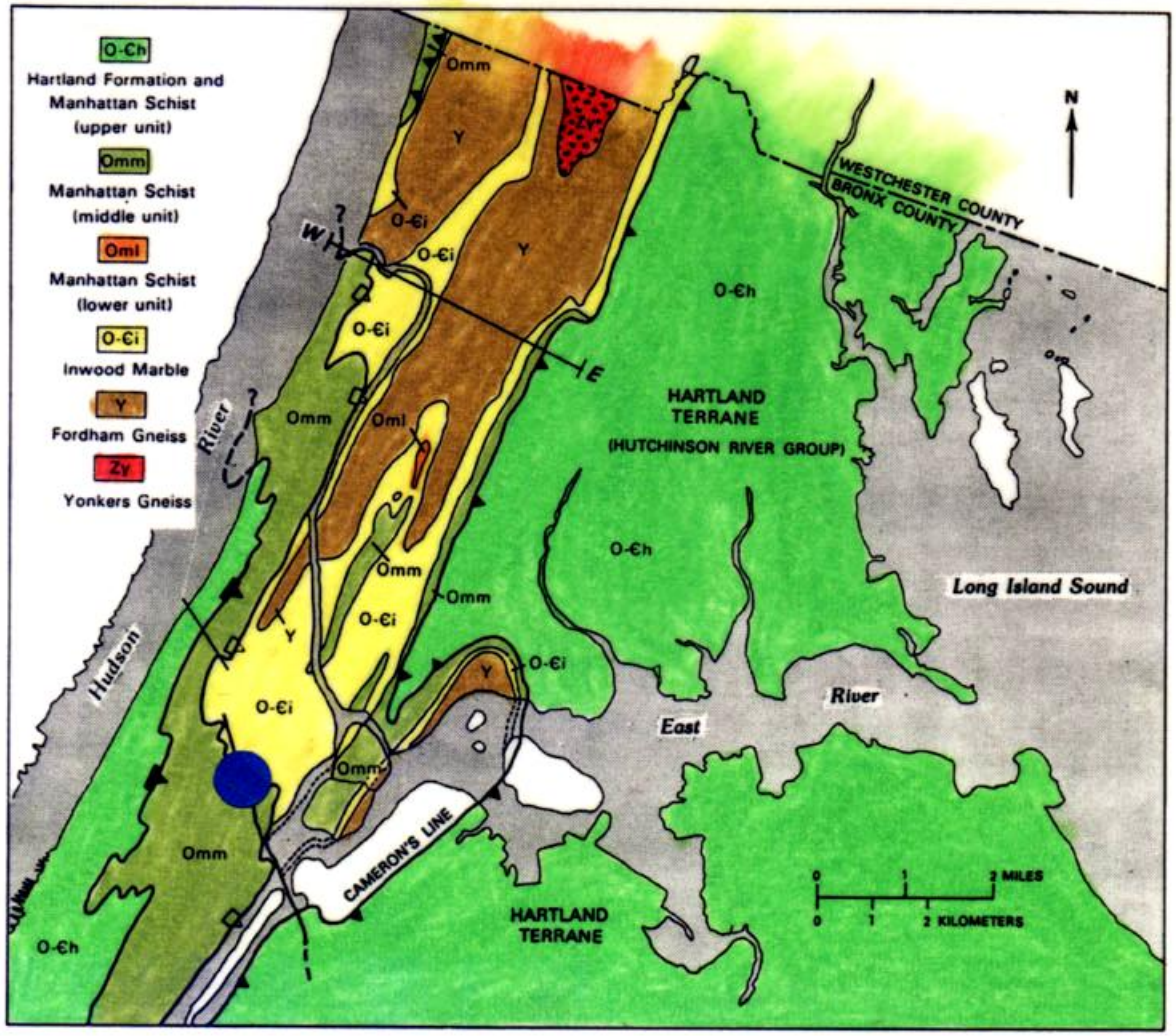

Stress Relief Adjacent to “Manhattanville” Fault
Queens Tunnel Sta. 249+50
CM

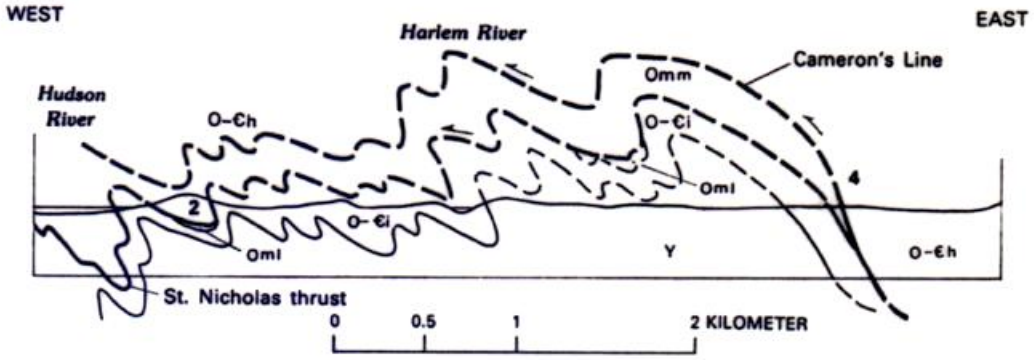

Crown Failure in Overstressed Rock
Queens Tunnel Sta. 253+40

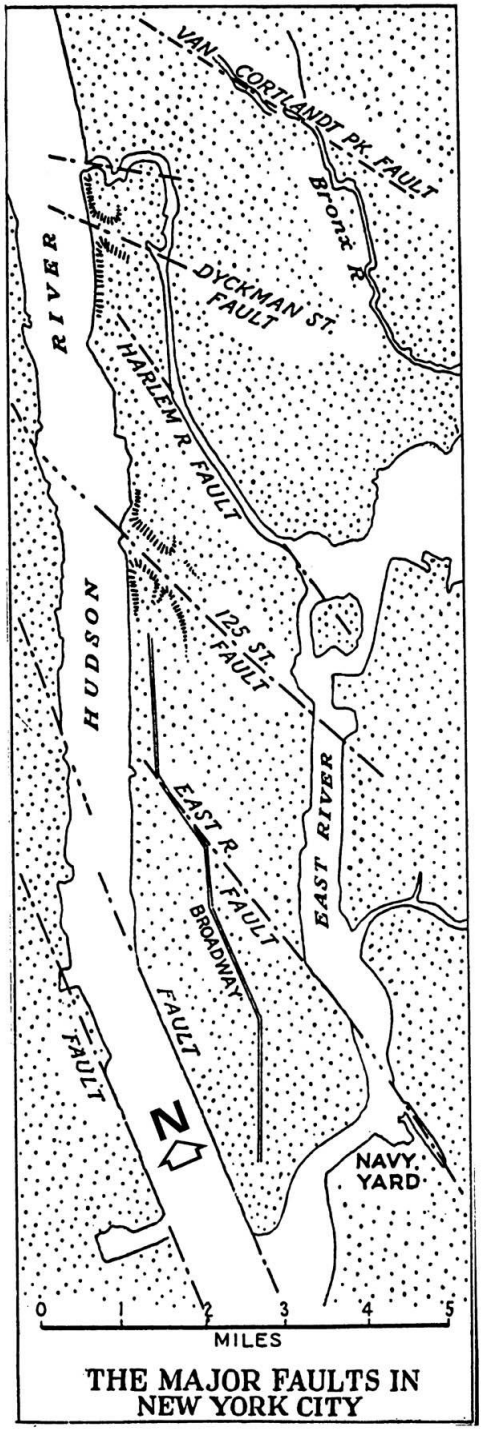
Zone 067b - Ring steel in sheared and highly faulted zo



125th Street "Manhattanville" Fault, Amsterdam Avenue







THE MAJOR FAULTS IN NEW YORK CITY


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