Imaging of the Earthquake Source Fault Beneath the Tokyo Metropolitan Region

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[3] Ch
[4] NIED (Tsukuba)
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Seismic reflection profiles image the PSP megathrust: geometry, physical properties

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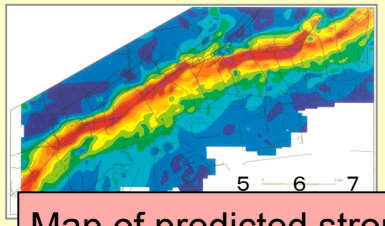
SPECIAL PROJECT FOR EARTHQUAKE DISASTER MITIGATION IN URBAN AREAS (2002-2007)

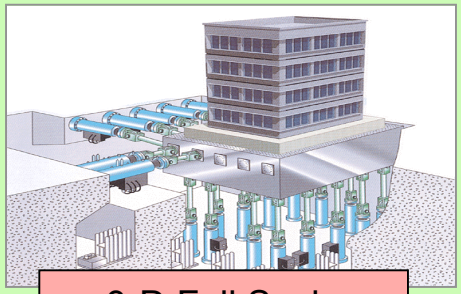
REGIONAL CHARACTERIZATION OF THE CRUST IN METROPOLITAN AREAS FOR PREDICTION OF STRONG GROUND MOTION

Deep Seismic Exploration



Map of predicted strong ground motions

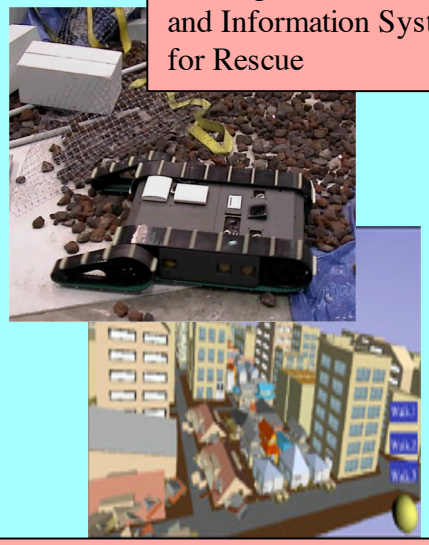
SIGNIFICANT IMPROVEMENT OF SEISMIC PERFORMANCE OF STRUCTURES



3-D Full Scale Earthquake Testing Facility

ADVANCED DISASTER MANAGEMENT SYSTEM

Development of Robotics and Information Systems for Rescue

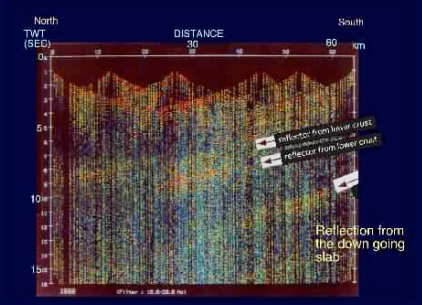


Integrated Earthquake Disaster Simulation

INTEGRATION OF EARTHQUAKE DISASTER MITIGATION RESEARCH RESULTS

REGIONAL CHARACTERIZATION OF THE CRUST IN METROPOLITAN AREAS FOR PREDICTION OF STRONG GROUND MOTION

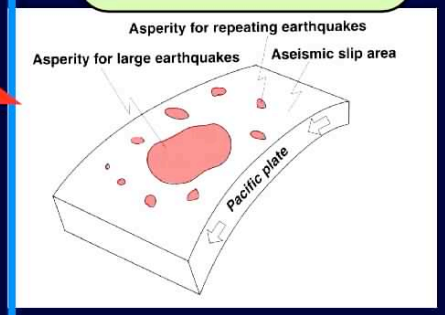
Seismic Profiling

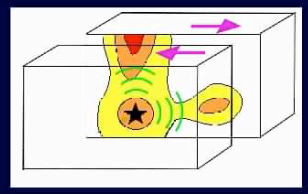


Drilling

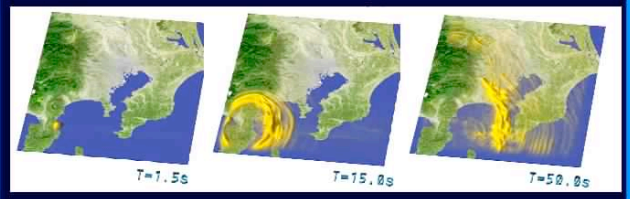
Modeling

Source fault

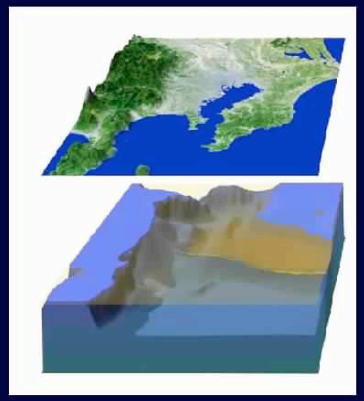




Estimation of Strong ground motion

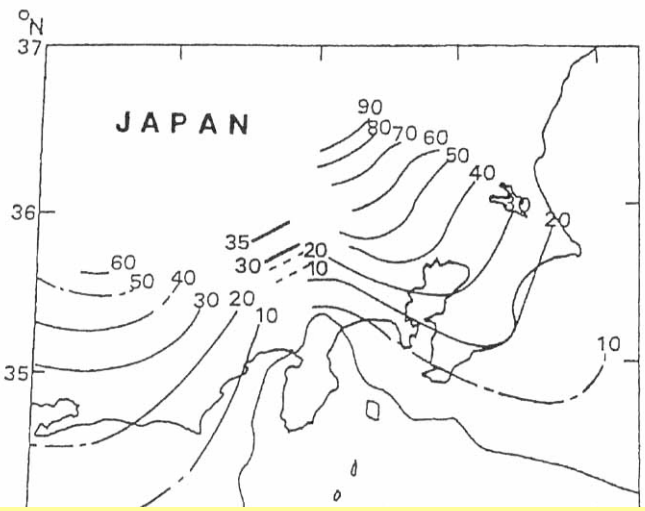


3D velocity and Q model

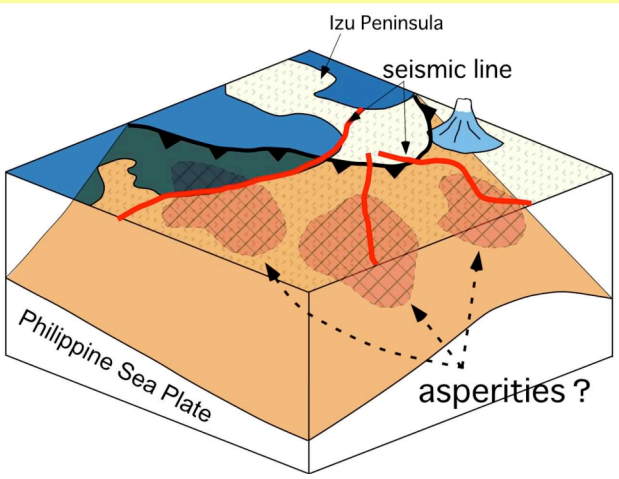


Targets

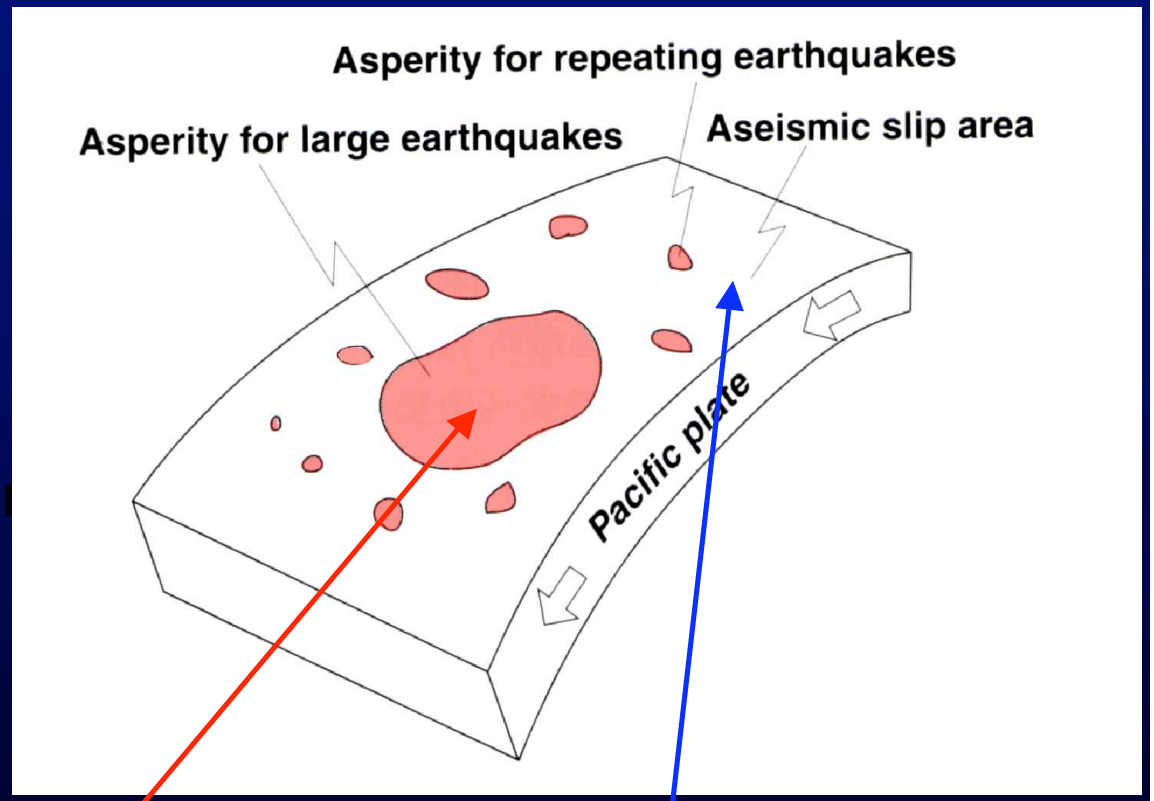
(I) Geometry of down-going Philippine Sea Plate



Imaging of upper surface of the Philippine Sea Plate by controlled source



(II) Physical Properties at PSP top

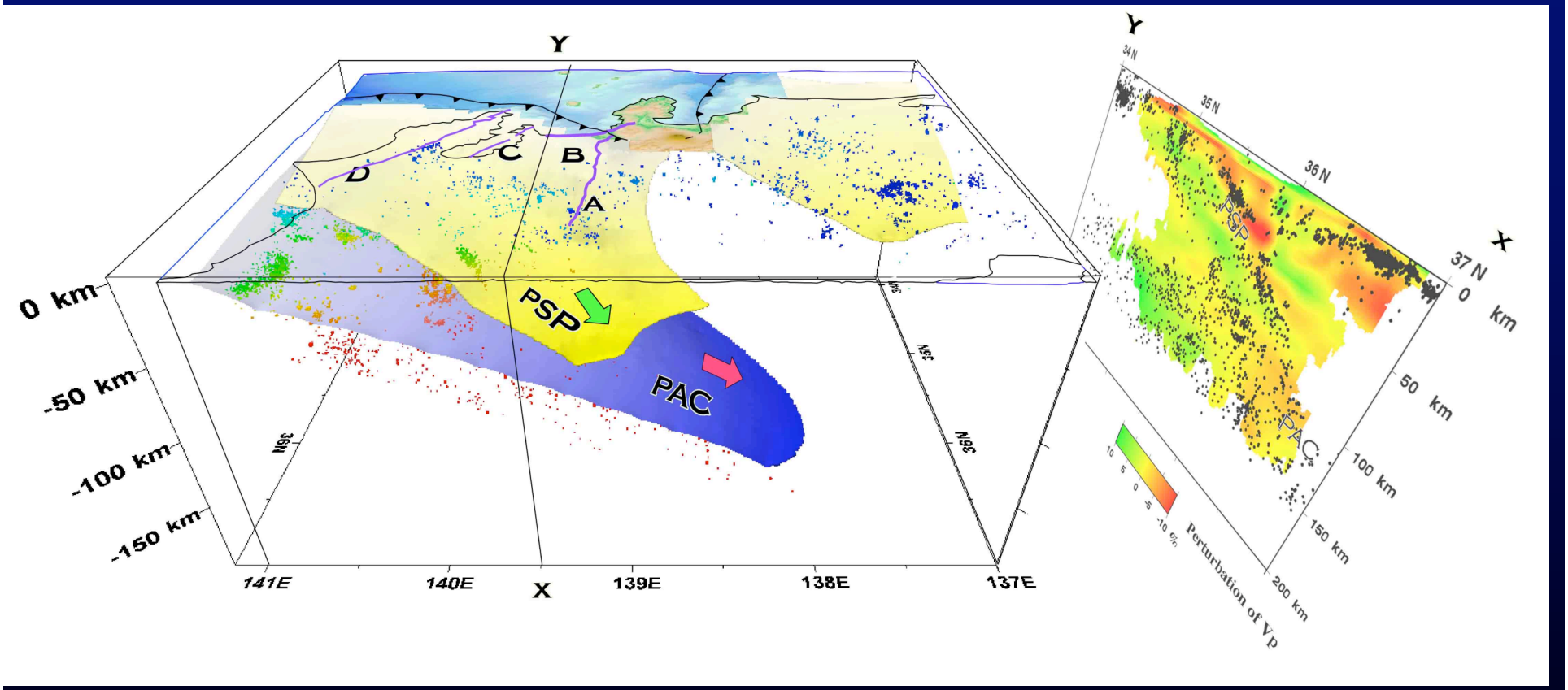


Asperity

Low seismicity
Low reflection coefficient?

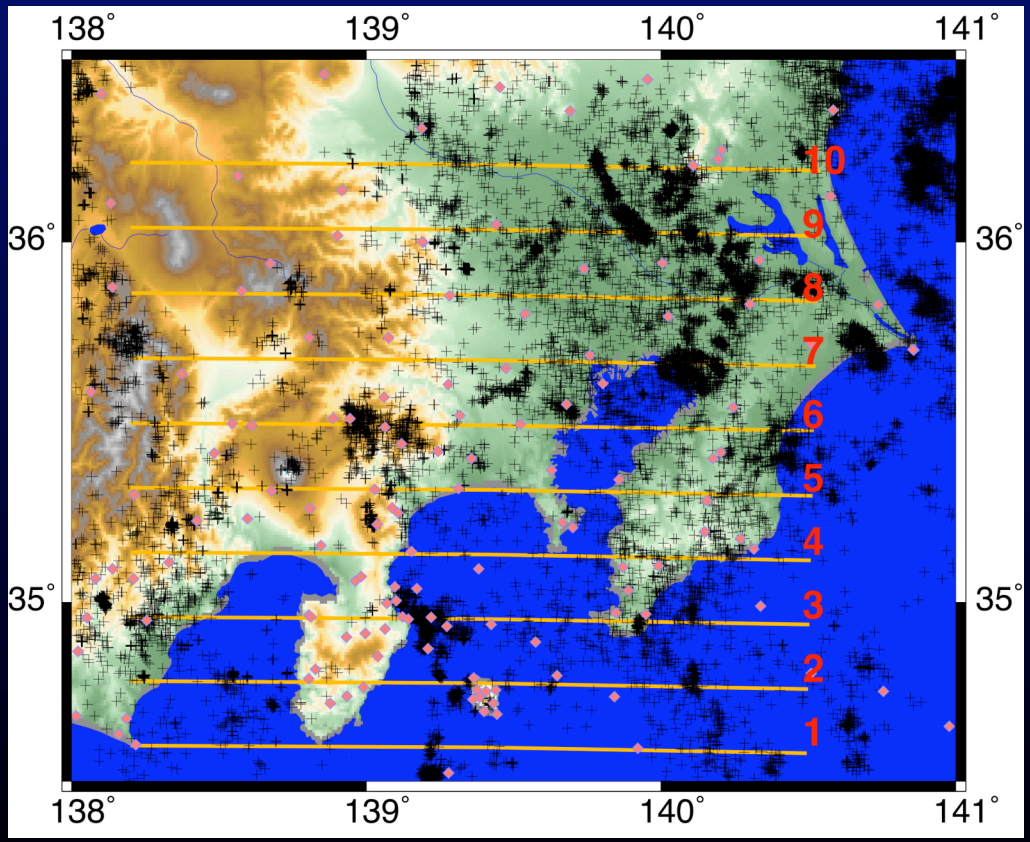
High seismicity
Slow earthquake
Aseismic slip
Repeated earthquakes

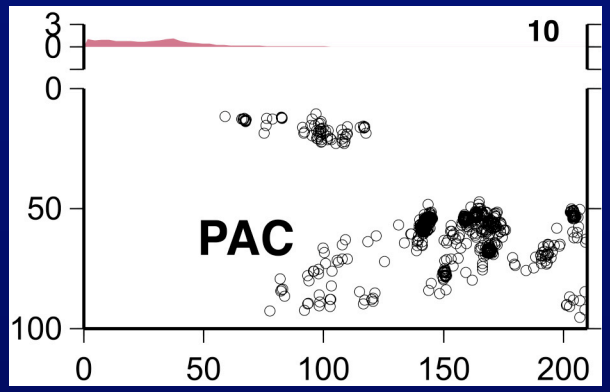
Geometry of down-going PSP and Pacific slabs with seismicity slice through Tokyo

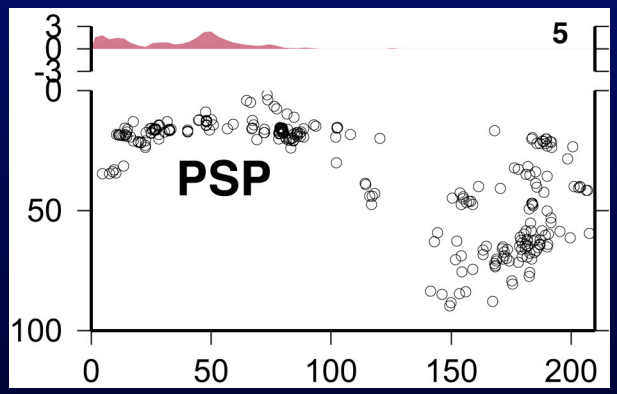


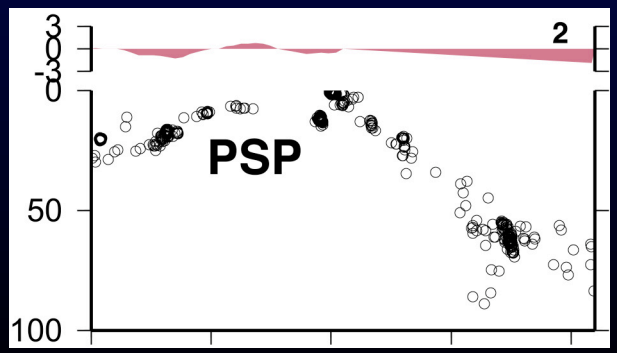
Joint Tomography-Hypocenter Relocation

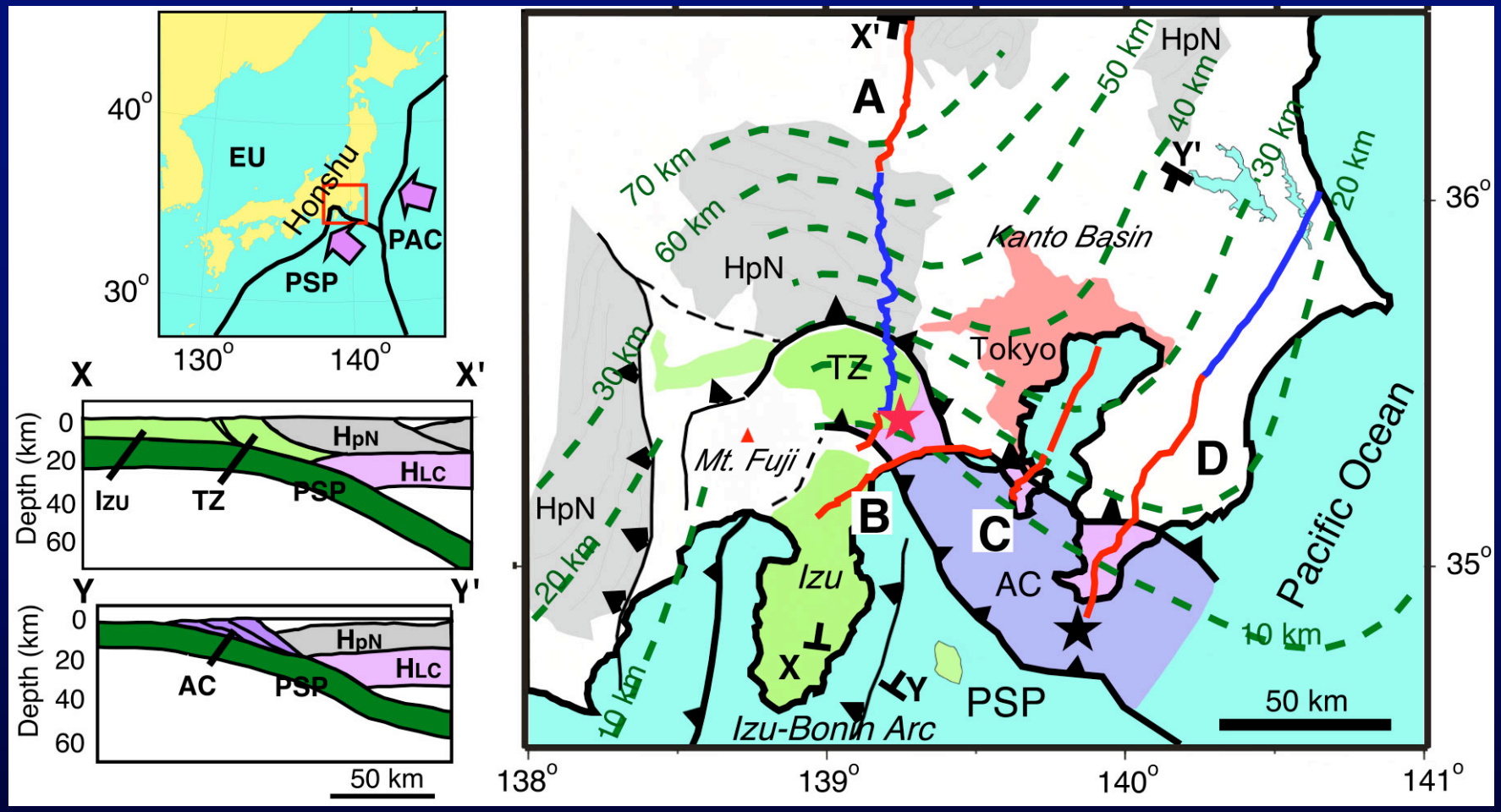
Francis Wu (SUNY/Binghamton)
Naoshi Hirata (ERI)
Makato Matsubara (NIED)
David Okaya (USC)











HpN: Honshu pre-Neogene
HLC: Honshu lower crust
TZ: Tazawa block (arc)
Izu: Izu-Bonin arc
Ac: Neogene accretionary complex

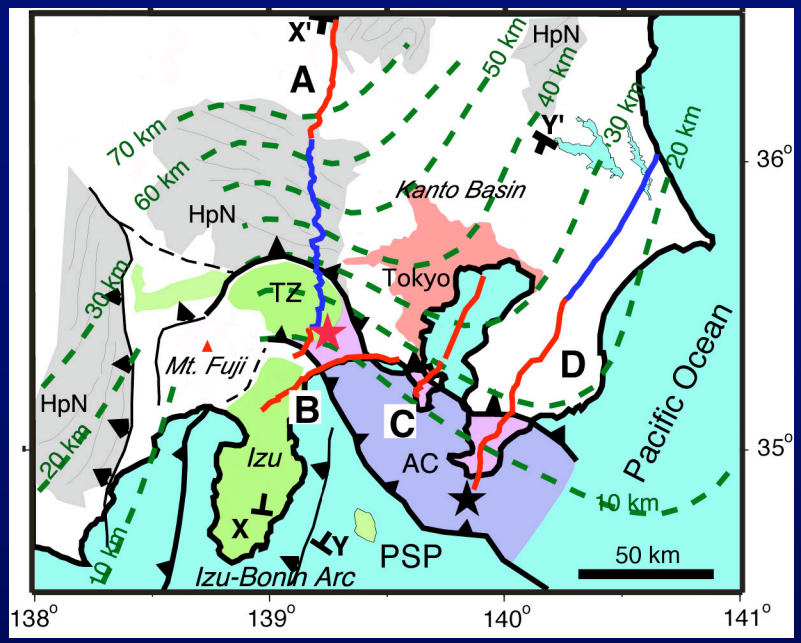
A-B-C-D: seismic profiles
(red - CDP profiling)
(blue - low fold explosion profiling)
★ - 1923 Great Kanto eq
PSP: Phil. Sea plate
– – PSP depth (Ishida, 1992)

E. Kanto Mts. 2003
A
Sagami 2003
B
C
Tokyo Bay 2003
D
Boso 2002

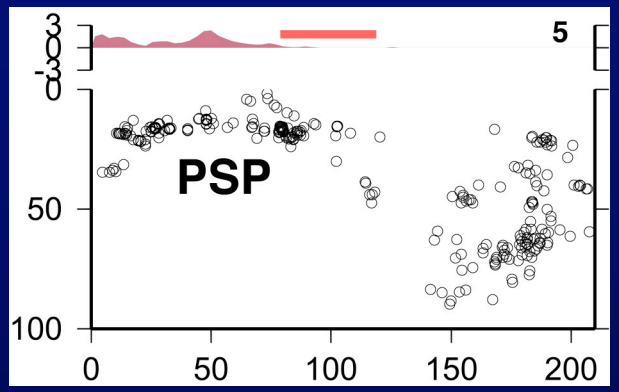
(ocean bottom cable)

SENSORS:
- CDP cable
- portable DAS
- ocean bottom cable
- MCS streamer

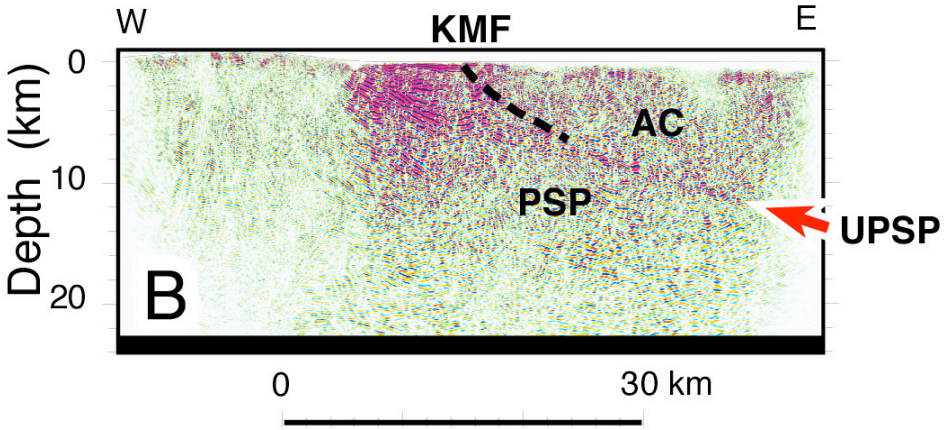
SOURCES:
- Vibroseis
- Explosions
- Airguns



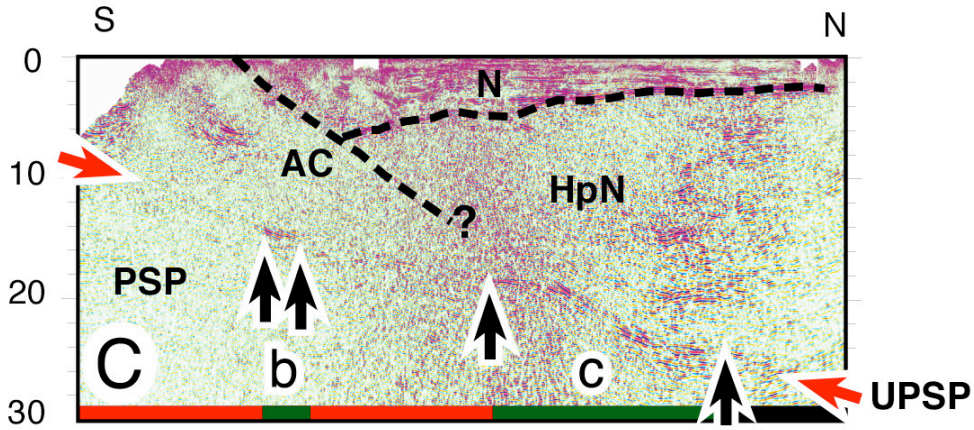
Seismicity across Sagami profile



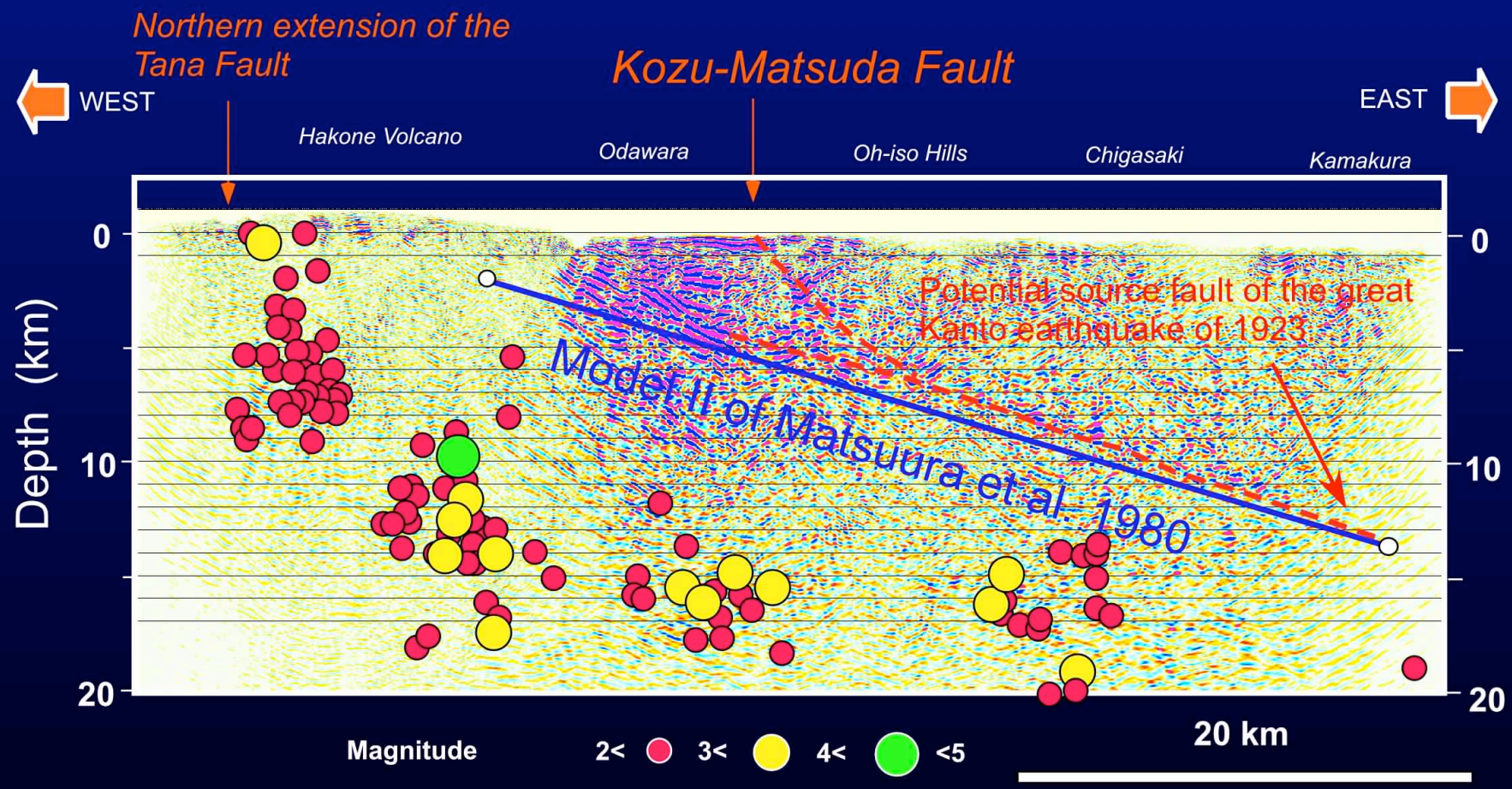
Sagami



Tokyo Bay



KMF - Kozu-Matsuda fault

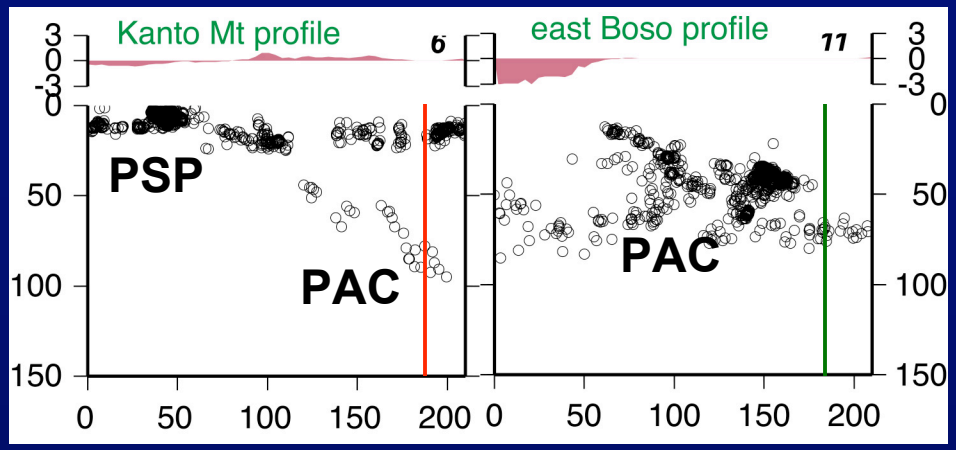


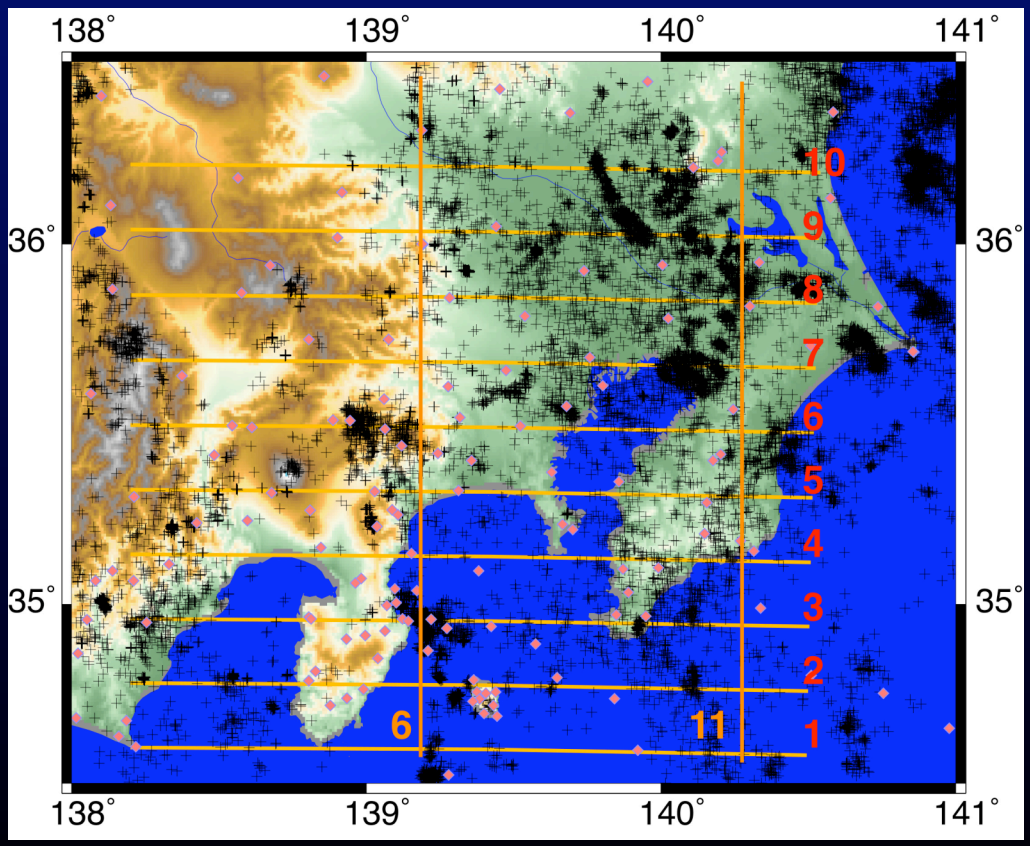
Relationship between the seismic section and hypocentral distribution after JMA unified hypocenters from October 97 to May 03.

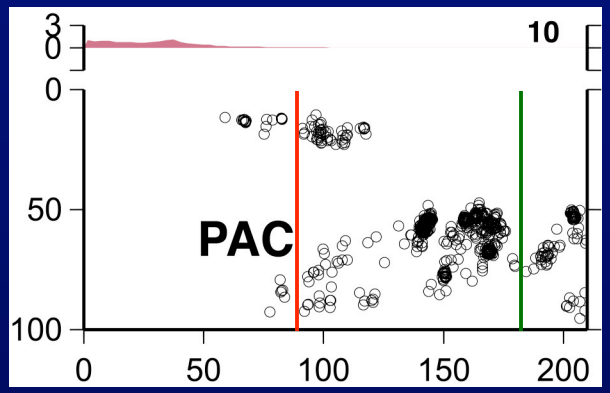
Sagami profile (B)

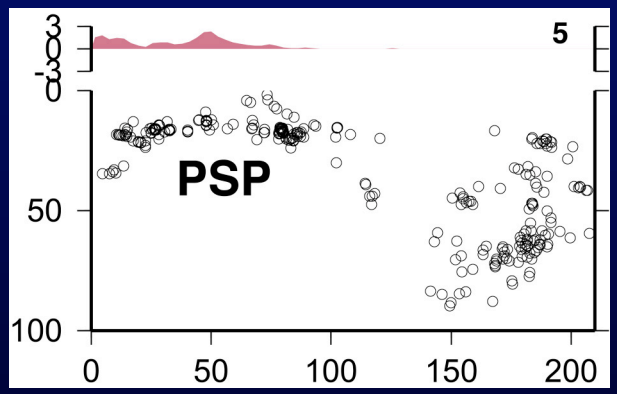
E. Kanto Mts. 2003
A
Sagami 2003
B
C
Tokyo Bay 2003
D
Boso 2002

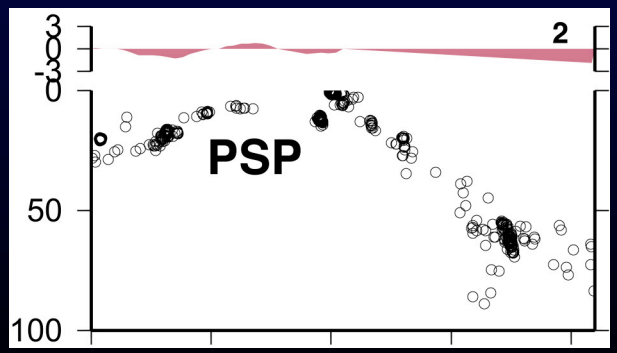
Tomography/Relocations



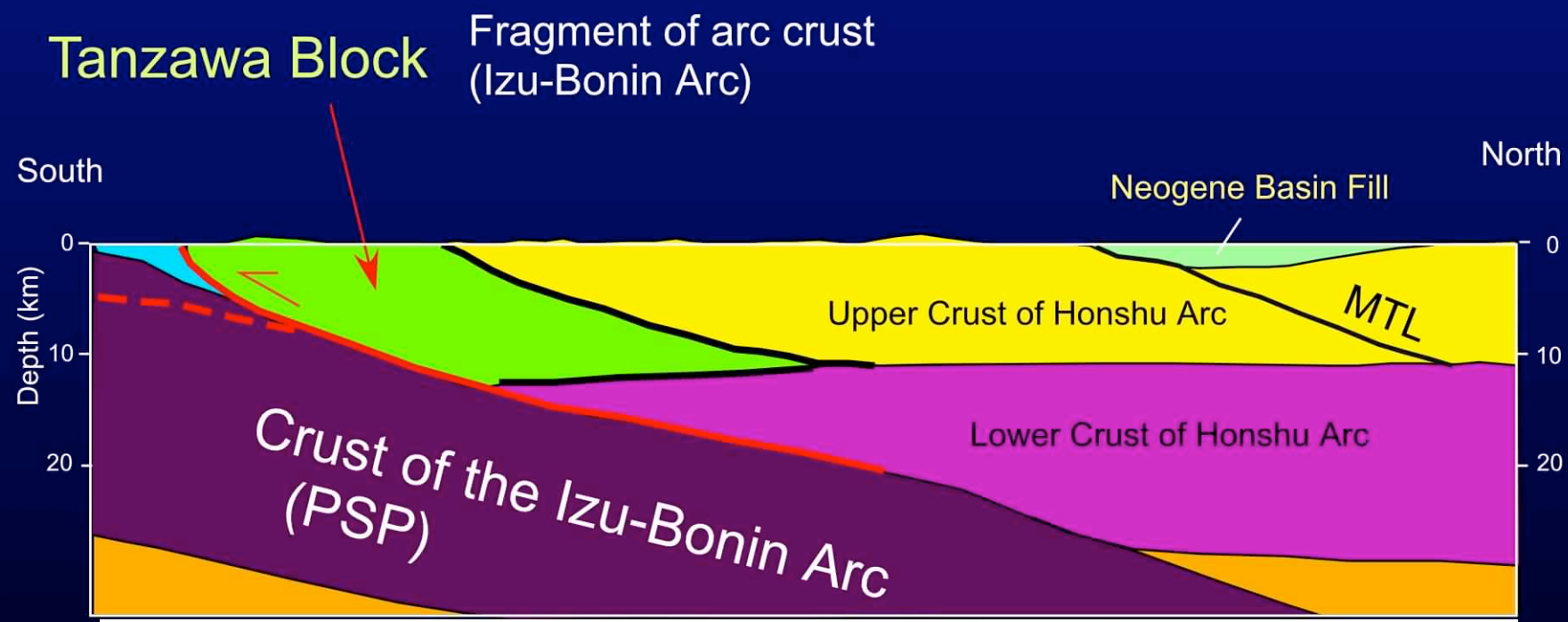


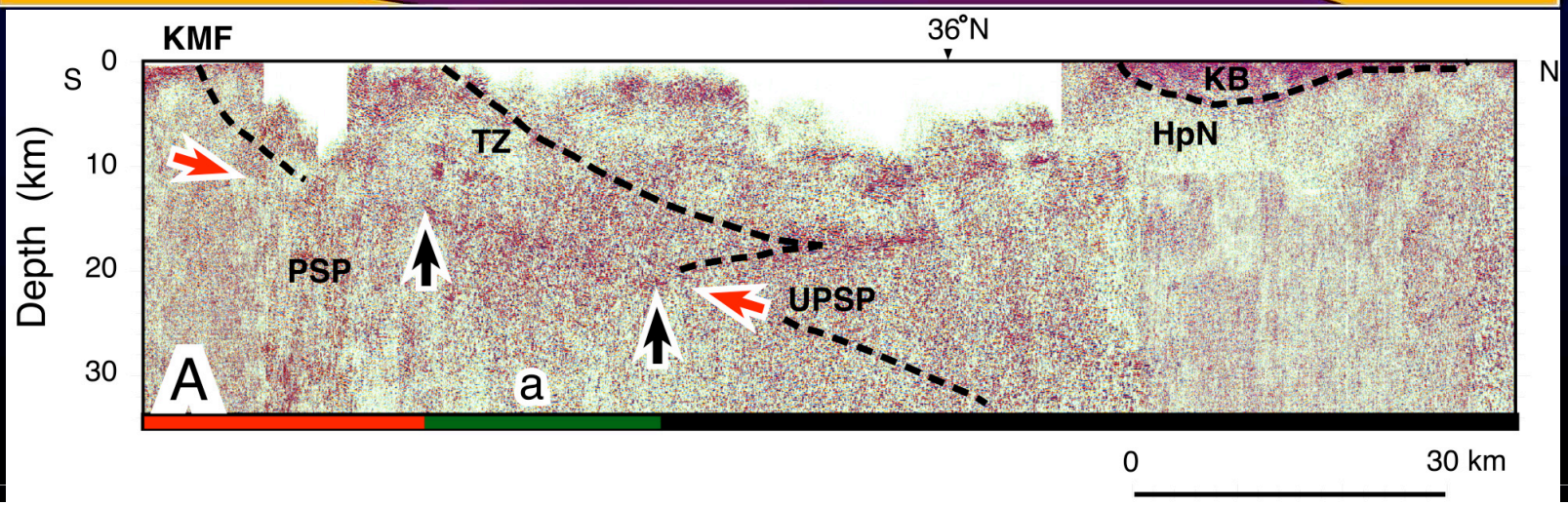


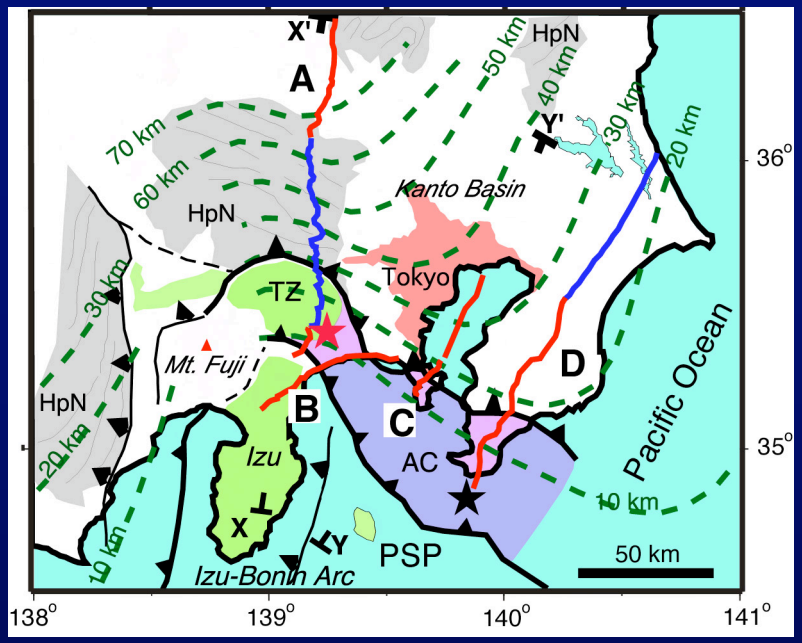




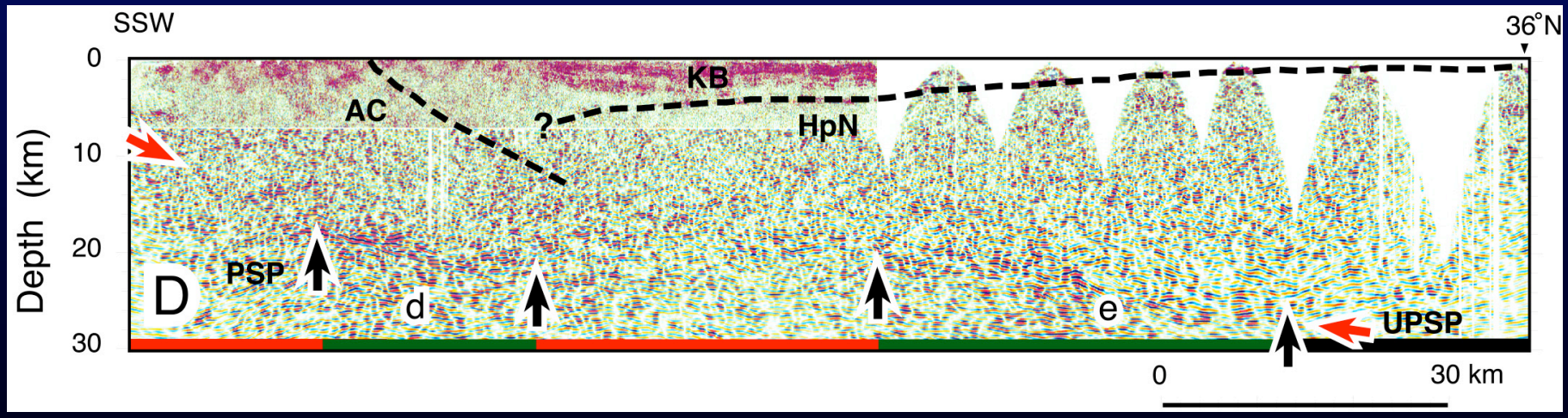
Kanto Mts profile (A)

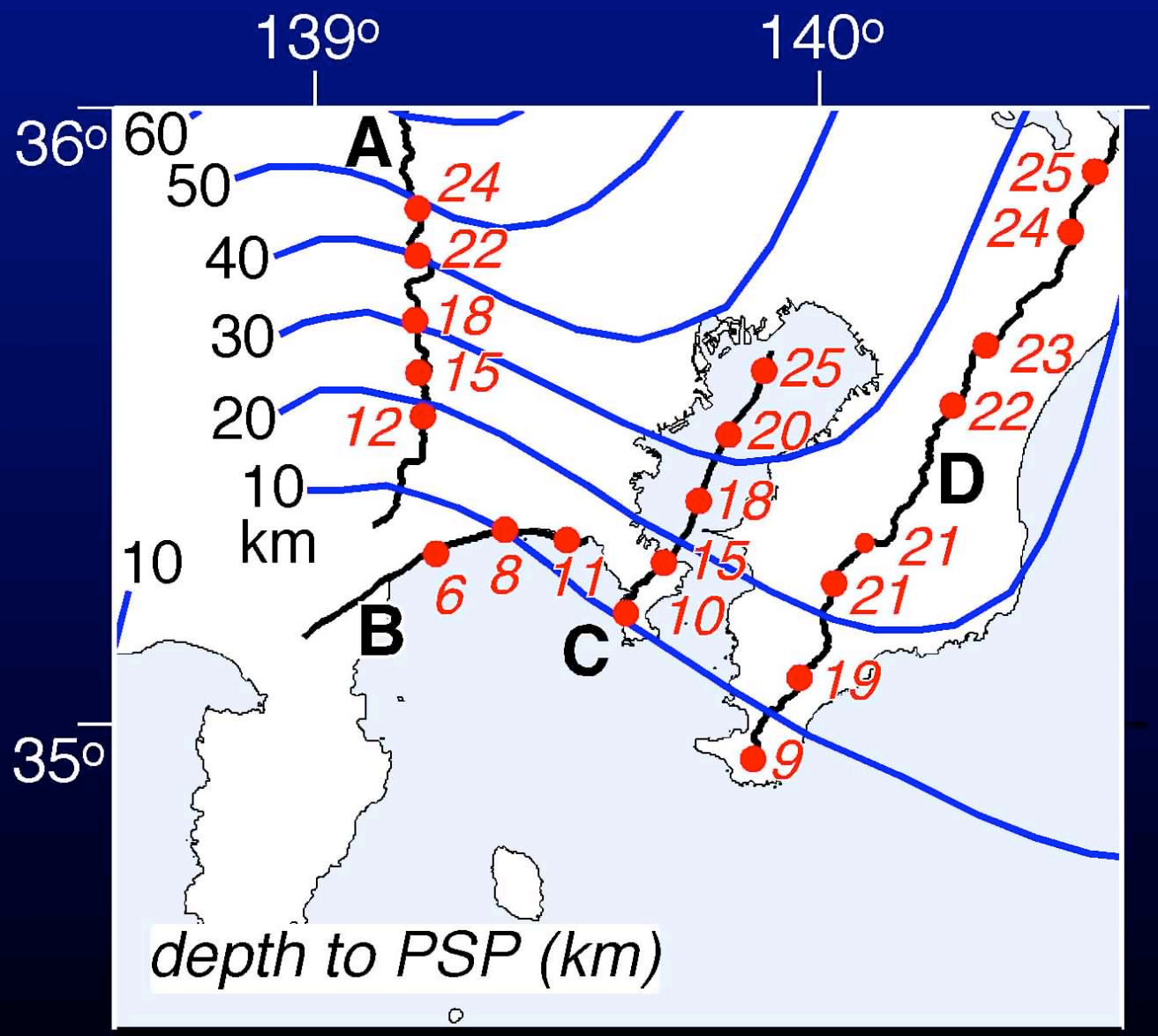






Boso profile (D)





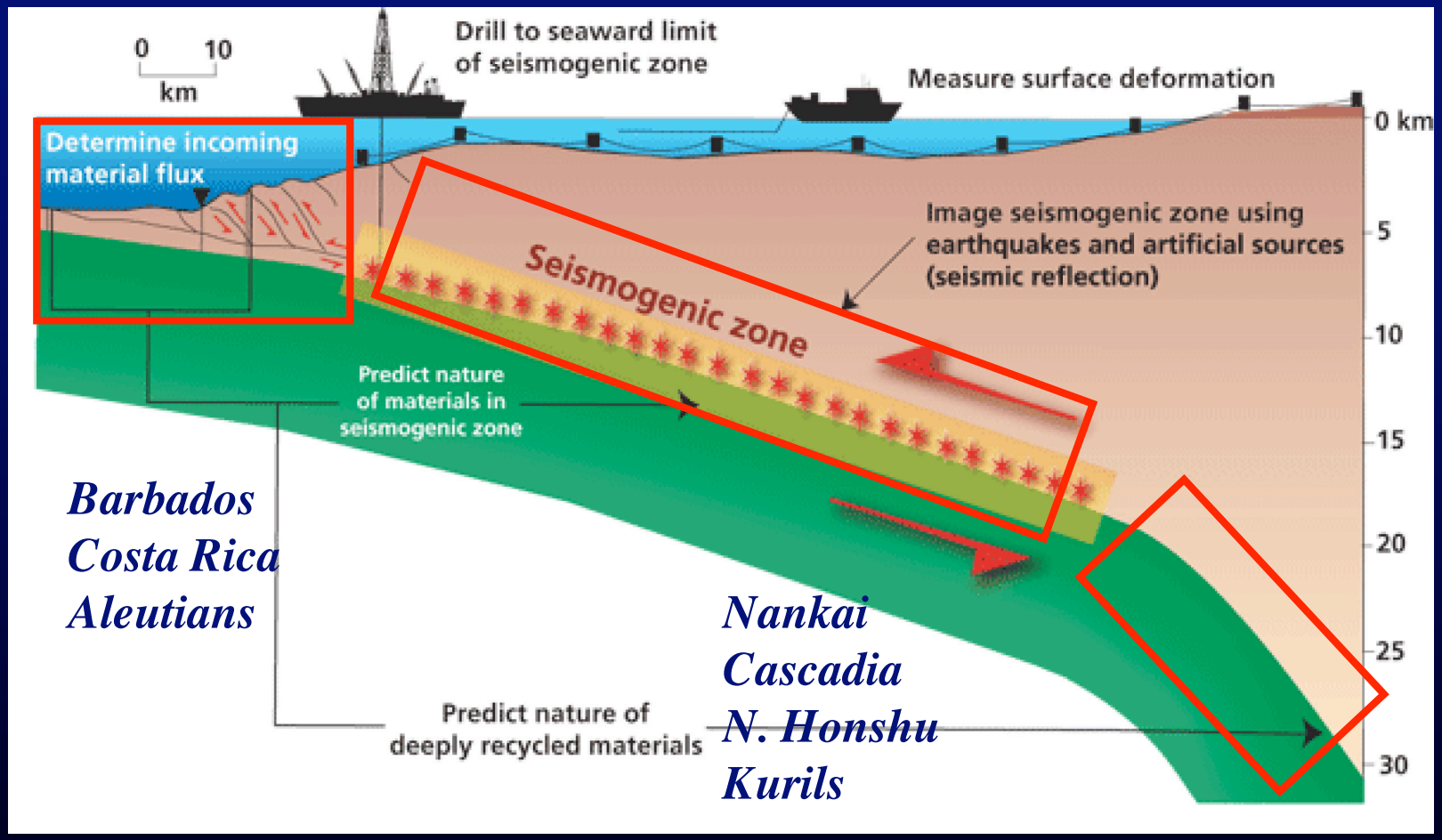
Depth to PSP

Seismicity after Ishida (1992)

Reflection profiling

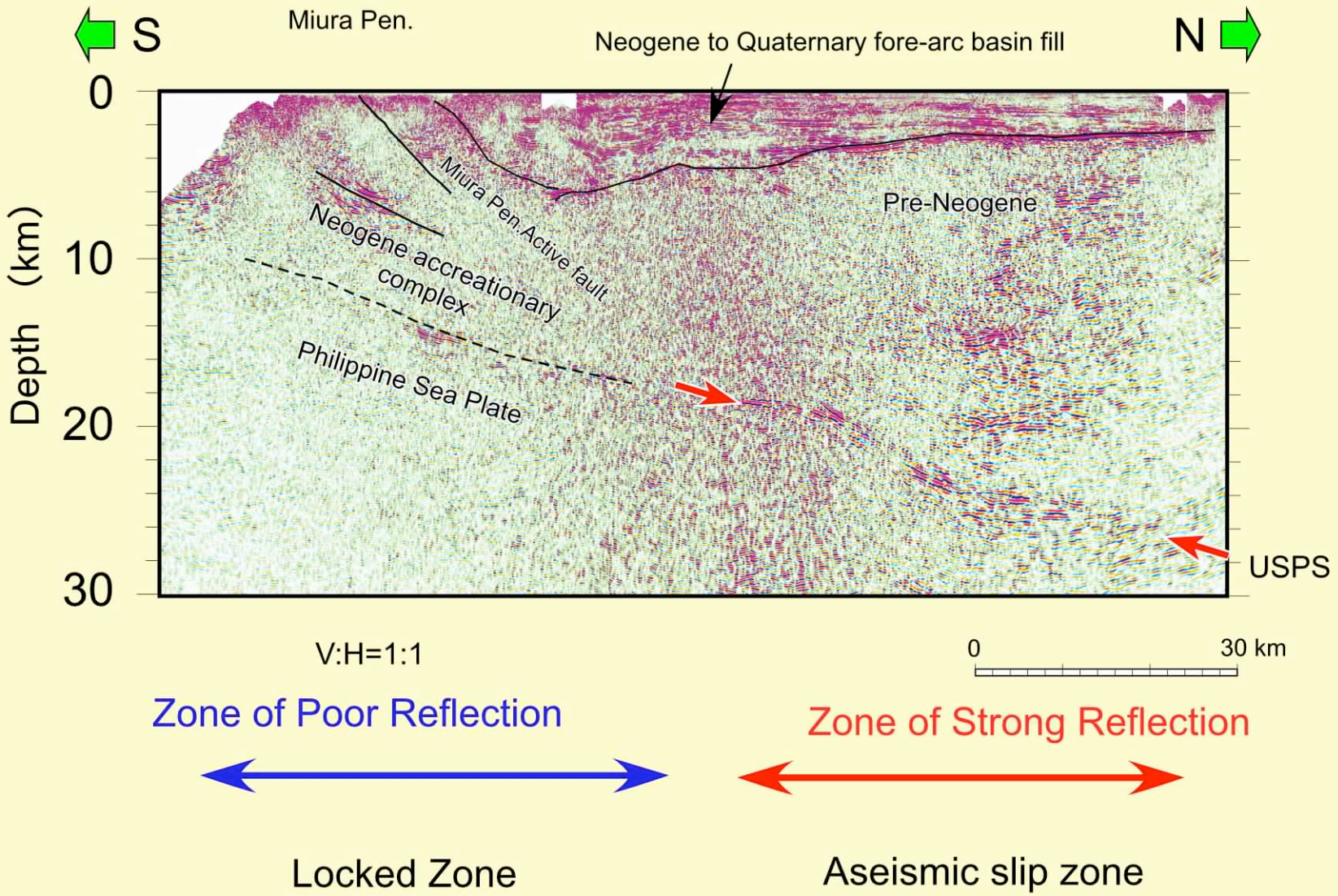
fluid-filled decollement:
not seismogenic;
strong reflection

seismogenic zone:
co-seismic (asperity);
weak or no reflection

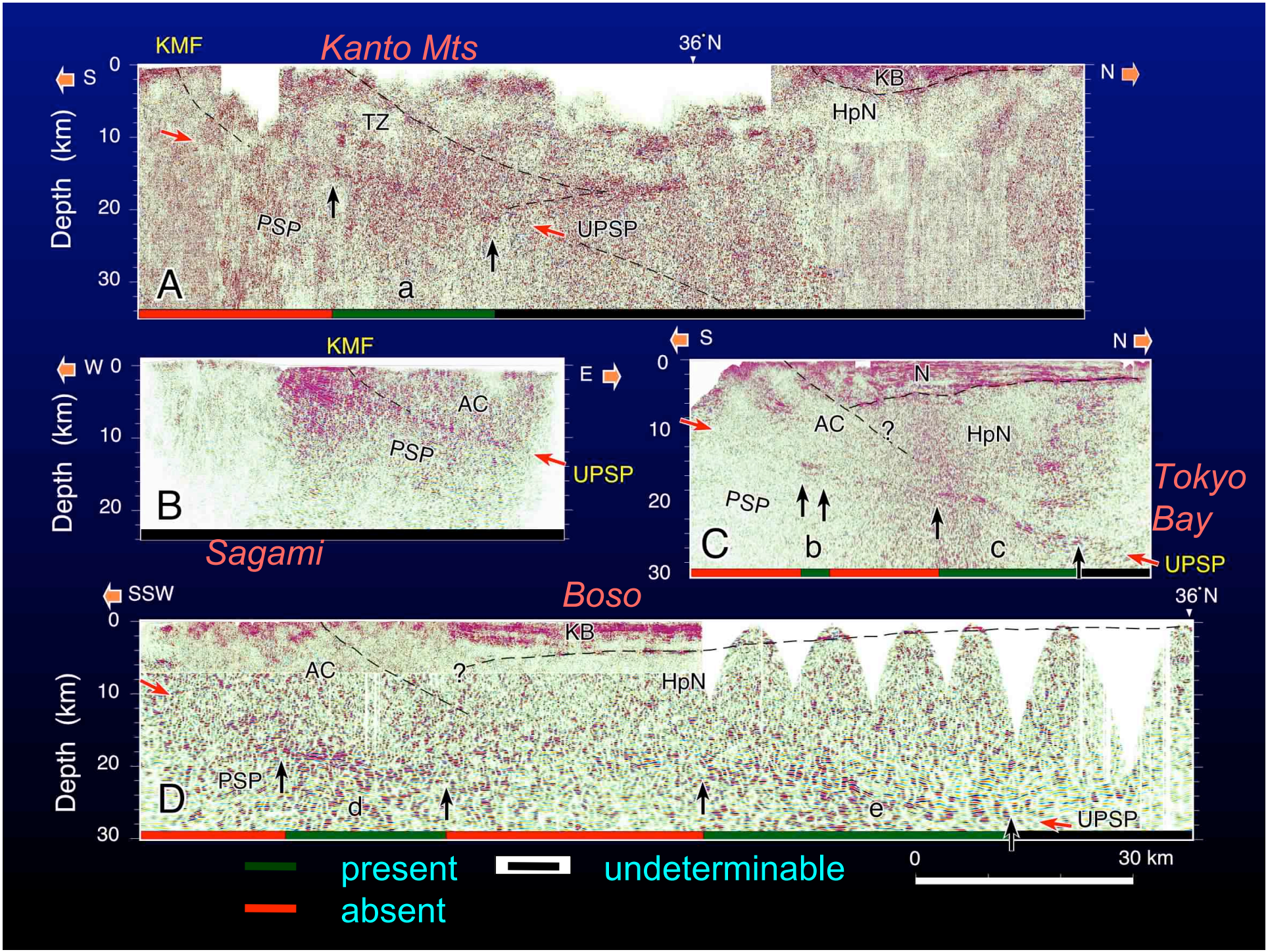


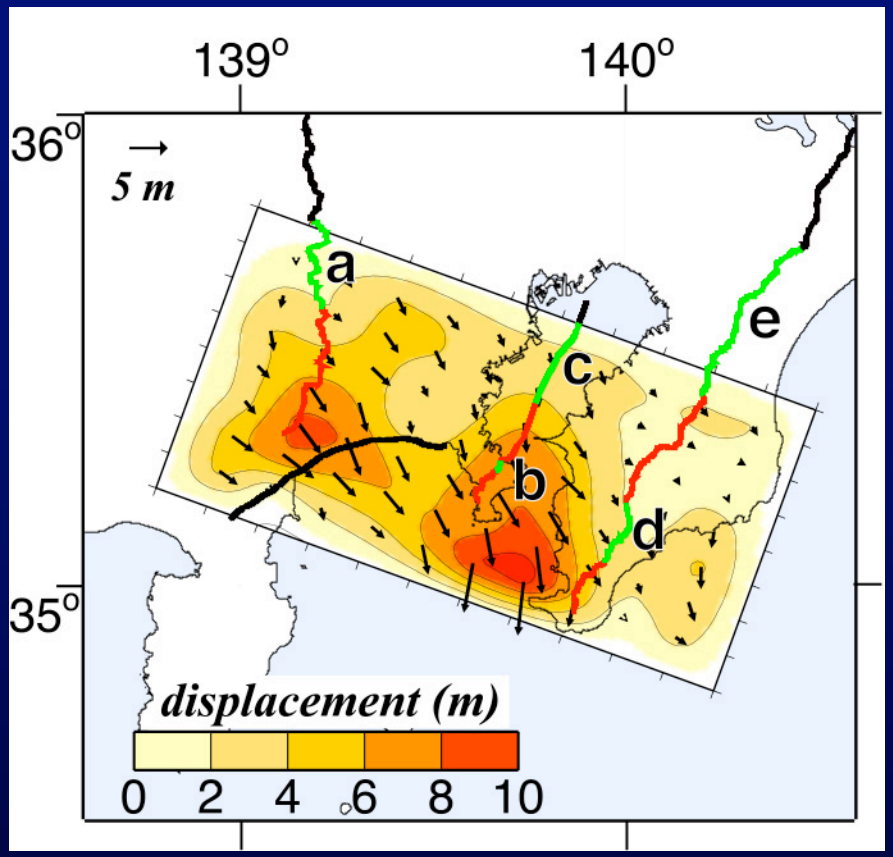
downdip: *less seismic - stable mechanical sliding aided by fluids; moderate to strong reflection*

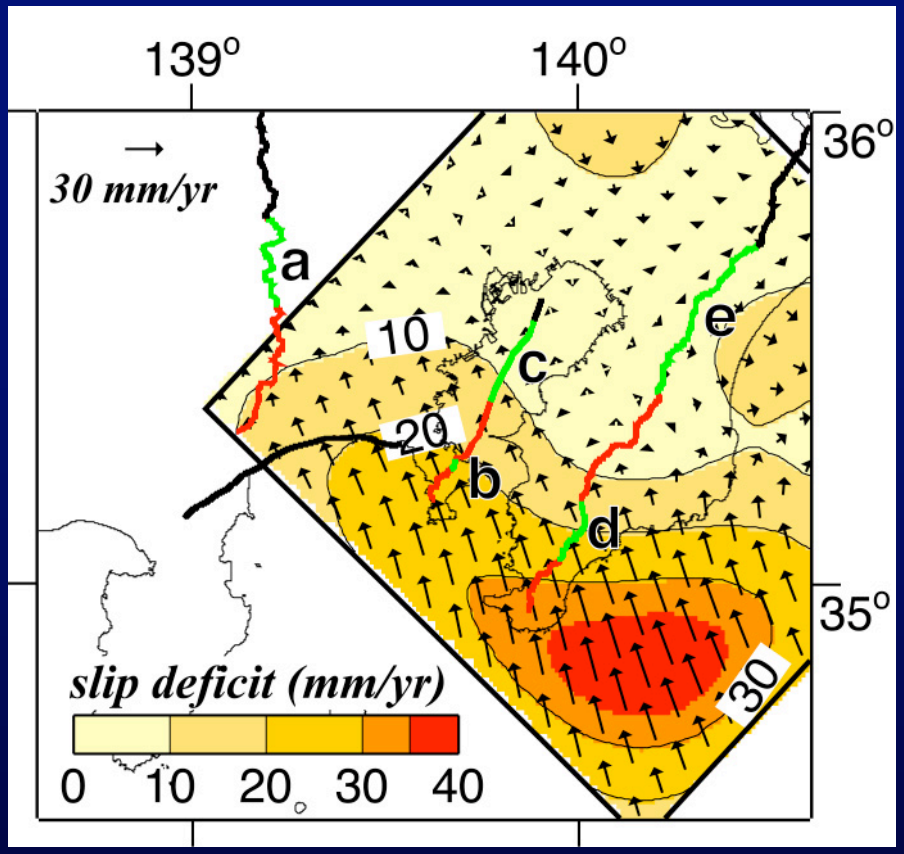
courtesy of MARGINS SEIZE



Tokyo Bay profile (C)


KMF
Kanto Mts
36˚N
S
N
Depth (km)
0
10
20
30
TZ
KB
HpN
PSP
UPSP
A
a
W
E
B
AC
Sagami
C
b
c
Tokyo Bay
SSW
Boso
D
d
e
present
absent
undeterminable
0
30 km





Co-seismic slip of the 1923 Kanto Earthquake

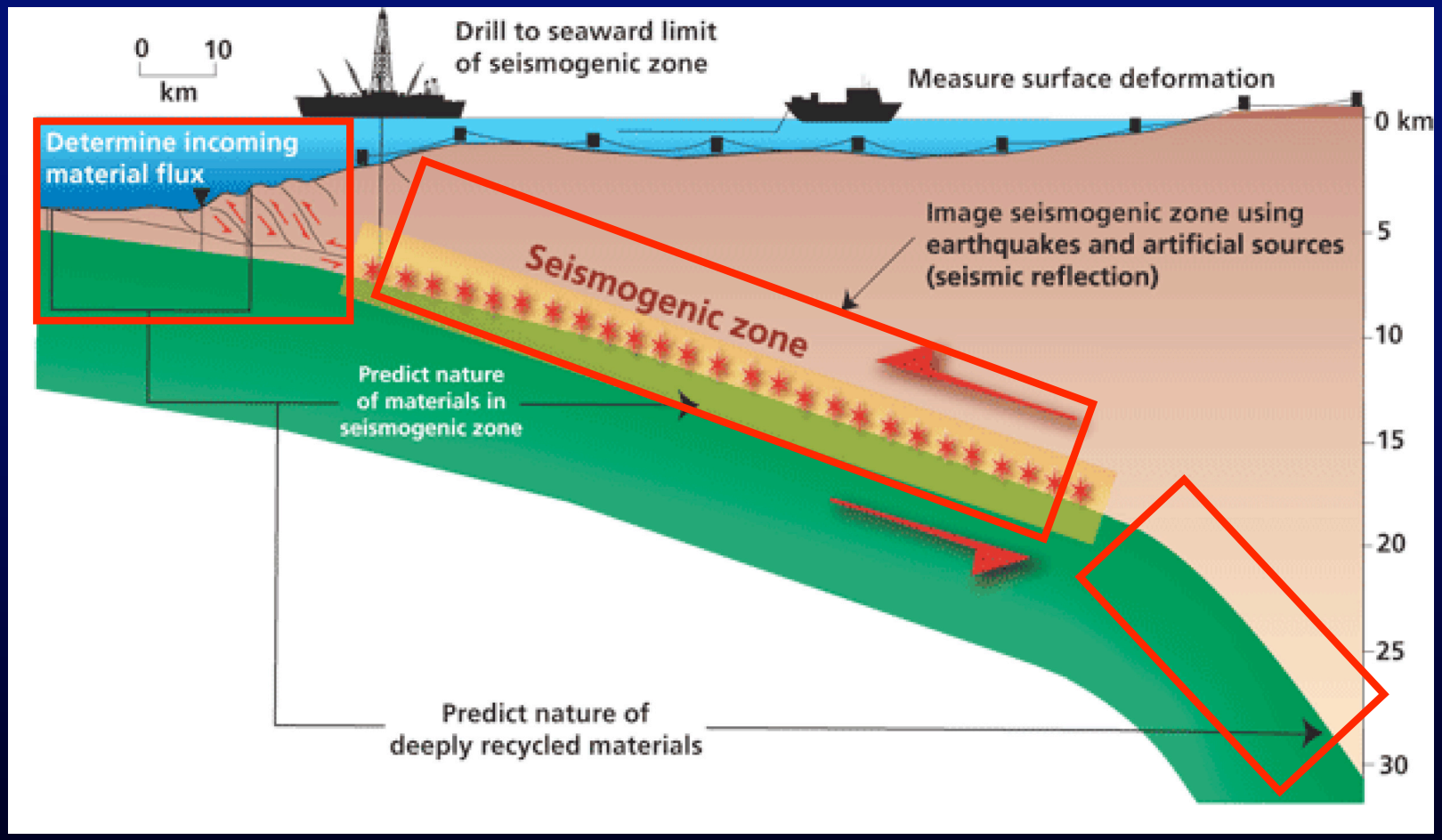
(Kabayashi & Koketsu, 2004; Wald & Somerville, 1995)

Slip deficit deduced from GPS

(Sagiya, 2004)

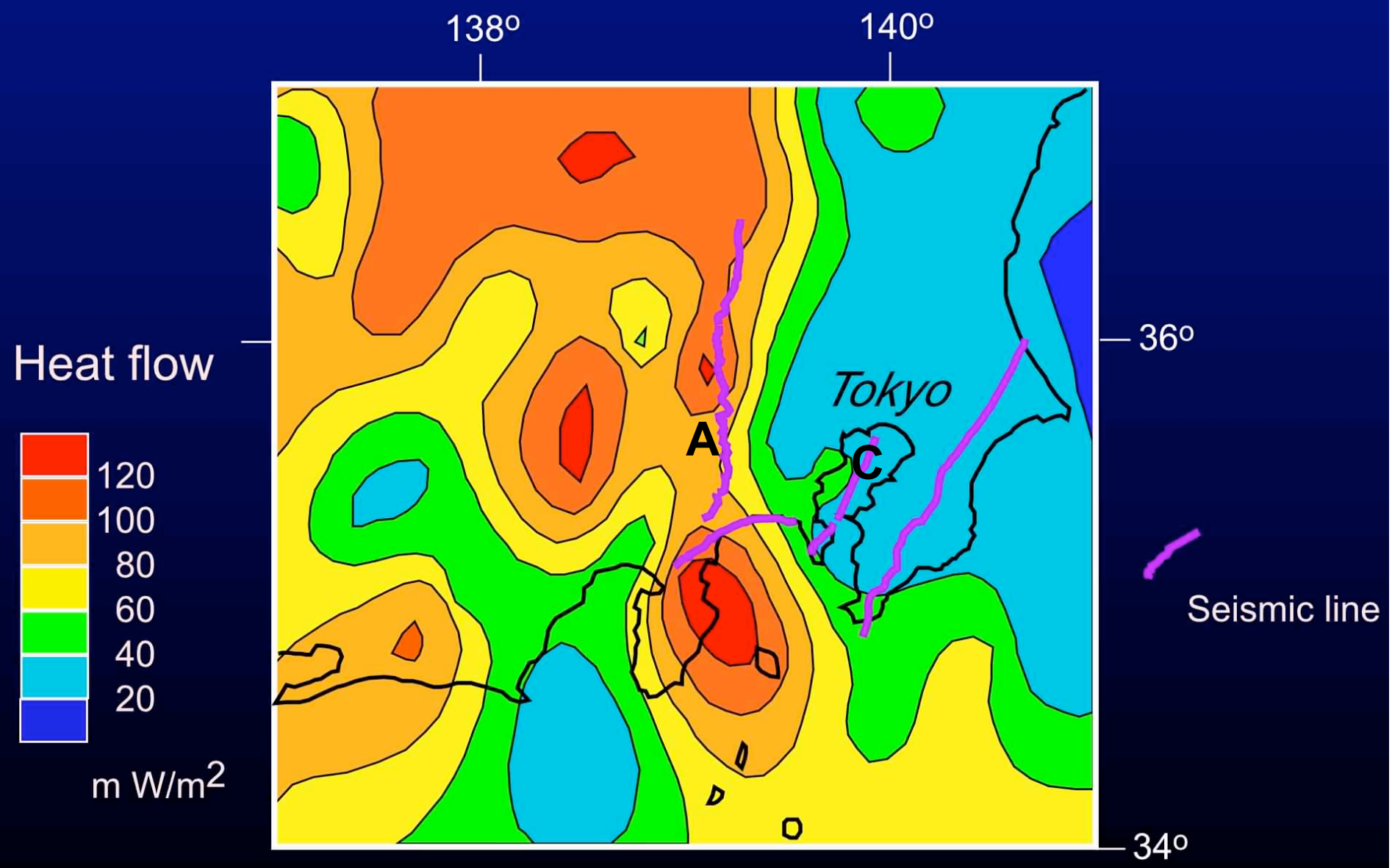
fluid-filled decollement:
not seismogenic; strong reflection

seismogenic zone:
co-seismic (asperity); weak or no reflection

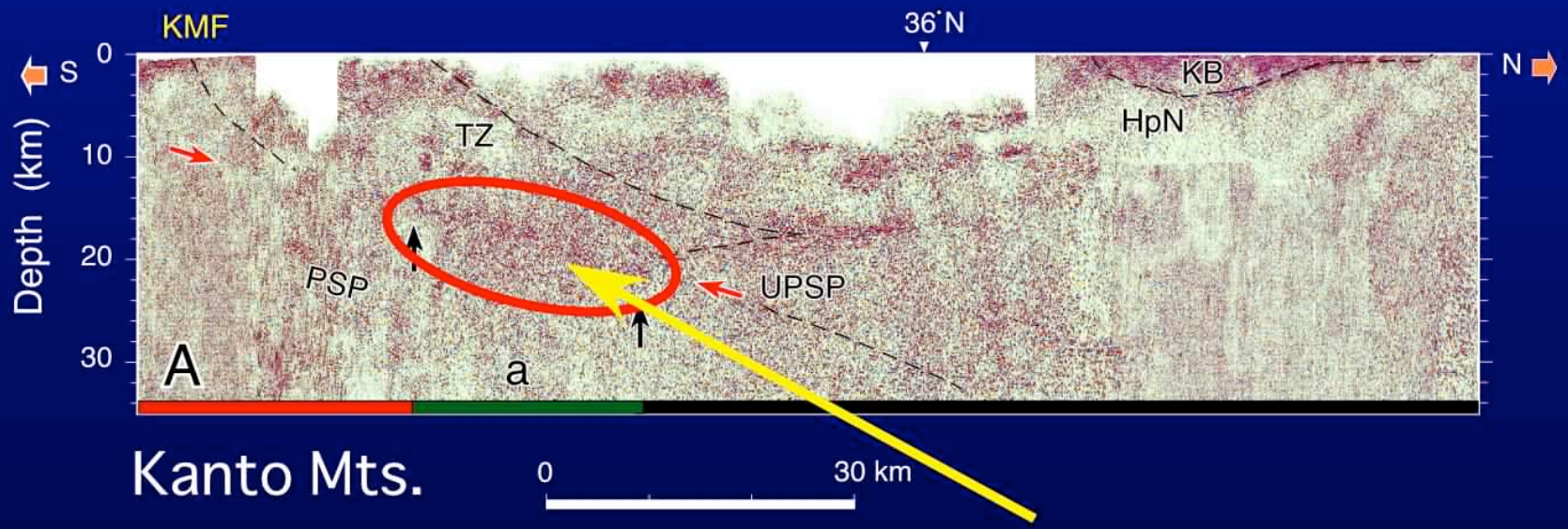


downdip: ***less seismic - stable mechanical sliding aided by fluids; moderate to strong reflection***

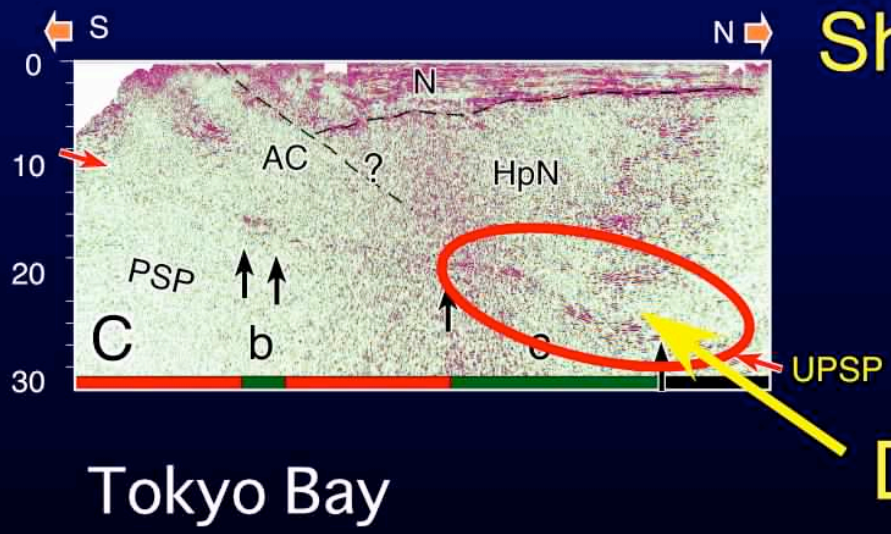
courtesy of MARGINS SEIZE



A generalized heat flow distribution map o central Japan (Lin et al., 1989)



Shallower reflective zone

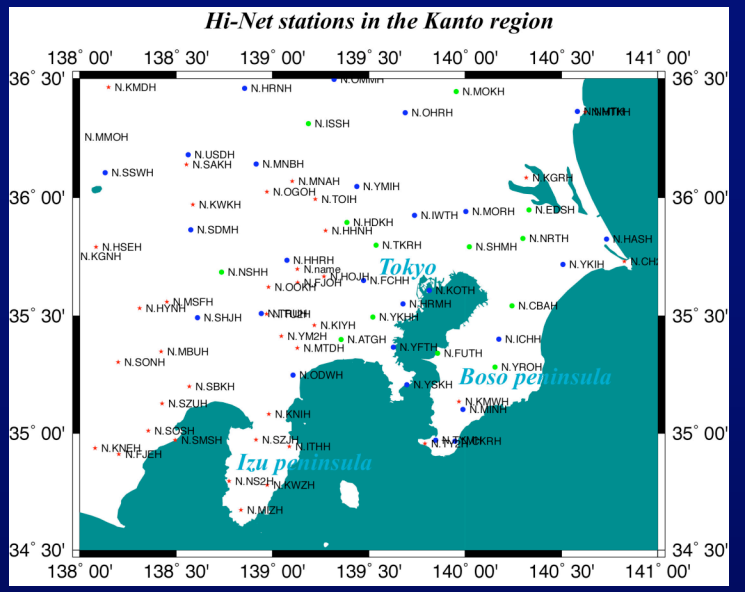


Deeper reflective zone

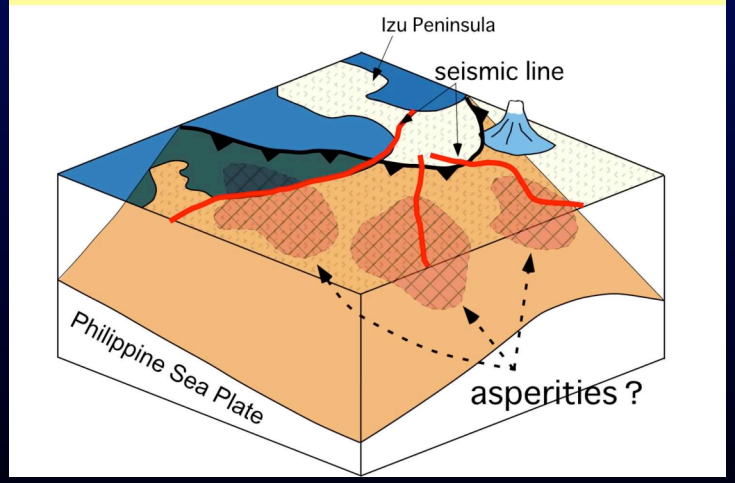
Additional US-Japan Collaboration

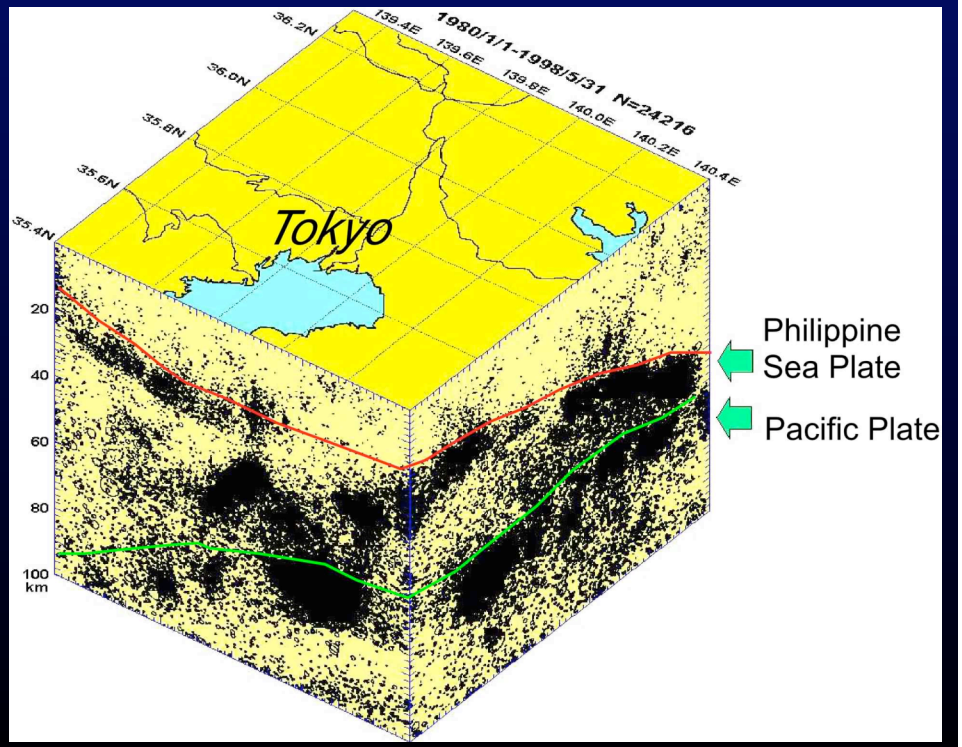
Receiver Function "Piercing Point"
Imaging of top of PSP
(geometry, physical properties)

Jeffrey Park (Yale)
David Okaya (USC)
Naoshi Hirata (ERI)
Toshihiro Igarashi (ERI)

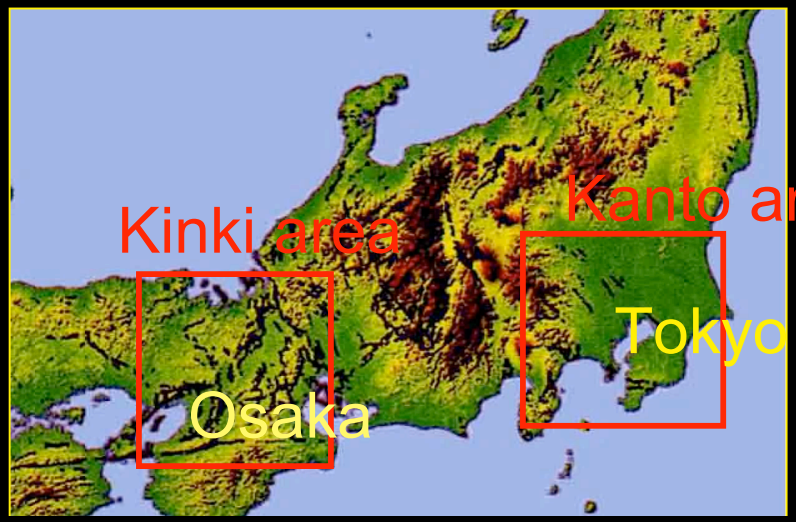


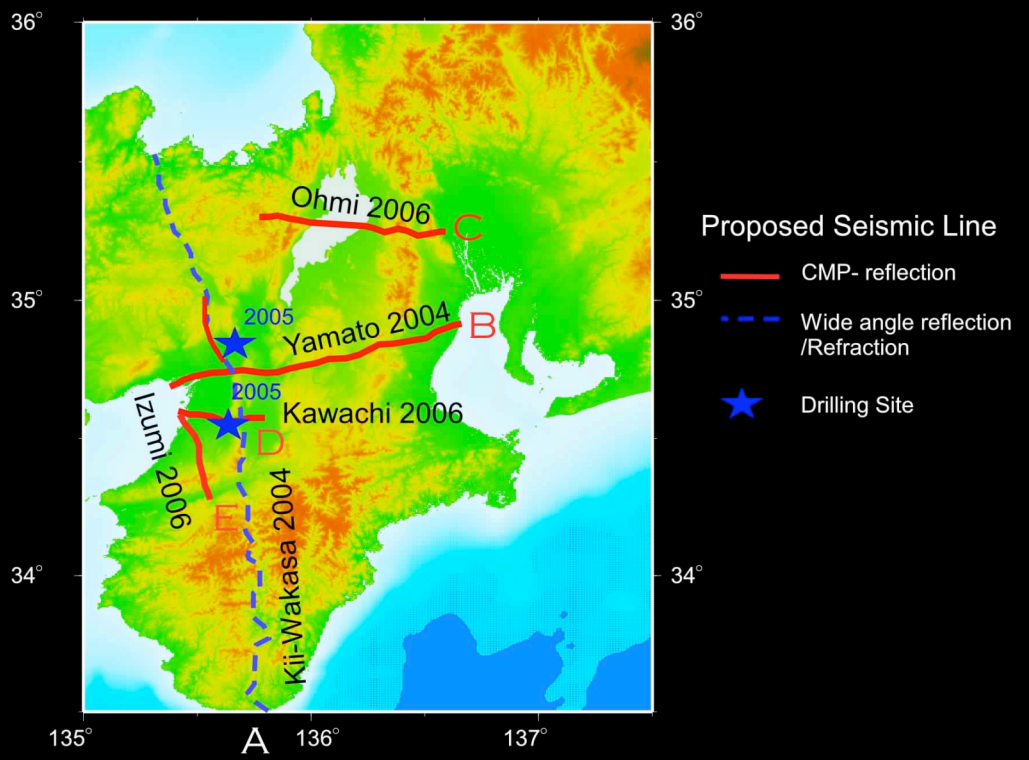
Imaging of upper surface of the Philippine Sea Plate by controlled source

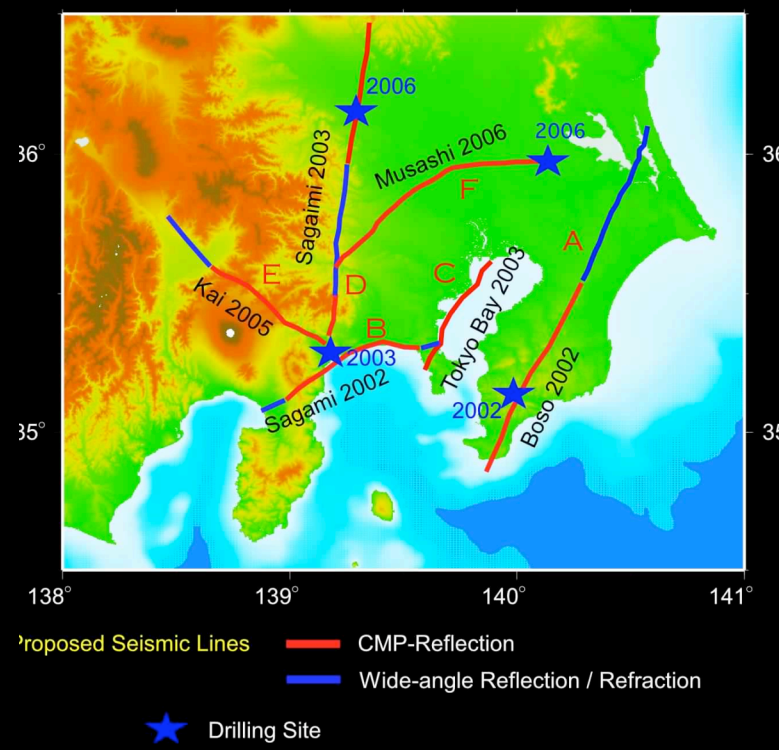




Upcoming Profiling Efforts (2004-2006)







SUMMARY

- Seismic profiling works in the Kanto urban environment.
- PSP geometry shallower than in results of previous studies.
- Reflectivity on the subduction mega-thrust is weaker in the asperity zone and stronger around it.
- Asperity / non-asperity zones respond to regional heat flow.
- PSP imaging aids understanding of megathrust source faults.