Lithospheric velocity structure, seismic source characteristics in Kuwait

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Iris Metadata Workshop, Kuwait 2013

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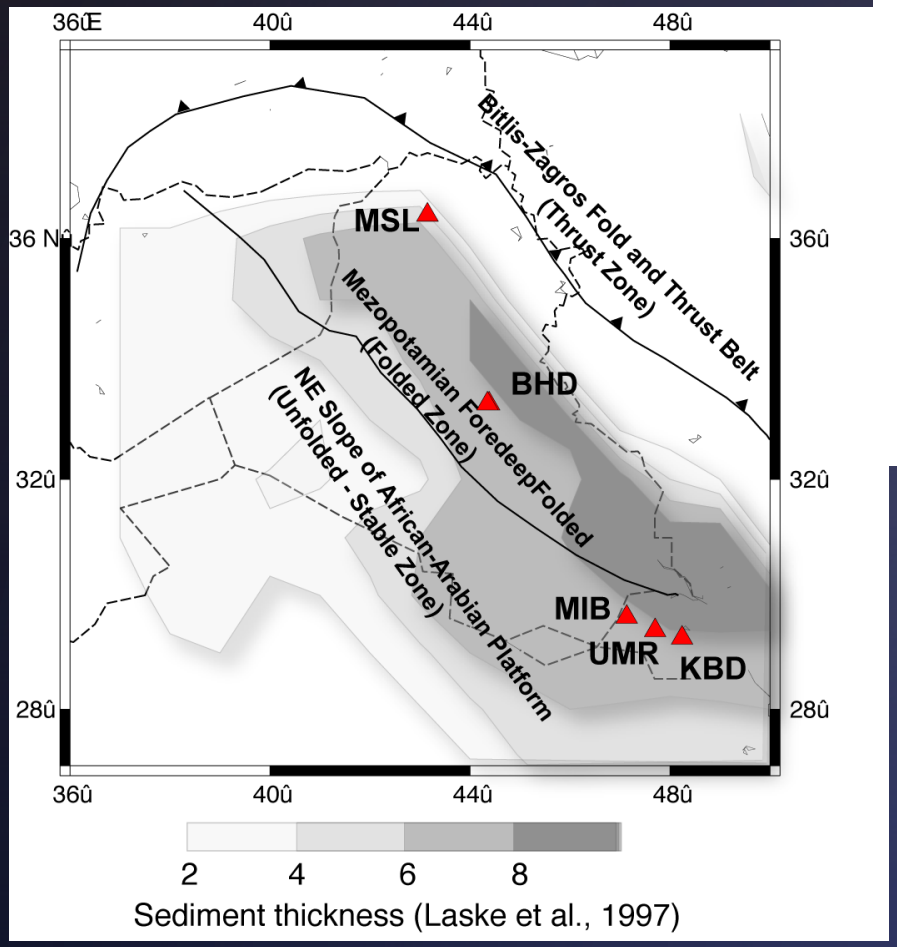
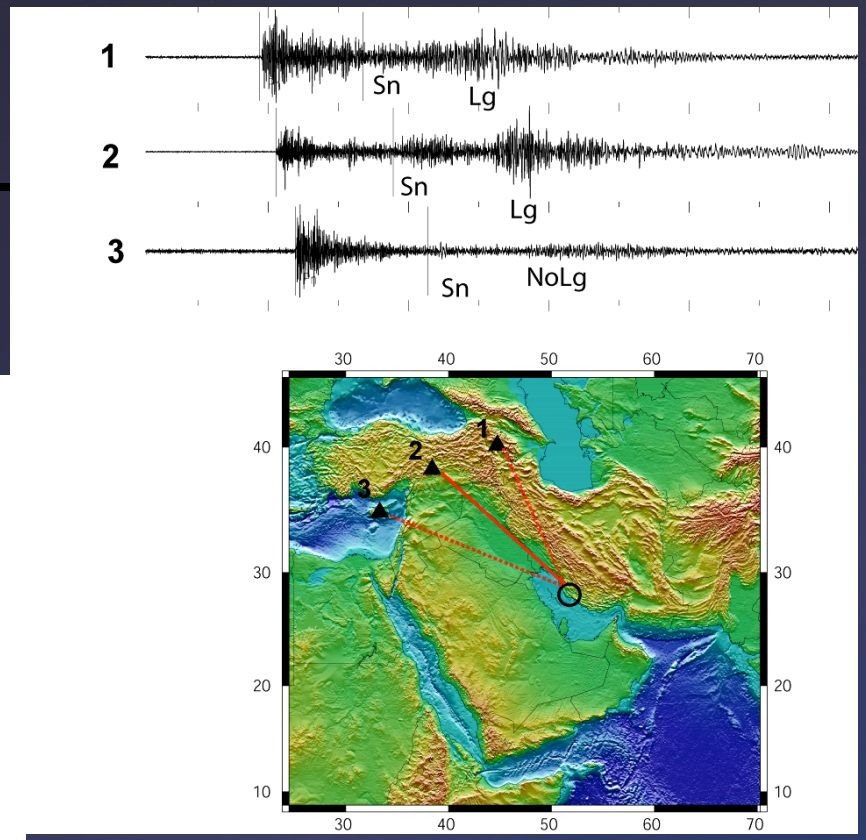
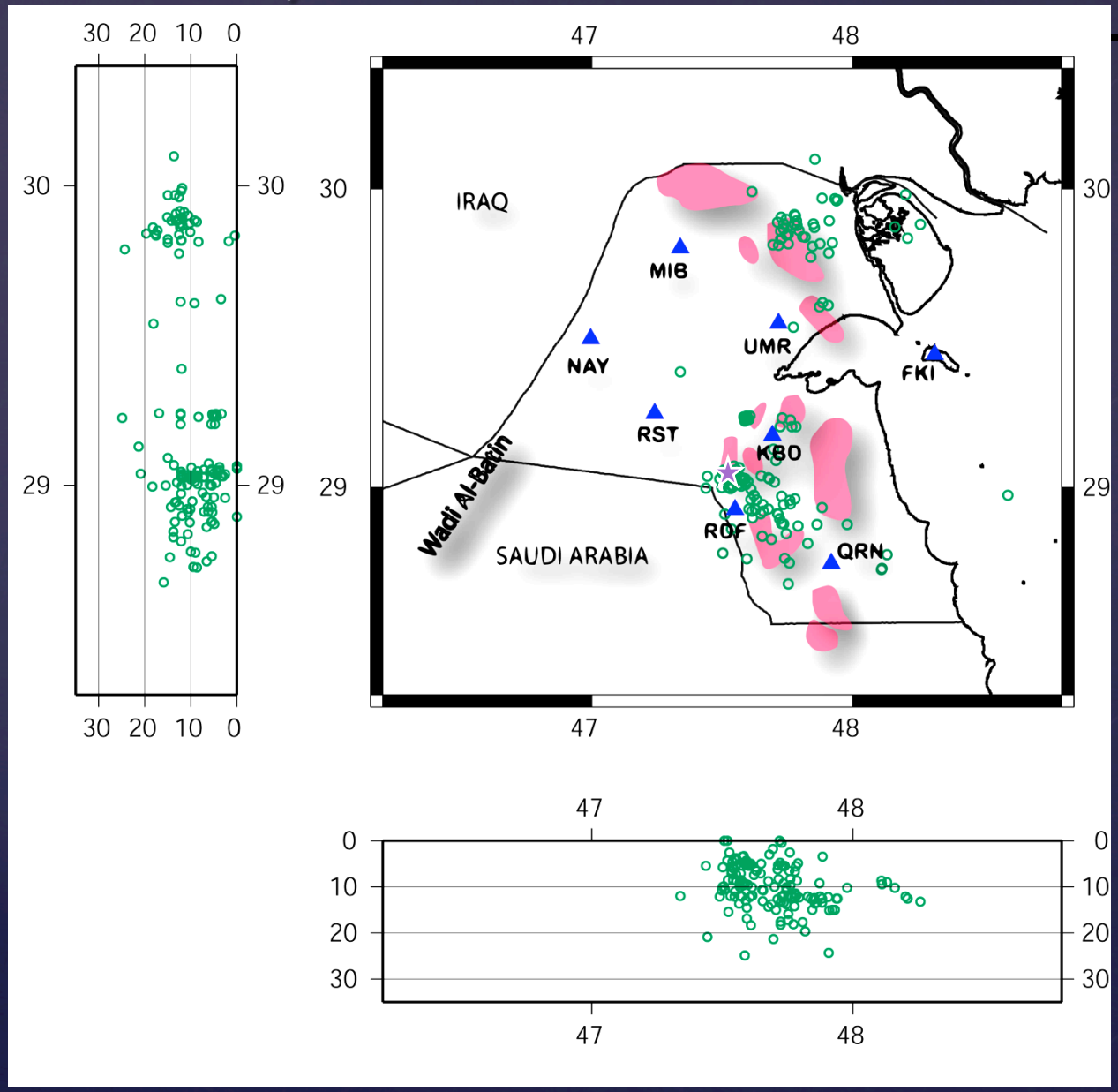
Tectonic setting and wave propagation





Oil Fields & Seismicity

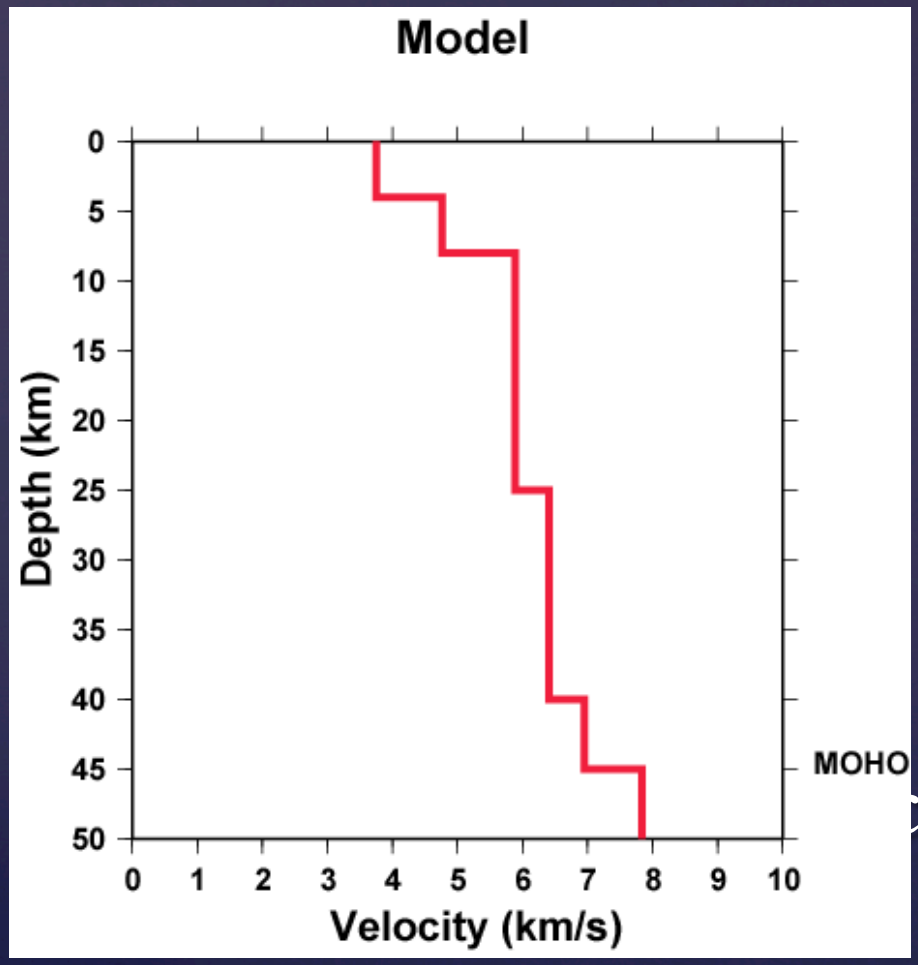
Seismicity



KISR operates a seismic network that consists of 8. All stations are digitized using 24-bit digitizers at 100 SPS.

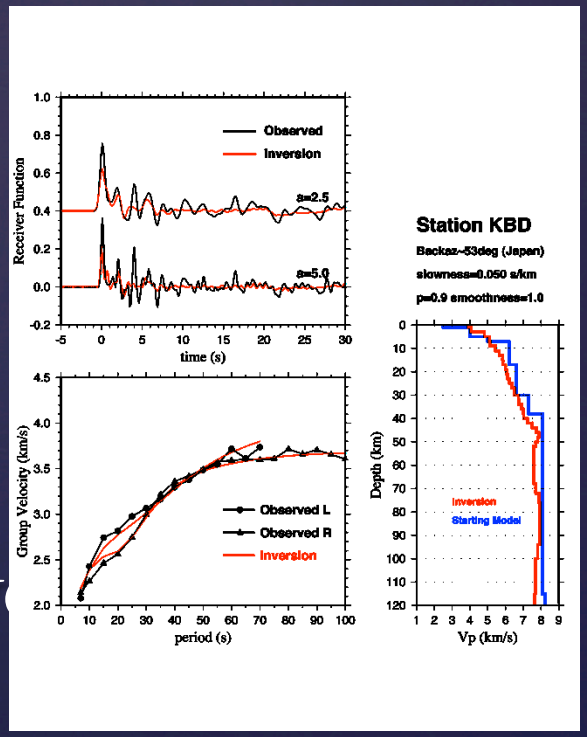
The continuous operation started on July, 1998 and data is telemetered back to KISR and 145 locatable events were recorded.

The seismicity appears to be concentrated on some of the smaller oil fields.



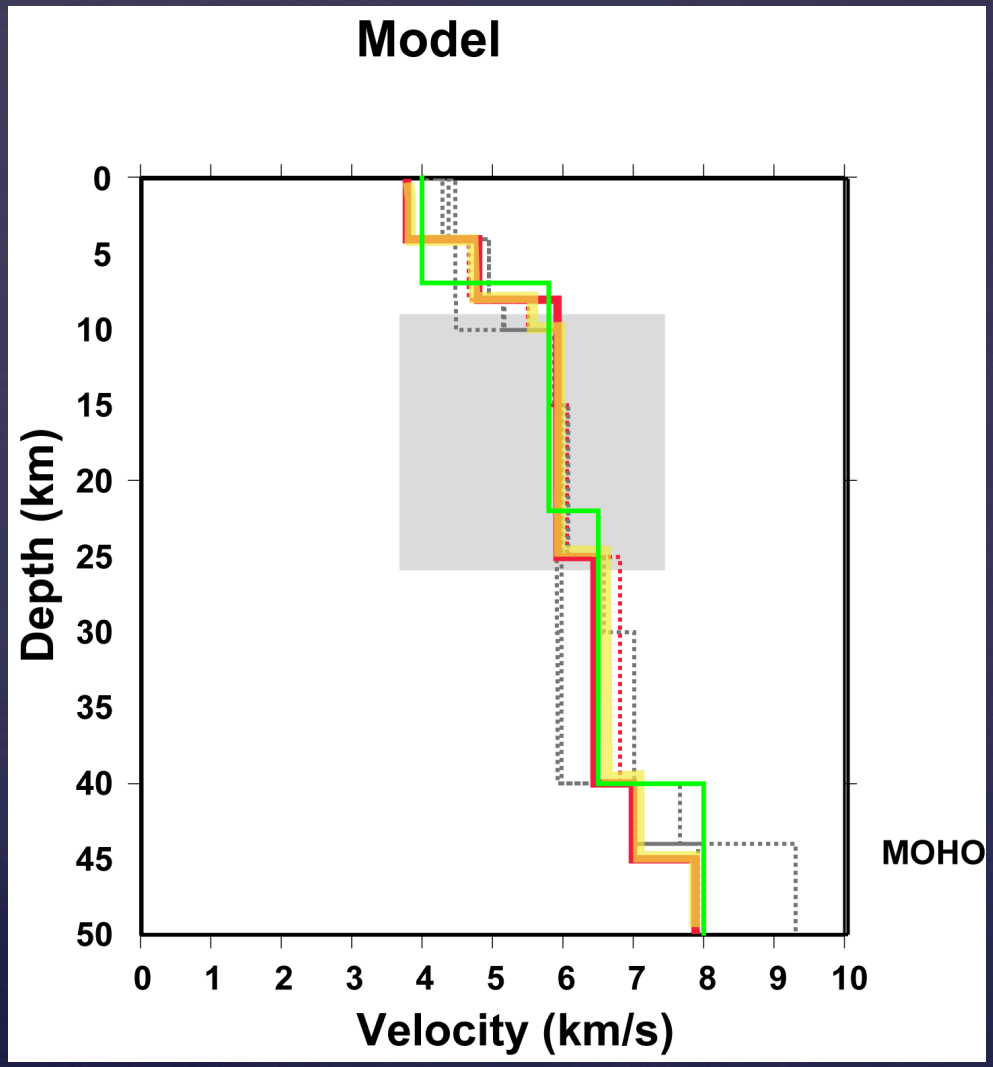
Crustal thickness = 45 km

Sedimentary thickness = 8 km



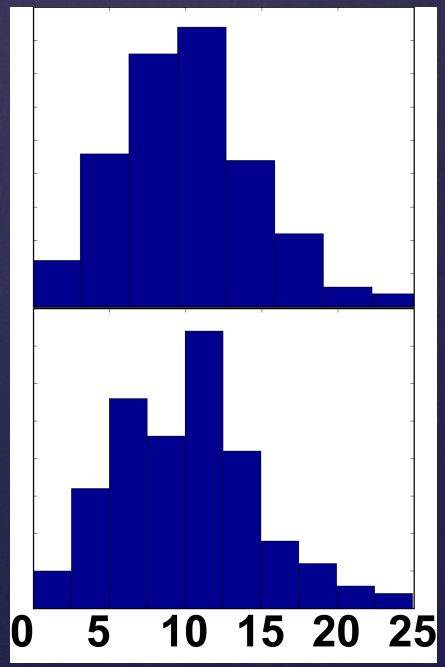
Pasyanos et al., 2005

Reference 1-D model from local travel times



VELEST jointly inverts for locations and 1-D velocity model ~ 80% variance reduction for the RMS residuals.

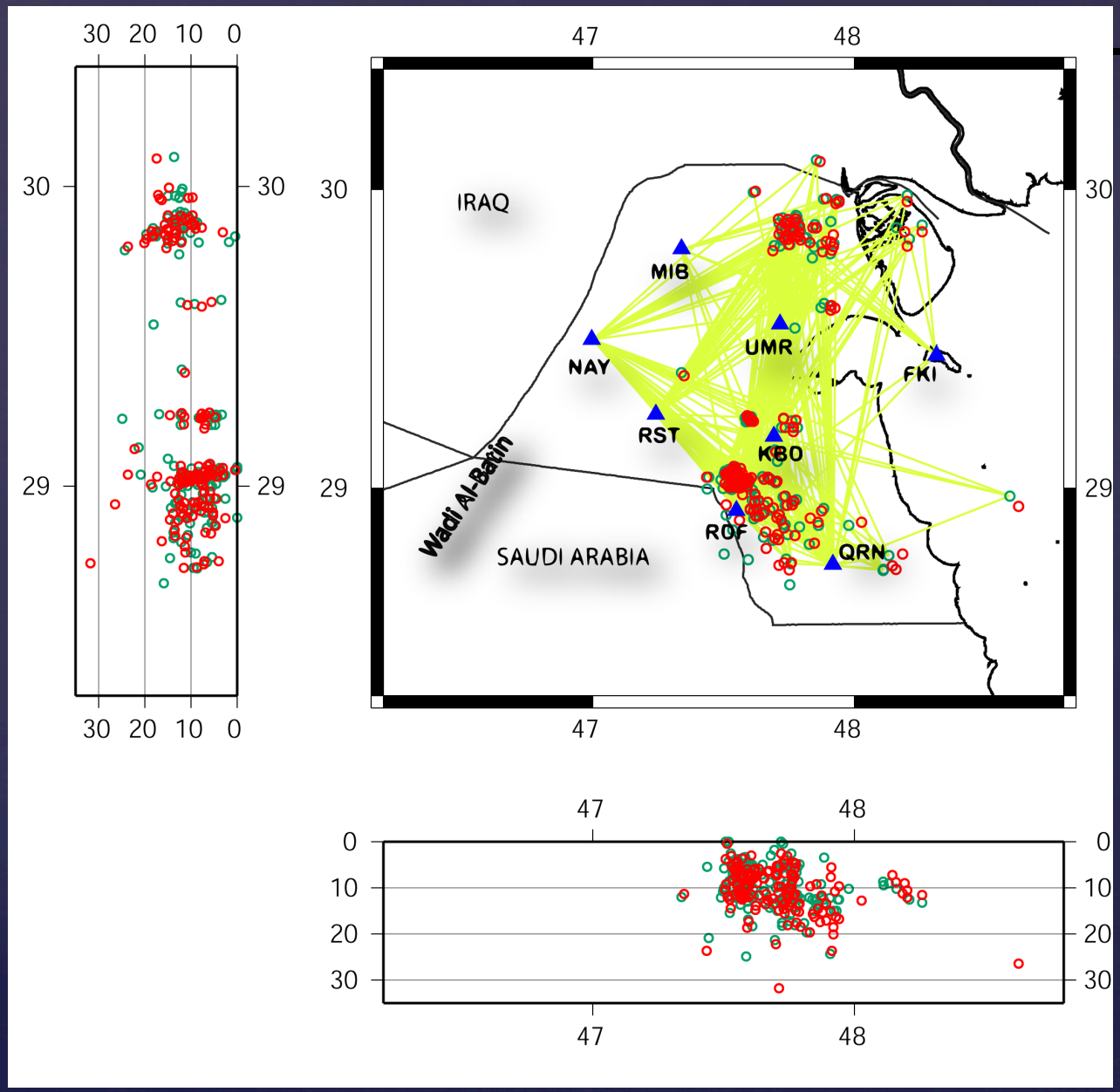
Hypocentral depth distribution



relocated

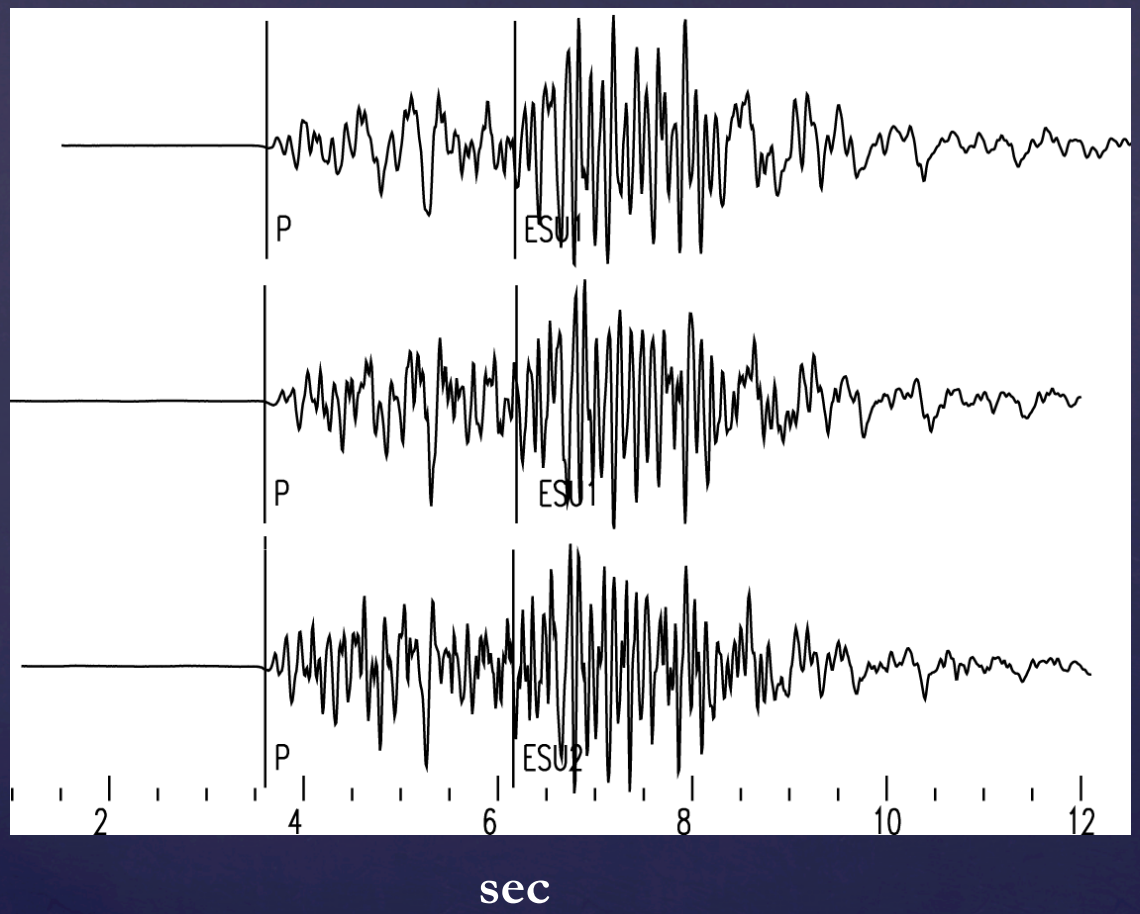
initial

Relocations



We do not observe a major shift of hypocenters inside the network. The maximum shift is 17km in horizontal direction

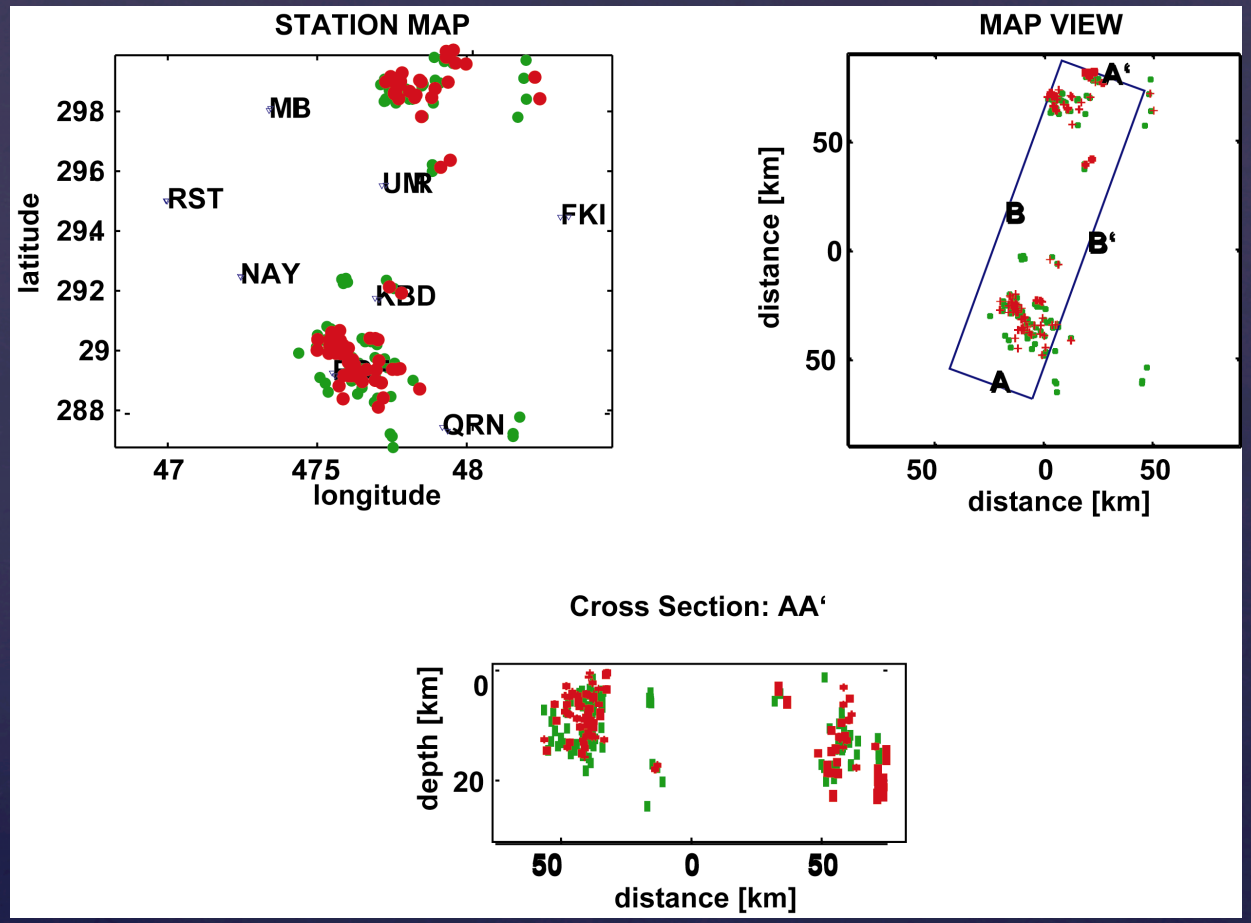
Clustering



Single station (RDF-closest to the clustered events) has a few number of highly correlated events.

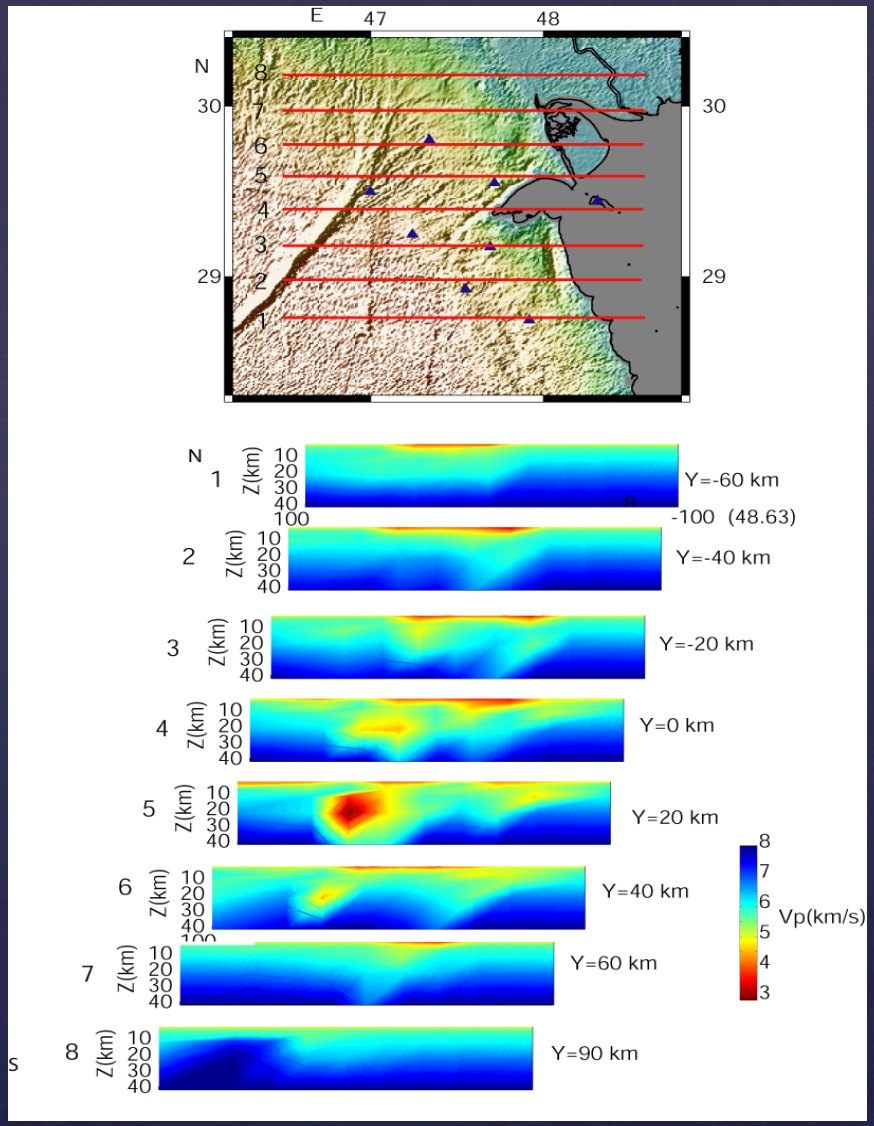
The number of events in the cluster are too few to make any correlation adjustments for the travel-time picks.

HYPODD relocations

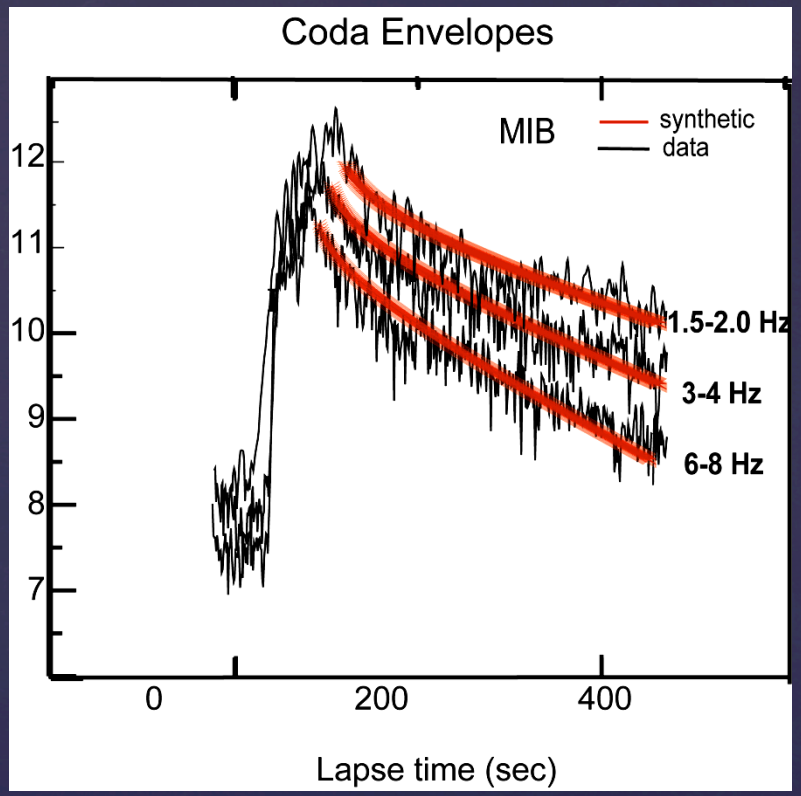


~1500 absolute P and S arrival times and ~3200 P and S wave arrival time differences

Preliminary TomoDD results



Source properties from coda amplitudes

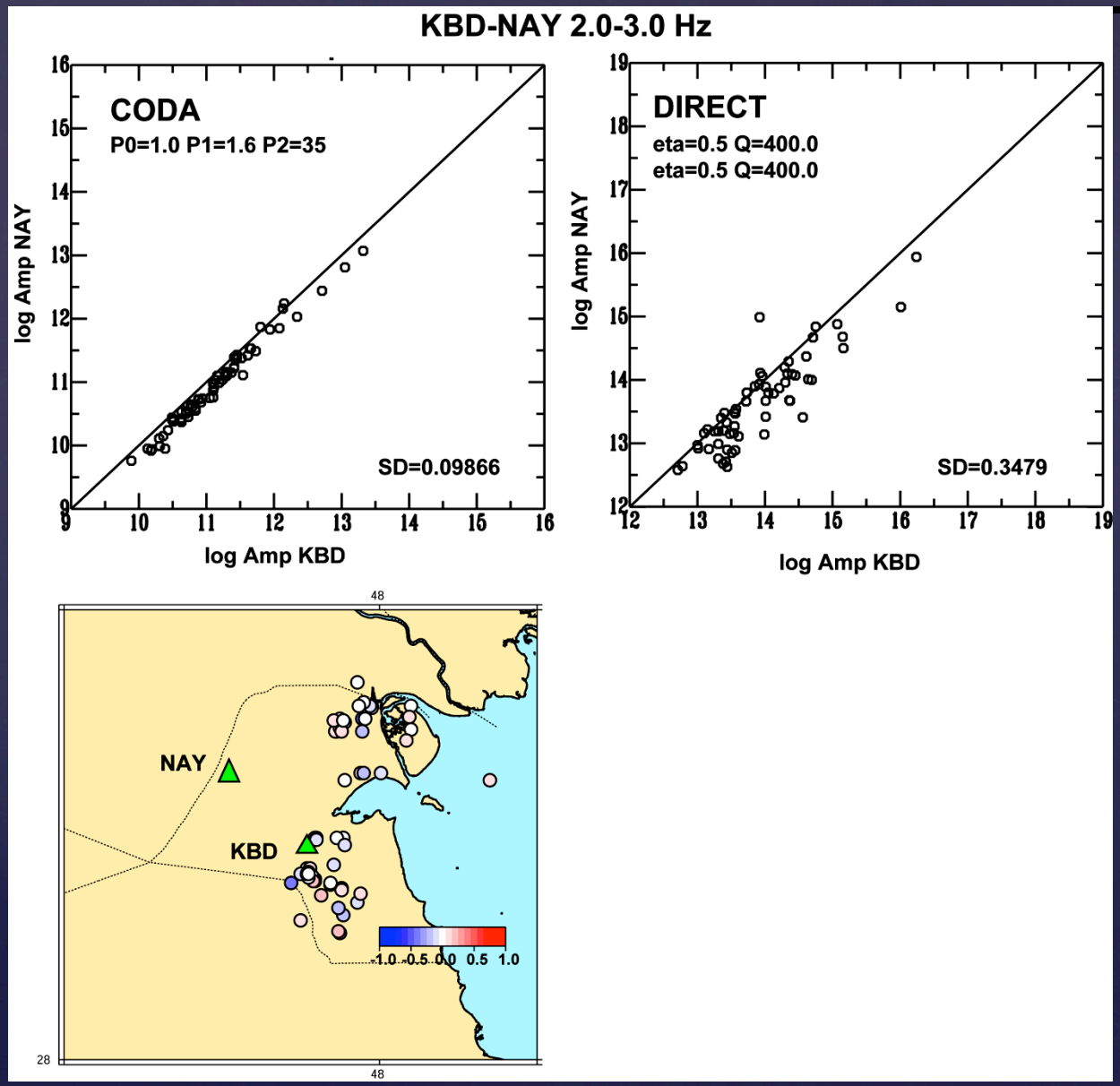


Narrow-band coda envelopes are formed from two horizontal components using the Hilbert Transform.

$$\log[\, A(f,t\backslash r) \,.\, t^{\gamma(r)} \,] = \log Ao - b(r) \,.t.\, \log(e)$$

γ and b are calculated by grid-search

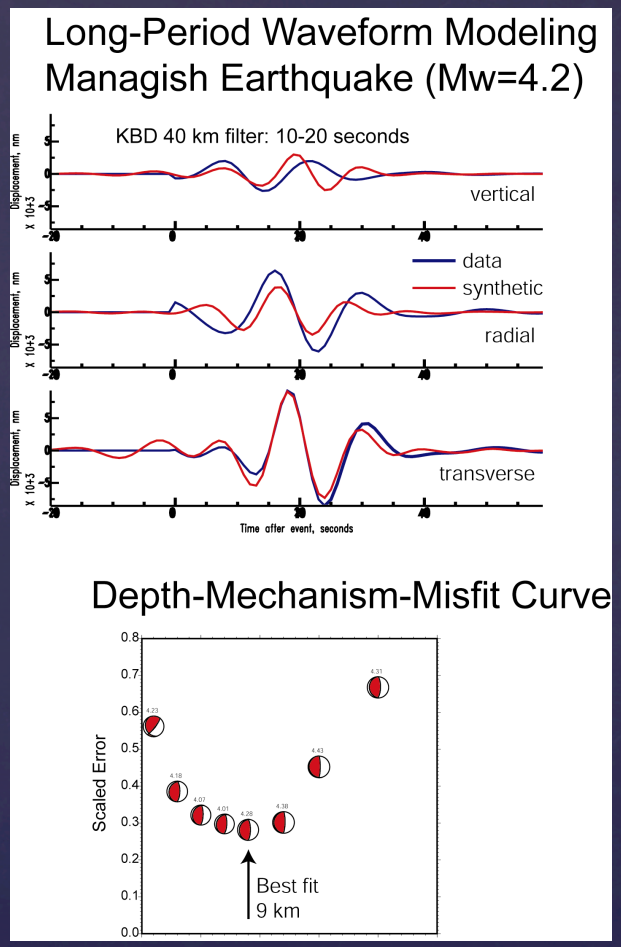
1-D path corrections for coda/direct waves



Inter-station variation for direct waves are about 3.5 times larger than coda waves.

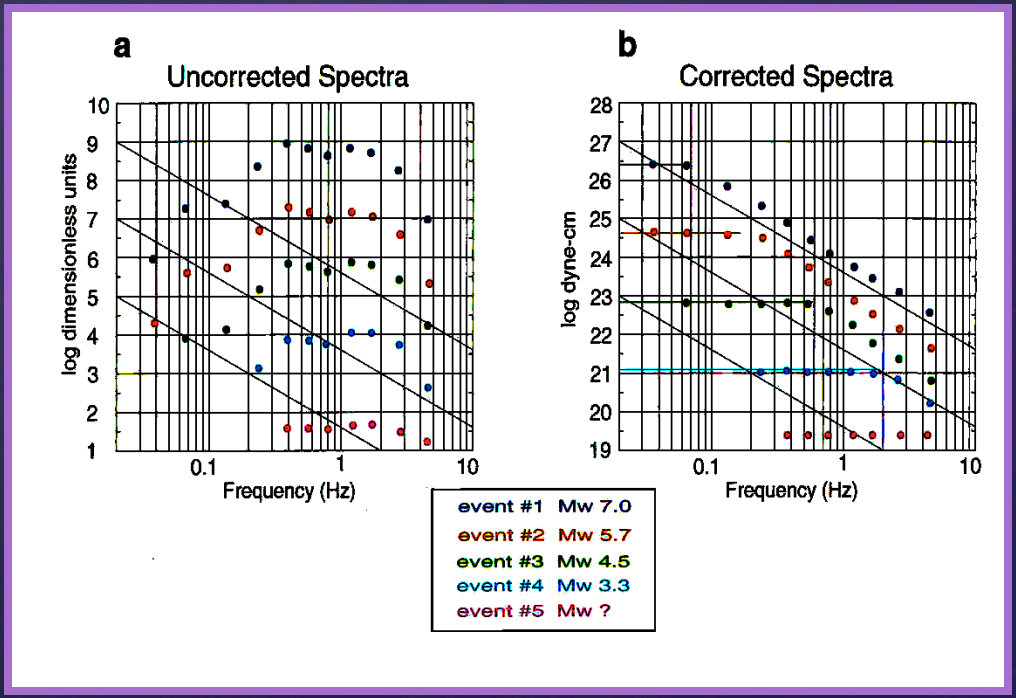
Based on the spatial residuals, a 1-D model for coda is perfectly adequate.

S to coda transfer corrections



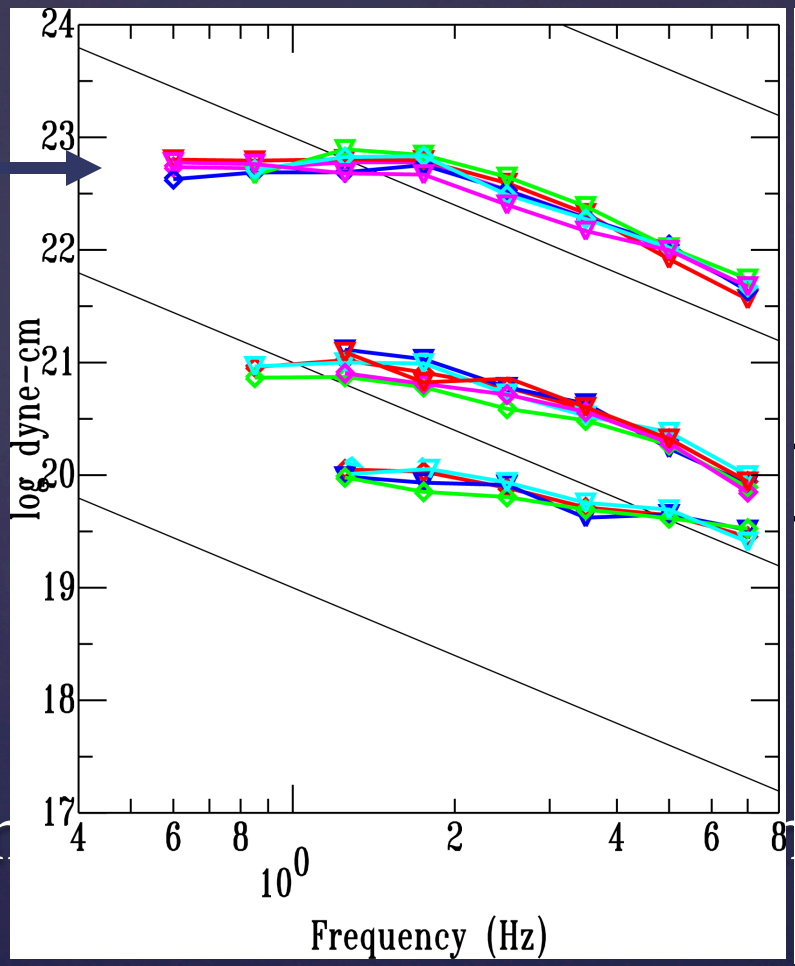
Rodgers et al., 2004

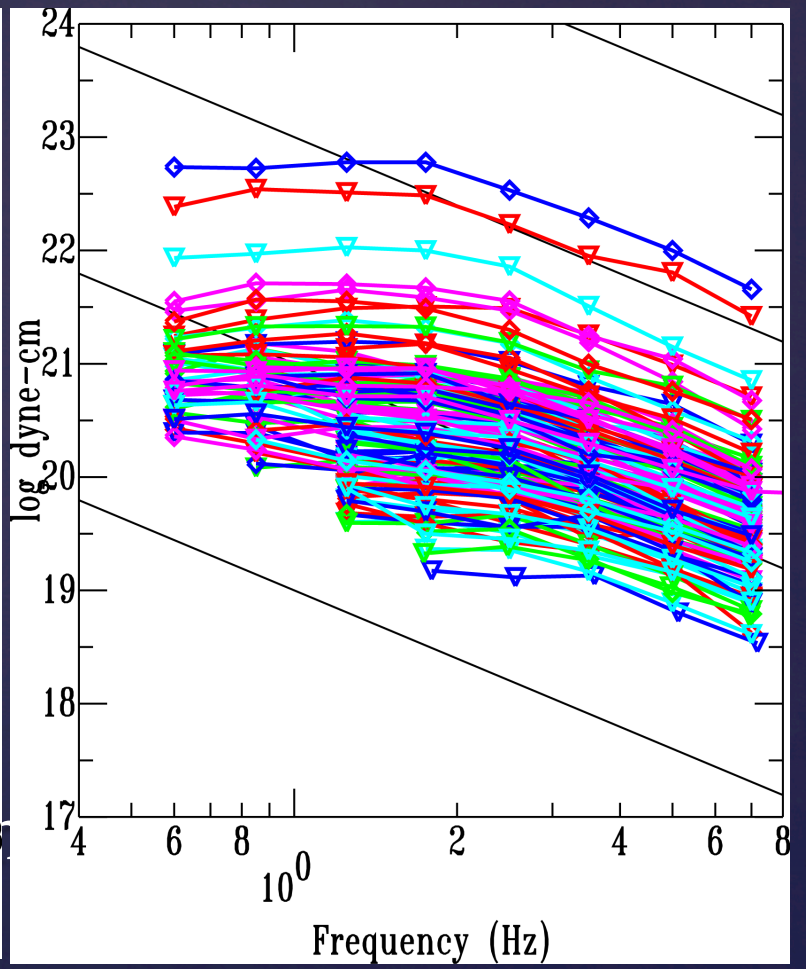
Distance corrected coda amplitudes measured at each frequency band are tied to an absolute scale by making frequency-dependent corrections



Minagish

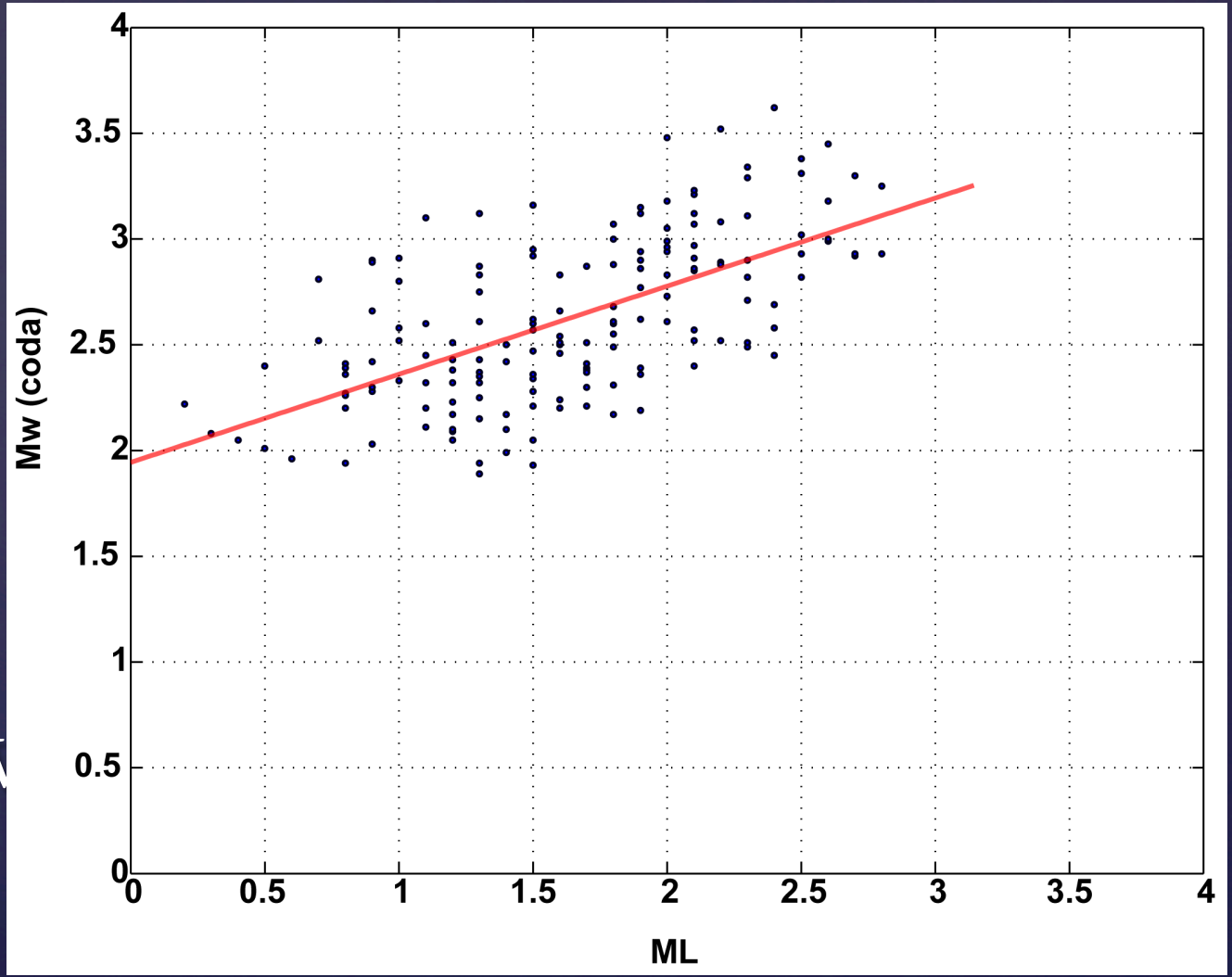
Mw=4.2



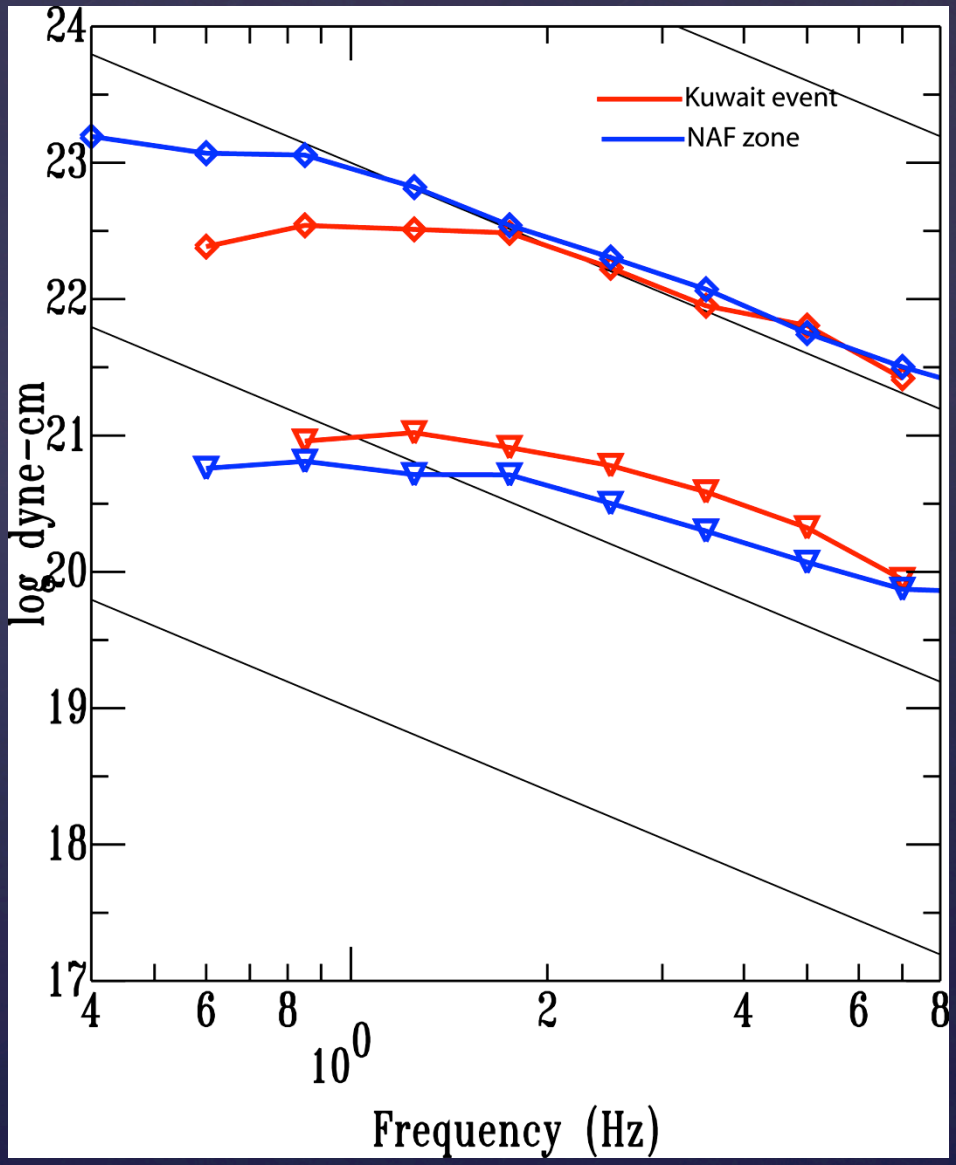


Mor

Mw



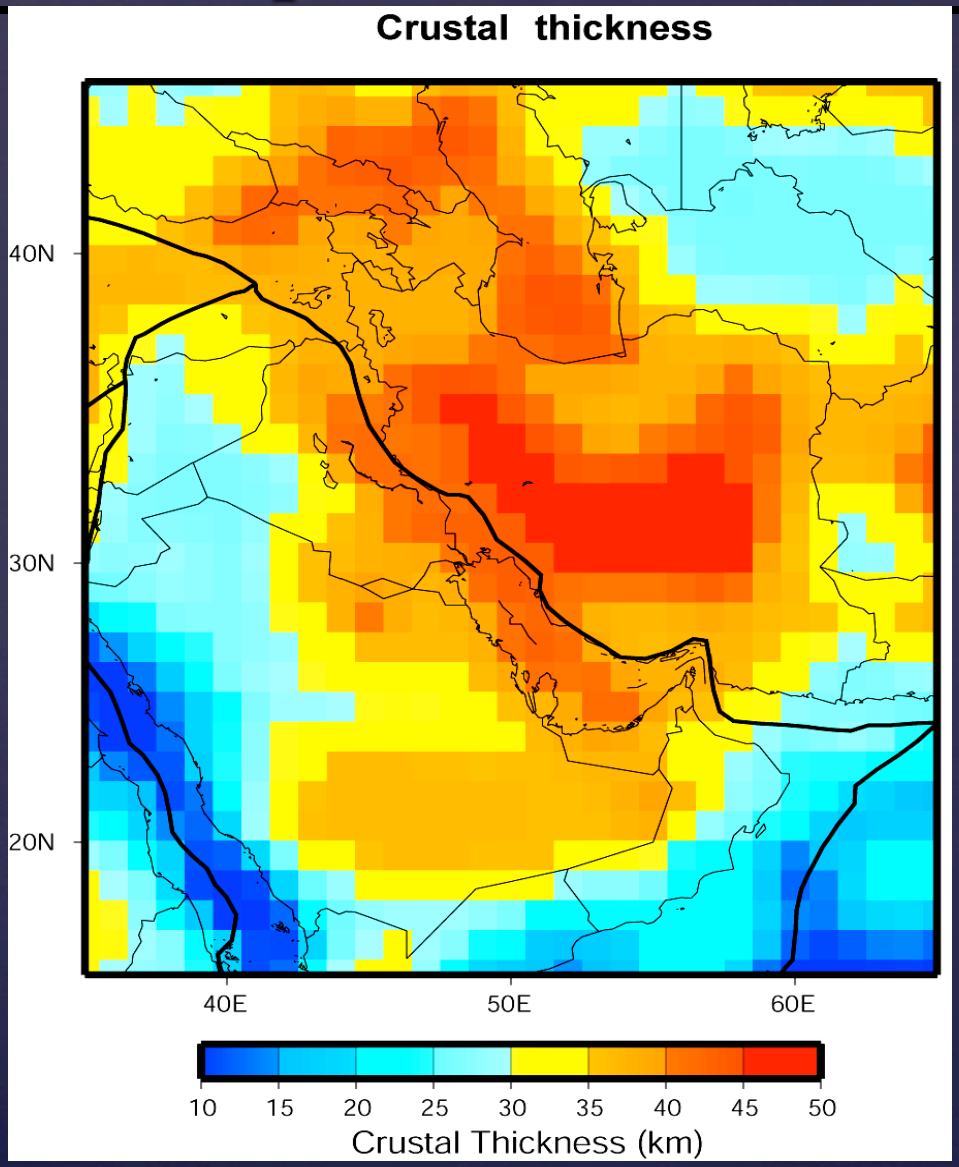
Tectonic event comparison



2 broad-band stations installed at MIB and UMR in 2010

Leveraged existing vaults of KNSN

Moho depth derived from surface waves

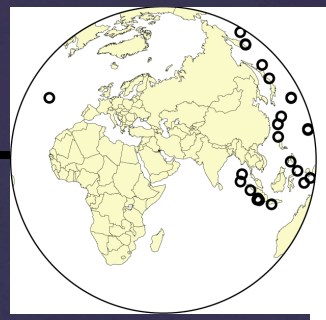


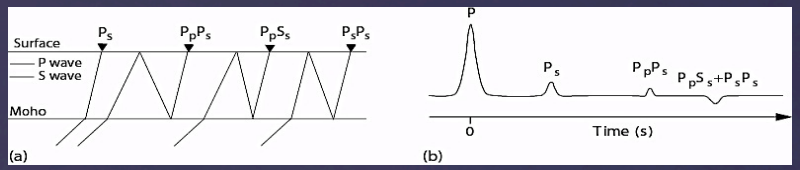
Pasyanos,

Personal communication

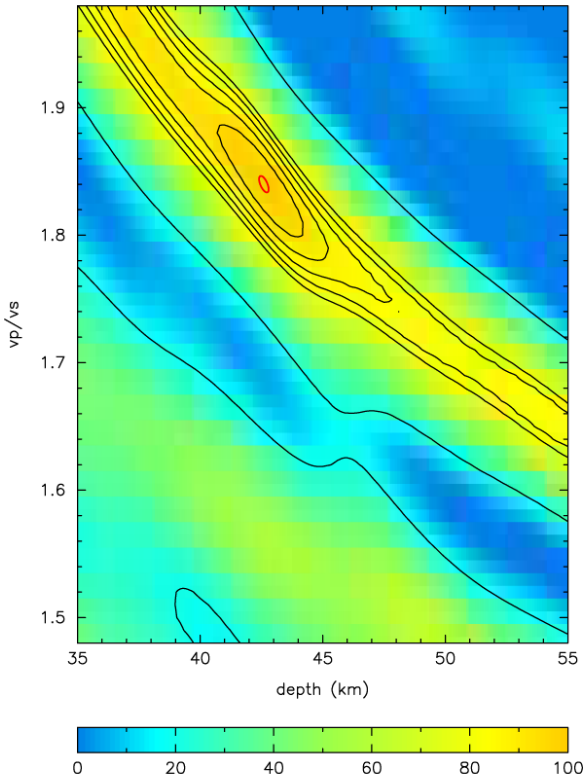
MIB

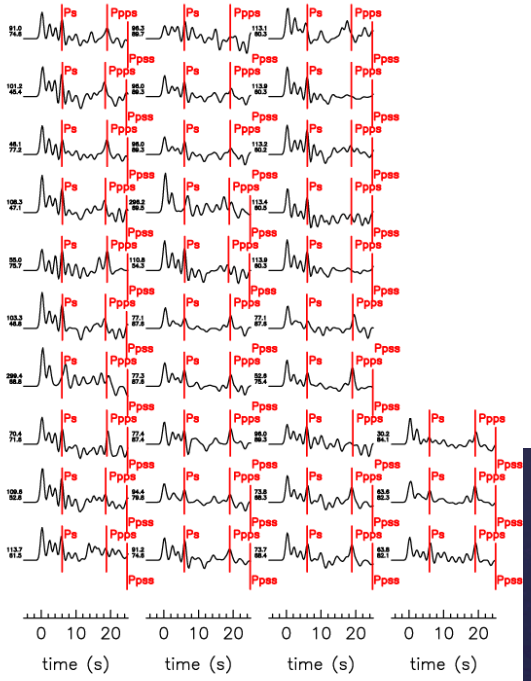
Moho Depth=43km

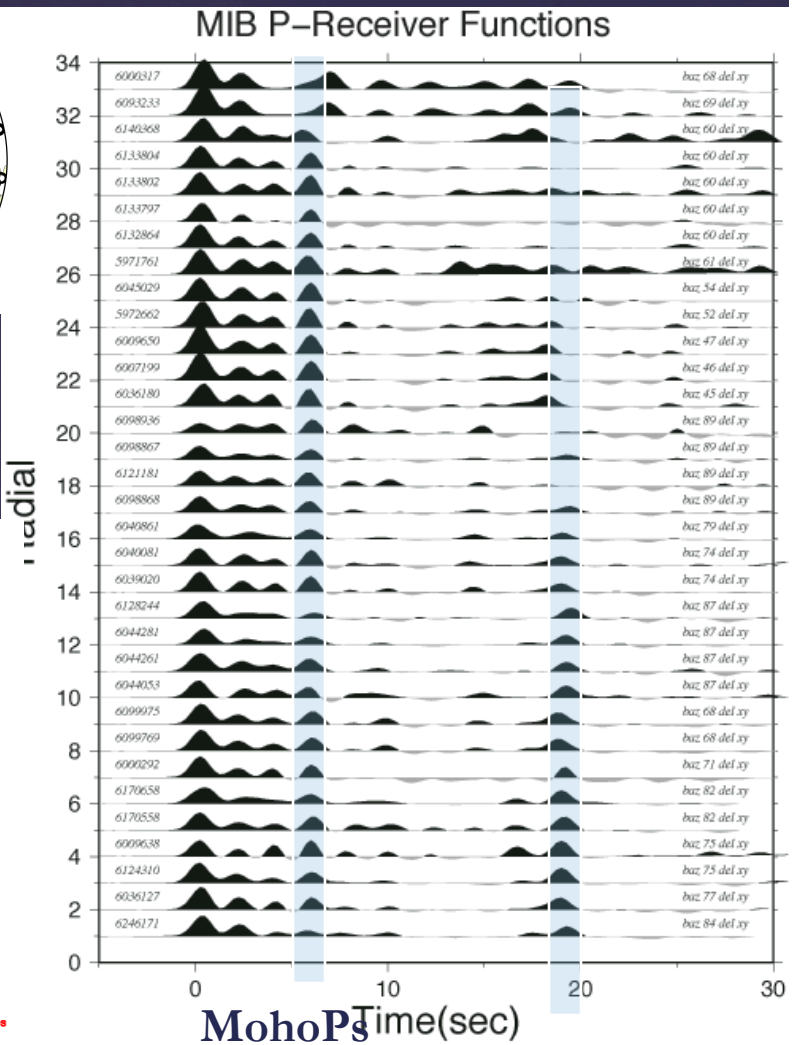




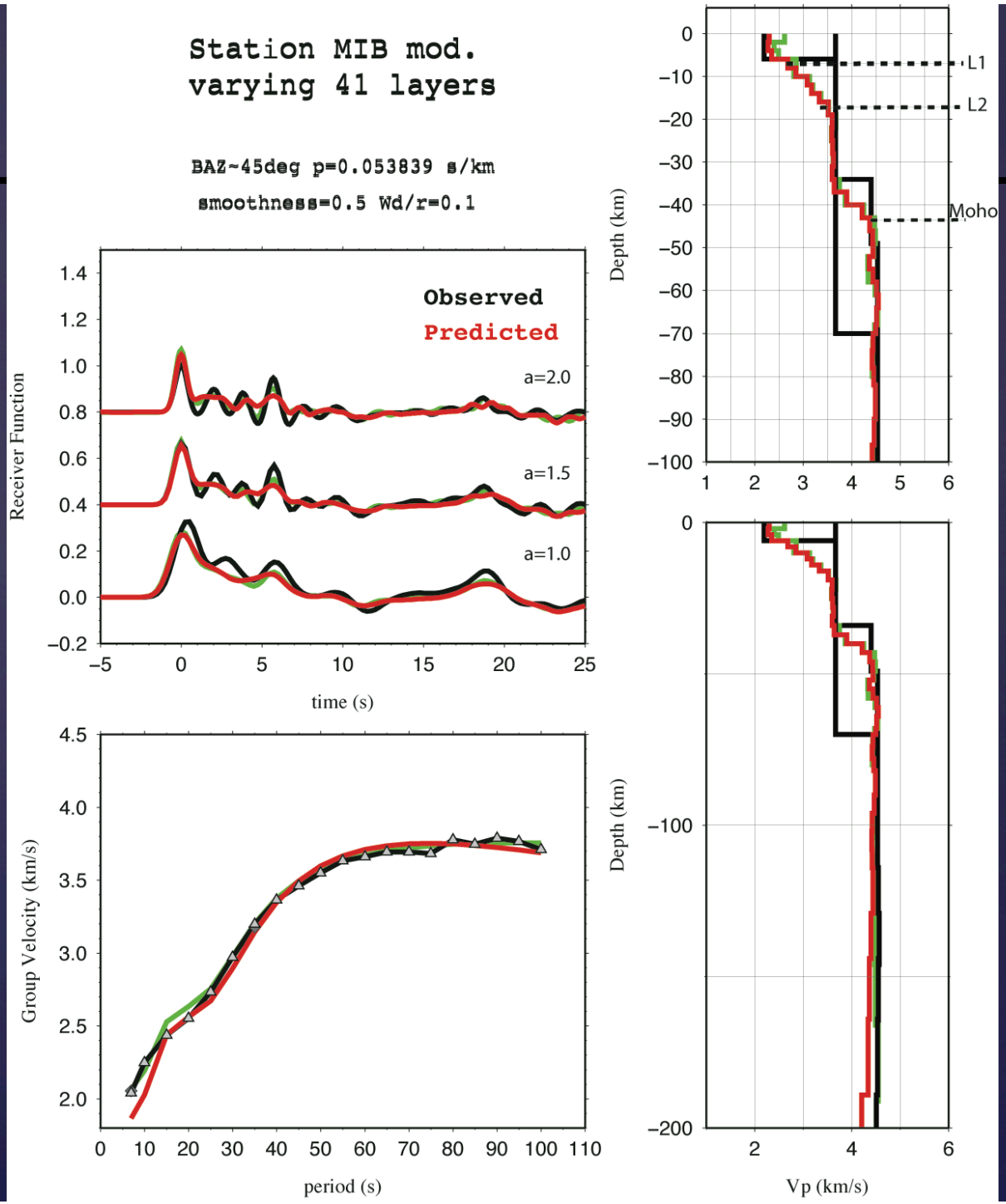
vp = 6.2 km/s h = 42.6+/−0.4 km vp/vs = 1.84+/−0.01 corr = −61.9 %

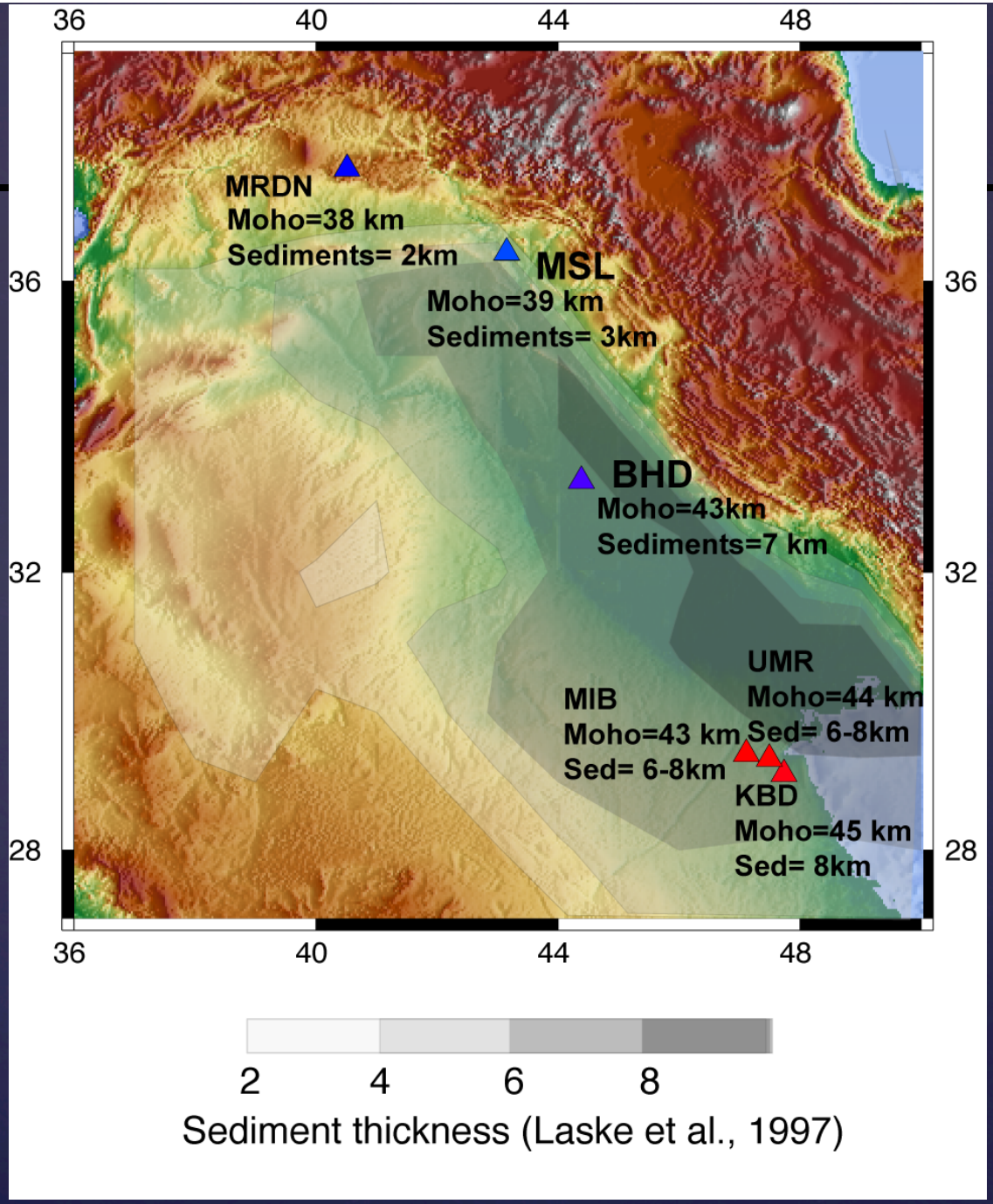






MohoPs


Station MIB mod.
varying 41 layers
BAZ~45deg p=0.053839 s/km
smoothness=0.5 Wd/r=0.1
Observed
Predicted
a=2.0
a=1.5
a=1.0
Receiver Function
time (s)
Group Velocity (km/s)
period (s)
Depth (km)
L1
L2
Moho
Vp (km/s)


36
40
44
48
36
32
28
MRDN
Moho=38 km
Sediments= 2km
MSL
Moho=39 km
Sediments= 3km
BHD
Moho=43km
Sediments=7 km
UMR
Moho=44 km
Sed= 6-8km
MIB
Moho=43 km
Sed= 6-8km
KBD
Moho=45 km
Sed= 8km
2
4
6
8
Sediment thickness (Laske et al., 1997)

The latest three-dimensional models capture vertical ground displacement far more accurately than one-dimensional models. These images show the ground motions for (a, b) one- and (c, d) three-dimensional models at different times after an event. Comparison with recorded ground motions indicates that the three-dimensional model better predicts the observed behavior.