LITHOSPHERIC EXPRESSION OF THE *NORUMBEGA FAULT ZONE* IN NORTH COASTAL MAINE

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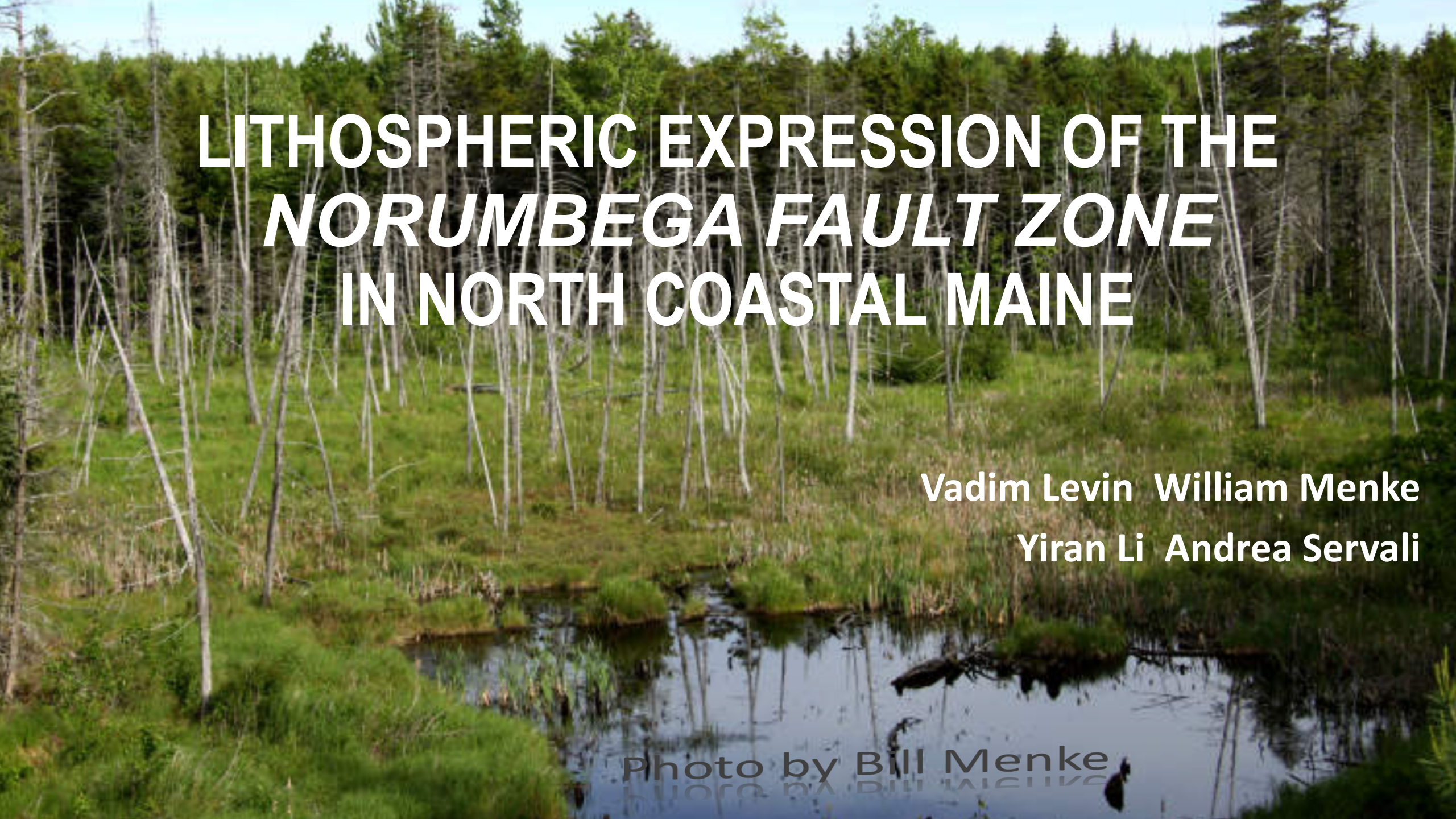
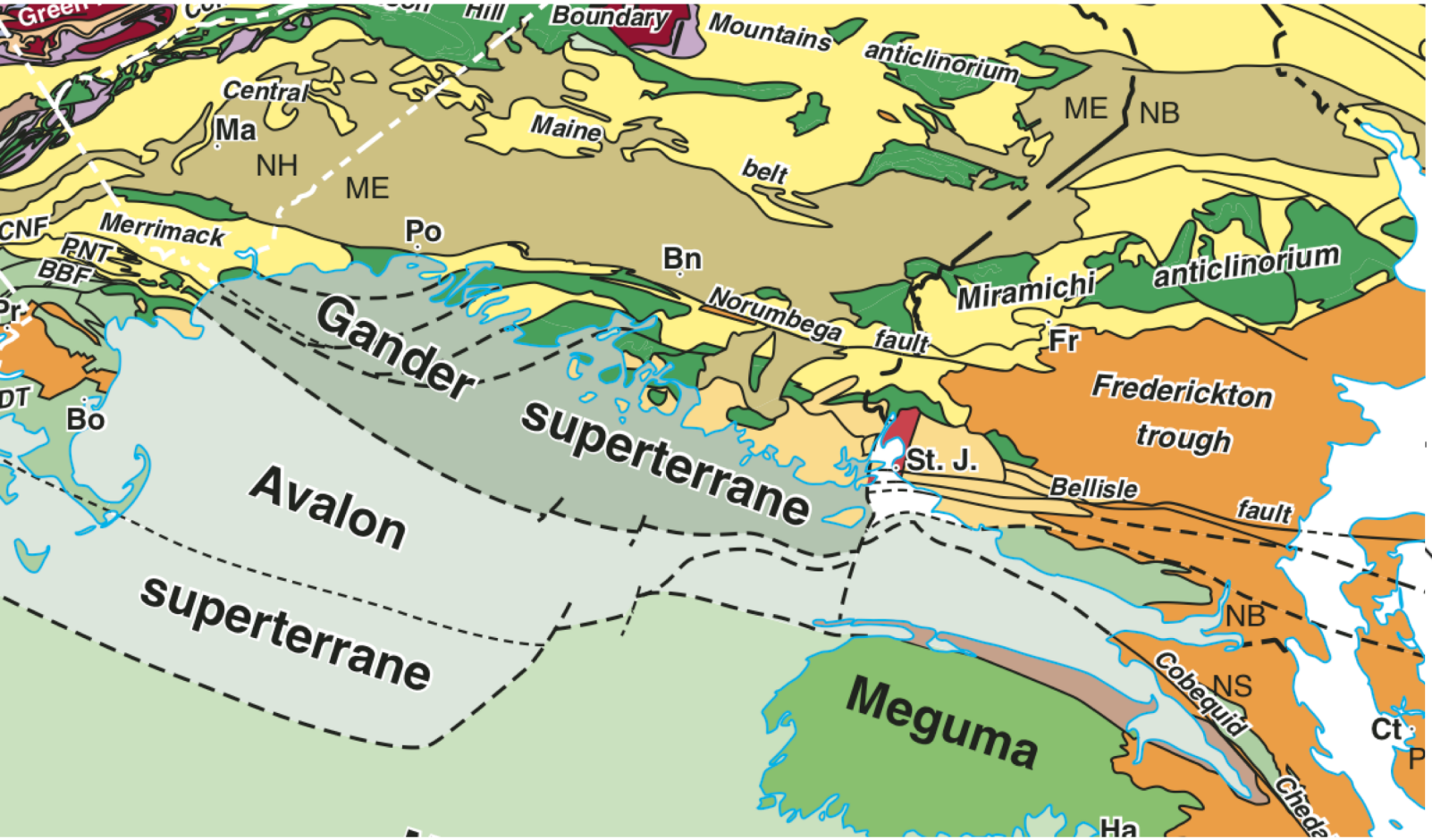
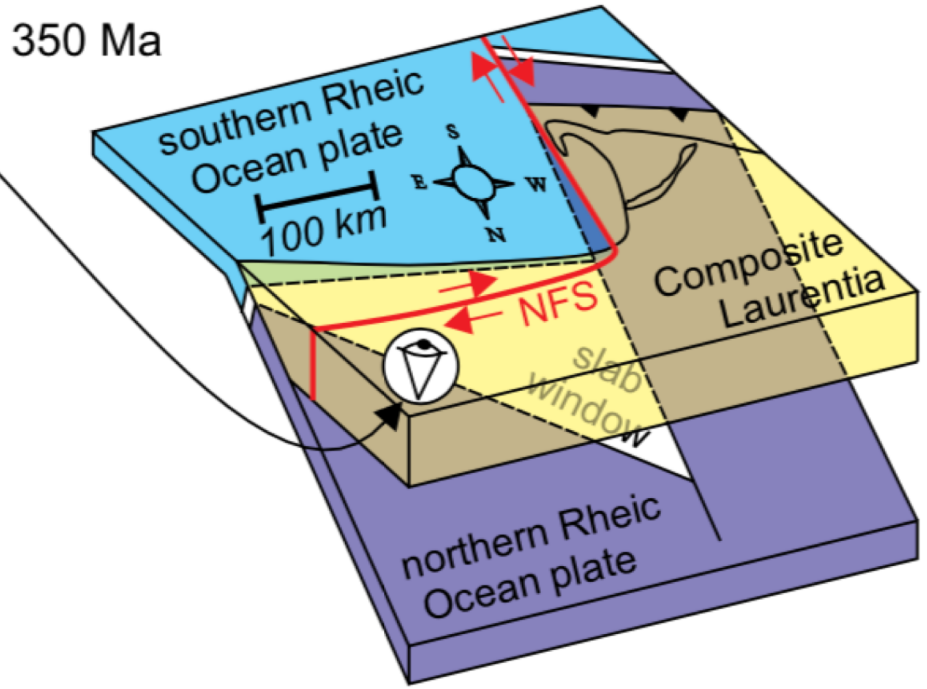
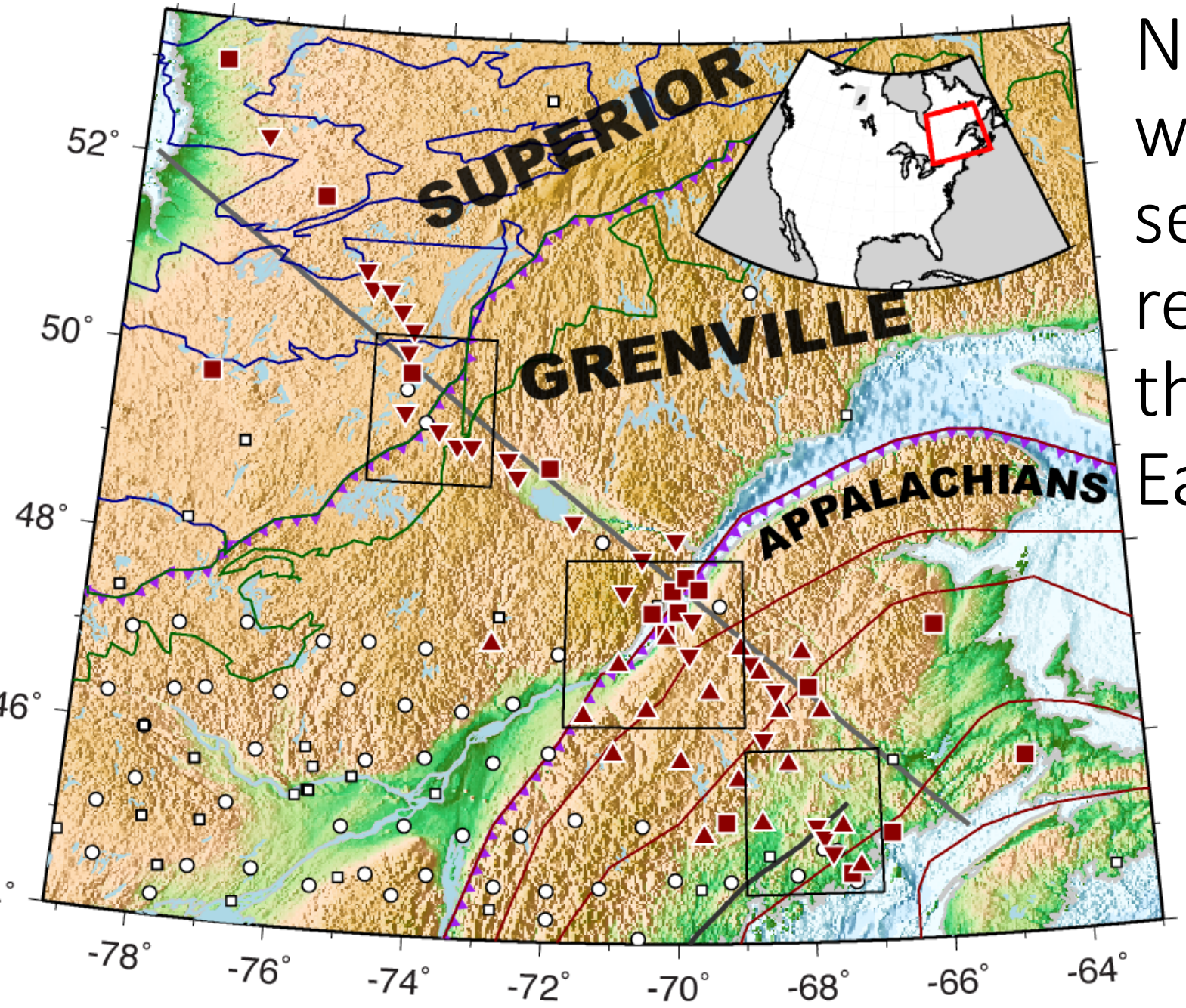


Norumbega Fault Zone is a major element of northern Appalachian tectonic framework



Its formation and subsequent activity is an important element of the Appalachian tectonic history

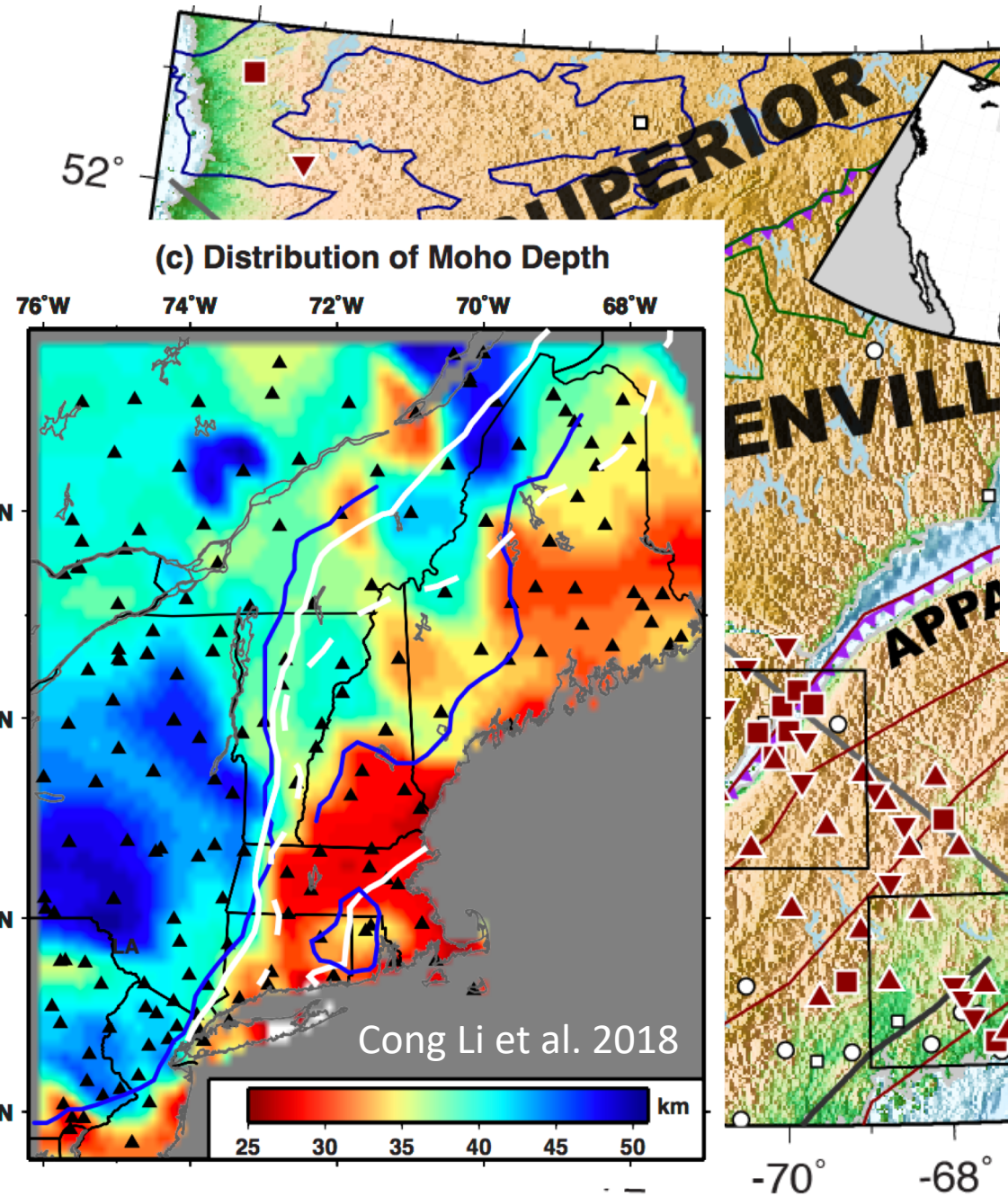


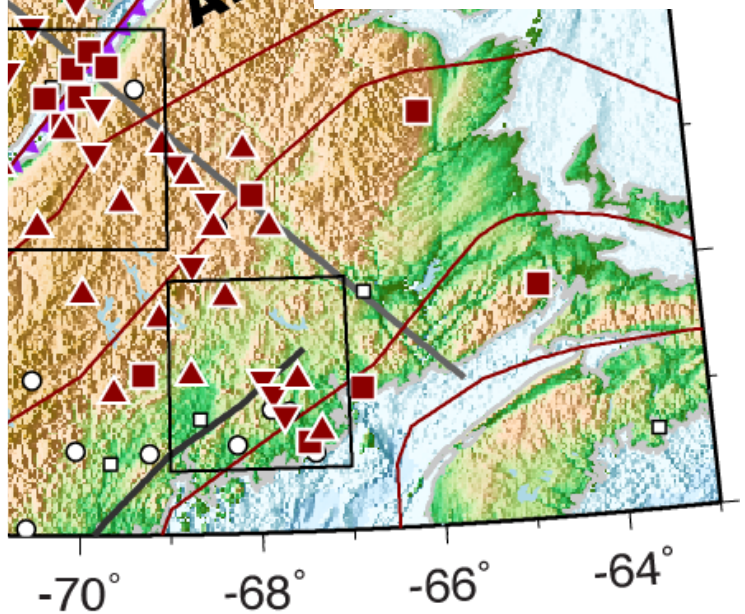


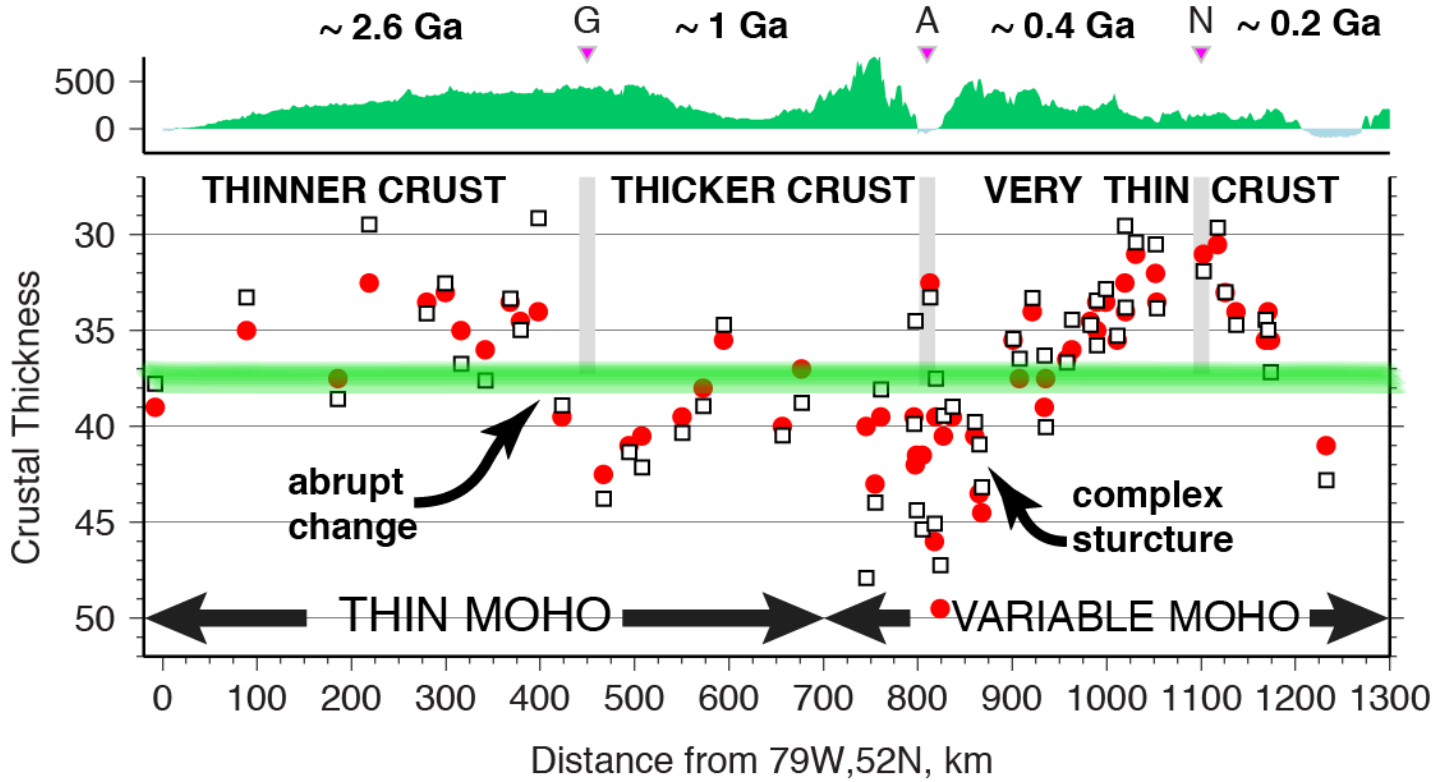
Norumbega Fault Zone was a target of a major seismological study recently completed in the framework of the Earthscope project.

earthscope
www.earthscope.org

NSF



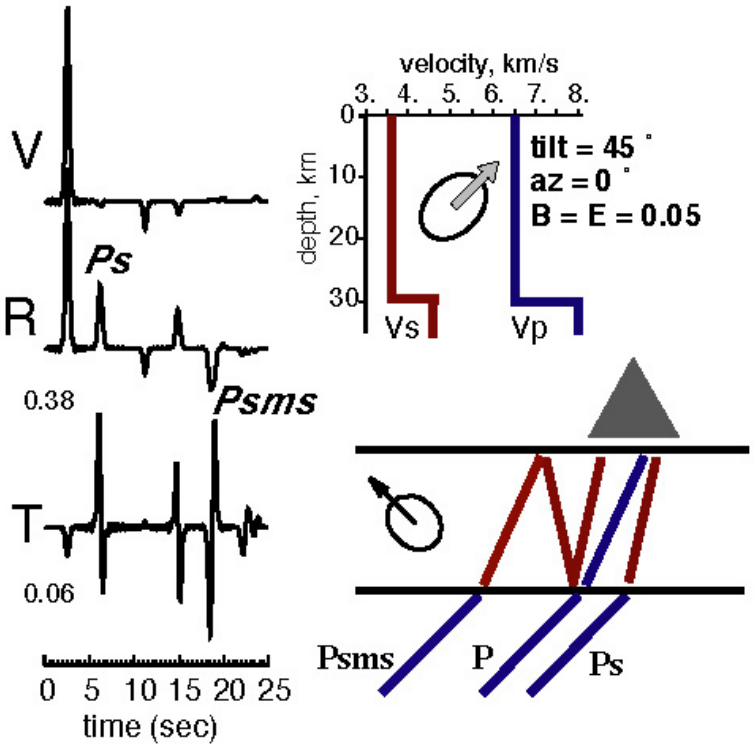


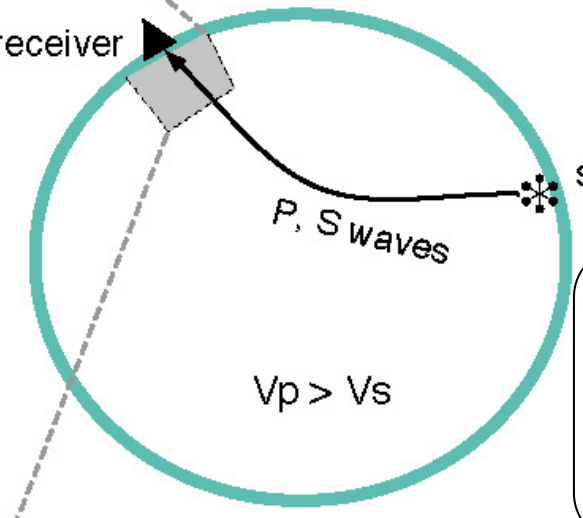


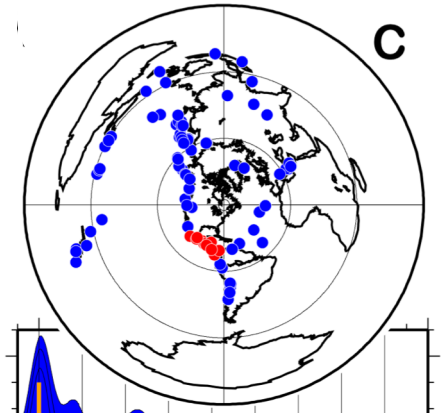
One of the key findings to date is an exceptionally thin crust beneath the NFZ

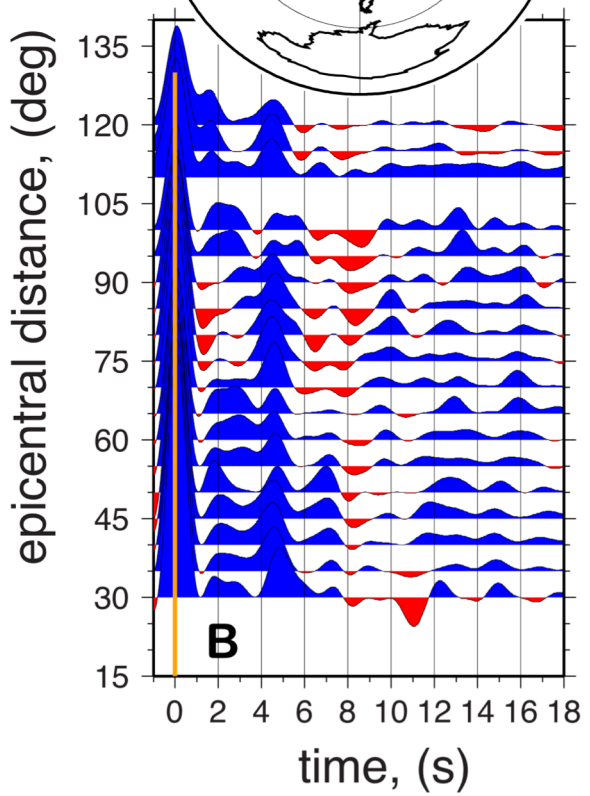
Methodology Slide I

Detecting boundaries at depth using records from far-away earthquakes



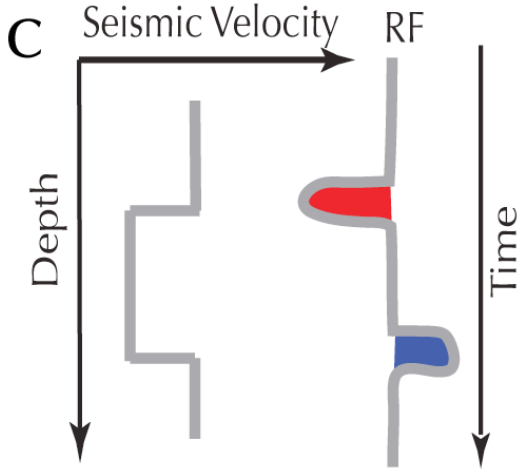






Using many earthquakes at one site builds CONFIDENCE

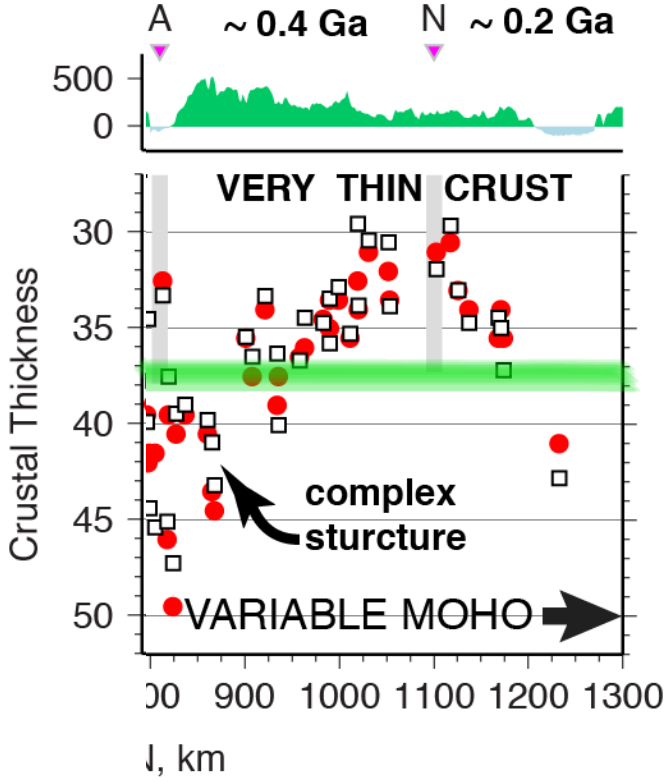
S-polarized phases in teleseismic P wave coda are generated at impedance contrasts beneath the receiver

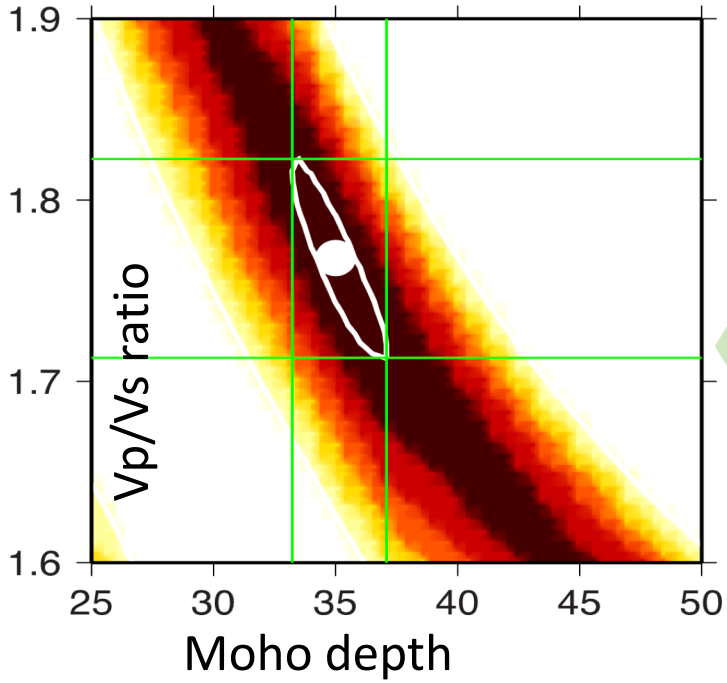


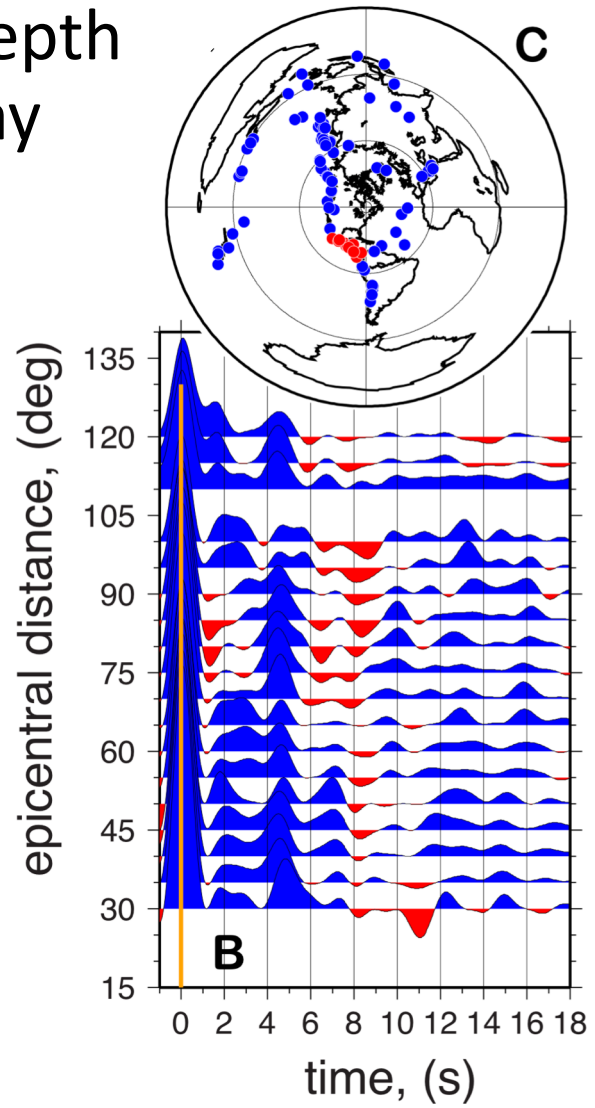
Time when pulse arrives → depth
Polarity → sense of change
Size of pulse → amount of change

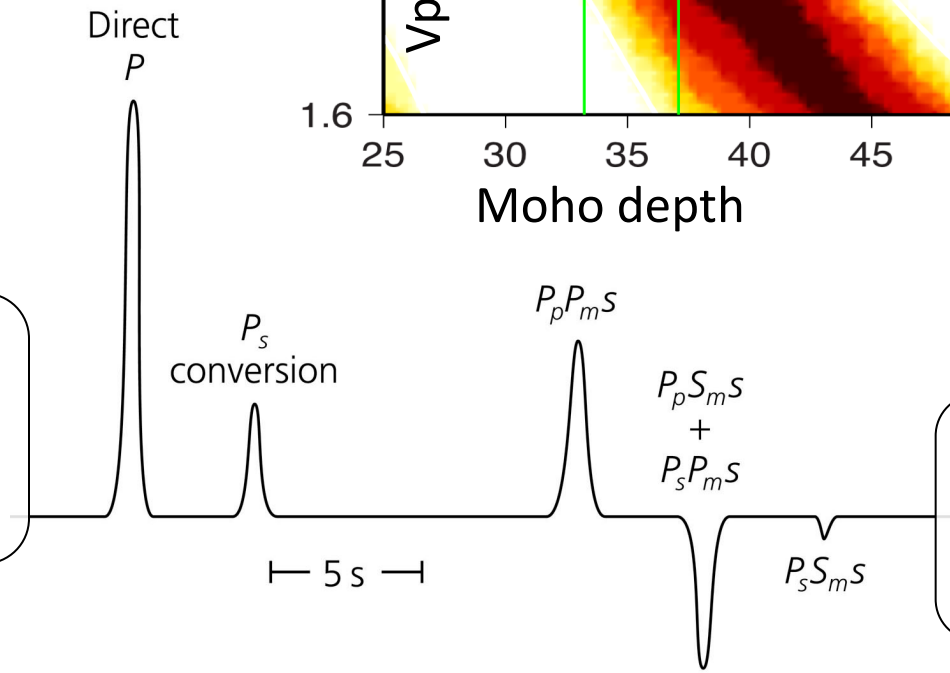
Methodology Slide II

Detecting boundaries at depth using records from far-away earthquakes





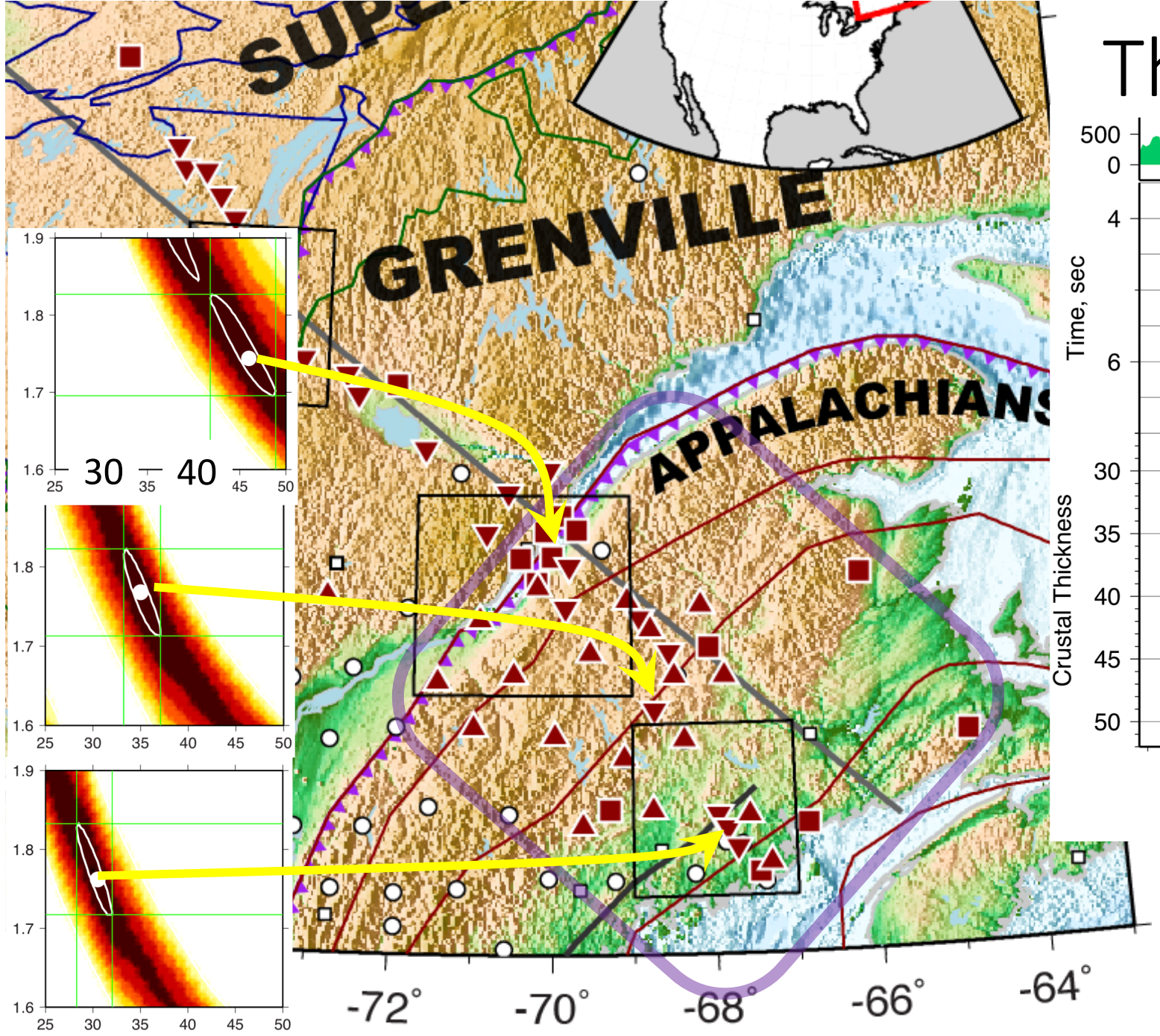


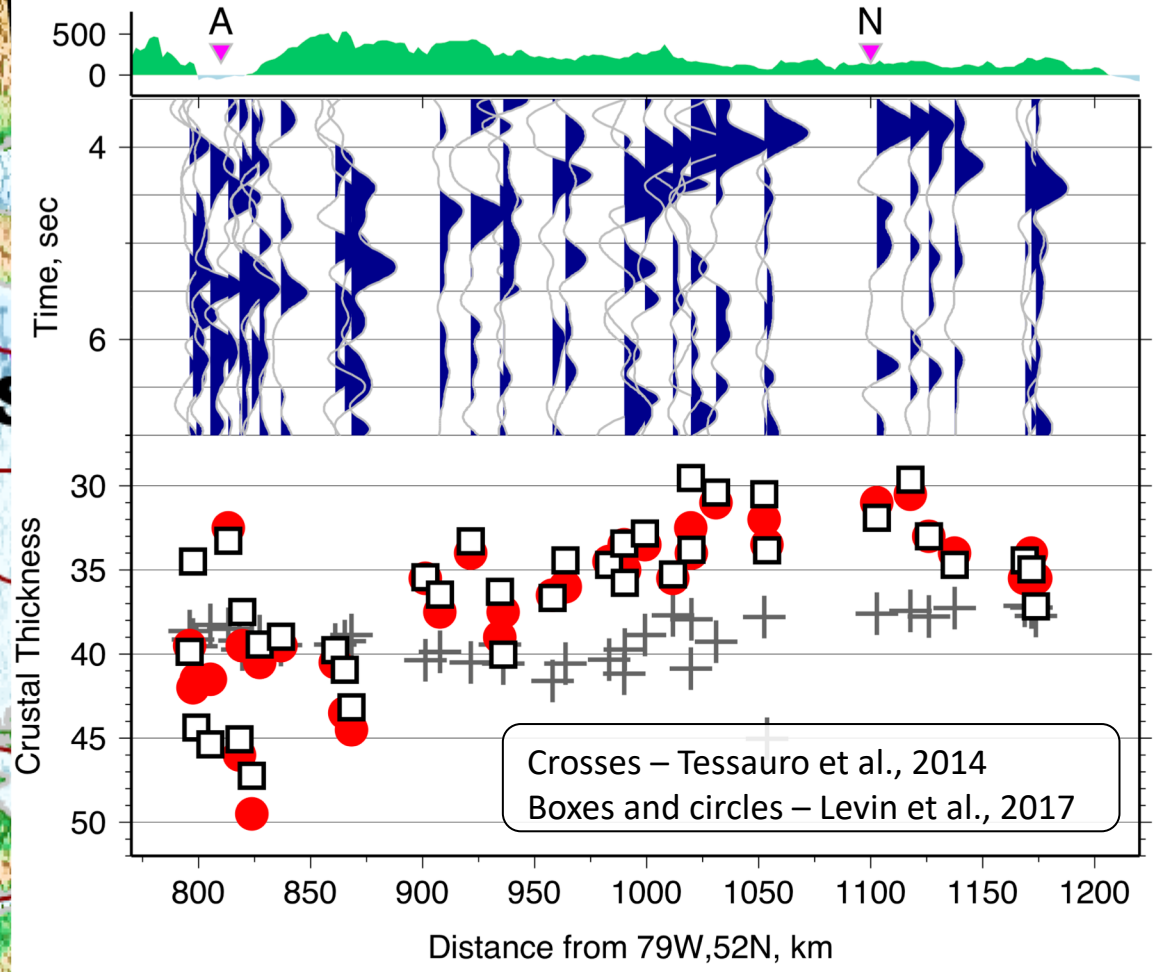


Assuming ***ONE*** boundary we can find a best-fitting values of ***DEPTH*** and ***Vp/Vs ratio***.

Receiver Function contains both direct and multiply reflected phases.

Thin Crust under NFZ

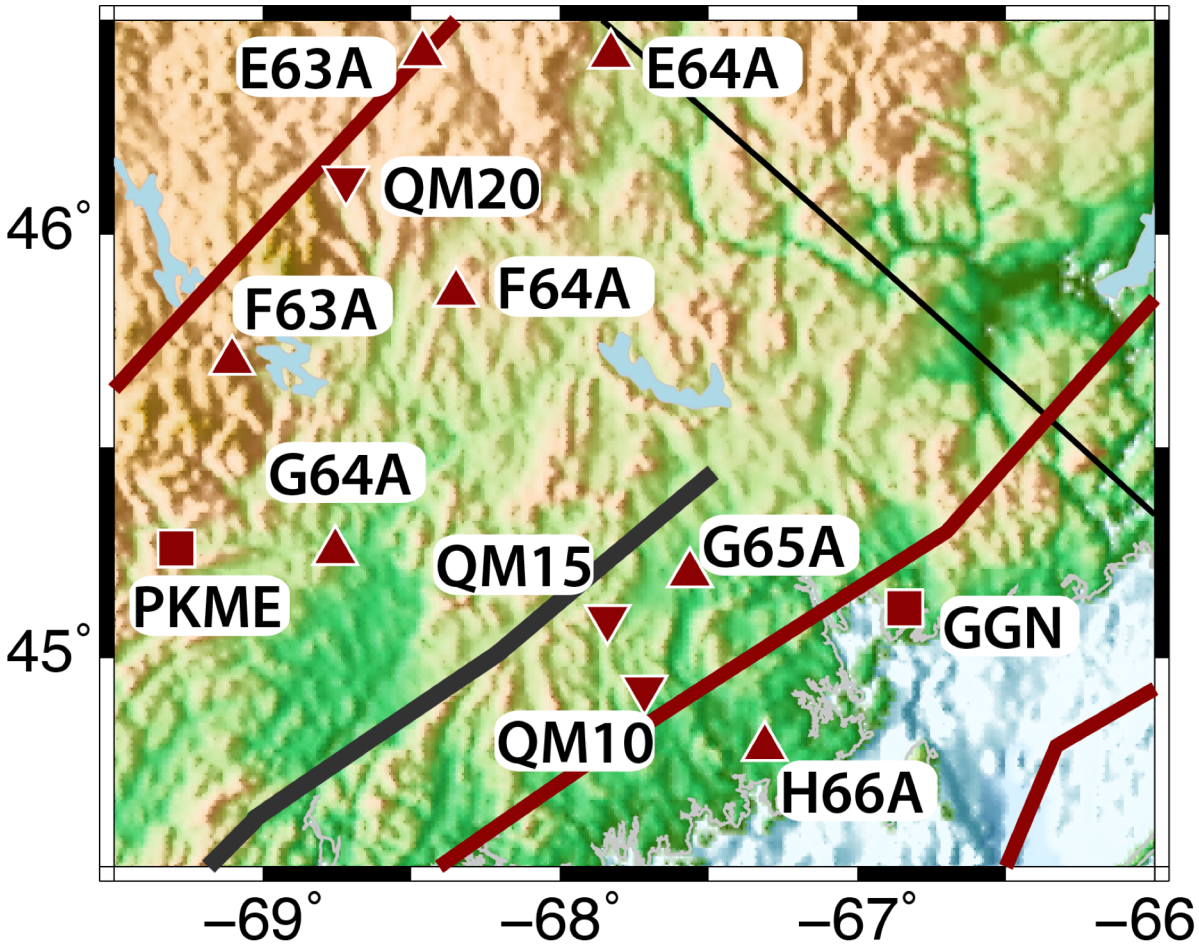




Time to Depth conversion depends on details of seismic velocity beneath the site.

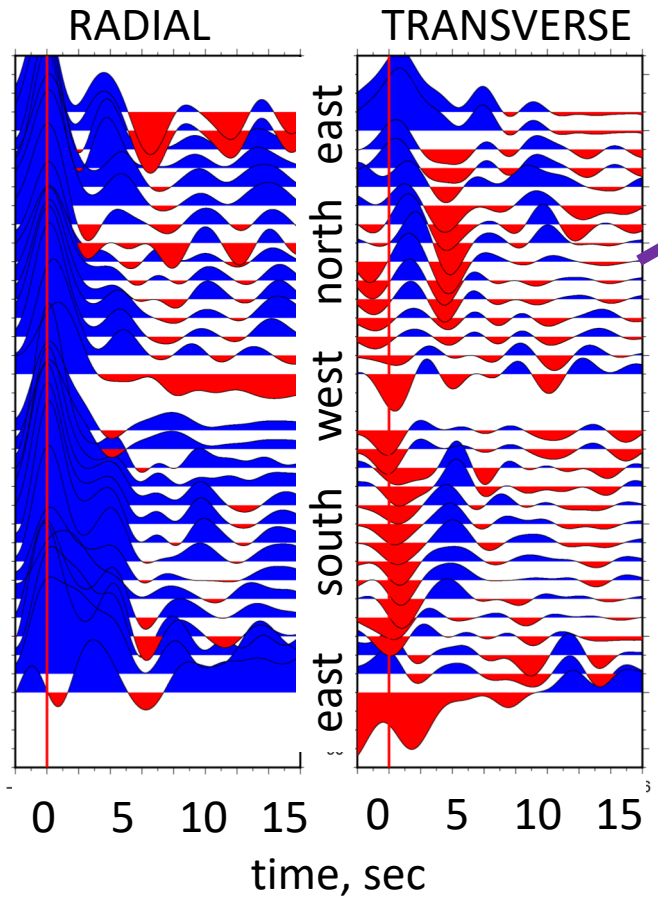
NEW TODAY: Detailed look at the Norumbega Fault Zone

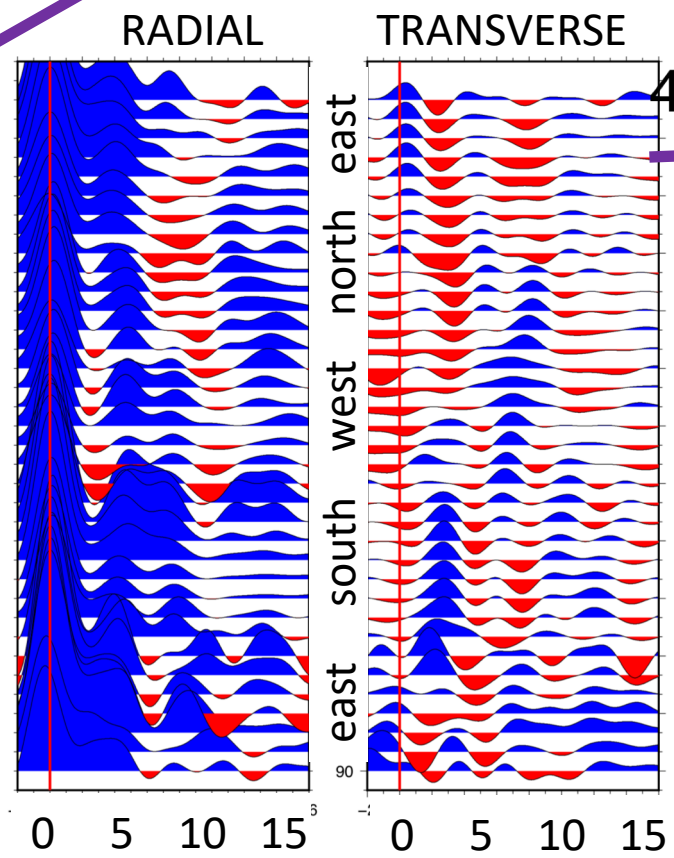
1. Looking Deeper:
   - Structure of the lithosphere
     - LAB?
     - Layering?
2. Looking Around:
   - Directional Variation as evidence for
     - Inclined boundaries?
     - …Anisotropy → rock fabric?

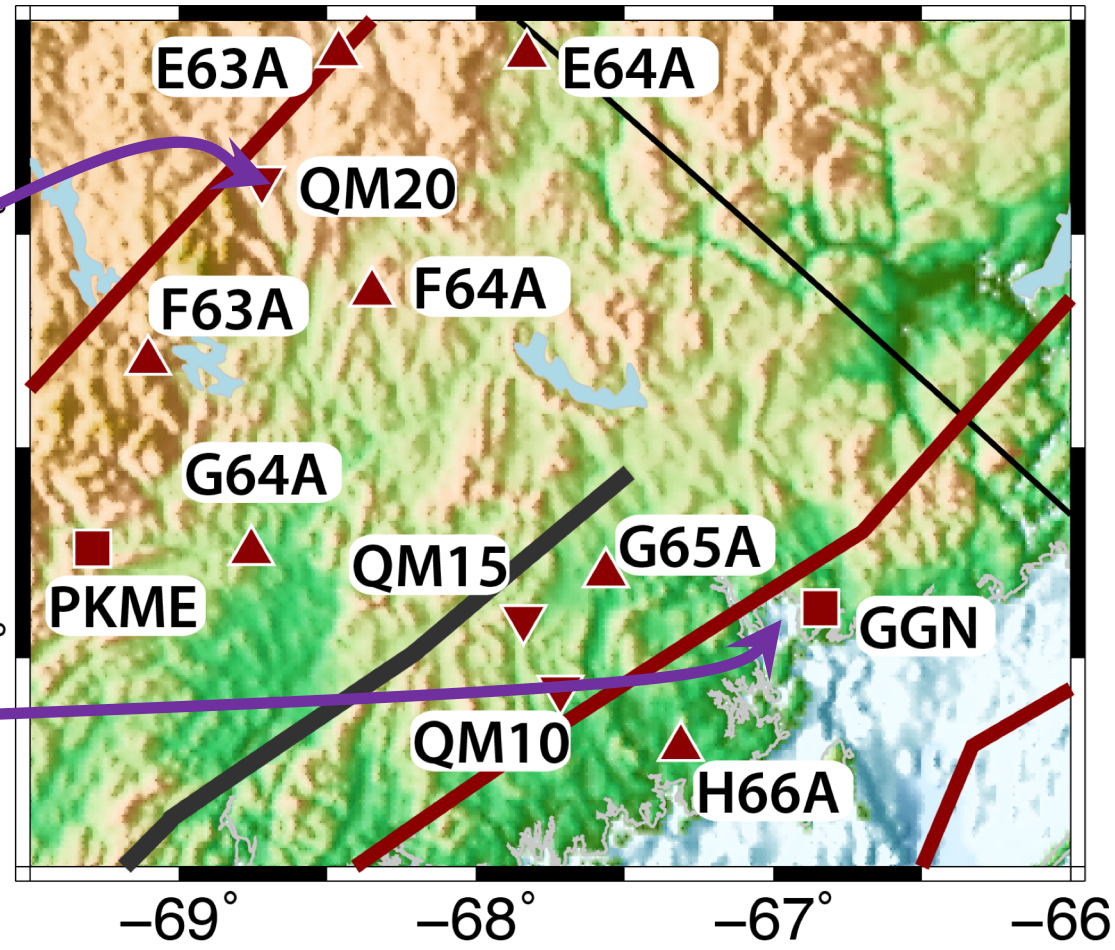


Sites near the NFZ selected for analysis on the basis of directional data coverage

CHALLENGE OF TOO MUCH DATA: which aspects are *important?*



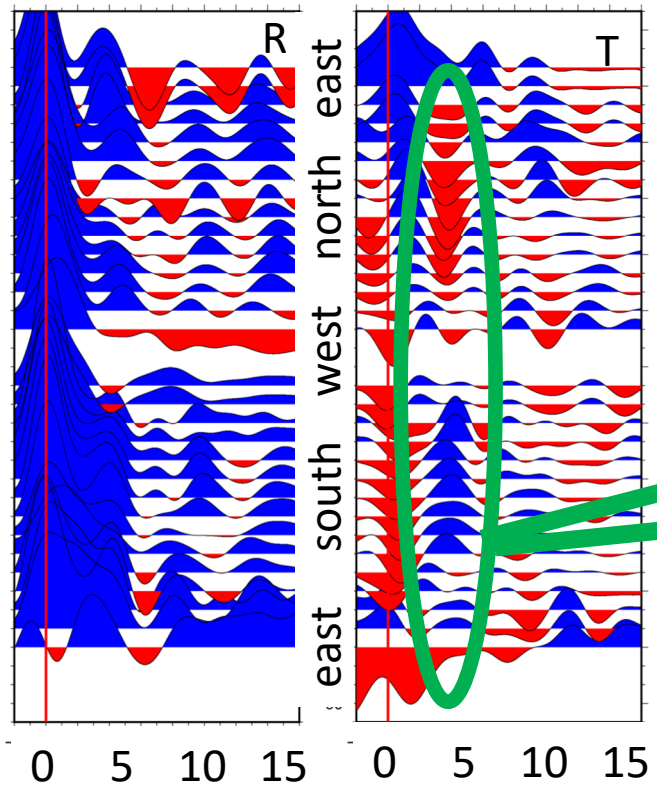


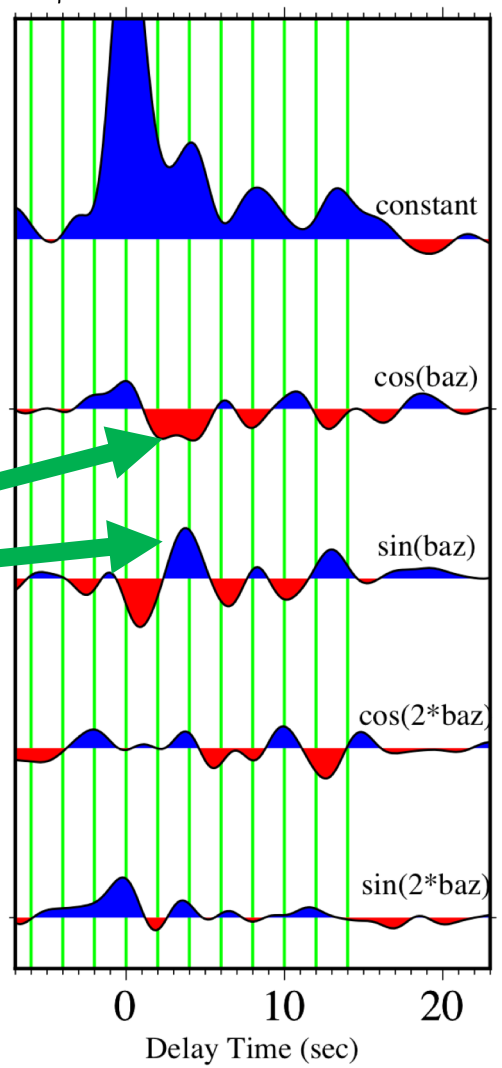


Use both R and T components;
Use longer periods – increase sensitivity to more gradual changes with depth.

Methodology Slide III

From two panels with many wiggly lines to 1 panel with 5 lines…





Harmonic decomposition of receiver functions:

- Looking around - isolating components of the wavefield with different patterns of directional variation

Constant Component
Reflects changes in *impedance* (product of speed and density → material properties)

Components varying as ***sin(baz)*** and ***cos(baz).***
Reflect effects of *dipping boundaries* and/or *anisotropy of seismic velocity* (changes in "texture" of rock at depth)

Components varying as ***sin(2baz)*** and ***cos(2baz).***
Reflect effects of *anisotropy* of seismic velocity (changes in "texture" of rock at depth)

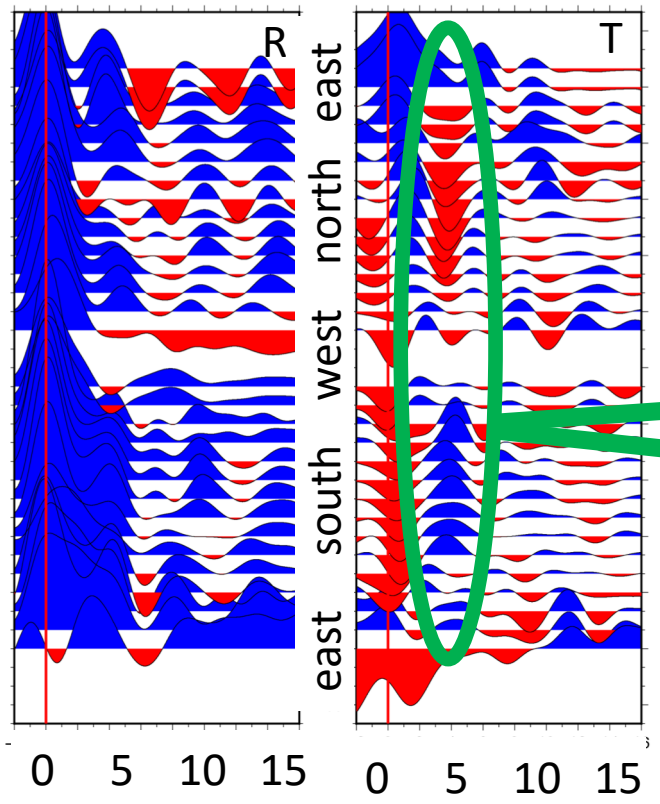
Vocabulary Word:
Backazimuth (BAZ) – direction from you to the earthquake

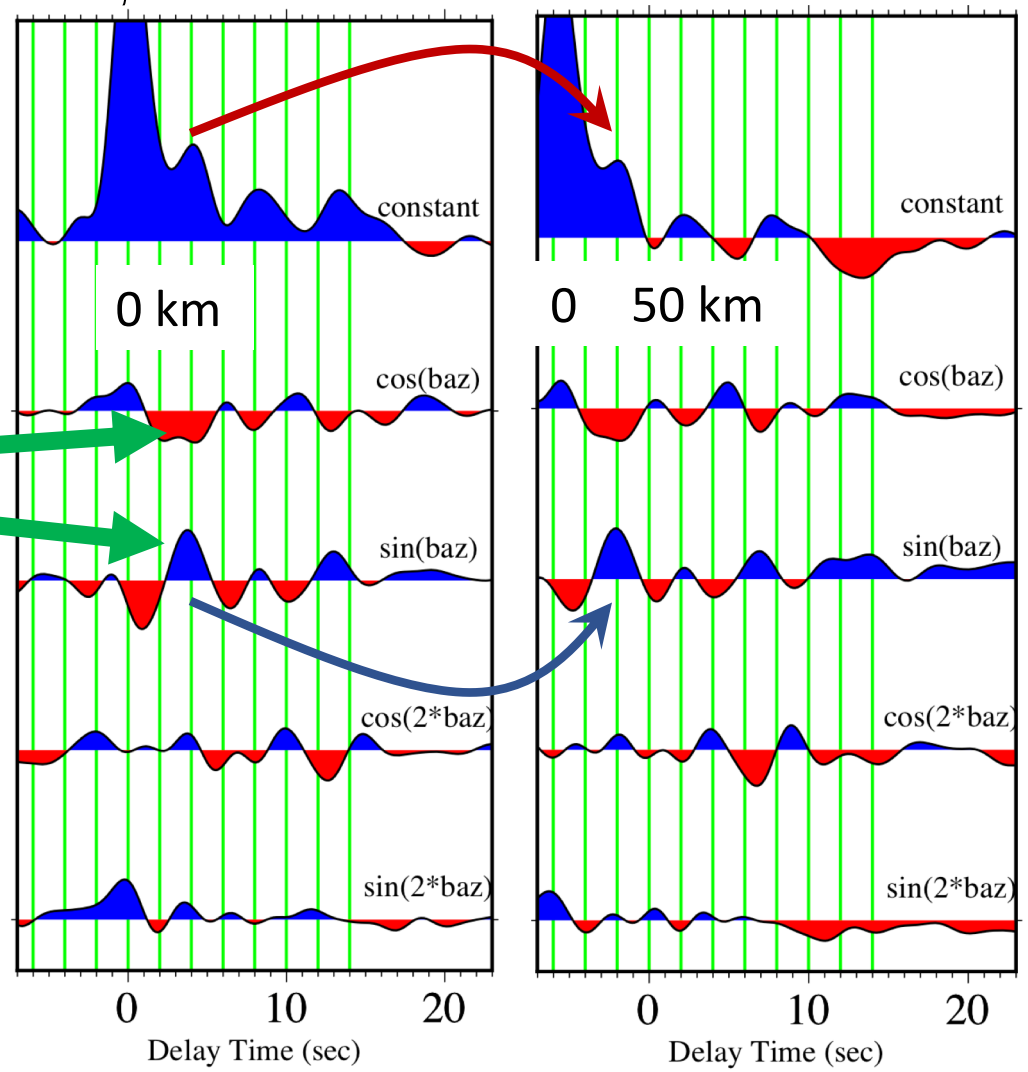
Methodology Slide IV

Depth migration of receiver functions:

- Looking deeper – extending the time line of receiver function to capture phases from grater depth

Shifting the reference depth from 0 km to 50 km makes later phases come out better





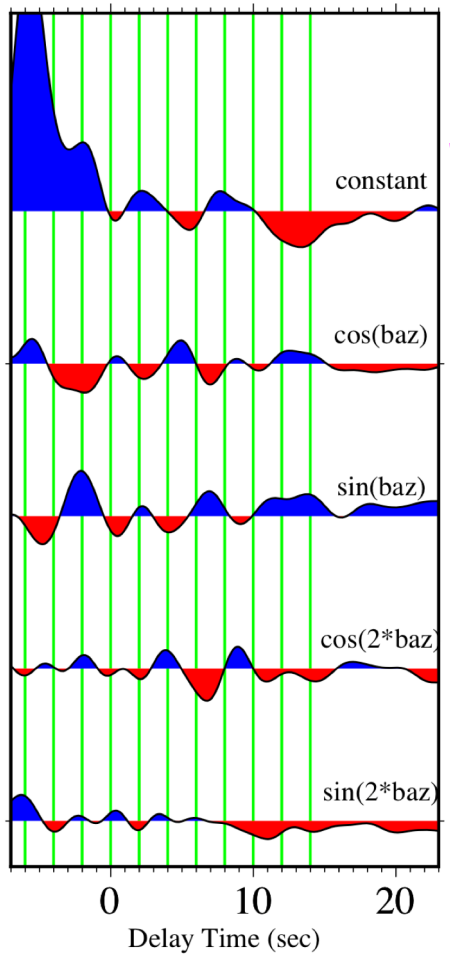
In order to compute receiver functions for a target depth of 50 km, we use a **model** of seismic velocity change with depth;

Crust –
Levin et. al., 2017;

Mantle –
Yuan et al., 2014

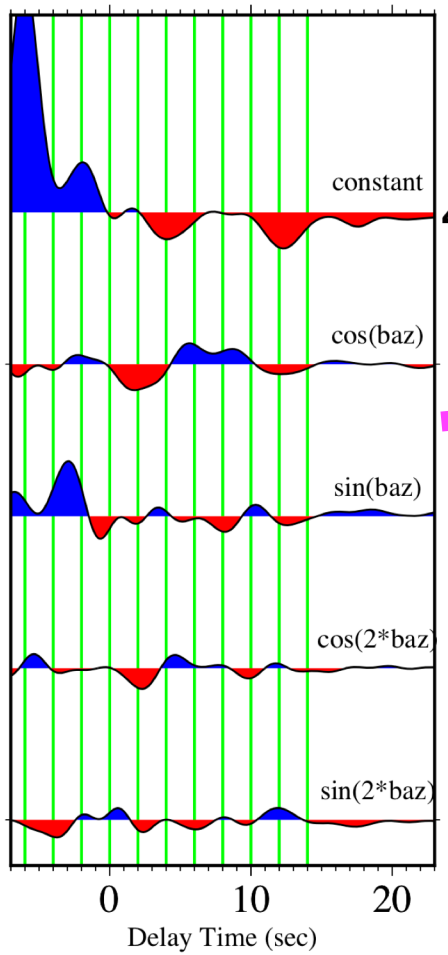
Vocabulary Word:
Migration – change of target position/depth during processing

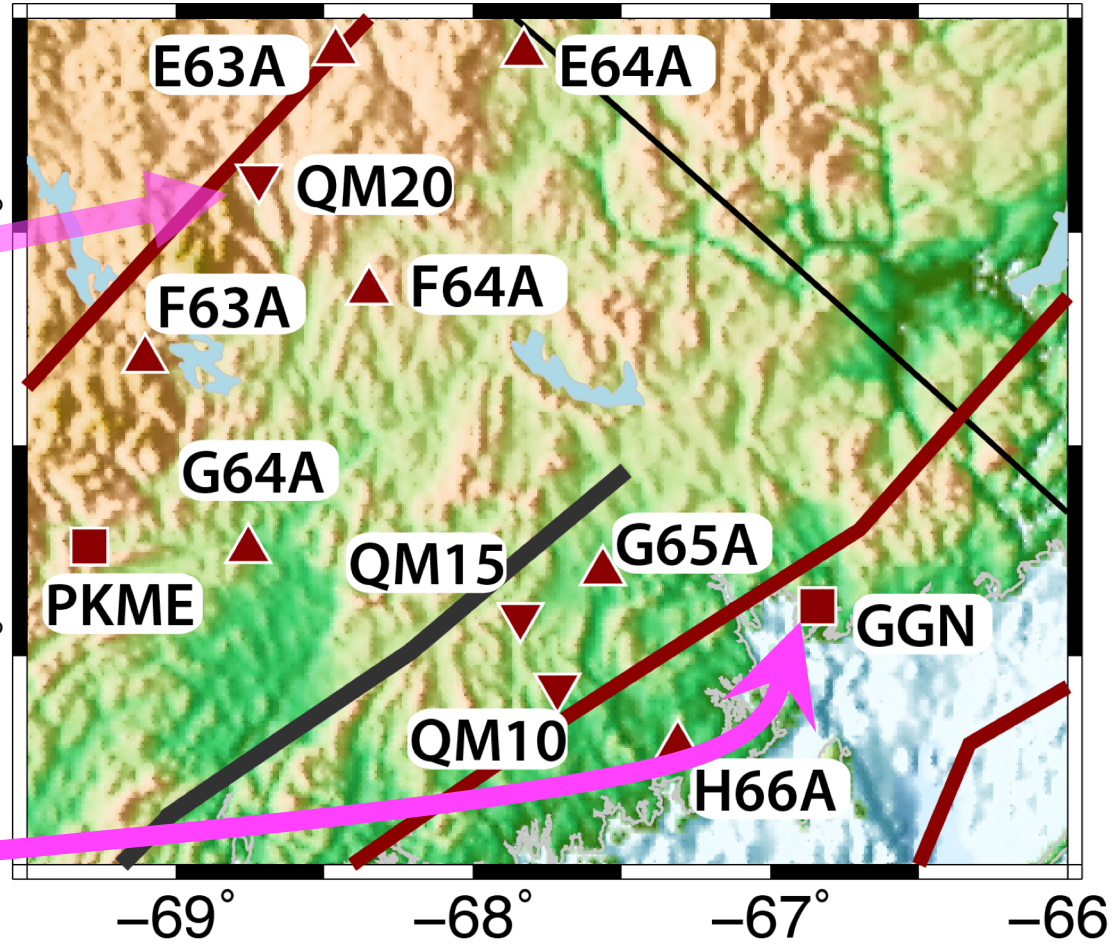
Harmonic components of receiver functions migrated to 50 km depth



PLAN:
Compare same components at different sites;

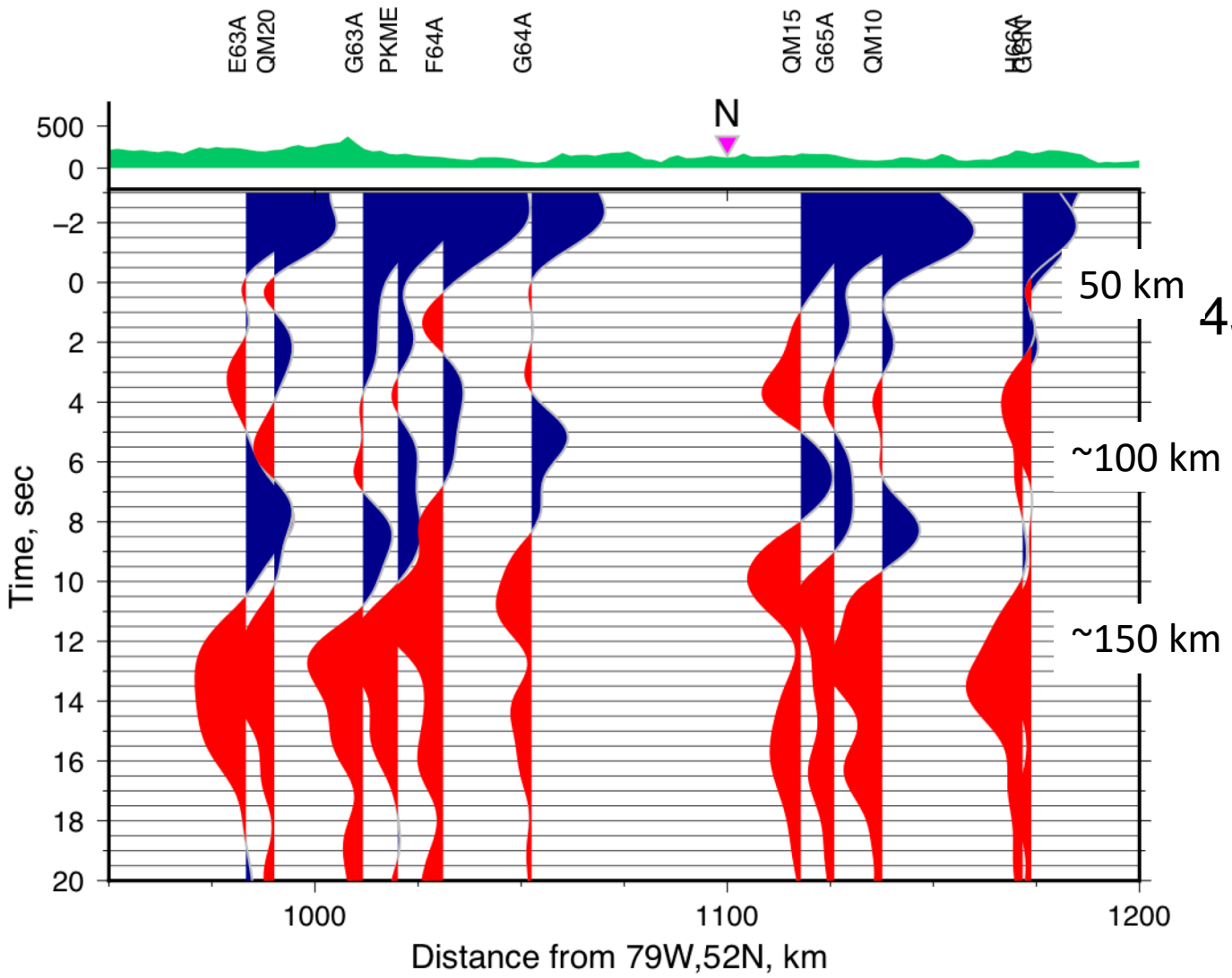
Look for similarities or differences

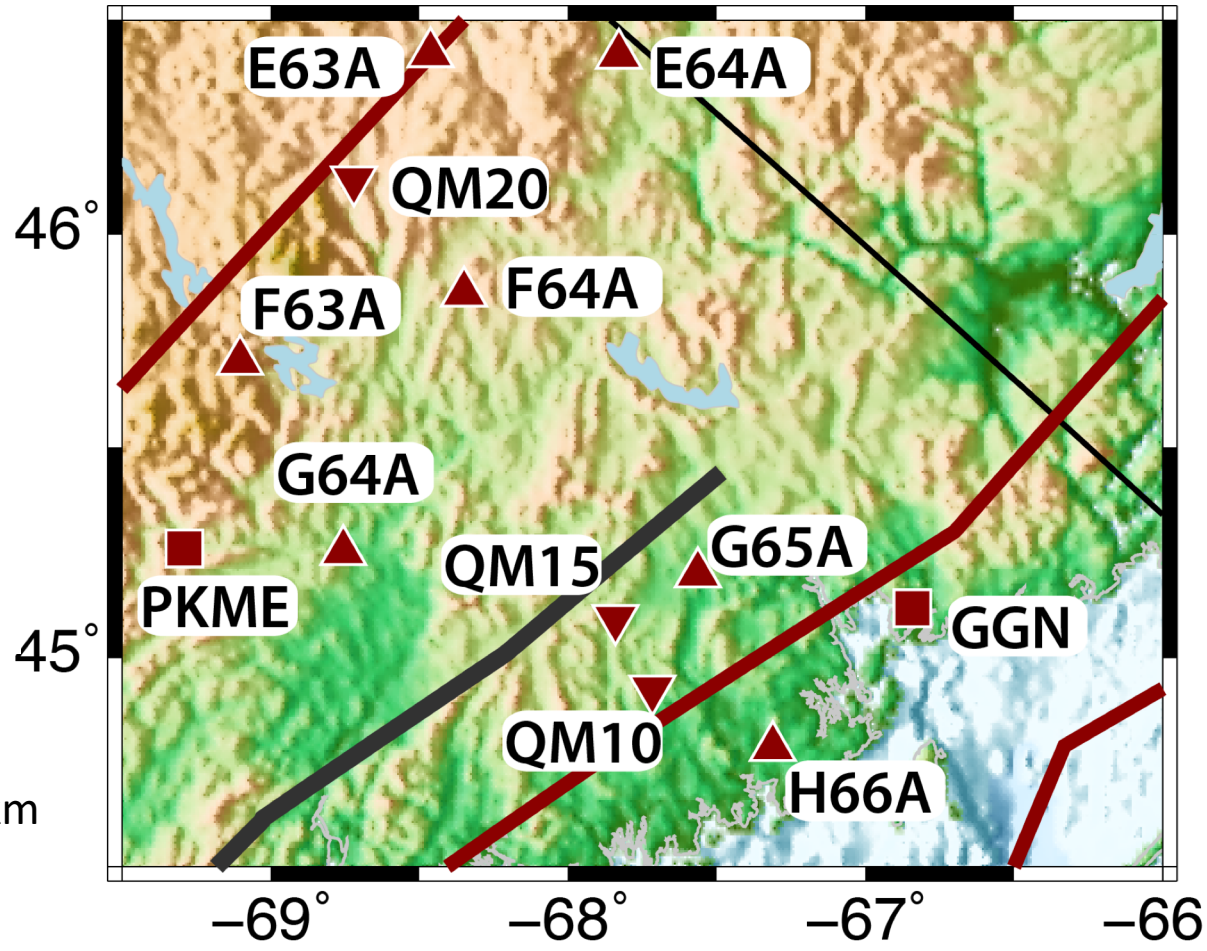




Constraints on changes in seismic properties (velocity *and* anisotropy) in the upper ~200 km:
From the surface to the asthenosphere

Constant Component:
is this the bottom of the plate?

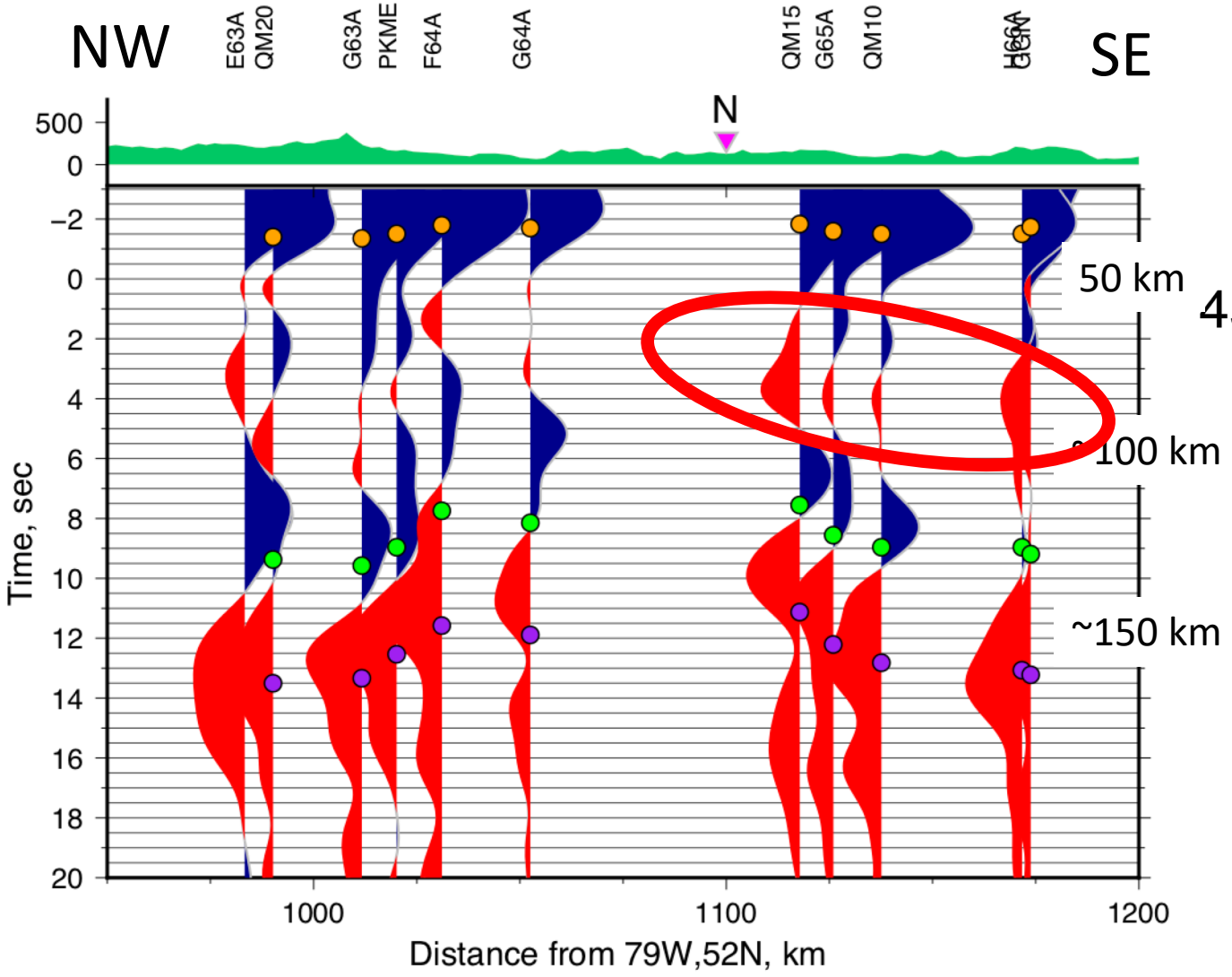


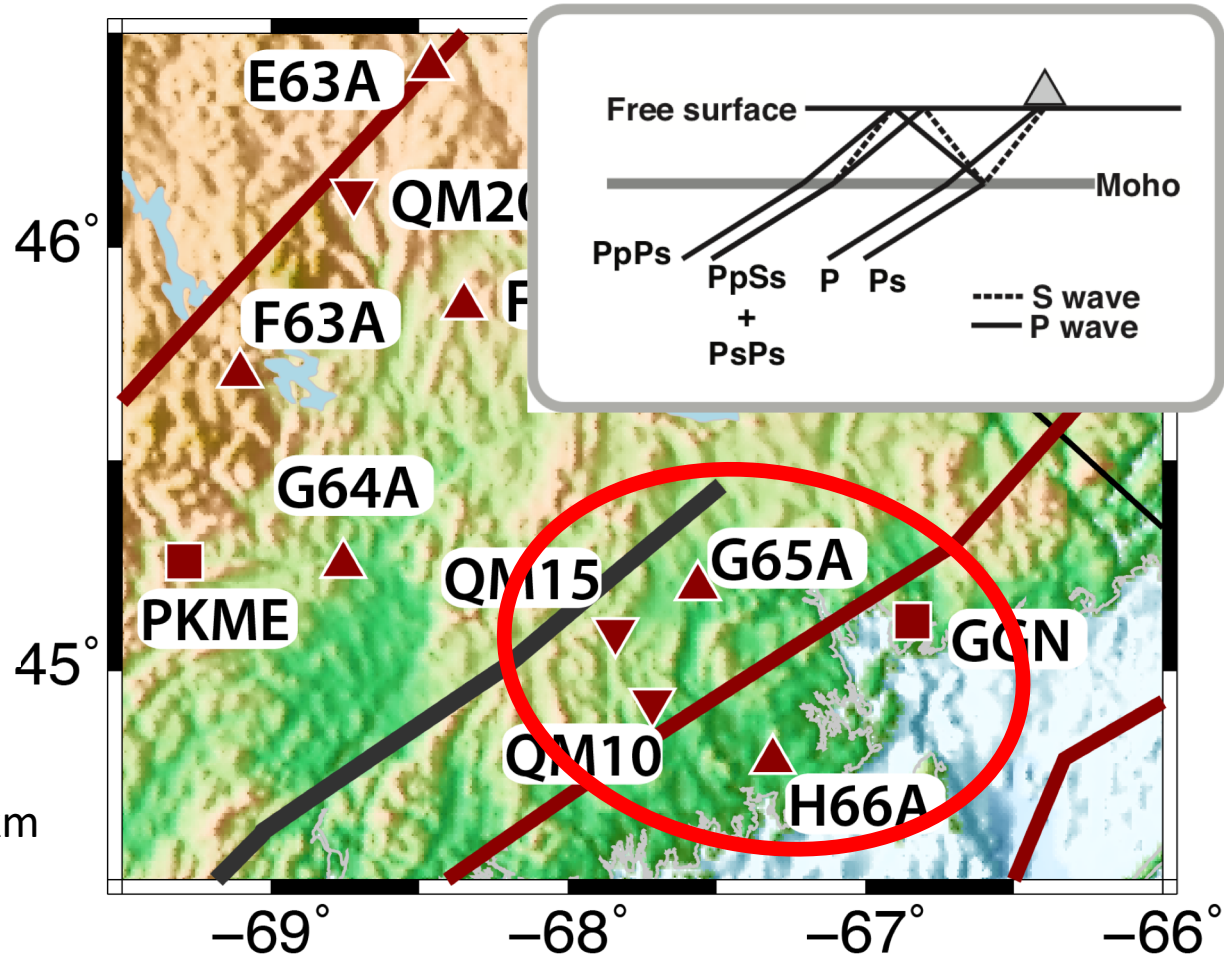


LARGE negative pulse at 12 -14 s – LAB?
(Lithospehre-Asthenosphere Boundary)

Positive pulse at -2 s – ***MOHO***
(saw this before ….)

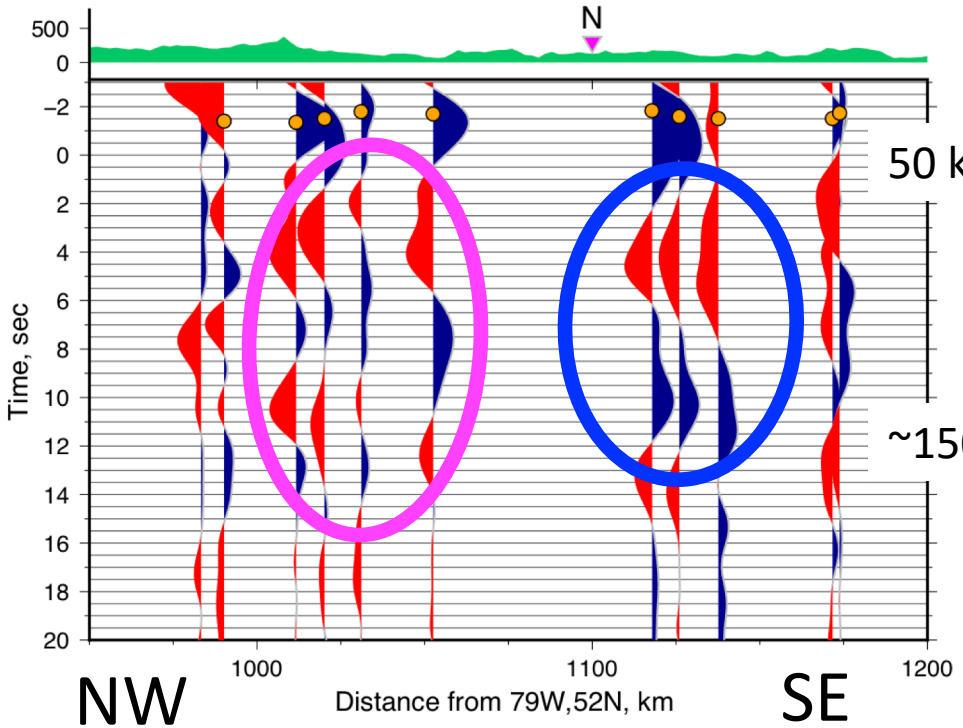
Constant Component: multiples… BUT there are other features too





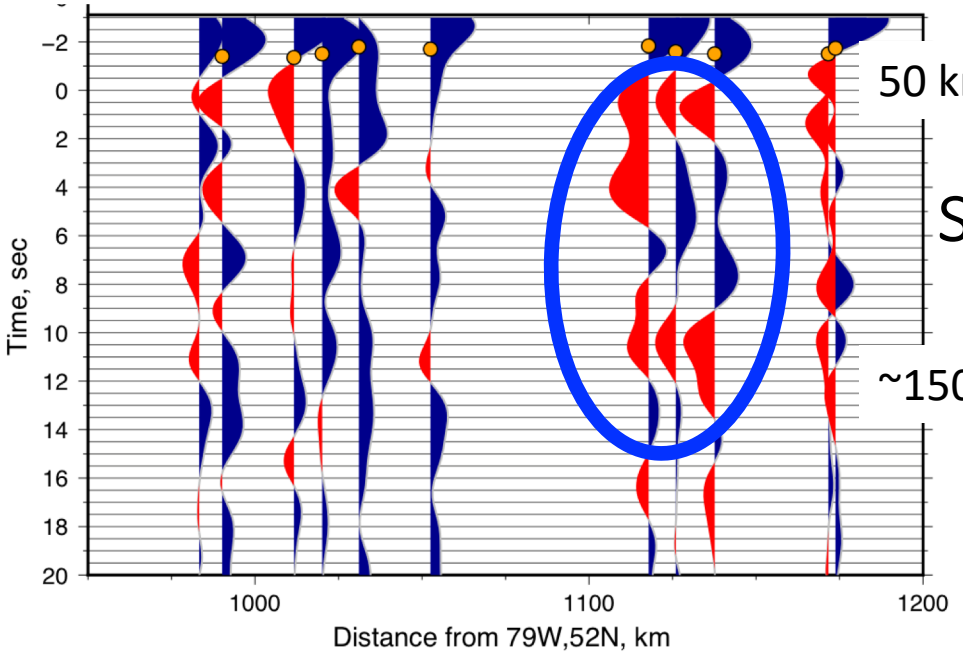
Negative pulse at 2-4 s to the SOUTH of NFZ marks a boundary 70-90 km deep

Positive pulse at 6-8 s and LARGE *negative* pulse at 12 -14 s – multiples;

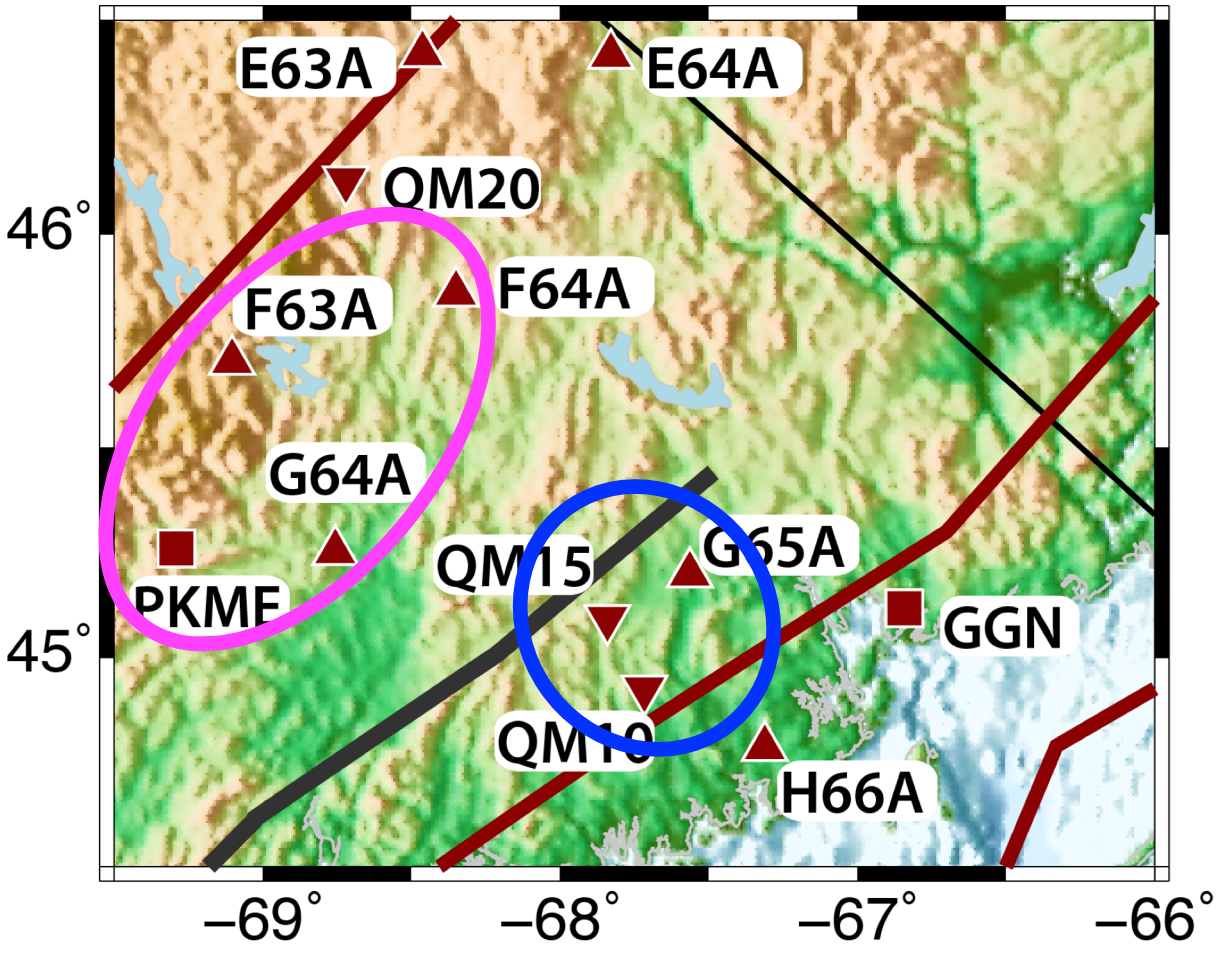


cos(baz)

NW SE



sin(baz)

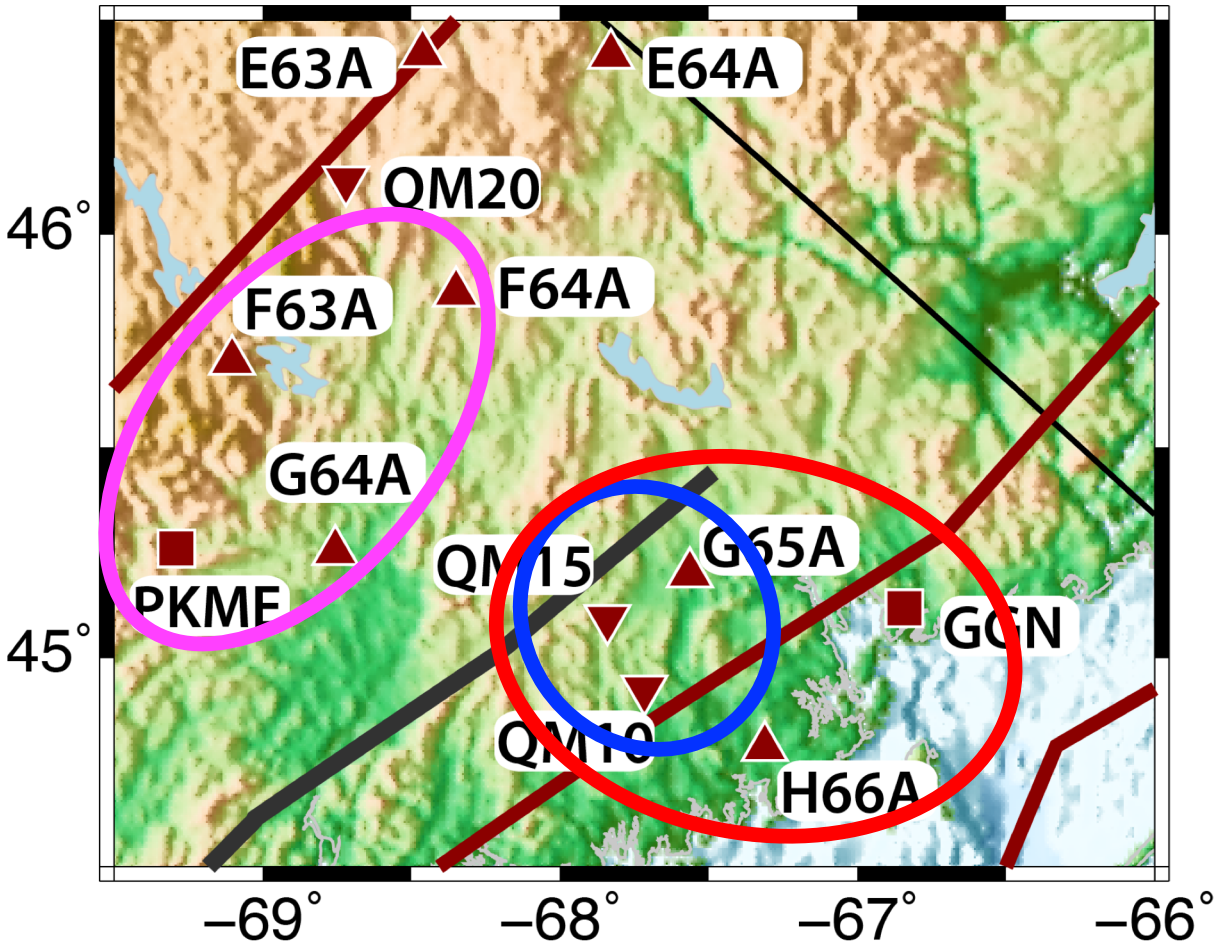


Stations *within* the NFZ show a similar pattern of phases on ***sin(baz)*** and ***cos(baz)*** components

A group of sites to the north of NFZ shows a *different* pattern

LITHOSPHERIC EXPRESSION OF THE NORUMBEGA FAULT ZONE

- Very thin (30 km) crust beneath NFZ
- Clear difference in attributes of lithospheric structure
  - Boundary at 70-90 km TO THE SOUTH of the NFZ
  - Two areas of distinct ”texture” within the lithosphere
    - Directly beneath the NFZ
    - To the NW of the NFZ



NFZ is a lithosphere-scale near-vertical tectonic boundary