The Abdus Salam
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2142-Presentation

Advanced Conference on Seismic Risk Mitigation and Sustainable Development

10 - 14 May 2010

Asi-Sisma Presentations

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Roma
ITALY

Advanced Conference on Seismic Risk Mitigation & Sustainable Development

10-14 May 2010, The Abdus Salam International Centre for Theoretical Physics

Miramare - Trieste

SISMA Project: *An integrated and multidisciplinary approach to seismic hazard*

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Description of the Project

- SISMA → Seismic Information System for Monitoring and Alert;
- SISMA is a three year Pilot Project mainly financed by the Italian Space Agency (co-financed by scientific team);
- Main goal of the project is the development of a prototypal system to support the user and the scientific expert in the decisional process for the management of the seismic hazard;
- Reference user of the SISMA project is the civil protection of Friuli-Venezia-Giulia.
- The Project follows ECSS Standard, developed and maintained mainly for space projects by ESA.

Phases of the Project

- SISMA is organized in three subsequent versions, incrementally adding new processors.
- For every version:
  - test session after the development
  - preoperational demonstration phase (fixed lenght)
- During the preoperational demonstration phase the products are generated and evaluated by the relevant scientific responsibles
- Review with user at the end of preoperational demonstration phase
- Actually we are in the developing phase of the V3 and in the demostration phase of the V2
- The version V1 has been accepted last december

Project Team

Italian Space Agency

Civil Protection of Friuli Venezia Giulia
User

Project Team

Galileian Plus
Prime Contractor

Università di Milano
Principal Investigator

Università di Trieste
Co-investigator

Politecnico di Milano
Co-investigator

Teleinformatica e Sistemi
Industrial Partner

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Dipartimento di Geoscienze

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Galileian Plus

- Prime Contractor, responsible of the project management activities and the development/integration of the system;
- Interface to the Italian Space Agency for the programmatic, technical and contractual aspects;
- Main interface to the Civil Protection of Friuli Venezia Giulia;
- Activities:
  - Integration and test of the system;
  - Development and integration of the user interface, the data and products archive and of the common SW infrastructure;
  - Responsible of GNSS data processing both for permanent stations and local surveys.

Università di Milano

- Principal Investigator, responsible of scientific activities;
- Interface to the Italian Space Agency and the User for scientific aspects;
- Responsable for training and dissimination
- Activities:
  - Development of GFM and SAR computation engines;
  - Integration of the SAR and GNSS data into GFM.

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- Co-investigator, responsible of the activities concerning seismological aspects;
- Responsable for preoperational demostration phase.
- Activities :
  - identification of the alerted areas on a regional scale,
  - definition of the morphostructural zonation and identification of highly seismogenetics nodes;
  - definition of the ground shaking through the computation of complete synthetic seismograms both for regional and local scale.
  - Event scenarios

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Politecnico di Milano

- Co-investigator, responsible of the activities concerning geodetics aspects;
- Responsabile for comunication and dissemination website
- Activities:
  - Computation of surface deformation by GNSS data analysis (both on a regional scale and on a local scale);
  - Organization and managing of GNSS data surveys on several active faults of the three test areas;
  - Development of algorithms for the bayesian integration.

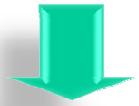
TeS Teleinformatica e Sistemi

- Activities:
  - Definition of SAR data and products archive;
  - Definition and development of interfaces for the management of the SAR archive.

SISMA Deterministic Approach

– SISMA new approach towards the understanding of earthquake generation process builds over three major concepts:

1) The availability of new generation of SAR satellites and of GNSS deformation data



2) The availability of integrated geophysical, geodetic and seismological information to a better knowledge of stress within active faults

3) The using in conjunction with the probabilistic approach, overcoming the shortcomings of the latter approach.

Multiscale analysis

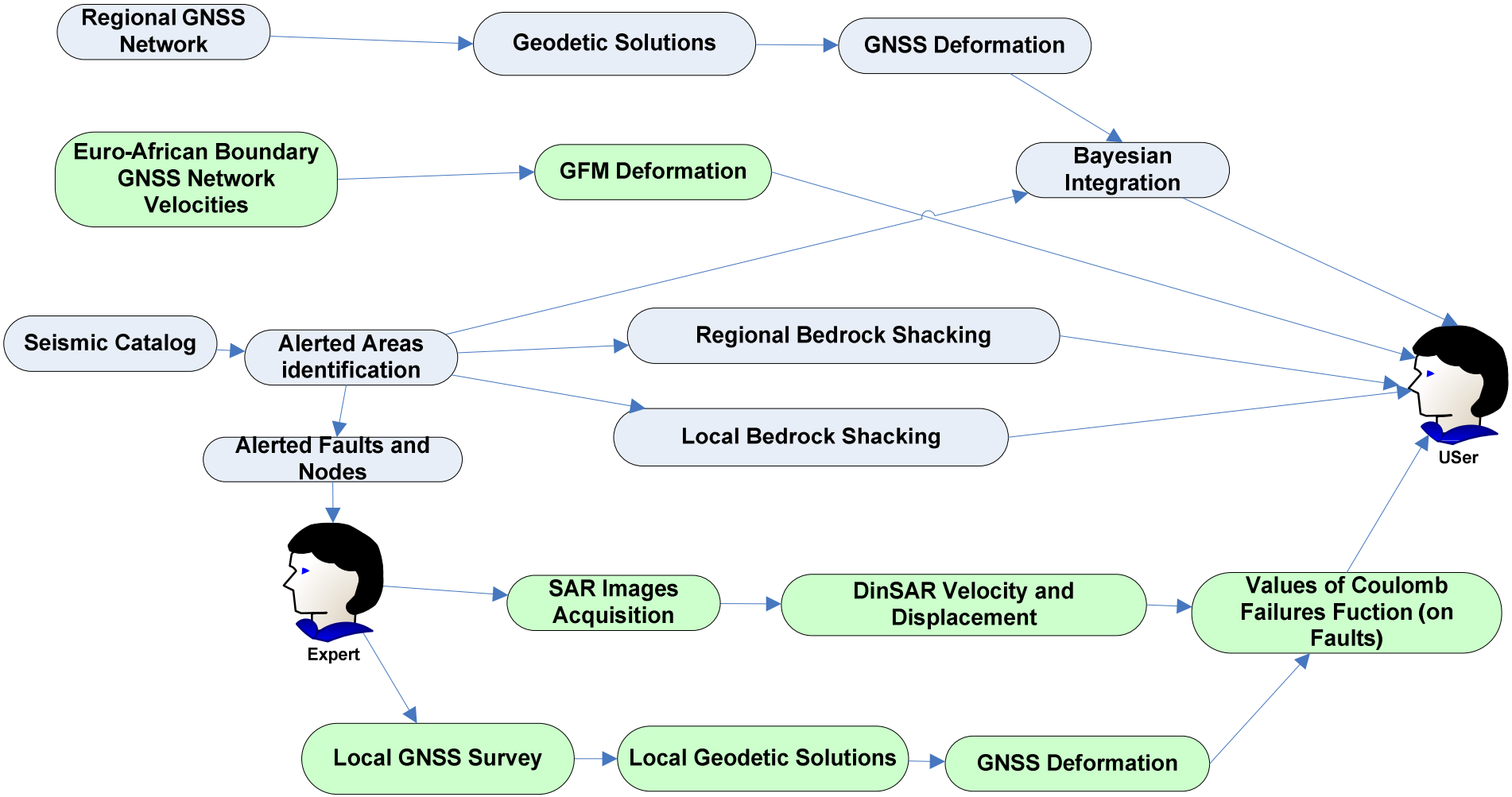
- GNSS Network Deformation Analysis
- GFM Deformation Analysis
- Seismic Alerted areas identification
- Integration of Seismic and Geodetic Results
- Bedrock Shaking

Regional Scale

Local Scale

- Alerted Nodes and Faults Identification
- Periodic GNSS Survey on Alerted Faults
- Acquisition of SAR Image on Alerted Areas
- DInSAR and GNSS Deformation Analysis
- GFIM Analysis (Coulomb Failure Function Values)
- Event Scenarios
- Bedrock Shaking

Basic Data Flow Diagram



Selected Test Areas

- Friuli-Venezia Giulia;
- Umbria-Marche;
- Pollino (Calabria).

These active seismogenetic zones are embedded within the diffuse plate boundary between Africa and Eurasia.

Selected Test Area: Reasons for Choice

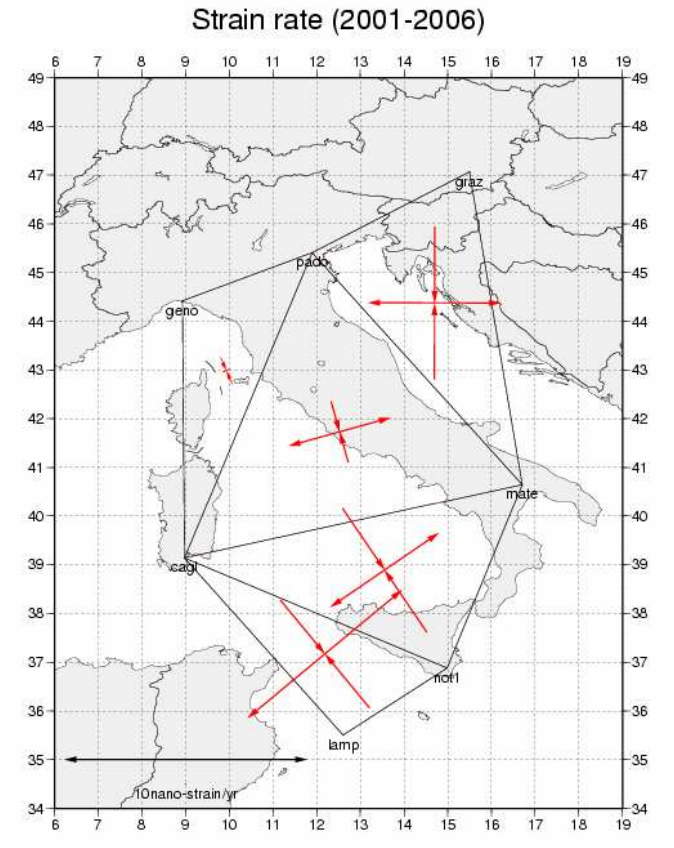
- Friuli-Venezia Giulia → Inter-seismic phase

- Pollino (Calabria) → pre-seismic phase
- monitoring of surface deformations, which is a possible indicator of stress built up on faults;

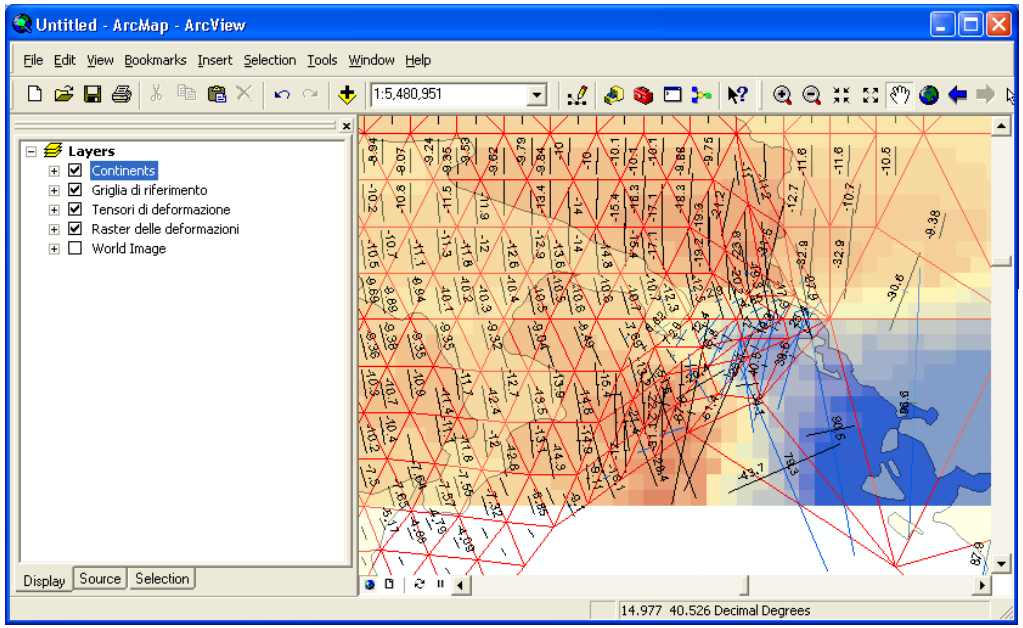
- Umbria-Marche → Post-seismic phase
- monitoring of possible phenomena that may affect the stress.

SISMA Products

Regional GNSS Deformation



GFM Deformation



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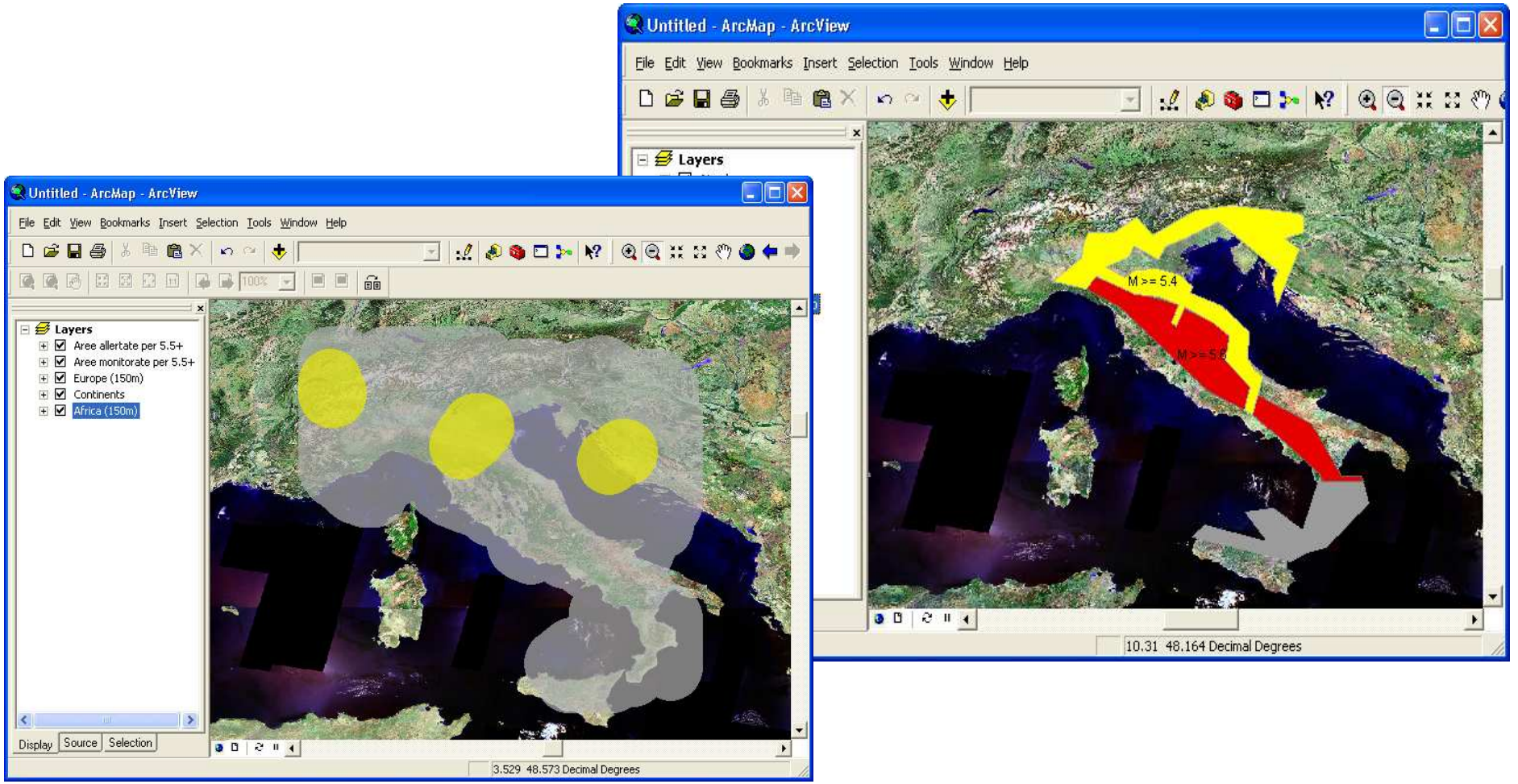
M8S and CN Alerted Areas



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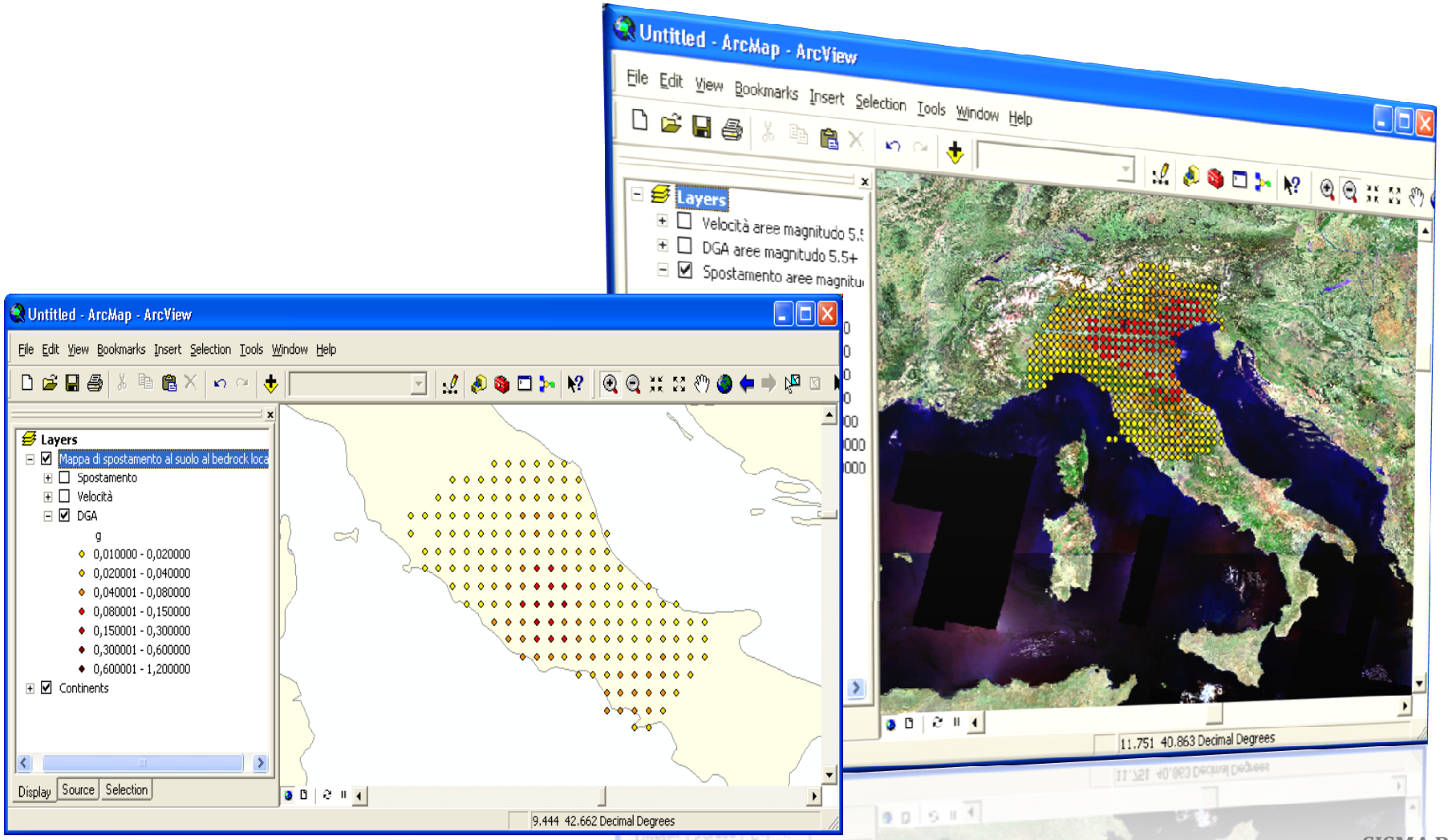
Local and Regional Bedrock Ground Shaking



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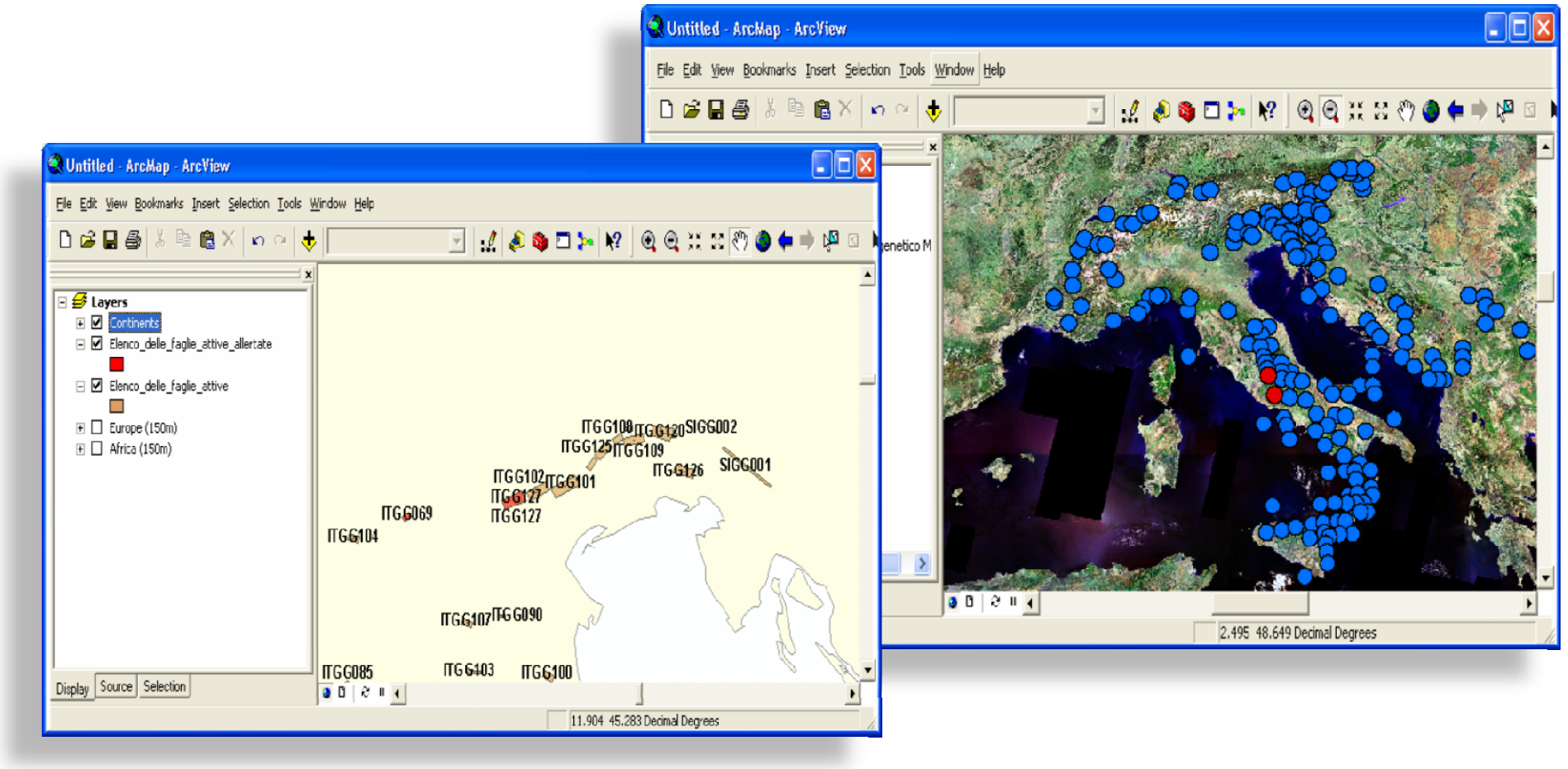
Alerted Seismogenetic Nodes and Faults



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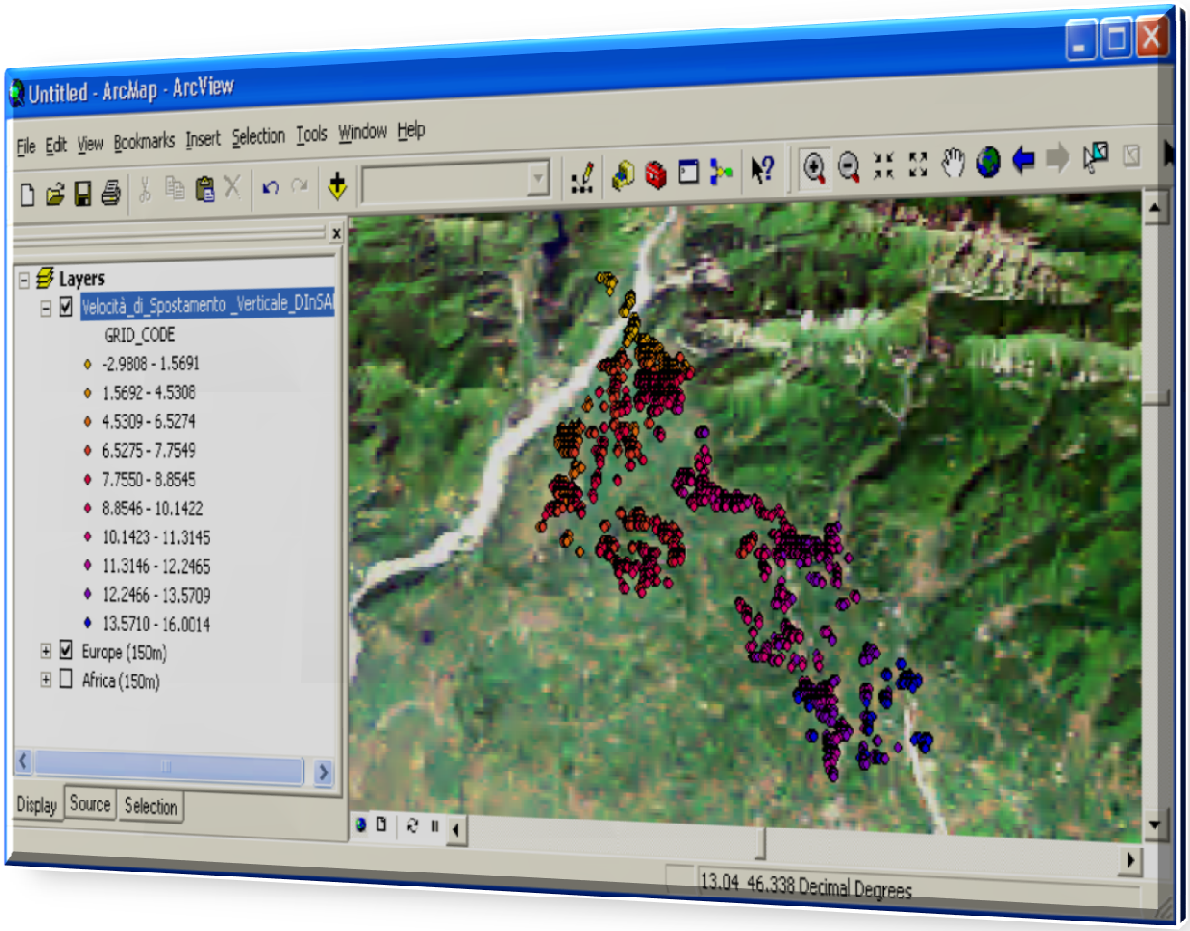
DInSAR Displacements



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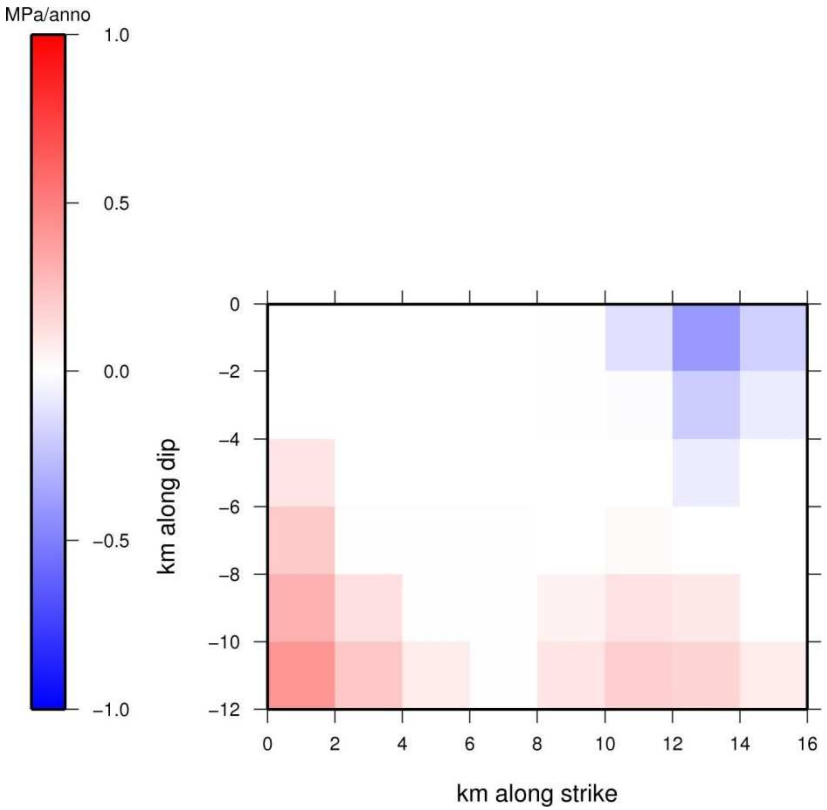
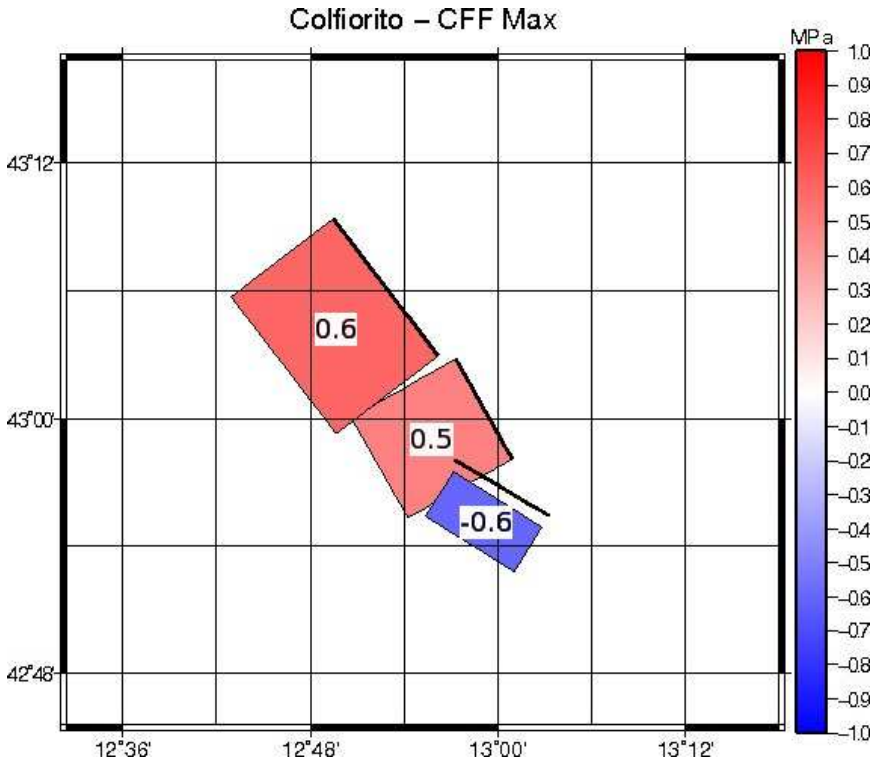
Coulomb Failure Function





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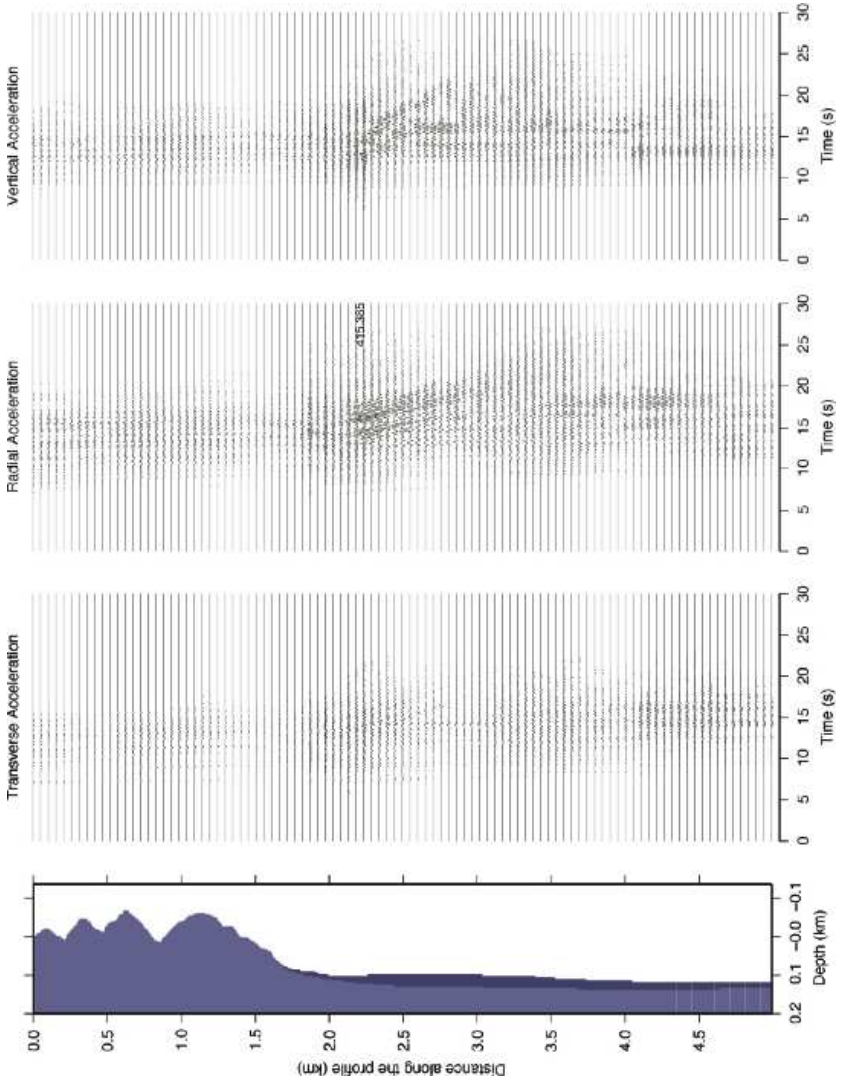
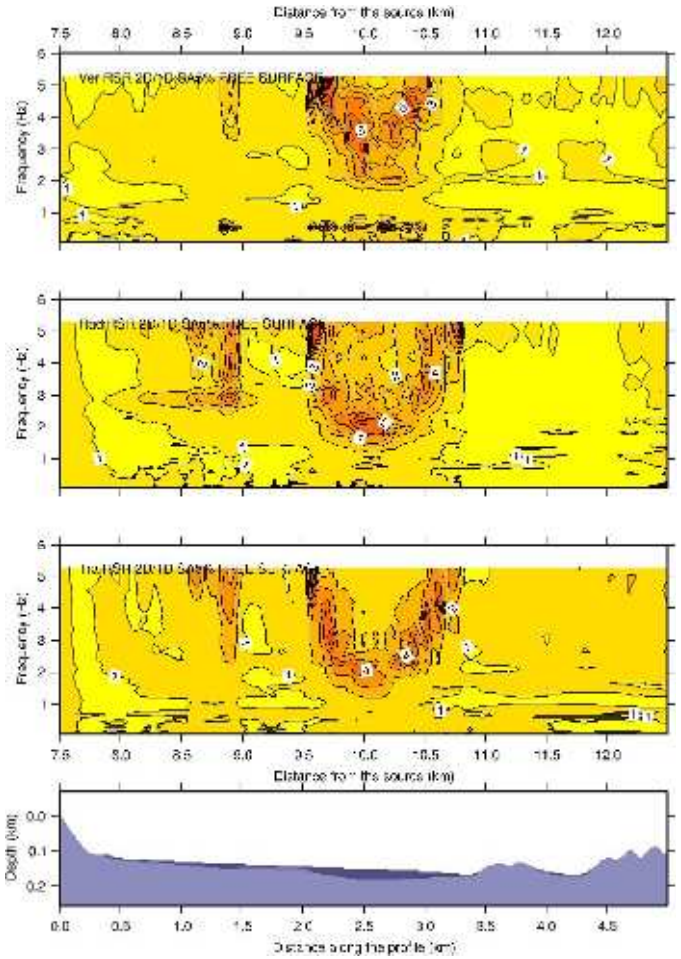
Synthetic seismograms



Spectra and spectral amplifications



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SISMA System Architecture

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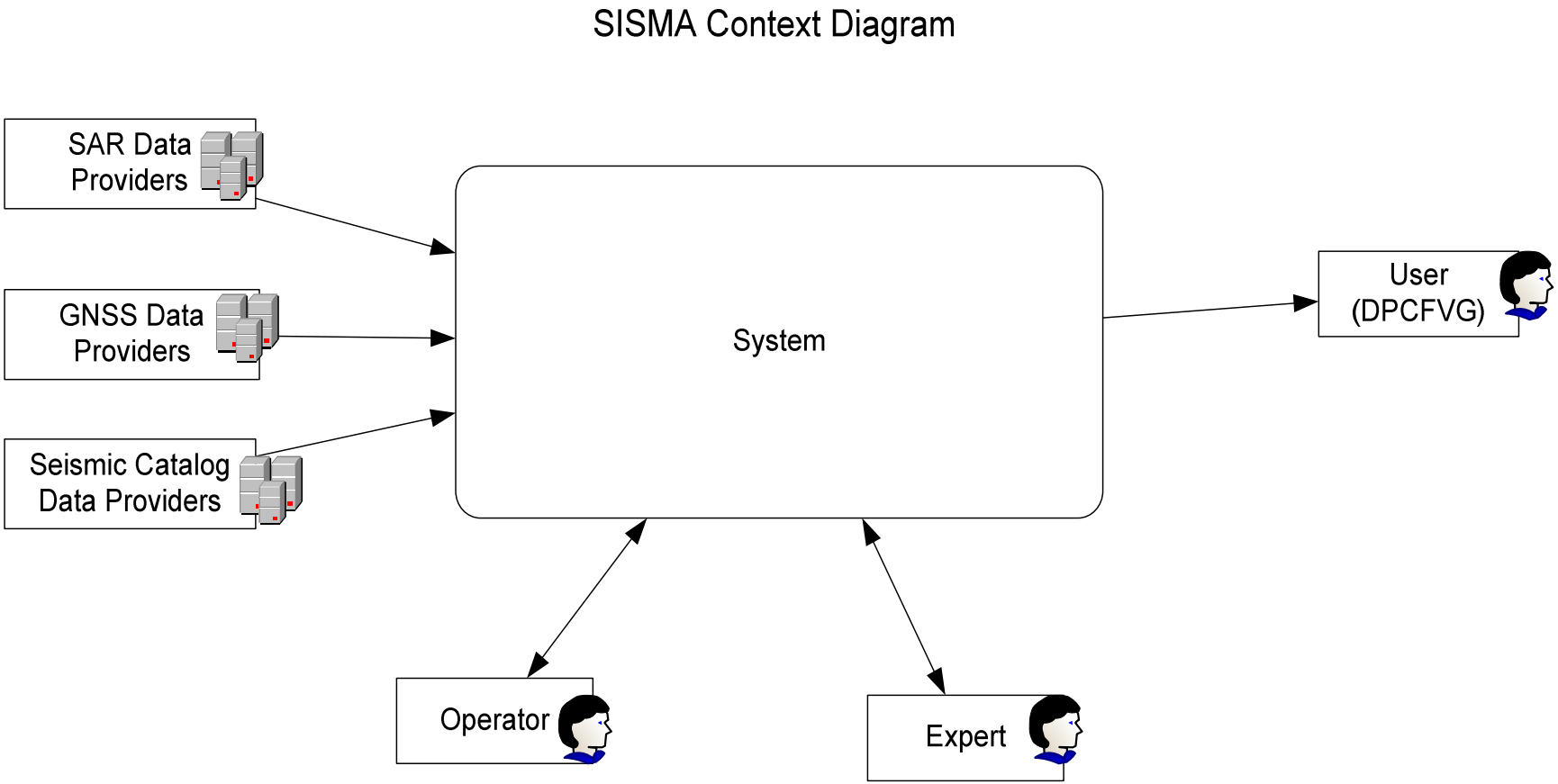
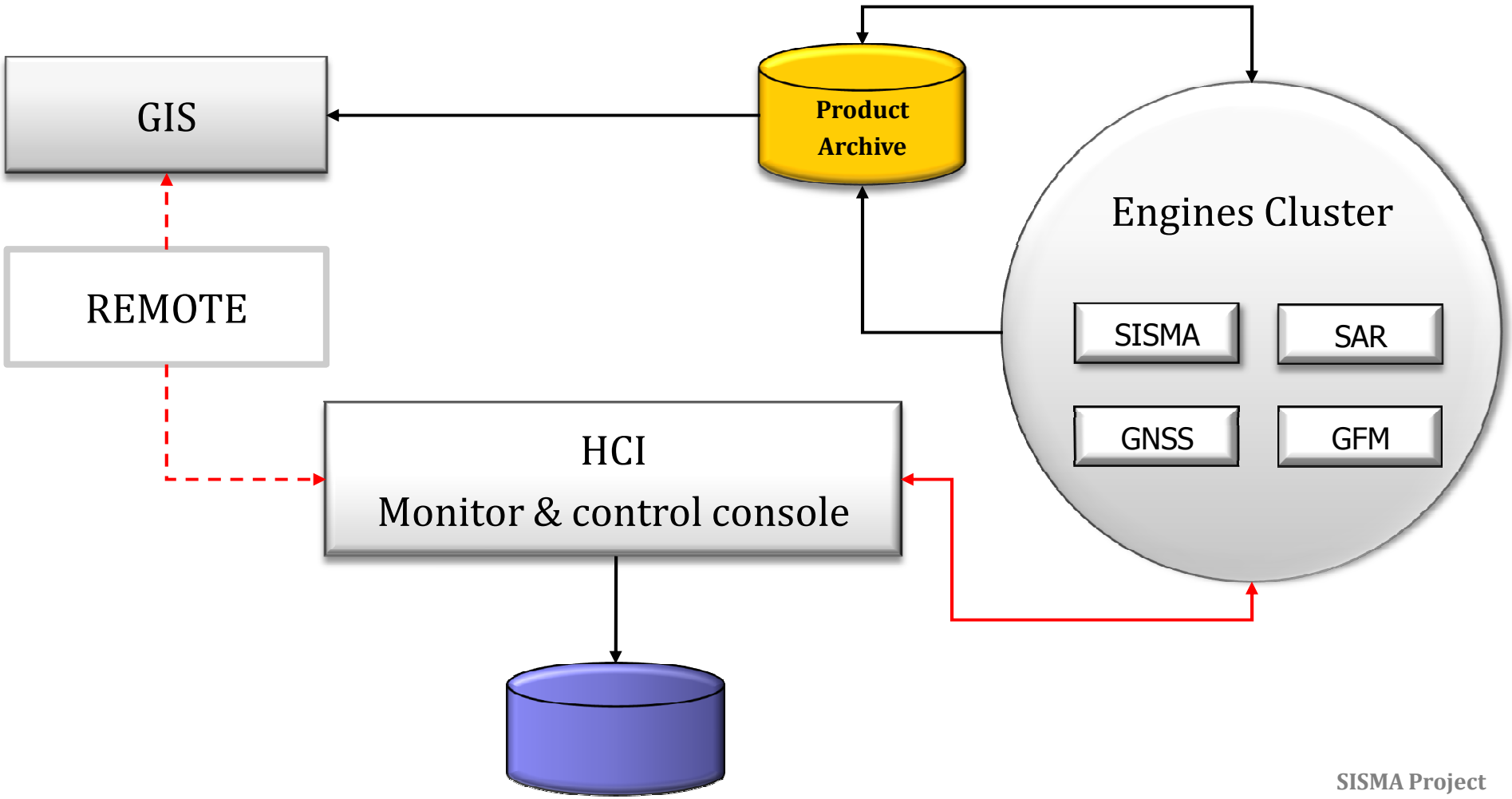
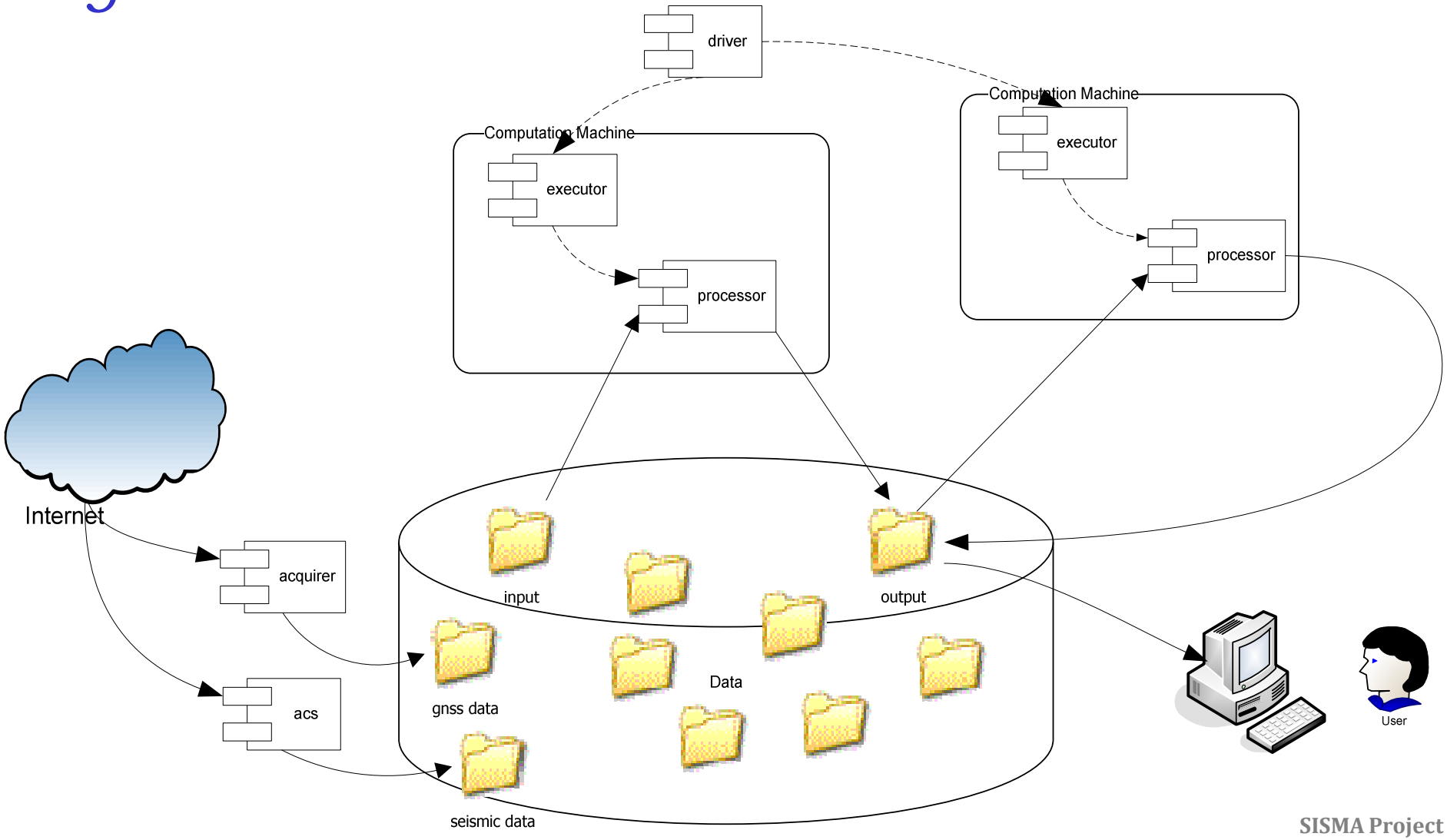
Overview of the System: Context diagram



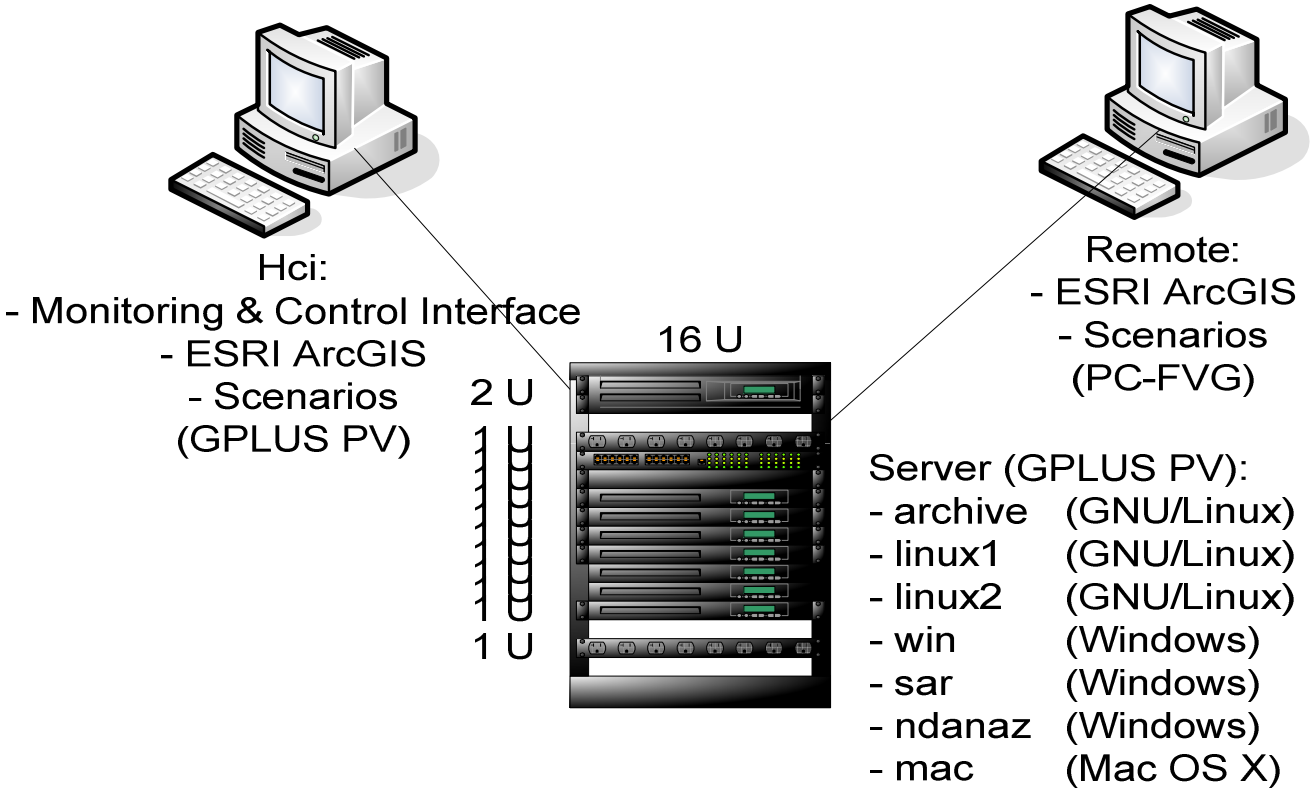
Overview of the System: Main functions



System Data Flow



Hardware and deployment



Functionalities

- Process scheduling
- Monitoring & Control
- Automatic Data acquisition
- Automatic conversion to ESRI shape-file

Process Scheduling

Two types of activation:

→ Time Driven:

A task activated on a given time

Examples:

Annual: Regional GNSS Deformation

Bimestrial: Identification of CN Alert

Half-yearly: Identification of M8S Alert

→ Data Driven:

A task that activated when a specific data is available

Examples: The calculation of regional bedrock ground shaking is done whenever a CN or M8S alerted area product is generated.

Monitoring and Control

Monitoring of the system resources:

- Free Memory
- Network availability

Monitoring of past and running processes execution:

- Start/stop time processes
- Traceability of the input of each process
- Listing of processes logs

Control of processes:

- Start of a new process
- Stop of a running process

Automatic conversion of products to ESRI Shapefile

All the maps must be available to the user in a GIS (in our case ESRI ArcGIS).

Scientific program → Proprietary format

Automatic conversion of output files (proprietary formats) to the standard format (ESRI Shapefile)

Automatic Data Acquisition

RINEX files

Earth Orientation Parameters

Precise Ephemeris

Seismic Catalog

Technologies

Problems:

- Many scientific programs from different partners
- Different programming languages:
  - Fortran, C, C++, Perl and Bash
- Different operating systems:
  - Windows, Mac OS X, GNU/Linux

Solution:

- Java → platform independent
- RMI → distribuited architecture

Conclusions

The challenge of SISMA is to integrate multiple disciplines such as geodesy, geophysics and seismology into an unique system providing an information that can be used for seismic hazard assessment;

Many technological and scientific challenges have to be faced, from the standardization of the I/O data to the integration of the results on a local scale;

SISMA is a step forward in the understanding of the earthquake generation process.