Innovative Multi-disciplinary European Research training Network on VolcanoEs"

SSC#1 : Short course in Seismology & Imaging

23th - 25th January 2023, ISTerre, University Grenoble Alpes, France

organizers : Stéphane Garambois & Jean Vandemeulebrouck

Topics: Volcanoes seismology, array signal processing, monitoring, tomography, DAS, Multiphysics

Venue : Grenoble Alpes campus, details to be announced to participants.

Possible schedule : Monday 23/01

09:00-10h00	Stéphane Garambois & Jean Vandemeulebrouck	Welcome - Introduction
10:00-12:00	Nikolai Shapiro	New insights on volcanic processes from seismology
13:30-17:30	Jean Soubestre	A practical guide of CovSeisNet, theory, examples and practical applications

Tuesday 24/01

08:30-12h00	Helle Pedersen	RESIF – EPOS data retrieving from data centers and some practical applications
13:30-17:00	Laurent Stehly	Seismic noise imaging and monitoring : theory and practical applications

Wednesday 25/01

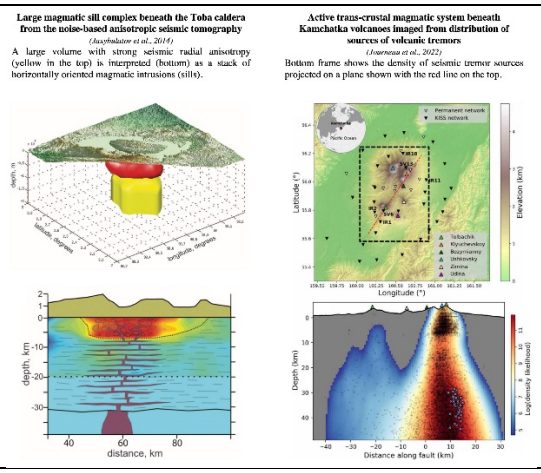
08:00	Jean Virieux	First-break traveltime tomography: where are we? Local Earthquake Tomography
10:15-12:15	Olivier Coutant	Distributed Acoustic Sensor (DAS) : methodology and examples
13:30-17:00	Jean Vandemeulebrouck Stéphane Garambois Claire Bouligand	Multiphysics session on volcanoes imaging : Electrical Resistivity Tomography, Magnetotellurics, Magnetics

NB : Only 15 places available. Applications should be sent to Jean Vandemeulebrouck and Stéphane Garambois before January 7th: jean.vandemeulebrouck@univ-smb.fr; Stephane.Garambois@univ-grenoble-alpes.fr

Details of the courses

New insights on volcanic processes from seismology.

In this lecture, we will see how analyses of continuous seismic records based on correlation-based approaches can be used to image the subsurface structure and to detect and locate sources of the volcanic seismicity. We will then discuss how the obtained seismological results can be interpreted in terms of physical functioning of volcano-magmatic systems.



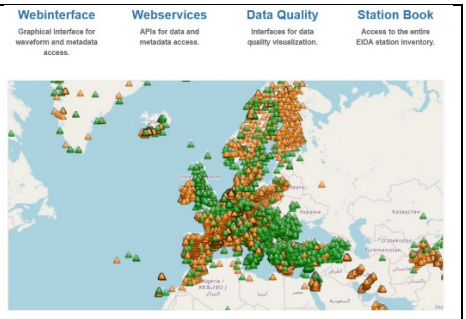
A practical guide of CovSeisNet : theory, examples and practical application

This short course will introduce the Covseisnet Python package (https://github.com/covseisnet/covseisnet), based on the seismic network covariance matrix, the equivalent in the Fourier domain of the classical inter-station cross-correlations matrix. Theoretical aspects will be presented, together with its capacity in terms of detection, clustering, location and classification of any kind of seismic signal, including challenging signals like continuous tremor. Examples of successful application of the method for characterizing volcanic tremor at different spatial scales will be shown. Finally, a practical application will be proposed for participants to use the package on their own laptop and possibly with their own dataset (a few days of data from several stations, only one component needed).

covseisnet

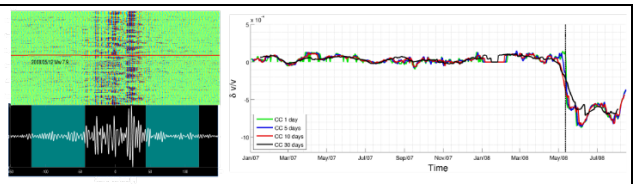
RESIF – EPOS data retrieving from data centers and some practical applications

In this Lecture you will learn about seismic networks, seismological data centers and how to discover and download data. Among others, we will discuss worldwide standards for metadata and data sharing and how these standards have made it possible to build software tools for data discovery and download. We will in particular focus on the European Data Distribution system, EIDA: discover seismic stations, download data and apply simple data processing, using the Python package Obspy.



Seismic noise imaging and monitoring : theory and practical applications

During this class we will discuss how to use seismic noise correlations for large scale tomography and to study the temporal evolution of the crust associated with earthquakes. The course will include an introduction to the theoretical aspects,

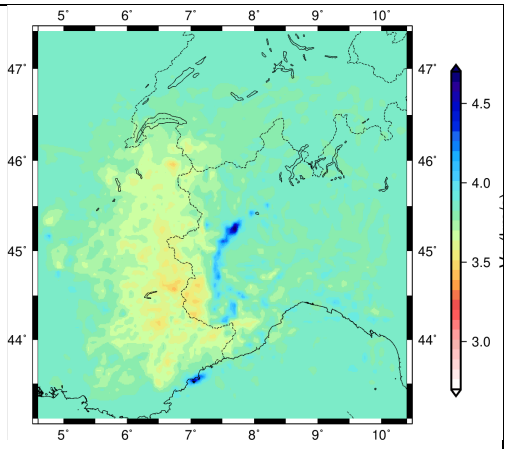


Seismic waves velocity variations associated with the 12 May 2008 Mw 7.9 Wenchuan Earthquakes

some examples of studies and a practical work in Python.	

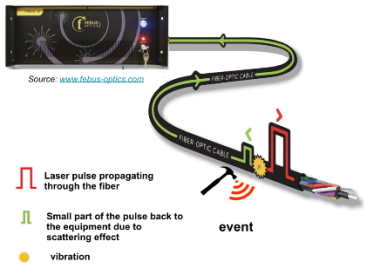
First-break traveltime tomography: where are we? Local Earthquake Tomography

Ray-based tomography has been for years the working horse for the low-resolution reconstruction of P wave and S wave velocities at different scales using local earthquakes. Taking benefit of a 30-years database on Western Alps, the variability of the different recovered models will highlight the influence of the different inversion strategies one often consider more or less implicitly. Eikonal-based tomography based on Eikonal solution has gained attention for different reasons: differences with ray-based tomography will be discussed, while limitations will be underlined when confronted to wave-equation tomography. Finally, perspectives on the joint hypocenter-velocity inversion are given with the drastic data increase, coming from the game changer using DAS technology.



Distributed Acoustic Sensor (DAS) : methodology and examples

In this course, we will introduce the basics principles behind DAS technology and a few applications in various fields concerning seismology (event detection, active shots, seismic noise).



Multiphysics session on volcanoes imaging : Electrical resistivity Tomography, Magnetotellurics, Magnetics

In this session, we will see how other geophysical techniques such as electrical resistivity tomography, magnetotellurics and magnetics, can shed light on volcanic structures in ways that are complementary to seismology, at different scales. The models of hydrothermal systems that result from these coupled approaches can also be validated by the use of thermodynamic codes.

Figure : An example of the joint use of ERT and seismic processing (Matched Field Processing) for imaging a fumarolic area. From Gresse et al., Scientific Reports, | *(2018) 8:7580* | DOI:10.1038/s41598-018-25448-y.