Task 6

Using Ambient Noise towards 4D Monitoring and Imaging

TEAM:

Ana Ferreira (UCL)
Andrea Morelli (INGV-Bolonha, TIDES PI)
Bruno Faria (INMG – CV)
Carlos Corela (IDL/FCUL)
Eleonore Stutzmann (IPGP)
Luis Matias (IDL/UL)
Graça Silveira (IDL/UL/ISEL)
Martin Schimmel (ICTJA/CSIC)
Nuno Dias (IDL/UL/ISEL)
Pierre Arroucau (DIAS)

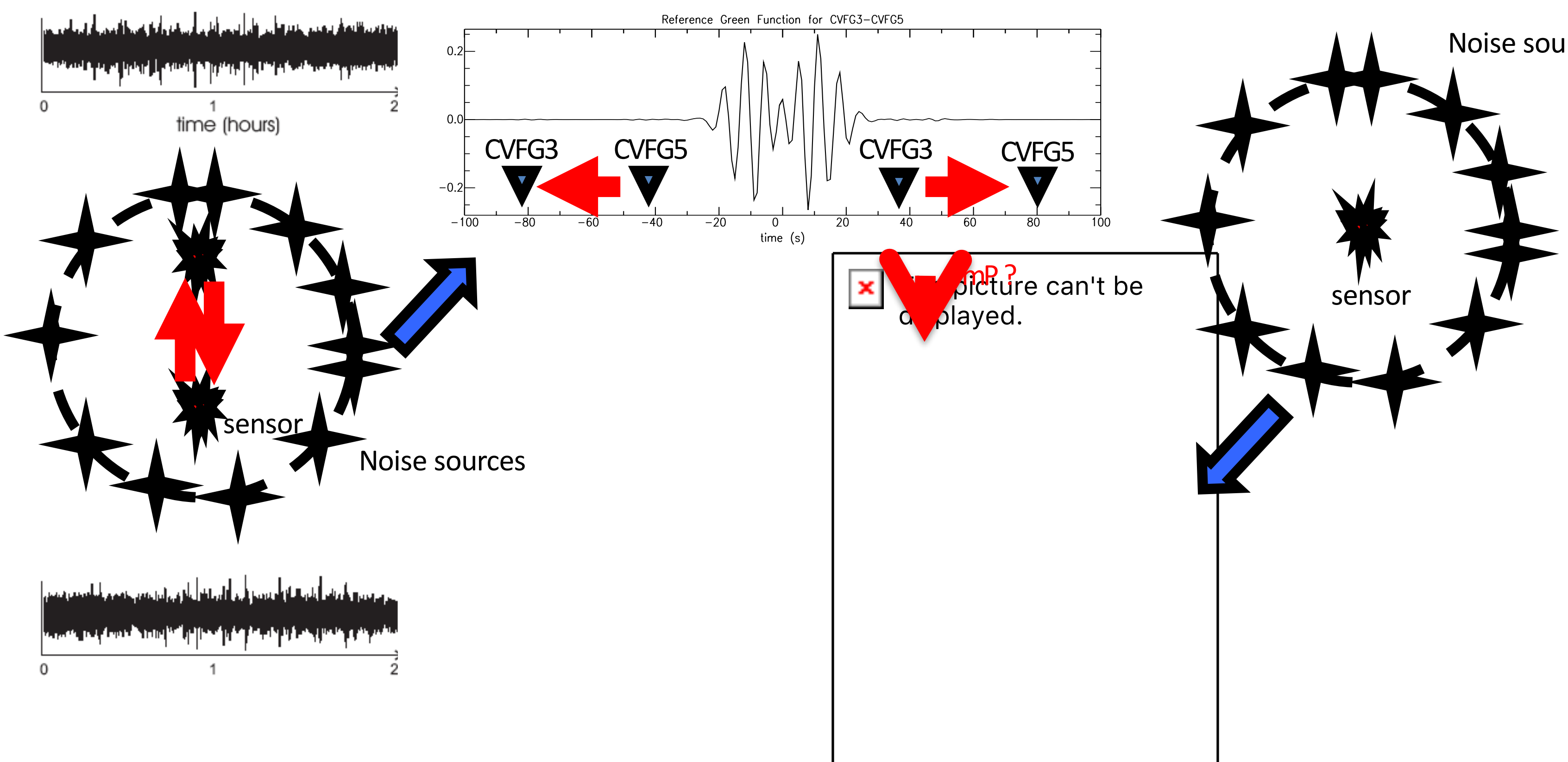
Joana Carvalho (PhD Student)
(Earthsystems IDL/UL)

Objective:

To compute a 4D seismic tomography of the Fogo volcano, characterizing the temporal evolution of small short- and long-term perturbations in the properties of seismic-wave propagation within the volcanic edifice.

Data:

- **Seismic ambient noise**
- Teleseismic data (if possible/needed)



T6.1. Raw-data quality control.

We will verify the time accuracy of seismic recordings, identify gaps, evaluate noise levels of individual seismic stations and assess true station orientation. A careful quality control of seismic data is essential to guarantee the accuracy of all subsequent data analysis. Quality control will be done in close cooperation with the team of Task 5.

Carlos Corela, Luis Matias, Nuno Dia, Bolseiro

T6.2. Short-term fluctuations of seismic velocities.

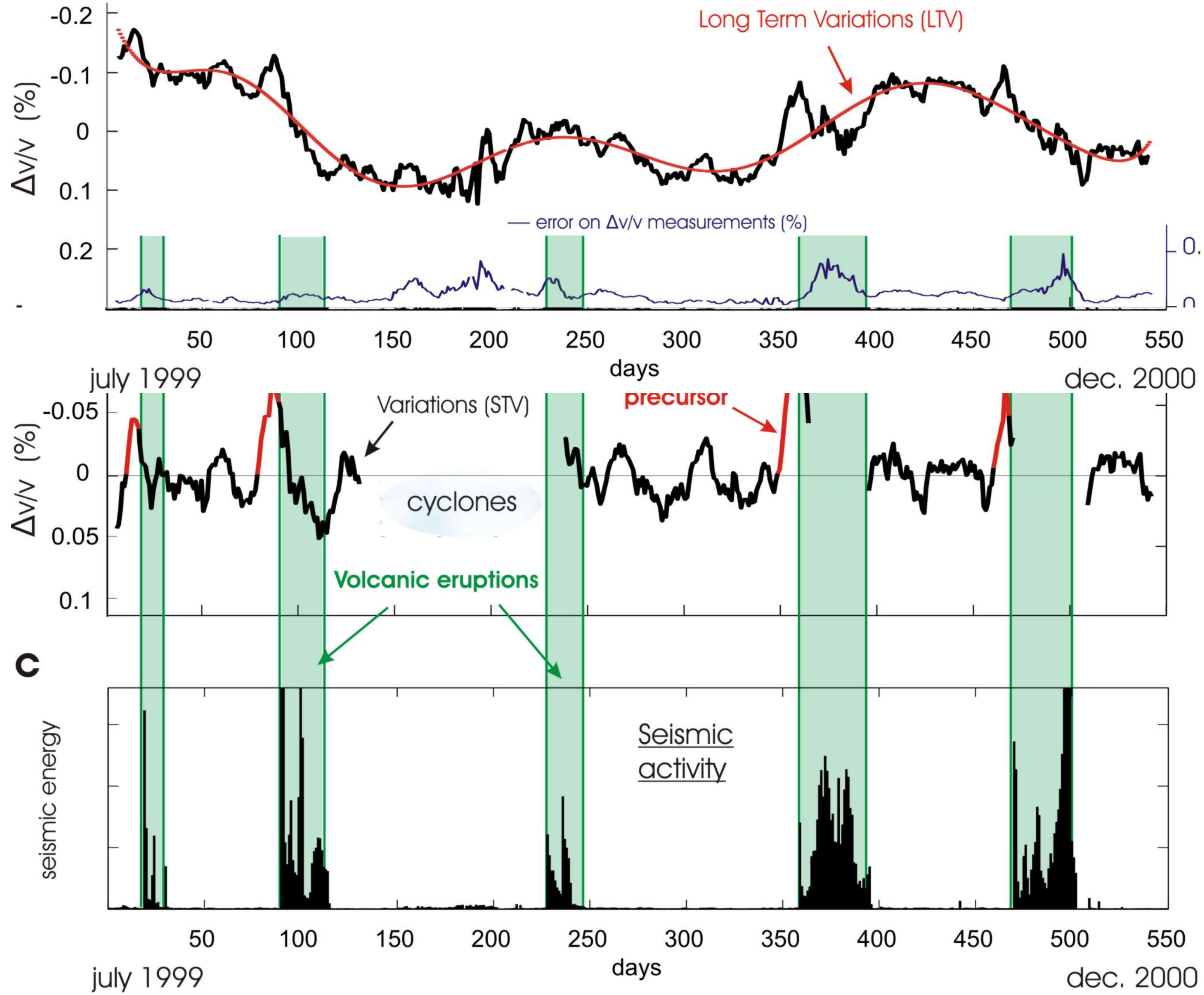
We will compute auto-correlations and cross-correlations of seismic ambient noise in order to monitor short-term velocity fluctuations. We will apply both linear- and phase-correlation method.

T6.3. Long-term seismic susceptibility.

We will first compute changes in Empirical Green Functions (EGF) before the eruption, aiming at imaging the rise of magma inside the volcano in the pre-eruptive phase. We will then investigate changes in EGF during and after the eruption, completing the description of the entire eruption cycle. Long-term seismic velocity changes will be compared with the deformation inferred from GNSS data (Task 7), aiming at relating variations in seismic velocities with those in strain rates.

Graça Silveira, Élèonore Stutzmann, Martin Schimmel (Nuno Dias)

Velocity drops preceding eruptions

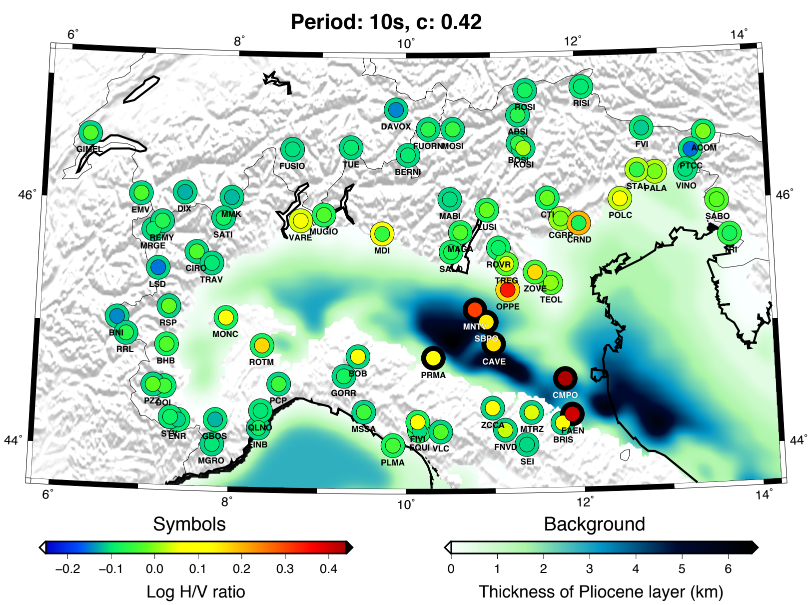


Brenguier et al., Nature Geoscience, 2008

T6.4. Shallow crustal structure inferred from ambient noise.

We will determine single-station Rayleigh wave H/V ratios using multicomponent ambient noise cross-correlations to map the shallow seismic structure. This technique is very powerful to image very shallow crustal structures.
Extra constraints on the seismic structure of the Fogo Island can, if needed, be provided by the analysis of H/V from teleseismic events and from Ps and Sp receiver functions. The latter requires high-quality records of teleseismic events in the appropriate epicentral distances.

Ana Ferreira, Andrea Morelli, Student



Ellipticity of Rayleigh waves in basin and hard-rock sites in Northern Italy

Berbellini et al., 2016

T6.5. 4D imaging of the volcanic structure.

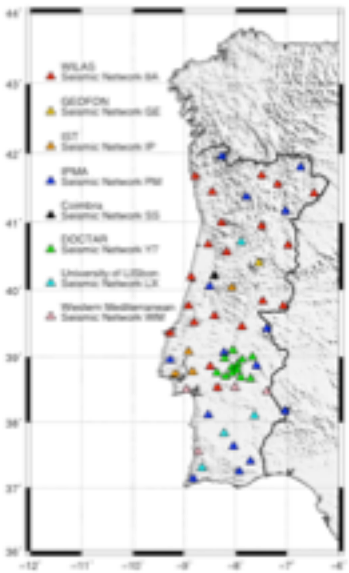
We will map spatial and temporal variations of seismic properties inside the volcanic building, based on the measurements obtained in T6.2. and T6.3. Because the heterogeneous network geometry of Fogo results in an uneven spatial distribution of dispersion measurements, we will invert the measurements using a transdimensional Bayesian formulation that performs a fully nonlinear stochastic search for model complexity, parameter definitions and seismic model. Resulting models will be interpreted together with the 3D contrast density model (Task 4) in a geodynamic sense.

T6.6. Local stress orientation and structural fabric.

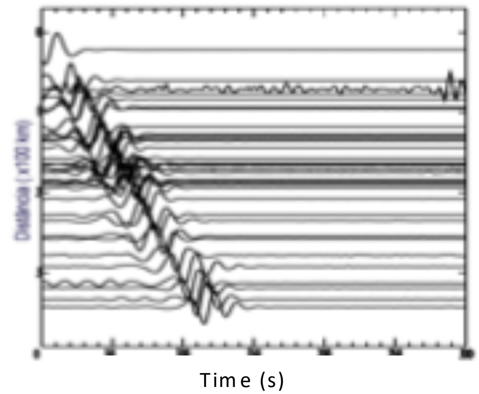
We will constrain the upper crustal seismic anisotropy from the multicomponent ambient noise tomography, providing insights into the local stress orientation and structural fabric.

Graça Silveira, Élèonore Stutzmann, Martin Schimmel, Pierre Arroucau, Joana Carvalho

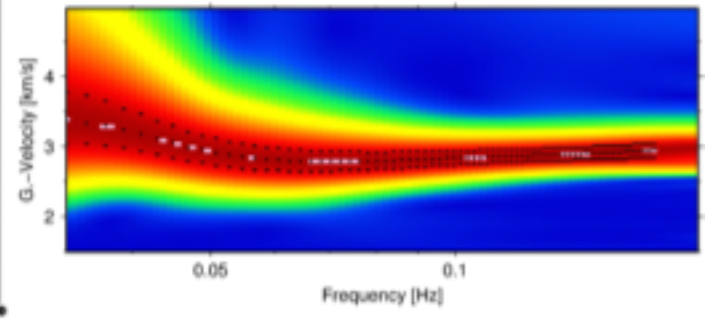
Distribution of the temporary and permanent broadband stations.

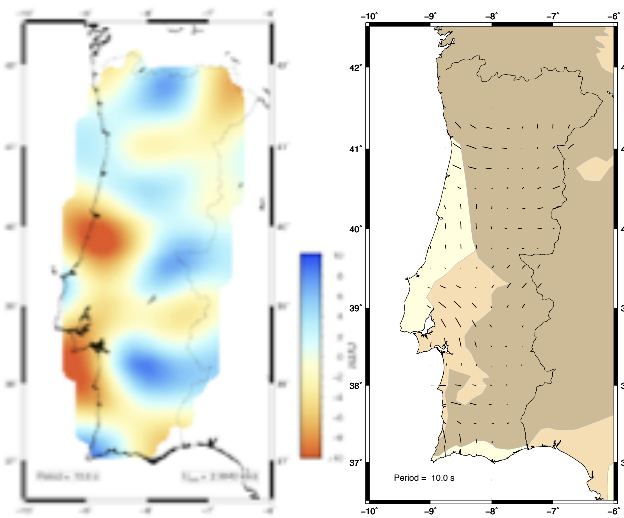


24 months ambient noise cross-correlating - COI with all other stations

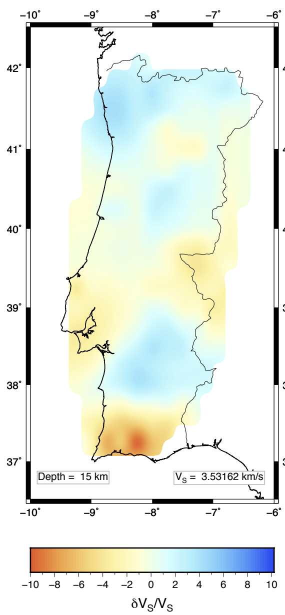


Time-frequency diagrams computed by S-transform

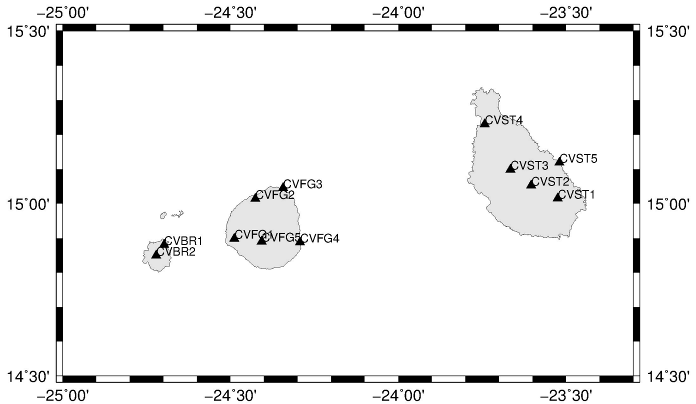




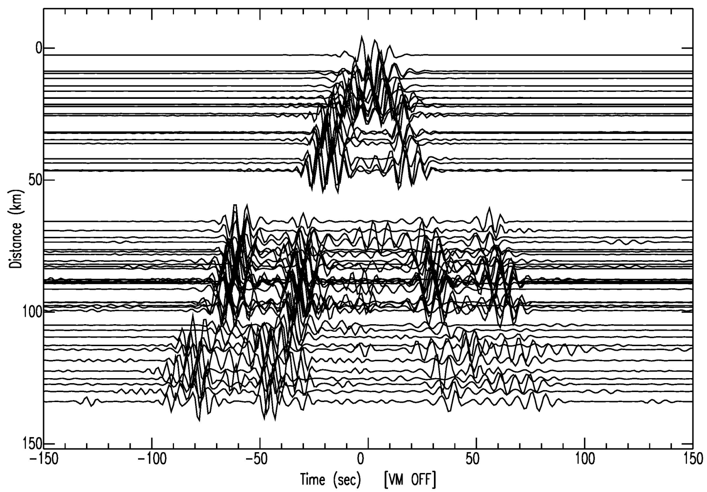
Rayleigh wave group velocity map and azimuthal anisotropy directions for 10 s obtained from the interstation measurements



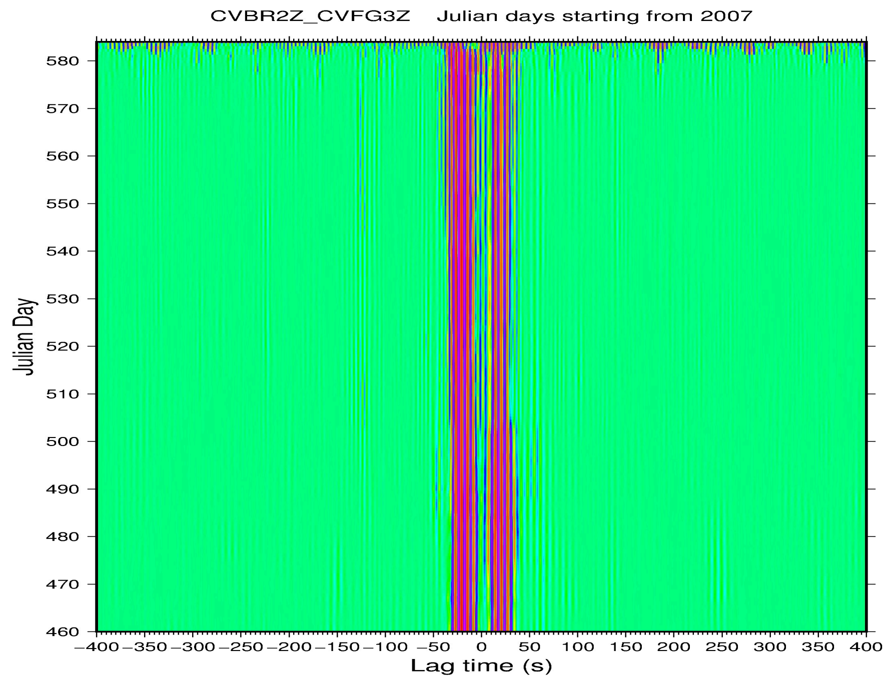
S-wave velocity perturbation map at 15 km depth. Perturbations are shown in percentage, with respect map average velocity.



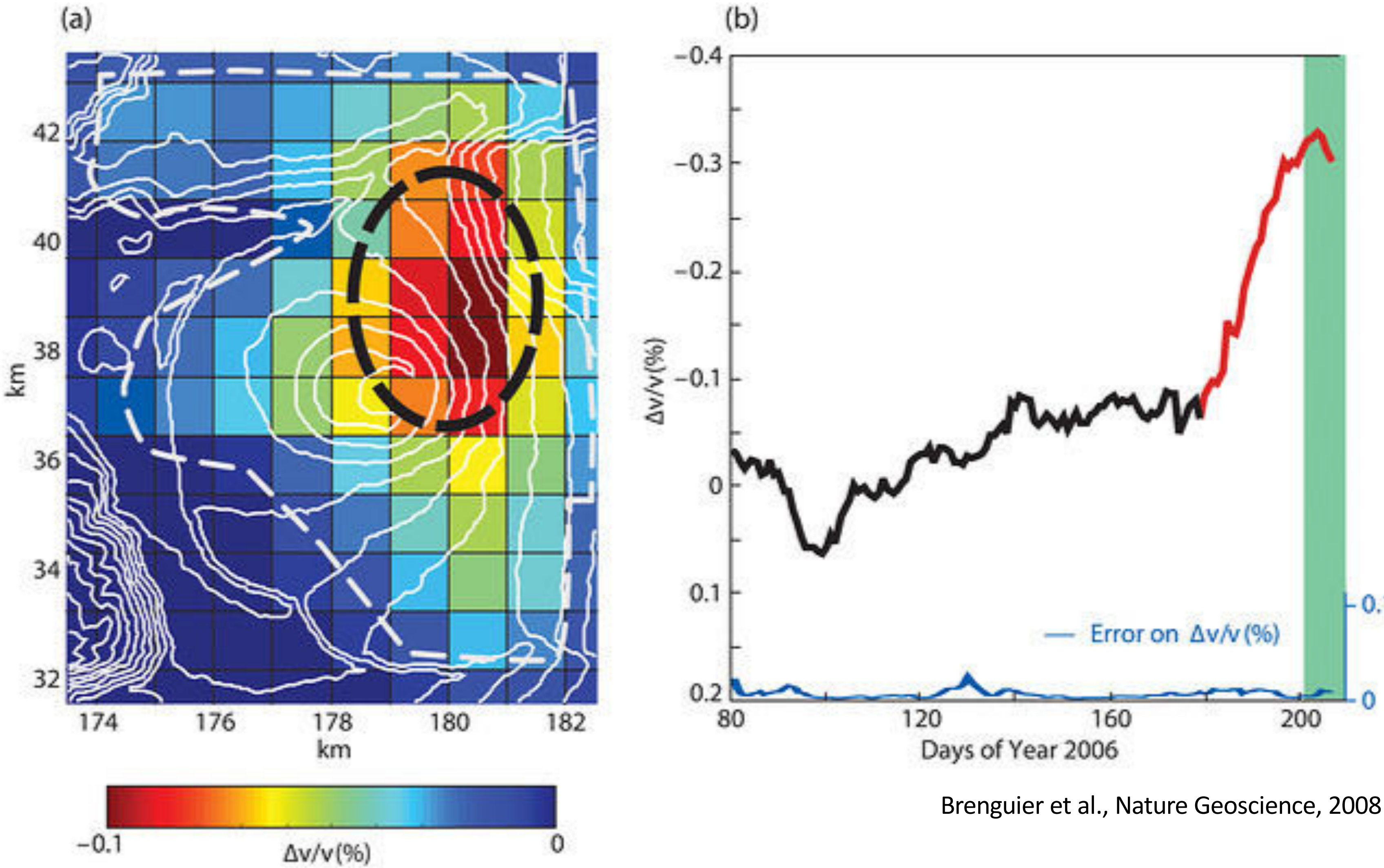
Distribution of the CV-PLUME broadband stations in Brava, Fogo and Santiago



10 months ambient noise cross-correlation



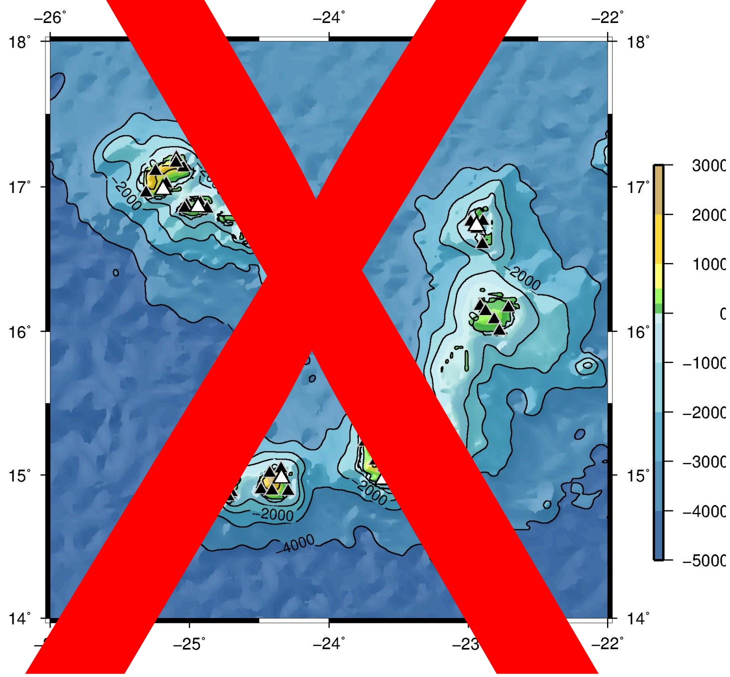
Noise cross correlations, stacked every 30 days, with 30 day overlapping.



Brenguier et al., Nature Geoscience, 2008

T6.7. Implementation of the developed algorithms, optimized for real-time usage, at INMG headquarters.

DATA



▲ CV-PLUME 10/2007 – 09/2008

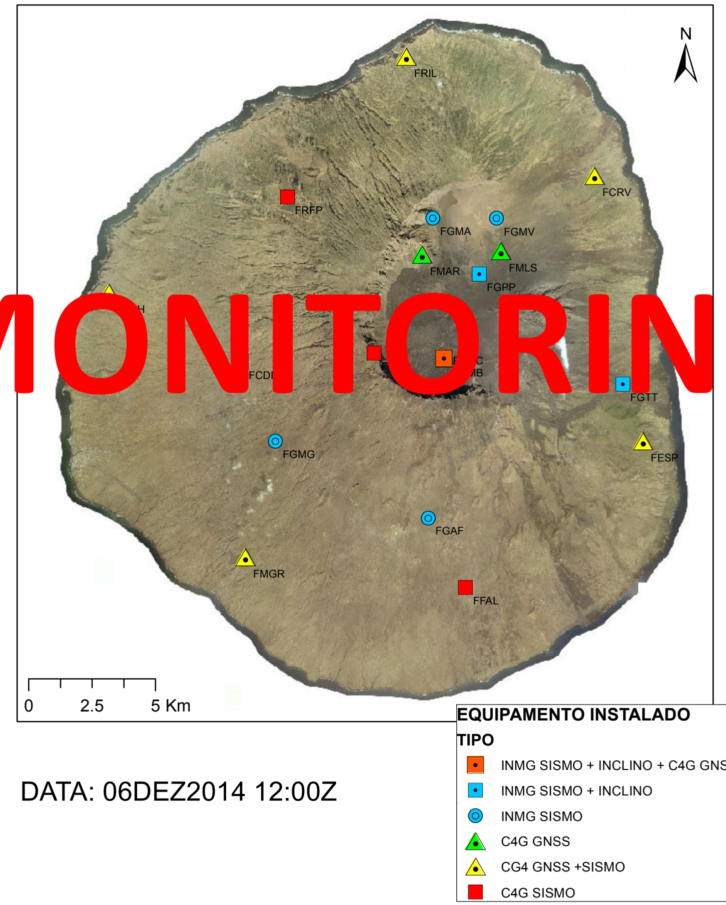
▲ Cape Verde Mantle Structure 2002 – 2004

+ SACV

INMG C4G

REDE DE MONITORIZAÇÃO PREVISTA
CRISE SISMICA - ILHA DO FOGO 2014
CABO VERDE

MONITORING



DATA: 06DEZ2014 12:00Z

Deliverables:

D6.1. – Guidelines for short- and long-term monitoring of temporal velocity changes (M20).

D6.2. – Image of the shallow crustal structure of the Fogo system (M33).

D6.3. – 4D seismic imaging of the Fogo system (M33).