36th General Assembly of the European Seismological Commission
2-7 September 2018 | Valletta - Malta
S09-23

IMAGING THE CRUSTAL STRUCTURE OF THE AZORES ISLANDS

Nuno A. Dias[1,2,*] and Idalina Veludo[3]

[1]Instituto Superior de Engenharia de Lisboa, Lisbon, Portugal; [2]Instituto Dom Luiz, Faculdade de Ciências da Universidade de Lisboa, Lisbon, Portugal;
[3]Instituto Português do Mar e da Atmosfera, I.P., Lisbon, Portugal

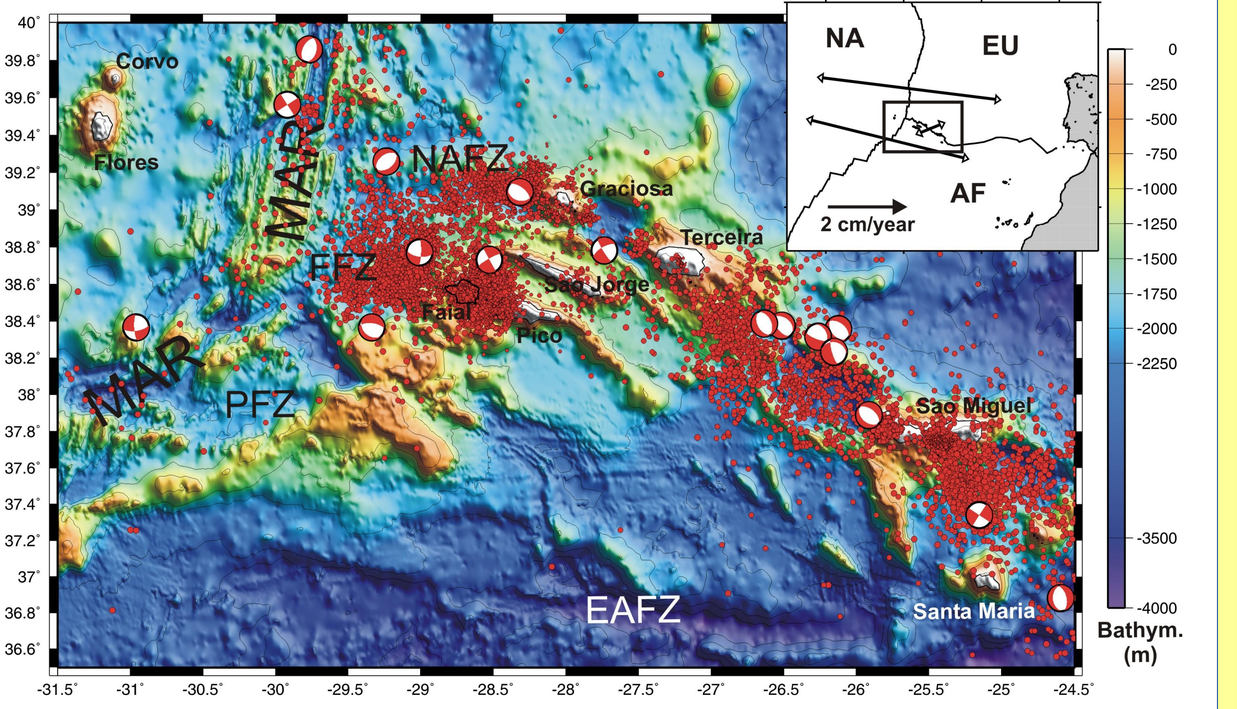
*E.-mail: nmdias@fc.ul.pt; ndias@adf.isel.pt

ISEL INSTITUTO SUPERIOR DE ENGENHARIA DE LISBOA | INSTITUTO DOM LUIZ | IPMA

Tectonic Setting

The Azores archipelago (Portugal), in the Central Atlantic Ocean, is located in a tectonic triple junction, between the American, Eurasia and African plates, whose morphologic expression is the Azores Plateau. Geodetic measurements indicate spreading rates of 23 mm/year for the Mid-Atlantic Ridge (MAR) and 2.1 mm/year for the Azorean segment (Terceira Ridge).

The Azores plateau is considered as the surface expression of the interaction between the Azores hotspot and the MAR, and presents significant tectonic and volcanic activity. The existence of an anomalously thick crust associated with excess magmatism, related with the Hotspot, has long been established for the Plateau, however the detailed characterization on its crustal structure, and its variability within the plateau is not yet fully performed.



Seismicity recorded in the Azores plateau area in the period 1998-2016 (IPMA), with focal mechanisms from Borges et al. (2007).
Inset: the Mid Atlantic Ridge (MAR) separates the North American plate (NA) from Eurasia (EU) and Africa (AF), with the Eurasia and Africa plates separated by the Azores Oblique Spreading Center (Terceira Ridge).

Data selection

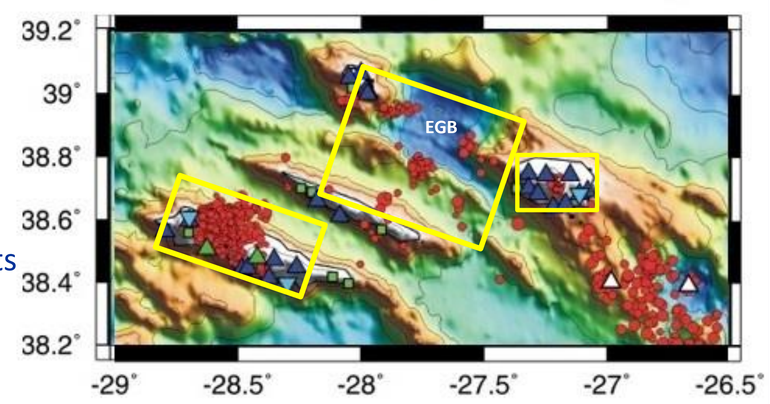
Selection criteria (trial and error):

- GAP ≤ 180º
- Minimum #stations: 5-6
- RMS < 0.5-0.6 s

⇓

3 sectors in Central Group:

- Faial-Pico ridge: **731** events
  - P-7709, S-4209
- Terceira island: **90** events
  - P-634, S-120
- East Graciosa Basin: **103** events
  - P-836 S-698

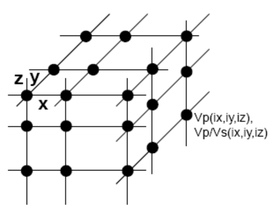


S-readings: low quality (weights), in Terceira and East Graciosa Basin
⇒ unstable Vp/Vs inversion, only Vp models

Methodology for Local Earthquake Tomography

Preliminary 1D inversion (minimum 1D model): VELEST code (Kissling et al., 1994)

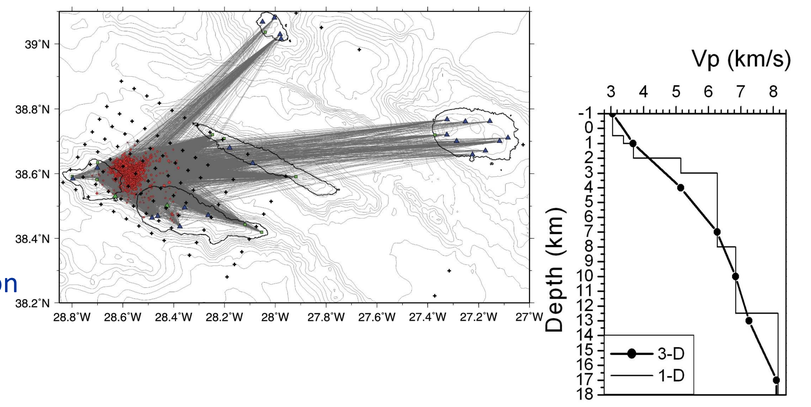
3D inversion: SIMUL2000 (Thurber and Eberhart-Phillips, 1999)



Faial-Pico sector:

- 5 km x 5 km (10x10)
- Rotation 20º
- Nº nodes: 756
- Overdetermination factor: 2.1

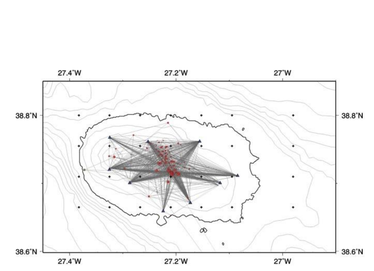
- Stable input 1D model inversion



Terceira sector:

- 5 km x 5 km (10x10)
- Nº nodes: 245
- Overdetermination factor: 1.1

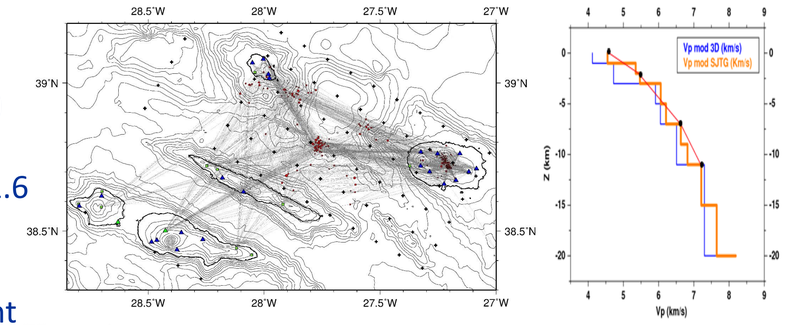
- Unstable input 1D model inversion



East Graciosa Basin sector:

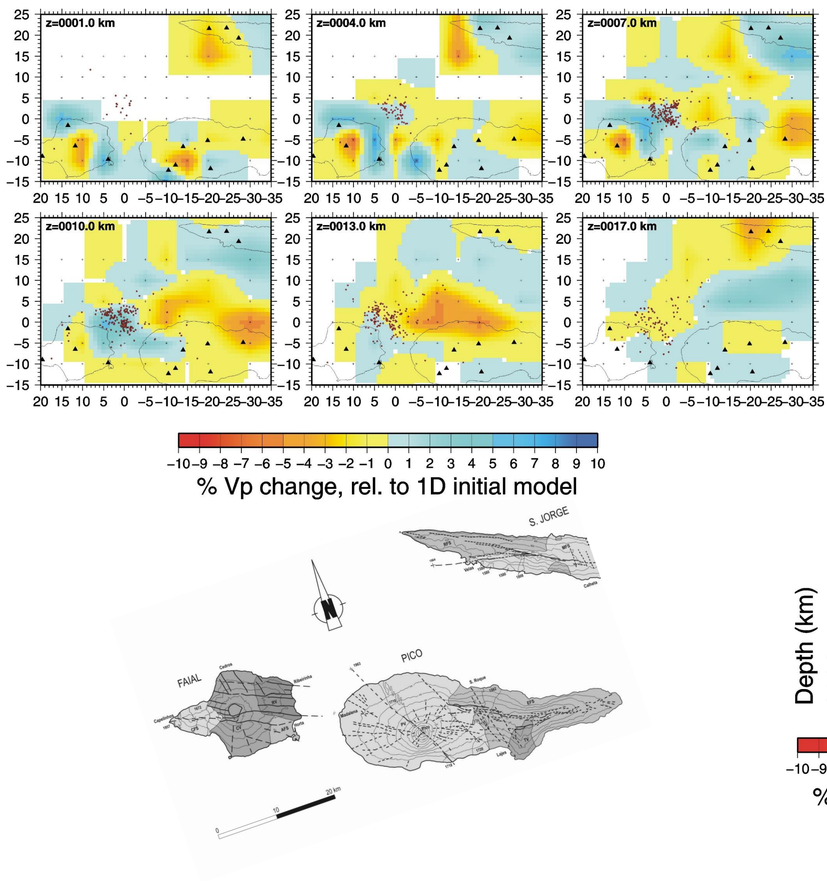
- 5 km x 5 km (10km & 15km)
- Nº nodes: 96
- Overdetermination factor: 1.6

- Unstable input 1D model Inversion, “manual” adjustment

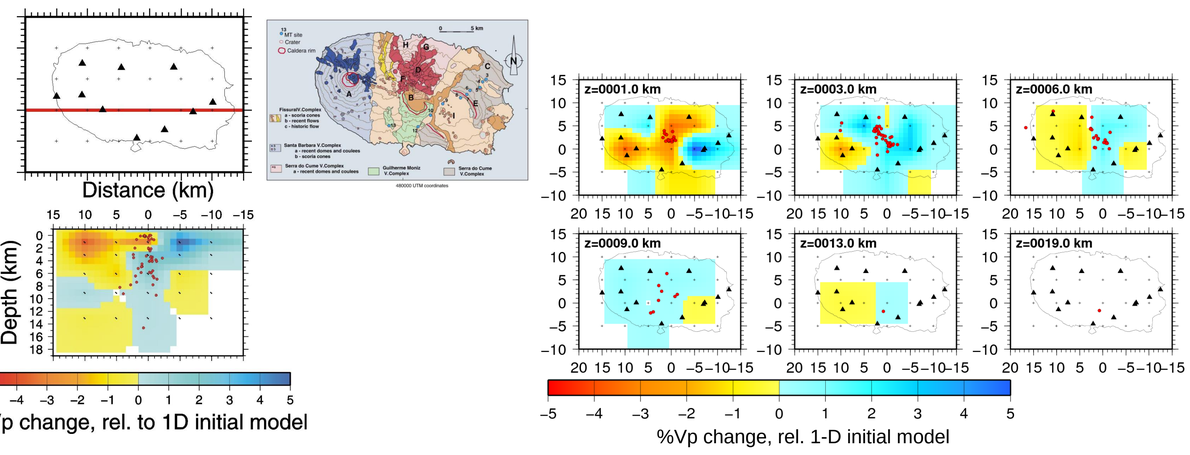


Preliminary Vp models

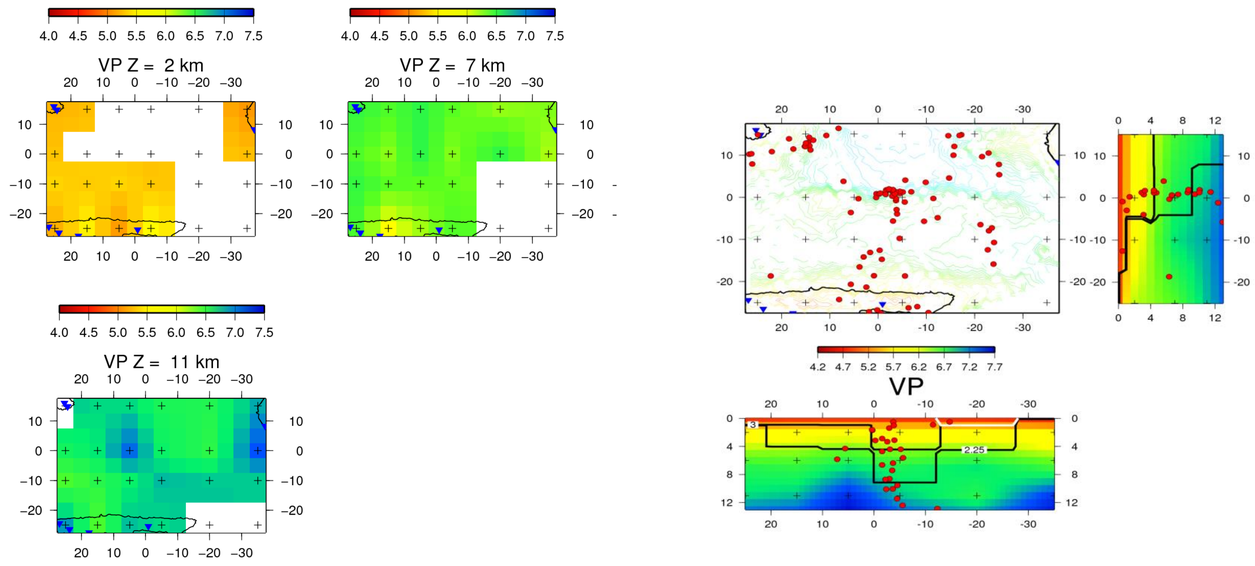
Faial-Pico Ridge: SF < 1.8



Terceira Island: SF < 2.0



East Graciosa Basin (EGB): SF < 2.2



Model Quality Assessment

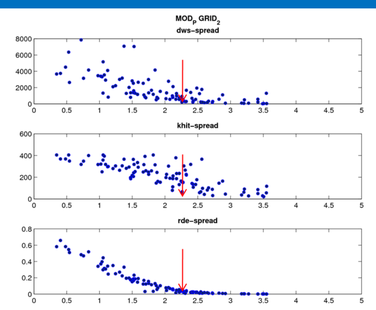
Numerical variables

- Ray hit-number per node
- Derivative weighted sum (DWS)
- Resolution matrix diagonal element (RDE)
- Spread Function (SF)

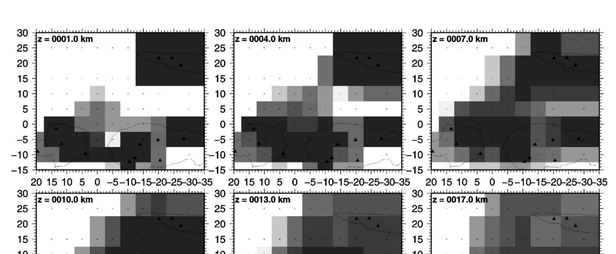
- **Balanced DWS-SF & RDE-SF graphs**

+

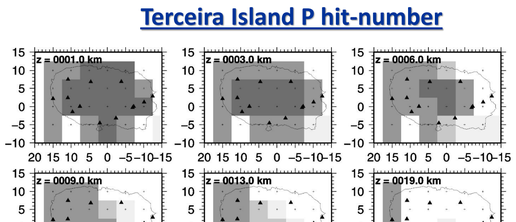
Synthetic sensitivity tests (checkerboards): not yet!



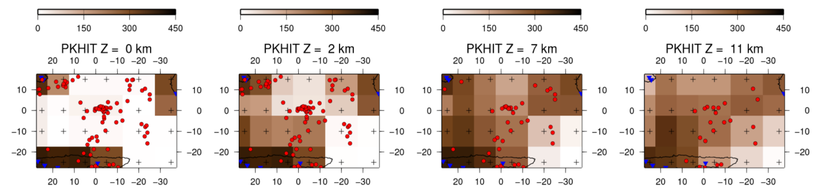
Faial-Pico Ridge P hit-number



Terceira Island P hit-number



East Graciosa Basin P hit-number



References

- Dias N.A., L. Matias, N. Lourenço, J. Madeira, F. Carrilho & J.L. Gaspar, 2007. Crustal seismic velocity structure near Faial and Pico Islands (Azores), from local earthquake tomography, Tectonophysics, 445 (3-4): 301-317, doi.10.1016/j.tecto.2007.09.001.
- Matias L., N.A. Dias, I. Morais, D. Vales, F. Carrilho, J. Madeira, J.L. Gaspar, L. Senos & A.B. Silveira, 2007. The 9th of July 1998 Faial Island (Azores, North Atlantic) seismic sequence. Journal of Seismology, 11(3): 275-298, doi.10.1007/s10950-007-9052-4.
- Kissling, E., Ellsworth, W.L., Eberhart-Phillips, D., Kradolfer, U., 1994. Initial reference models in local earthquake tomography. J. Geophys. Res. 99, 19635–19646.
- Thurber, C., Eberhart-Phillips, D., 1999. Local earthquake tomography with flexible gridding. Comput. Geosci. 25, 809–818. doi:10.1016/S0098-3004(99)00007-2