# From Plate Deformation to Geohazards: The Eastern Margin of the Adriatic Plate *(DEFORM)*

## Programme Committee:

Prof. Dr. Eline Le Breton, *Freie Universität Berlin,* ***geology, plate kinematics***

Prof. Dr. Claudio Faccenna, *Helmholtz-Zentrum Potsdam – Deutsches GeoForschungsZentrum,* ***geology, geodynamics***

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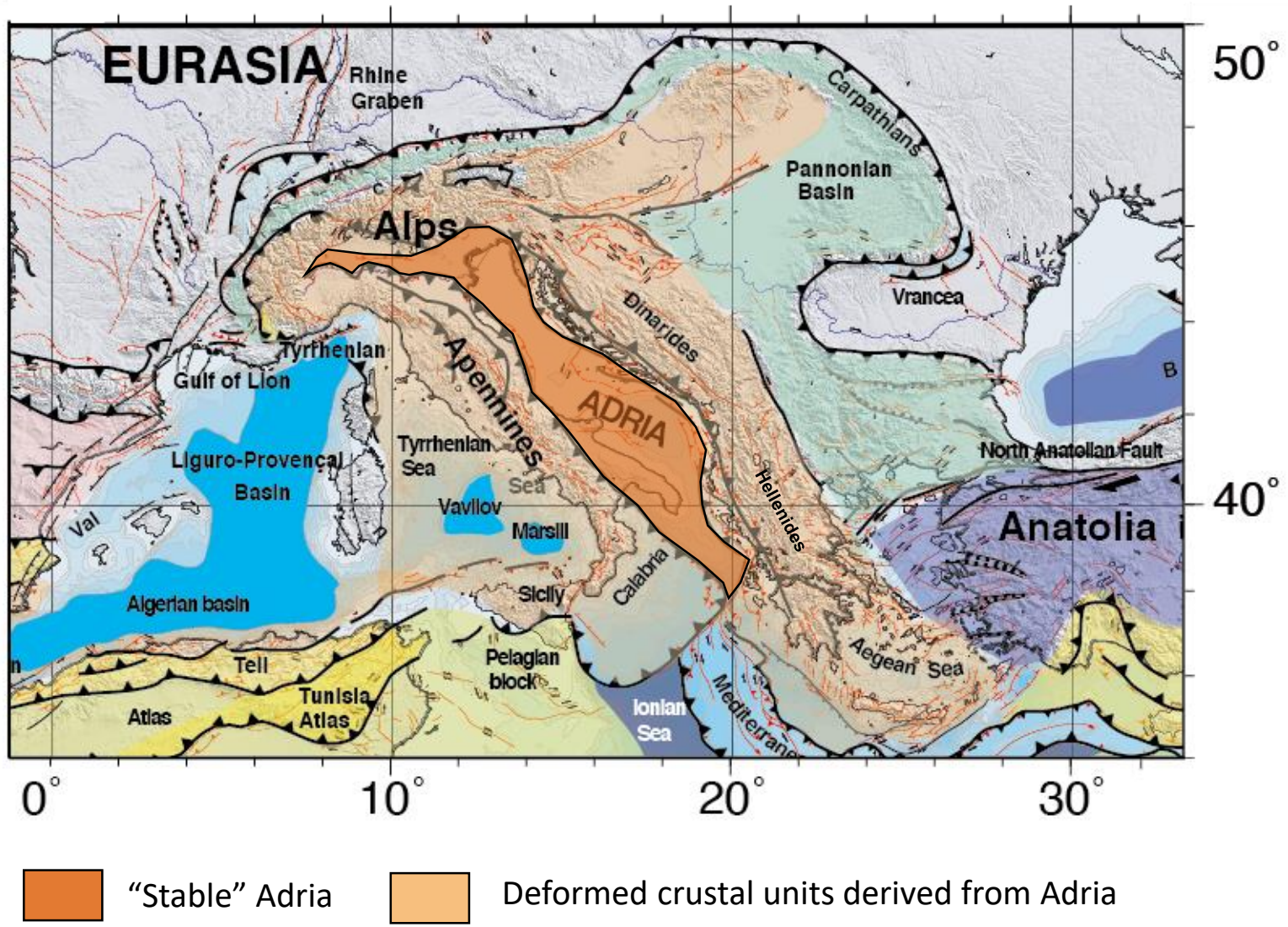
Prof. Dr. Heidrun Kopp, *GEOMAR Helmholtz-Zentrum für Ozeanforschung Kiel,* ***marine geodynamics***

Prof. Dr. Thomas Meier, *Christian-Albrechts-Universität Kiel*, ***seismology***

**Research Themes:**

1. Dynamics of plate deformation - from oceanic subduction to continental collision **(plate-scale processes)**
   - Plate configuration?
   - Geodynamic drivers?
2. Active faults and diffuse deformation at plate boundary zones **(fault-scale processes)**
   - Localized vs. diffuse deformation?
   - Seismic vs. aseismic behaviour?
3. Physical rupture models for seismic and tsunami hazard assessment **(geohazards)**
   - Physical modelling of geohazards?
   - Factors controlling geohazards?



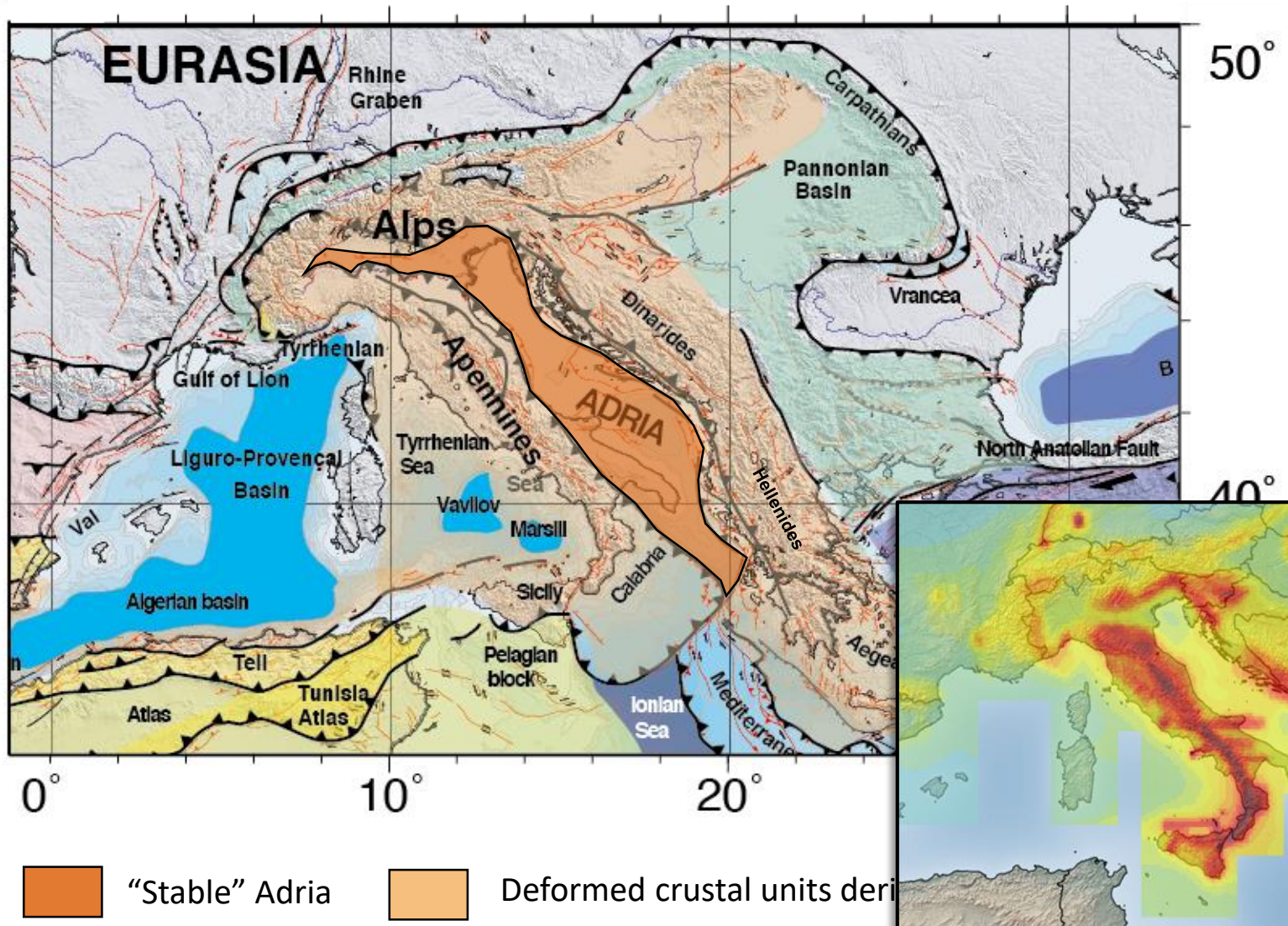

"Stable" Adria

Deformed crustal units derived from Adria

- Broad plate boundary zones
- Multiple subduction setting
- Switches in subduction polarity
- Slab break-offs and rollback, trench retreat and upper-plate extension

C. Faccenna, E. LeBreton

- Broad plate boundary zones
- Multiple subduction setting
- Switches in subduction polarity
- Slab break-offs and rollback, trench retreat and upper-plate extension
- Geohazards (earthquakes, tsunamis, landslides, volcanic eruptions)







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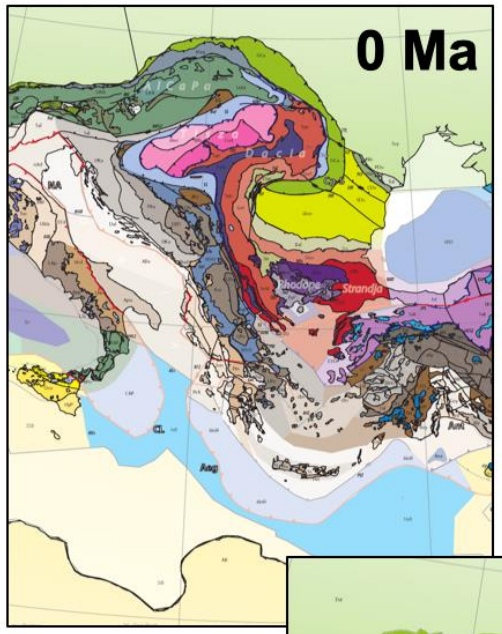
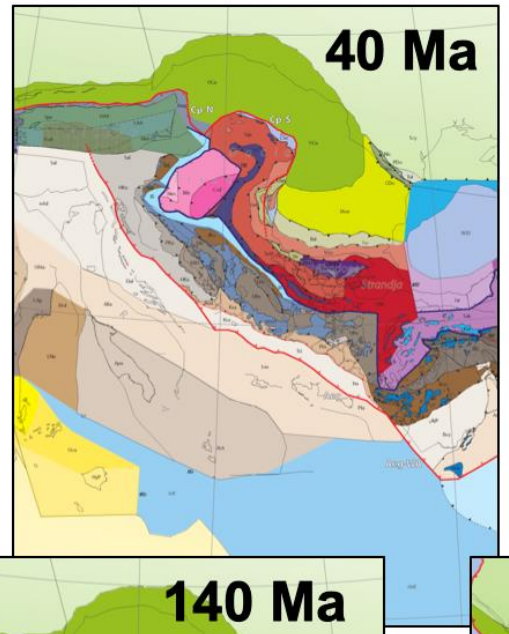
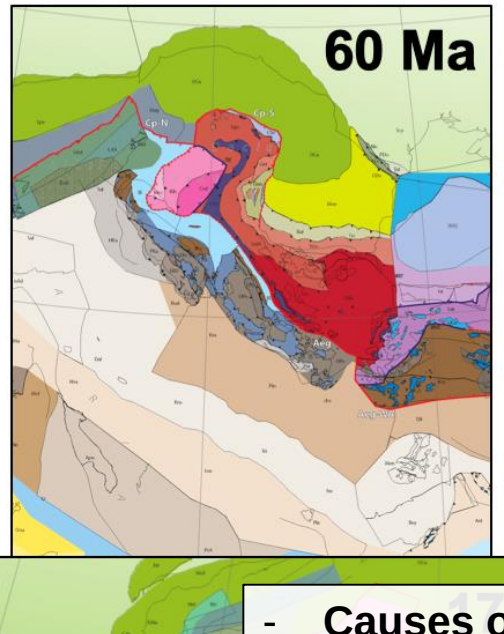
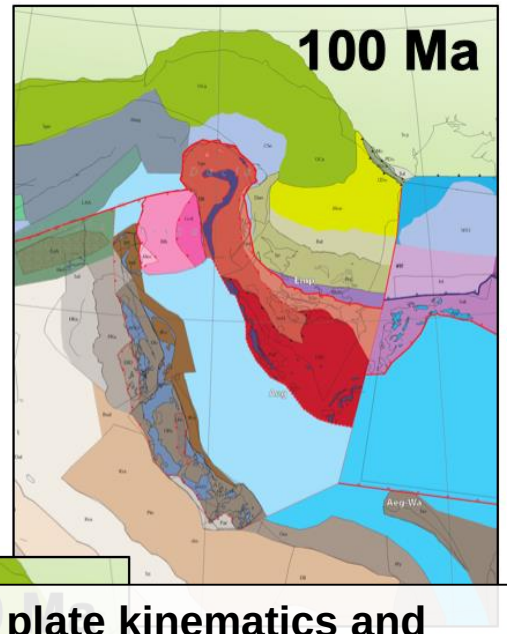
Woessner et al. 2013

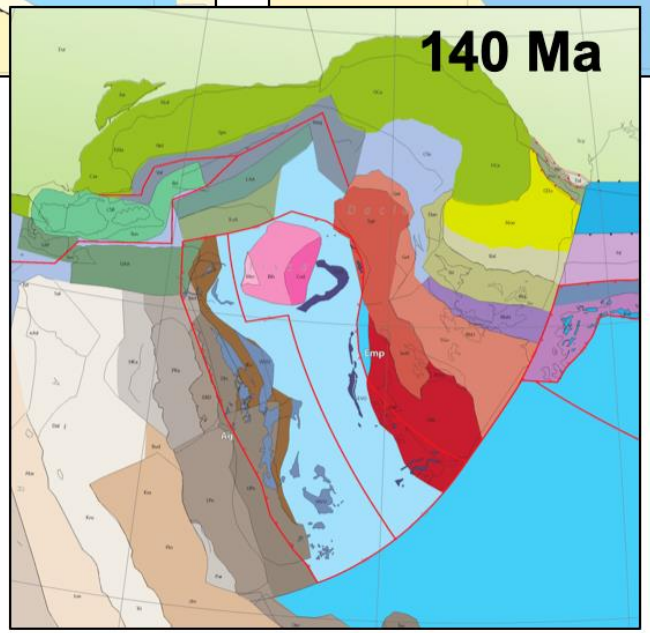
# Adria: plate kinematic reconstruction

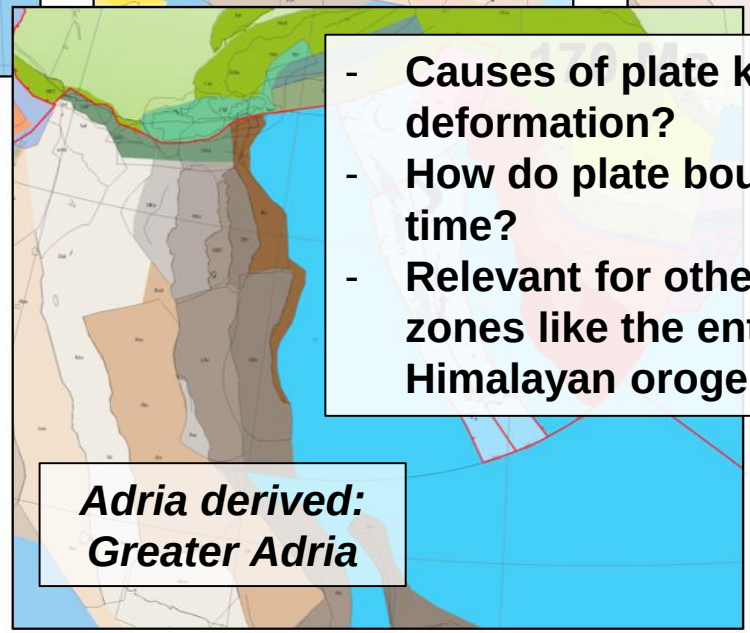


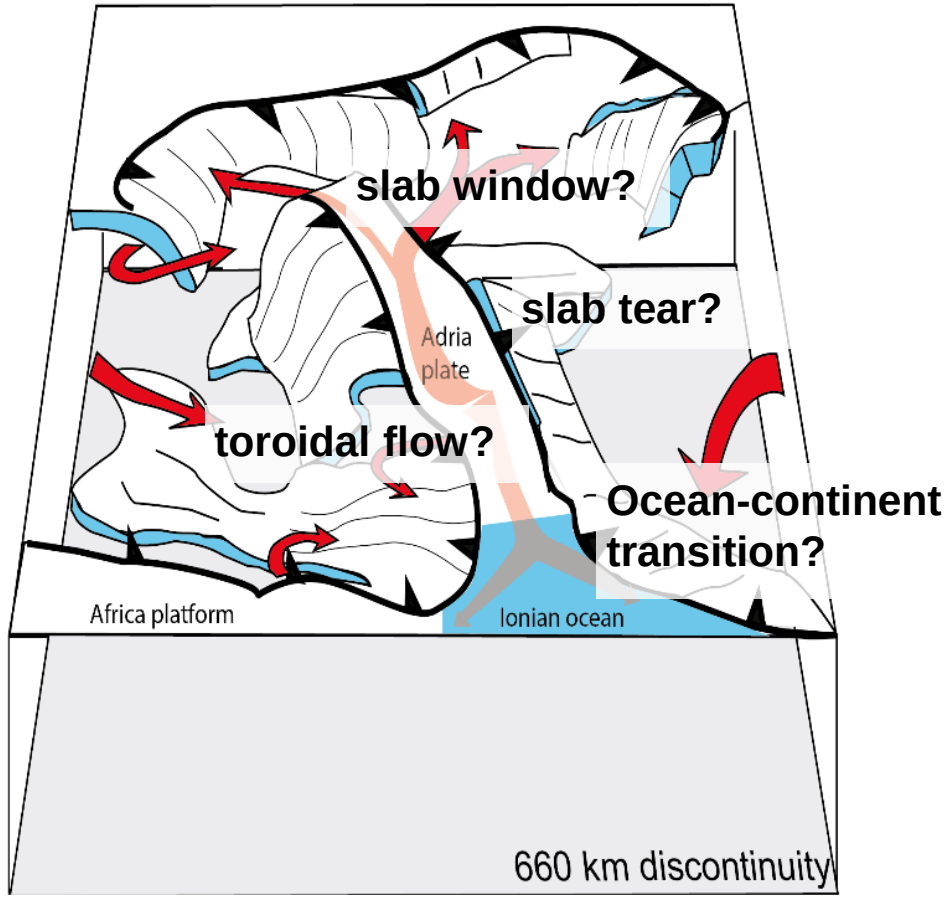



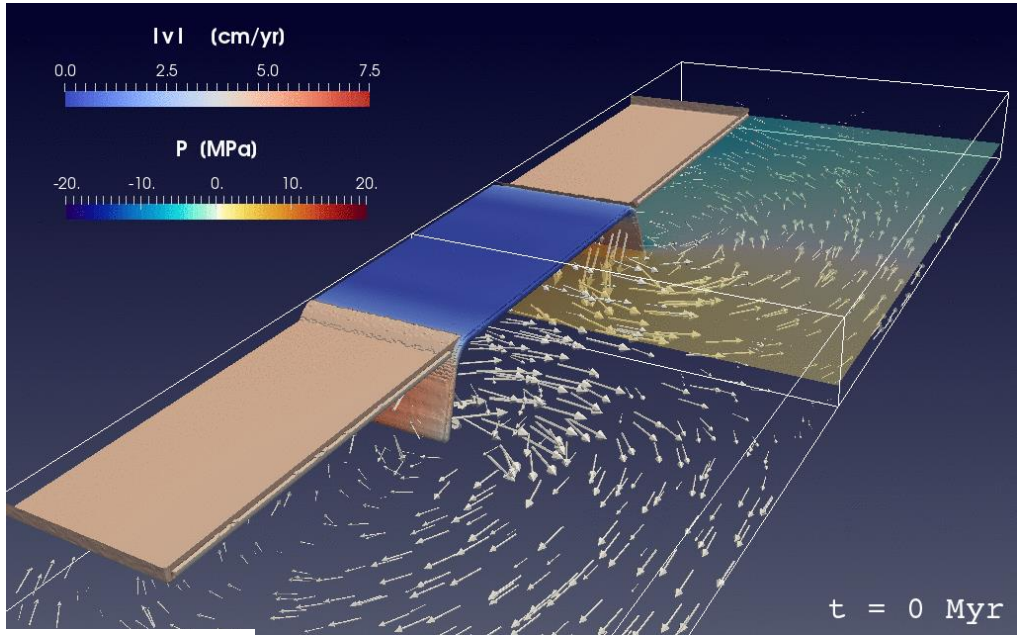

- **Causes of plate kinematics and deformation?**
- **How do plate boundaries evolve through time?**
- **Relevant for other broad plate boundary zones like the entire Mediterranean-Himalayan orogenic belt or Indonesia**

van Hinsbergen et al. 2020

# Causes for plate deformation: slabs, asthenospheric flow




*Kiraly et al. (2018)*

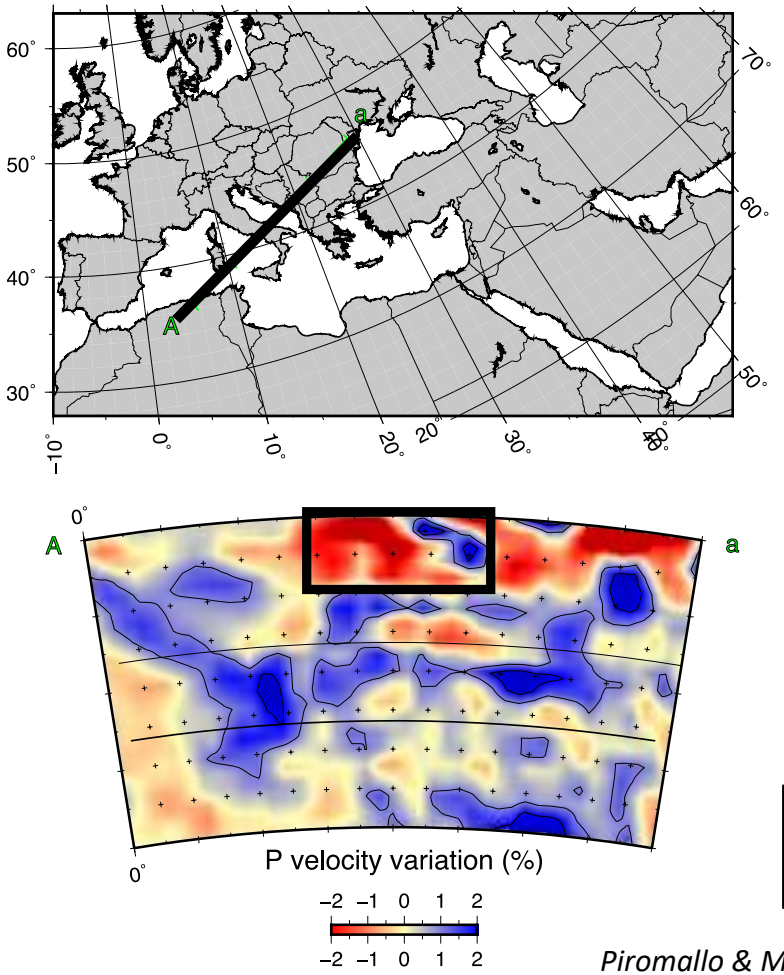



*Holt et al. (2017)*

- **Geodynamic 3D modelling using realistic plate configurations?**

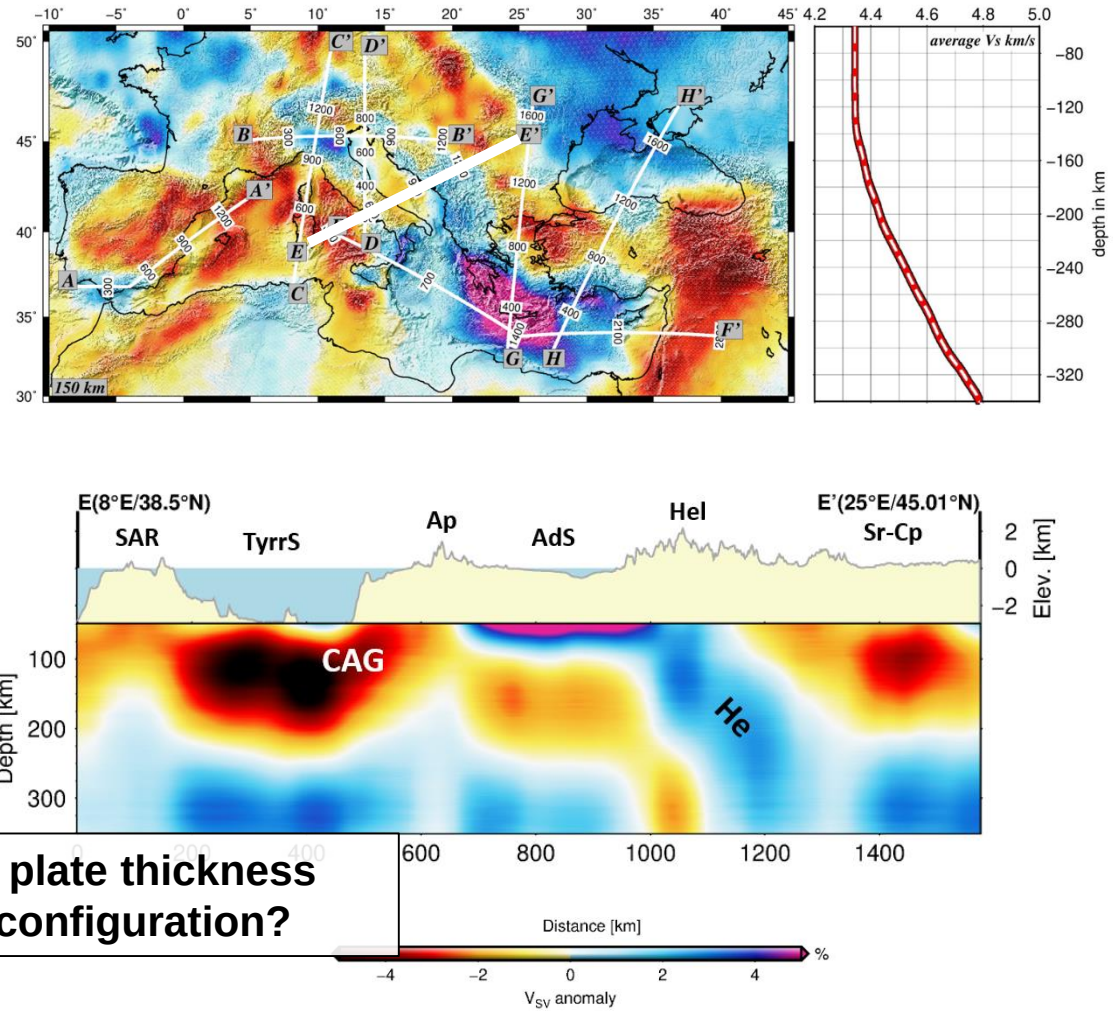
# Constraints for 3D geodynamic modelling: passive seismic imaging

## regional Vp tomography




*Piromallo & Morelli (2003)*

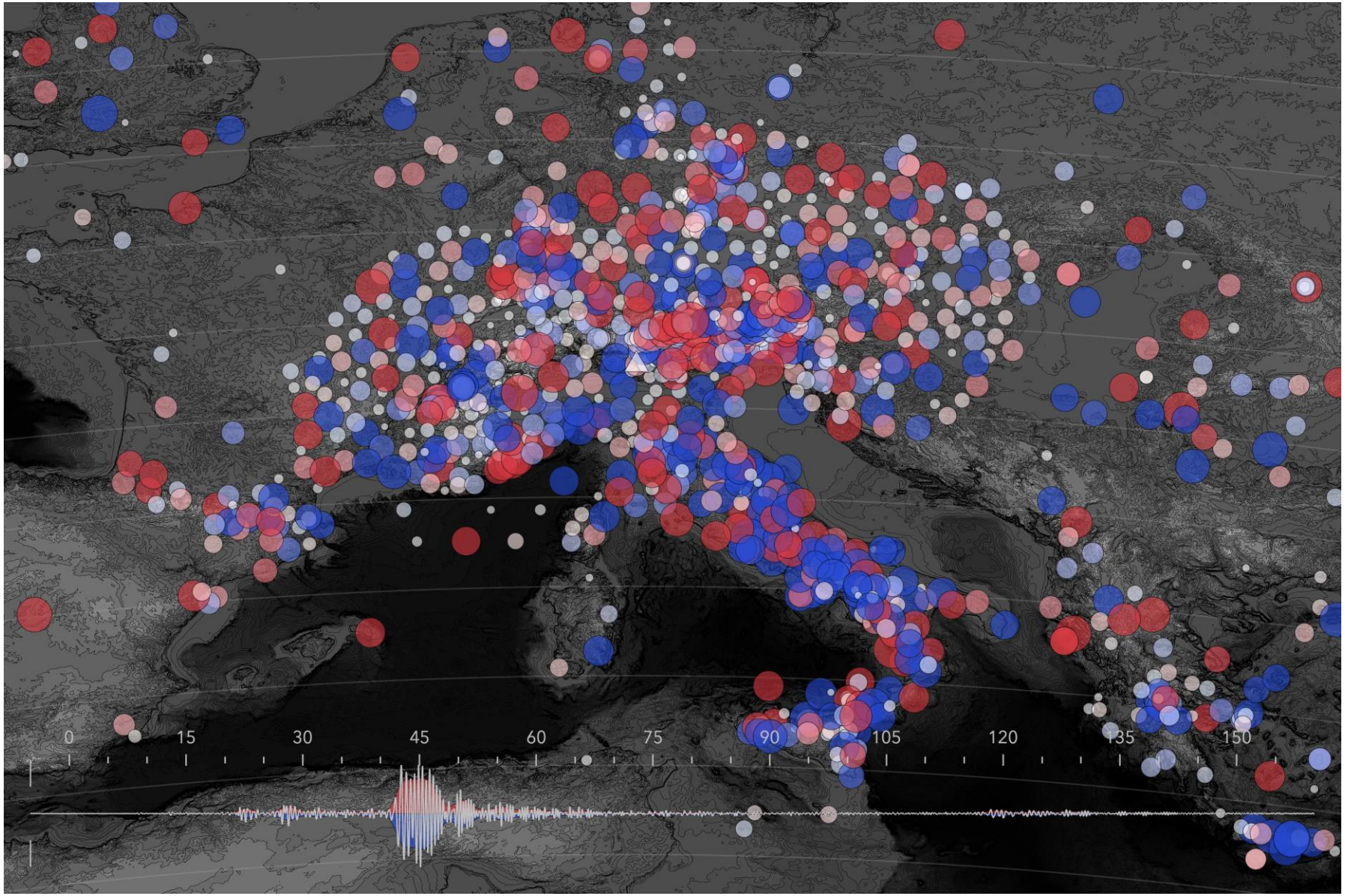
## regional Vs tomography



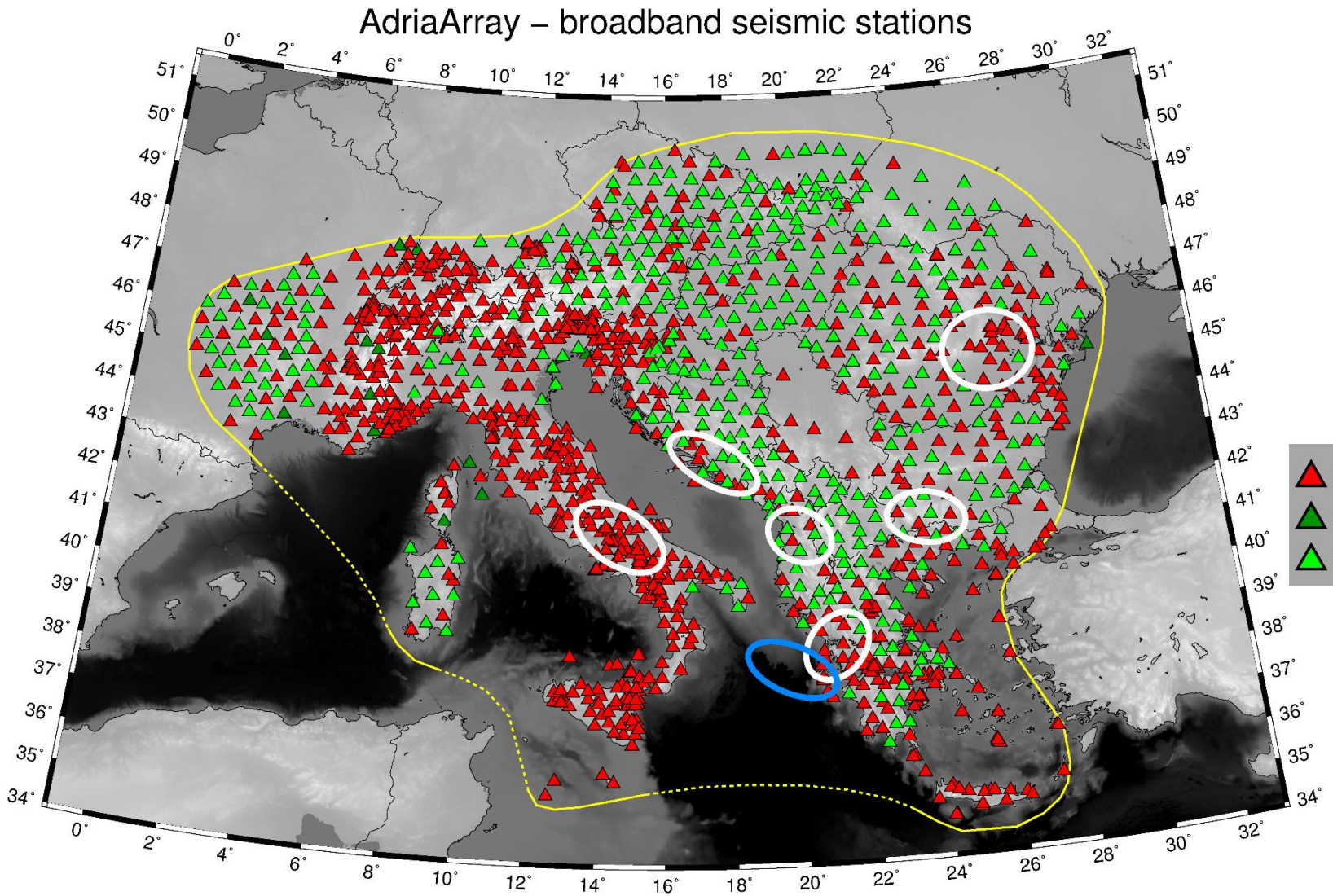

*El-Sharkawy et al. (2020)*

– **Details of the plate thickness and 3D plate configuration?**

# Wavefields AlpArray + European networks (south atlantic, 28.01.2018)




Tesch et al. (2021)

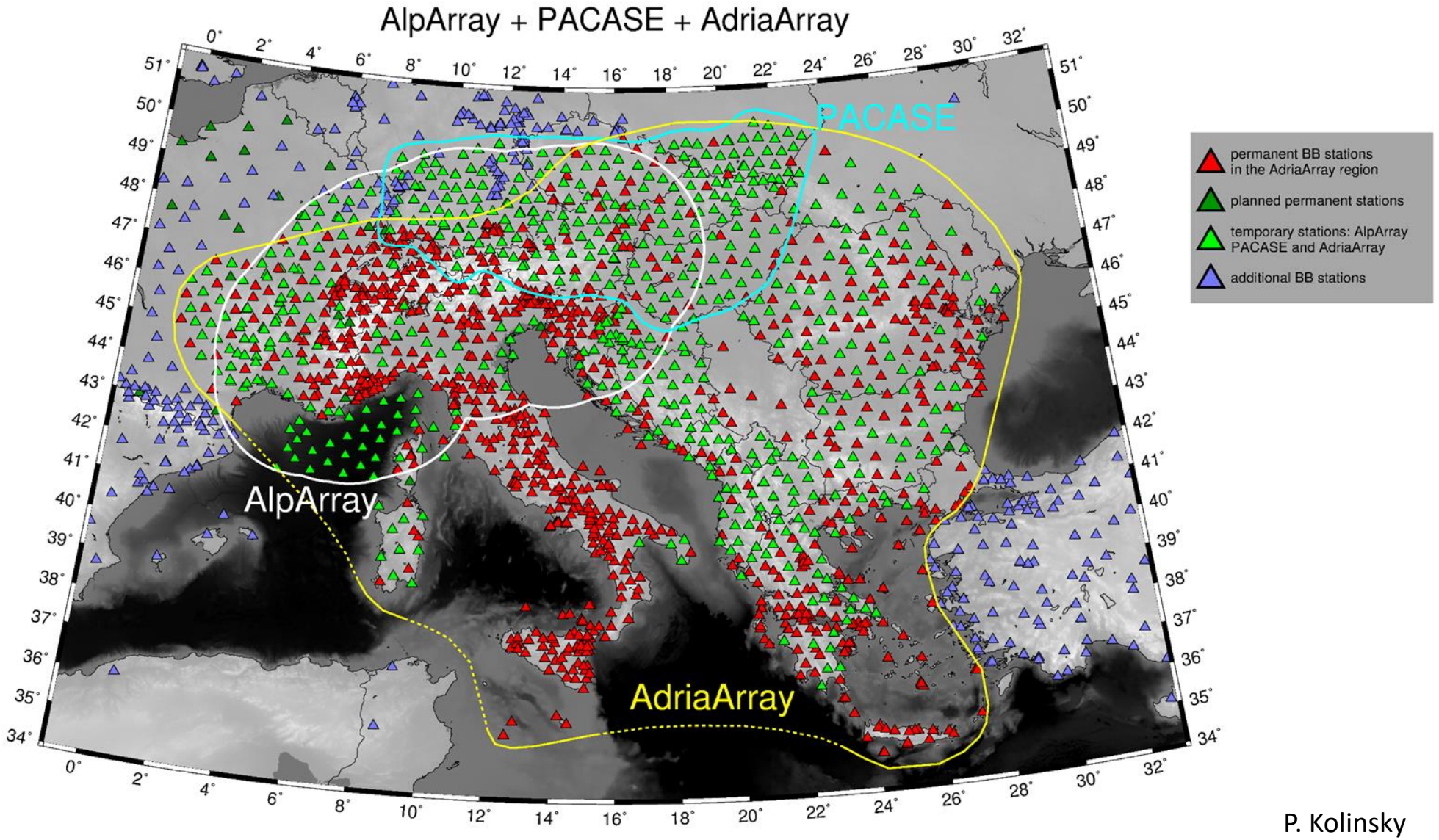



**AdriaArray**

- 1380 broad-band stations (971 permanent including 89 non-EIDA stations, 409 temporary stations)
- local experiments
- almost 50 institutions (27 countries) interested
- Preparation since 2018
- AdriaArray Seismology Group: May 2022 (coordinator: T. Meier)
- 2022-2024

- **EPOS – SP**
- **ORFEUS/EIDA**

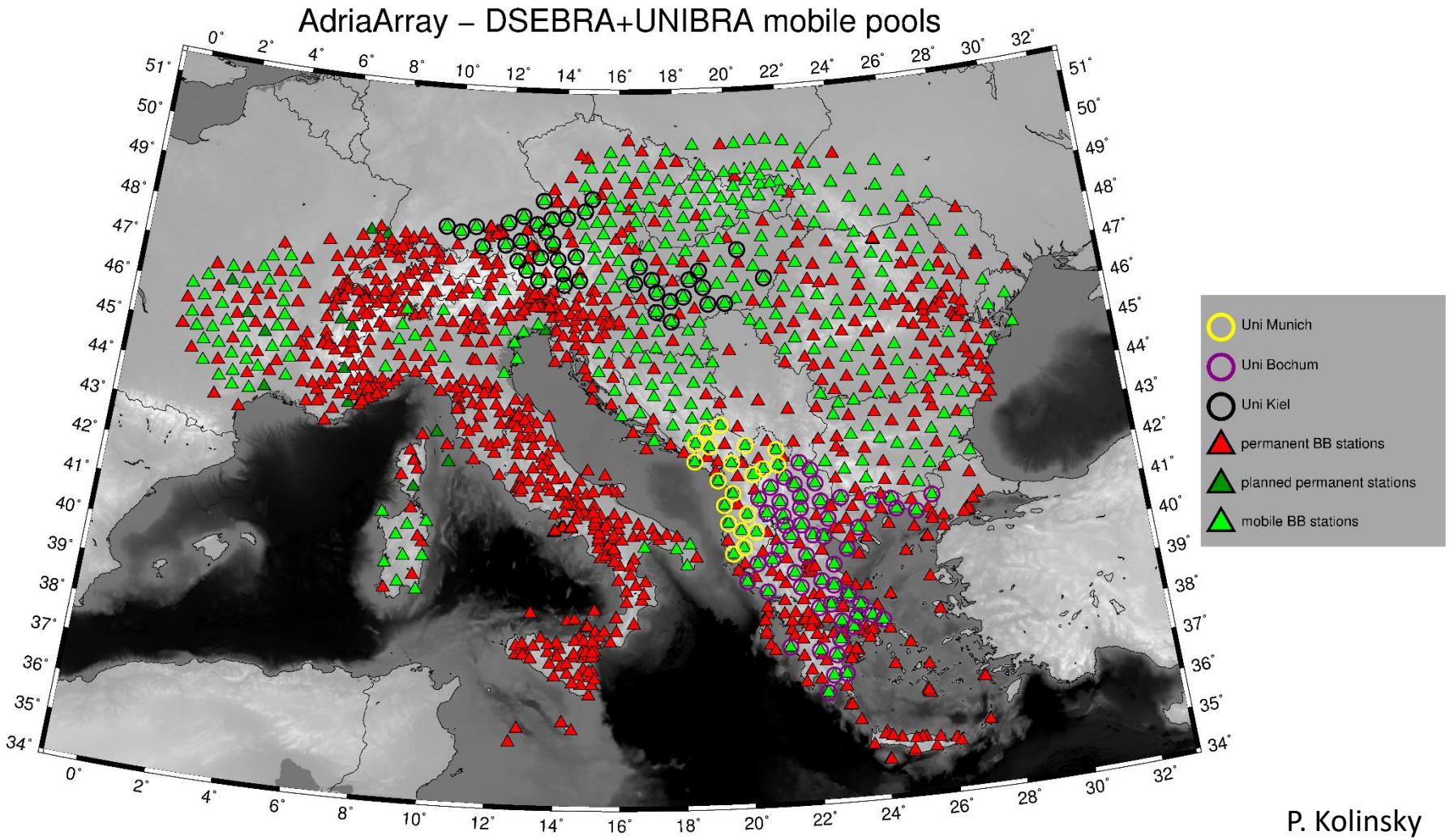
P. Kolinsky


AlpArray + PACASE + AdriaArray
PACASE
AlpArray
AdriaArray
permanent BB stations in the AdriaArray region
planned permanent stations
temporary stations: AlpArray PACASE and AdriaArray
additional BB stations

P. Kolinsky

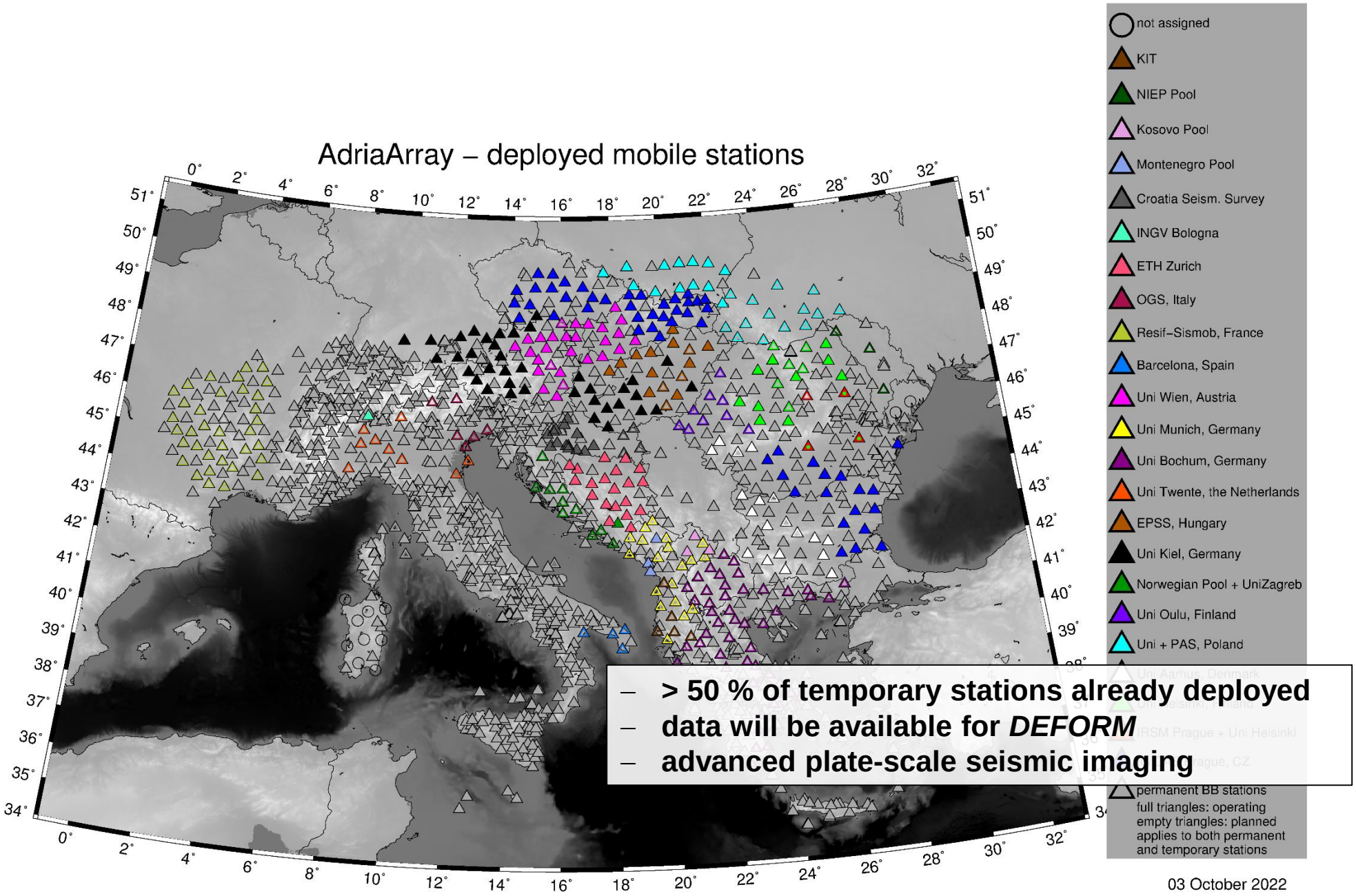
**DSEBRA**

- 4D-MB: pool of 100 broad-band stations (ca. 3 M€, operation ca. 0.3 M€)
- 4 universities: Bochum, Frankfurt, Kiel, Münster
- Deployment in AlpArray from 2016-2019 by LMU Munich
- 2019-2022: PACASE (Pannonian Carpathian Seismic Experiment)
- Since June 2022: AdriaArray

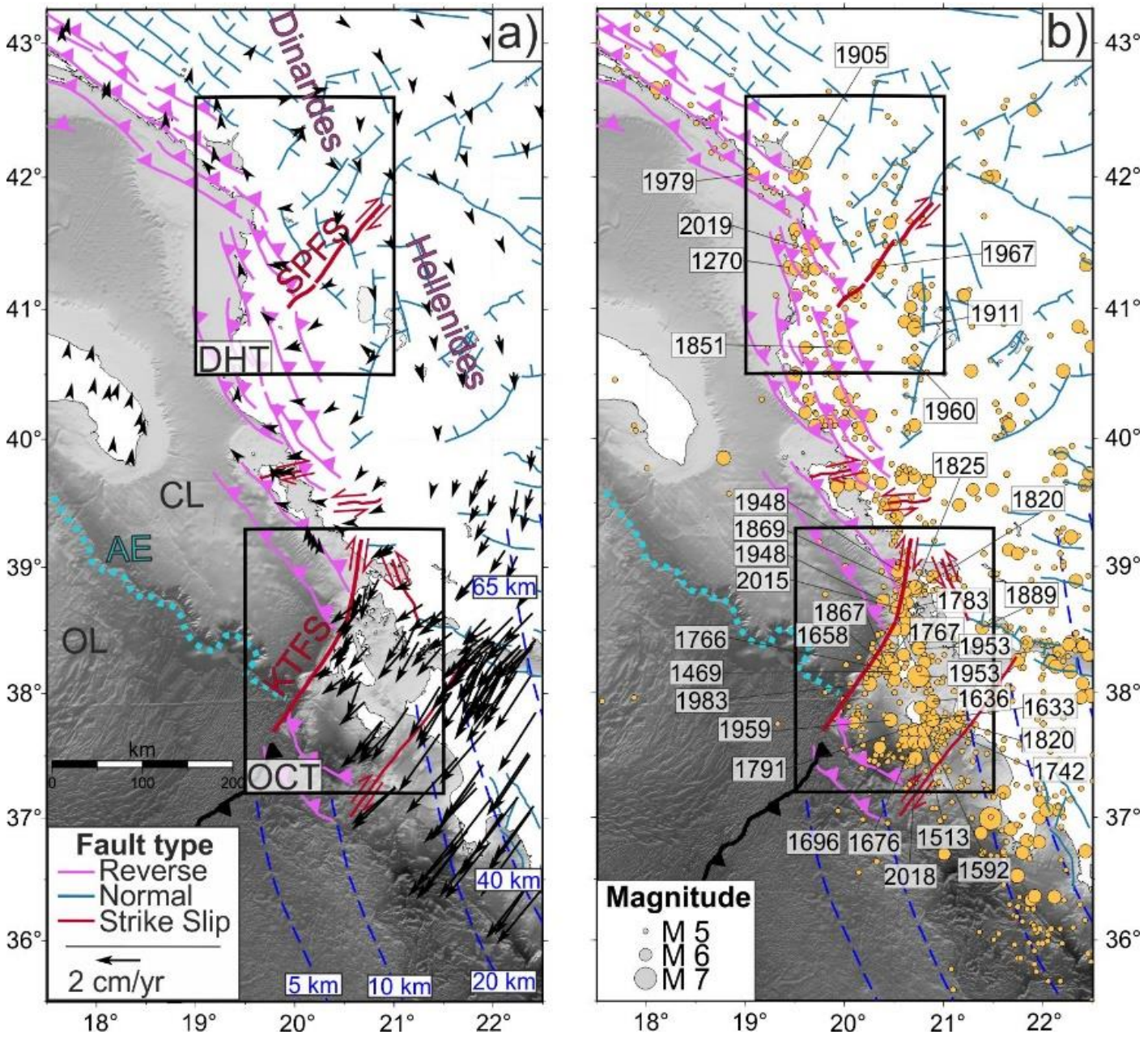



- 100 DSEBRA stations (Germany, Austria, Hungary, Montenegro, Northern Macedonia, Greece)
- Focus on eastern margin of the Adriaric Plate

P. Kolinsky



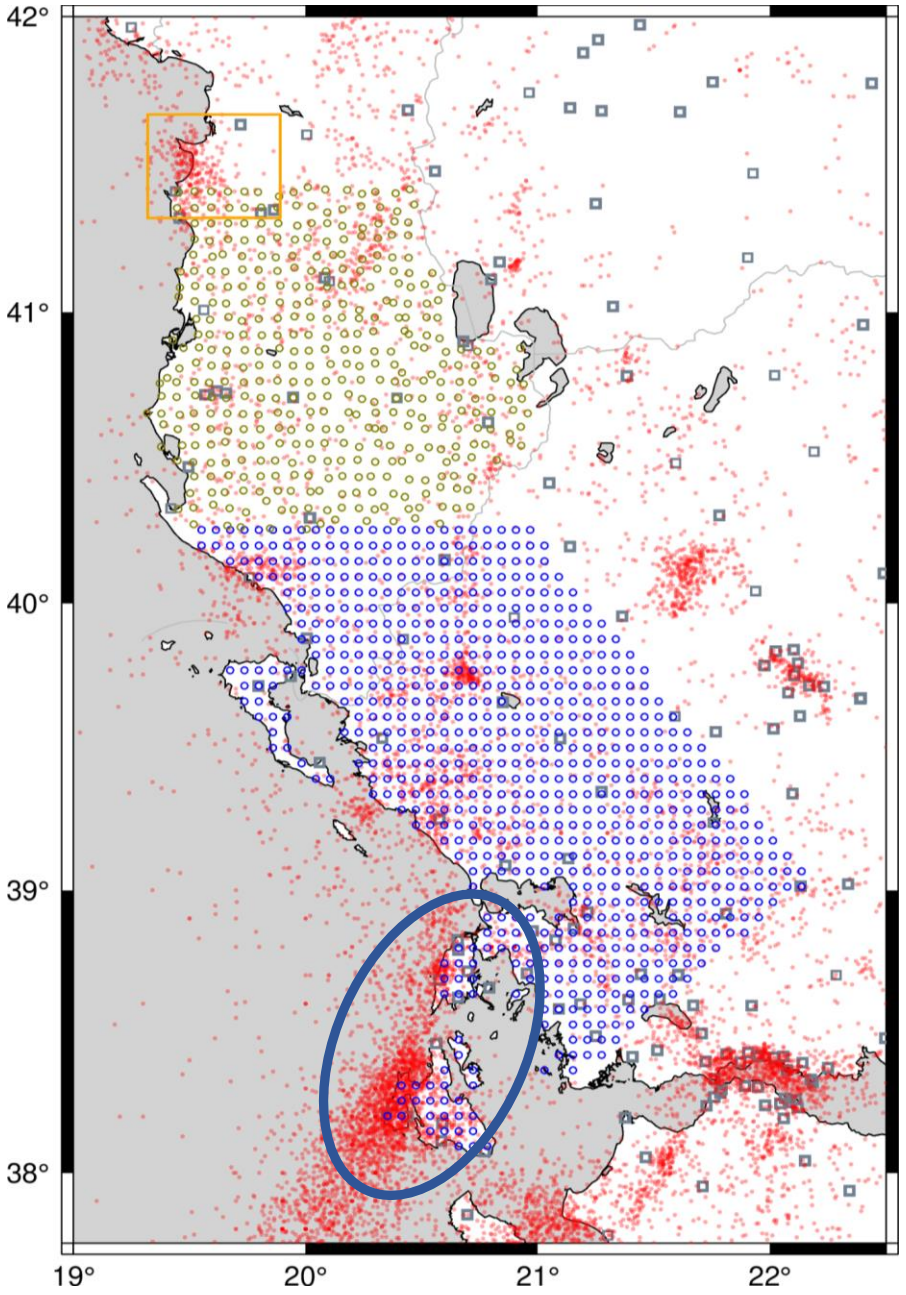

- **> 50 % of temporary stations already deployed**
- **data will be available for *DEFORM***
- **advanced plate-scale seismic imaging**




## *DEFORM:* detailed analysis of fault systems in key areas

- Dinarides-Hellenides Transition (DHT): Mw 6.7 earthquakes in 1967 and 1979, Mw 6.4 Durrës in 2019
- Ocean-Continent Transition (OCT): Kefalonia Transform Fault System - Mw 7.0 1953 and the Mw 6.8 1983, Mw 6.5 Lefkada in 2015

- **Evolution of faults (slip and recurrence rates)?**
- **Geometry and seismogenic potential of faults?**
- **3D stress fields?**




***DEFORM:***

- **Rolling LargeN experiment:**
  - 400 are currently deployed in Albania (DHT), yellow circles
  - 500 short period stations, 6 km station spacing, two campaigns, blue circles

- **Microseismicty: location of faults, stress field**
- **High-resolution image of upper crust**

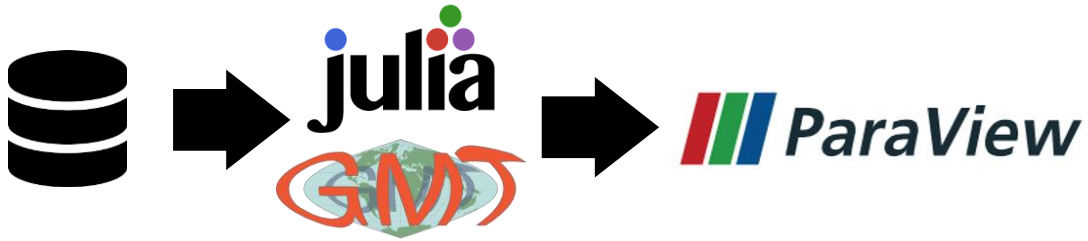
- **Marine experiment:**
  - Bathymetry, AUV, active seismics (< 1.5 s TWT), coring (< 15 m)
  - OBS

- **Fault morphology 1 m resolution**
- **Reconstruct: submarine mass transport, landslides, lateral displacement**
- **Microseismicity, crustal tomography**

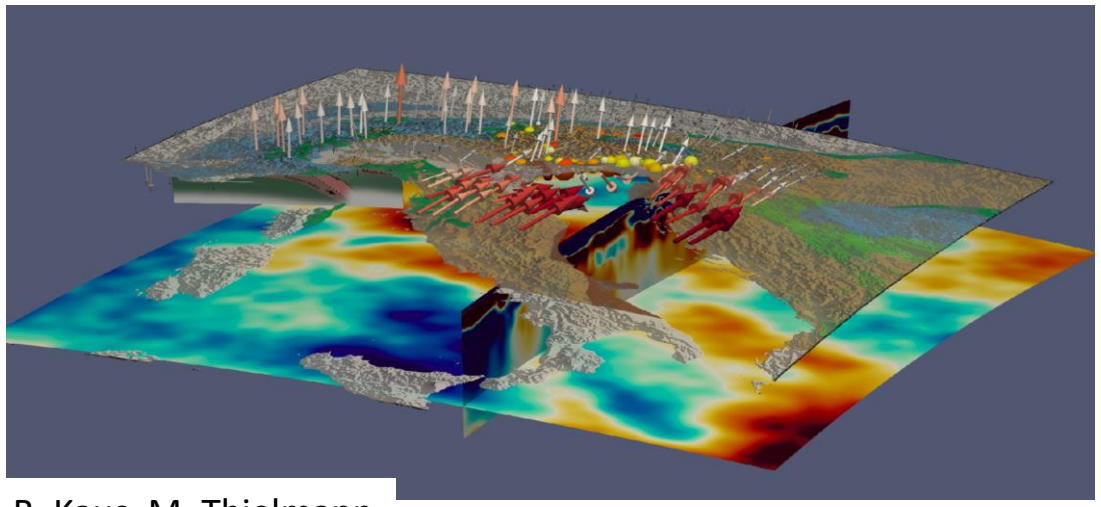
F. Gross, H. Kopp, S. Krastel, A. Rietbrock, F. Tilmann

## Data management: Geophysical Model Generator (open source platform)

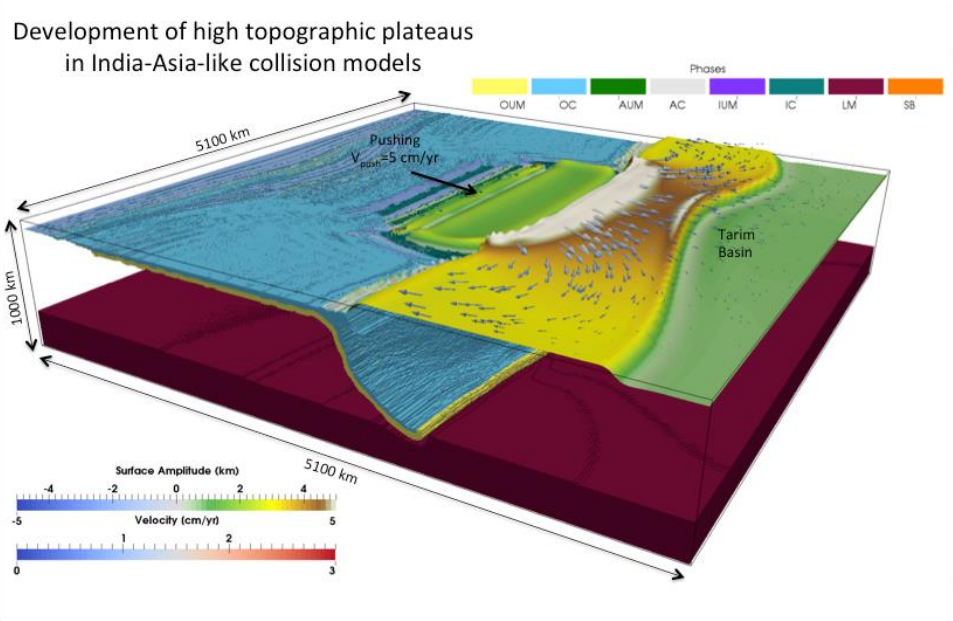
1. Import geophysical data (tomography, seismics, seismicity, bathymetry, receiver functions, GPS velocities, anisotropy, figures)
2. Convert imported data to a common data format for further processing
3. Export to Paraview-compatible format for visualization
4. Jointly interpret data (e.g. geomIO)
5. Create model setups for numerical models (LaMEM)




**Geodynamic modelling of plate deformation (LaMEM)**



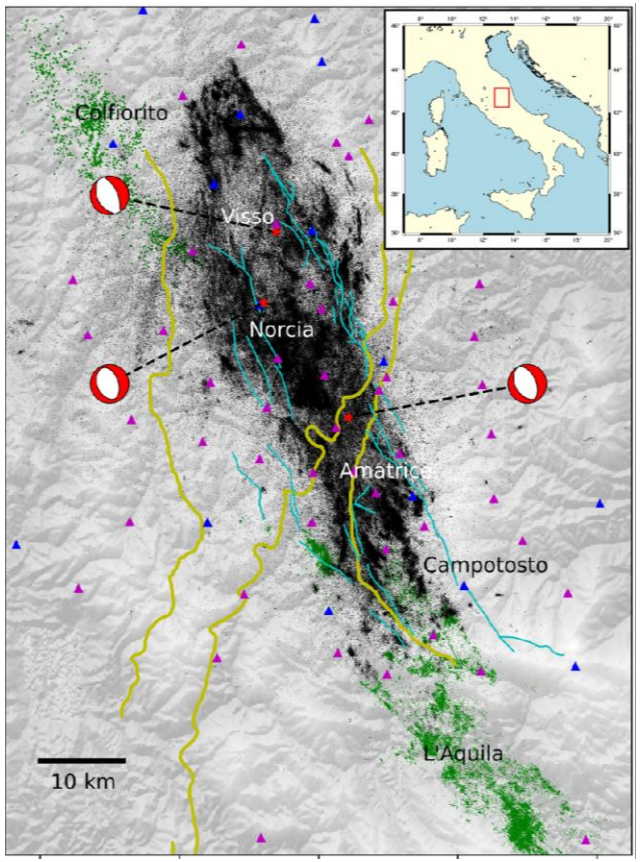
B. Kaus, M. Thielmann

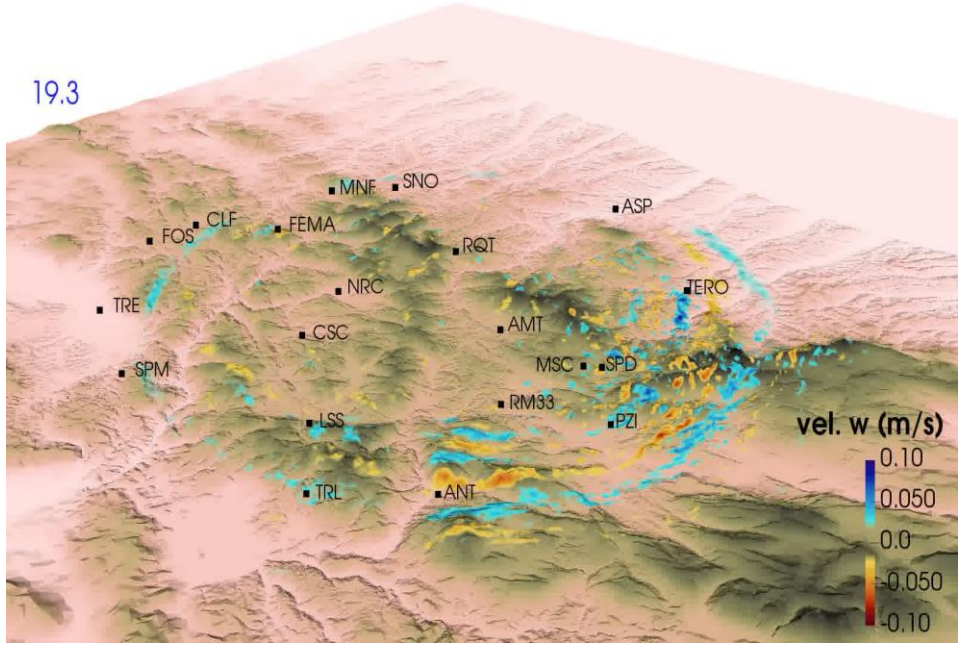


## Coupling geodynamic and geohazard modelling

- Physics-based modelling of geohazards
- Input: 3D plate and local crustal models, fault geometry, realistic stress field
- Output: Evaluation with field records (geomorphology, slip rates, source mechanisms, surface deformation)

Amatrice Mw 6.2 earthquake in 2016



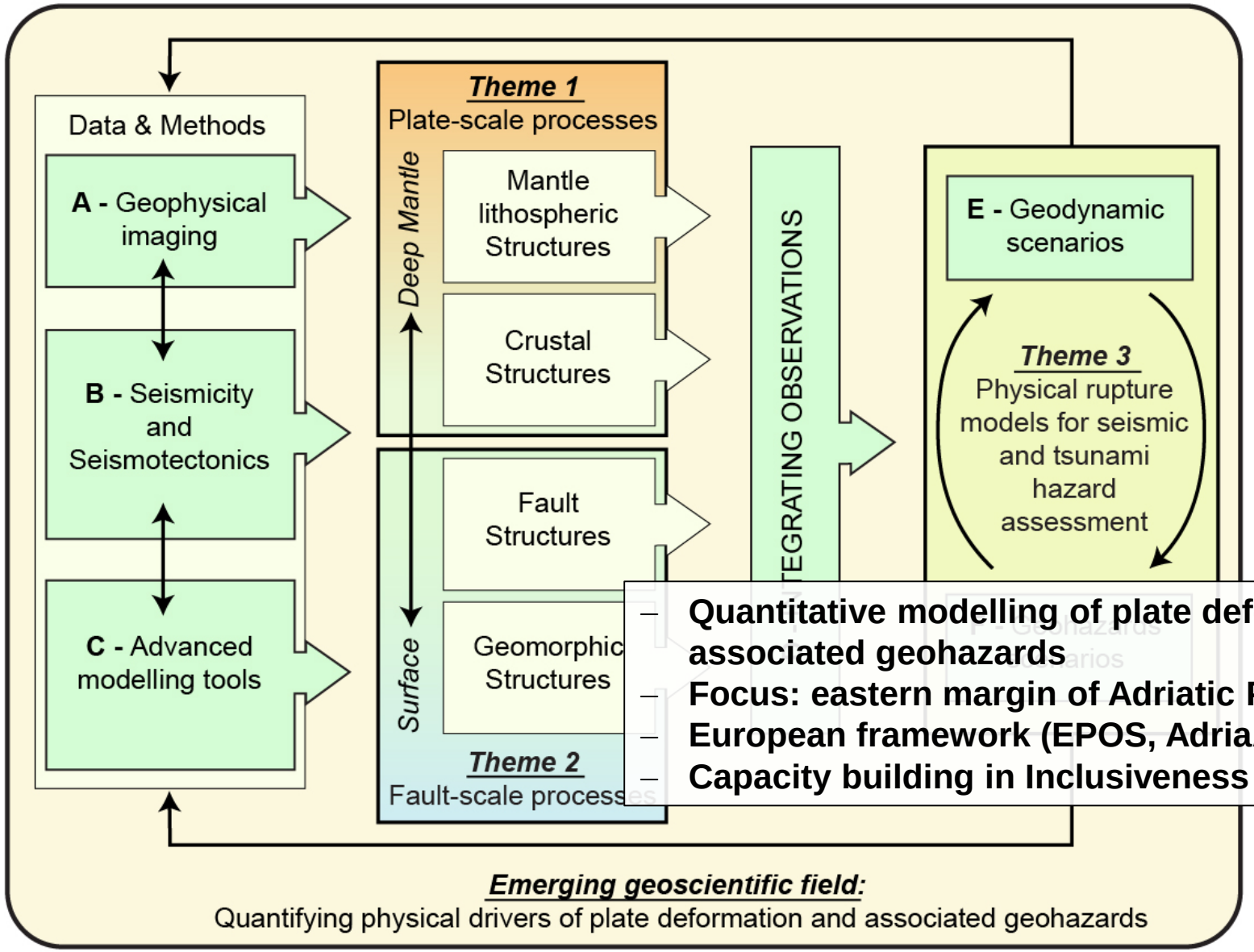




A. Gabriel

Broadband dynamic rupture simulation (>5 Hz) combining fault roughness and topography with Bayesian dynamic source inversion

Taufiqurrahman et al., AGU 2021

# *DEFORM*




- **Quantitative modelling of plate deformation and associated geohazards**
- **Focus: eastern margin of Adriatic Plate**
- **European framework (EPOS, AdriaArray)**
- **Capacity building in Inclusiveness Target Countries**

# *DEFORM:* **potential PIs** (according to round table discussion in February, 2022)

| | | | |
|---|---|---|---|
| 1 | Prof. Dr. Nevena Andric-Tomasevic, *KIT* | 29 | Prof. Dr. Jonas Kley, U. Göttingen |
| 2 | Dr. Andrey Babeyko, *GFZ Potsdam* | 30 | Prof. Dr. Achim Kopf, U. Bremen |
| 3 | Prof. Dr. Jörn Behrens, *U. Hamburg* | 31 | Prof. Dr. Heidrun Kopp, GEOMAR Kiel |
| 4 | Prof. Dr. Christian Berndt, *GEOMAR Kiel* | 32 | Prof. Dr. Sebastian Krastel, U. Kiel |
| 5 | Prof. Dr. Jonathan Bedford, *U. Bochum* | 33 | Dr. Rebecca Kühn, U. Halle |
| 6 | Prof. Dr. Anne Bernhardt, *FU Berlin* | 34 | Dr. Dietrich Lange, GEOMAR Kiel |
| 7 | Dr. Gian-Maria Bocchini, *U. Bochum* | 35 | Prof. Dr. Thomas Meier, U. Kiel |
| 8 | Prof. Dr. Jean Braun, GFZ Potsdam | 36 | Dr. Sabrina Metzger, GFZ Potsdam |
| 9 | Prof. Dr. Eline Le Breton, FU Berlin | 37 | Dr. Max Moorkamp, LMU München |
| 10 | Dr. Silvia Crosetto, GFZ Potsdam | 38 | Prof. Dr. Andreas Mulch, SM Frankfurt |
| 11 | Prof. Dr. Fabrice Cotton, GFZ Potsdam | 39 | Prof. Dr. Thorsten Nagel, U. Freiberg |
| 12 | Dr. Gareth Crutchley, GEOMAR Kiel | 40 | Dr. Jan Pleuger, FU Berlin |
| 13 | Prof. Dr. Torsten Dahm, GFZ Potsdam | 41 | Prof. Dr. Klaus Reicherter, RWTH Aachen |
| 14 | Dr. Anke Dannowski, GEOMAR Kiel | 42 | Prof. Dr. Andreas Rietbrock, KIT Karlsruhe |
| 15 | Dr. Stefanie Donner, BGR Hannover | 43 | Prof. Dr. Georg Rümpker, U. Frankfurt |
| 16 | Prof. Dr. Thibault Duretz, U. Frankfurt | 44 | Prof. Dr. Magdalena Scheck-Wenderoth, GFZ Potsdam |
| 17 | Prof. Dr. Jörg Ebbing, U. Kiel | 45 | Dr. Antje Schlömer, U. München |
| 18 | Prof. Dr. Todd Ehlers, U. Tübingen | 46 | Dr. Bernd Schurr, GFZ Potsdam |
| 19 | Prof. Dr. Claudio Faccenna, GFZ Potsdam | 47 | Prof. Dr. Jeroen Smit, U. Bochum |
| 20 | Prof. Dr. Wolfgang Friederich, U. Bochum | 48 | Dr. Henriette Sudhaus, U. Kiel |
| 21 | Prof. Dr. Alice Gabriel, U. München | 49 | Prof. Michael Stipp, U. Halle |
| 22 | Dr. Felix Gross, U. Kiel | 50 | Prof. Dr. Morelia Urlaub, GEOMAR Kiel |
| 23 | Dr. Christoph Grützner, U. Jena | 51 | Dr. Marcel Thielmann, U. Bayreuth |
| 24 | Prof. Dr. Rebecca Harrington, U. Bochum | 52 | Prof. Dr. Frederik Tilmann, GFZ Potsdam |
| 25 | Prof. Dr. Mark Handy, FU Berlin | 53 | Prof. Dr. Kamil Ustaszewski, U. Jena |
| 26 | Prof. Dr. H. Igel, LMU München | 54 | Dr. Joachim Wassermann, U. München |
| 27 | Dr. Marion Jegen, GEOMAR Kiel | 55 | Prof. Dr. Ulrich Wegler, U. Jena |
| 28 | Prof. Dr. Boris Kaus, U. Mainz | | |