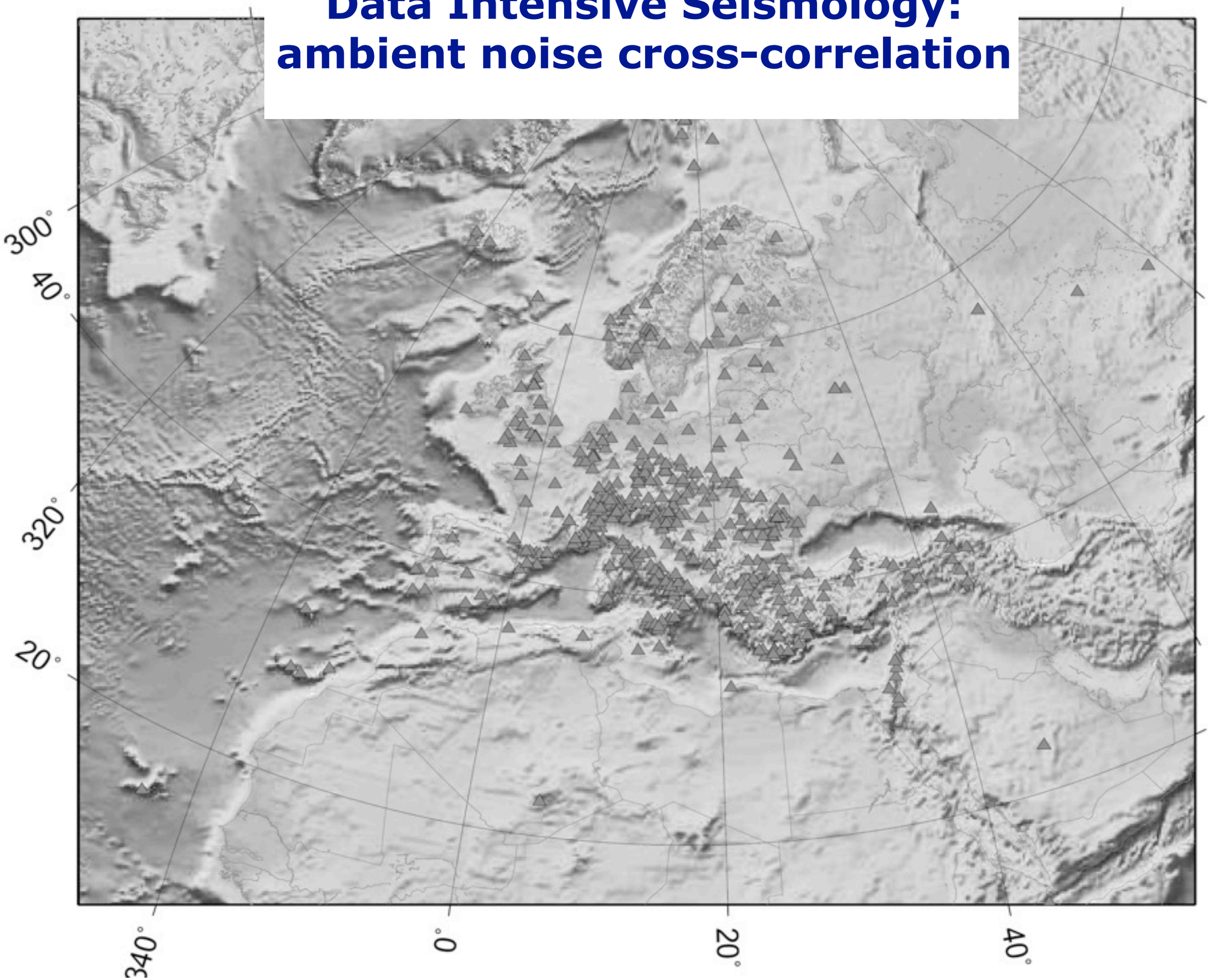
Data Intensive Seismology: ambient noise cross-correlation



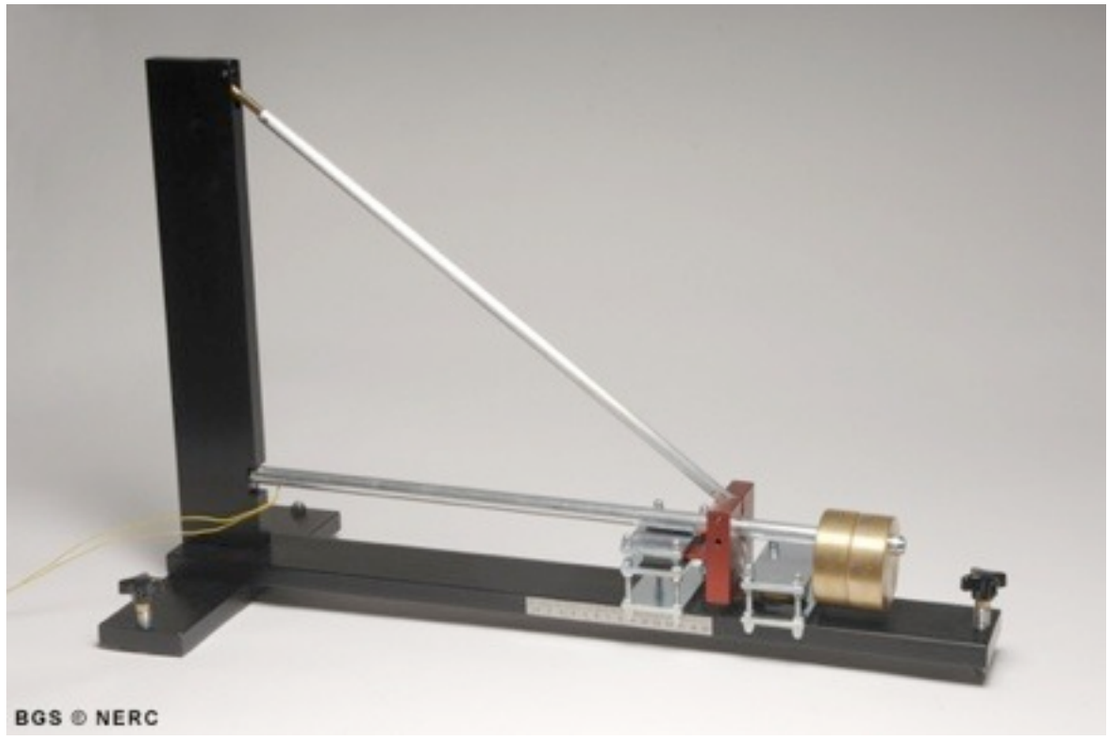
Live Seismicity

click the title to access live seismic monitor at
http://www.iris.edu/seismon/

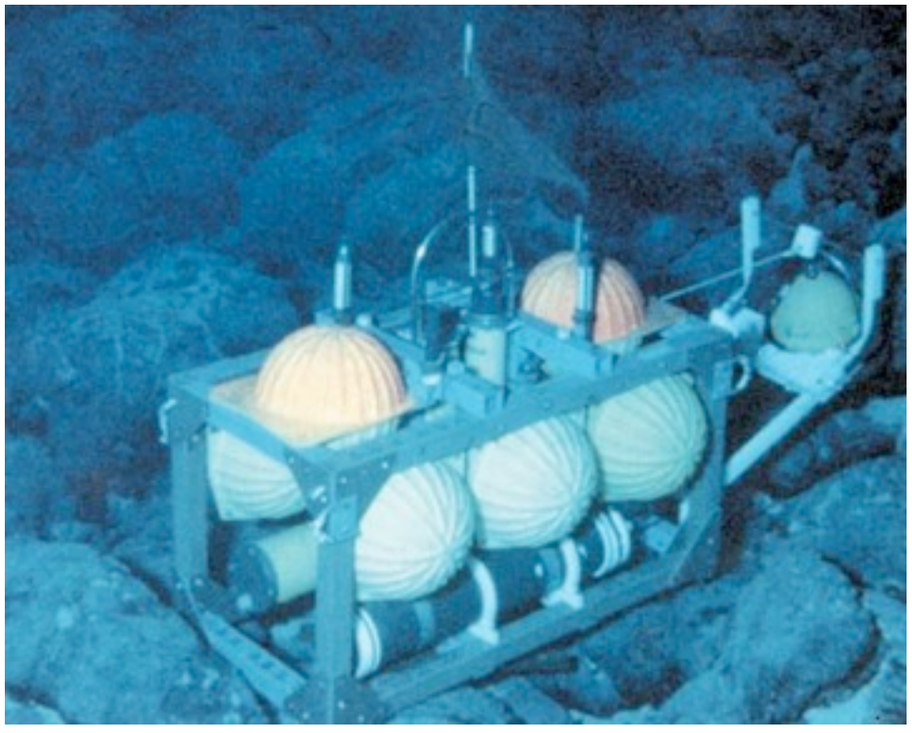
Seismometers

132 CE - Zhang Heng

BGS - Educational



Ocean bottom

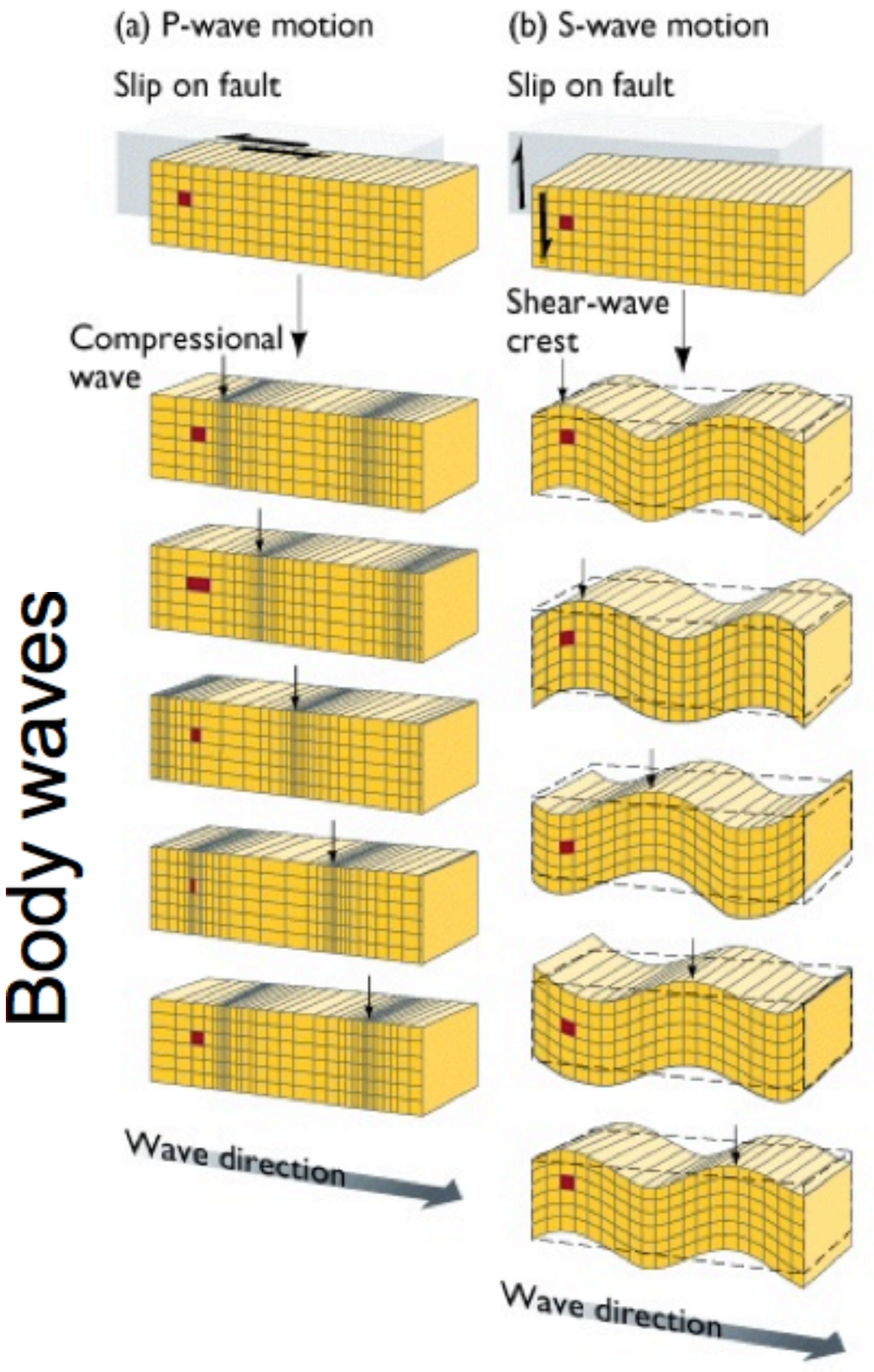


Typical field installation

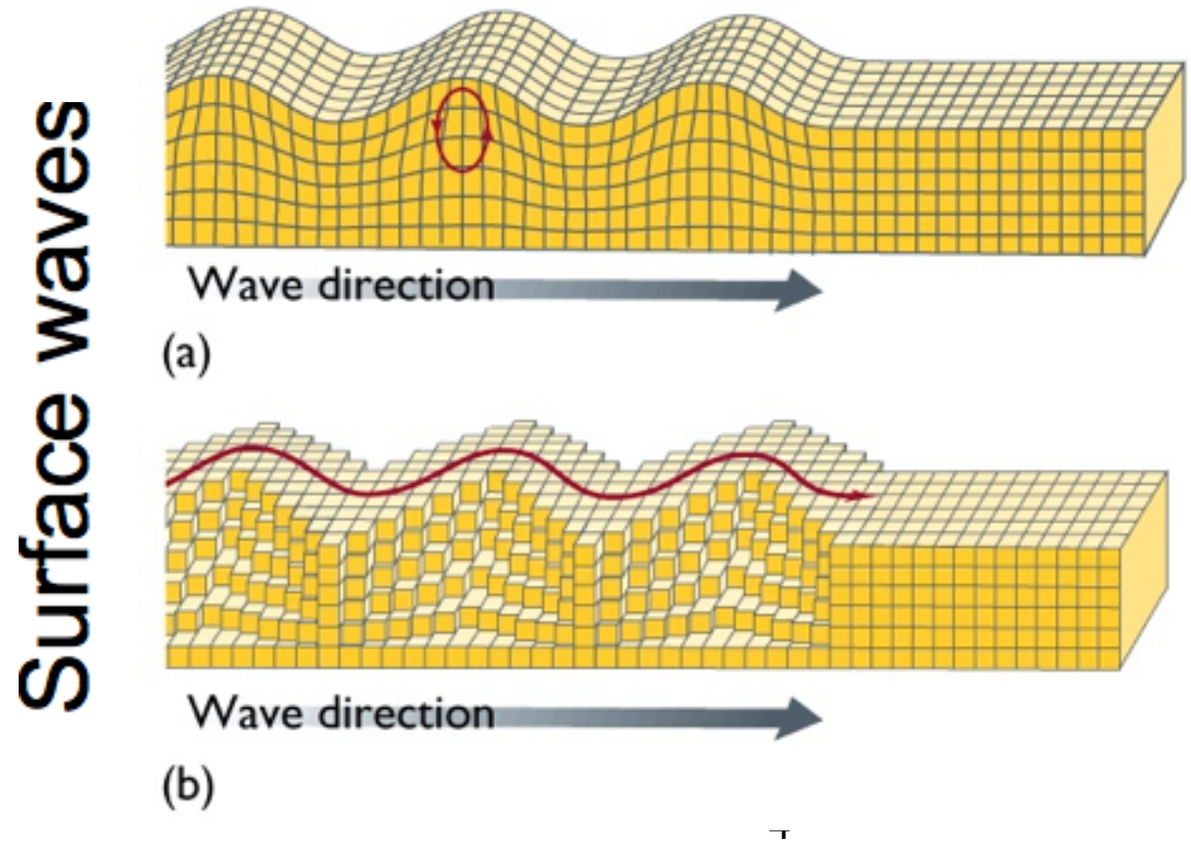
Seismic wave propagation

Earthquakes generate waves of energy which travel through the earth at different velocities

The propagation velocity depends on **density** and **elasticity** of the medium and tends to increase with depth, and ranges from approximately 2 to 8 km/s in the Earth's crust up to 13 km/s in the deep mantle

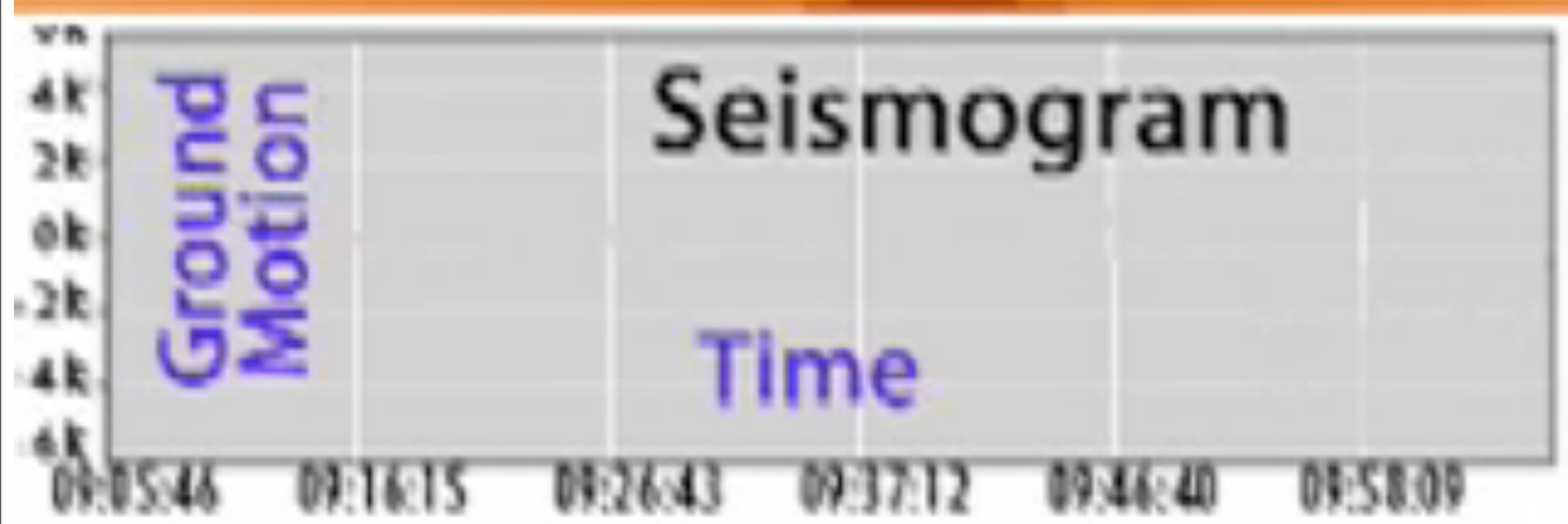


Low frequencies and large amplitude → most destructive



earth scope

Building response to simplified seismic wave behavior



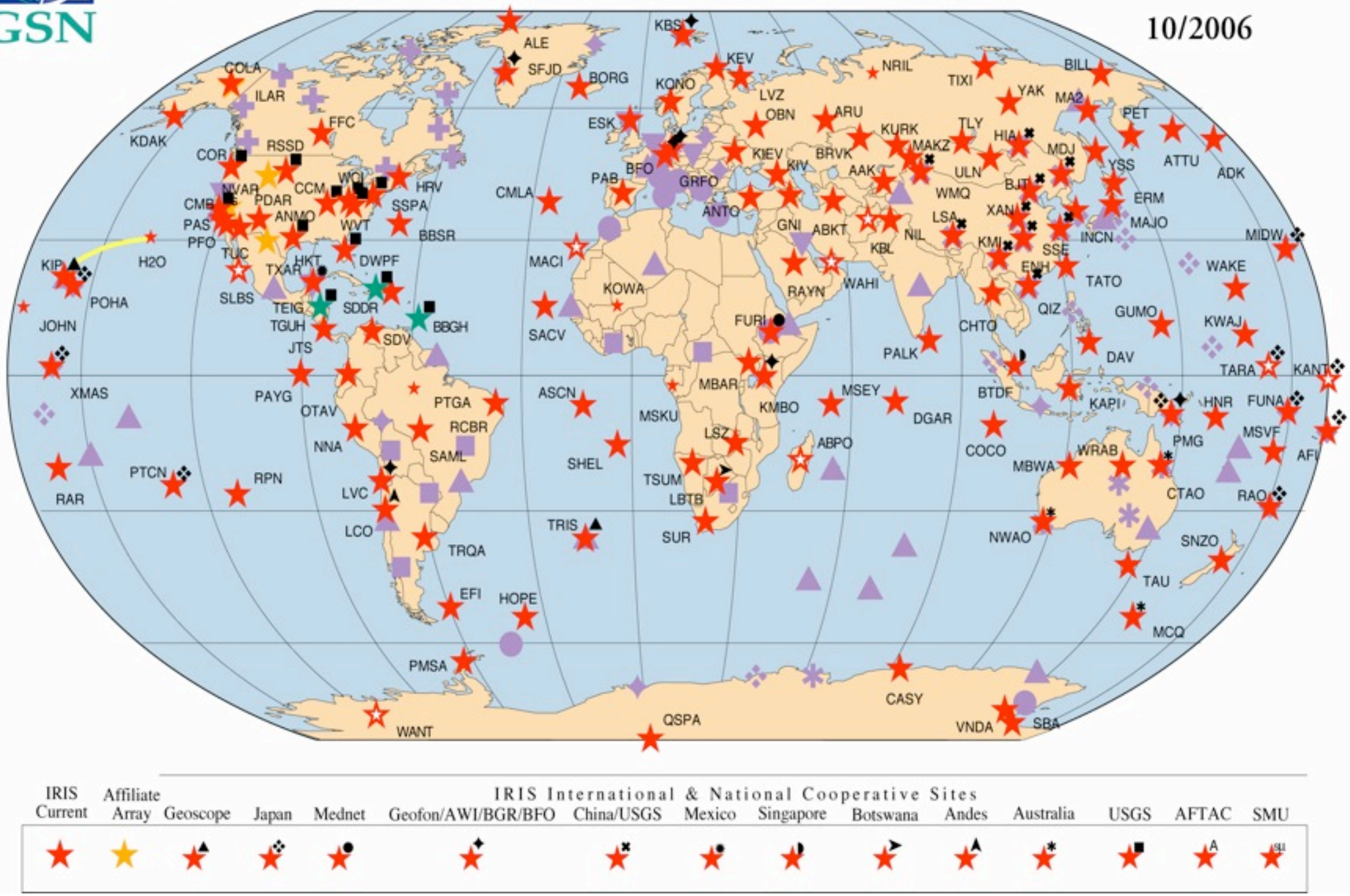
All scales exaggerated

GLOBAL SEISMOGRAPHIC NETWORK

& INTERNATIONAL FEDERATION OF DIGITAL SEISMOGRAPHIC NETWORKS

GSN

10/2006

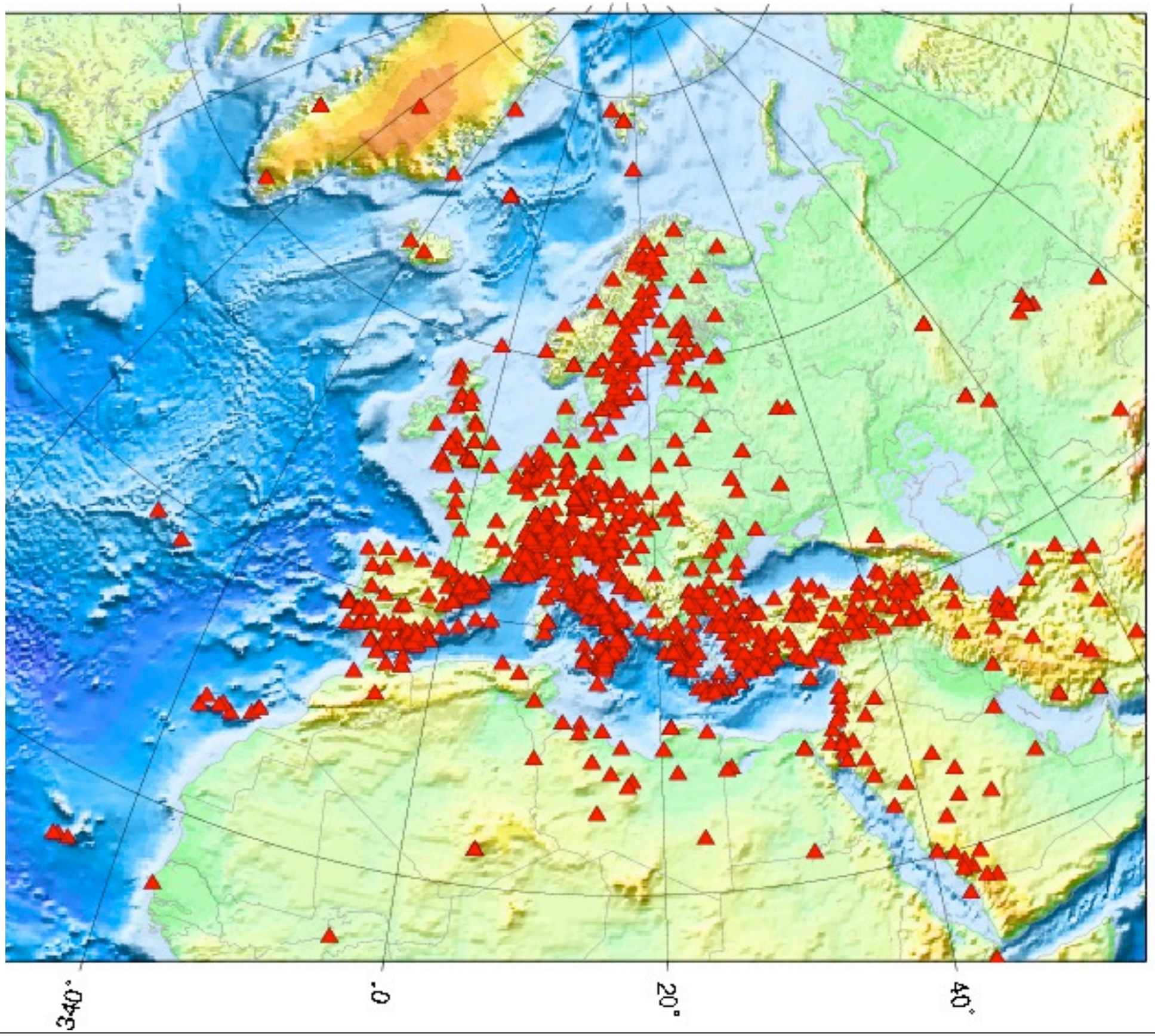


IRIS International & National Cooperative Sites

IRIS Current	Affiliate Array	Geoscope	Japan	Mednet	Geofon/AWI/BGR/BFO	China/USGS	Mexico	Singapore	Botswana	Andes	Australia	USGS	AFTAC	SMU

Data open accessible for research

Broadband Stations in Europe and surroundings



Observatories:
>100 networks

Integrated data access:
~ 50%

Funding:
National public,
Hazard/Risk,
Projects.
Occasionally
Research
No EU funds!

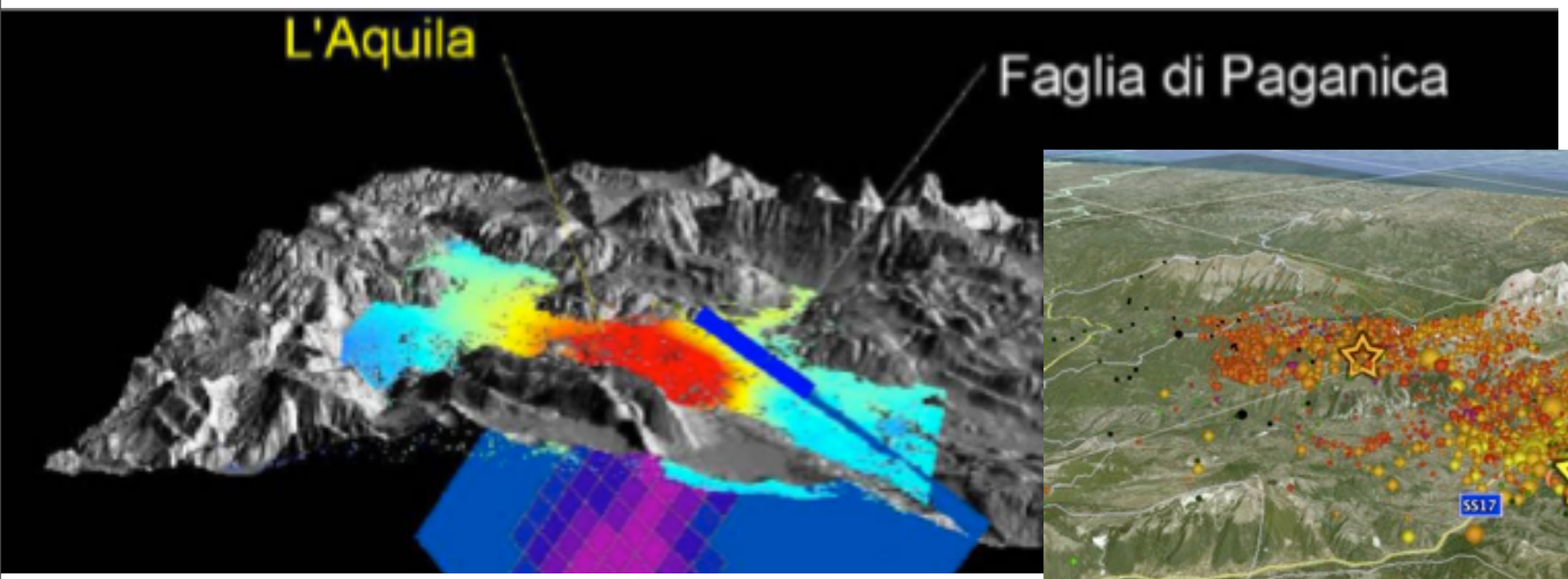
Political aspects on data exchange:
Middle East
Russia
Northern Africa

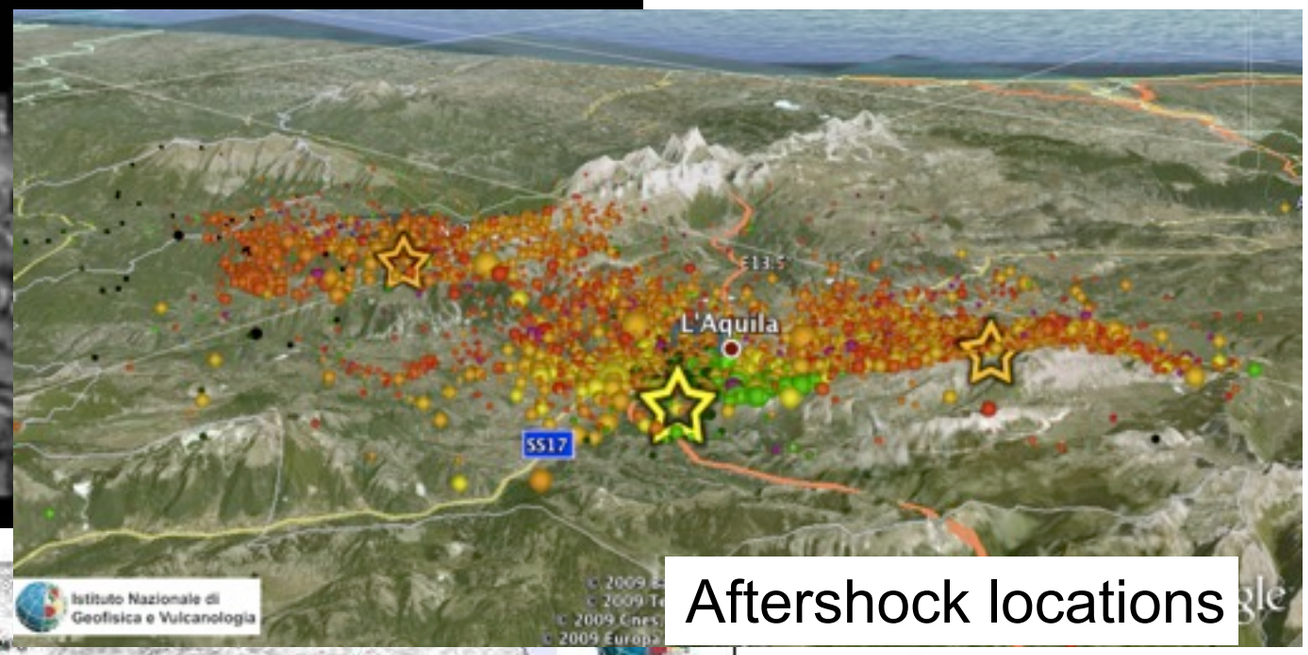
Orfeus

Data Integration:

Observations, modelling, GPS, SAR, geology…

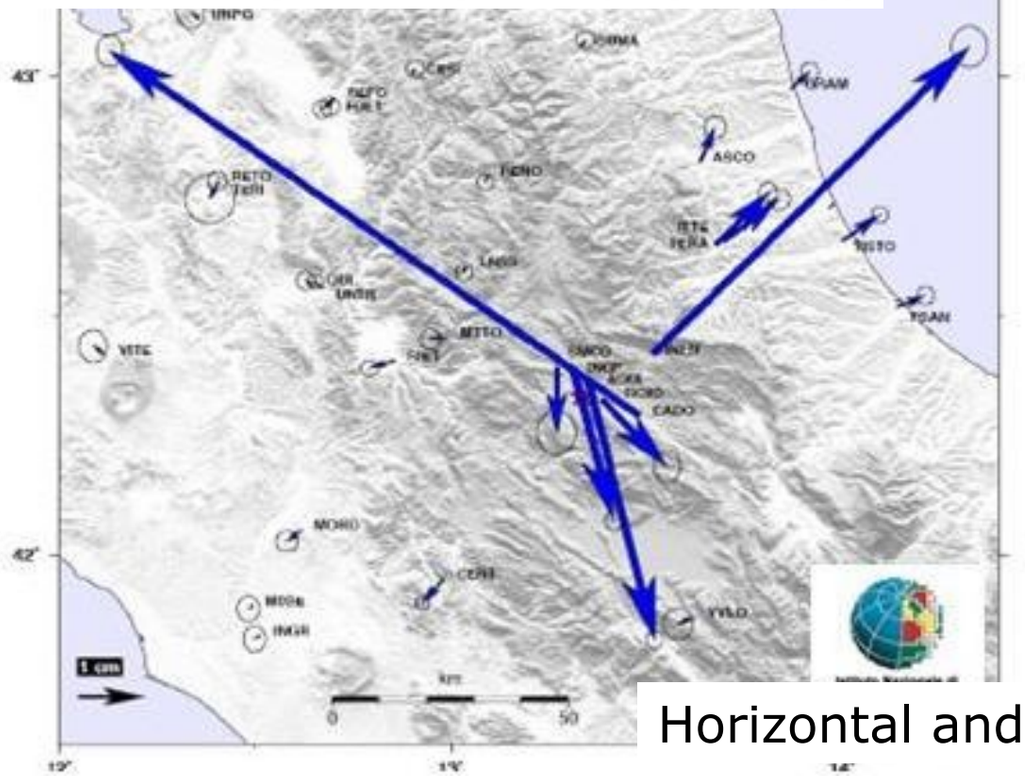
EPOS initiative
www.epos-eu.org

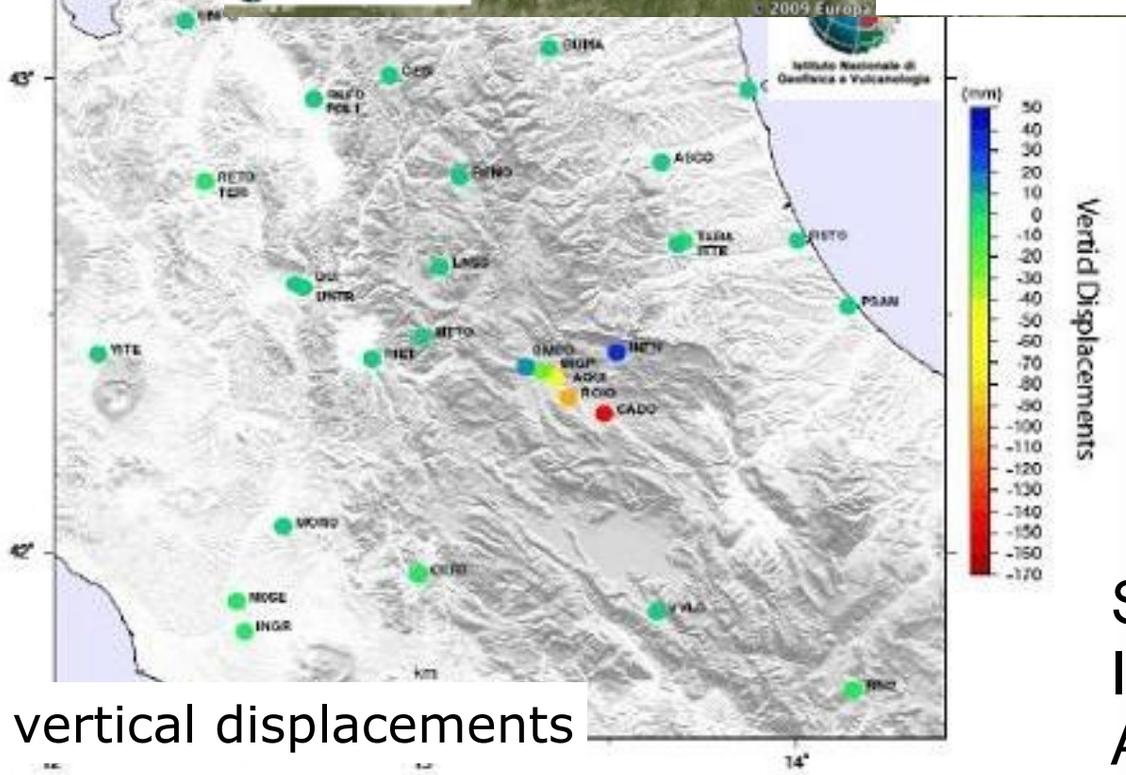




Aftershock locations

Modelling, topography, geology

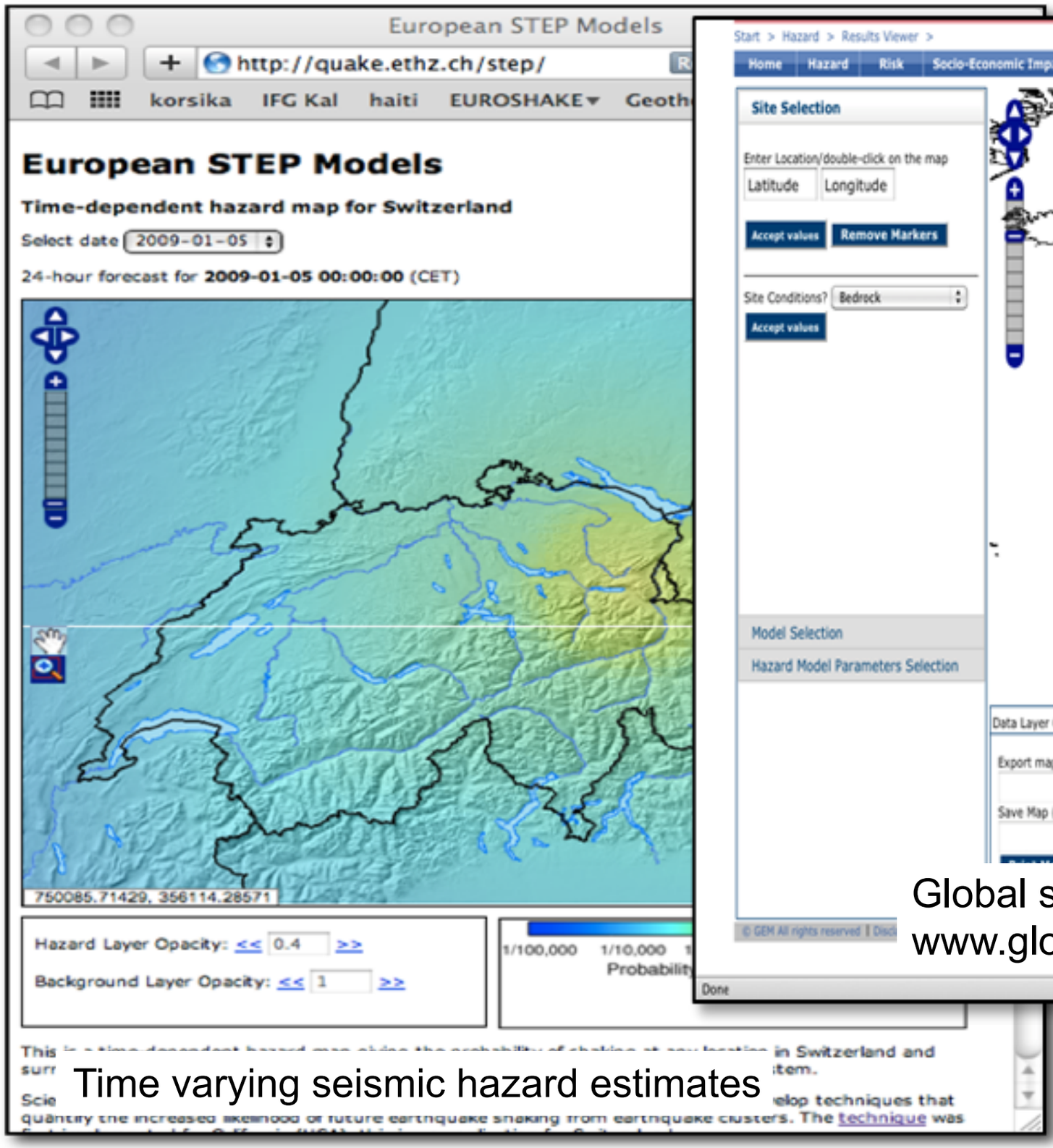


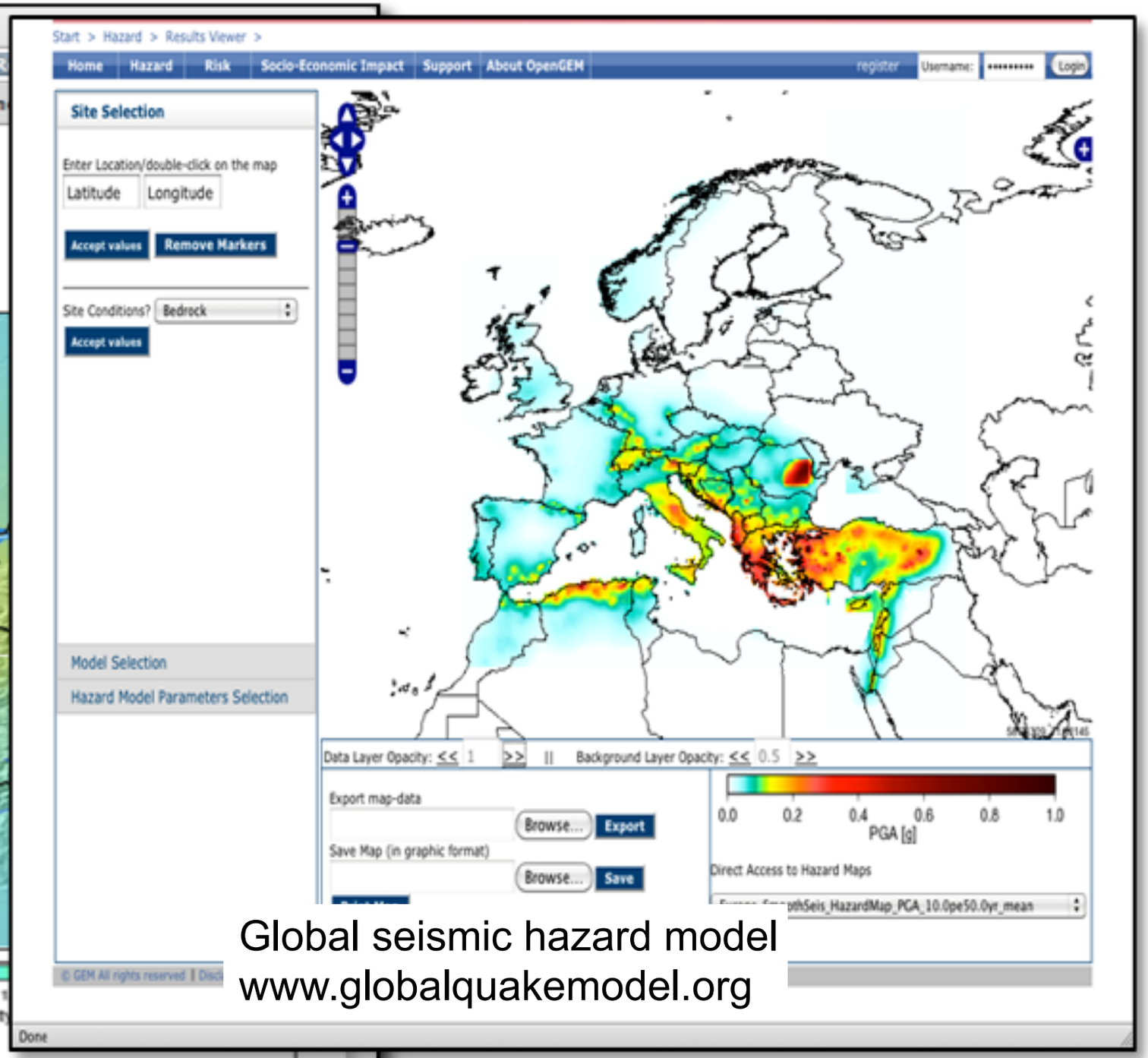


Horizontal and vertical displacements

Source:
INGV,
ASI-SIGRIS

Seismic hazard modelling and time varying seismic hazard





The need for E-Infrastructure

- Gigantic Earth Science Data Volumes require the development of new approaches to web-based data and model exchange, data mining and visualization

  (500 seismometers yield ≈17 GB/day and 6.2 TB/year)

- "Virtual Earth Laboratory" - Hypothesis testing will make increasingly use of high-performance simulation technology of Earth's dynamic behaviour

- "software as infrastructure" – scientific simulation technology needs to be adapted and maintained for wide use by the community

- "data rich" Elements: Web-based superstructure linking Earth Science Data Centres, standardize multi-disciplinary data and model exchange

- "cpu rich" Elements: Simulation and processing technology needs to be professionally engineered, linked to the European High-Performance Computing infrastructure and the scientific data infrastructure

Seismology: More data more discoveries? Definitively yes!

Before 2000 only event digital data
→ Earthquake and event oriented studies

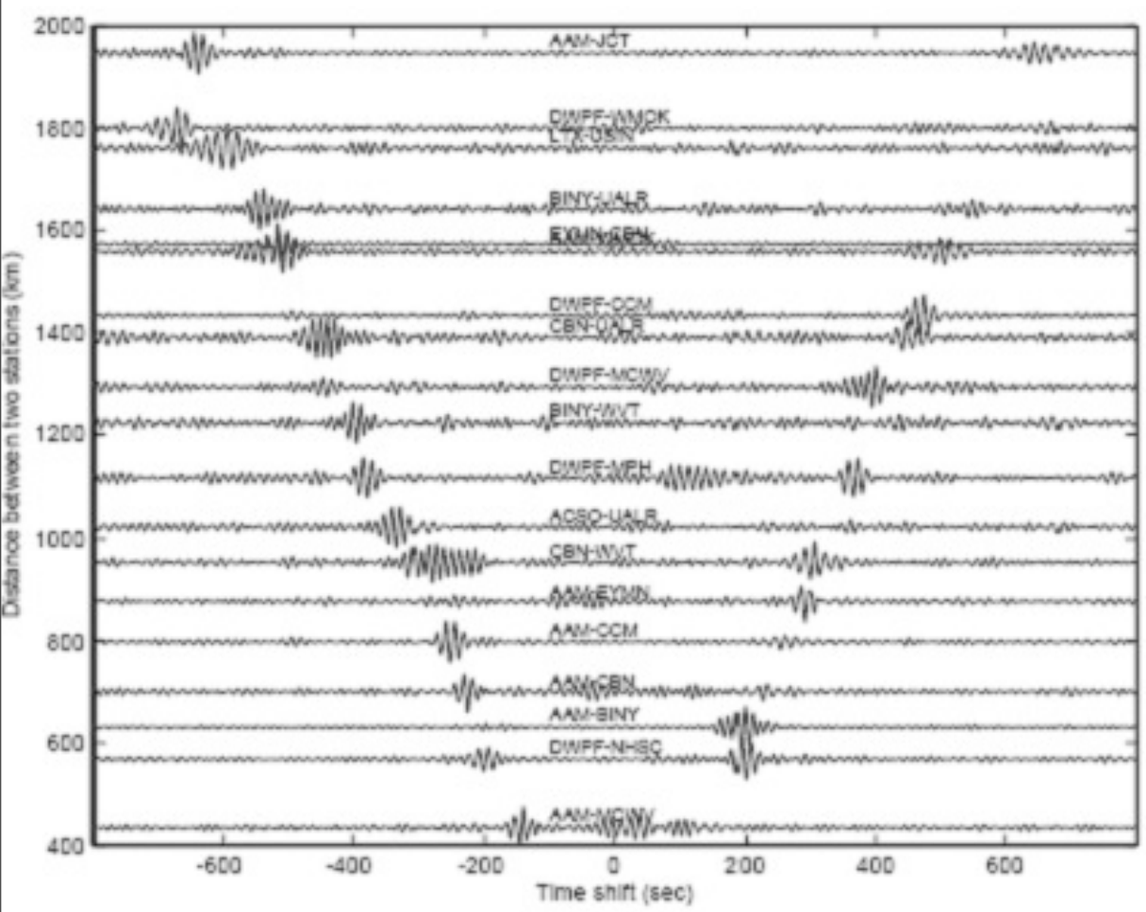
After 2000 continuous digital data:
- Noise data used for detecting and identifying:
→
- **Glacier movement and fracturing**
- **Velocity structures**
- Large and small **slow seismic events**
- **Non volcanic tremors**
- **Localised time varying velocities**
- **Earth hum** (low frequency constant background noise)

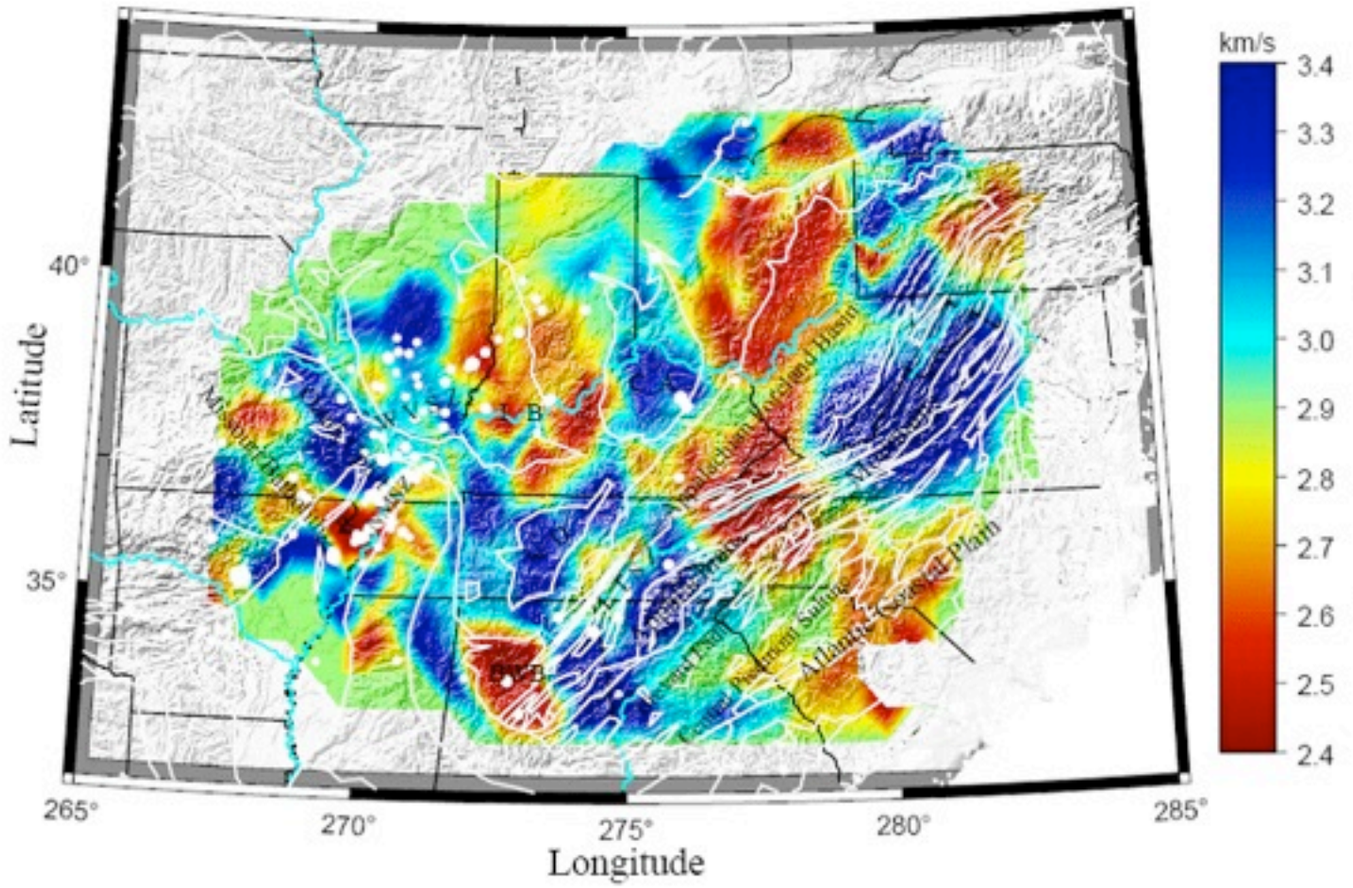
Seismic Interferometry

Utilizes the cross-correlation of signal pairs to reconstruct the impulse response of a given media

In particular **ambient noise interferometry** focuses on the noise signatures originating at depth recorded at surface receivers to retrieve the **Green** function between these receivers.

This technique is also called **Passive Imaging**





Ambient Noise Interferometry workflow