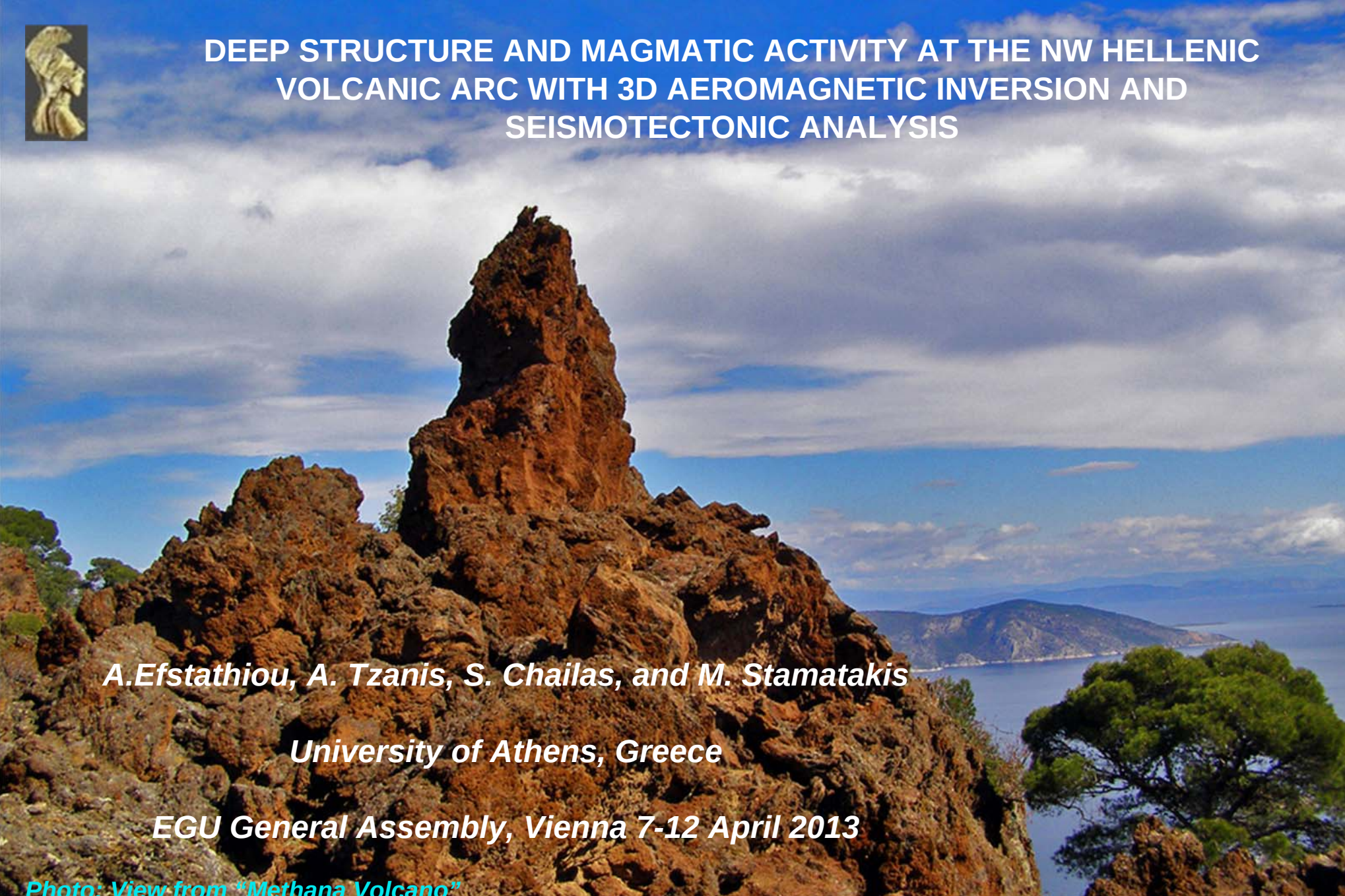

DEEP STRUCTURE AND MAGMATIC ACTIVITY AT THE NW HELLENIC VOLCANIC ARC WITH 3D AEROMAGNETIC INVERSION AND SEISMOTECTONIC ANALYSIS

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University of Athens, Greece

EGU General Assembly, Vienna 7-12 April 2013

Photo: View from "Methana Volcano"

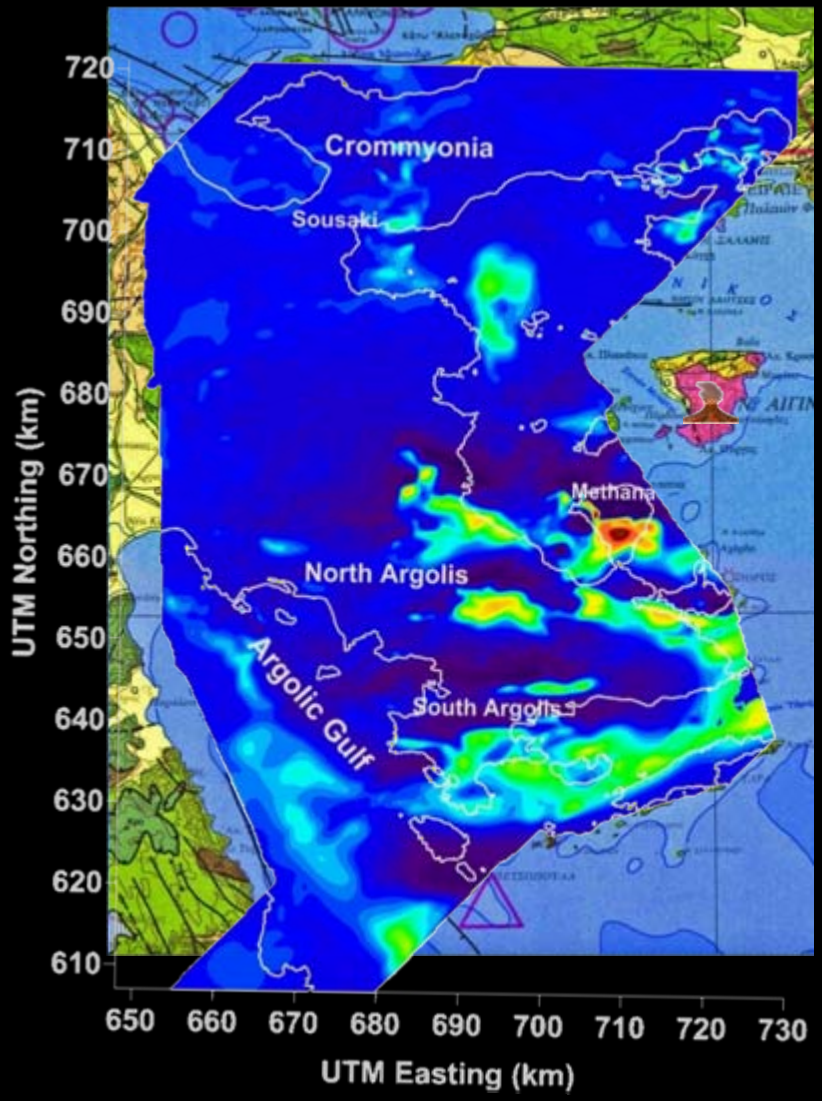
INTRODUCTION

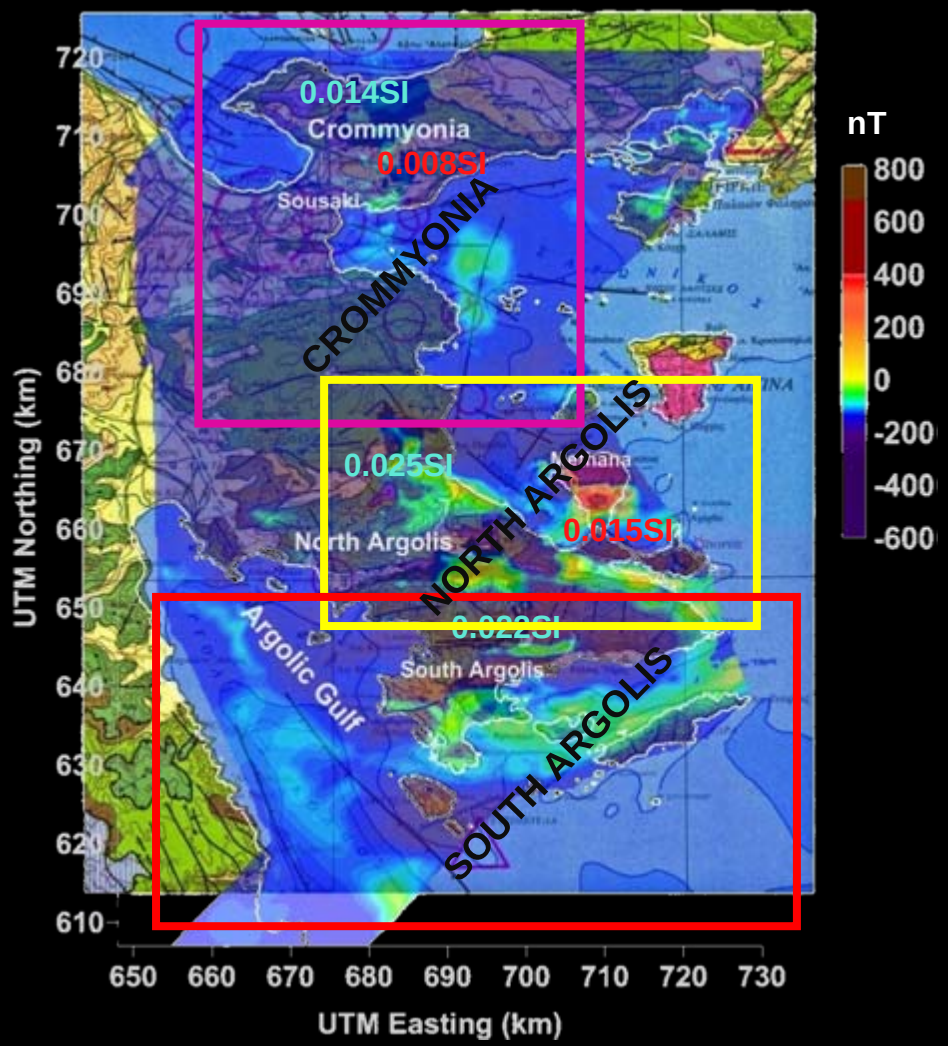
Geophysical and seismotectonic methods of analysis were applied in order to investigate the deep structure and magmatism of **the north-western stretch of the Hellenic Volcanic Arc (HVA)** which appears to be due to Neogene volcanism.

The study was based on:

1. **Field observations.**
2. **In situ measurements of magnetic susceptibility.**
3. **The results of a 3-dimensional inversion of aeromagnetic data.**
4. **Seismotectonic data of local crustal and subcrustal earthquakes.**

GEOLOGY AND ITS RELATION TO MAGNETIC ANOMALIES





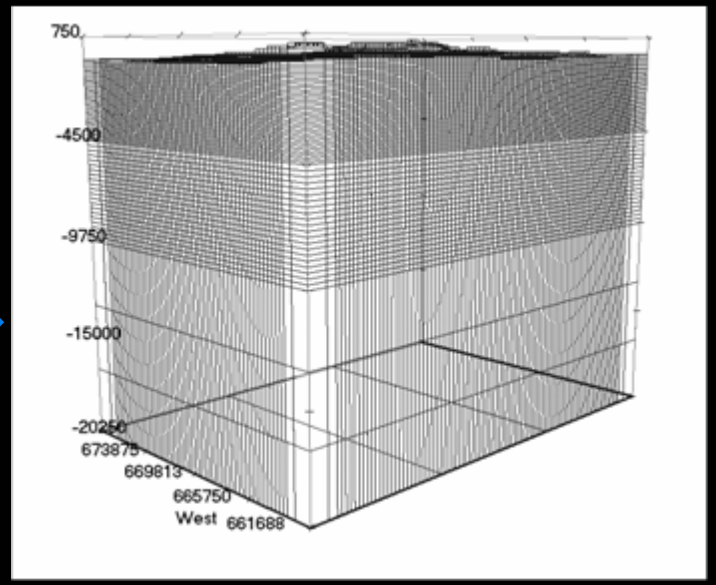
Aeromagnetic data from Chailas et al (2010) *"Compilation of a unified and homogeneous aeromagnetic map of the Greek mainland", Bulletin of the Geological Society of Greece*, 2010. Proceedings of the 12th International Congress, Patras, May

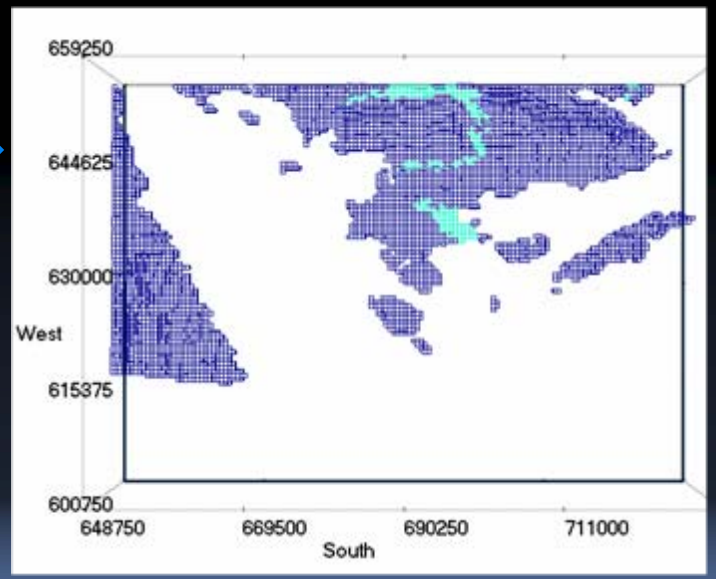
INVERSION OF AEROMAGNETIC DATA

- ***UBC-GIF (University of British Columbia-Geophysical Inversion Facility) 3D*** magnetic inversion algorithms (*Li &Oldenburg, 1996*).

General features:

1. **The earth is discretized in terms of parallelepiped voxels , each assigned with a susceptibility value that varies during the inversion.**
2. **Topography is taken into account.**
3. **Geological Constraints are included: Groups of voxels representing known geological units can be assigned with invariable susceptibility values based on in situ measurements (surface, borehole etc.)**
4. **The inversion obeys strict smoothness constraints: voxels are not allowed to change independently of their neighbours.**

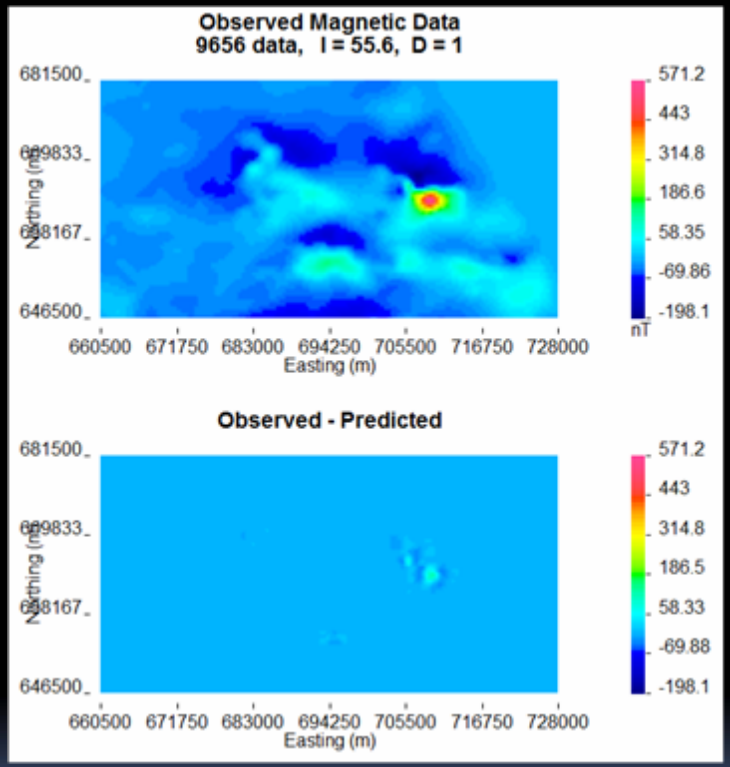




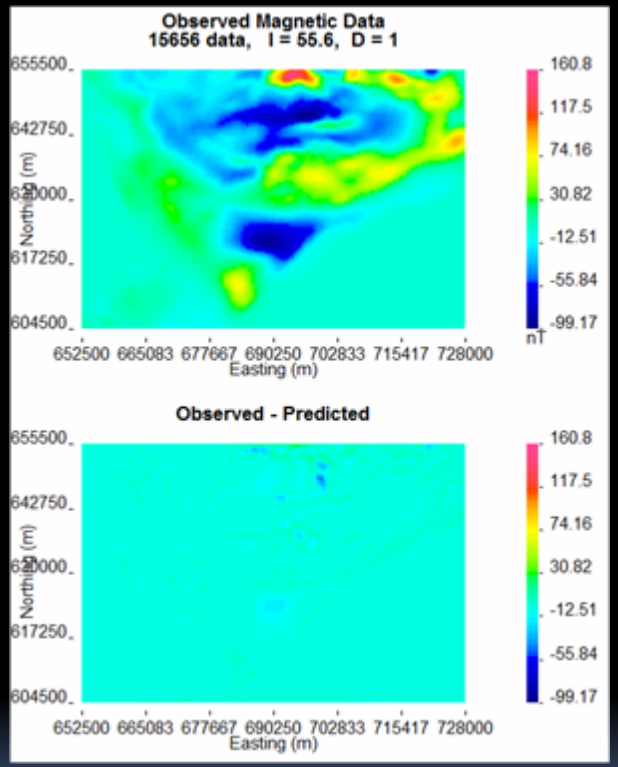
RESULTS (Observed-Predicted data)

The aeromagnetic map was upwarded to 1100m AMSL for Argolis Peninsula and to 1600m AMSL for Crommyonia, i.e above the highest topographic point.

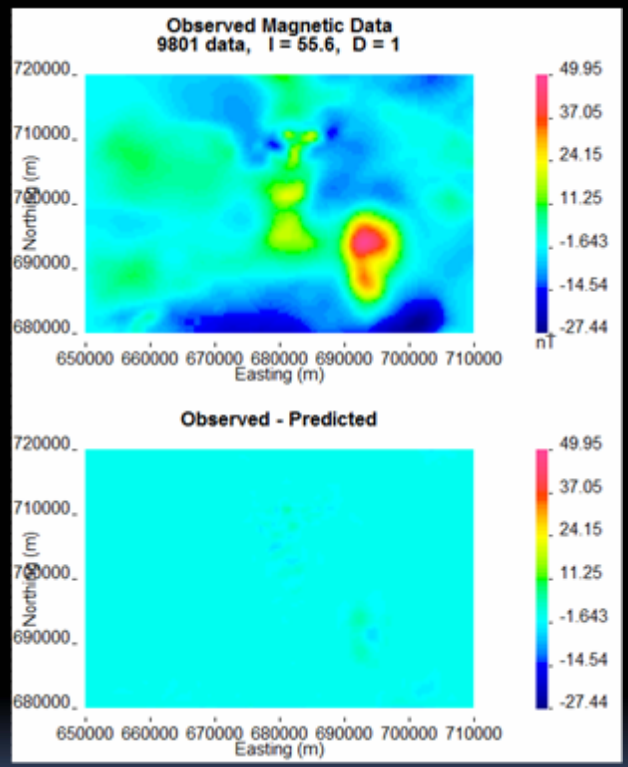
North Argolis



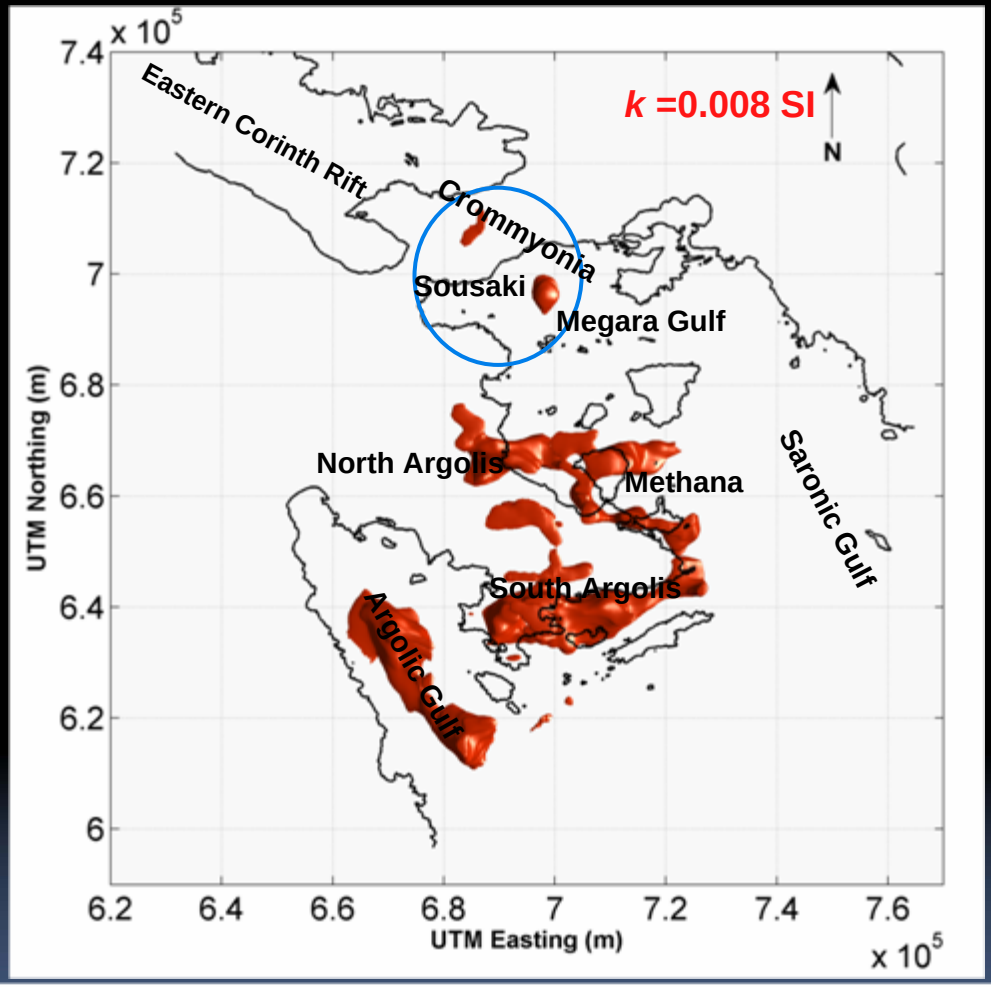
South Argolis

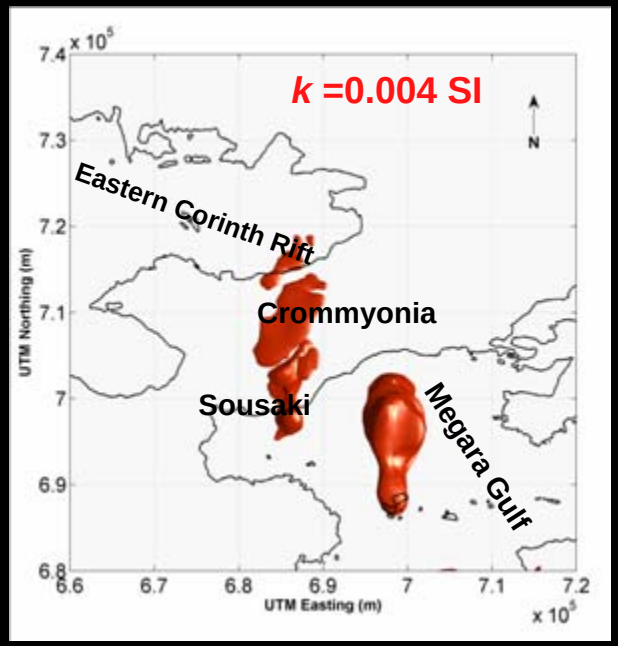


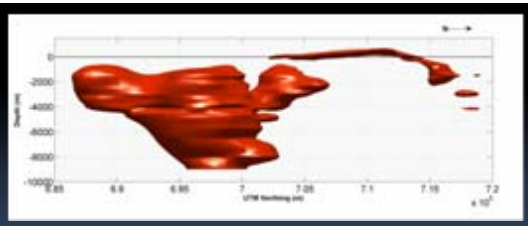
Crommyonia

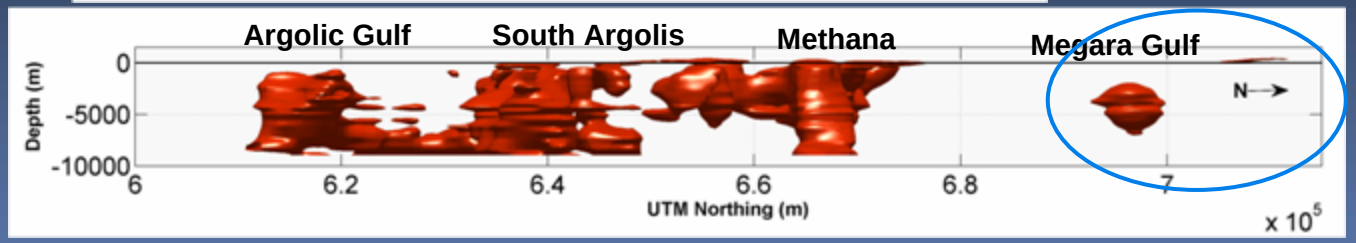


SUSCEPTIBILITY MODEL





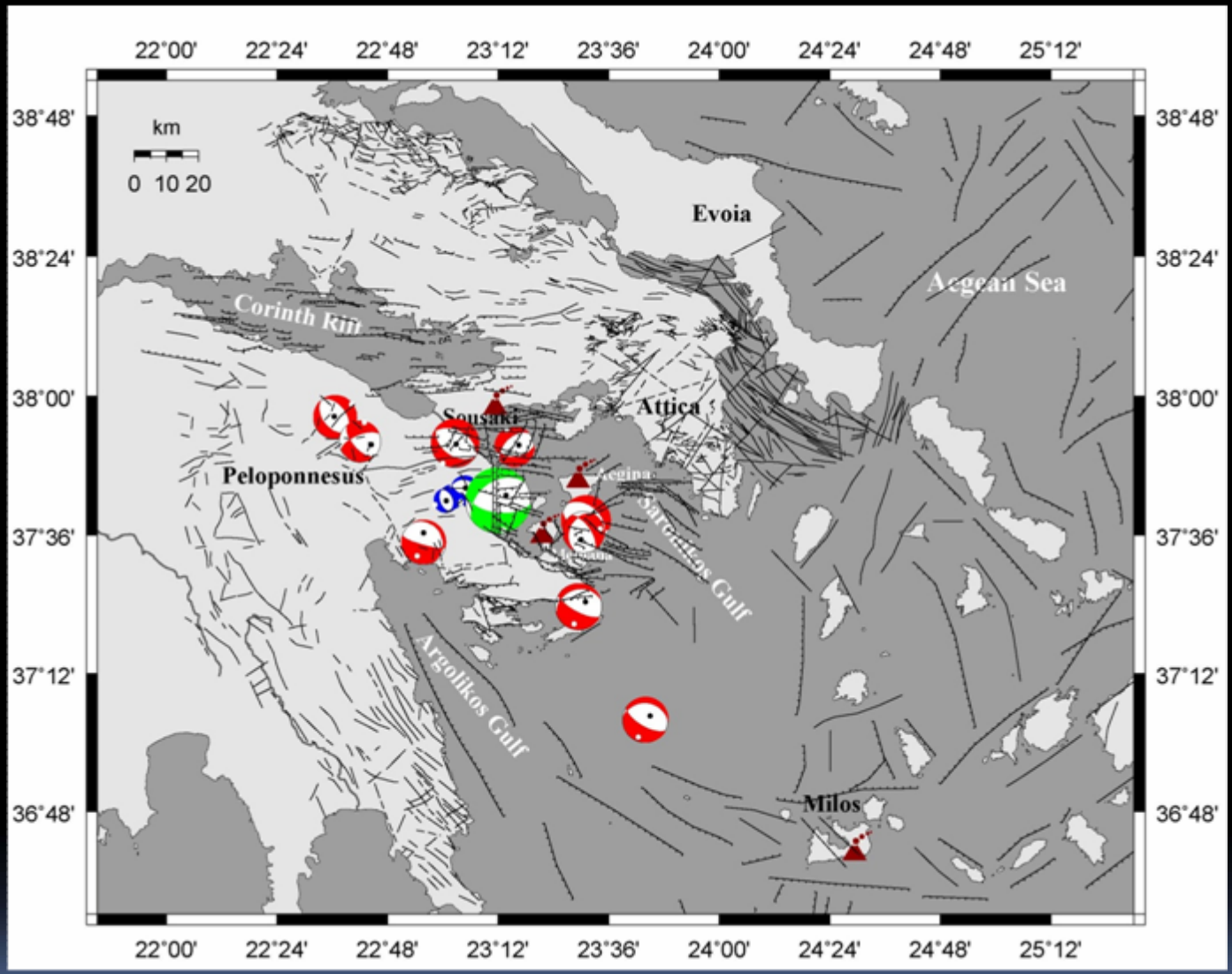




Superficial domains
OPHIOLITIC SCALES

Deep reaching domains
PPROBABLE PLUTONITES

CRUSTAL EARTHQUAKES AND TECTONICS



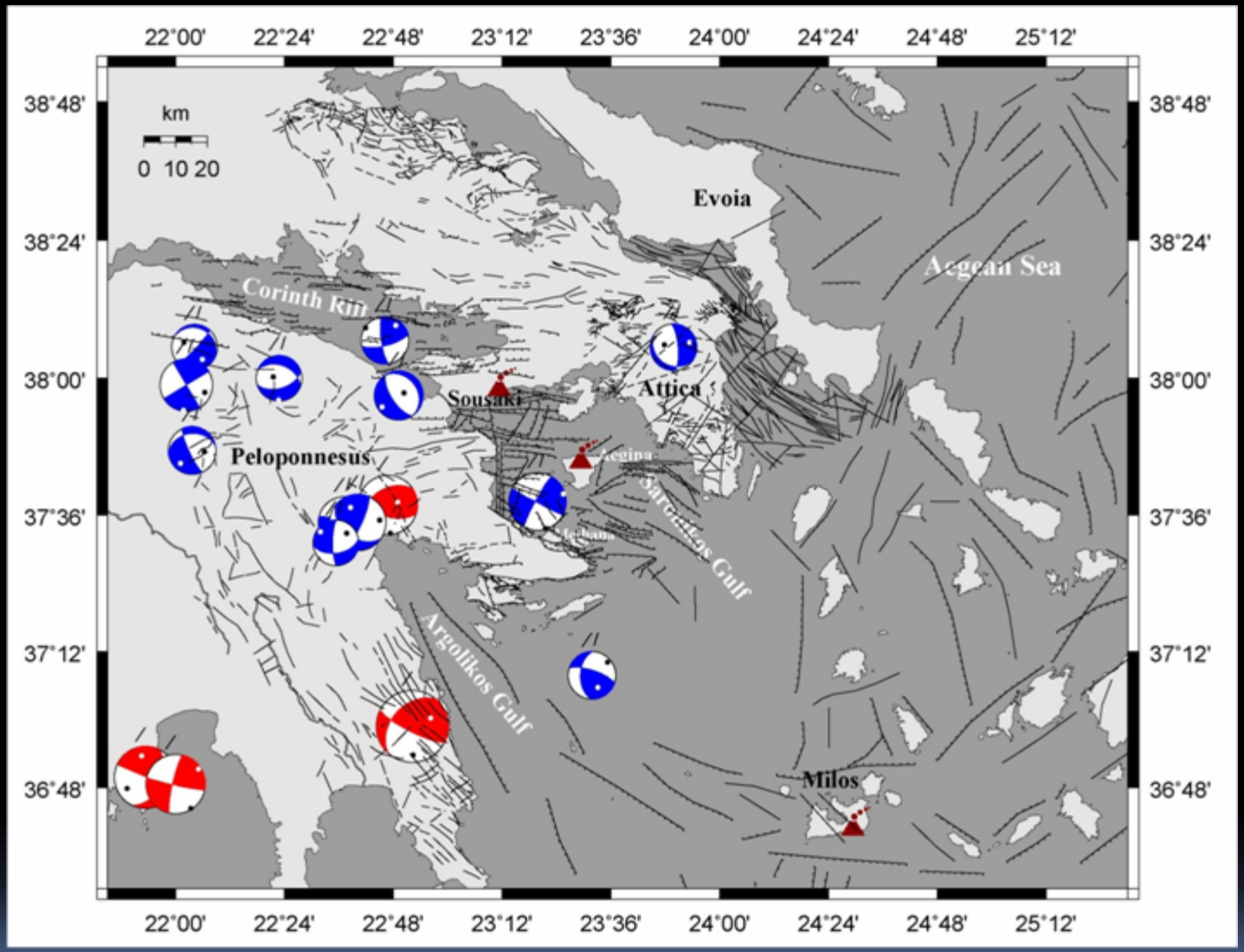
Source for compilation of the tectonic map:

- Papadeas (1989), *Geological map of Attica, IGME.*
- General Seimotectonic map of Greece, *1:500.000*, *IGME.*
- Kokkalas & Aydin (2012), *Geological Magazine, 150,193-224.*
- Skourtsos & Kranis (2009), *International Journal of Earth Sciences.*
- Papanikolaou et al (1988), *Basin Research 1,167-1 76.*
- Vasilopoulou S.,(2000) *Thesis, University of Athens, Faculty of Geology.*
- Kranis, H.D. 1999, Ph.D. Thesis, GAIA, No. 10, Univ. of Athens.
- Palyvos, N., 2001, Ph.D. Thesis, Univ. of Athens, Dep. of Geology.
- Stefatos A. et al, 2002, Basin Research, v. 14, p. 439-542.

Source of focal mechanisms of crustal earthquakes:

- **ATHENET**
  http:/dggsl.geol.uoa.gr
- **Hatzfeld et al, 1993**
- **Ritsema, 1974**

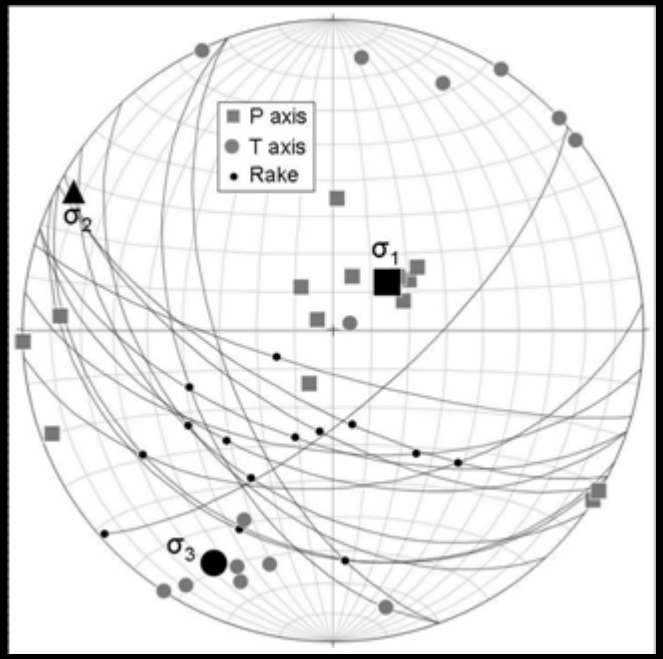
SUBCRUSTAL EARTHQUAKES



Source of focal mechanisms of subcrustal earthquakes :

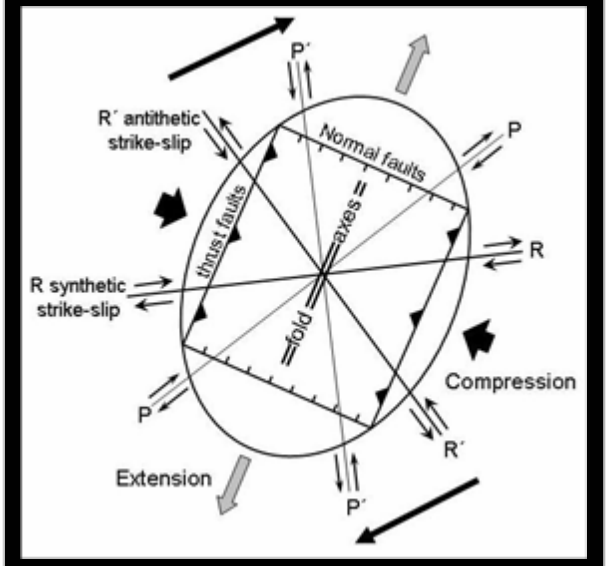
- **Harvard CMT catalogue**
- **Konstantinou et al**, *Seismol. Res. Lett.*, ***81, 750–760, doi:10.1785/gssrl.81.5.738, 2010***

STRESS FIELDS OF EARTHQUAKES

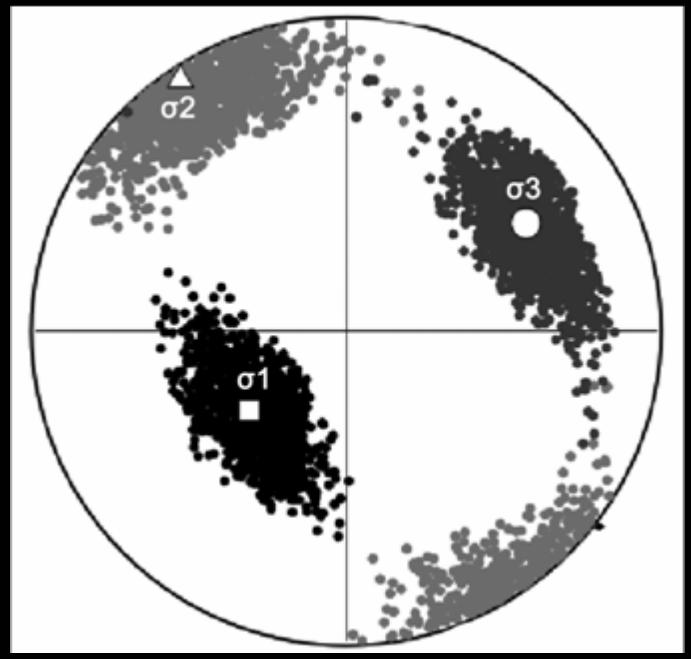


CRUSTAL EARTHQUAKES:
The stress field is computed from focal mechanisms by inversion. The method of Michael (1984, 1987) was applied !

σ_1 : azimuth N57°, plunge 78°
σ_3 : azimuth N201°, plunge 10°



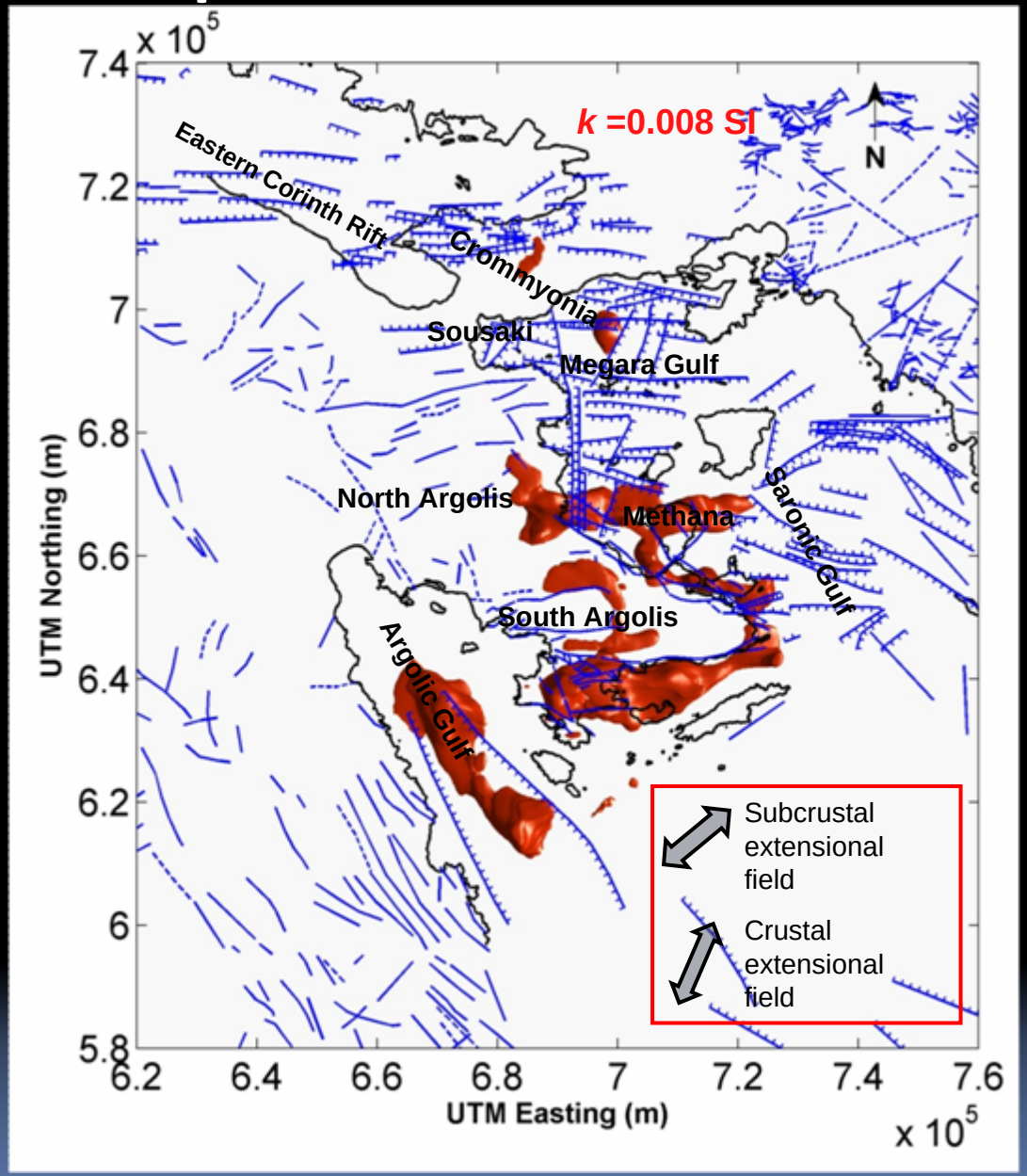
Expected faulting models based on Riedel shear theory

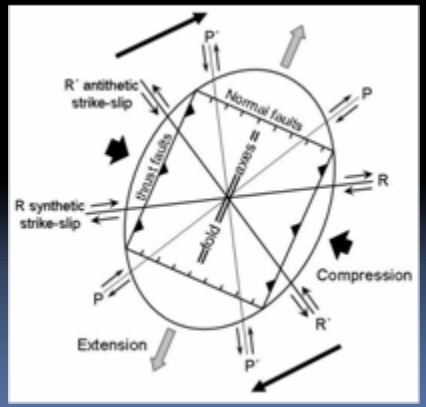


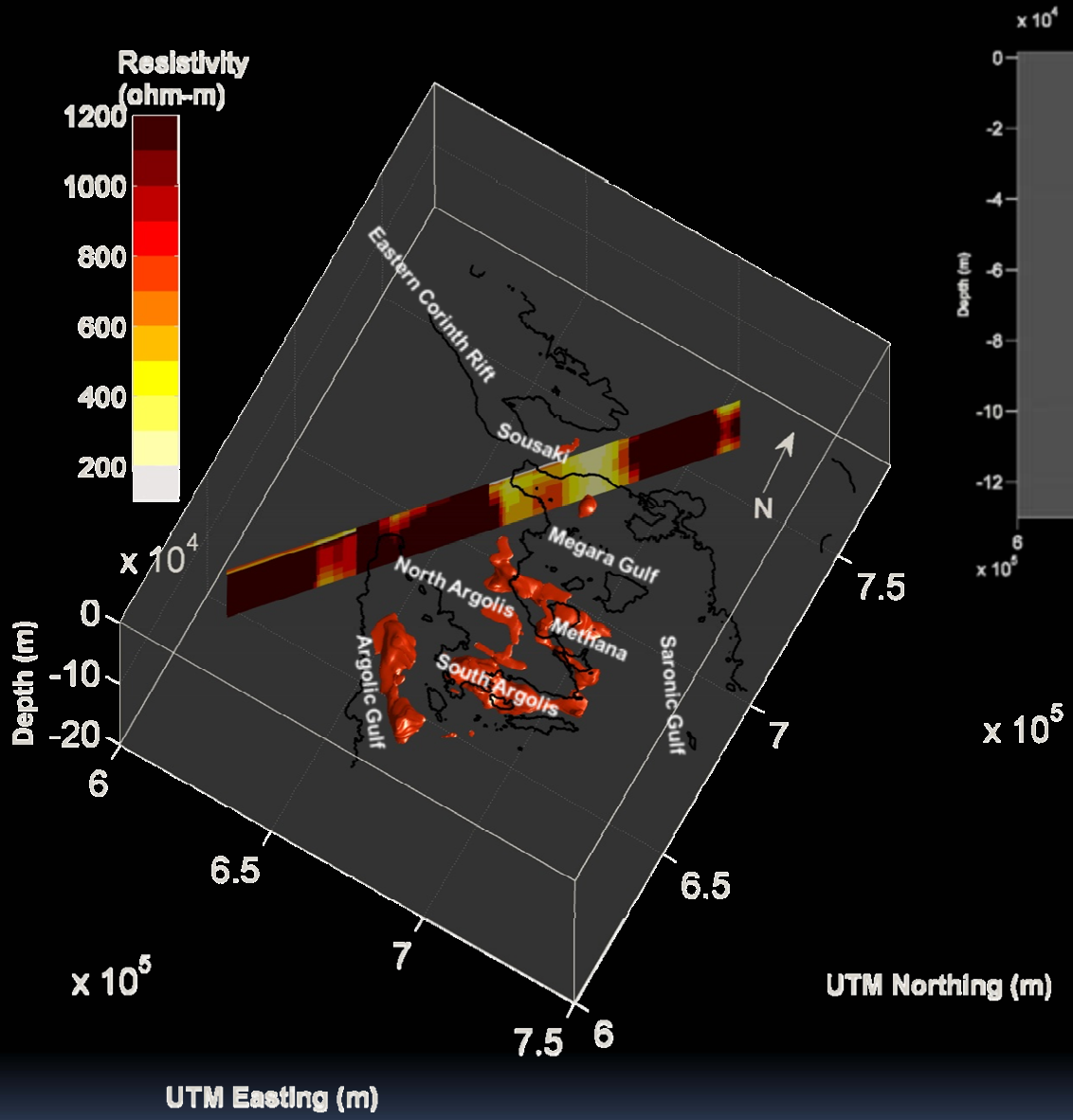
SUBCRUSTAL EARTHQUAKES (depth 50-80km):
From Rodogianni et al, *Earth Planets Space, 63, 139–144, 2011.*

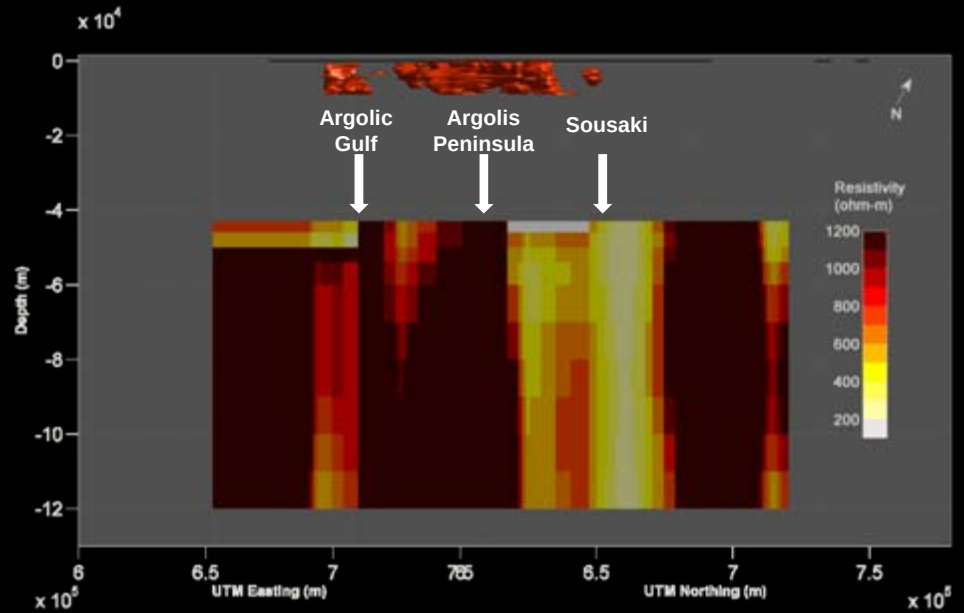
σ_1 : azimuth N231°, plunge 57°
σ_3 : azimuth N59°, plunge 33°

Relationship between Tectonics and Magmatism





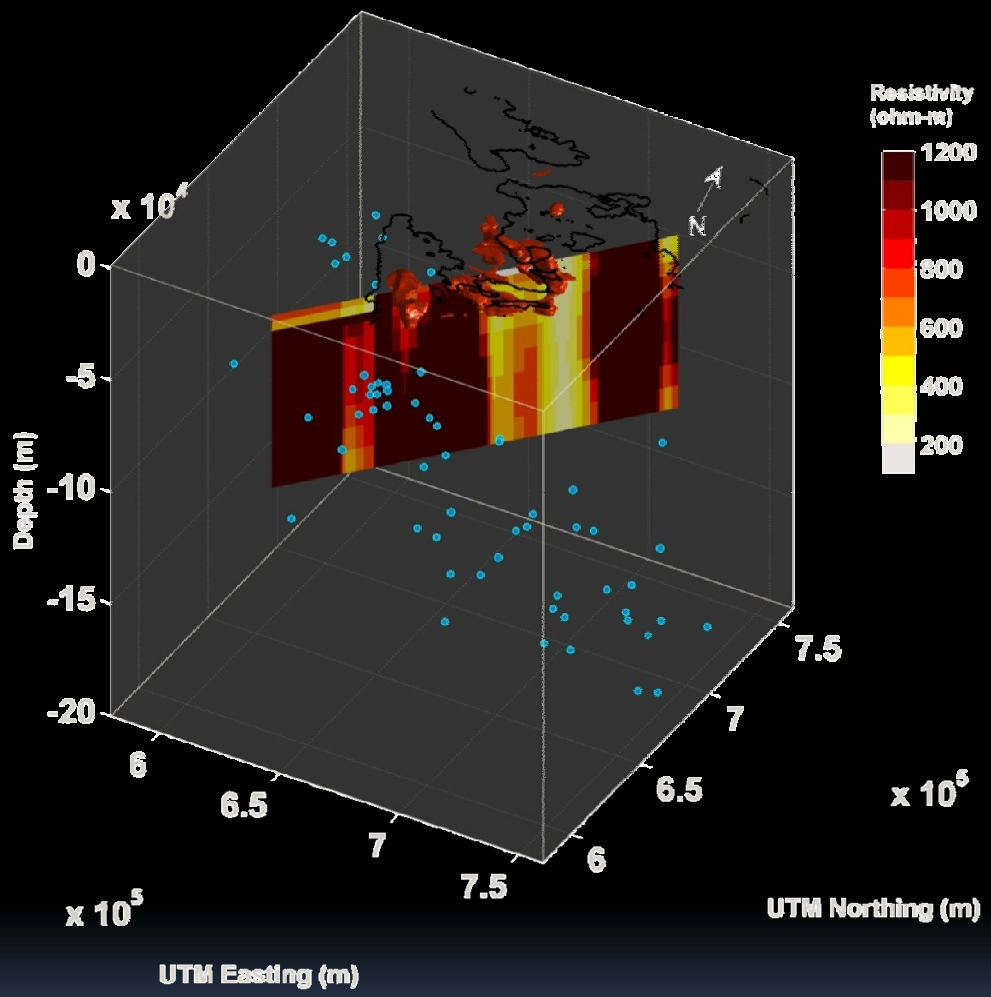


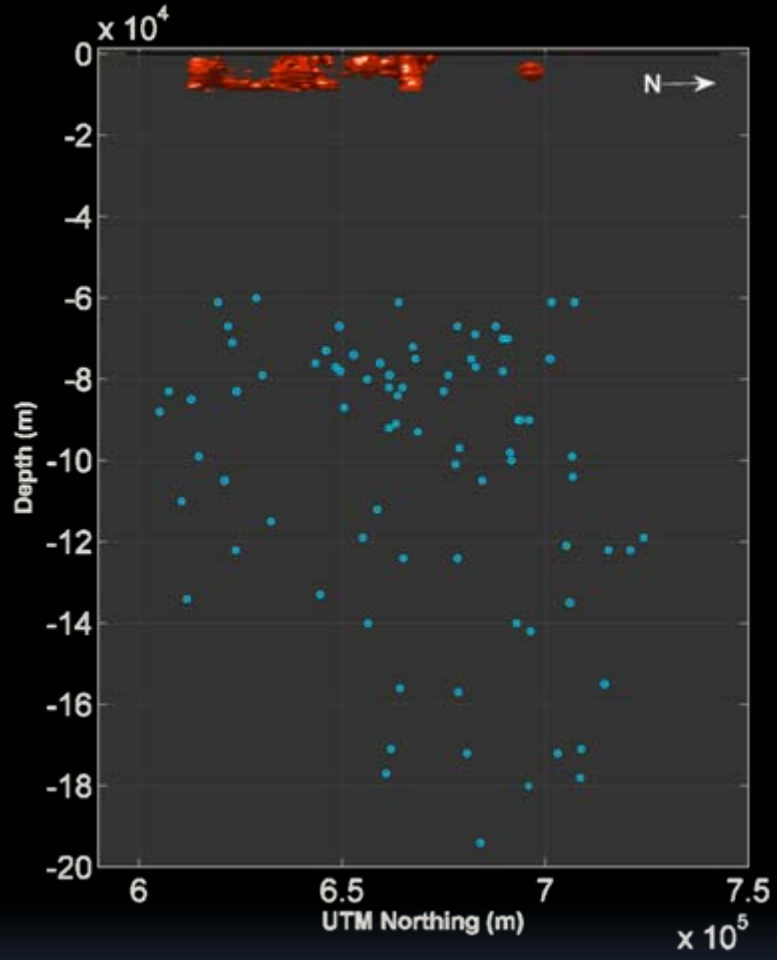


The susceptibility model together with the 2D magnetotelluric section of Galanopoulos et al (2005, *Tectonophysics* 409, 73–84.

The MT profile is included by courtesy of prof. E. Lagios).

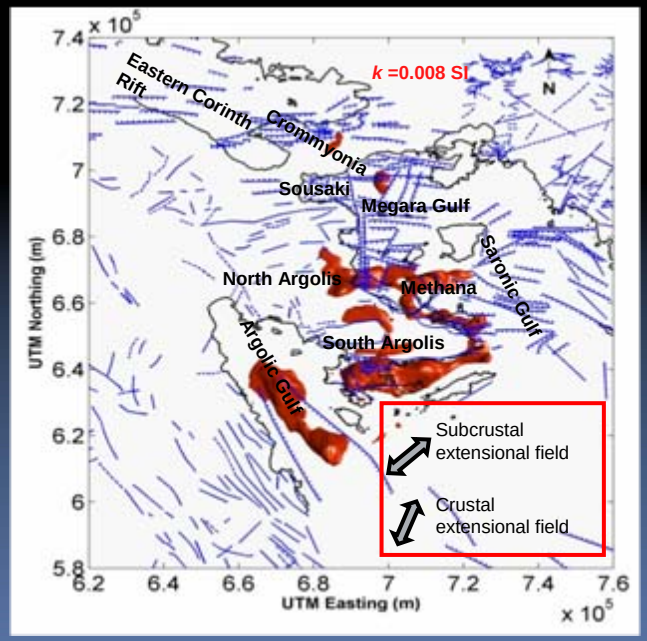
Intermediate depth earthquakes taken from the International Seismological Centre, *On-line Bulletin*, http://www.isc.ac.uk.





Conclusions

- Ophiolite formations observed at the surface are flakes (scales left from past orogenetic episodes).
- Apparent differentiation of magmatic and volcanic products between Argolis and Crommyonia evident in lithology (Andesites vs Dacites) and susceptibility (in situ and modelled).
- Hitherto unknown massive plutonic magmatism beneath Argolis Peninsula which appears to be controlled by the geometry of the subducting slab and the interplay between sub-crustal and crustal extensional stress fields
- The scenario for the emplacement of the plutonites entails:



- While the sub-crustal field pulls to the NE with a significant heave to the NW, the crustal field pulls to the SW.
- Low rate spreading in an ENE-WSW direction is expected, perpendicular to the strike of the slab, which should maximize along the inflection (steepening) of the slab.
- This may be a plausible explanation for the formation of upper mantle melt along the axis of the Argolic Gulf , the Argolic Gulf itself and the intrusions along its axis.
- The interaction of the subcrustal and crustal stress field results in a complex segmentation of the crust, their coupling also appears to facilitate and control the widespread and pervasive plutonic and volcanic magmatism of the study area and the Argolid in particular.

THANK YOU!!!