



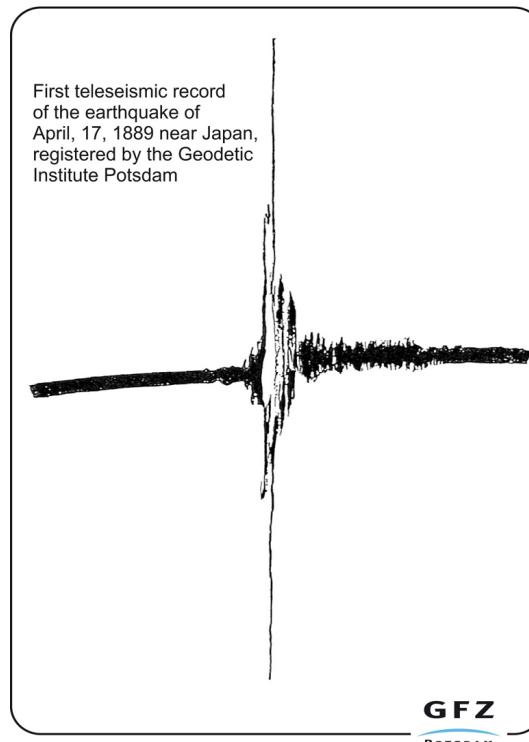
# Geophysical Data Analysis

L01: Data, Observables & Instruments - An Introduction



# Geophysical Data Analysis

## L01: Data, Observables & Instruments - An Introduction

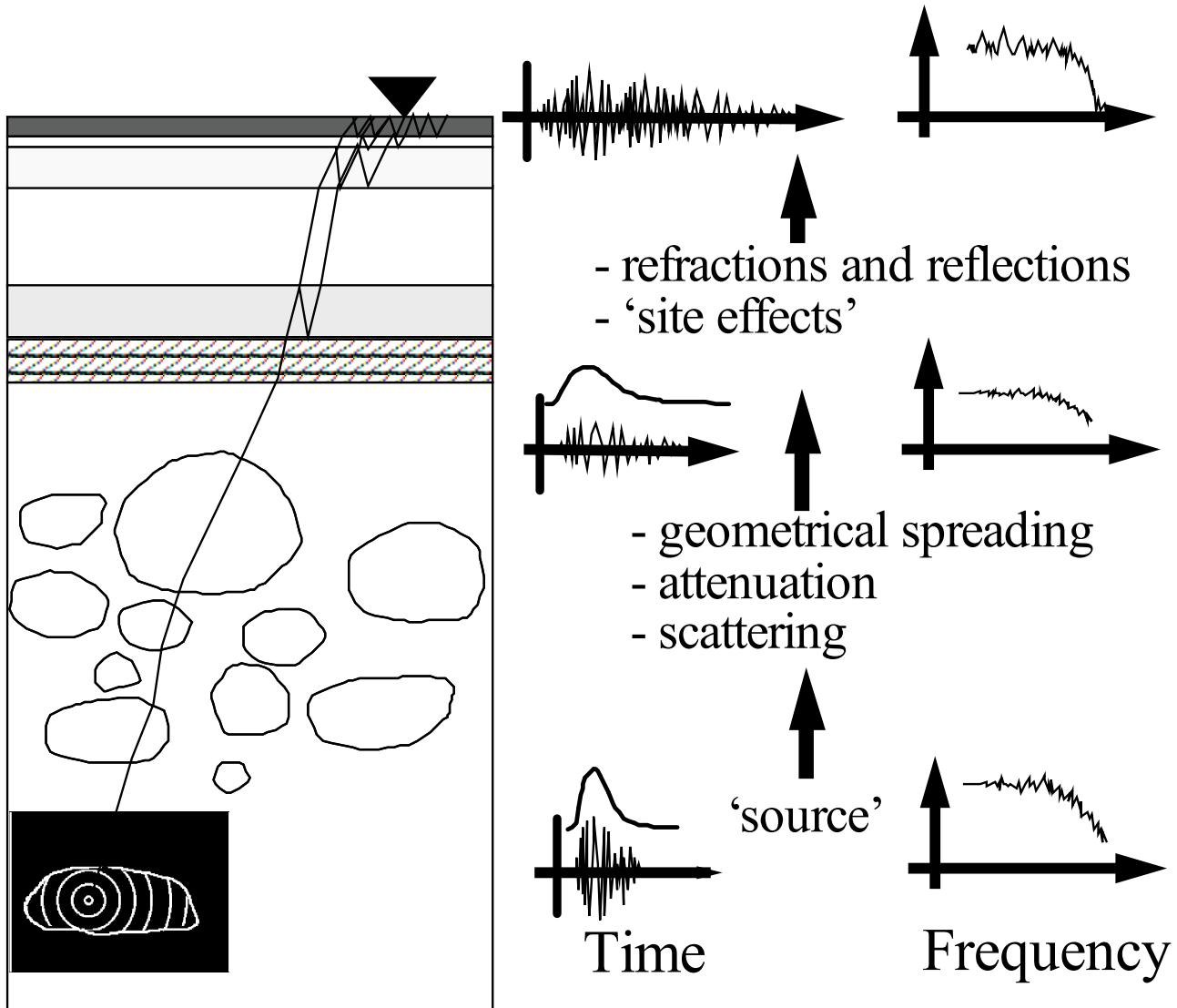


# Literature

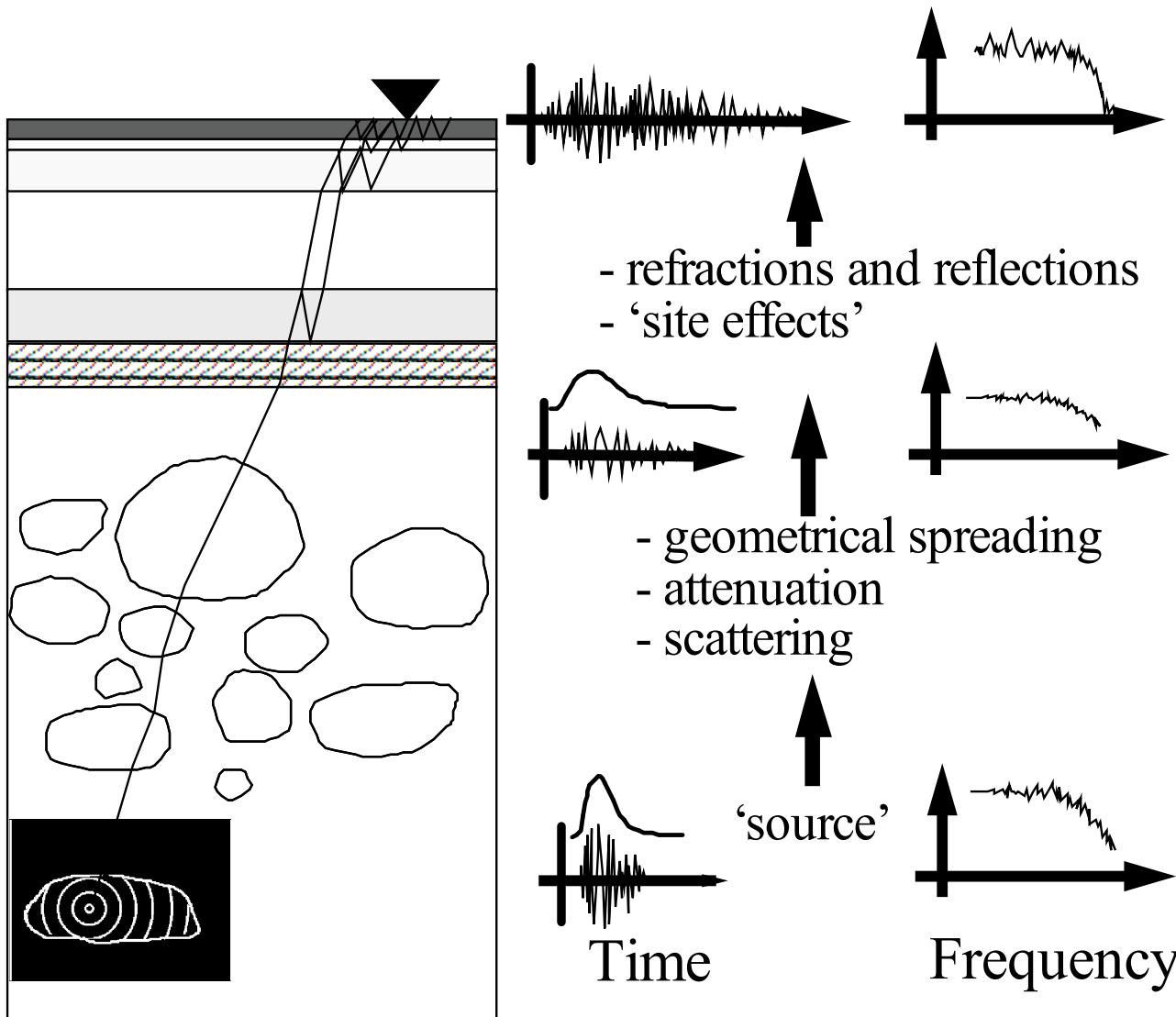
- Stein, J. Y. (2000). Digital Signal Processing, A Computer Science Perspective, Wiley -Interscience publication, ISBN 0-471-29546-9.
- Gubbins, D. (2004). Time Series Analysis and Inverse Theory for Geophysicist, Cambridge University Press, ISBN 0521819652
- Hayes, M. H. (2009). Statistical Digital Signal Processing and Modeling, John Wiley & Sons, Inc.
- Priestley, M. B. (1981). Spectral analysis and time series: probability and mathematical statistics (No. 04; QA280, P7.)
- Buttkus, B. (2012). Spectral analysis and filter theory in applied geophysics. Springer Science & Business Media.
- Scherbaum, F. (2013). Of poles and zeros: Fundamentals of digital seismology (Vol. 15). Springer Science & Business Media.
- Kanasewich, E. R. (1981). Time sequence analysis in geophysics. University of Alberta.

# Why bother?

# Why bother?

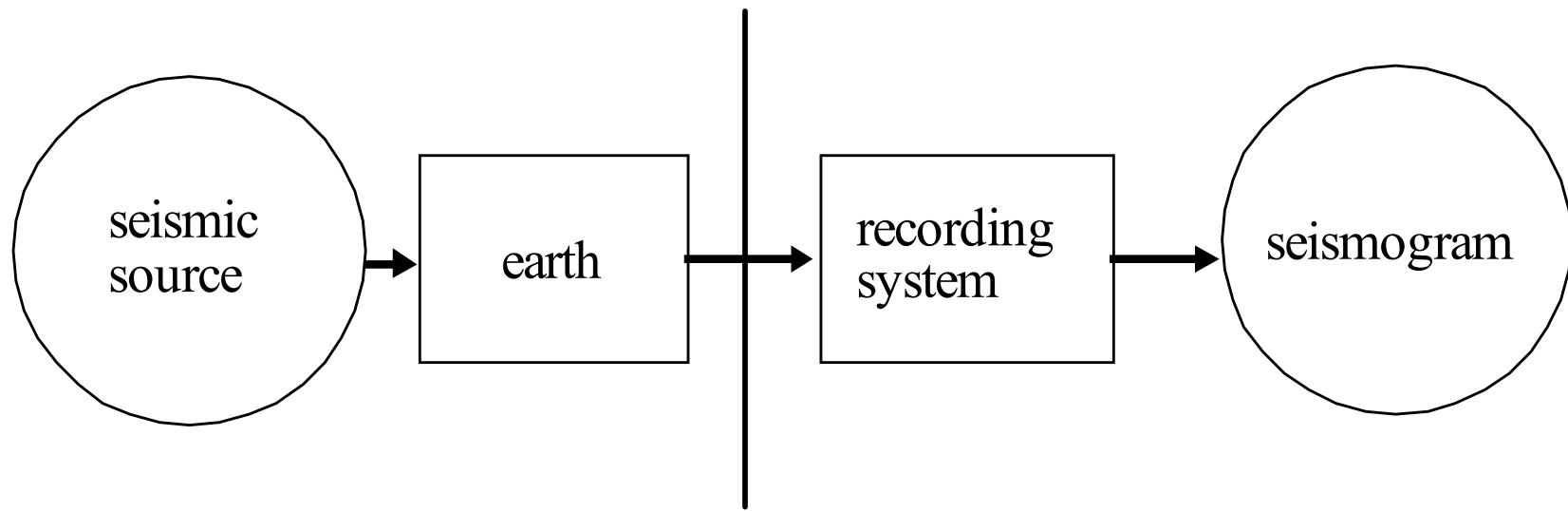


# Why bother?



... depending  
on what is  
desired, we  
have to  
separate source  
from path  
effects using  
signal  
processing

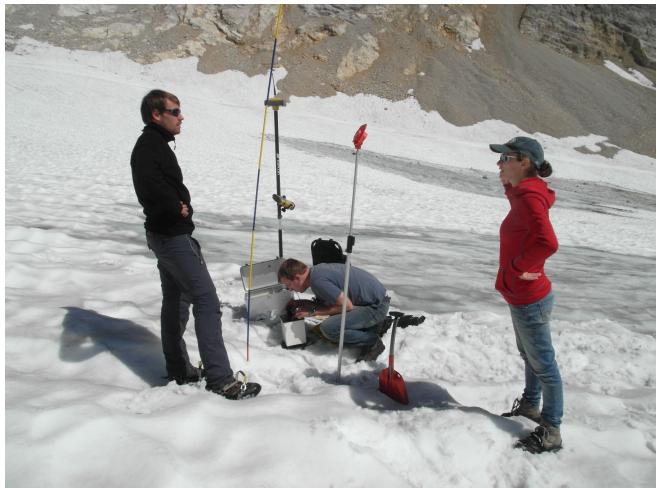
# But first: the instrument!



# Work-Flow in Geophysics

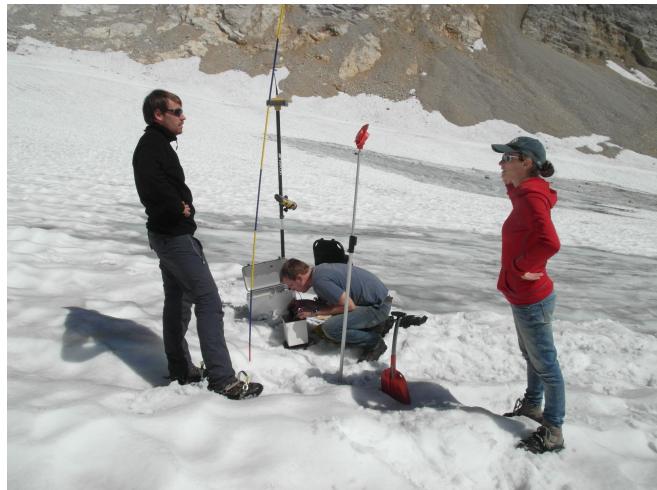
# Work-Flow in Geophysics

## 1: Data Collection



# Work-Flow in Geophysics

1: Data Collection

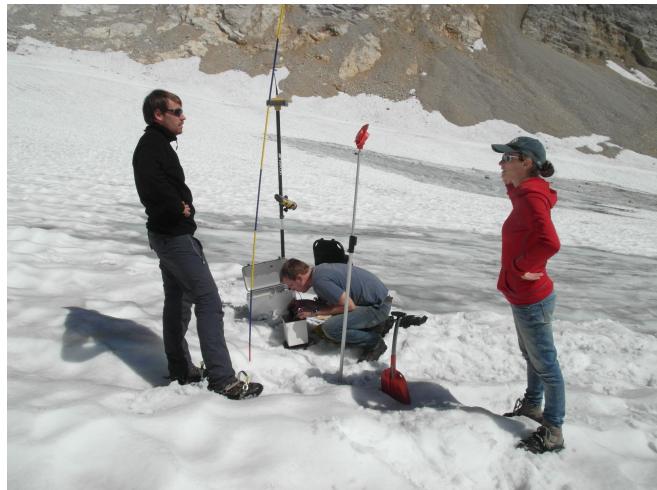


2: Pre-Processing



# Work-Flow in Geophysics

1: Data Collection

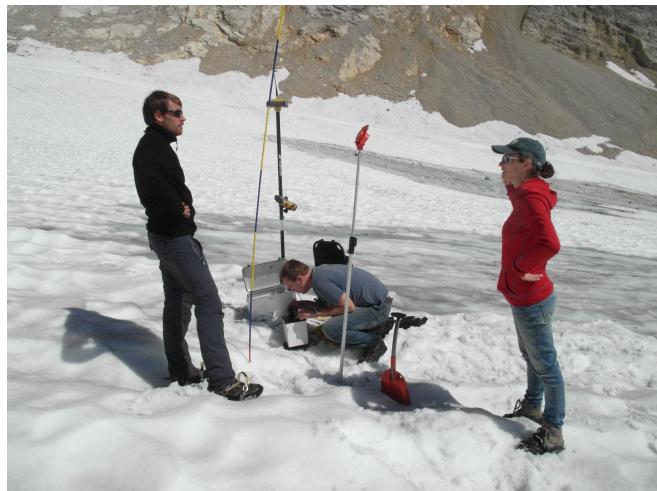


2: Pre-Processing

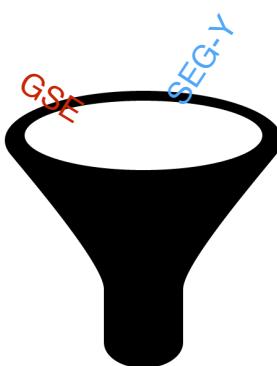


# Work-Flow in Geophysics

1: Data Collection



2: Pre-Processing

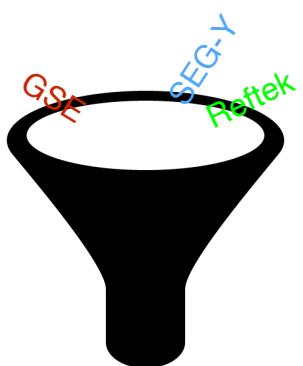


# Work-Flow in Geophysics

1: Data Collection

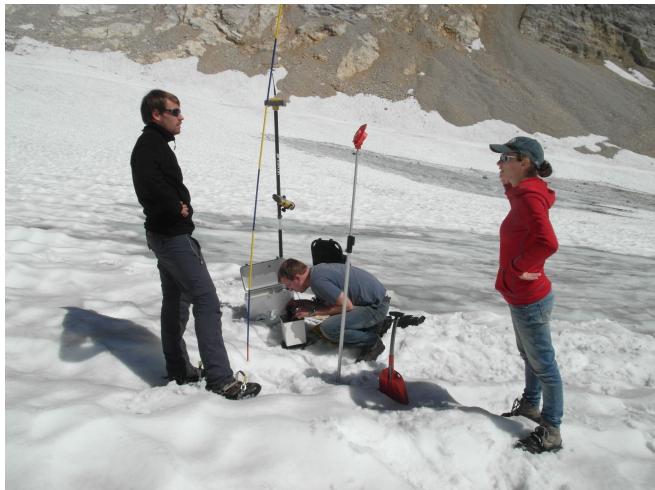


2: Pre-Processing

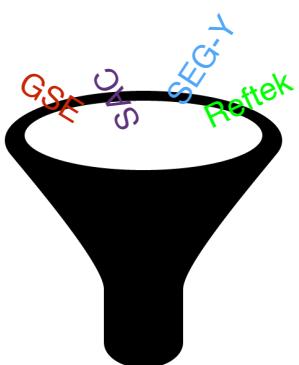


# Work-Flow in Geophysics

1: Data Collection

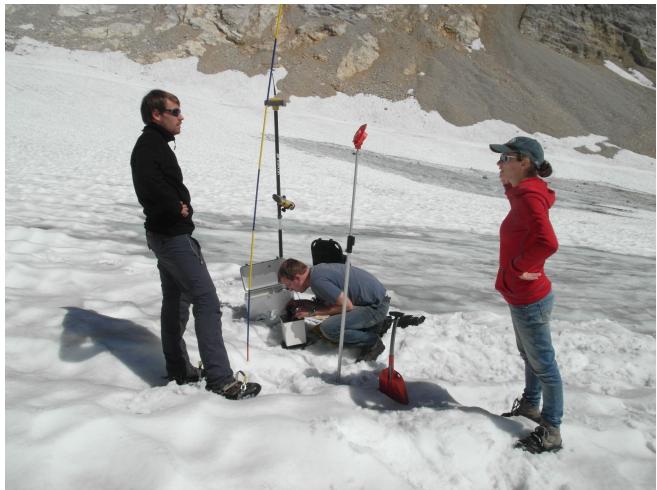


2: Pre-Processing

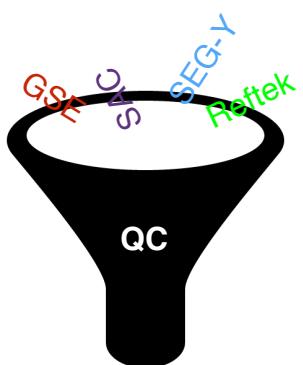


# Work-Flow in Geophysics

1: Data Collection

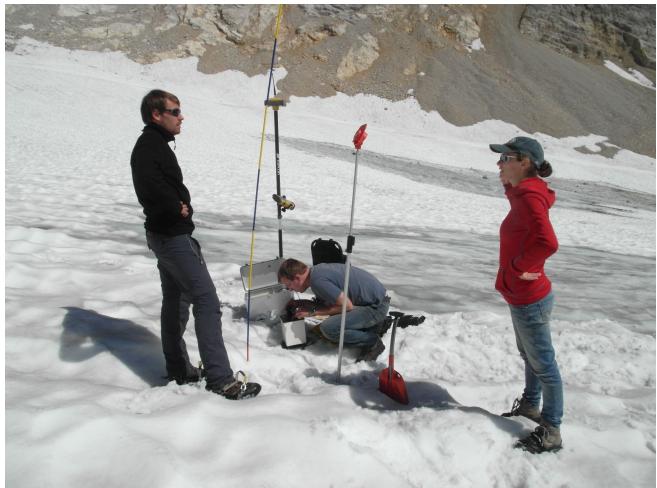


2: Pre-Processing

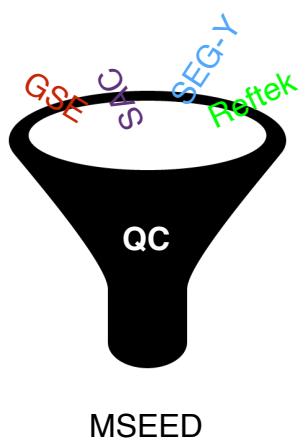


# Work-Flow in Geophysics

1: Data Collection

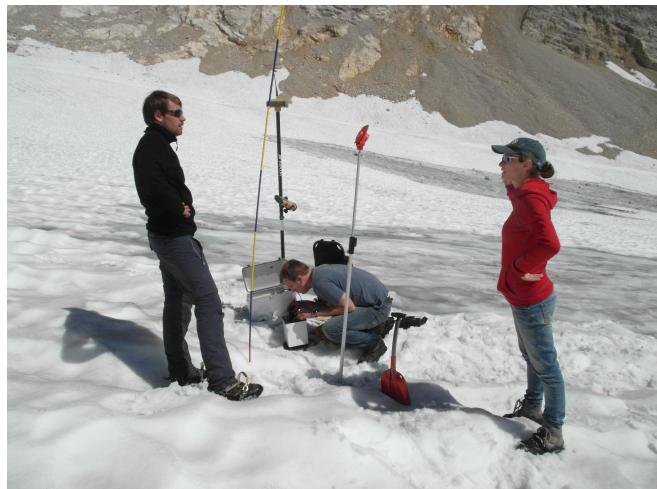


2: Pre-Processing



# Work-Flow in Geophysics

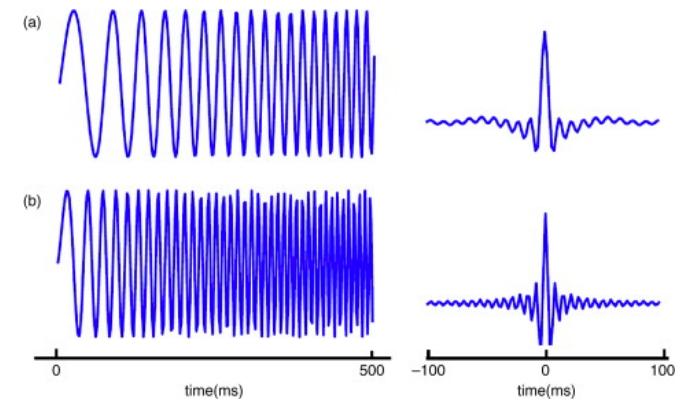
1: Data Collection



2: Pre-Processing



3: Processing

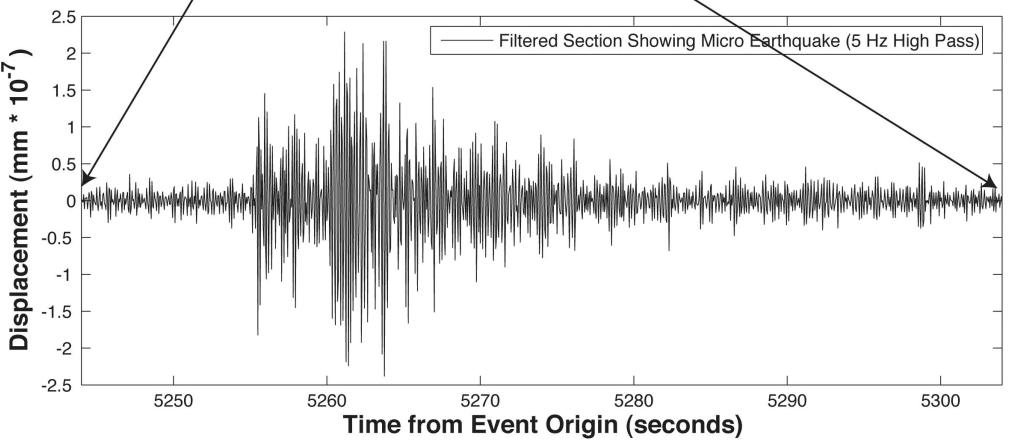
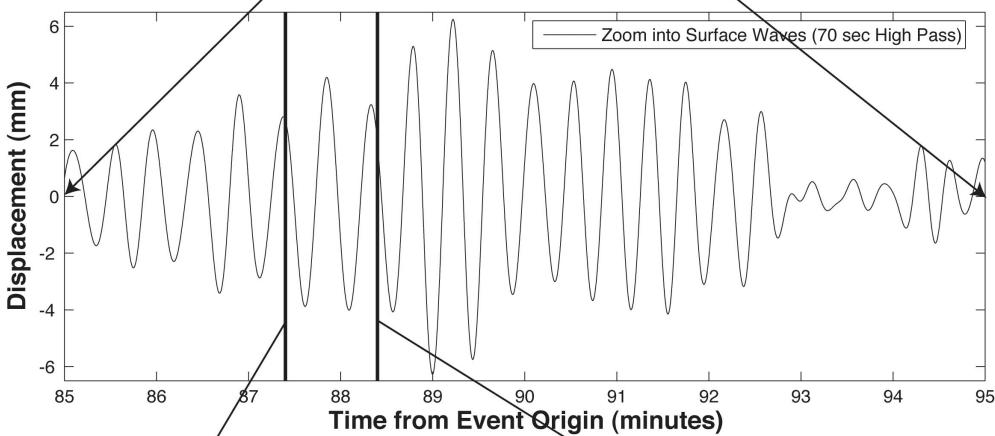
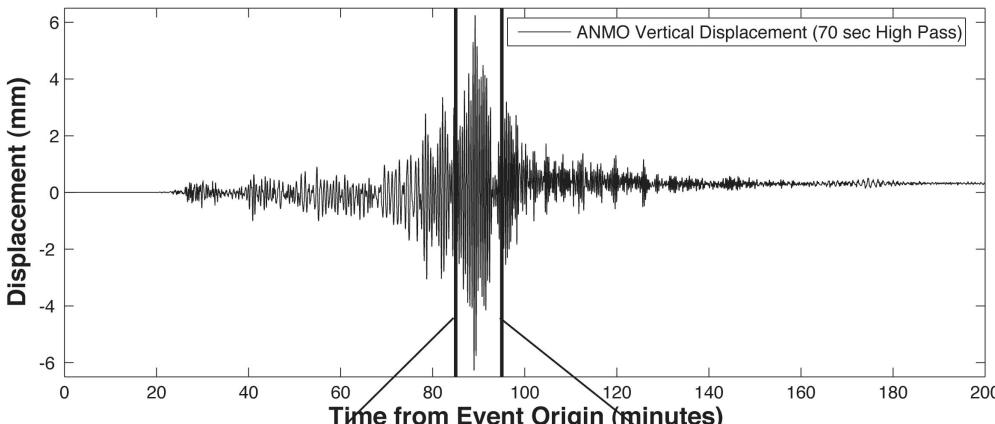
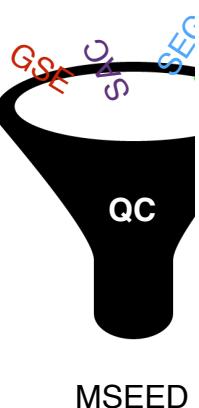


# Work-Flow in

## 1: Data Collection

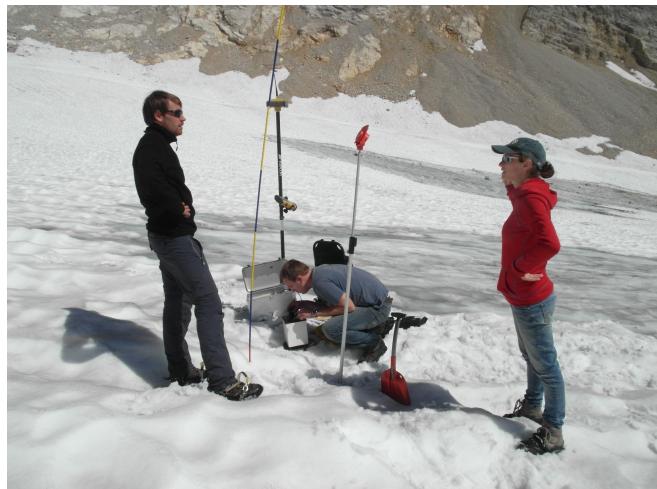


## 2: Pre-Proces

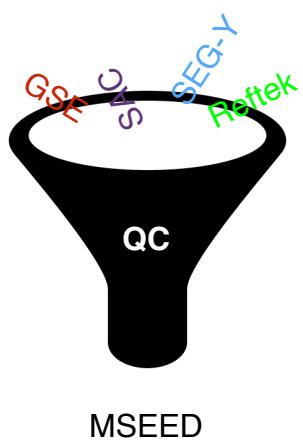


# Work-Flow in Geophysics

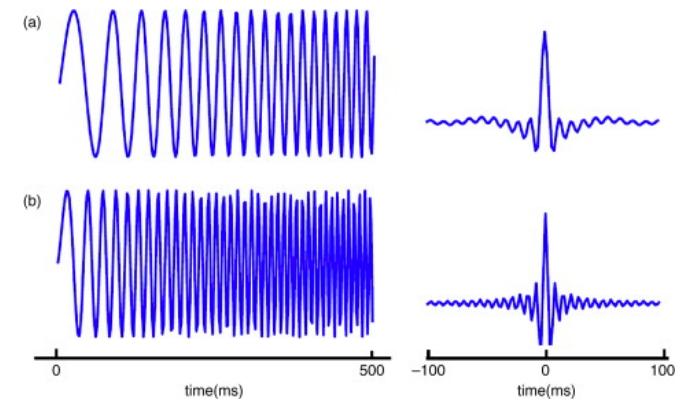
1: Data Collection



2: Pre-Processing

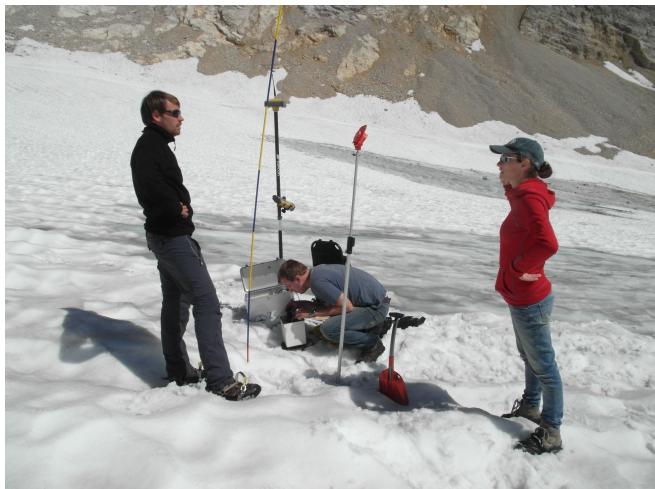


3: Processing

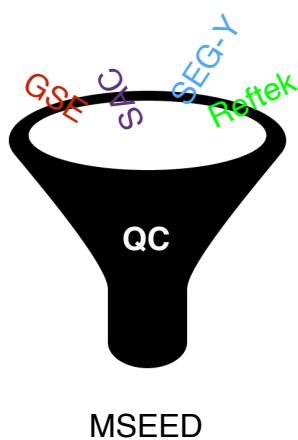


# Work-Flow in Geophysics

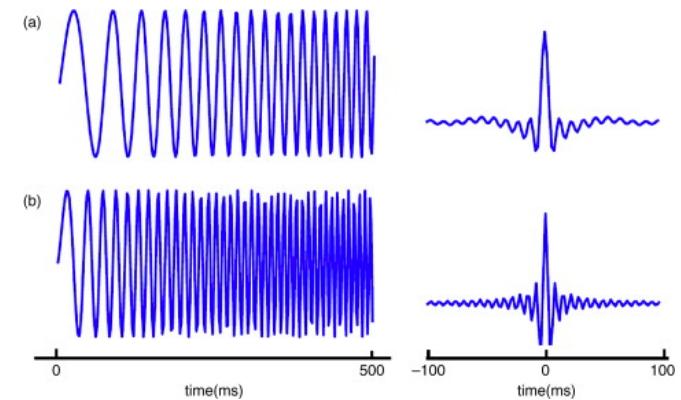
1: Data Collection



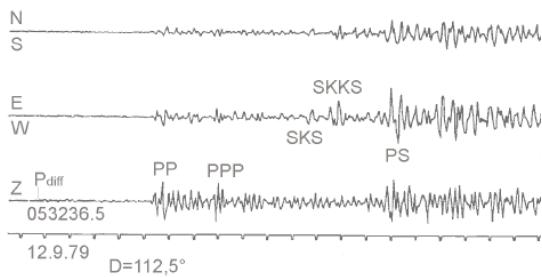
2: Pre-Processing



3: Processing



4: Analysis/Inversion

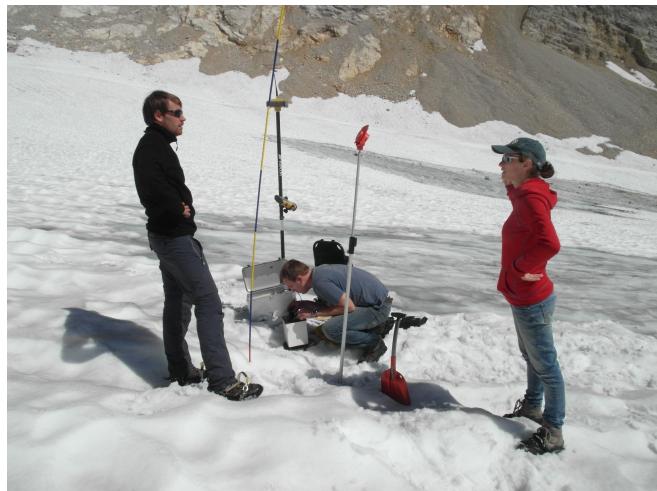


$$\mathbf{m} = \mathbf{F}^{-1}(\mathbf{d})$$

Inversion

# Work-Flow in Geophysics

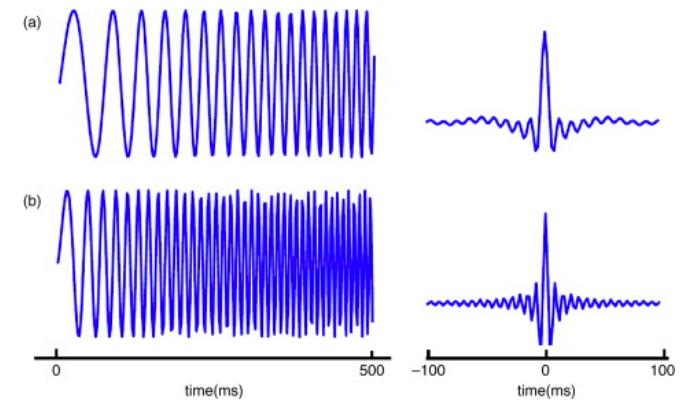
1: Data Collection



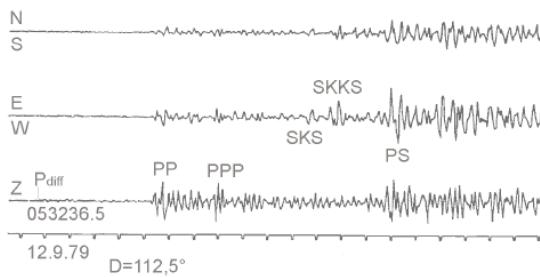
2: Pre-Processing



3: Processing



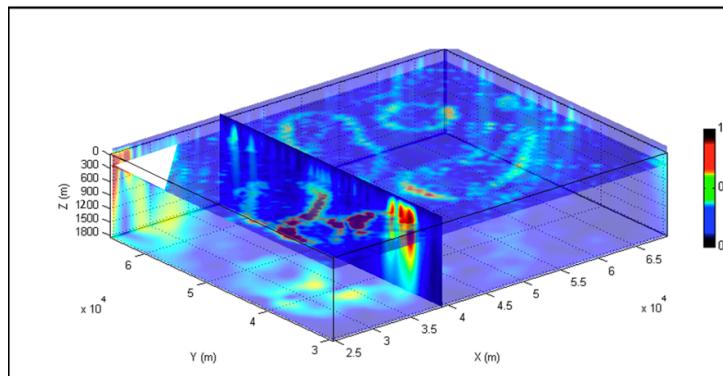
4: Analysis/Inversion



$$\mathbf{m} = \mathbf{F}^{-1}(\mathbf{d})$$

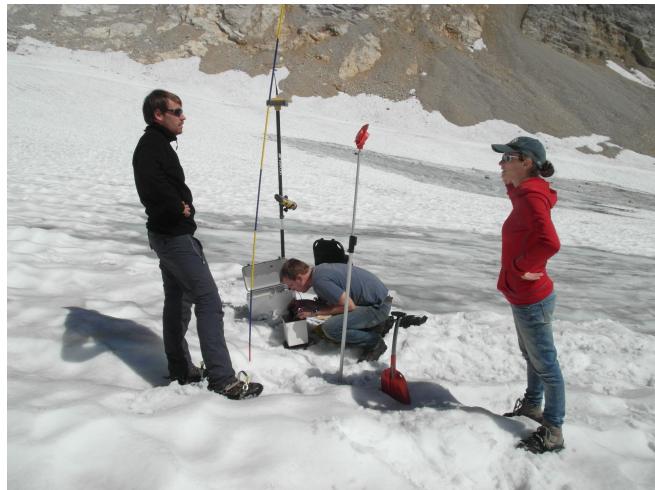
Inversion

5: Visualisation



# Work-Flow in Geophysics

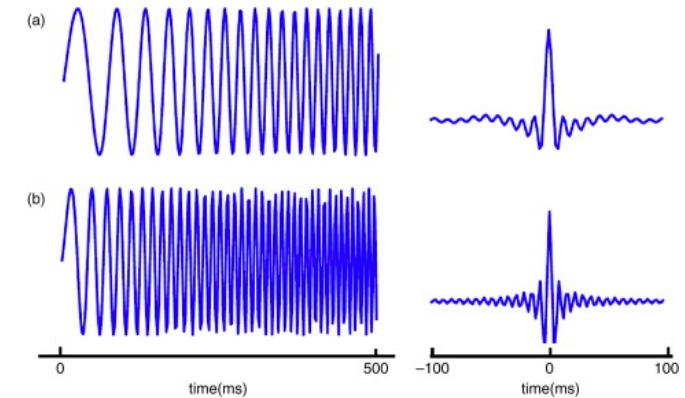
1: Data Collection



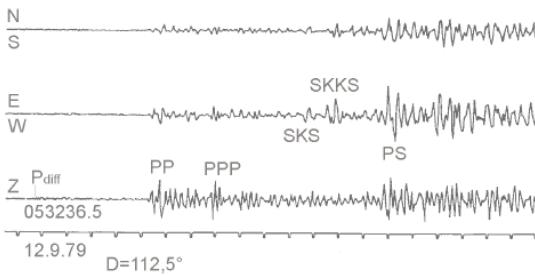
2: Pre-Processing



3: Processing



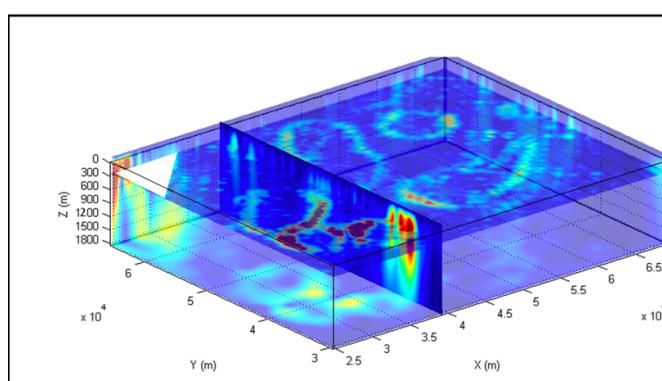
4: Analysis/Inversion



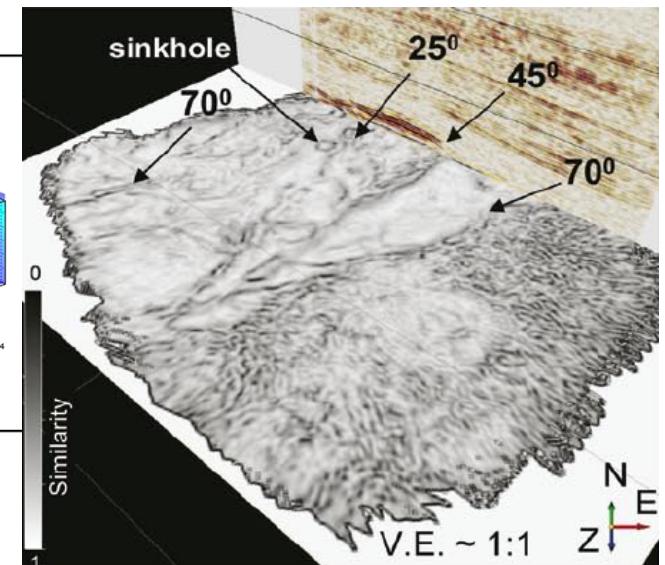
$$\mathbf{m} = \mathbf{F}^{-1}(\mathbf{d})$$

Inversion

5: Visualisation

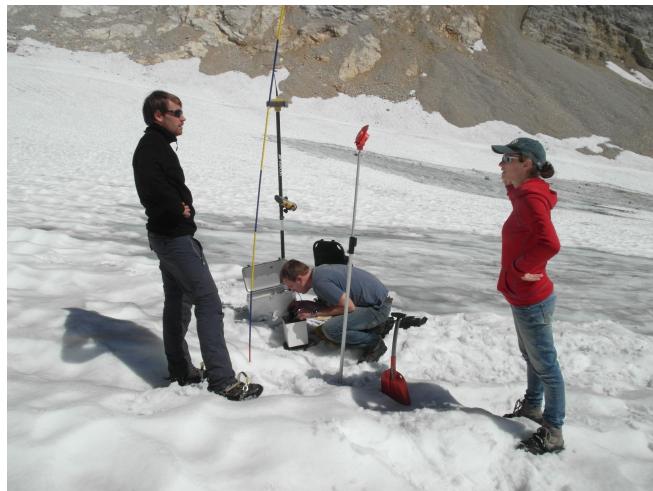


6: Interpretation



# Work-Flow in Geophysics

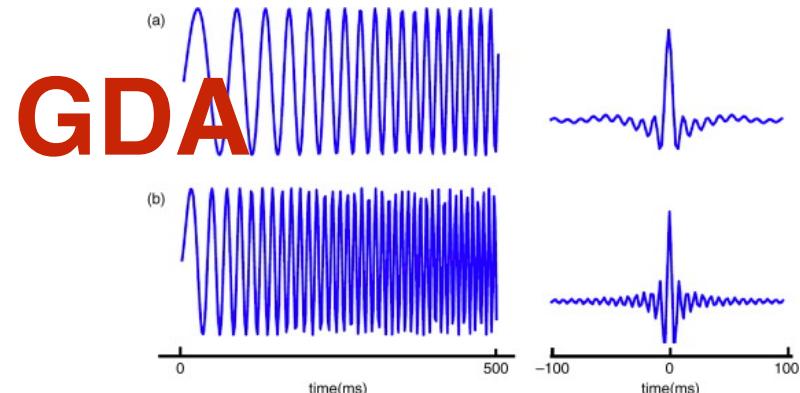
1: Data Collection



2: Pre-Processing

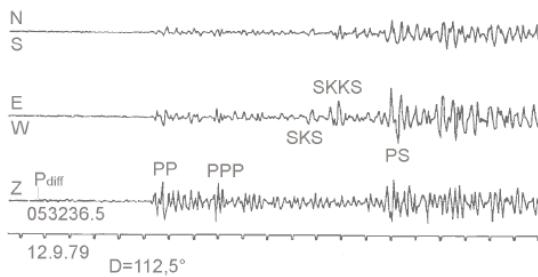


3: Processing



GDA

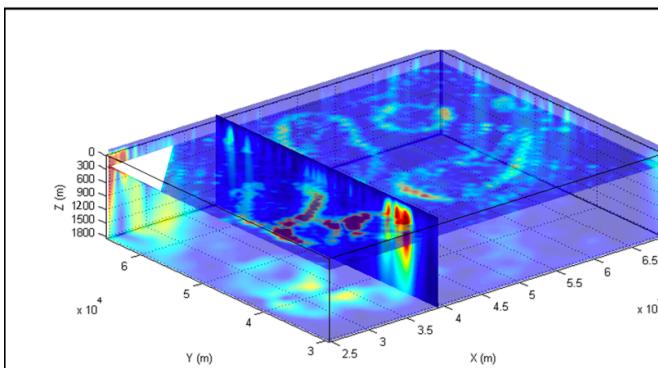
4: Analysis/Inversion



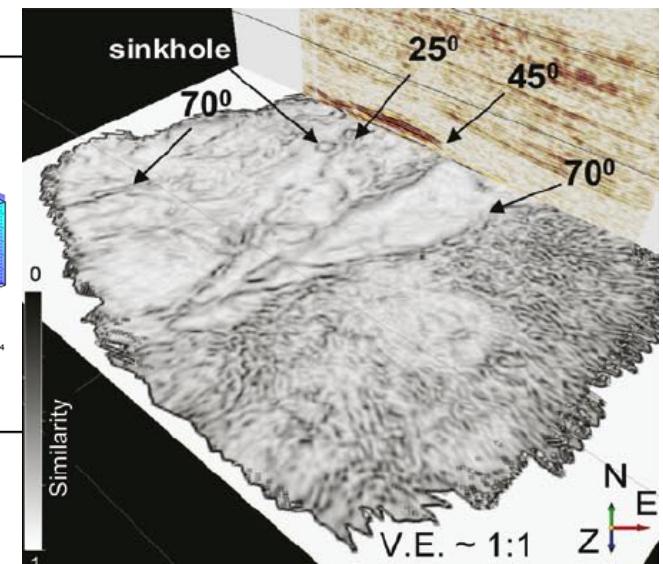
$$\mathbf{m} = \mathbf{F}^{-1}(\mathbf{d})$$

Inversion

5: Visualisation



6: Interpretation



# Be Aware:

# Be Aware:

- Every manipulation of data (analog/digital) will change its (their) content, behaviour etc

# Be Aware:

- Every manipulation of data (analog/digital) will change its (their) content, behaviour etc
- some of which are irreversible

# Be Aware:

- Every manipulation of data (analog/digital) will change its (their) content, behaviour etc
- some of which are irreversible
- always work on **copies** of data – never change the **raw data!!!**

# What is Data?

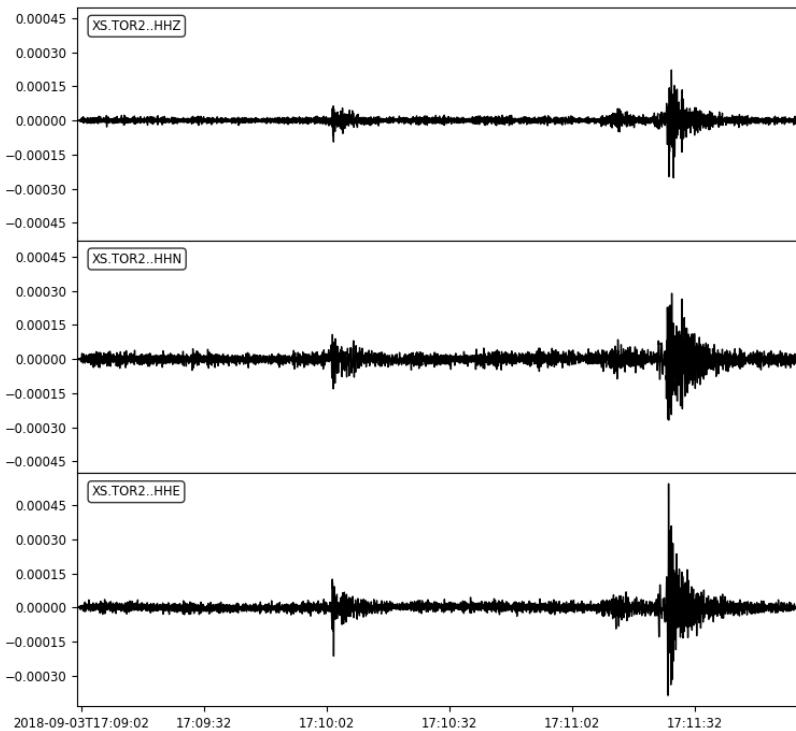
“Data is defined as facts or figures, or information  
(that’s stored in or used by a computer)”

<https://www.yourdictionary.com/data> (Apr 29, 2022)

# What is Geophysical Data?

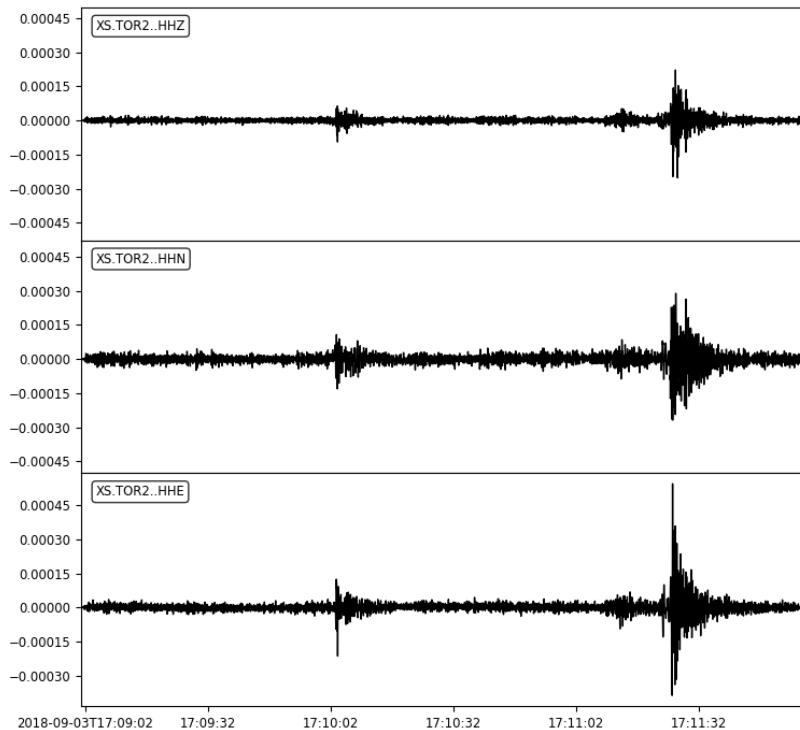
# What is Geophysical Data?

2018-09-03T17:09:01 - 2018-09-03T17:12:00



# What is Geophysical Data?

2018-09-03T17:09:01 - 2018-09-03T17:12:00

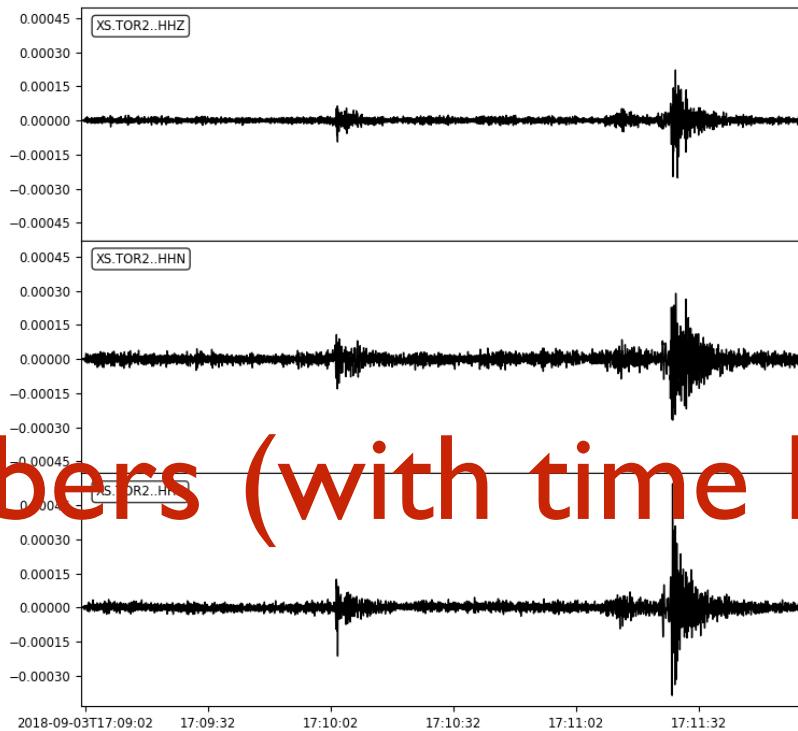


[5]: print(st[0].data)

```
[0.00000000e+00  1.63912466e-10  
6.93998203e-10 ..., -2.33506887e-06  
-2.33414802e-06 -2.33337034e-06 ]
```

# What is Geophysical Data?

2018-09-03T17:09:01 - 2018-09-03T17:12:00



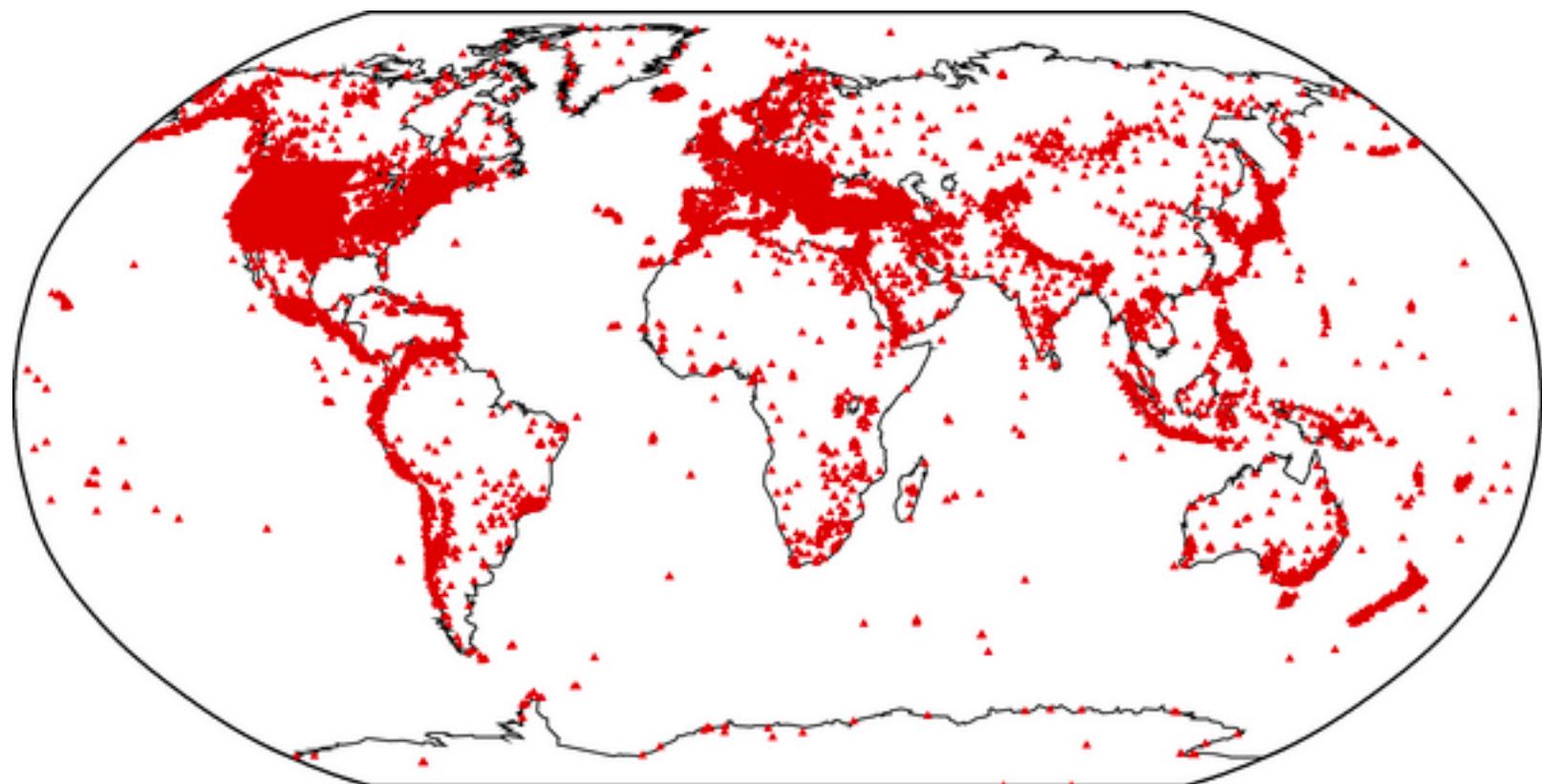
Numbers (with time history)

[5]: print(st[0].data)

```
[0.00000000e+00  1.63912466e-10  
6.93998203e-10 ..., -2.33506887e-06  
-2.33414802e-06 -2.33337034e-06 ]
```

# Prominent Data Resources

## Seismic Stations



<http://www.isc.ac.uk/registries/>

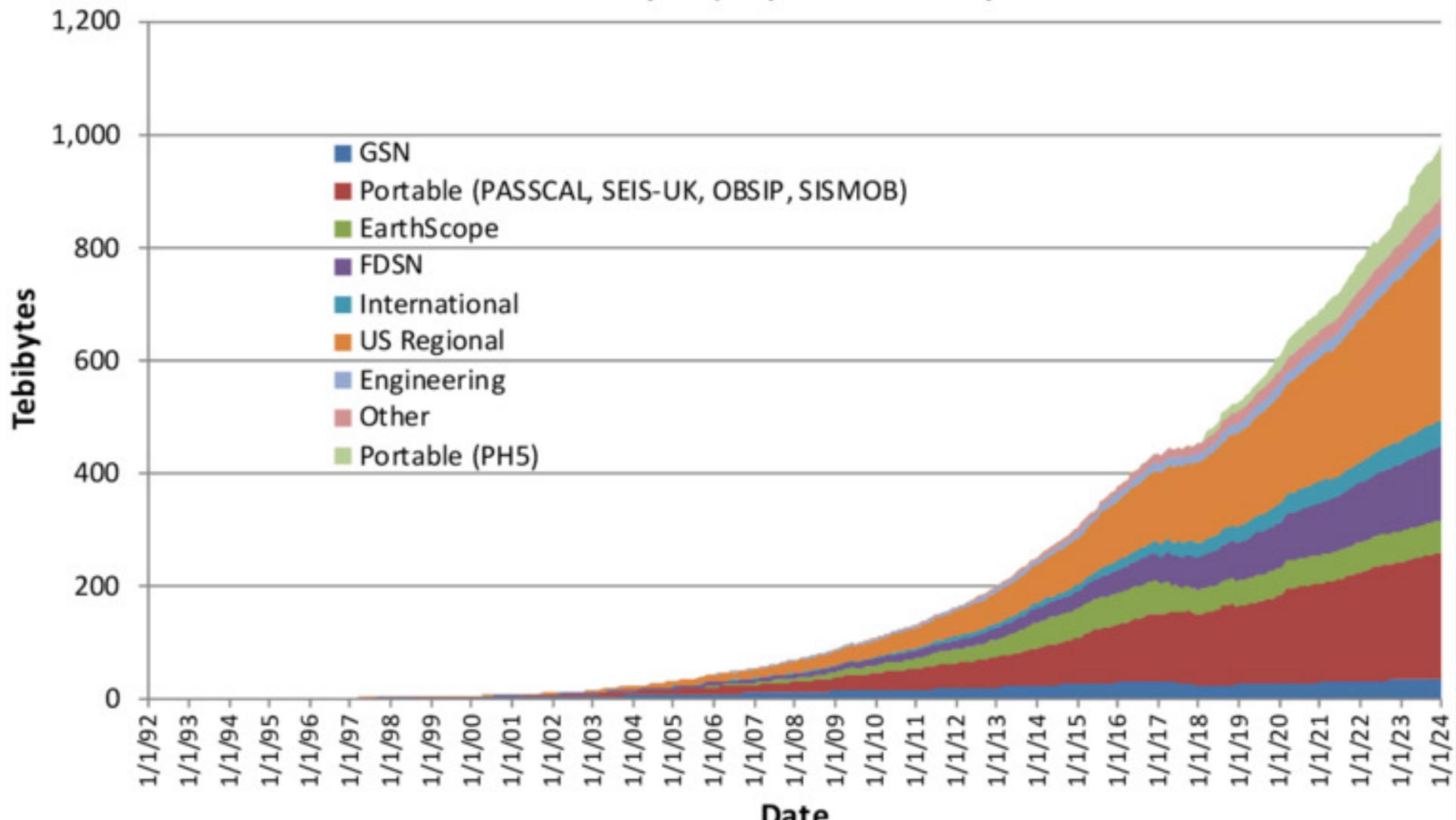
>26000 station (registered) in 2023

# Data Volume Transported



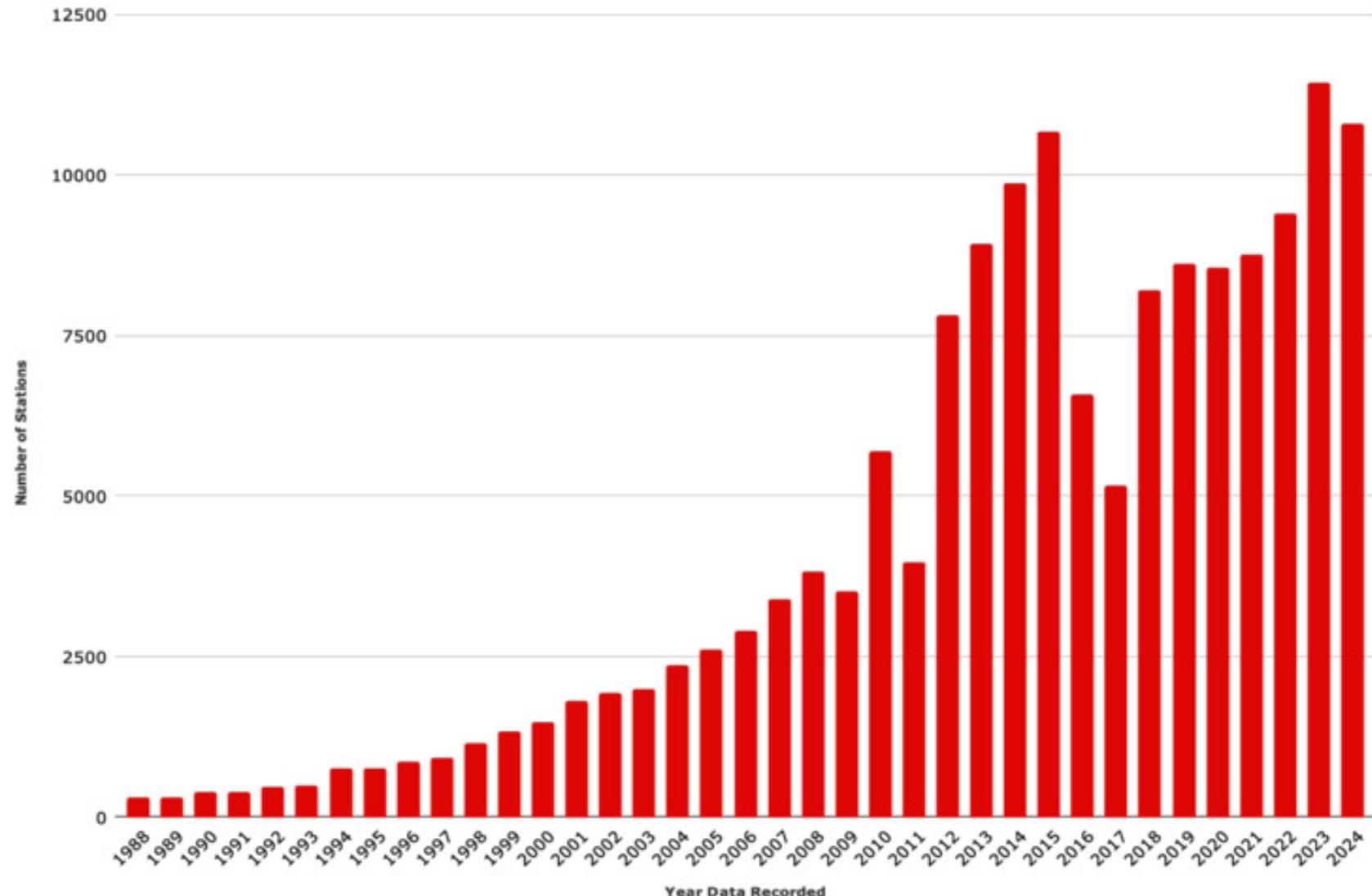
## Archive Size

983 Tebibytes (TiB) as of 1 January 2024



# Data Volume Transported

Stations Submitting Data to the IRIS DMC  
as of 04-01-2024



# Important Landing Pages

**Orfeus** Home Organization ▾ Data & Services ▾ Other ▾

## ORFEUS Data Center WebDC3 Web Interface

[Explore events](#) [Explore stations](#) [Submit request](#) [Download data](#) [Console](#) [Information](#)

**Events Controls** Use this to select events to compose your request.

**Event and Station Map** Here the events and stations you choose will be displayed. Use the mouse to drag the map around. Use the Ctrl-Mouse to draw areas for limiting the search of events and stations when the appropriate modules are enabled.

**Event Information**

Catalog Services  
User Supplied

Catalog Service: GFZ

Date Interval (yyyy-mm-dd): 2020-07-09 – 2020-07-16

Minimum Magnitude: 3

Depth from 0 to 999 km

Coordinates: (Use -ve for S/W; +ve for N/E)

N  
90  
W -180 180 E

Use left SHIFT + drag mouse to select regions.

Legend Help

**Event and Station List** Use these tables to check which events and stations have been selected by your search criteria. You can interactively remove unwanted items. Your final request will be built from the currently displayed information.

<http://orfeus-eu.org/webdc3/>

# Important Landing Pages

GEOFON and EIDA Data Archives

GEOFON | EIDA | Imprint | Data Protection

**EIDA** **GFZ**  
Helmholtz Centre  
POTS DAM

Explore events Explore stations Submit request Download data View console [doc Help](#)

**Events Controls**

**Event Information**

Catalog Services User Supplied

Catalog Service: GFZ

Date Interval (yyyy-mm-dd):  
2020-07-09 – 2020-07-16

Minimum Magnitude: 3

Depth from 0 to 999 km

Coordinates: (Use -ve for S/W; +ve for N/E)

N  
90  
W -180 180 E  
-90 Clear  
S

Reset Append

**Event and Station Map**

223.12, 12.21

Use left SHIFT + drag mouse to select regions.

[Legend Help](#)

**Event and Station List**

Request: Freeze Delete Stations Save Stations Delete Events

**Events (78 events)**

Origin Time	Mag.	Type	Lat.	Long.	Depth	Region
2020-07-15T21:39:41	5.6		7.57	-81.80	10.0	Panama
2020-07-15T17:33:54	4.2		36.98	71.42	93.0	Afghanistan-Tajikistan Border Region
2020-07-15T15:00:43	5.1		-15.89	67.18	10.0	Mid Indian Ridge
2020-07-15T08:59:55	5.1		51.77	-177.20	10.0	Andeanof Islands, Aleutian Islands
2020-07-15T08:56:30	4.7		-56.62	-25.48	10.0	South Sandwich Islands Region
2020-07-15T03:51:40	5.3		-26.62	178.64	645.0	South of Fiji Islands
2020-07-15T00:53:42	4.8		-65.33	179.50	10.0	Balleny Islands Region
2020-07-14T23:33:59	5.7		-7.19	120.48	597.0	Flores Sea

**Stations (-)**

No Stations loaded

<http://eida.gfz-potsdam.de/webdc3/>

### Stations Controls

**Station Information**

Browse Inventory User Supplied

### Networks

Year from 1980 to 2020:

Network Type: All permanent nets

Network Code: BW (1980) - BayernNetz [▼]

\* = temporary network; + = restricted access

### Stations

by Code by Region by Events

Filter stations by station code: All Stations

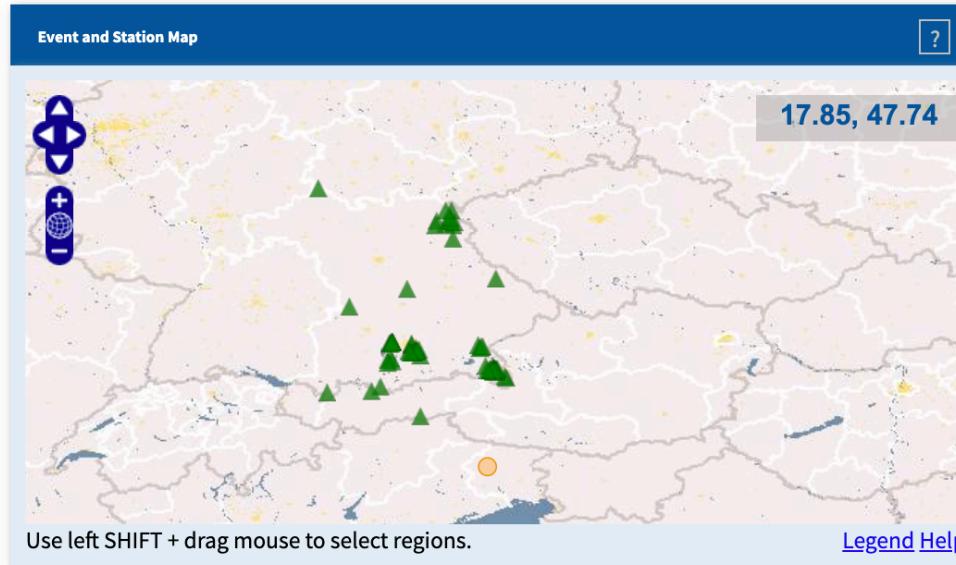
### Streams

by Code by Sampling

Choose the desired set of channels:  
Use SHIFT and CTRL to extend the set.

EH  
HH  
BH  
EL

Reset Append



### Event and Station List

Request: Freeze Delete Stations Save Stations Delete Events

**Events (78 events)**

<input type="checkbox"/>	Origin Time ▲▼	Mag. ▲▼	Type	Lat. ▲▼	Long. ▲▼	Depth ▲▼	Region ▲▼
<input checked="" type="checkbox"/>	2020-07-15T21:39:41	5.6		7.57	-81.80	10.0	Panama
<input checked="" type="checkbox"/>	2020-07-15T17:33:54	4.2		36.98	71.42	93.0	Afghanistan-Tajikistan Border Region
<input checked="" type="checkbox"/>	2020-07-15T15:00:43	5.1		-15.89	67.18	10.0	Mid Indian Ridge
<input checked="" type="checkbox"/>	2020-07-15T08:59:55	5.1		51.77	-177.20	10.0	Andreanof Islands, Aleutian Islands
<input checked="" type="checkbox"/>	2020-07-15T08:56:30	4.7		-56.62	-25.48	10.0	South Sandwich Islands Region
<input checked="" type="checkbox"/>	2020-07-15T03:51:40	5.3		-26.62	178.64	645.0	South of Fiji Islands
<input checked="" type="checkbox"/>	2020-07-15T00:53:42	4.8		-65.33	179.50	10.0	Balleny Islands Region
<input checked="" type="checkbox"/>	2020-07-14T23:33:59	5.7		-7.19	120.48	597.0	Flores Sea

### Stations (73 stations)

<input type="checkbox"/>	Network ▲▼	Station ▲▼	Lat. ▲▼	Long. ▲▼	O/R	Streams
<input checked="" type="checkbox"/>	BW	ALTM	49.00	11.52	O	.EHE,,EHN,,EHZ
<input checked="" type="checkbox"/>	BW	BE1	47.91	11.22	O	.EHE,,EHN,,EHZ
<input checked="" type="checkbox"/>	BW	BE2	47.92	11.26	O	.EHE,,EHN,,EHZ
<input checked="" type="checkbox"/>	BW	BE3	47.88	11.28	O	.EHE,,EHN,,EHZ
<input checked="" type="checkbox"/>	BW	BE4	47.86	11.22	O	.EHE,,EHN,,EHZ
<input checked="" type="checkbox"/>	BW	BGDS	47.64	13.03	O	.HHE,,HNN,,HHZ
<input checked="" type="checkbox"/>	BW	BGLD	47.65	13.01	O	.EHE,,EHN,,EHZ
<input checked="" type="checkbox"/>	BW	BHG	47.72	12.88	O	.HHE,,HNN,,HHZ
<input checked="" type="checkbox"/>	BW	BIB	48.15	11.25	O	.HHE,,HNN,,HHZ
<input checked="" type="checkbox"/>	BW	DHFO	48.01	11.63	O	.EHE,,EHN,,EHZ
<input checked="" type="checkbox"/>	BW	FFB1	48.16	11.28	O	.HH1.,HH2..HHZ
<input checked="" type="checkbox"/>	BW	FFB2	48.16	11.27	O	.HH1..HH2..HHZ

[Explore events](#) [Explore stations](#) [Submit request](#) [Download data](#) [View console](#)
[doc](#) [Help](#)

**Make Request** [?](#)

### Time Window selection:

Relative Mode  Absolute Mode

Use an absolute time window.

Start

End

**Request Type:**

- Waveform (Mini-SEED)
- Metadata (StationXML)
- Metadata (Text)

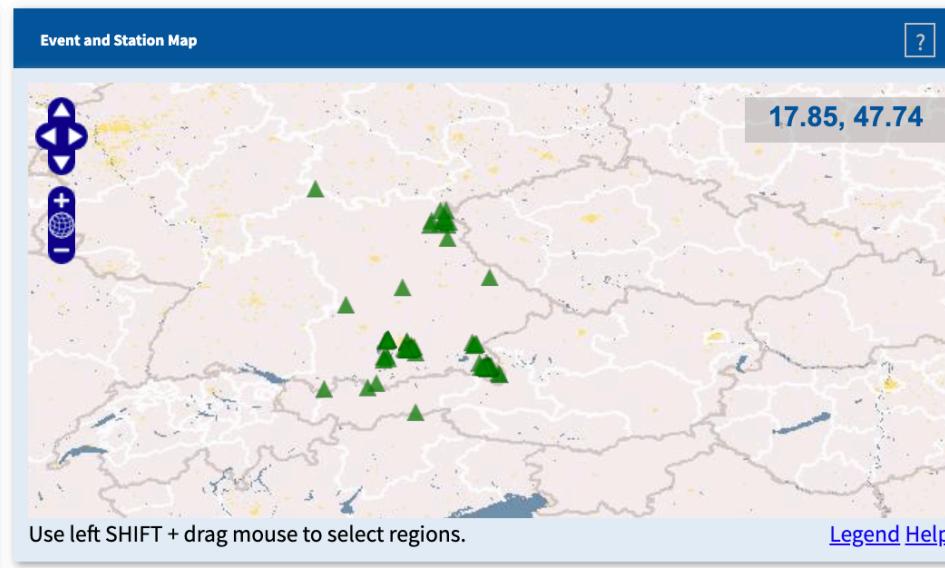
**Authentication:**

Current ID: Anonymous  
Valid until: N/A

[Load Token](#) [Remove Token](#)

[Reset](#)

[Review](#) [Submit](#)



**Event and Station List** [?](#)

**Request:** [Freeze](#) [Delete Stations](#) [Save Stations](#) [Delete Events](#)

**Events (-)**  
*No Events loaded*

**Stations (73 stations)**

<input type="checkbox"/>	Network	Station	Lat.	Long.	O/R	Streams
<input checked="" type="checkbox"/>	BW	ALTM	49.00	11.52	O	.EHE,,EHN,,EHZ
<input checked="" type="checkbox"/>	BW	BE1	47.91	11.22	O	.EHE,,EHN,,EHZ
<input checked="" type="checkbox"/>	BW	BE2	47.92	11.26	O	.EHE,,EHN,,EHZ
<input checked="" type="checkbox"/>	BW	BE3	47.88	11.28	O	.EHE,,EHN,,EHZ
<input checked="" type="checkbox"/>	BW	BE4	47.86	11.22	O	.EHE,,EHN,,EHZ
<input checked="" type="checkbox"/>	BW	BGDS	47.64	13.03	O	.HHE,,HHN,,HHZ
<input checked="" type="checkbox"/>	BW	BGLD	47.65	13.01	O	.EHE,,EHN,,EHZ
<input checked="" type="checkbox"/>	BW	BHG	47.72	12.88	O	.HHE,,HHN,,HHZ
<input checked="" type="checkbox"/>	BW	BIB	48.15	11.25	O	.HHE,,HHN,,HHZ
<input checked="" type="checkbox"/>	BW	DHFO	48.01	11.63	O	.EHE,,EHN,,EHZ
<input checked="" type="checkbox"/>	BW	FFB1	48.16	11.28	O	.HH1,,HH2,,HHZ
<input checked="" type="checkbox"/>	BW	FFB2	48.16	11.27	O	.HH1,,HH2,,HHZ

[Explore events](#) [Explore stations](#) [Submit request](#) [Download data](#) [View console](#)
[doc](#) [Help](#)

**Make Request** [?](#)

### Time Window selection:

Relative Mode  Absolute Mode

Use an absolute time window.

Start

End

00:00:00

23:59:59

### Request Type:

Waveform (Mini-SEED)  Metadata (StationXML)  Metadata (Text)

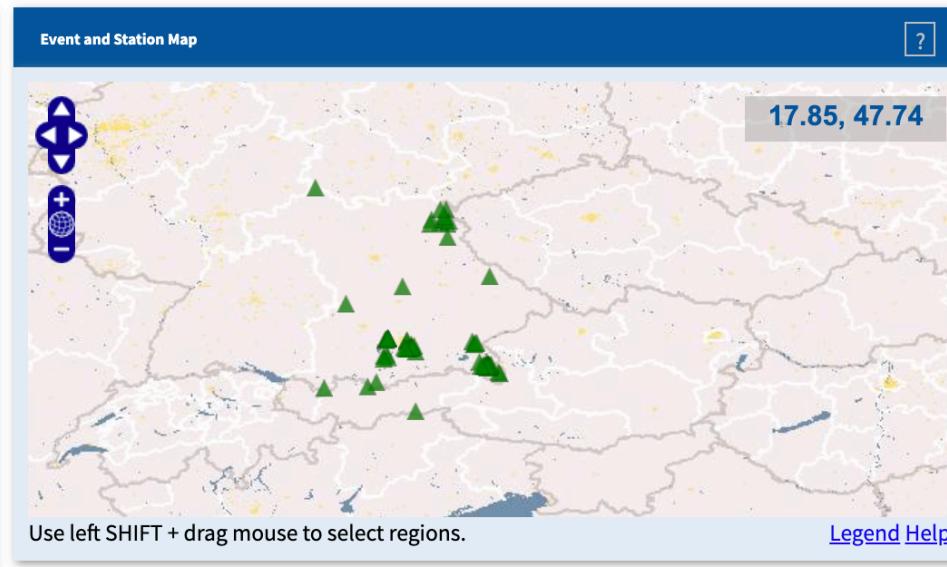
**Authentication:**

Current ID: Anonymous  
Valid until: N/A

[Load Token](#) [Remove Token](#)

[Reset](#)

[Review](#) [Submit](#)



**Event and Station List** [?](#)

**Request:** [Freeze](#) [Delete Stations](#) [Save Stations](#) [Delete Events](#)

### Events (-)

No Events loaded

### Stations (73 stations)

<input type="checkbox"/>	Network	Station	Lat.	Long.	O/R	Streams
<input checked="" type="checkbox"/>	BW	ALTM	49.00	11.52	O	.EHE,,EHN,,EHZ
<input checked="" type="checkbox"/>	BW	BE1	47.91	11.22	O	.EHE,,EHN,,EHZ
<input checked="" type="checkbox"/>	BW	BE2	47.92	11.26	O	.EHE,,EHN,,EHZ
<input checked="" type="checkbox"/>	BW	BE3	47.88	11.28	O	.EHE,,EHN,,EHZ
<input checked="" type="checkbox"/>	BW	BE4	47.86	11.22	O	.EHE,,EHN,,EHZ
<input checked="" type="checkbox"/>	BW	BGDS	47.64	13.03	O	.HHE,,HHN,,HHZ
<input checked="" type="checkbox"/>	BW	BGLD	47.65	13.01	O	.EHE,,EHN,,EHZ
<input checked="" type="checkbox"/>	BW	BHG	47.72	12.88	O	.HHE,,HHN,,HHZ
<input checked="" type="checkbox"/>	BW	BIB	48.15	11.25	O	.HHE,,HHN,,HHZ
<input checked="" type="checkbox"/>	BW	DHFO	48.01	11.63	O	.EHE,,EHN,,EHZ
<input checked="" type="checkbox"/>	BW	FFB1	48.16	11.28	O	.HH1,,HH2,,HHZ
<input checked="" type="checkbox"/>	BW	FFB2	48.16	11.27	O	.HH1,,HH2,,HHZ

[Explore events](#) [Explore stations](#) [Submit request](#) [Download data](#) [View console](#)
[doc](#) [Help](#)

[Make Request](#) [?](#)

### Time Window selection:

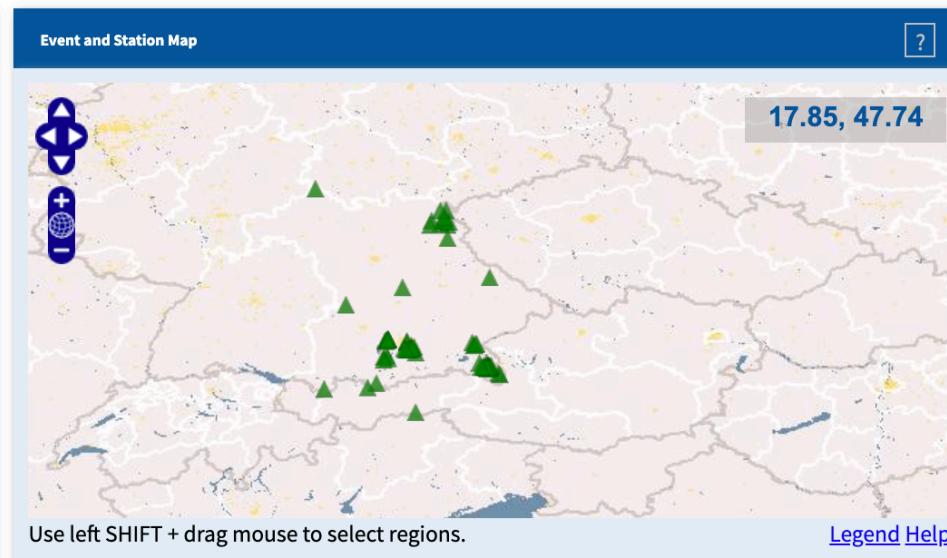
Relative Mode [Absolute Mode](#)

Use an absolute time window.

Start

End

[Request](#) [Reset](#) [Review](#) [Submit](#)



[Event and Station List](#) [?](#)

[Request](#) [Freeze](#) [Delete Stations](#) [Save Stations](#) [Delete Events](#)

### Events (-)

No Events loaded

### Stations (73 stations)

<input type="checkbox"/>	Network	Station	Lat.	Long.	O/R	Streams
<input checked="" type="checkbox"/>	BW	ALTM	49.00	11.52	O	.EHE,,EHN,,EHZ
<input checked="" type="checkbox"/>	BW	BE1	47.91	11.22	O	.EHE,,EHN,,EHZ
<input checked="" type="checkbox"/>	BW	BE2	47.92	11.26	O	.EHE,,EHN,,EHZ
<input checked="" type="checkbox"/>	BW	BE3	47.88	11.28	O	.EHE,,EHN,,EHZ
<input checked="" type="checkbox"/>	BW	BE4	47.86	11.22	O	.EHE,,EHN,,EHZ
<input checked="" type="checkbox"/>	BW	BGDS	47.64	13.03	O	.HHE,,HHN,,HHZ
<input checked="" type="checkbox"/>	BW	BGLD	47.65	13.01	O	.EHE,,EHN,,EHZ
<input checked="" type="checkbox"/>	BW	BHG	47.72	12.88	O	.HHE,,HHN,,HHZ
<input checked="" type="checkbox"/>	BW	BIB	48.15	11.25	O	.HHE,,HHN,,HHZ
<input checked="" type="checkbox"/>	BW	DHFO	48.01	11.63	O	.EHE,,EHN,,EHZ
<input checked="" type="checkbox"/>	BW	FFB1	48.16	11.28	O	.HH1,,HH2,,HHZ
<input checked="" type="checkbox"/>	BW	FFB2	48.16	11.27	O	.HH1,,HH2,,HHZ

**Station Metadata:**  
Information about characteristics of deployed instruments

Current ID: Anonymous  
Valid until: N/A

[Load Token](#) [Remove Token](#)

[Reset](#)

[Review](#) [Submit](#)

# Important Landing Pages

**CSEM**  
**EMSC**

LASTQUAKE  
the official EMSC earthquakes app

Current time: 2020-07-16 06:14:38 UTC

ANDROID APP ON Google play  
Available on the App Store

Member access  
Name: \_\_\_\_\_  
Pwd: \_\_\_\_\_  
Sign in

Earthquake information | Testimonies, photos | Information services | For seismologists | Projects | Publications & docs

You are here : EMSC | Our sponsors: GeoSIG | [Donate](#) | About EMSC

Euro-Med earthquakes | Worldwide earthquakes with M4.0+

Choose your map :  Last 1h  Last 24h  Last 48h  Last week  Last 2 weeks

40 earthquakes on this map

Last update 2020-07-16 06:11

EMSC

Mag: 2.0  3.0  4.0  5.0  6.0  7.0

I felt an earthquake

Latest significant earthquakes

Special Reports [+]

- Mw=6.6 Earthquake of 2 May 2020 and...
- Report on the M6.8 Elazig (Turkey)...

The EMSC is the European infrastructure for seismological products in

**EPOS**  
EUROPEAN PLATE OBSERVATION SYSTEM

News & Announcements [+]

- New Turkish Accelerometric Database...
- International Training Course 2020 on...
- "Crowdsourcing speeds up earthquake...

Explore Data & Services

Recent Pictures From Eyewitnesses



<https://www.emsc-csem.org/#2>

# Important Landing Pages

You are here : **EMSC** > Earthquake > M 3.7 - FRANCE - 2020-07-16 03:19:44 UTC

Our sponsors: **GeoSIG**

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[About EMSC](#)



**M 3.7 - FRANCE - 2020-07-16 03:19:44 UTC**



I felt this earthquake

[Summary](#)

[Maps](#)

[Testimonies](#)

[Pictures](#)

[List of data providers](#)

[Scientific data](#)

[You felt this earthquake. Tell us!](#)

- ▶ Magnitude **ML 3.7**
- ▶ Region **FRANCE**
- ▶ Date time **2020-07-16 03:19:44.5 UTC**
- ▶ Location **46.82 N ; 0.33 W**
- ▶ Depth **2 km**
- ▶ Distances 295 km SE of Saint Helier, Jersey / pop: 28,000 / local time: 04:19:44.5 2020-07-16  
57 km NW of Poitiers, France / pop: 86,000 / local time: 05:19:44.5 2020-07-16  
3 km NE of Chiché, France / pop: 1,500 / local time: 05:19:44.5 2020-07-16

Source parameters reviewed by a seismologist

**More information at:**

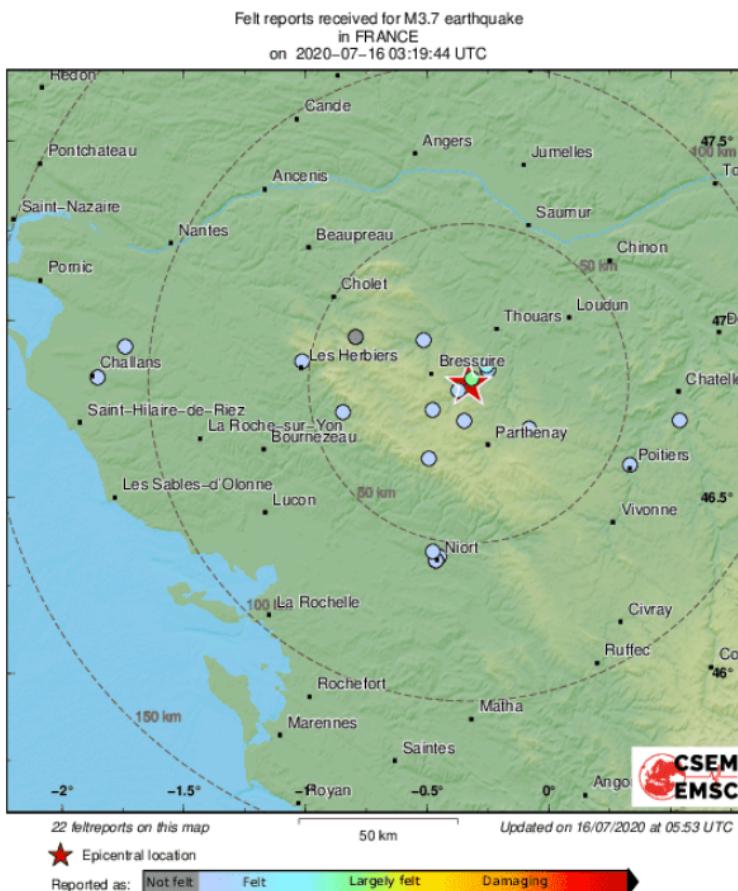
- Laboratoire de Détection et de Géophysique Bruyères-le-Châtel, France
- Réseau National de Surveillance Sismique Strasbourg, France
- Bureau Central Sismologique Francais (BCSF) Strasbourg, France
- Plan Séisme (*Information sur les bons gestes à appliquer en cas de séisme*)
- Bureau de Recherches Géologiques et Minières, France



# Important Landing Pages

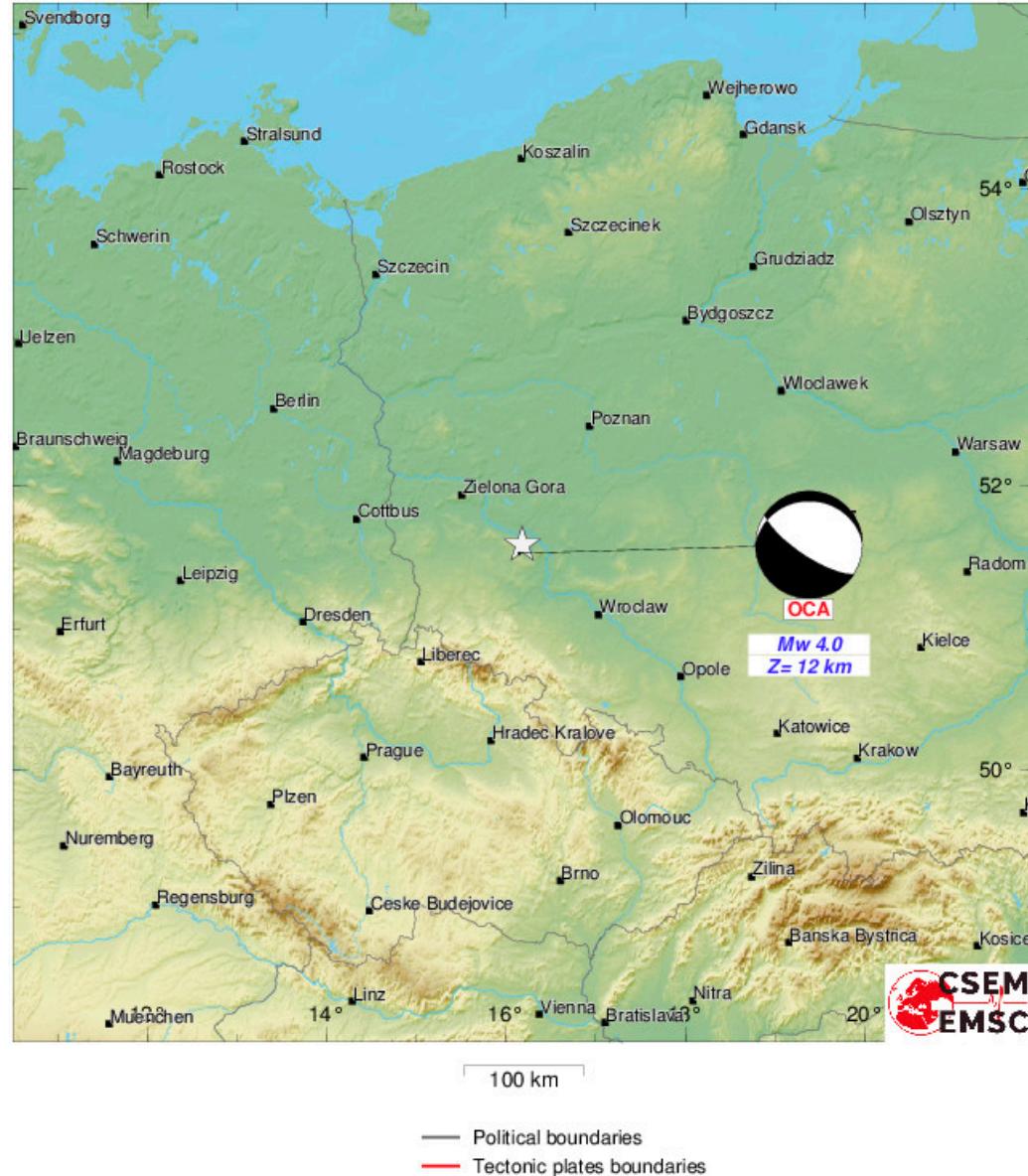
Map

Graphs



Map created with the testimonies provided by the eyewitnesses (click to enlarge).

# Important Landing Pages



# Important Landing Pages

**GEOFON**

Imprint | Data Protection  
**GFZ**  
Helmholtz Centre  
POTS DAM

Home Mission Earthquake Info Waveform Access Software Contribute About

GE global seismic network Seismic waveform data archive Rapid earthquake information

Leaflet | Network and earthquake data GEOFON | Map data © OpenStreetMap contributors | Zoom @torfsen

Recent earthquakes (last 14 days)  Seismic stations  GE  Others

MOST RECENT EVENTS >

5.6	2020-07-15 21:39:41	Panama
4.2	2020-07-15 17:33:54	Afghanistan-Tajikistan Border Re...
5.1	2020-07-15 15:00:43	Mid Indian Ridge
5.1	2020-07-15 08:59:55	Andreanof Islands, Aleutian Isla...

GEOFON NEWS >

2020-06-23: SeisComp version 4 released  
Read more about the new SeisComp at <https://www.seiscomp.de/> ...

2020-06-02: Update to Station XML  
We are in the process of upgrading our production machines ...

SUBSCRIBE FOR MORE INFORMATION

Seeking earthquake alerts, or recent data center activities? Try the interactive GEOFON Forum

Learn about our SeisComp software at the [SeisComp3 forum](#) in cooperation with [geofon GmbH](#)

<https://geofon.gfz-potsdam.de/>

# Important Landing Pages

Imprint | Data Protection

**GFZ**  
Helmholtz Centre  
POTS DAM

[Home](#) [Mission](#) [Earthquake Info](#) [Waveform Access](#) [Software](#) [Contribute](#) [About](#)

[Filter](#) [FAQ](#) [RSS](#)

[Earlier events](#) [No newer events](#)

Mag	F-E Region	Time (UTC)	Depth (km)
5.6	Panama	2020-07-15 21:39:41 (9 h ago)	10
4.2	Afghanistan-Tajikistan Border Region	2020-07-15 17:33:54 (13 h ago)	93
5.1	Mid Indian Ridge	2020-07-15 15:00:43 (15 h ago)	10
5.1	Andreaeof Islands, Aleutian Islands	2020-07-15 08:59:55 (21 h ago)	10
4.7	South Sandwich Islands Region	2020-07-15 08:56:30 (21 h ago)	10
5.3	South of Fiji Islands	2020-07-15 03:51:40	645
4.8	Balleny Islands Region	2020-07-15 00:53:42	10
5.7	Flores Sea	2020-07-14 23:33:59	597
5.0	Near N. Coast of New Guinea, PNG.	2020-07-14 22:49:20	10
4.9	Vanuatu Islands	2020-07-14 19:15:16	168
4.1	Southeast of Honshu, Japan	2020-07-14 14:13:38	434
5.0	Kuril Islands	2020-07-14 13:21:08	82
4.2	E Russia-NE China Border Region	2020-07-14 08:45:59	562
4.5	Cyprus Region	2020-07-14 08:33:14	63
4.6	Off Coast of Central America	2020-07-14 08:25:20	82

# Important Landing Pages

GEOFON

Imprint | Data Protection

GFZ  
Helmholtz Centre  
POTS DAM

Home Mission Earthquake Info Waveform Access Software Contribute About

F-E Region Panama  
Time 2020-07-15 21:39:41.9 UTC  
Magnitude 5.6 (Mw)  
Epicenter 81.80°W 7.57°N ↗  
Depth 10 km  
Status M - manually revised ⓘ

Moment tensor solutions

GEOFON standard <sup>1</sup>	Time 2020-07-15 21:39:41
	Magnitude 5.6
	Latitude 7.59°N
	Longitude 81.77°W
	Depth 11 km
	Nodal planes
	Strike 159°
	Dip 70°
	Rake 116°
	283°
	32°
	38°

<sup>1</sup> GEOFON standard inversion using body and surface waves. [Details].

# Important Landing Pages



International Seismological Centre

[About ISC](#) [ISC Products](#) [ISC Bulletin](#) [ISC-GEM Catalogue](#) [ISC-EHB Bulletin](#)

[Int. Station Registry](#) [IASPEI GT](#) [Event Bibliography](#) [Dataset Repository](#) [Seismological Contacts](#)

[Home](#) [About ISC](#) [Staff](#) [Contact us](#) [Site Map](#)

## ISC News

2020-07-10

[Newsletter 2020 Apr-Jun](#)

2020-04-09

[ISC-GEM Catalogue Ver 7.0 Released](#)

2020-02-05

[Rebuilt ISC Bulletin \(1964-2010\) is available](#)

2020-01-20

[ISC-EHB 1964-2016 paper published in ESS](#)

2019-11-21

New Paper released: The (Mythical) M 8.2 Off Coast of Peru Earthquake of 12 December 1908, *Seism. Res. Lett.*

2019-07-09

[Seismological Dataset Repository is live](#)  
[Past news](#)

## News for / from data contributors

[SRL Call for Papers: Focus Section on Monitoring During Crisis](#)

[Seismic Monitoring at the Turkish National Seismic Network \(TSN\)](#)

[Operating procedures of the Servicio Sismológico Nacional, Mexico](#)

International Seismological Centre

Centre Séismologique International

Международный Сейсмологический Центр

国际地震センター

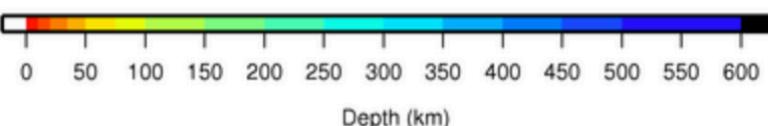
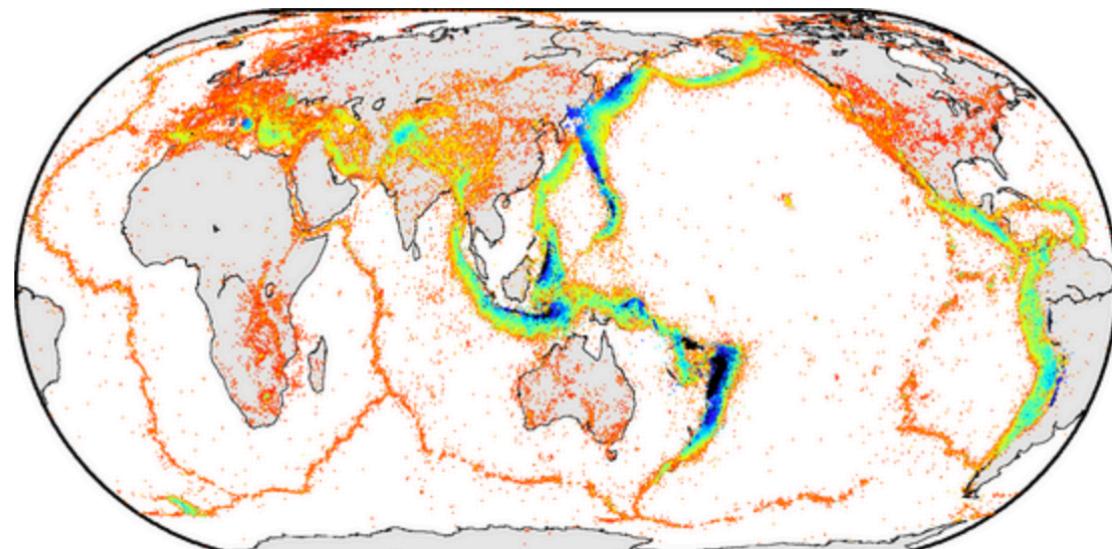
国际地震中心

Internationales Seismologisches Zentrum

المركز الدولي لبحث الزلازل

Centro Internacional de Sismología

## ISC locations: 1964 to present



# Important Landing Pages

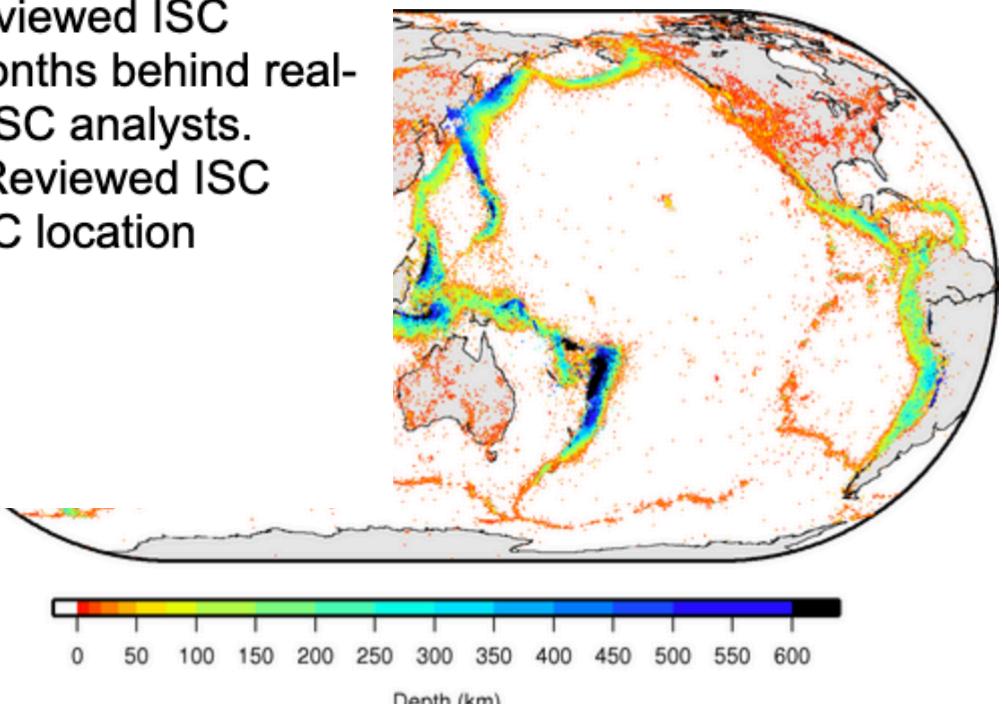
 f t Home About ISC Staff Contact us Site Map

Catalogue ISC-EHB Bulletin  
Dataset Repository Seismological Contacts

The main purpose of the ISC is to compile the [ISC Bulletin](#), regarded as the definitive record of the Earth's seismicity. Data is collected from over 130 [agencies](#) worldwide and is available online soon after being received. The Reviewed ISC Bulletin is typically available 24 months behind real-time and is manually checked by ISC analysts. With sufficient data events in the Reviewed ISC Bulletin are relocated using the ISC location algorithm ([ISClloc](#)).

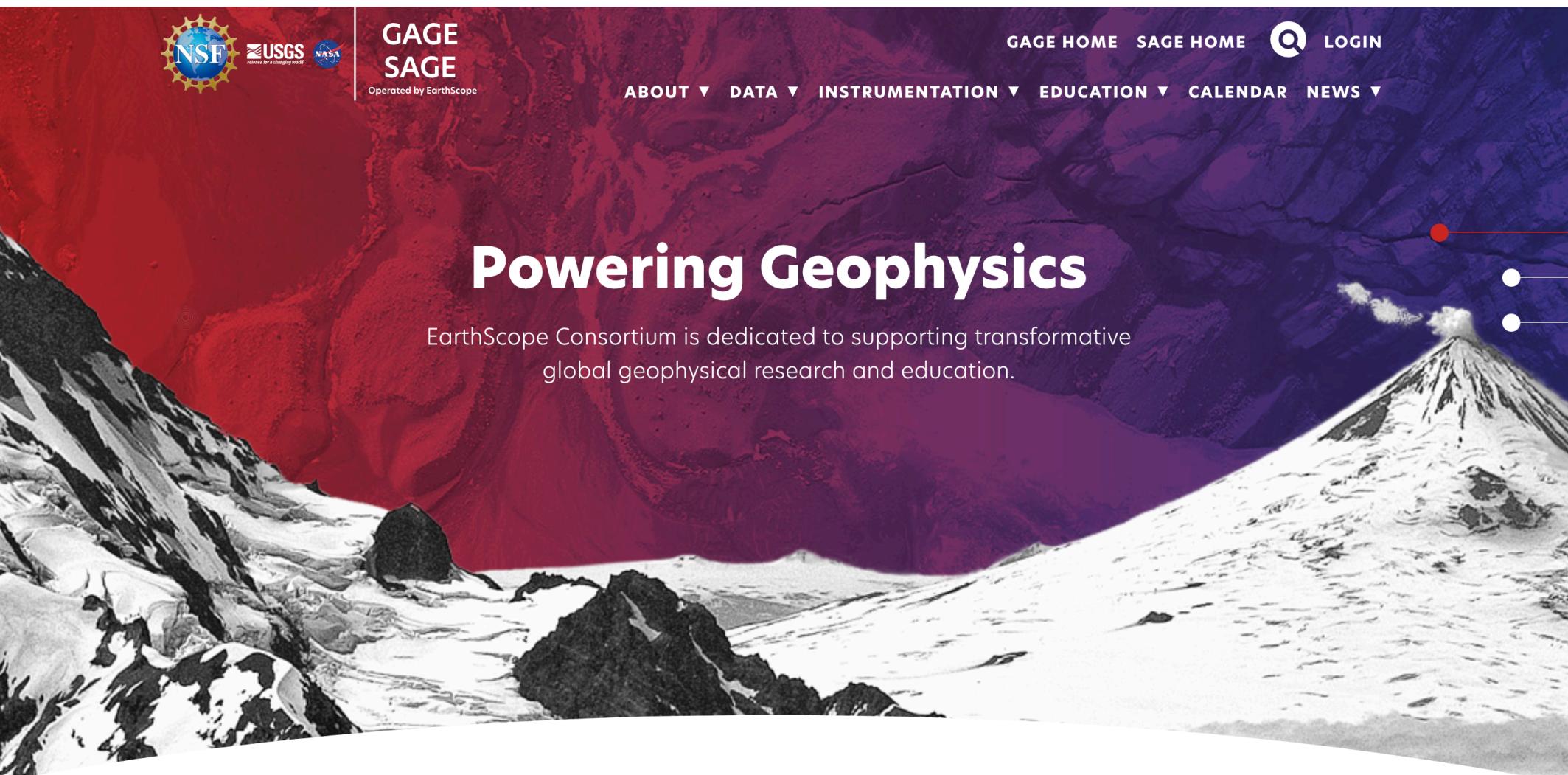
[more information](#)

[Seismic Monitoring at the Turkish National Seismic Network \(TSN\)](#)  
[Operating procedures of the Servicio Sismológico Nacional, Mexico](#)



ie | Международный Сейсмологический Центр | 国際地震センター  
um | المركز الدولي لبحث الزلازل | Centro Internacional de Sismología  
tions: 1964 to present

# Important Landing Pages



<http://earthscape.org>

**Our Science Support**

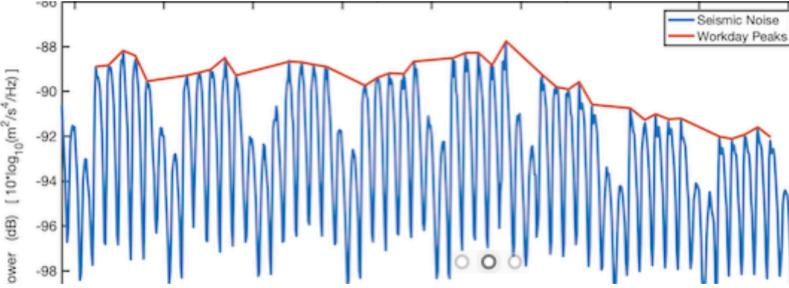
# Important Landing Pages

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## IRIS Incorporated Research Institutions for Seismology

**RESEARCH** Data, derived products, software, web services    **EDUCATION** Lessons, lectures, videos, public displays    **FACILITIES** Directories, programs, networks, centers    **EARTHQUAKES** Recent earthquakes, teachable moments    **ABOUT IRIS** Organization, governance, news, jobs, annual reports    **RESOURCES** Publications, webinars, posters, newsletters, proposals

  
Power (dB) [ $10^{\log_{10}(m^2/s/Hz)}$ ] vs Frequency (Hz). The graph shows two data series: Seismic Noise (blue line with vertical spikes) and Workday Peaks (red line). The Seismic Noise level is consistently lower than the Workday Peaks level.

**Reduction in seismic noise because of changes in human activity**  
Researchers who study Earth's movement are seeing a drop in seismic noise as a result of transport networks and other human activities being shut down. [Continue Reading ➤](#)

**NEWS AND ANNOUNCEMENTS**

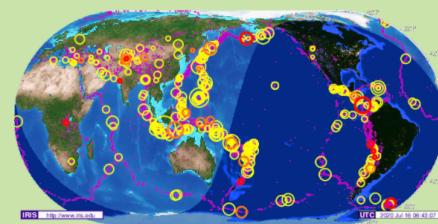
- ★ FAQs on the Merger of IRIS and UNAVCO Jul 9
- ★ Update #4 on Joint IRIS/UNAVCO Negotiations Jun 30
- ★ RFI: Seeking Expressions of Interest from IRIS and UNAVCO Member Institutions for Hosting Future Geophysical Facilities Jun 22
- ★ WANTED: Your Suggestions for the Name of a New Non-Profit - Deadline is July 15, 2020 Jun 17

**UPCOMING EVENTS**

- Jul 21** IRIS/SSA Distinguished Lectureship Series  
OMSI Virtual Science Pub
- Aug 10-17** 2020 Distributed Acoustic Sensing Virtual Workshop and Tutorial  
Virtual
- Mar 9-10** Marine Seismology Symposium  
Maritime Conference Center, Linthicum Heights, Maryland,

**EARTHQUAKE Resources**

**Seismic Monitor**

  
A world map showing seismic activity. Numerous yellow and red circles of varying sizes represent earthquake epicenters. A legend indicates magnitudes: 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, and 8.0. A timestamp at the bottom right shows UTC 2020 Jun 16 06:45:07.

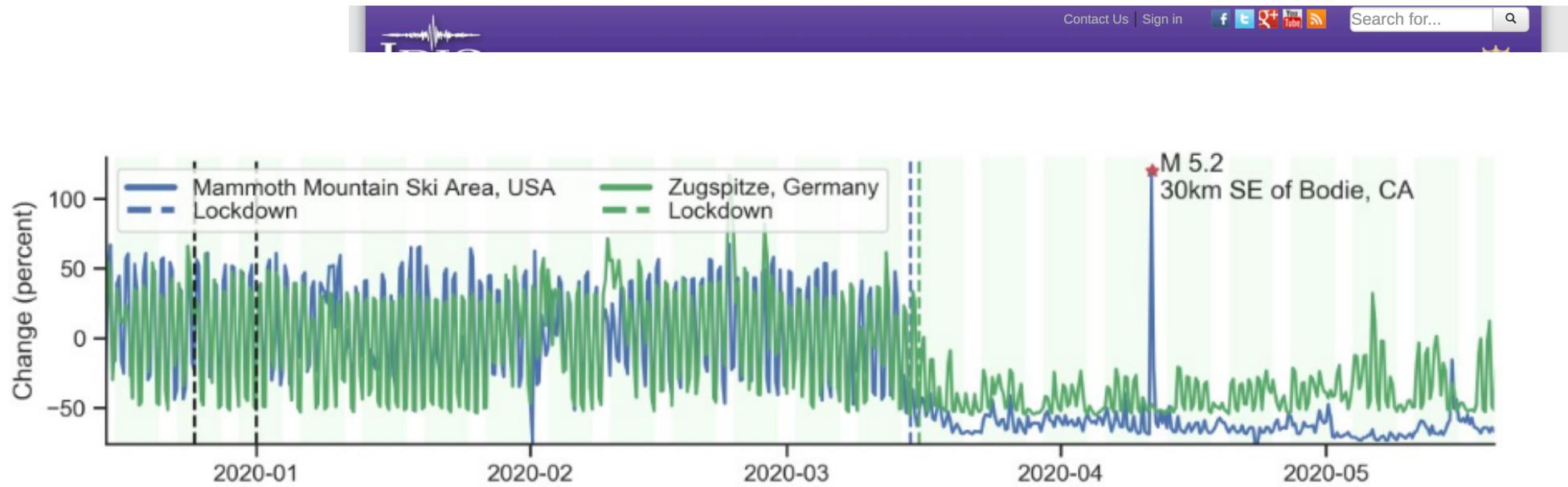
Recent Earthquake Teachable Moments > Magnitude 5.8 - California 2020-06-24

**NEW ANIMATION! Bomb or Earthquake?**  
How do seismologists tell the difference between an explosion and an earthquake, when both shake the ground? Find out in this new animation!

**New Animation! Cascades Subduction Zone —What can the landscape tell us?**  
This animation describes the geographic provinces of the Pacific Northwest, including the subducting plate, the subduction boundary, the Coast Range, the lowlands, and the Cascades mountain range.

<https://www.iris.edu/hq/>

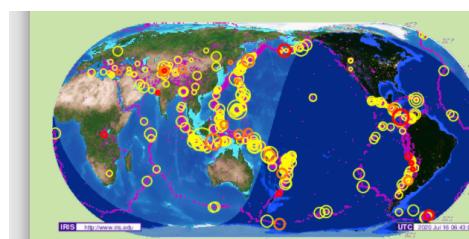
# Important Landing Pages



**Fig. S5. Lockdown effects on seismic noise in touristic ski resort areas.**

Temporal changes of hiFSAN at two touristic ski resort areas: Mammoth Mountain (USA - station NC.MCY) and Zugspitze (Germany, station BW.ZUGS), showing the effect of the complete stop of the resorts' lifts or cog-wheel railway

<https://www.iris.edu/hq/>



## NEW ANIMATION! Bomb or Earthquake?

How do seismologists tell the difference between an explosion and an earthquake, when both shake the ground? Find out in this new animation!

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# Important Landing Pages

## Data at IRIS

### Data Types

#### Time Series data

Continuous seismic instrument recordings from thousands of stations worldwide. This is the primary IRIS archive.

#### Metadata

Includes information such as recording instrument characteristics and data quality; this is generally used to determine the waveform data to request.

#### Event data

Catalog of 4 million+ events, this is useful in determining the timeframe for retrieving useful data.

#### Assembled data

Discrete collections of waveform data, generally recorded over a period of weeks or months. Assembled data are often [active source](#), meaning that they include artificial seismic events such as explosive blasts intended to seismically map a given region.

#### Data products

Calculated datasets providing a higher-level view of the raw data. For example, the [GMV](#) product is an animated map showing ground movement across hundreds of stations during an earthquake.

#### Historical data

Scanned seismograms and other information from pre-digital sources.

# Important Landing Pages

## Data Delivery

### Web Services

This is the base delivery mechanism for most IRIS data. It can be accessed directly, but a variety of convenient wrappers are available.

### Application Programming Interfaces

APIs are available via [Java](#), [Matlab](#), and [Python](#) libraries, as well as command line [fetch](#) scripts.

### Web Tools

#### Downloadable Software

#### Other Data Centers

#### How to Cite Data Sources

## Time Series Data

### Web and Email-based Tools

[BREQ\\_FAST](#) takes requests via email and delivers data via FTP/HTTP.

[SeismiQuery](#) provides low-level access to IRIS data via web forms.

[Wilber3](#) offers a rich UI for acquiring data related to a given seismic event.

See our [full set of web tools](#).

### Downloadable Software

[SAC](#) (Seismic Analysis Code) is a general purpose interactive program designed for the study of sequential signals, especially time series data.

[JWEED](#) is a Java program for requesting data related to events.

[SEEDLink](#) is a protocol for streaming real-time data.

See our [full set of software tools](#).

# Important Landing Pages

## Data Delivery

### Web Services

This is the base delivery mechanism for most IRIS data. It can be accessed directly, but a variety of convenient wrappers are available.

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### Web Tools

#### Downloadable Software

#### Other Data Centers

#### How to Cite Data Sources

### **Time Series Data**

#### Web and Email-based Tools

[BREQ\\_FAST](#) takes requests via email.

[SeismiQuery](#) provides a search interface.

[Wilber3](#) offers a rich UI.

See our [full set of web tools](#).

#### Downloadable Software

[SAC](#) (Seismic Analysis Code) is a software package for the study of sequential signals.

[JWEED](#) is a Java program for waveform extraction.

[SEEDLink](#) is a protocol for real-time data exchange.

See our [full set of software](#).

## Metadata

### **Web Tools**

[Metadata Aggregator](#) (MDA) provides a browsable list of all networks and stations archived at the DMC.

[GMap](#) displays networks on an interactive map.

[BUD](#) provides information on near real-time holdings.

[New Data](#) added recently to the DMC archive.

## Other Data Types

### **Assembled Data**

[Request assembled data](#)

[Assembled request status](#)

### **Event Data**

[Interactive Earthquake Browser](#) (IEB) shows recent earthquakes on an interactive map.

# Important Landing Pages

<https://www.unavco.org/data/data.html>



## Data

UNAVCO promotes research by providing access to data that our community of geodetic scientists uses for quantifying the motions of rock, ice and water that are monitored by a variety of sensor types at or near the Earth's surface. After processing, these data enable millimeter-scale surface motion detection and monitoring at discrete points, and high-resolution strain imagery over areas of tens of square meters to hundreds of square kilometers. The data types include **GPS/GNSS**, **SAR** and **Lidar/SfM**, **strain and seismic borehole data**, and **Tropospheric data**. Most of these can be accessed via **web services**. In addition, GPS/GNSS data sets, TLS data sets, and InSAR products are assigned digital object identifiers. See our [About Data](#) page for more information. See our data [help](#) page to request support or custom data acquisition.



WORLD DATA SYSTEM

ICSU WDS Regular Member certification since 2015



## Data Attribution

The UNAVCO GAGE Facility archives datasets and derived data products collected by community investigators funded by a variety of sources.

The data user bears sole responsibility for adhering to the UNAVCO [Data Policy](#).

[Acknowledgment of GAGE Support](#)

[Data Citation Guidance](#)

[Search GPS/GNSS Dataset DOIs](#)

# Important Landing Pages

The screenshot shows the USGS Earthquake Hazards Program website. The header features the USGS logo and the tagline "science for a changing world". Below the header, there's a decorative background image of a seismogram.

The main navigation bar includes links for "Earthquakes", "Latest Earthquakes", "Earthquake Lists, Maps & Statistics", "Search Earthquake Catalog" (which is highlighted), "Real-time Feeds & Notifications", "Information by Region", "ANSS ComCat Documentation", and "Errata for Latest Earthquakes".

The left sidebar has sections for "Earthquakes", "Hazards", "Data", "Learn", "Monitoring", and "Research", with a search bar at the bottom.

The central content area is titled "Search Earthquake Catalog". It contains a message about search results being limited to 20,000 events and provides links to "Help", "ANSS Comprehensive Earthquake Catalog (ComCat) Documentation", "Developer's Corner - Library of functions and wrapper scripts for accessing and using tools for the NEIC's ComCat data", and "Significant Earthquakes Archive".

The "Basic Options" section includes "Magnitude" (radio buttons for "2.5+", "4.5+", and "Custom", with "2.5+" selected), "Date & Time" (radio buttons for "Past 7 Days" (selected), "Past 30 Days", and "Custom"), and date/time inputs for "Start (UTC)" (2020-07-09 00:00:00) and "End (UTC)" (2020-07-16 23:59:59).

<https://earthquake.usgs.gov/earthquakes/search/>

# Important Landing Pages

All Based on:

**FDSNWS:**

Federation of Digital Seismic Networks - WebServices

# Important Landing Pages



- [About FDSN](#)
- [Mailing Lists](#)
- [Meetings](#)
- [Membership](#)
- [Networks](#)
- [Publications](#)
- [Services](#)
- [Structure](#)
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## International Federation of Digital Seismograph Networks

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### About the FDSN

The International Federation of Digital Seismograph Networks (FDSN) is a global organization. Its membership is comprised of groups responsible for the installation and maintenance of seismographs either within their geographic borders or globally. Membership in the FDSN is open to all organizations that operate more than one broadband station. Members agree to coordinate station siting and provide free and open access to their data. This cooperation helps scientists all over the world to further the advancement of earth science and particularly the study of global seismic activity. The FDSN also holds commission status within IASPEI.

The FDSN goals related to station siting and instrumentation are to provide stations with good geographic distribution, recording data with 24 bits of resolution in continuous time series with at least a 20 sample per second sampling rate. The FDSN was also instrumental in development of a universal standard for distribution of broadband waveform data and related parametric information. The Standard for Exchange of Earthquake Data (SEED) format is the result of that effort.

### Network Codes

Network codes are also assigned by the FDSN in order to provide uniqueness to seismological data streams. Network operators request these unique codes for both permanent and temporary networks. Network Code request forms are [here](#).

[FDSN historical information](#)



International Federation of Digital Seismograph Networks

07:36:22

# Important Landing Pages

All Based on:

**FDSNWS:**  
Federation of Digital Seismic Networks - WebServices

[http://erde.geophysik.uni-muenchen.de/fdsnws/datalogic/1/query?  
net=BW&sta=RJOB&cha=EHZ&start=2010-02-27T06:30:00.000&end=2010-02-27T10:30:00.000](http://erde.geophysik.uni-muenchen.de/fdsnws/datalogic/1/query?net=BW&sta=RJOB&cha=EHZ&start=2010-02-27T06:30:00.000&end=2010-02-27T10:30:00.000)

# Important Landing Pages

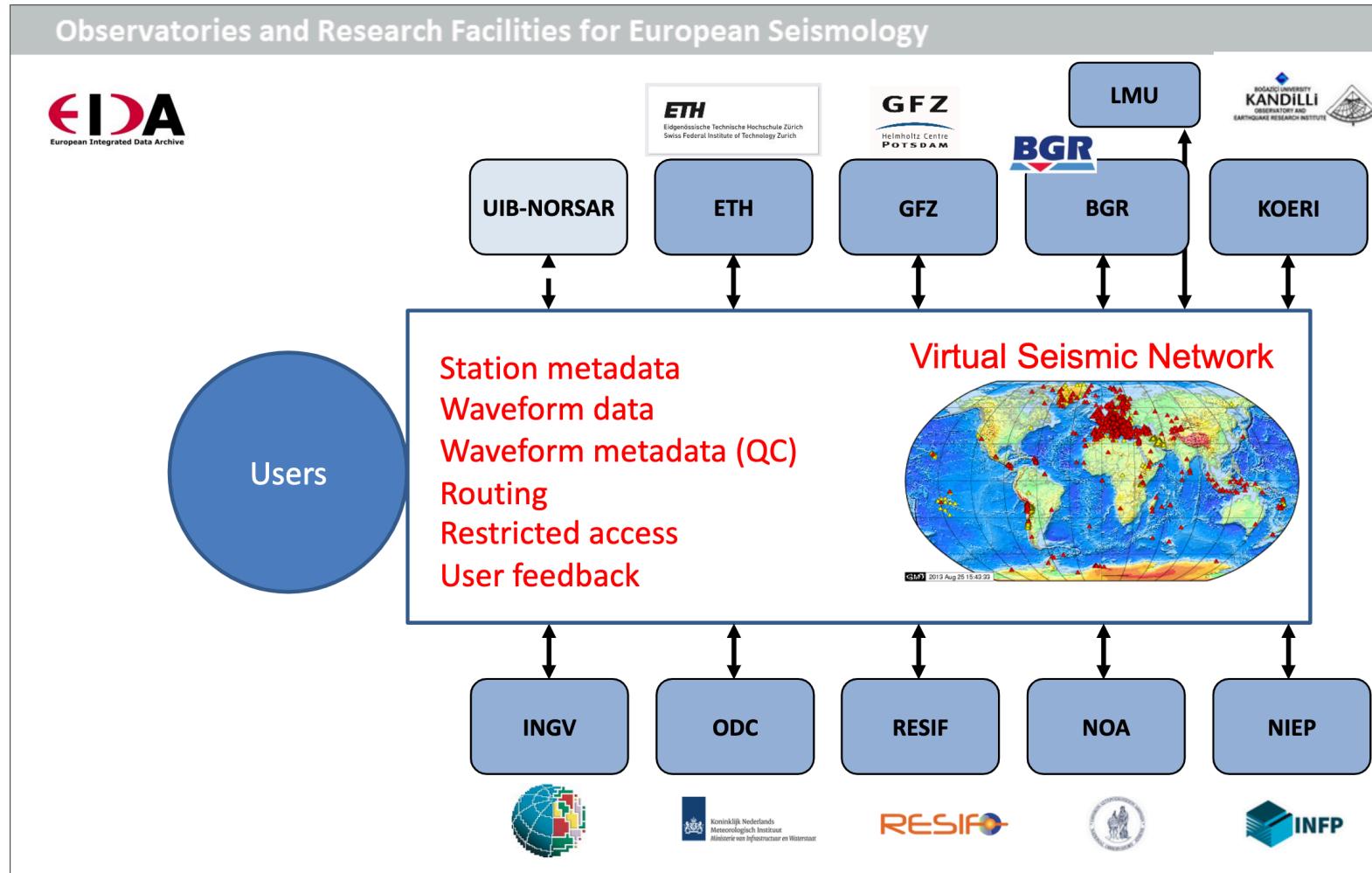
All Based on:

**FDSNWS:**  
Federation of Digital Seismic Networks - WebServices

[http://erde.geophysik.uni-muenchen.de/fdsnws/datalogic/1/query?  
net=BW&sta=RJOB&cha=EHZ&start=2010-02-27T06:30:00.000&end=2010-02-27T10:30:00.000](http://erde.geophysik.uni-muenchen.de/fdsnws/datalogic/1/query?net=BW&sta=RJOB&cha=EHZ&start=2010-02-27T06:30:00.000&end=2010-02-27T10:30:00.000)

In this course, we will learn more convenient mechanisms to access the data centers

# Important Services



# Important Services

**Orfeus**

**EIDA**  
European Integrated Data Archive

**EOSC-hub**

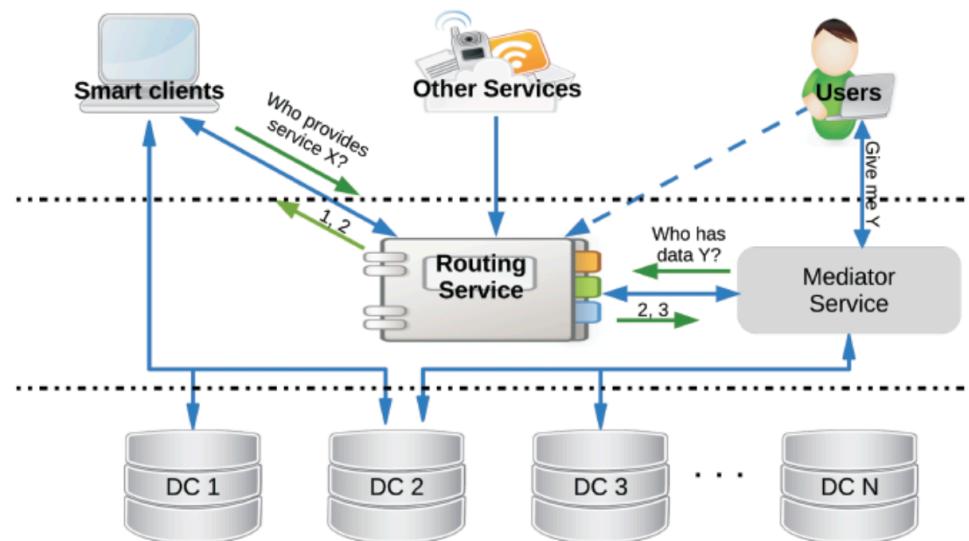
**EPOS**

Observatories and Research Facilities for European Seismology

## The EIDA routing service

What does a routing service?

- Provides routing to data (streams)
- Routing to services
- Routing priorities
- Station discovery by geographical location



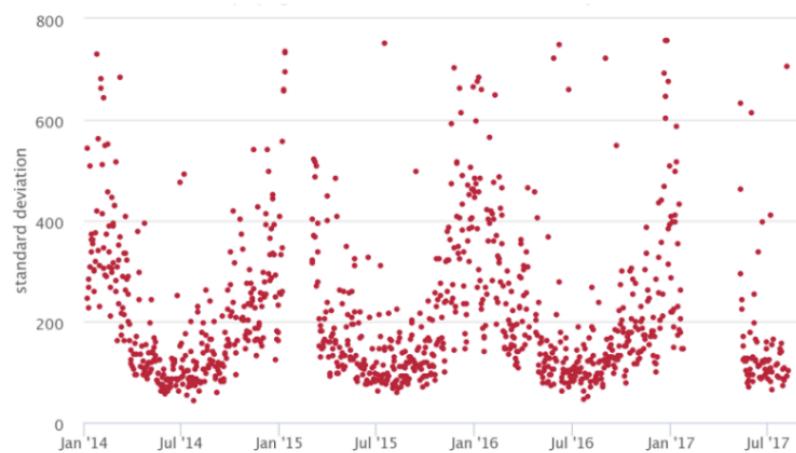
Can also be deployed as a standalone router to run on the client side to create virtual DCs

# Important Services

## WFCatalog

Sample Metric Options				
max_gap	0	Maximum gap length in seconds		Float
max_overlap	0	Maximum overlap length in seconds		Float
num_gaps	0	Number of gaps		Integer
num_overlaps	0	Number of overlaps		Integer
num_samples	86400	Number of samples		Integer
percent_availability	100	Percentage of available data		Percentage
sample_max	100	Maximum sample value		Integer
sample_min	-100	Minimum sample value		Integer
sample_mean	0	Mean sample value		Integer
sample_rms	0	Quadratic mean of samples		Float
sample_stdev	0	Standard deviation of samples		Float
sample_lower_quartile	0	25th percentile of samples		Float
sample_median	0	50th percentile of samples		Float
sample_upper_quartile	0	75th percentile of samples		Float
sum_gaps	0	Sum of data gaps in seconds		Float
sum_overlaps	0	Sum of data overlaps in seconds		Float

# WFCatalog



## Data Metrics

Graphical interface showing daily waveform metrics.

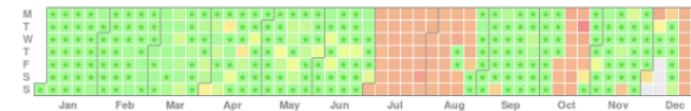
### 2011 NL.WTSB.01.BHE

Average yearly availability over 365 available days: **98.679%**



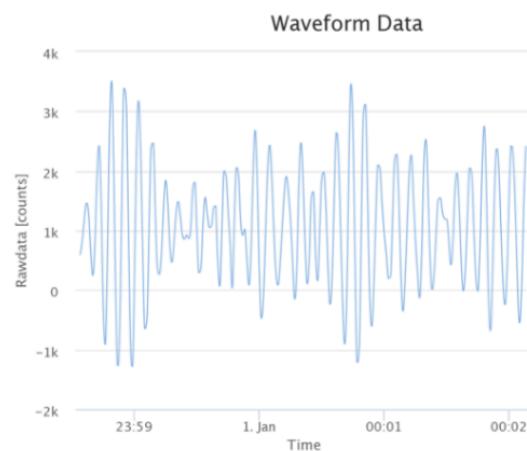
### 2012 NL.WTSB.01.BHE

Average yearly availability over 362 available days: **76.873%**



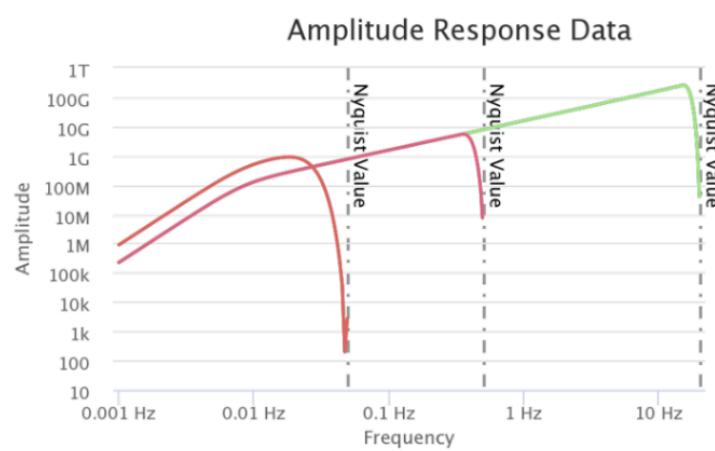
## Data Availability

Graphical interface showing daily data availability.



## Waveform Viewer

Graphical interface showing for viewing waveform data.



## Instrument Response

Interface showing instrument response characteristics.

# Important Landing Pages

<http://www.wdc.bgs.ac.uk/>

## World Data Centre for Geomagnetism, Edinburgh

[See our data »](#)

### About

Find out more about the WDC for Geomagnetism, Edinburgh.

[View details »](#)

### Usage Rules

Find out how these data can be used and by who.

[View details »](#)

### Contact

We want your data! Find out how to submit datasets, or ask a question about our holdings.

[View details »](#)



British  
Geological  
Survey

© UKRI 2020

Operated by the [British Geological Survey](#).



A Regular Member of the [World Data System](#).

# Important Landing Pages

<https://www.intermagnet.org/index-eng.php>



**INTERMAGNET**

INTERMAGNET Data

Conditions of Use

Data Download

Data Formats

Observatory Plots

- Magnetic Field (XYZ)
- Magnetic Field (HDZ)
- Declination/Inclination
- Rate of Change (dB/dt)

CD-ROM/DVD (Definitive data)

[List of Available CDs/DVD](#)

CD-ROM/DVD Production

## INTERMAGNET Data

Content now located at [https://intermagnet.github.io/data\\_conditions.html](https://intermagnet.github.io/data_conditions.html).

INTERMAGNET data are available as magnetograms or as digital data files. Policies and procedures for making this data available are the responsibility of each GIN.

Geomagnetic data can be downloaded via your browser. The availability of data files is dependant on the publishing delay of participating institutes. Pre-INTERMAGNET data may be available via one of the World Data Centres (WDC) or the observatory contact of the specific Magnetic Observatories (IMOs).

Geomagnetic data can also be downloaded via the [INTERMAGNET FTP](#).

Plots can be generated for all INTERMAGNET data available through this web site.

### Conditions of Use

The member institutes of INTERMAGNET invest considerable resources to operate their magnetic observatories to INTERMAGNET standards. It is important that the institutes producing the data have a measure of the scientific return on their investment. Accordingly, we have the following Conditions of Use.

### Conditions of Use for data provided through INTERMAGNET

The data made available through INTERMAGNET are provided for your use and are not for commercial use or sale or distribution to third parties without the written permission of the institute operating the observatory. Publications making use of the data should include an acknowledgment statement of the form given below. A citation reference should be sent to the INTERMAGNET Secretary ([secretary\\_intermagnet@gfz-potsdam.de](mailto:secretary_intermagnet@gfz-potsdam.de)) for inclusion in a publications list on the INTERMAGNET website.

### Acknowledgement of data from observatories participating in INTERMAGNET

We offer two acknowledgement templates. The first is for cases where data from many observatories have been used and it is not practical to list them all, or each of their operating institutes. The second is for cases where research results have been produced using a smaller set of observatories.

### Suggested Acknowledgement Text (template 1)

The results presented in this paper rely on data collected at magnetic observatories. We thank the national institutes that support them and

# The Future!

<http://www.epos-eu.org>

CONTACT US

INTRANET



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SERVICES ▾

PROJECTS ▾

PARTNERS

COMMUNICATION ▾



## Welcome to the **EPOS DATA PORTAL**

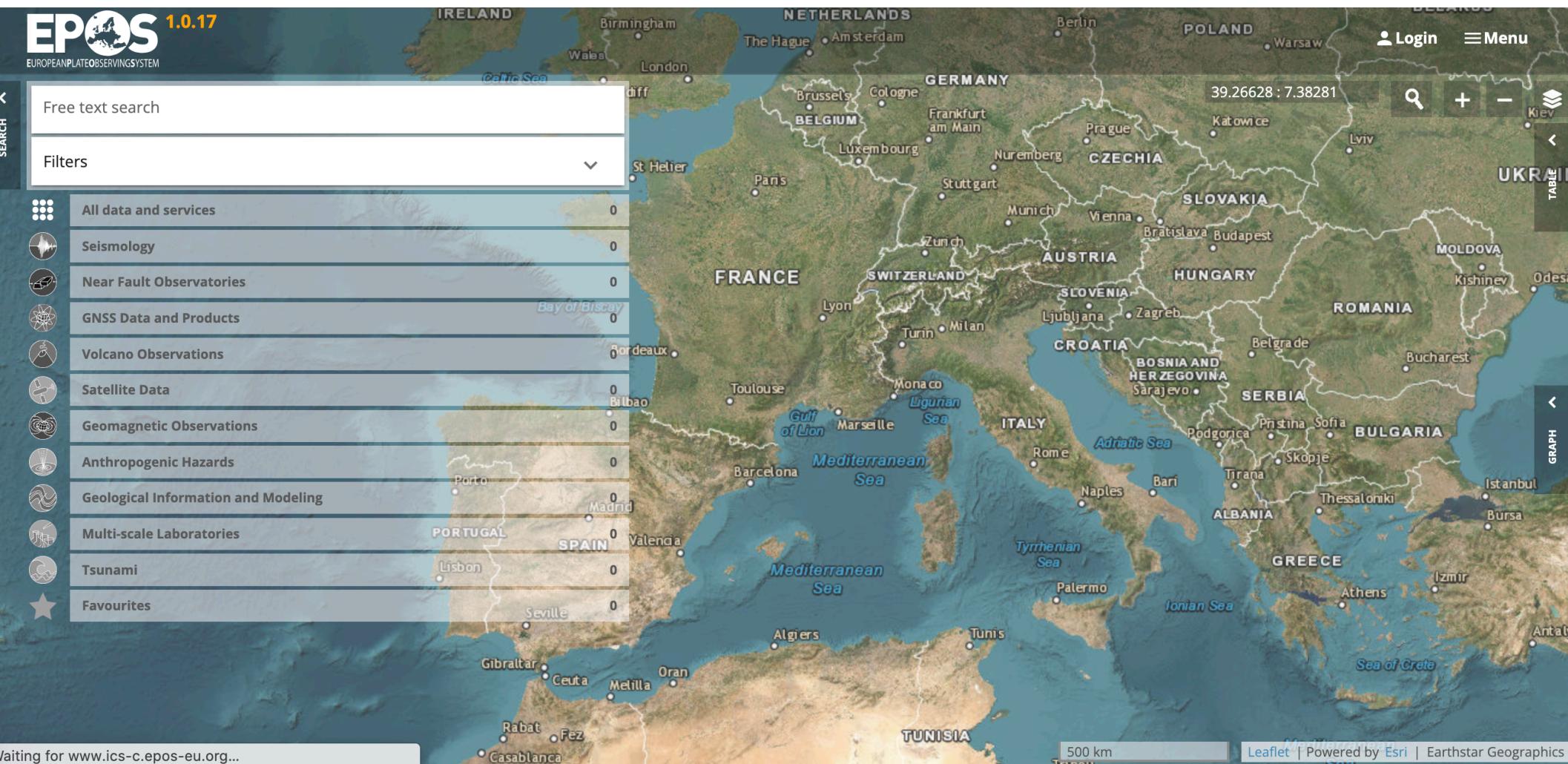
A multi-disciplinary open data portal for integrated access  
to Solid Earth science datasets

[Data Access](#)

Integrated Data Portals

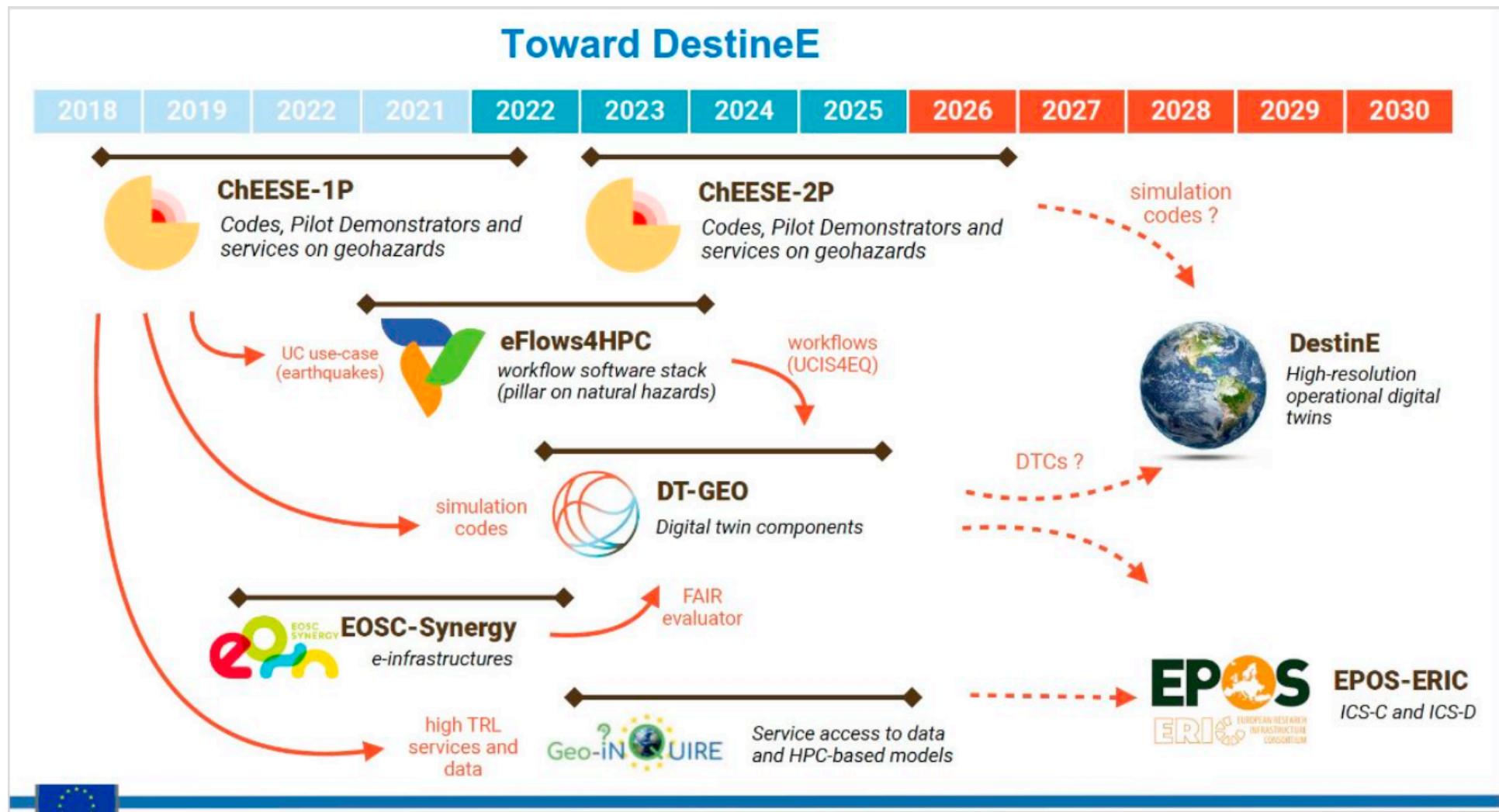
# The Future!

<http://www.epos-eu.org>



Integrated Data Portals

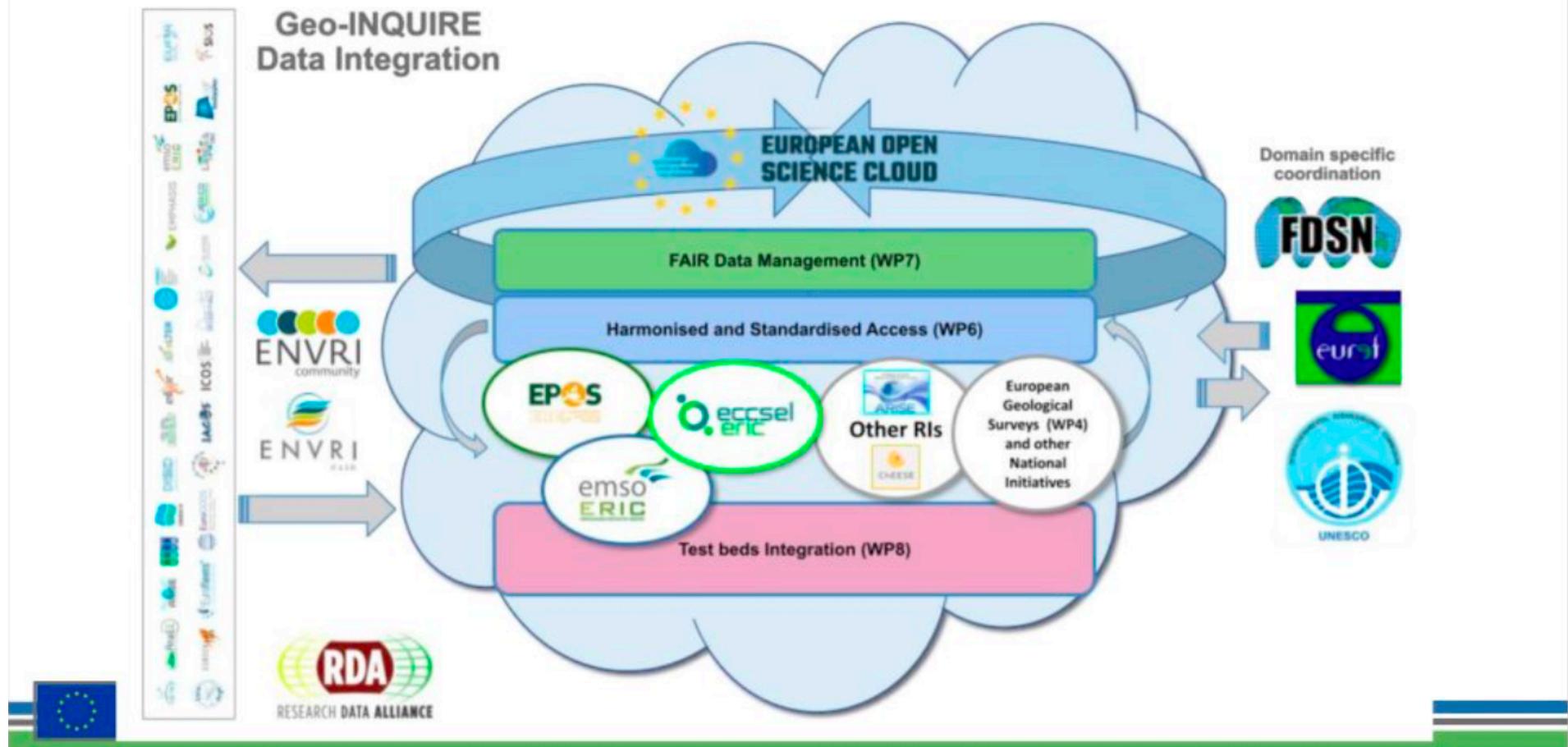
# The Future!



Simulation Environment

# The Future!

## How do we develop interoperability ?



Integrated Cloud Services

# The Future!

Search    Browse ▾    Suggest    Resources ▾    Contact    

**re3data.org**  
REGISTRY OF RESEARCH DATA REPOSITORIES

Search...

 Search

It is now mandatory for many journals that you publish also your data at a freely accessible data repository

# The Future!

The output of research is not only journal articles but also **data sets, model code, samples, etc.** Only the entire network of interconnected information can guarantee integrity, transparency, reuse, and reproducibility of scientific findings. Moreover, all of these resources provide great additional value in their own right.

Hence, it is particularly important that data and other information underpinning the research findings are "**findable, accessible, interoperable, and reusable**" (FAIR) not only for **humans** but also for **machines**.

# The Future!

<https://en.unesco.org/science-sustainable-future/open-science/recommendation>

English Français Español Русский العربية 中文 ENHANCED BY Google

Member States Staff Intranet

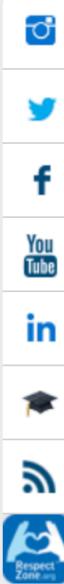
 **unesco** "Building peace in the minds of men and women"

 IN BRIEF  WHAT WE DO  WHERE WE WORK  PARTNERS  JOIN US  RESOURCES

Home > Open Science > UNESCO Recommendation on Open Science

## Open Science





# Important for the Network Operator



Observatories and Research Facilities for European Seismology

## How to cite seismic data

Citing is based on network code.

If the network has a DOI: Refer to the data as you would to a normal scientific manuscript, and include the reference in the normal list of references.

Network, citation and DOI information can be found at <http://www.fdsn.org/networks/>  
If many networks are used: most journals accept a 'Data Section'

### Example:

'We used data from GEOSCOPE (Institut De Physique Du Globe De Paris (IPGP) and Ecole Et Observatoire Des Sciences De La Terre De Strasbourg (EOST), 1982) and GEOFON (Geofon Data Centre, 1993).'

### References:

GEOFON Data Centre, 1993. GEOFON Seismic Network. Deutsches GeoForschungsZentrum GFZ.  
<https://doi.org/10.14470/tr560404>

Institut De Physique Du Globe De Paris (IPGP), & Ecole Et Observatoire Des Sciences De La Terre De Strasbourg (EOST), 1982. GEOSCOPE, French Global Network of broad band seismic stations.  
Institut de Physique du Globe de Paris (IPGP). <https://doi.org/10.18715/geoscope.g>

# Data - Formats?

... for recording

- e.g. Guralp gcf, reftek, ...

... for exchange

- contain additional information in header, e.g. instrument characteristic
- e.g. gse, seed, mseed & stationXML, quakeML, ...

... for processing

- almost every code has its own working format
- e.g. Q, sac, seisan, obspy ...

# Data - Formats?

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Again more about this later....

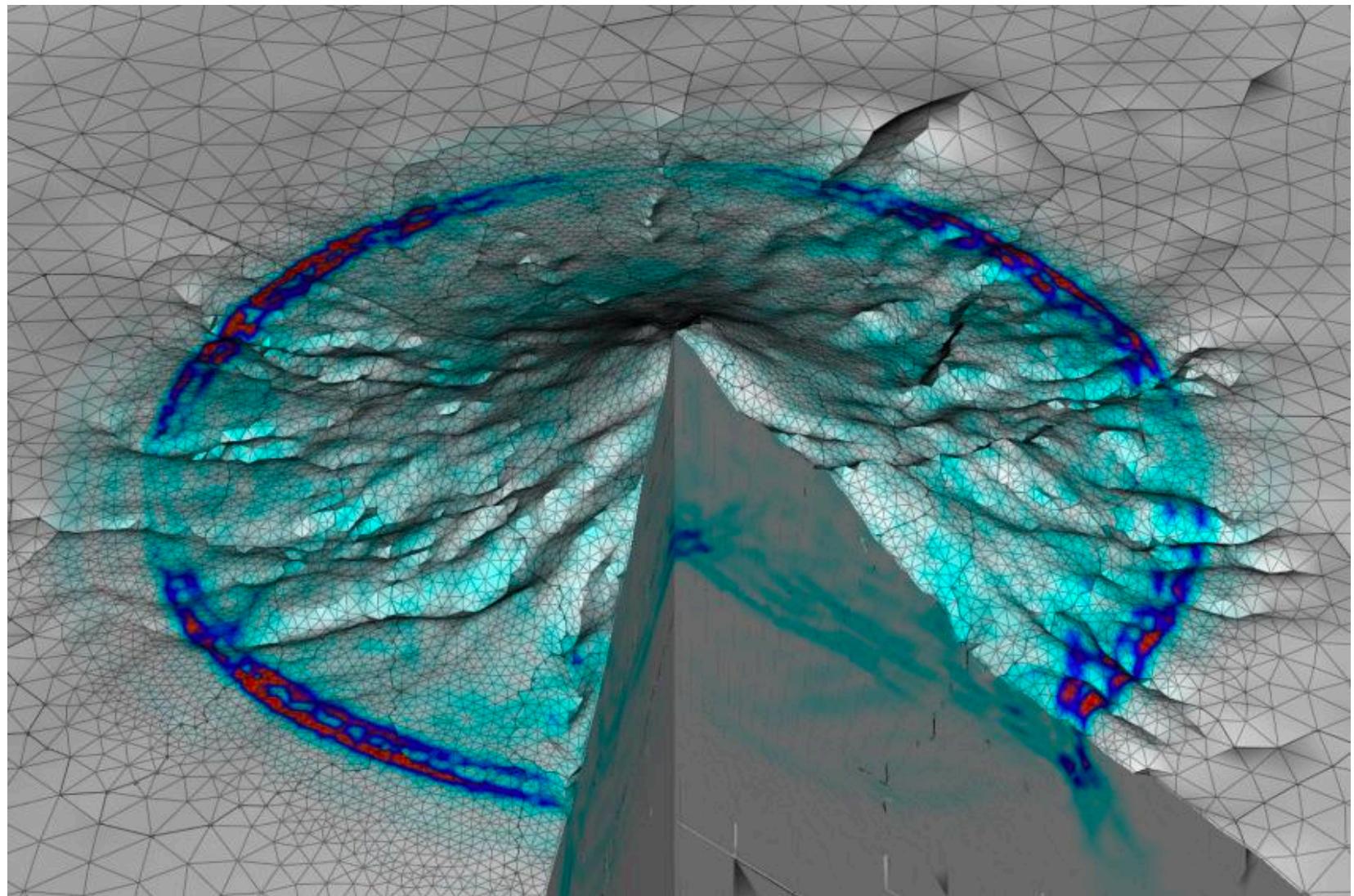
# Data - Formats?

... few more words on format:

- simple, machine and human readable formats are getting more and more important
- XML, JSON are widely used
- format should support automatic up- and download with “on-the-fly” validation check
- RESTful (REpresentational State Transfer) services are most common to put and get data from (-> FDSNWS)

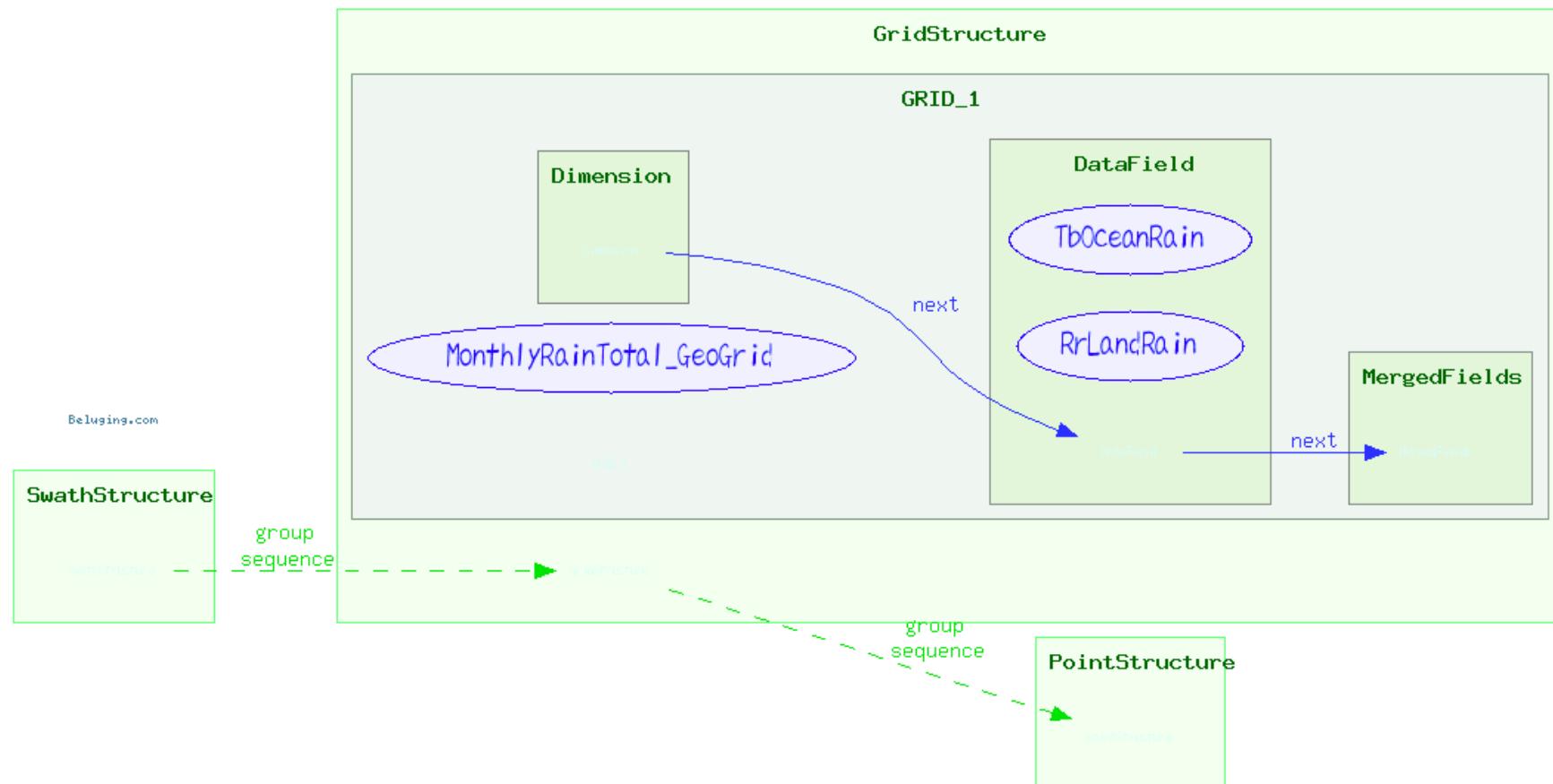
# Data - Formats?

New: 3D-Volume + Time Data



# Data - Formats?

## HDF-5



Eg. STEAD (STanford EArthquake Dataset)

```
In [4]: merge.keys()
```

```
Out[4]: <KeysViewHDF5 ['data']>
```

```
data = merge['data']
```

# formats?

## HDF5

```
In [6]: data.keys()
```

```
Out[6]: <KeysViewHDF5 ['20100622205905-UH1_EV',  
'20100622205905-UH2_EV', '20100622205905-UH3_EV',  
'20100622205905-UH4_EV', '20100622210059-NORI_EV',  
'20100622210059-RJOB_EV', '20100622210059-RTBE_EV',  
'20100622210059-UH1_EV', '20100622210059-UH2_EV',  
'20100622210059-UH3_EV', '20100622210059-UH4_EV',  
'20100622210243-UH1_EV', '20100622210243-UH2_EV',  
'20100622210243-UH3_EV', '20100622210243-UH4_EV',  
'20100622210424-UH1_EV', '20100622210424-UH3_EV', '  
| MonthlyRainTotal_GeoGrid  
| KrLandRain  
| MergedFields
```

Beluging.com

```
dd=data["20210319124756-KIST1_EV"]
```

```
In [13]: dd[:,0]
```

```
Out[13]: array([ 3.7295725 , -0.69235405,  0.67189923,  
...,  9.03570362, 4.18481218,  7.60535769])
```

Eg. STE

```
In [15]: dd.attrs.keys()
```

```
Out[15]: <KeysViewHDF5 ['back_azimuth',  
'coda_end_sample', 'network_code', 'p_arrival_sample',  
'p_status', 'p_travel_sec', 'p_weight', '..)  
'receiver_code', 'receiver_elevation', '..)  
'receiver_latitude', 'receiver_longitude', ..)  
'receiver_type', 's_arrival_sample', 's_status', ..)
```

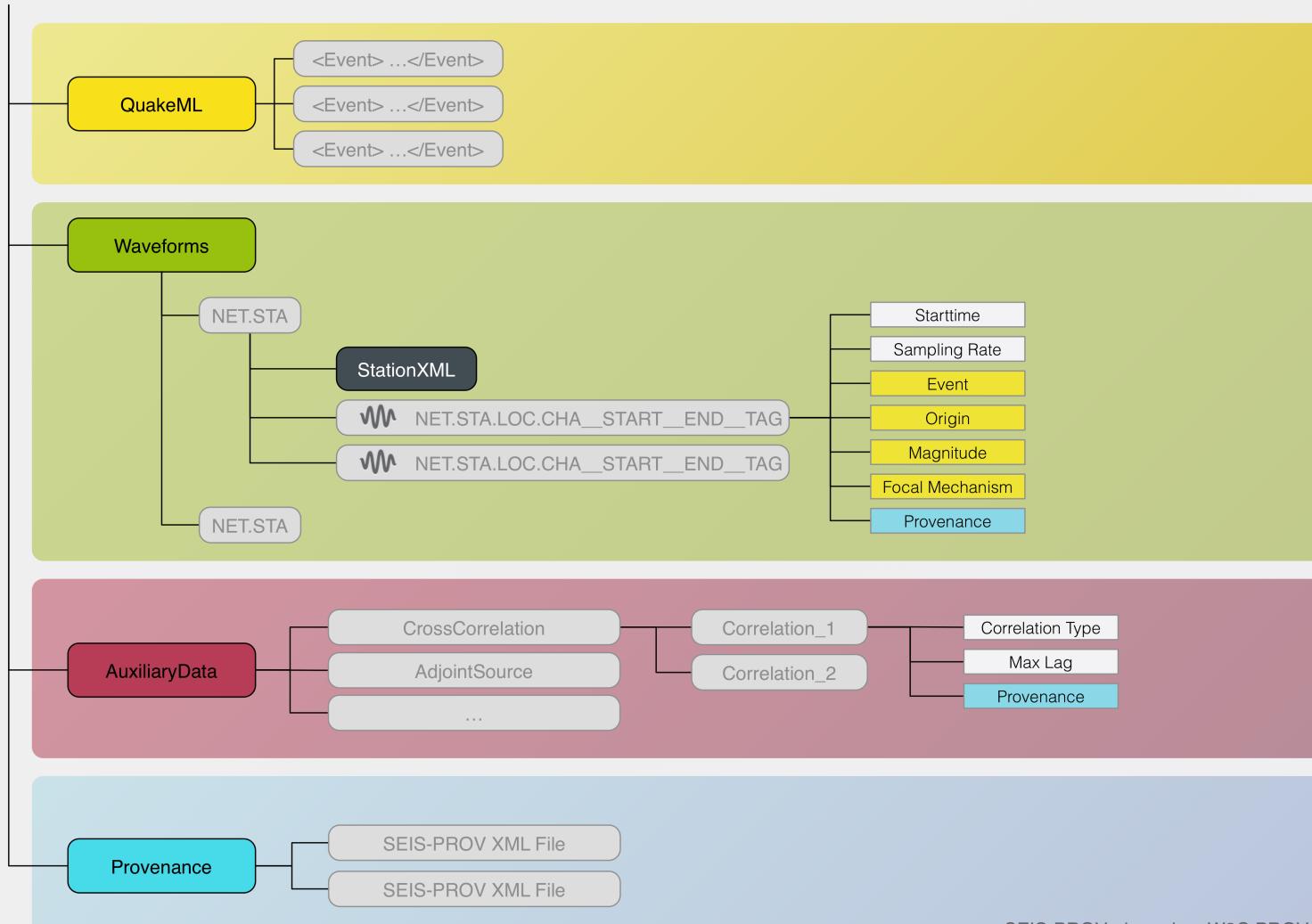
PointStructure

group sequence

# Data - Formats?

## Adaptable Seismic Data Format

CONTAINER (HDF5) => broad tool support, works on essentially all platforms of interest



# Naming of Your Data

We still stick to the SEED naming (pretty complete)

BW.RJOB..HHZ

# Naming of Your Data

We still stick to the SEED naming (pretty complete)

BW.RJOB..HHZ

Network Code  
(to be registered at FDSN)

# Naming of Your Data

We still stick to the SEED naming (pretty complete)

Station Code  
(to be registered at ISC)

BW.	RJOB	..	HHZ
-----	------	----	-----

Network Code  
(to be registered at FDSN)

# Naming of Your Data

We still stick to the SEED naming (pretty complete)

Station Code  
(to be registered at ISC)

BW.RJOB.HHZ

Network Code  
(to be registered at FDSN)

Location Code  
(numeric: e.g. 00)

# Naming of Your Data

We still stick to the SEED naming (pretty complete)

Station Code  
(to be registered at ISC)



Channel Code  
(following SEED)

Network Code  
(to be registered at FDSN)

Location Code  
(numeric: e.g. 00)

# Naming of Your Data

## Band Code

The first letter specifies the general sampling rate and the response band of the instrument. (The “A” code is reserved for administrative functions such as miscellaneous state of health.)

<b>Band code</b>	<b>Band type</b>	<b>Sample rate (Hz)</b>	<b>Corner period (sec)</b>
F	...	≥ 1000 to < 5000	≥ 10 sec
G	...	≥ 1000 to < 5000	< 10 sec
D	...	≥ 250 to < 1000	< 10 sec
C	...	≥ 250 to < 1000	≥ 10 sec
E	Extremely Short Period	≥ 80 to < 250	< 10 sec
S	Short Period	≥ 10 to < 80	< 10 sec
H	High Broad Band	≥ 80 to < 250	≥ 10 sec
B	Broad Band	≥ 10 to < 80	≥ 10 sec
M	Mid Period	> 1 to < 10	
L	Long Period	≈ 1	
V	Very Long Period	≈ 0.1	
U	Ultra Long Period	≈ 0.01	
R	Extremely Long Period	≥ 0.0001 to < 0.001	
P	On the order of 0.1 to 1 day <sup>1</sup>	≥ 0.00001 to < 0.0001	
T	On the order of 1 to 10 days <sup>1</sup>	≥ 0.000001 to < 0.00001	
Q	Greater than 10 days <sup>1</sup>	< 0.000001	
A	Administrative Instrument Channel	variable	NA
O	Opaque Instrument Channel	variable	NA

1. These are approximate values. The sample rate should be used for the correct Band Code.

# Instrument Code and Orientation Code

The second letter specifies the family to which the sensor belongs. In essence, this identifies what is being measured. Each of these instrument types are detailed in this section.

The third letter in the channel name is the Orientation Code, which provides a way to indicate the directionality of the sensor measurement. This code is sometimes used for a purpose other than direction, which is instrument-specific. When orthogonal directions are used, there are traditional orientations of North (N), East (E), and Vertical (Z), as well as other orientations that can readily be converted to traditional ones. These options are detailed with each instrument type. Use N or E for the orientation when it is within 5 degrees of north or east. Use 1 or 2 when orientations are more than 5 degrees from north or east. Put the actual orientation of the sensor in the dip and azimuth fields of blockette 52.

**Seismometer:** Measures displacement/velocity/acceleration along a line defined by the dip and azimuth.

## Instrument Code

H	High Gain Seismometer
L	Low Gain Seismometer
G	Gravimeter
M	Mass Position Seismometer
N*	Accelerometer

\* historically some channels from accelerometers have used instrumentation codes of L and G. The use of N is the FDSN convention as defined in August 2000.

## Orientation Code

Z N E	Traditional (Vertical, North-South, East-West) (see 5 degree convention above)
A B C	Triaxial (Along the edges of a cube turned up on a corner)
T R	For formed beams (Transverse, Radial)
1 2 3	Orthogonal components but non traditional orientations (see 5 degree convention above)
U V W	Optional components
Dip/Azimuth:	Ground motion vector (reverse dip/azimuth if signal polarity incorrect)
Signal Units:	M, M/S, M/S**2, (for G & M) M/S**2 (usually)
Channel Flags:	G

Tilt Meter: Measures tilt from the horizontal plane. Azimuth is typically N/S or E/W.

**Instrument Code**

A

**Orientation Code**

N E Traditional

Dip/Azimuth: Ground motion vector (reverse dip/azimuth if signal polarity incorrect)

Signal Units: Radians

Channel Flags: G

Creep Meter: Measures the absolute movement between two sides of a fault by means of fixing a metal beam on one side of the fault and measuring its position on the other side. This is also done with light beams.

The orientation and therefore the dip and azimuth would be perpendicular to the measuring beam (light or metal), which would be along the average travel vector for the fault. Positive/Negative travel would be arbitrary, but would be noted in the dip/azimuth. Another type of Creep Meter involves using a wire that is stretched across the fault. Changes in wire length are triangulated to form movement vector.

**Instrument Code**

B

**Orientation Code**

Unknown

Dip/Azimuth: Along the fault or wire vector

Signal Units: M

Channel Flags: G

**Magnetometer:** Measures the magnetic field where the instrument is sitting. They measure the part of the field vector that is aligned with the measurement coil. Many magnetometers are three axis. The instrument will typically be oriented to local magnetic north. The dip and azimuth should describe this in terms of the geographic north.

Example: Local magnetic north is 13 degrees east of north in Albuquerque. So if the magnetometer is pointed to magnetic north, the azimuth would be + 103 for the E channel. Some magnetometers do not record any vector quantity associated with the signal, but record the total intensity. So, these would not have any dip/azimuth.

**Instrument Code**

F

**Orientation Code**

Z N E              Magnetic

Signal Units:      T — Teslas

Channel Flags:     G

**Humidity:**        Absolute/Relative measurements of the humidity. Temperature recordings may also be essential for meaningful results.

**Instrument Code**

I

**Orientation Code**

O              Outside Environment

I              Inside Building

D              Down Hole

1 2 3 4        Cabinet Sources

All other letters available for mnemonic source types.

Dip/Azimuth:      Not applicable — Should be zero.

Signal Units:      %

Channel Flags:     W

# Common Observables

# Common Observables

- Acceleration/Velocity/Displacement/Strain/  
Rotations

# Common Observables

- Acceleration/Velocity/Displacement/Strain/Rotations
- Geomagnetic field

# Common Observables

- Acceleration/Velocity/Displacement/Strain/Rotations
- Geomagnetic field
- Gravimetric field

# Common Observables

- Acceleration/Velocity/Displacement/Strain/Rotations
- Geomagnetic field
- Gravimetric field
- Temperature (heat flow)

# Common Observables

- Acceleration/Velocity/Displacement/Strain/Rotations
- Geomagnetic field
- Gravimetric field
- Temperature (heat flow)
- Radioactivity (dating)

# Common Observables

- Acceleration/Velocity/Displacement/Strain/Rotations
- Geomagnetic field
- Gravimetric field
- Temperature (heat flow)
- Radioactivity (dating)
- Petrology/Sedimentology Palaeontology (especially for dating)

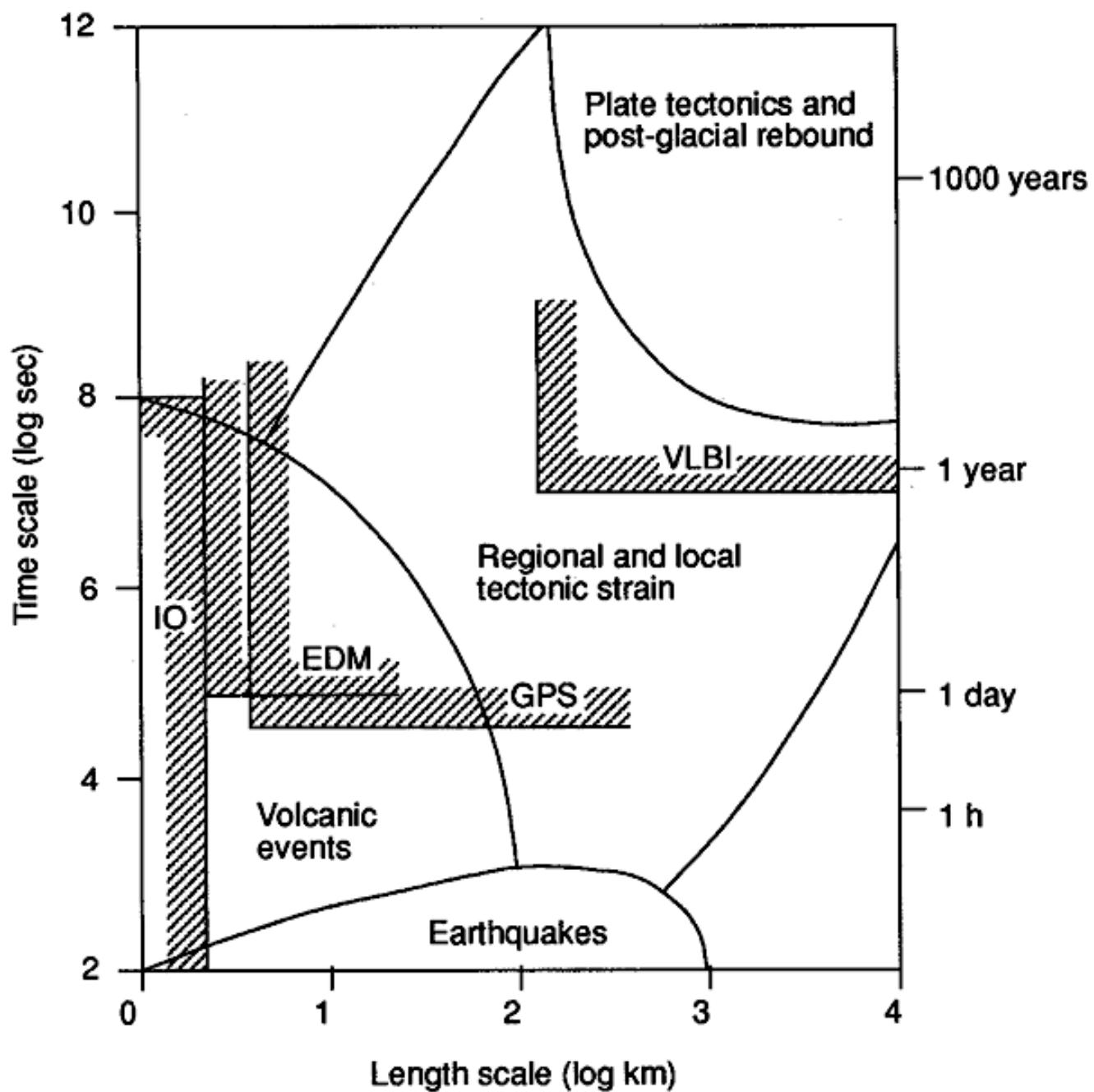
# Common Observables

- Acceleration/Velocity/Displacement/Strain/Rotations
- Geomagnetic field
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- Temperature (heat flow)
- Radioactivity (dating)
- Petrology/Sedimentology Palaeontology (especially for dating)
- Chemistry: /bulk composition /trace element ratios /thin section

# Common Observables

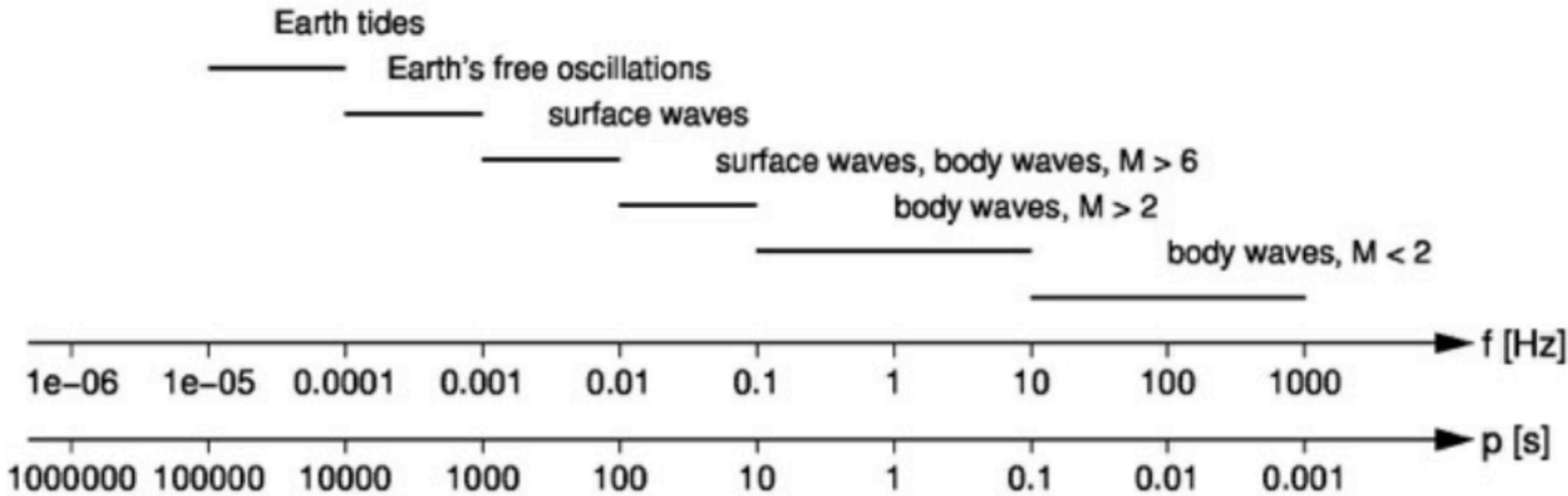
- Acceleration/Velocity/Displacement/Strain/Rotations
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# Time Length Scales



# Time Scales in Seismology

- Laboratory signals 0.000001 - 0.001s
- Seismic exploration 0.001 - 0.1s
- Earthquakes 0.01 - 100s
- Coseismic deformation 1 - 1000s
- Eigenmodes of the Earth (Normal Modes) 1000s
- Postseismic deformation > 10000s



# Time Scales in Seismology

- Laboratory signals 0.000001 - 0.001s
- Seismic exploration 0.001 - 0.1s
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