ISC data – long-term fundamentals of seismological research in Prague

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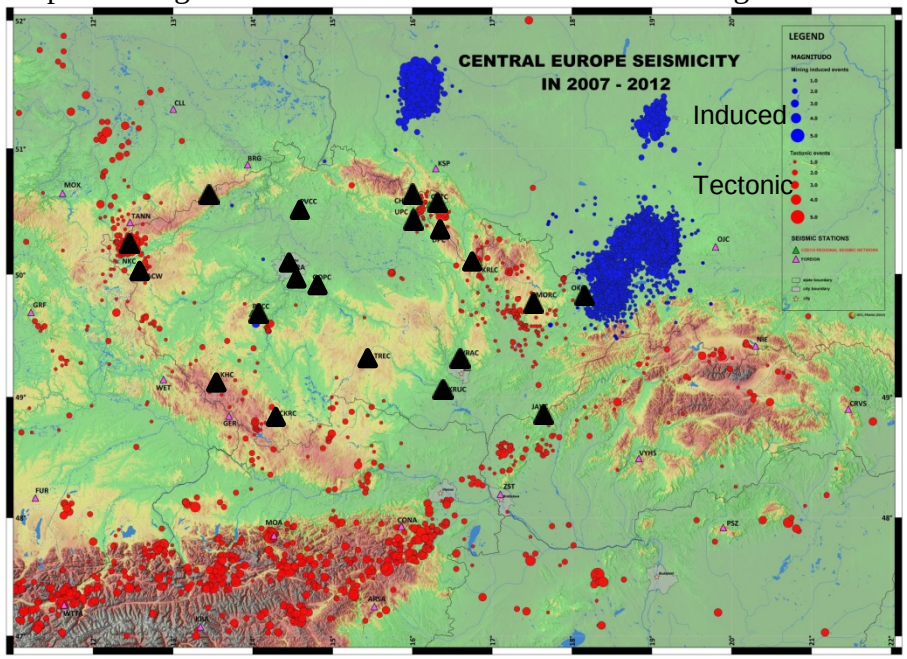
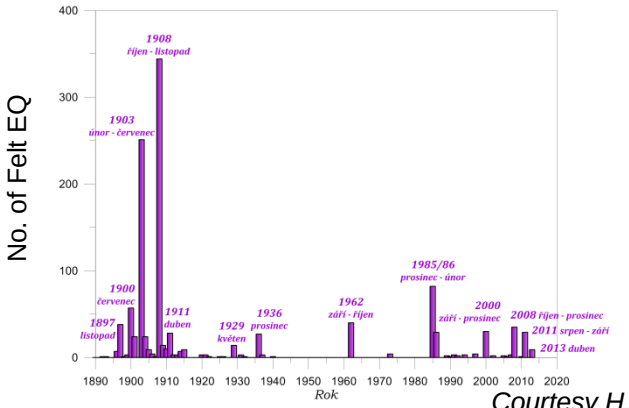
- Seismic activity in central Europe, north of the Alps and Carpathians – LOW
- Seismology has long tradition in the Czechoslovakia/Czech Republic

Czech Regional Seismological Network (CRSN, 2015)
http://www.ig.cas.cz/en/structure/observatories/czech-regional-seismological-network



The highest activity
West Bohemia/ Vogtland region –**Earthquake swarms**



Courtesy H. Čermáková

The first seismic station installed **Cheb(Eger) 1908**, currently **local network WEBNET** monitors seismic activity of the region

EQ Catalogues/Bulletins 1914 - 1917 by British Association for the Advancement of Science (BAAS)
EQ Catalogues/Bulletins 1918 - 1963 International Seismological Summary (ISS)
EQ Catalogues/Bulletins 1964 – present **International Seismological Centre ISC**

CRSN reports its measurements to seismological centers, incl. the ISC and its predecessors, and publishes complete annual Seismological Bulletins:

- Printed version 1908 – 1994 archive of historical bulletins → ISC
- Web version 1976 – present http://www.czechgeo.cz/en/gfu-bulletin/ V. Kárník

Examples of ISC data application, incl. its predecessor ISS

Seismicity of Europe

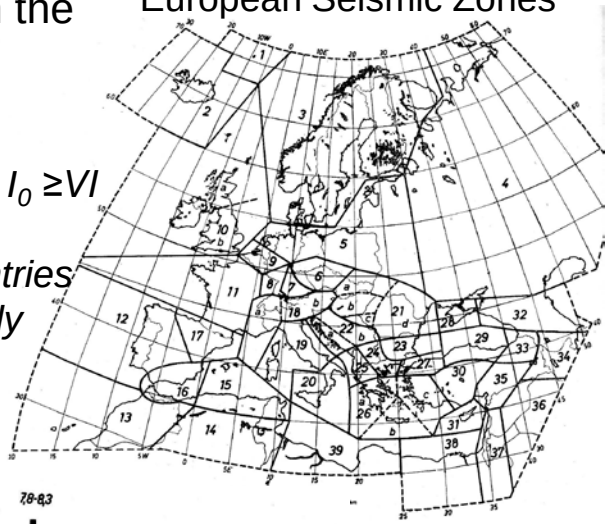
- Major goal - to learn the general laws of EQ occurrence with the aim of protecting mankind from the disastrous effects of EQ

Seismicity of the European Area, Part 1 *Kárník, 1968*

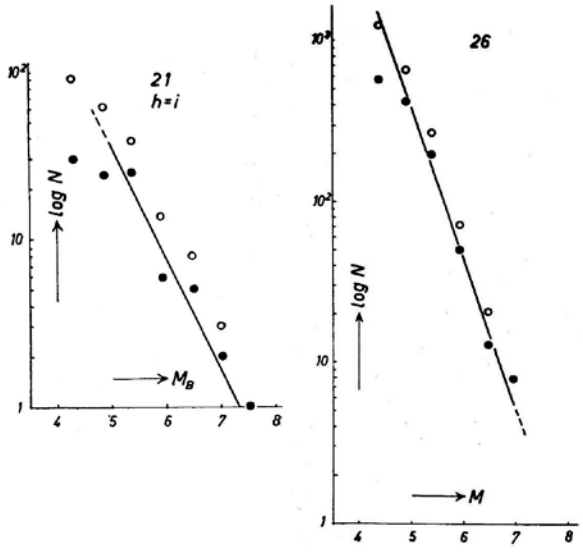
EQ catalogue 1901 – 1955, magnitude M≥4.5 or macroseismic intensity I_0 ≥VI

Incomplete and different classifications of EQ provided by individual countries
Main task – to elaborate a convenient method and to classify EQ uniformly
Regional **M**=a $\mathbf{I_0}$ +b log **h** + c

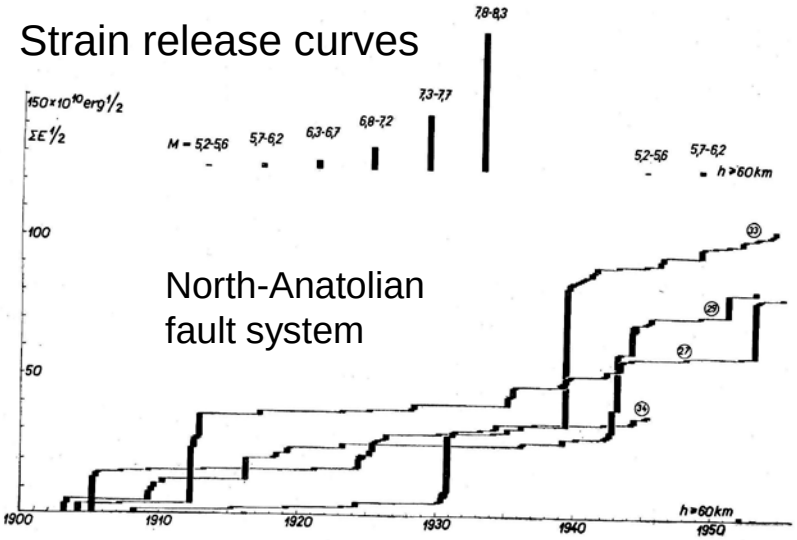
European Seismic Zones



Magnitude-Frequency relations for European Seismic Zones
Log N = a – b M



Strain release curves



North-Anatolian fault system

migration or coincidence of seismic activity

Examples of ISC data application

Seismicity of Europe

Seismicity of the European Area, Part 1 *Kárník, 1968*

EQ catalogue 1901 – 1955, magnitude M≥4.5 or macroseismic intensity I_0 ≥VI

Seismicity of the European Area, Part 2 *Kárník, 1971*

EQ catalogue 1801 – 1900, macroseismic intensity I_0 ≥VII

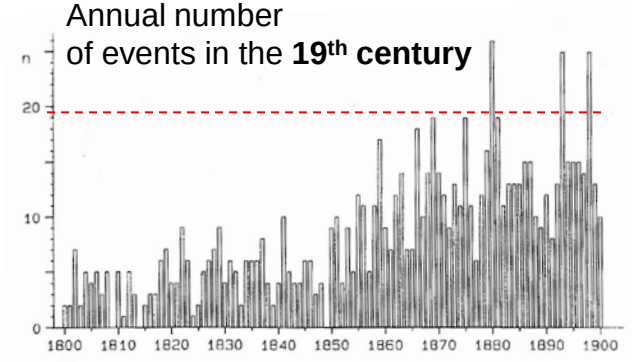
Seismicity of Europe and Mediterranean *Kárník, 1996*

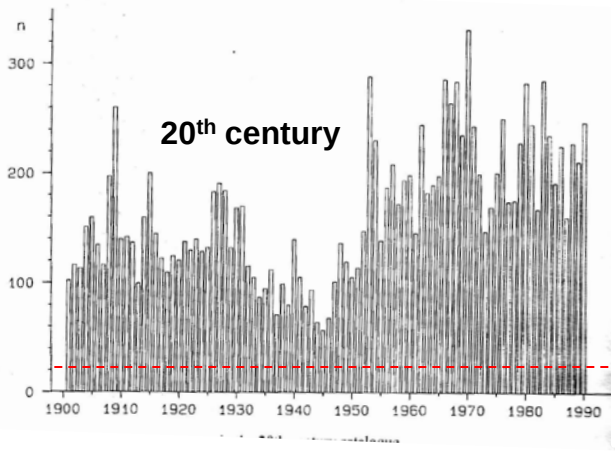
EQ catalogue 1956 – 1990, magnitude M_S≥3.8 or macroseismic intensity I_0 ≥V (MSK)
Revision of EQ catalogue 1901 – 1955 → homogeneous 1901-1990 EQ catalogue

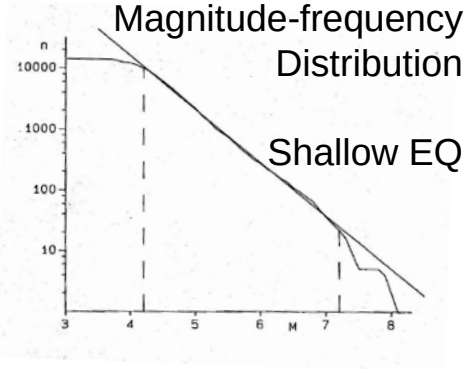
Expansion of modern seismograph networks

- *lower magnitude threshold – weak events in the ISC cataloques*
- *change in magnitude determination - ISC magnitude short-period PV : m_b ~M_S*

$m_b = 0{,}46M_{LH} + 2.47$







Examples of ISC data application

Homogeneous Magnitude System (HMS) in Eurasian continent

- established by method of successive optimization of station corrections and calibrating functions

WORLD DATA CENTER A
for
Solid Earth Geophysics

REPORT SE-18

HOMOGENEOUS MAGNITUDE SYSTEM OF THE EURASIAN CONTINENT: P WAVES

BY
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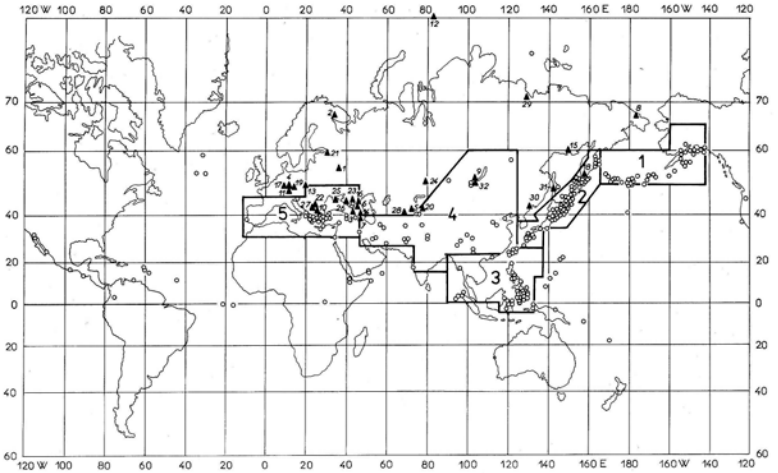
ENVIRONMENTAL DATA AND INFORMATION SERVICE
Boulder, Colorado 80303, USA



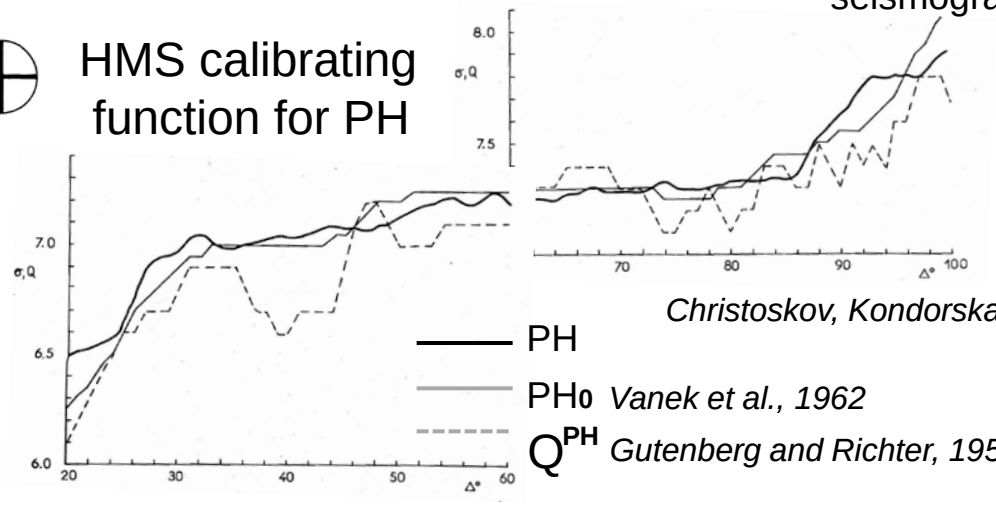
1. Distribution of HMS reference stations (full triangles), earthquake epicentres (open circles), and geographical regions; numbers of stations correspond to Tab. 1.

ISC parameters
for selected 286 EQ
1966-1970
recorded at 32 stations

PH, PV, SH, SV, LH, LV
on broad-band
Class-C seismographs

PVs
short-period Class-A
seismographs

HMS calibrating function for PH

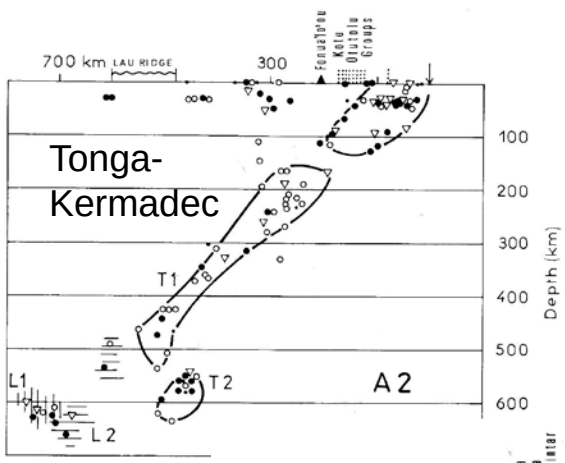


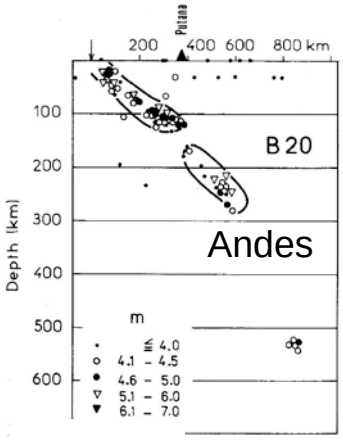
Christoskov, Kondorskaya, Vanek, 1983

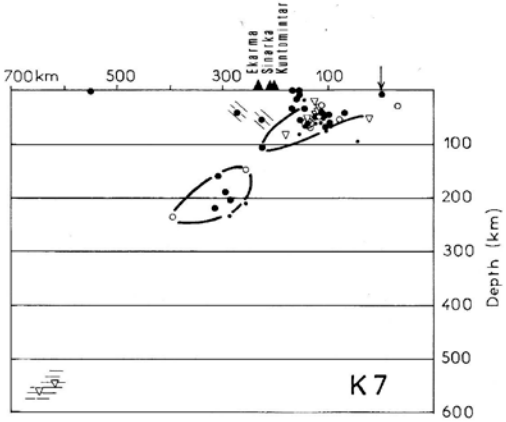
Examples of ISC data application

Morphology of Wadati-Benioff Zones

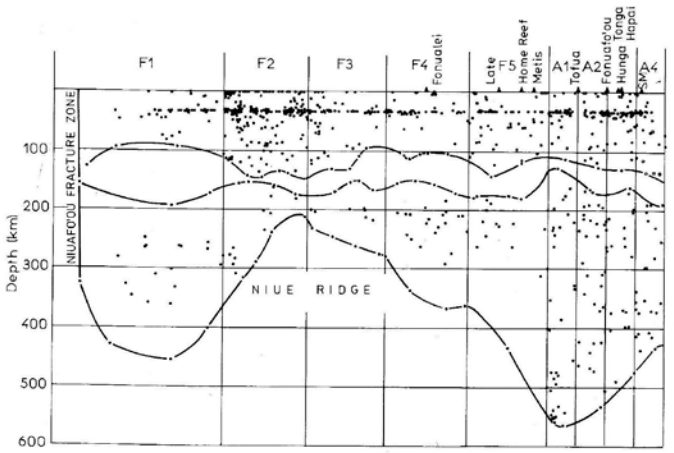
- Established on basis of earthquake foci distribution acc. to ISC parameters in the Regional Catalogue of Earthquakes since 1967
- Close relation of the intermediate aseismic gap with Andean andesitic volcanism
- non-uniform rate of subduction related to the tectonic features of subducted oceanic plates *(e.g. Hanus and Vanek 1978)*







Morphology of the Wadati-Benioff zone in the northern part of the Tonga region



Intermediate aseismic gap

Hanus and Vanek 1985

Lower limit of the W-B zone

Examples of ISC data application

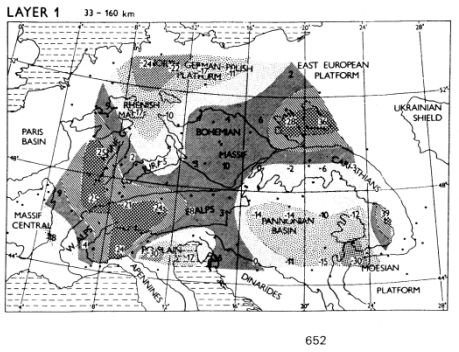
Parametric data published in the ISC catalogues has been used in many other studies in the geophysical institutions in Prague in the past, e.g. in:

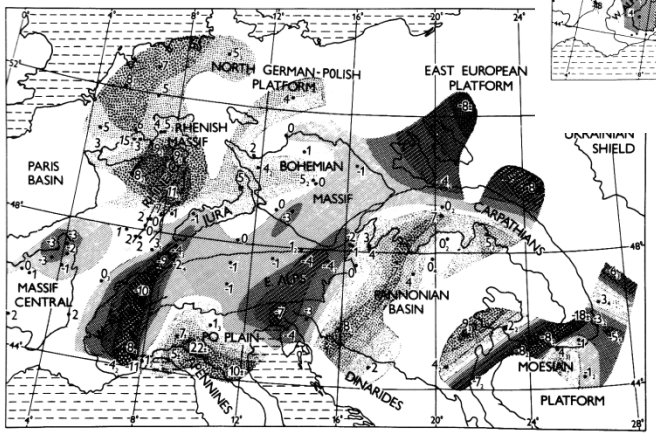
- Systematic and homogenize EQ location
- Developing regional travel times - Friuli, local EQ (tectonic or induced) in CZ
- Local EQ magnitudes
- Very detailed magnitude studies – revealed incorrect intrinsic constant of KIRNOS instrument at station PRU

ISC bulletins – Phase arrival times and Amplitude data

- the first 2º-by-2º body-wave tomography in central Europe

- the first detailed estimates of the LAB and anisotropy in the mantle lithosphere



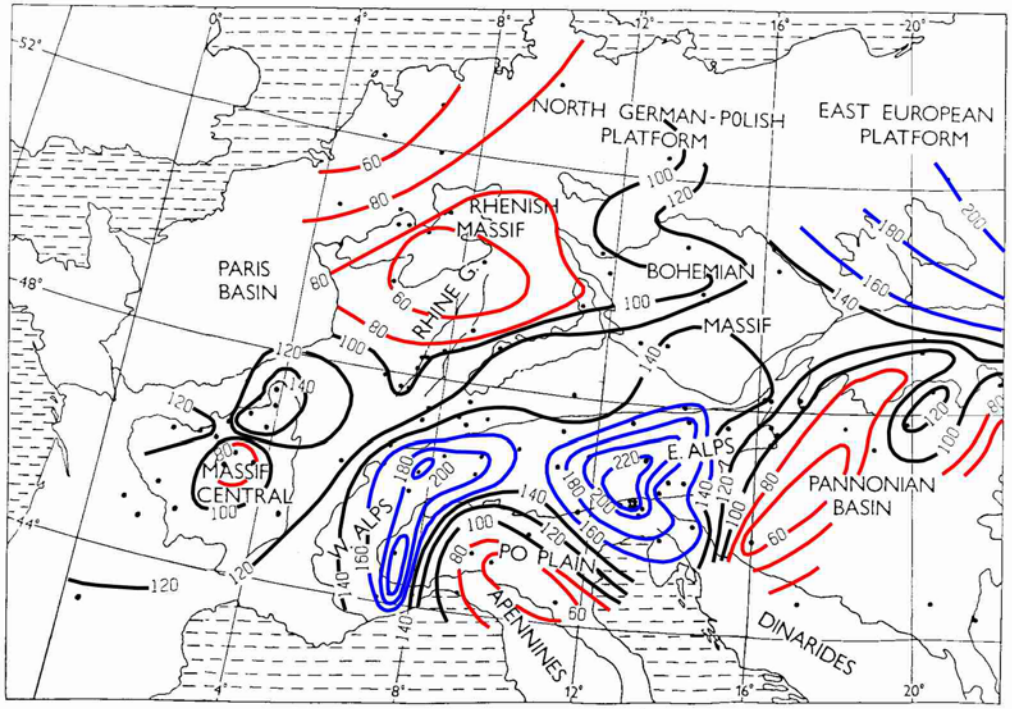


Babuška et al. Annal. Geophys.1984, GJI 1984

Examples of ISC data application

Lithosphere as a high-velocity portion of the outer shell of the Earth

LAB derived from the P-wave arrivals in the ISC bulletins



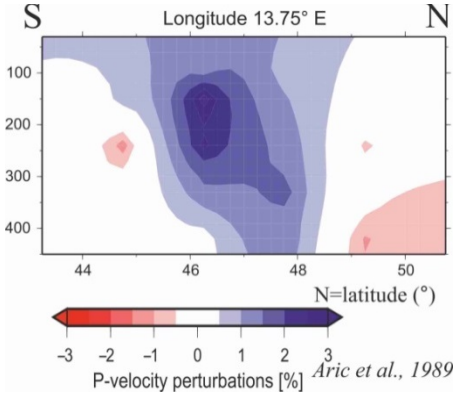
Babuška et al., 1984; 1987; Babuška and Plomerová , 1992

- Lateral ***variations of lithosphere in thickness*** ~ mapped through ***lateral variations of isotropic P-wave velocity***
- **dH/dRo = 9.4 km/0.1s** Empirically derived for Europe (*Babuška et al., 1984*)

Data extracted from the ISC bulletins
manually, processed carefully
~100 stations
events from epic. dist. 20-100º

- Thin lithosphere beneath basins; thick L towards the EEC and beneath the Alps;
- Two separated roots of subducting lithosphere beneath the Alps:
- Western Alps: European lithosphere subducts to SE
- Eastern Alps: very steep root slightly to the N

Babuška, Plomerová, Granet, Tectonophys. 1990



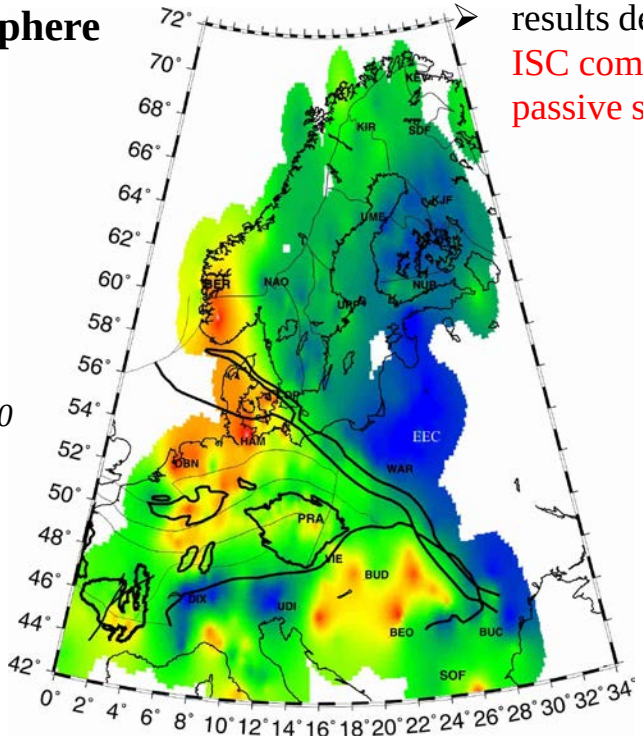
Usage of parametric data published by the ISC at present:

- though digital seismology has changed the way of data processing and analyzing - demands on precise EQ location and magnitude determination remains

Thickness of European lithosphere

Plomerová and Babuška, Lithos 2010

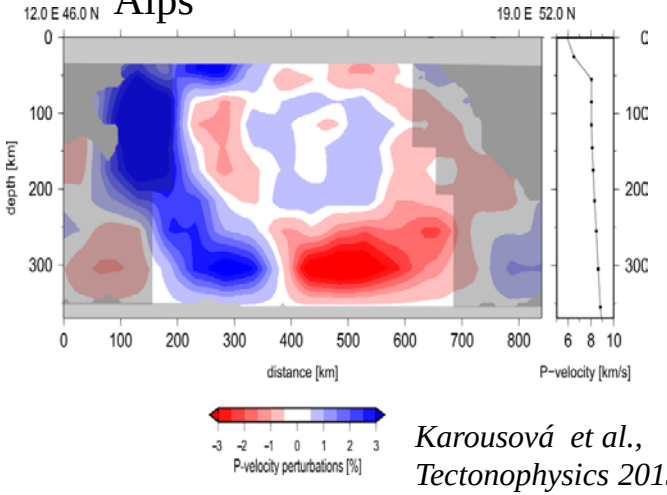
Data from PASSEQ (2006-2008) experiment incorporated



- results derived from arrivals times from the ISC complemented by results from several passive seismic experiments.

E. Alpine lithosphere root steeply dipping ***to the North*** in detailed regional tomography of the upper mantle (BOHEMA III + 1/2 ALPASS experiments)

SW Alps Bohemian Massif NE

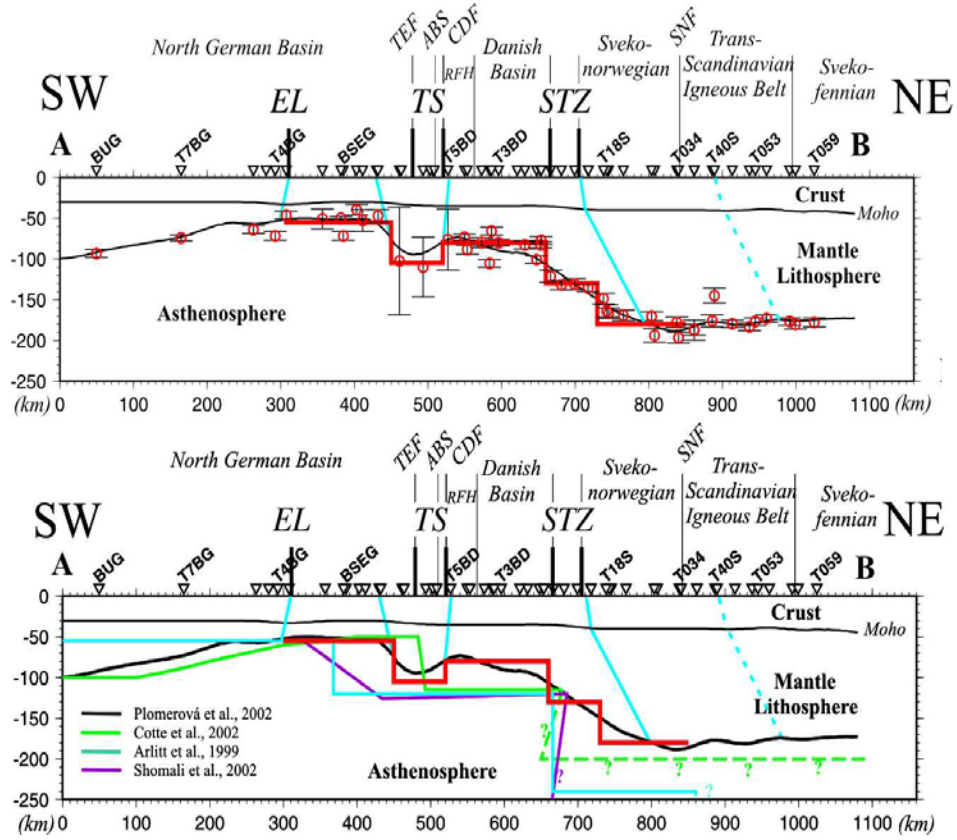


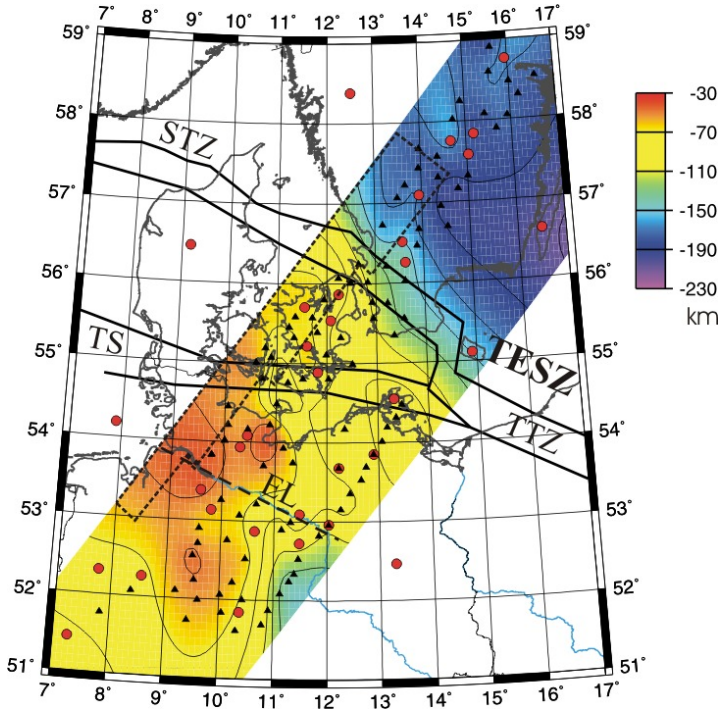
Karousová et al., Tectonophysics 2013

By incorporating results from temporary stations

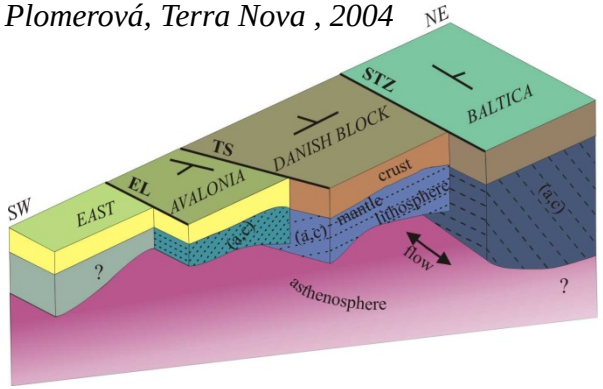
- the general features of LAB did not change
- greater details in the LAB relief can be modelled in regions covered by dense networks of stations

LAB around the western TESZ from P-wave travel times - TOR data





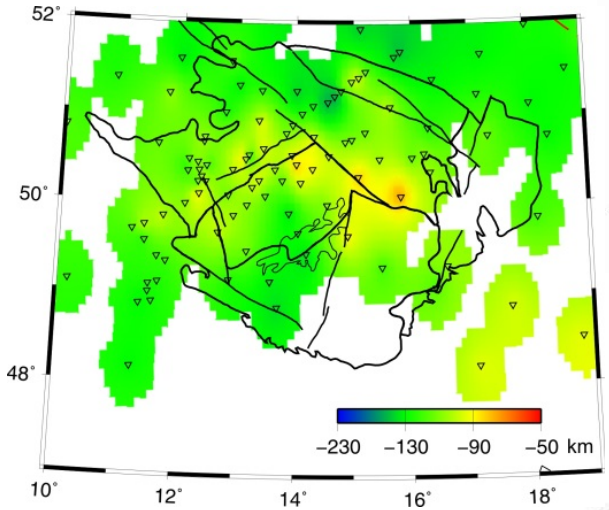
Plomerová et al., Tectonophys., 2001,
Babuška and Plomerová, Terra Nova , 2004



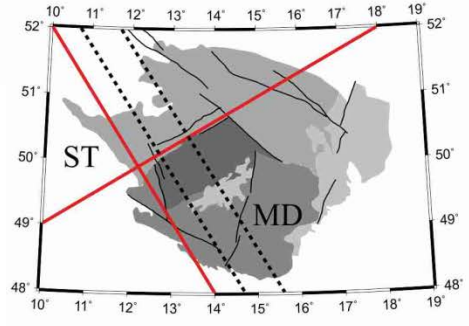
The Danish Basin may represent an allochtonous microplate with “ready-made” mantle lithosphere fabric prior to its docking between Avalonia and Baltica, probably before the Caledonian deformation.

Teleseismic P-wave tomography

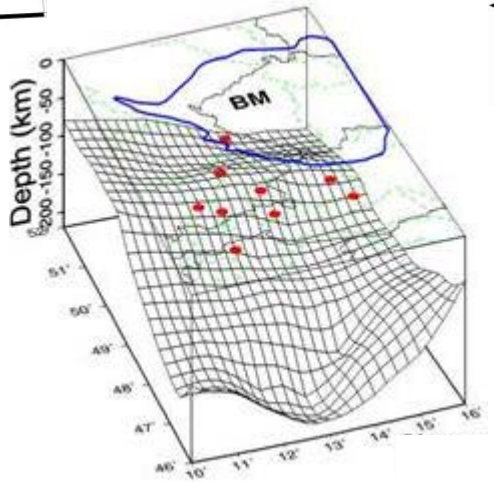
LAB relief beneath the Bohemain Massif

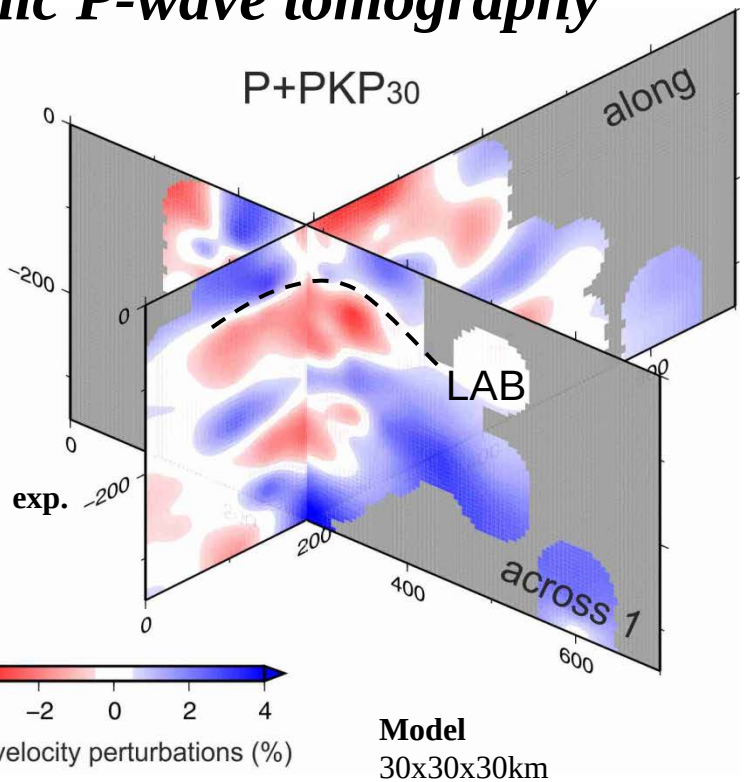


Derived from EgerRift and PASSEQ experiment data



DATA – BOHEMA exp.
17 776 rays
295 events
165 stations



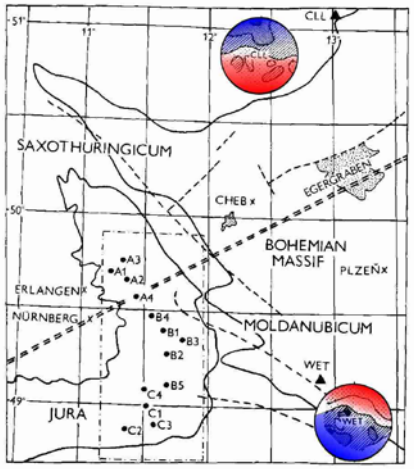


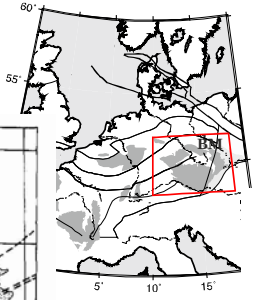
Model
30x30x30km
350km depth

Plomerová et al., PAGEOPH 1998

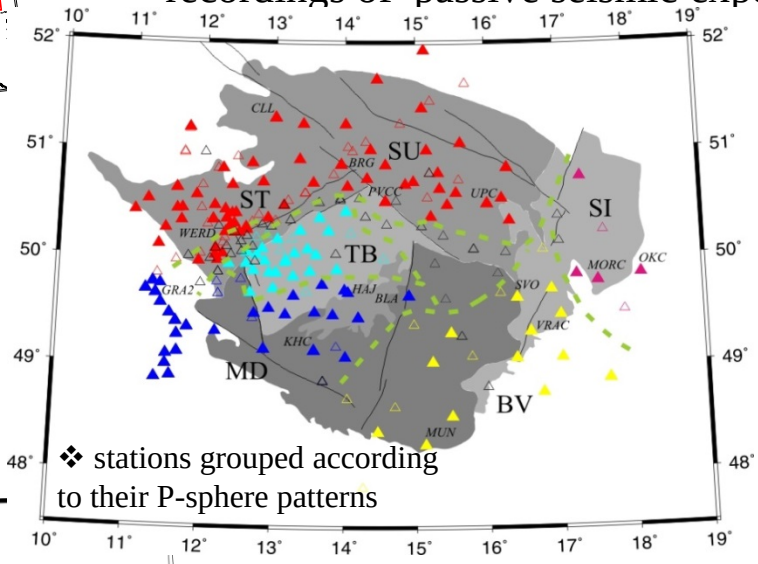
Domains of mantle lithosphere - each with consistent anisotropic signal

Data source:
ISC arrival times





Data source: **correlated picks of P arrival times** of recordings of passive seismic experiments

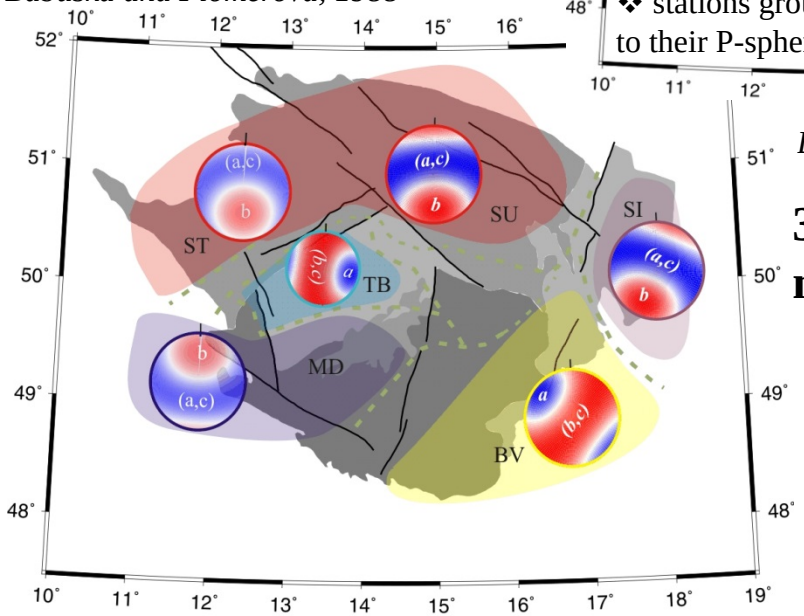


Passive seismic experiments in the BM

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

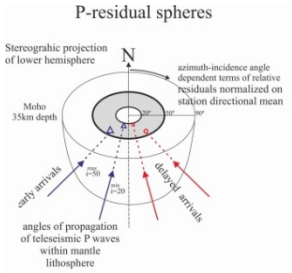
Babuška and Plomerová, 1988

❖ stations grouped according to their P-sphere patterns



Babuška and Plomerová., Gondwana Res. 2013

3D self-consisten anisotropic models of BM lithosphere domains



Joint inversion of directional travel-time deviations in the P spheres and shear-wave splitting

Conclusions

- Parametric ***data*** provided by the ***ISC maintains its significance to the research*** and represents a ***long-term fundamentals of seismological research in Prague***.

- The IG CAS reports regularly its seismic data to the ISC and incorporates the ISC locations and magnitude determination into CRSN annual bulletins.

- In the past, V. Kárník, J. Vaněk and J. Plomerová contributed to the successful operation of the ISC as members of the Exec. Committee and Gov. Council.

- ***Irreplaceable feature of the ISC*** functioning lies in providing the ***long-term continuity of the high-quality data***, which is ***substantial*** for quality of the ***scientific research*** in different fields of ***geosciences***.

Thanks for your attention