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MOBNET in the AlpArray studies of the lithosphere

J. Plomerová, L. Vecsey, H. Žlebčíková, V. Babuška, H. Kampfová and AlpArray WGs

Institute of Geophysics, Czech Acad. Sci., Prague

AlpArray-EASI WG
AlpArray-IVREA WG
AlpArray WG

2018 CzechGeo/EPOS workshop

Prague, Dec 5, 2018

MOBNET

- **pool of temporary seismic stations** of the IG CAS, step by step ***developed since mid 90th***
- financial support: grant agencies GACR, GAAV or Czech Academy of Sciences
- Since **2016 incorporated into the CzechGeo/EPOS** infrastructure
- currently consists of 65 pairs of BB/SP seismometers and GAIA data acquisitions systems
- at present: **30 BB stations of the MOBNET involved in the AlpArray** project and two complementary projects – AlpArray-EASI, AlpArray-IVREA

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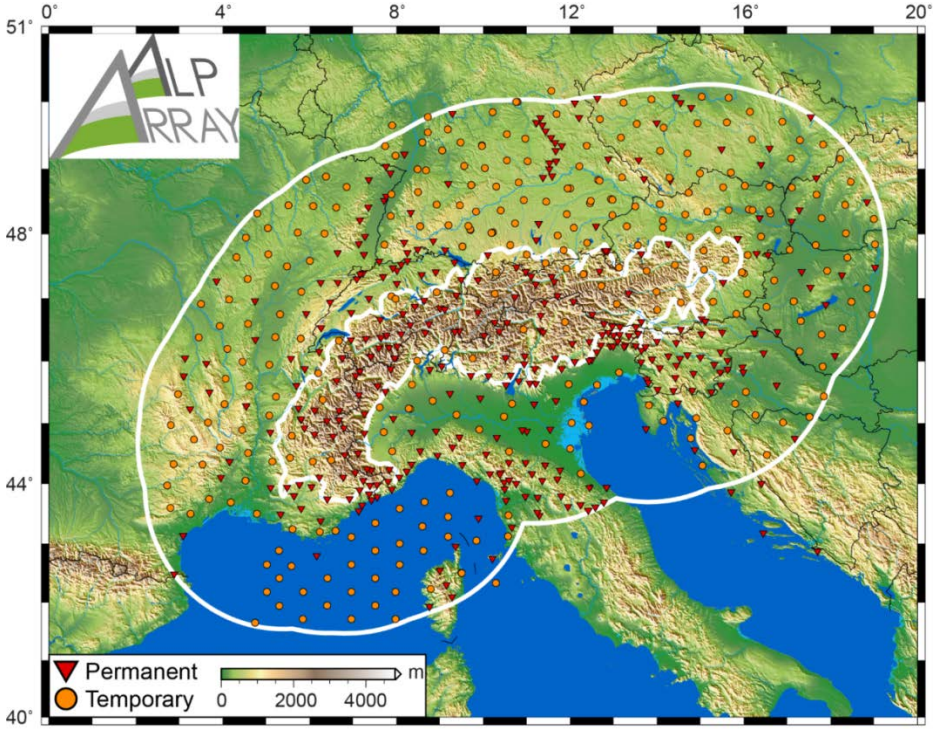
AlpArray – European initiative - advanced study of the **Alps-Apennines-Carpathians-Dinarides orogenic system**

- Relation to mantle dynamics
- Plate reorganizations
- Surface processes and seismic hazard
- High-resolution 3D images of structures and physical properties of the lithosphere and the upper mantle



AlpArray Seismic Network

~360 permanent stations
~260 temporary BB stations
30 OBS in Liguria

- homogeneous inter-station spacing of ~52 km, distance of any place to a station <30km

The AlpArray Seismic Network: A Large-Scale European Experiment to Image the Alpine Orogen, ***Surveys in Geophysics 2018***, https://doi.org/10.1007/s10712-018-9472-4

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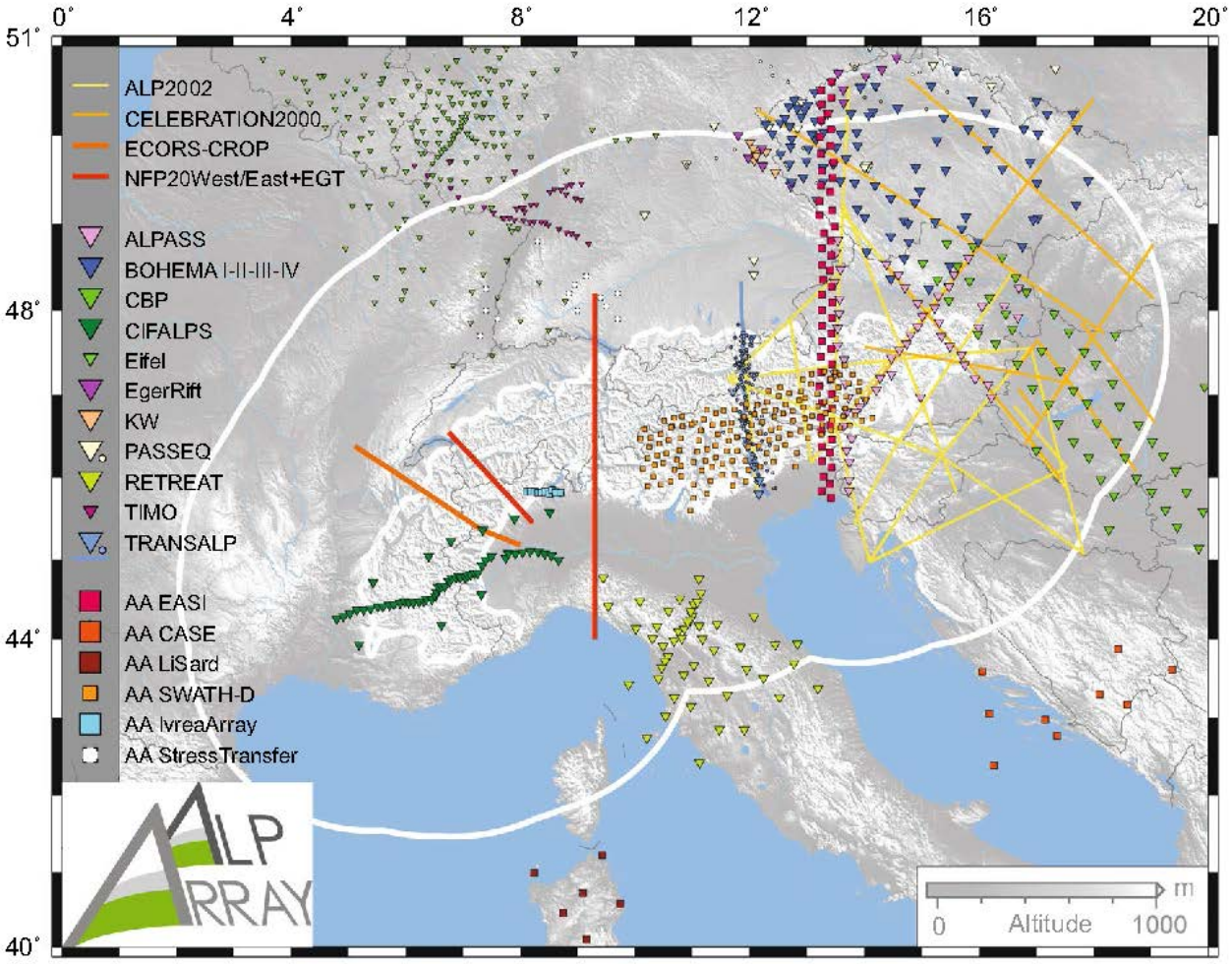
Selected seismological project in the greater Alpine area



The AlpArray Seismic Network: A Large-Scale European Experiment to Image the Alpine Orogen, ***Surveys in Geophysics 2018***, https://doi.org/10.1007/s10712-018-9472-4

Passive seismic experiments are designed to help answer questions related to specific structural targets in different provinces

- ***tools to study upper mantle fabrics*** **– body-wave anisotropy** evaluated from directional dependences of **travel time deviations** of teleseismic P waves and **shear-wave splitting** (analogy of optical birefringence)
- 3D **tomography images of velocity** in the crust and upper mantle
- to map **LAB** and delimit **boundaries of mantle lithosphere domains**
- **RF –** to map velocity discontinuities in the crust and upper mantle
- Ambient noise – velocity structure of the crusty and uppermost mantle

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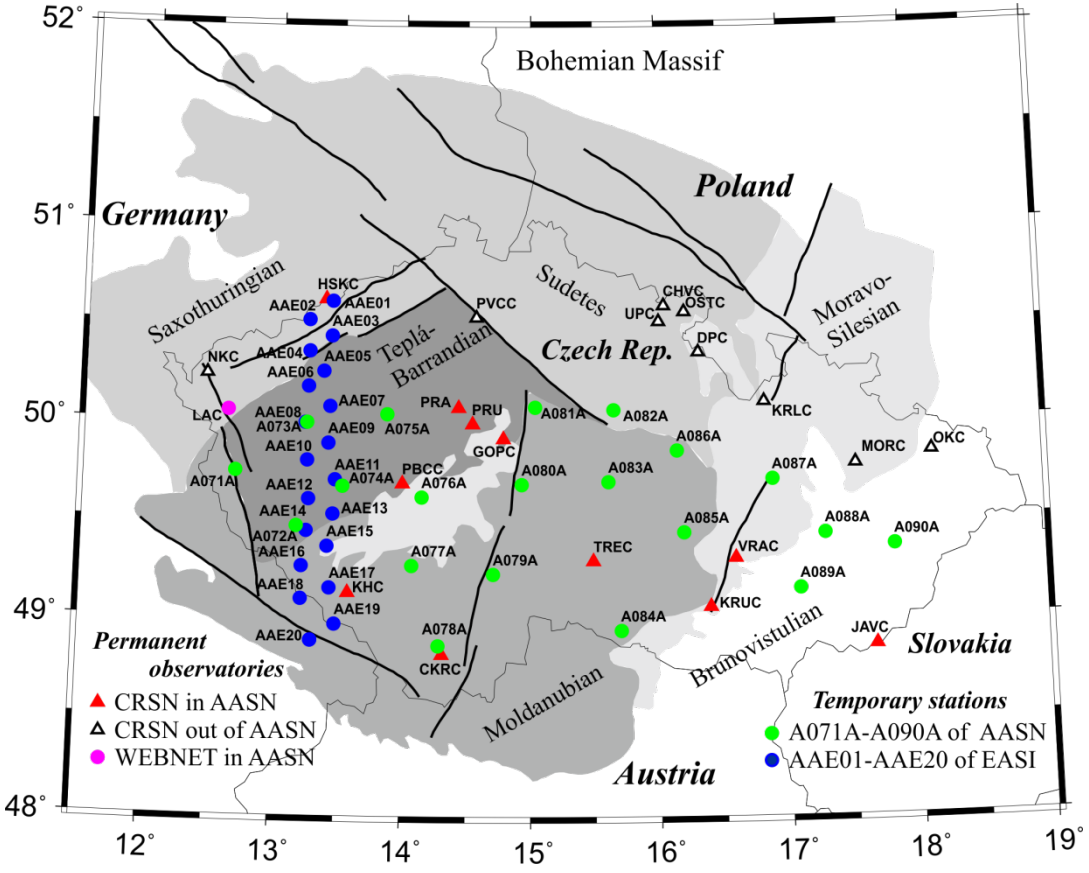
MOBNET for AlpArray in the Bohemian Massif



EASI 2014- 2015

ch-cz-at-i

Data: *ETH* (EIDA node)

data access restricted for 3 years

October 2018 – data access opened

AlpArray

autumn 2015 – March 31, 2019

Data: *ORFEUS* (EIDA node)

data access restricted for 3 years

after the data collection is completed

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A076A

Maková Hora

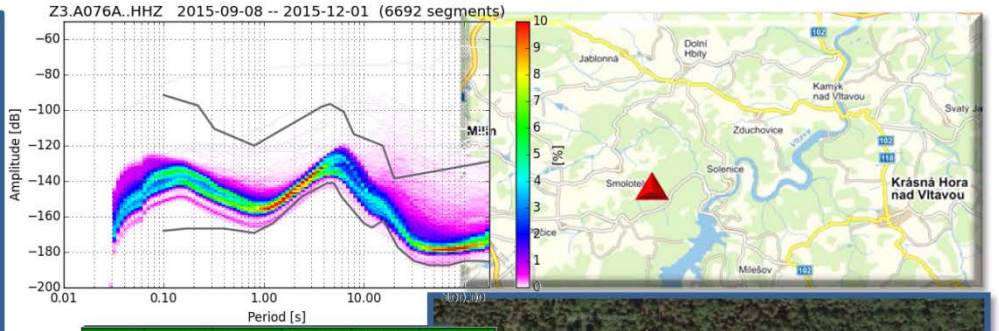
INSTALLATION

Start : 8.9.2015
Lat : 49.6168
Lon : 14.1494
Alt : 532 m

EQUIPMENT

Sensor : CMG-3T 120 s
Depth : 3 m
Recorder : Gaia 1
Power : electricity grid

The station is located on the lower ground floor of the former rectory pilgrimage church at Maková Hora (Poppy Mountain). Upper ground floor is occasionally used for recreational purposes.
Seismometer is installed in the shaft on concrete pillars built on bedrock.
The GPS antenna is brought out through the window, length - 5 m, direction - S, view open.
Geomorphology: Benešov Uplands.
Subsoil: orthogneiss.



Results from the AlpArray passive experiments and further plans

- **AlpArray-EASI** - model of the **crust** - Moho beneath the **BM** and the **E. Alps** (*Hetenyi et al., Tectonophysics 2018*)
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- **What after the AlpArray** – appeared as very efficient European collaboration and fertile scientific research
  Adria Array proposal

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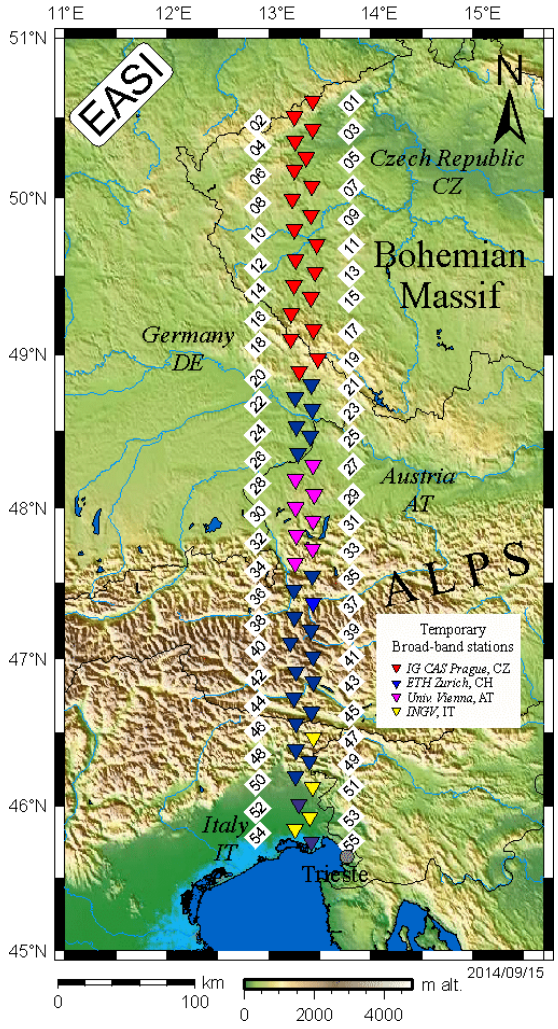
AlpArray - EASI 2014-2015



mseed data (**292 GB**) from all 20 CZ stations
→ in EIDA ETHZ

Research topics:

Crust:

Reciever Functions – Ps, Sp
in cooperation with
G. Hetenyi ETH/UniL
I. Bianchi (Univ. Vienna)
Hetenyi et al., Tectonophysics,2018
Ambient noise study (*J. Kvapil et al.*)

Structure of the upper mantle:

Anisotropy - SKS splitting
- P spheres
Tomography P velocity
Along with surrounding permanent stations
running in 2014-2015

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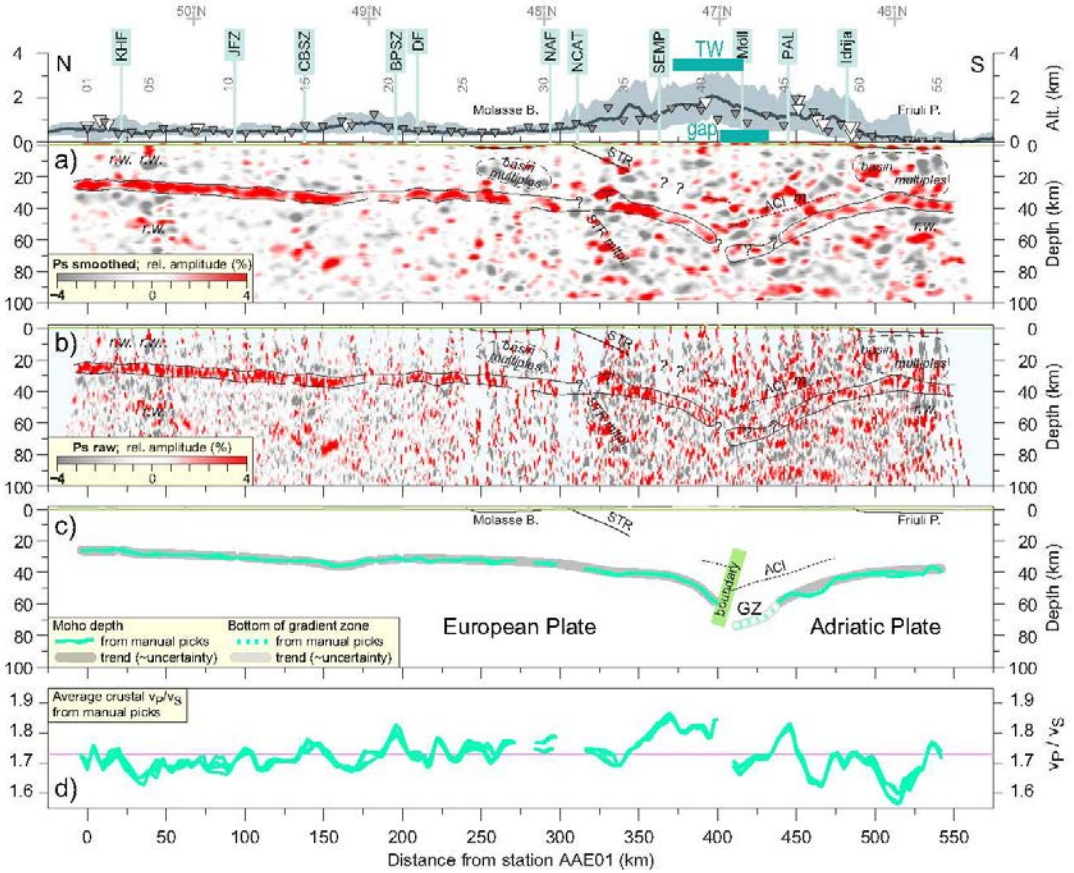
Interpreted migrated smoothed receiver-function profile showing structures



AlpArray-EASI

From mountain summits to roots: Crustal structure of the Eastern Alps and Bohemian Massif along longitude 13.3°E

G. Hetényi, J. Plomerová, I. Bianchi, H. Kampfová Exnerová, G. Bokelmann, M.R. Handy, V. Babuška, AlpArray-EASI Working Group, ***Tectonophysics 744 (2018)*** 239–255, https://doi.org/10.1016/j.tecto.2018.07.001

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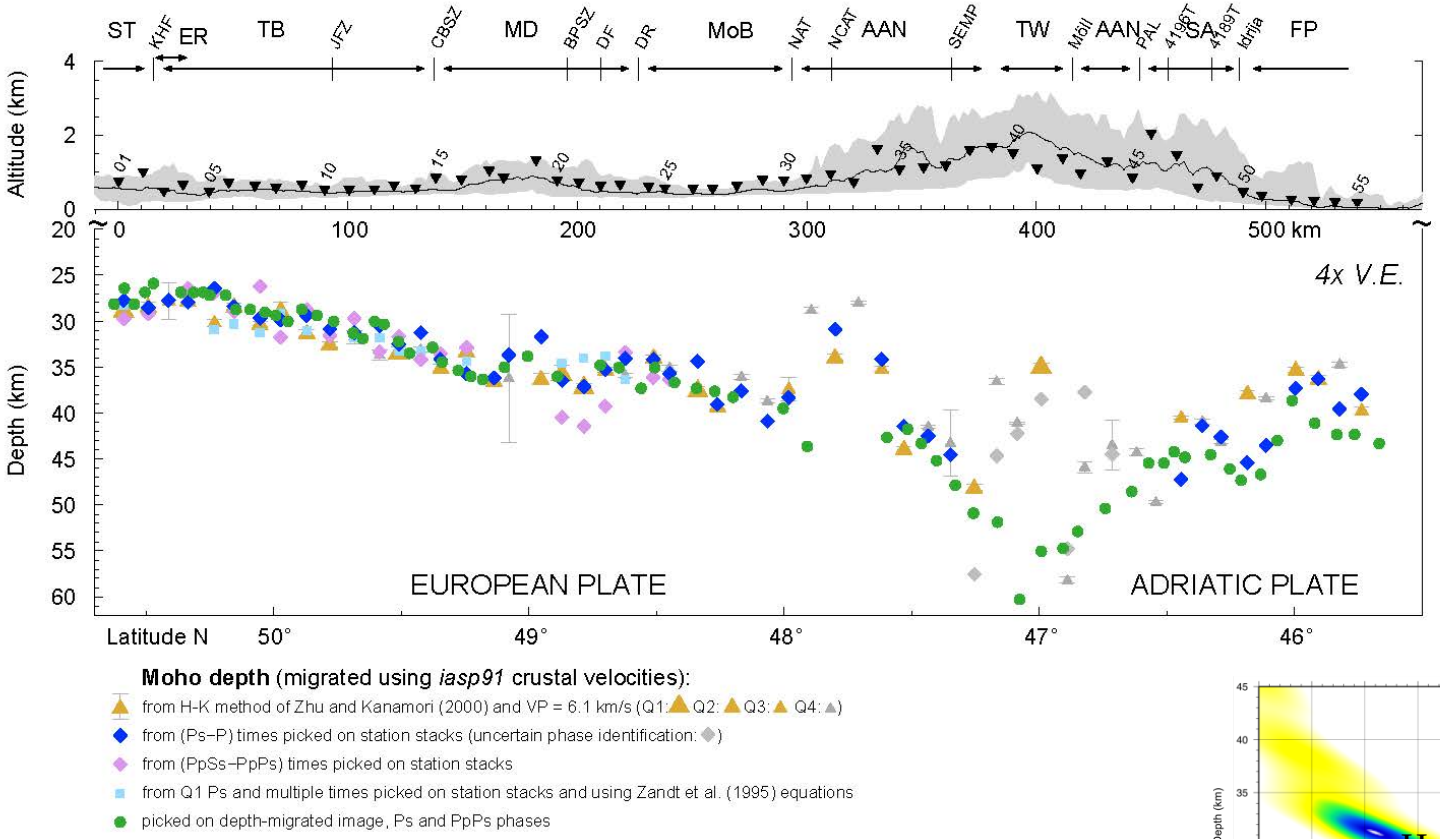
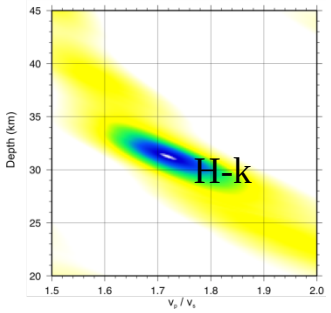
Moho depth estimates from different methods

AlpArray-EASI





Zhu, Kanamori, 2000

From mountain summits to roots: Crustal structure of the Eastern Alps and Bohemian Massif along longitude 13.3°E

G. Hetényi, J. Plomerová, I. Bianchi, H. Kampfová Exnerová, G. Bokelmann, M.R. Handy, V. Babuška, AlpArray-EASI Working Group, ***Tectonophysics 744 (2018)*** 239–255, https://doi.org/10.1016/j.tecto.2018.07.001

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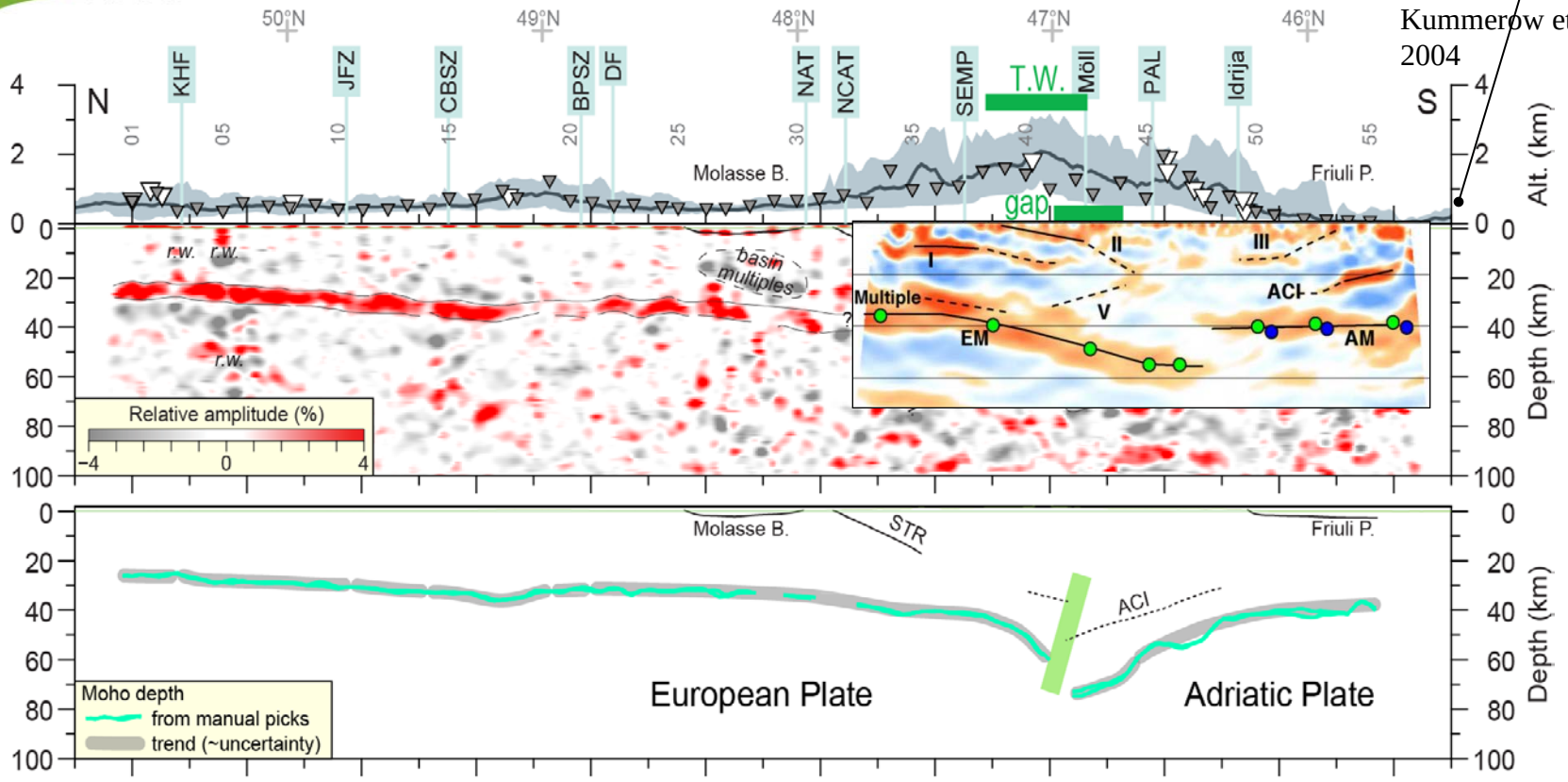
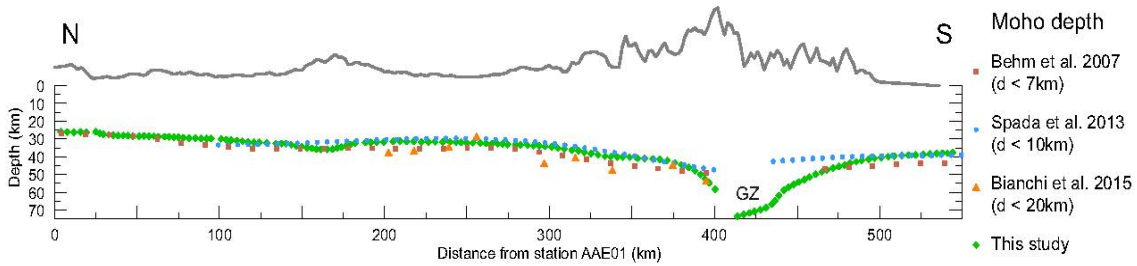
Interpretation of Depth migrated P-RF

TRANSALP RF at 12°E Kummerow et al. 2004





AlpArray-EASI

Hetenyi et al., Tectonophysics 2018

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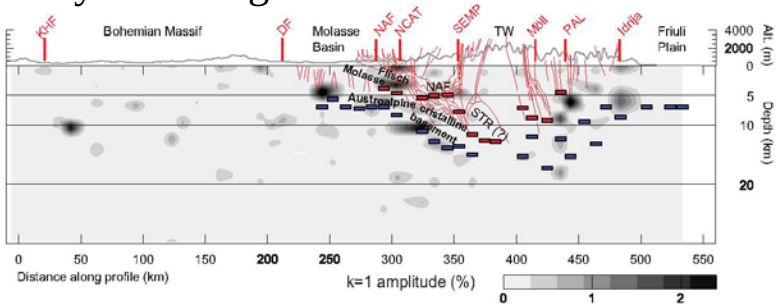
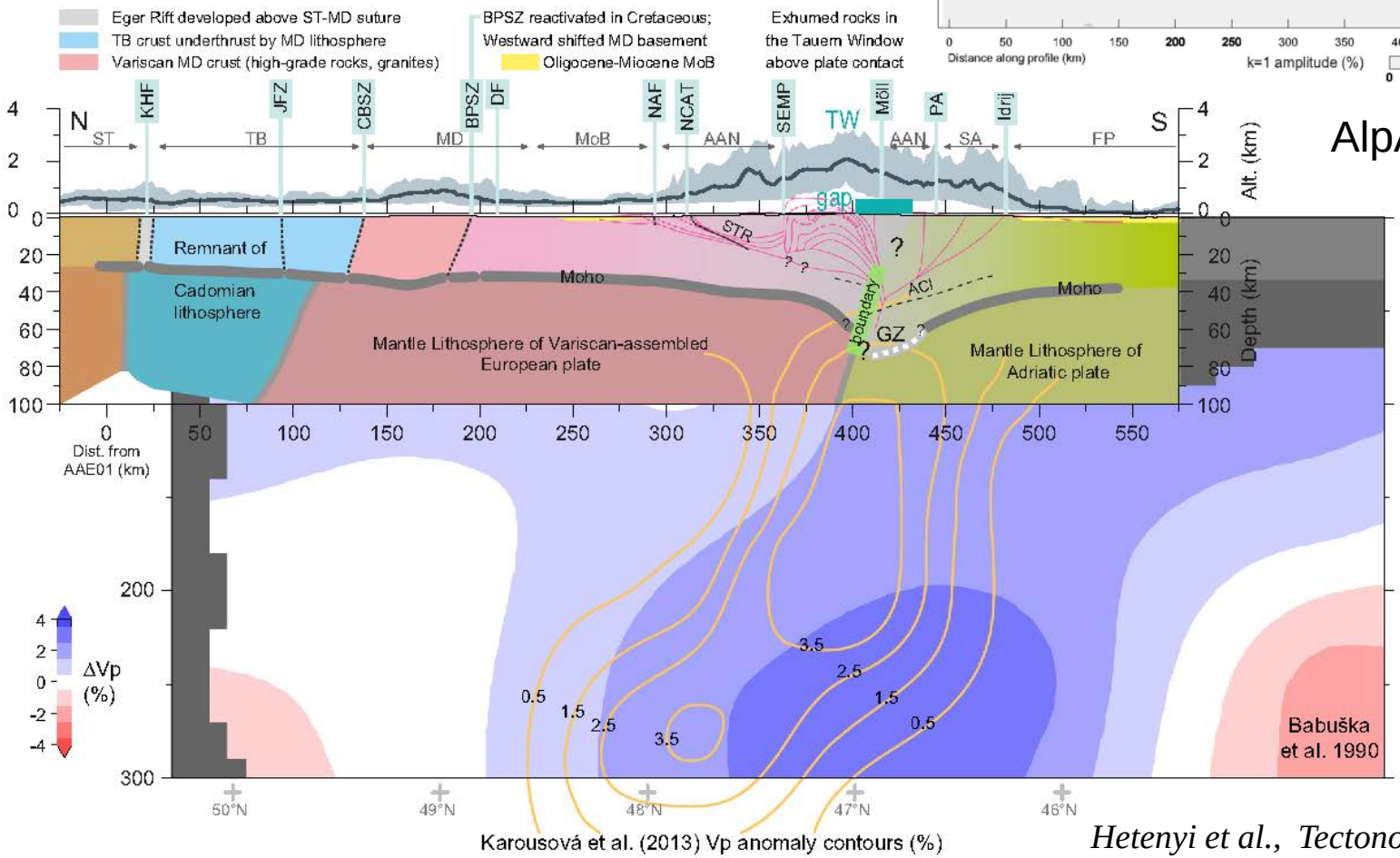
Interpretation of the EASI receiver-function results complemented with previous geological and geophysical knowledge

Shallow structure from the harmonics analysis of single station receiver functions.





AlpArray-EASI

Karousová et al. (2013) Vp anomaly contours (%)

Hetenyi et al., Tectonophysics 2018

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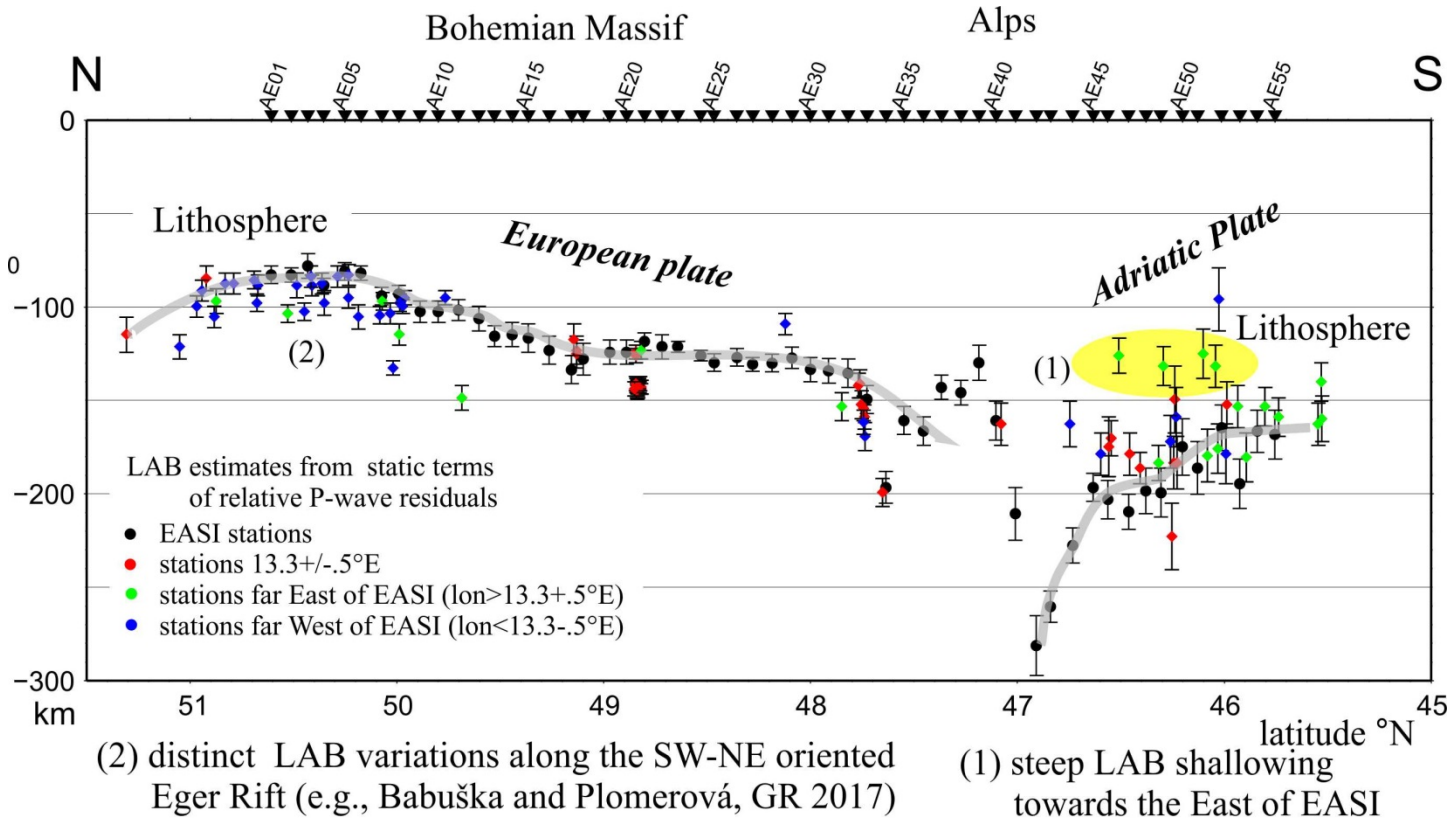
LAB depth estimate from EASI ± 100km station data



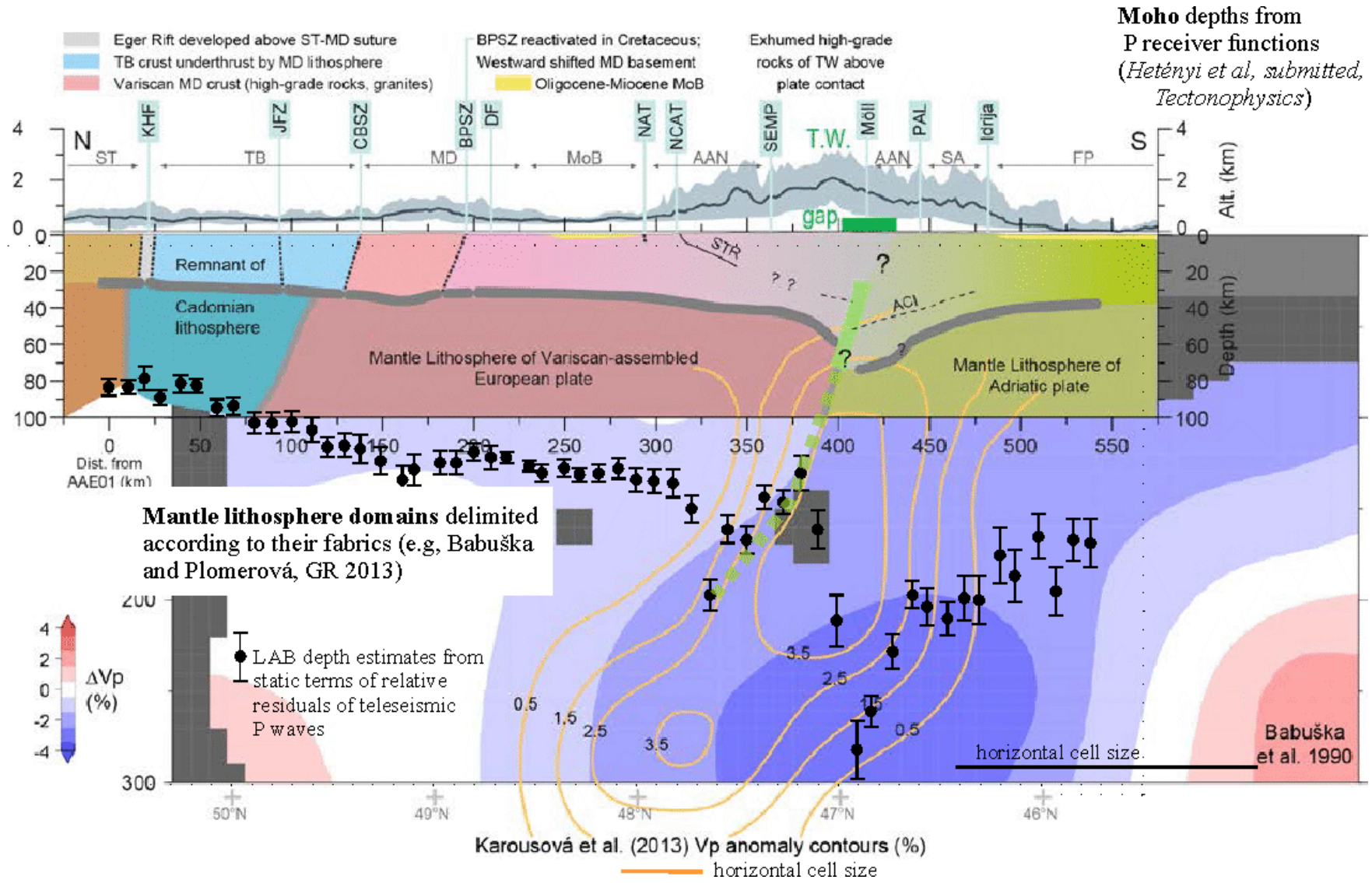
(2) distinct LAB variations along the SW-NE oriented Eger Rift (e.g., Babuška and Plomerová, GR 2017)

(1) steep LAB shallowing towards the East of EASI

Geophysical Research Abstracts
Vol. 20, EGU2018-12326-1, 2018

EGU2018-12326

Plomerova et al., under prep.


Moho depths from P receiver functions (Hetényi et al, submitted, Tectonophysics)
Eger Rift developed above ST-MD suture
TB crust underthrust by MD lithosphere
Variscan MD crust (high-grade rocks, granites)
BPSZ reactivated in Cretaceous; Westward shifted MD basement
Oligocene-Miocene MoB
Exhumed high-grade rocks of TW above plate contact
KHF
JFZ
CBSZ
BPSZ
DF
NAT
NCAT
SEMP
T.W.
Moll
PAL
Idrija
N
S
ST
TB
MD
MoB
AAN
AAN
SA
FP
gap
Alt. (km)
Depth (km)
Remnant of Cadomian lithosphere
STR
AOI
Mantle Lithosphere of Variscan-assembled European plate
Mantle Lithosphere of Adriatic plate
Dist. from AAE01 (km)
Mantle lithosphere domains delimited according to their fabrics (e.g, Babuška and Plomerová, GR 2013)
ΔVp (%)
LAB depth estimates from static terms of relative residuals of teleseismic P waves
0.5
1.5
2.5
3.5
horizontal cell size
Babuška et al. 1990
50°N
49°N
48°N
47°N
46°N
Karousová et al. (2013) Vp anomaly contours (%)
horizontal cell size

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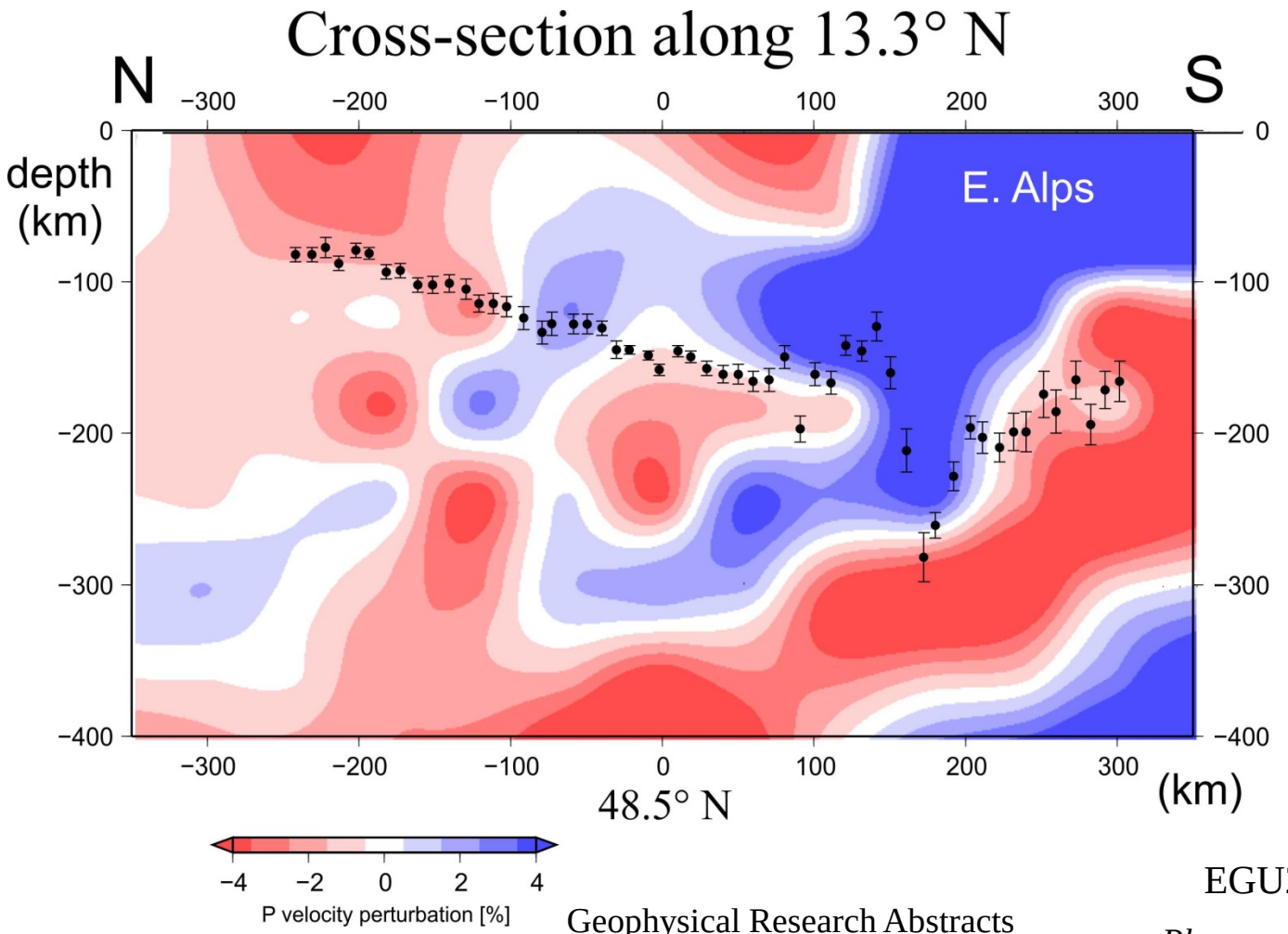
Preliminary P-wave tomography from EASI ± 100km station data



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EGU2018-12326

Plomerova et al., under prep.

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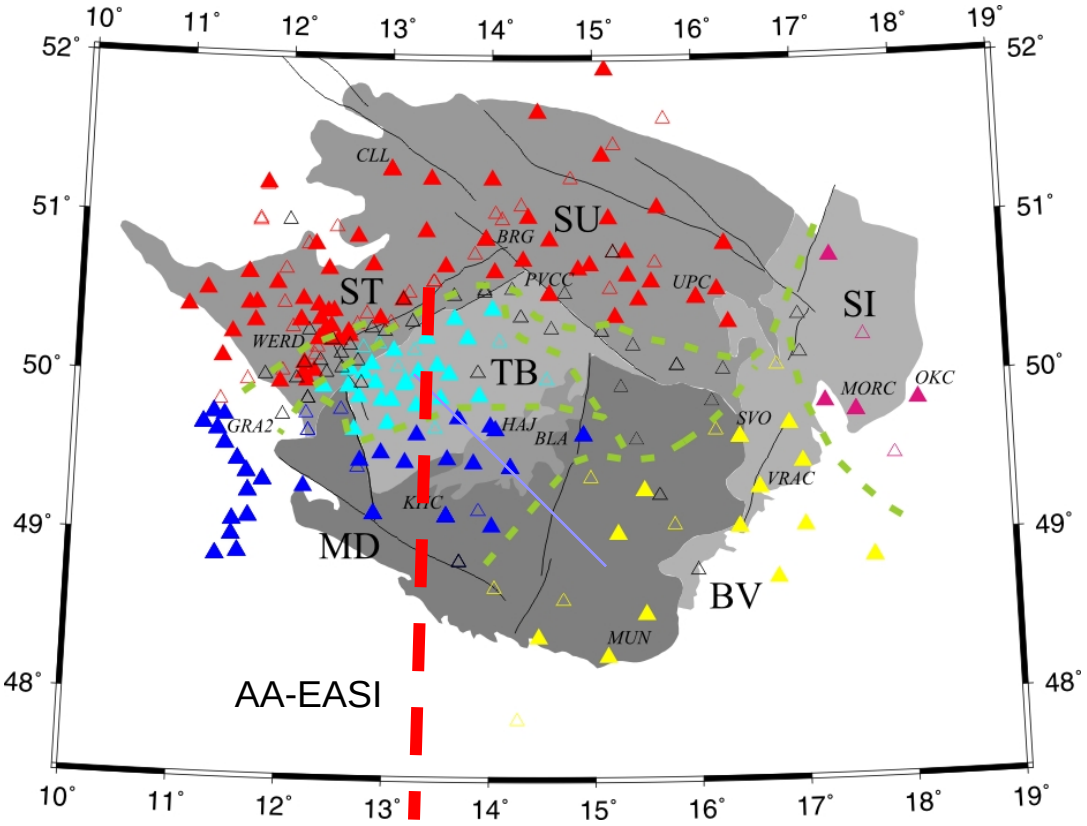
Domains of mantle lithosphere - each with consistent fabric



Previous passive seismic experiments in the BM

Exp'92 *1992* *CZ*
MOSAIC 1998-1999 CZ-F
BOHEMA 2001-2003 CZ-F-G
BOHEMA II 2004-2005 CZ
BOHEMA III 2005-2006 CZ
ALPASS 2005-2006 intern.
PASSEQ 2006-2008 intern.
Eger Rift 2007-2011 CZ

- stations grouped according to their P-sphere patterns

  Babuška and Plomerová., Gondwana Res. 2013

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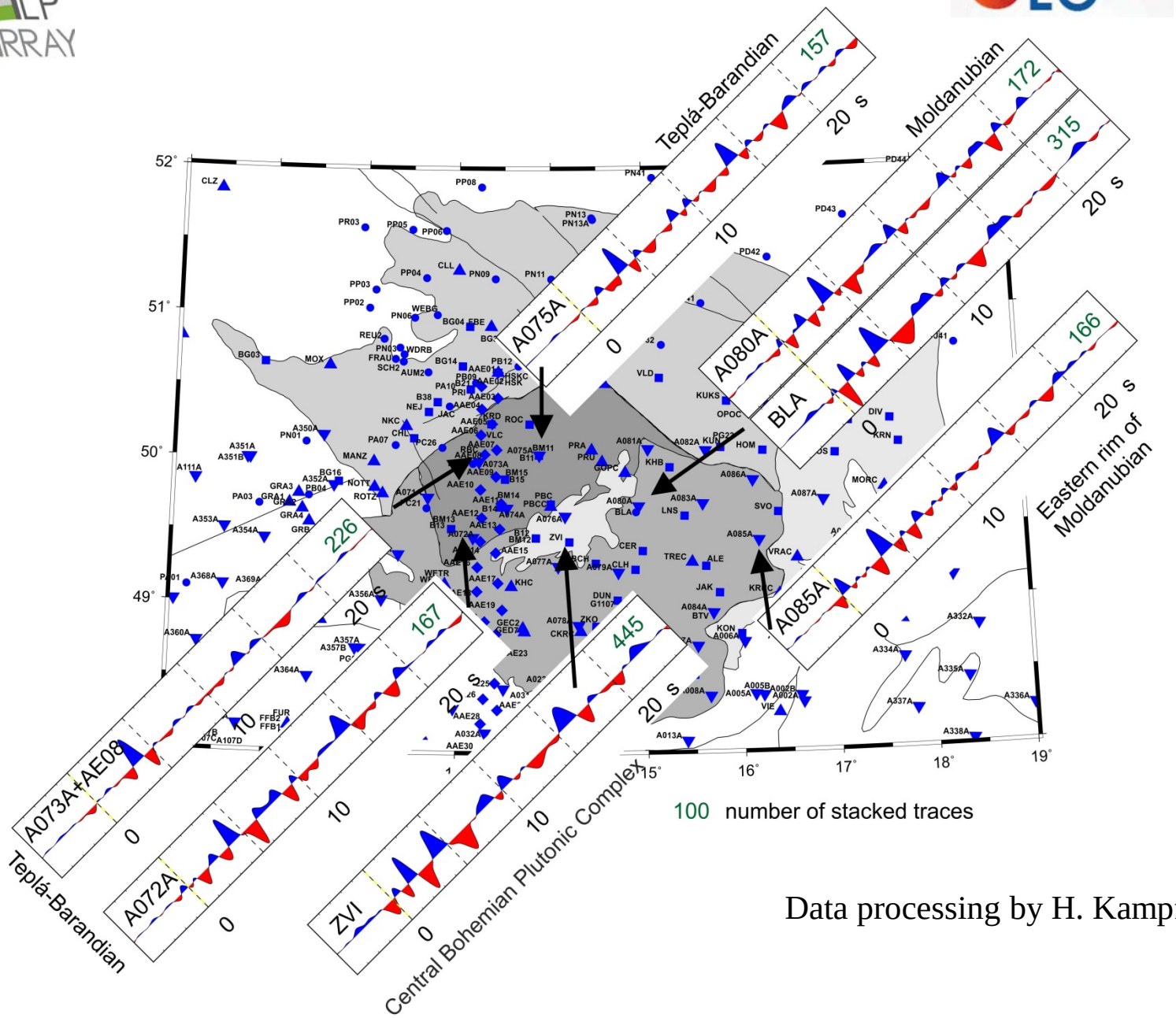

Data processing by H. Kampfova

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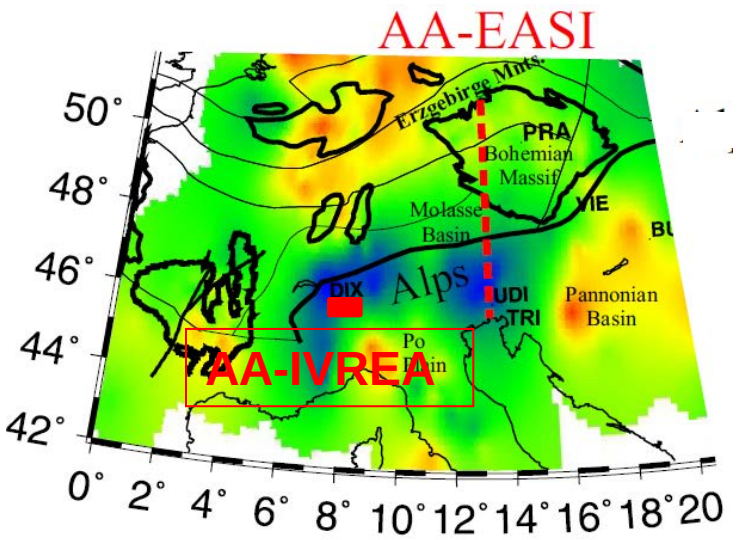
AlpArray-IVREA



- Joint UNIL + IG Prague + INGV Genova project
- 10 BB stations from MOBNET
- June 2017 - summer 2019
- Joint seismology and gravity field measurents
- Ivrea Geophysical Body – fast velocity anomaly beneath the Ivrea-Verbano Zone

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EGU General Assembly 2018

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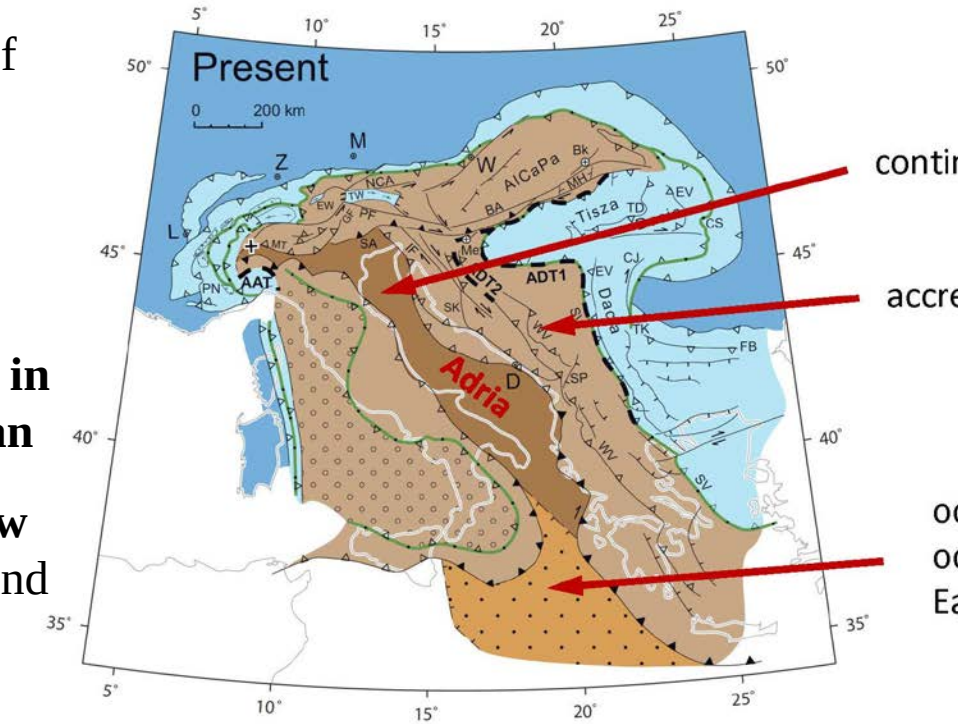
  Adria Array proposal

AdriaArray proposal by T. Meier (Uni. Kiel)

Major aims and targets

- investigate **deformation** of the **entire dissolving Adriatic plate**
- understand driving geodynamic forces of **seismicity and volcanism in the central Mediterranean**
- understand **creation of new continental** (Pannonian) and **oceanic** (Tyrrhenian) **lithospheres**

tectonics – Adria a dissolving plate

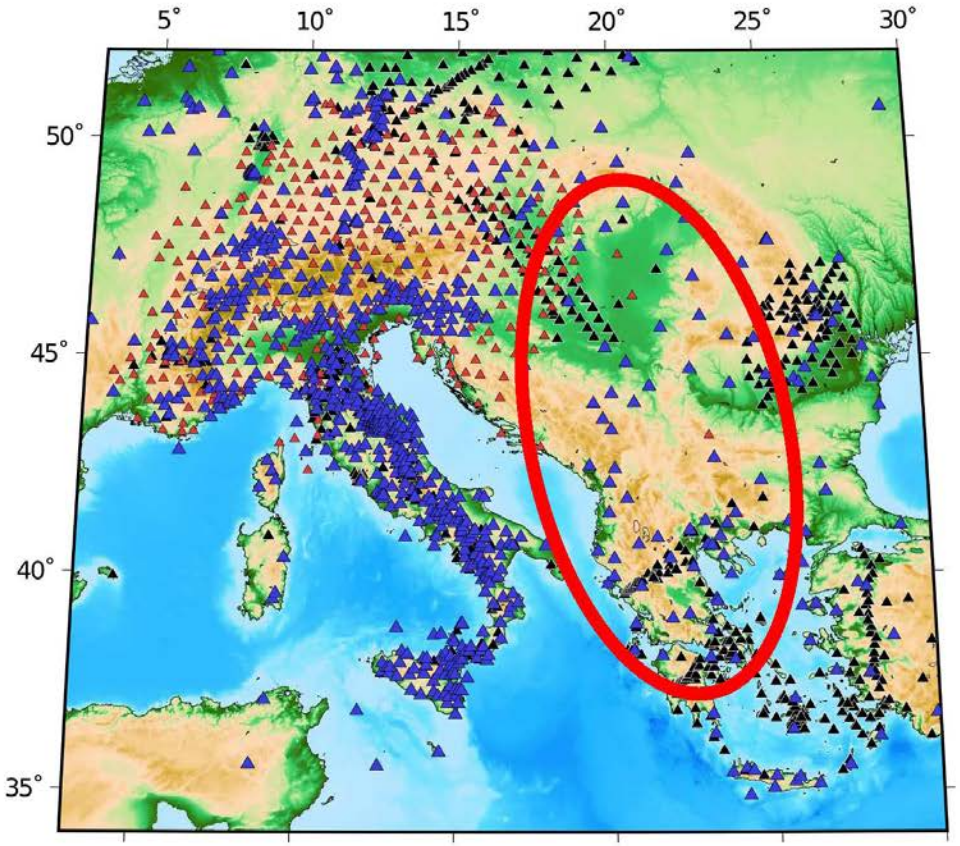


Handy et al. (2015, modified)

- **Shift the AlpArray towards SE Europe**: backbone network consisting of permanent and temporary stations + densification in key areas

- Operation **2020-2022**
- min 2 year in operation

AdriaArray – Central Mediterranean



- backbone: permanent + temporaty stations (non-equidistant?)
- + temporary stations in key areas (local experiments)
- + OBS

combination with AlpArray data + existing permanent stations and data in the central Mediterranean

-> unique data set

▲ AlpArray station
▲ permanent station, other network
▲ temporary station, other network

(Apr 2018)

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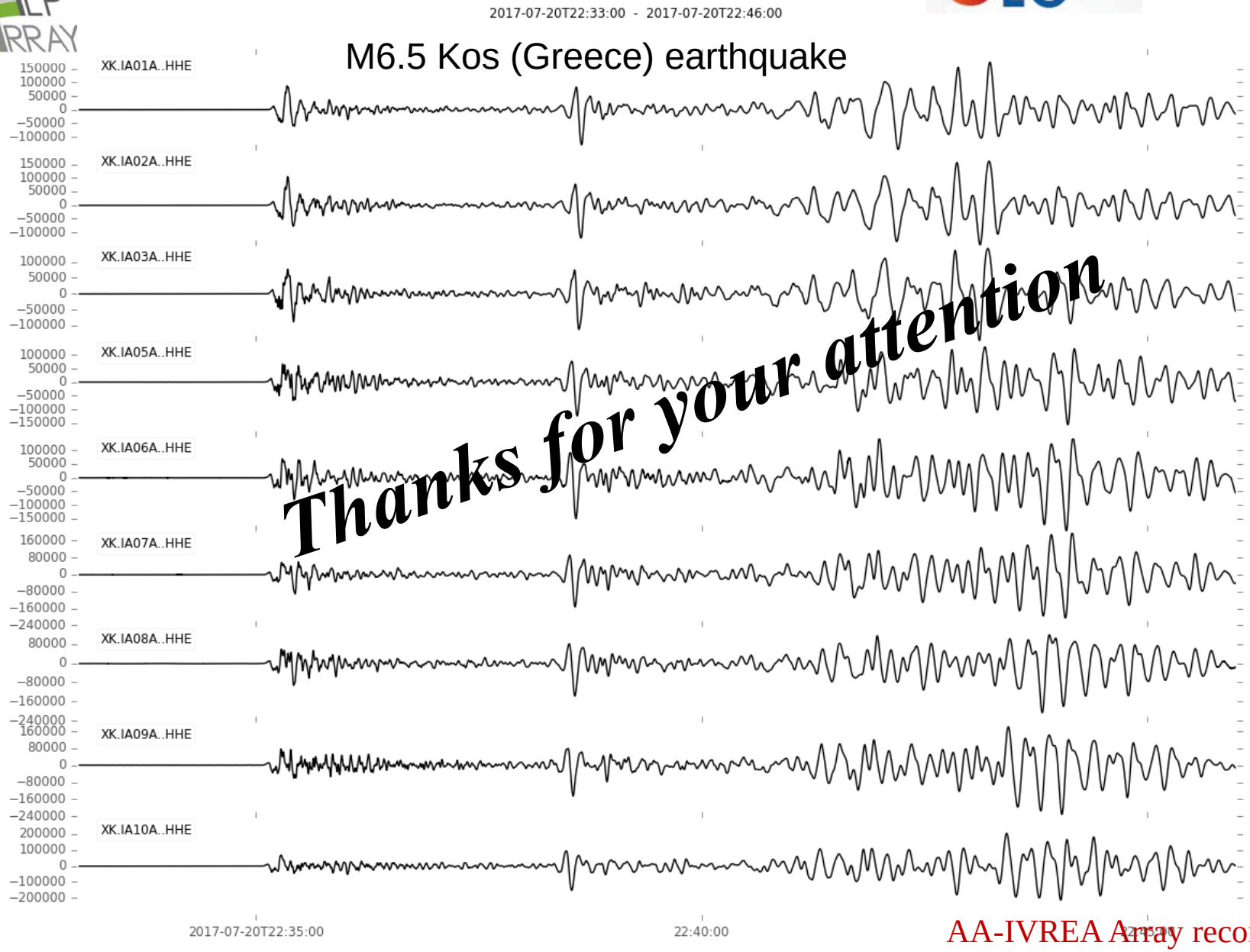

AA-IVREA Array records