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GROUND - BASE MONITORING SYSTEM FOR THE NATURAL HAZARDS ASSESMENT DUE TO LANDSLIDE ACTIVITY

D. A. STANICA, D. STANICA and C. DIACOPOLOS
Institute of Geodynamics of the Romanian Academy
Bucharest – Romania, E-mail: armand@geodin.ro

OUTLINE:

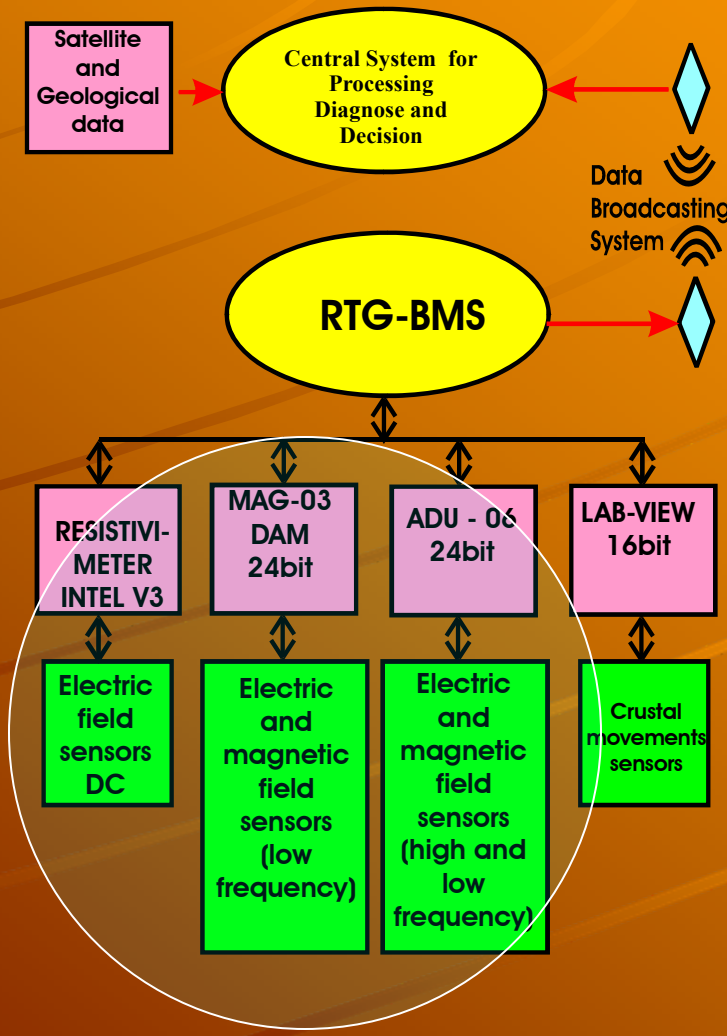
Landslides related to seismic events

1. variables, indices and indicators for landslides;
2. implementation and continuous improvement of the real-time ground base monitoring system depending on the landslide test sites conditions;
3. innovation in integrated geo-sensors structure for network conditions;
4. real time signals processing for pattern recognition in “pre disaster” and “at disaster” circumstances;
5. assessment and quantification of the geodynamic precursory parameters related to the landslide phenomena;
6. provision of early-warning against the risk arising from landslide process.

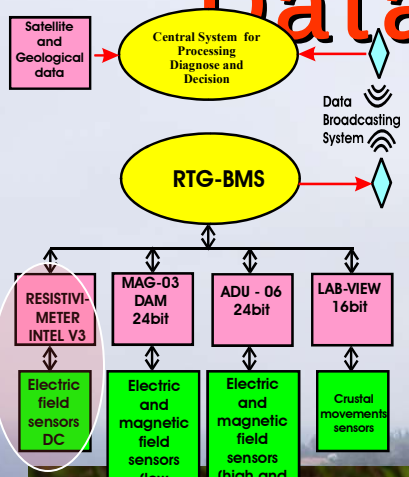
Variables, indices and indicators for Landslides

Variables	Indices	Indicators
•Geophysical: electromagnetic (perpendicular resistivity - $\rho_{\perp}$, parallel resistivity - $\rho_{\parallel}$, skew, strike, the hodograph of the impedance tensor), DC-electric (apparent resistivity) and geomagnetic (Bzn); •Geological and geotechnical: lithological and structural features, tectonics, position of morphological characteristics, terrain gradient, internal friction angle, bulk density, plastic and liquid limit, particle size distribution, soil pH, etc.; •Hydro geological: groundwater levels characteristics, fluctuation and impact on the slope stability; •Vegetation: impact of vegetation on slope stability, timber harvest impact, etc. •Climate: temperature, frequency and intensity of the rains and storms short and intense events;	•Time series distribution of the geophysical, geological, geotechnical and climate parameters; •Statistical distribution of historical events; •Arial and frequency-size distribution of landslides; •Frequency of earthquakes and tectonic processes associated (active faults); •Identification of regularities or irregularities of events which might facilitate prediction; •Changes in landscape of the affected areas.	•Anomalous behavior of the geophysical, geological, geotechnical and climate parameters; •Real time quantification and hierarchy of all the variables in order to evaluate the risk factors and vulnerability; •Population, socio-economic and natural environment exposed to the landslides; •Loss of human and socio-economic values exposed to the risk.

Real-time ground base monitoring system



Data acquisition module for GeoElectric field



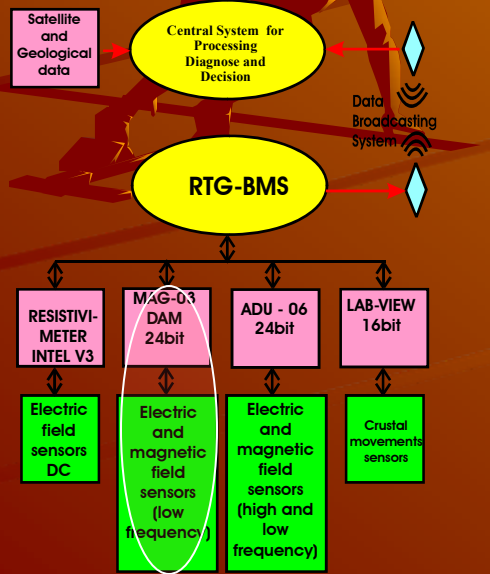
Fieldwork Configuration

Resistivimeter (INTEL V3, Romania) is compact and self-contained thanks to an integrated receiver and transmitter, with internal memory of 64 K, sampling rate of 0.2s, output power up to 200mA, communication trough serial interface enhanced by utility software for Windows

Data acquisition module for continuous monitoring of the Geomagnetic field

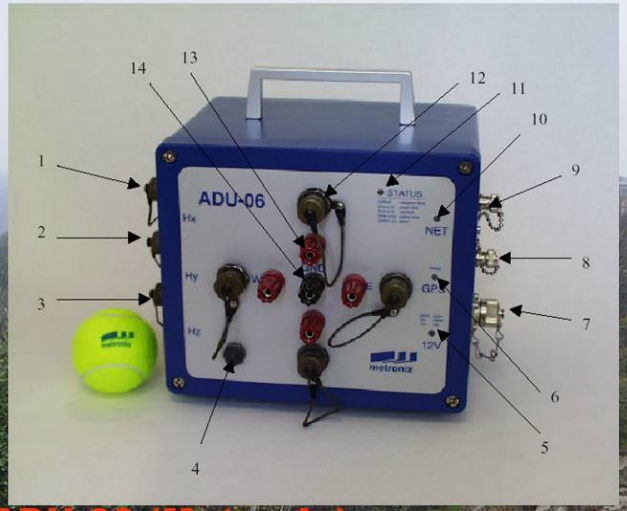
MAG-03DAM acquisition module

6 channel, 24 bit resolution, sampling rate programmable, internal and external battery of 12 V , data storage on laptop HD;



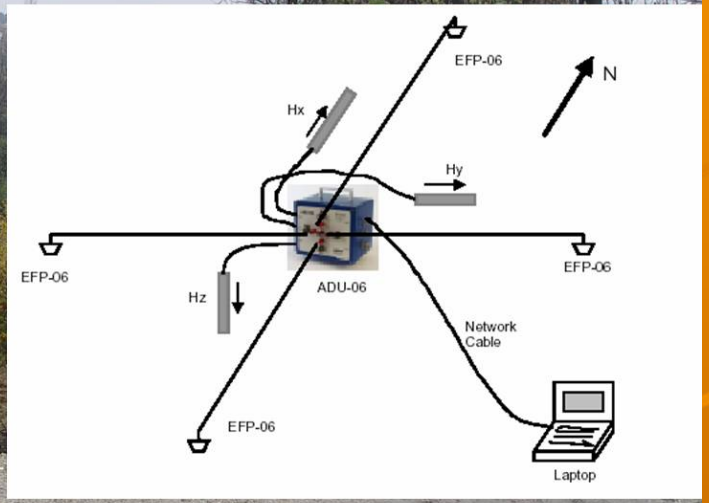
Geomagnetic System Configuration

Data acquisition module for electromagnetic (EM) field

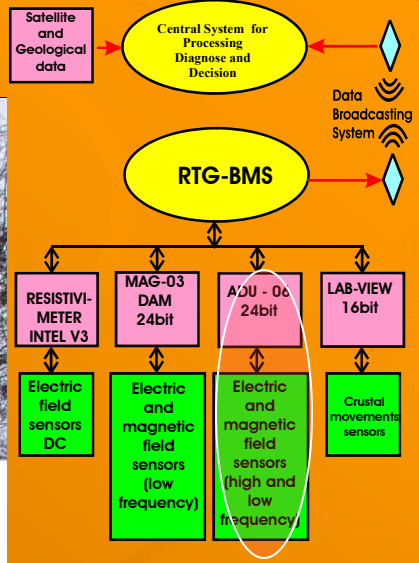


ADU-06 (Metronix)

5 channel including GPS-clock; frequency range DC to 20 kHz; 24 bit resolution and data storage on the internal 440 MB flash disk, 2 A/D converters per channel, GPS antenna, two battery of 12 V ;



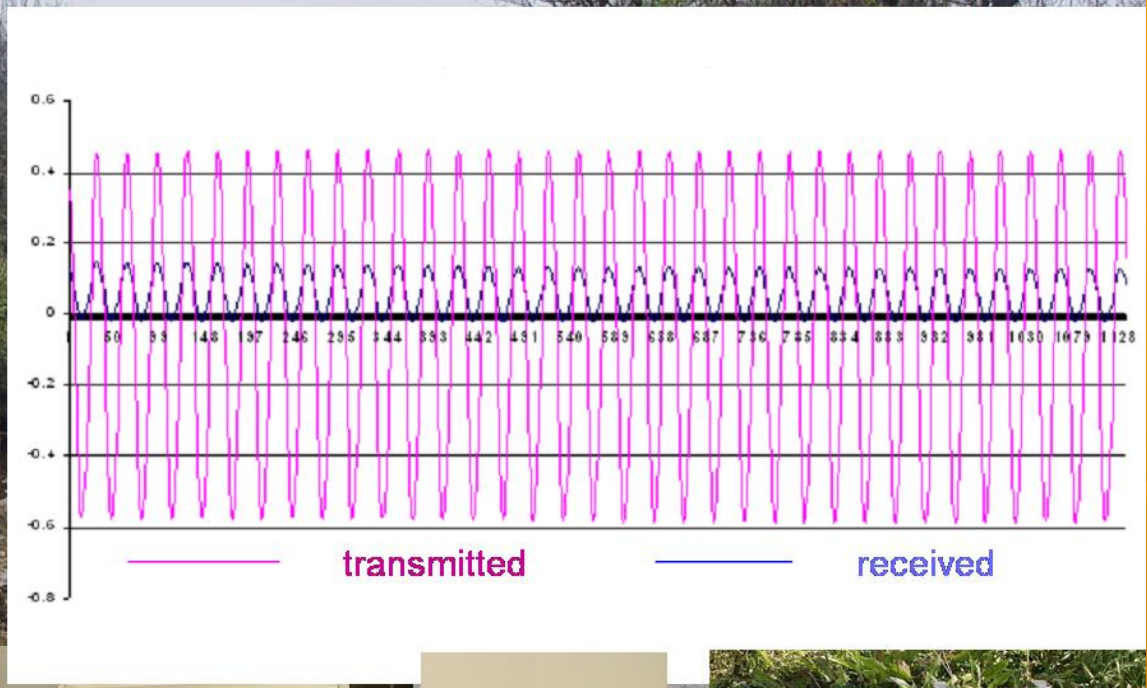
EM System configuration
EFP06- electric sensor
Hx, Hy, Hz – magnetic sensors



GeoElectric Sensors

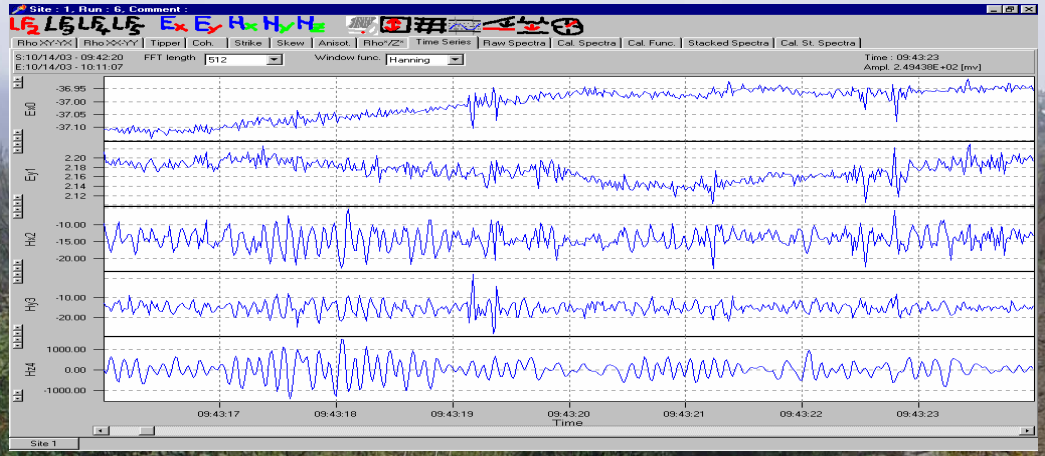
Laboratory studies for :

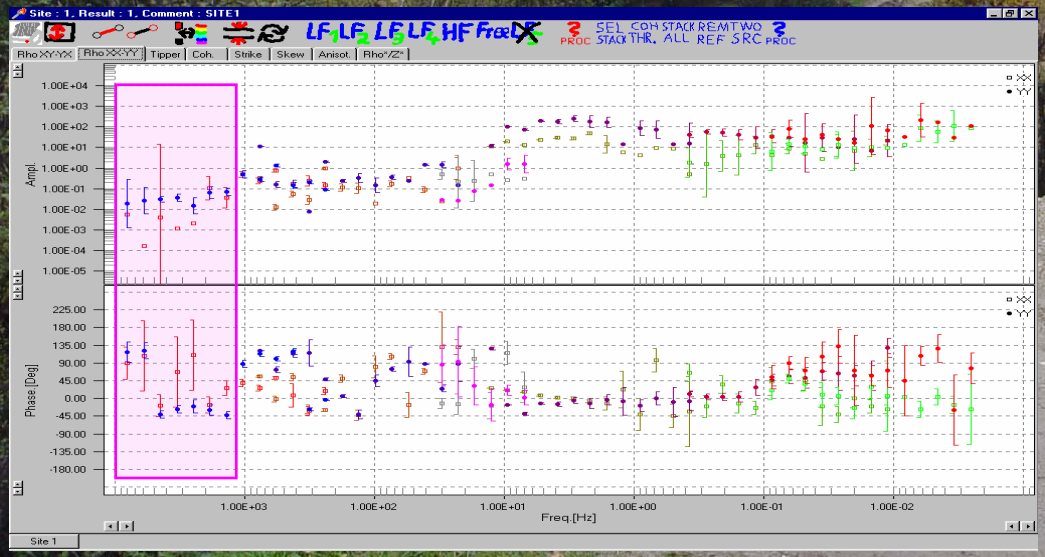
- optimisation and time stability of the specific sensors structure
- Two types : Pb-PbCl2 and Cu-CuSO4, both having solution of kaolin gel, very stabile in time (IG-RA, Romania)



Software (MAPROS Packages)

The following basic tasks are performed by MAPROS:



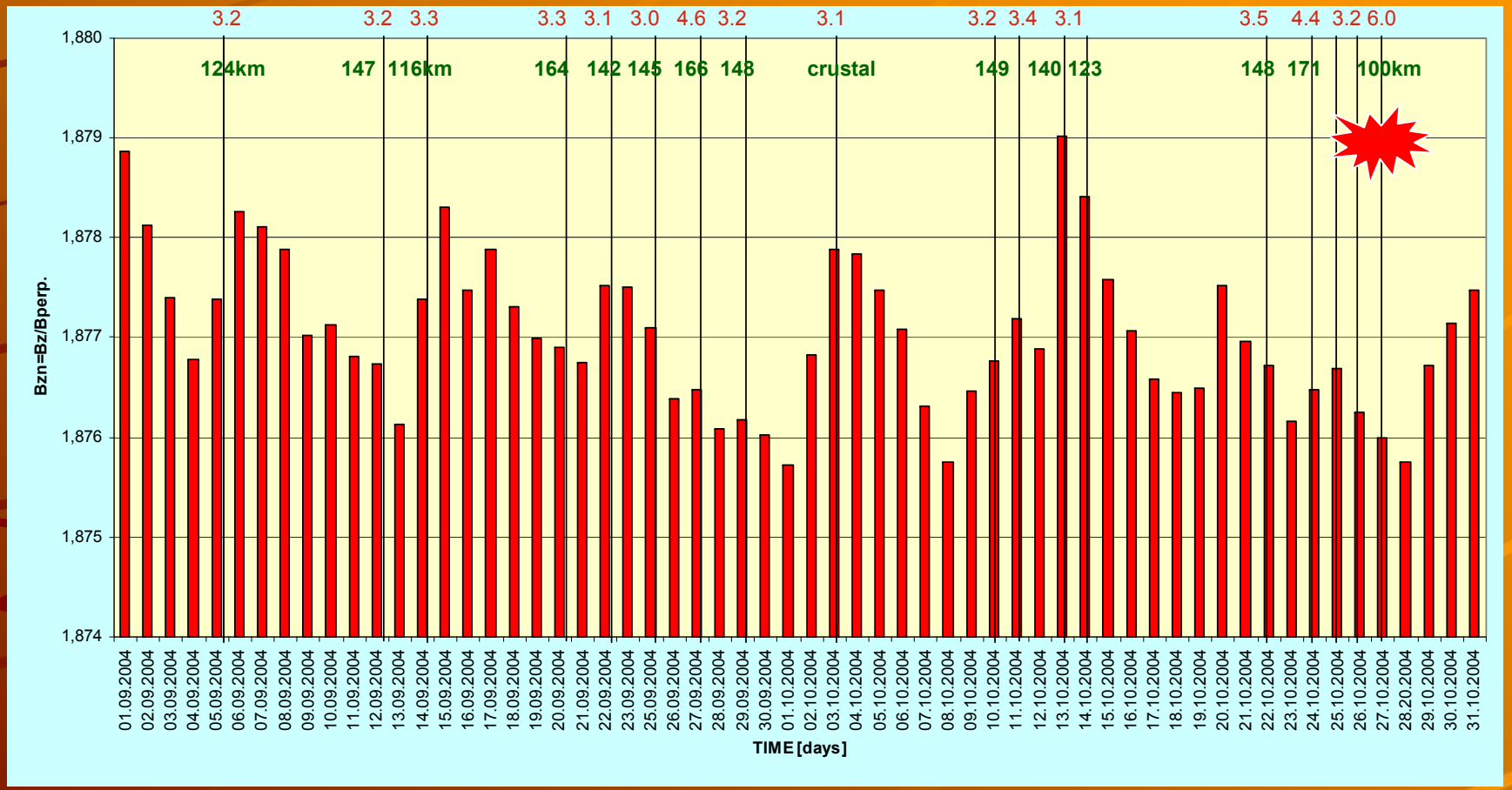


Real time data acquisition and processing ;

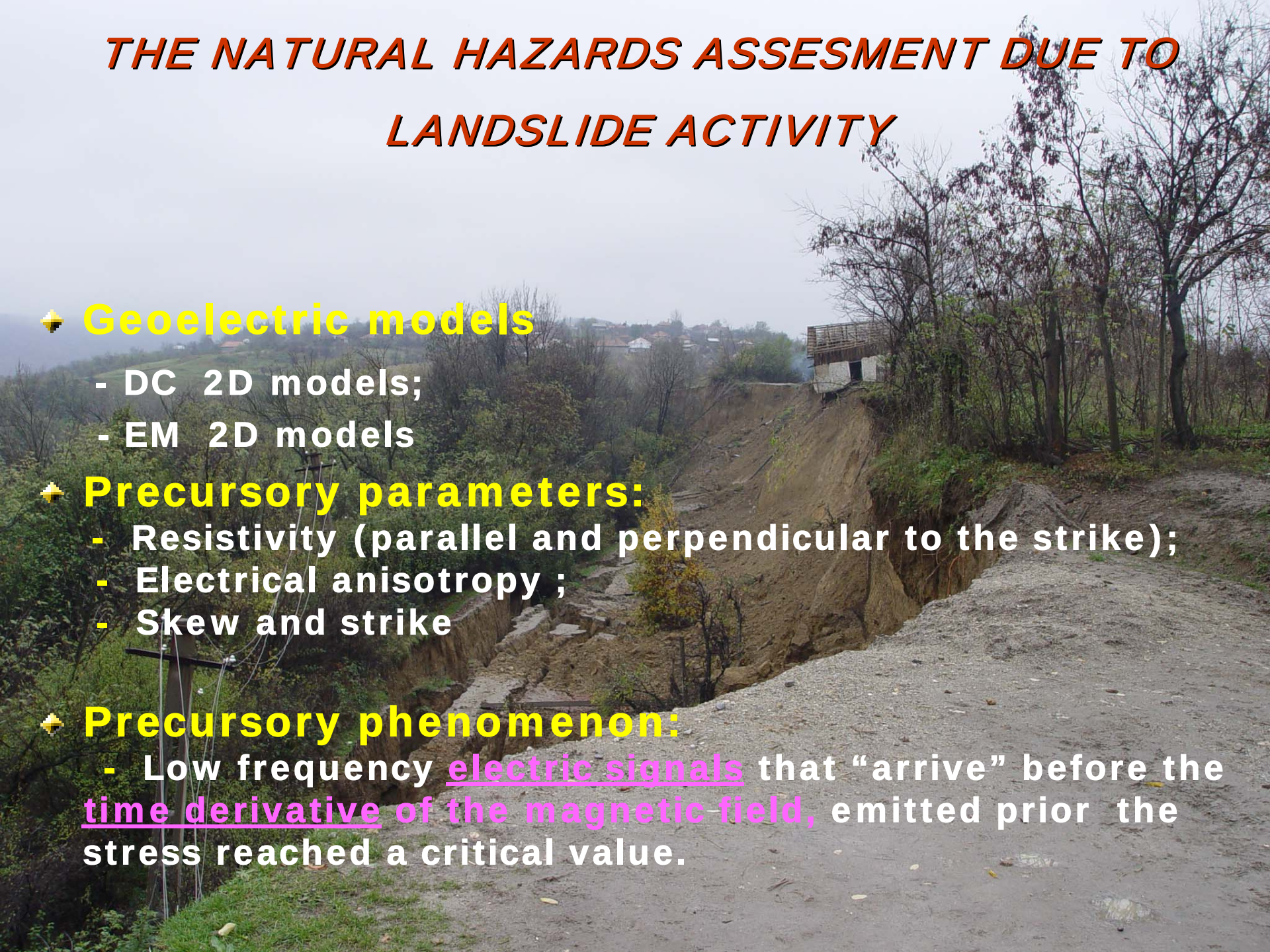
Robust estimation of the transfer functions;

Real time display of time series and all important EM-parameters ($\rho_{\parallel}$ $\rho_{\perp}$, anisotropy, strike, skew, etc.);

Bzn disturbances linked to the seismic events



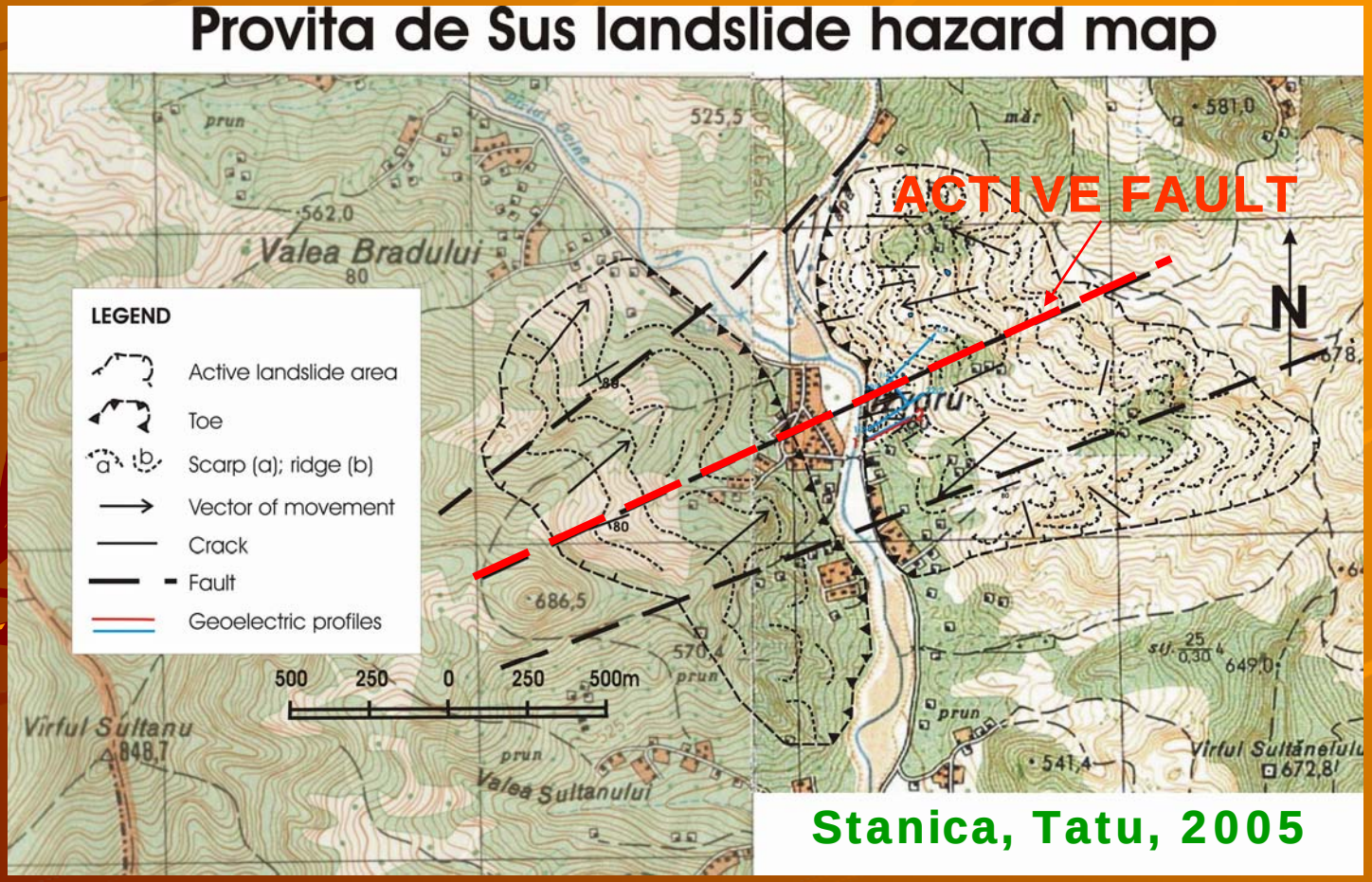
THE NATURAL HAZARDS ASSESMENT DUE TO LANDSLIDE ACTIVITY



- **Geoelectric models**
  - DC 2D models;
  - EM 2D models
- **Precursory parameters:**
  - Resistivity (parallel and perpendicular to the strike);
  - Electrical anisotropy ;
  - Skew and strike
- **Precursory phenomenon:**
  - Low frequency electric signals that “arrive” before the time derivative of the magnetic field, emitted prior the stress reached a critical value.

PROVITA VALLEY

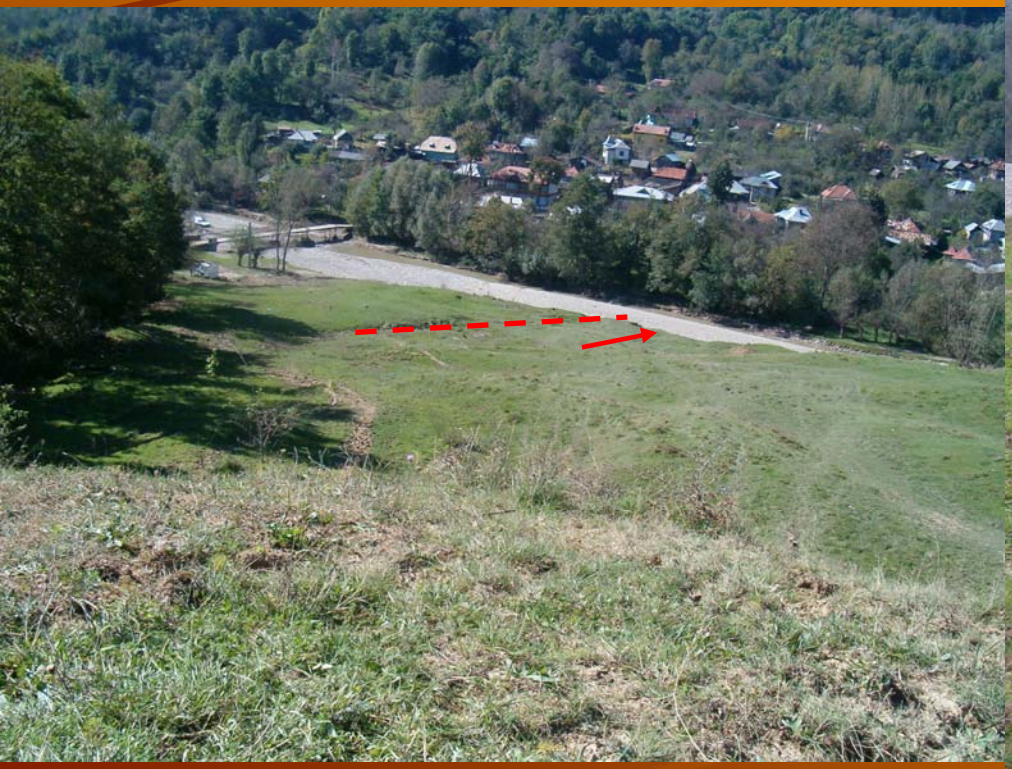
test area for monitoring and diagnosis of typical landslides parameters



PROVITA DE SUS

- test site -

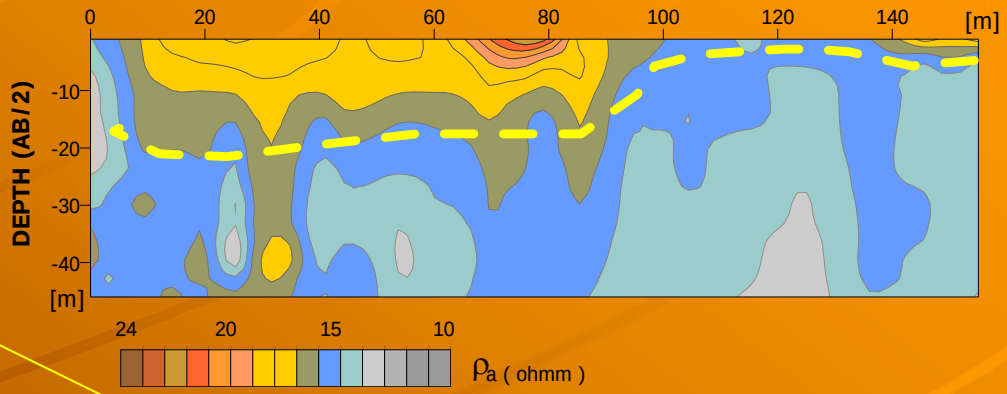
for monitoring of the typical landslides parameters



2D specific geodynamic models

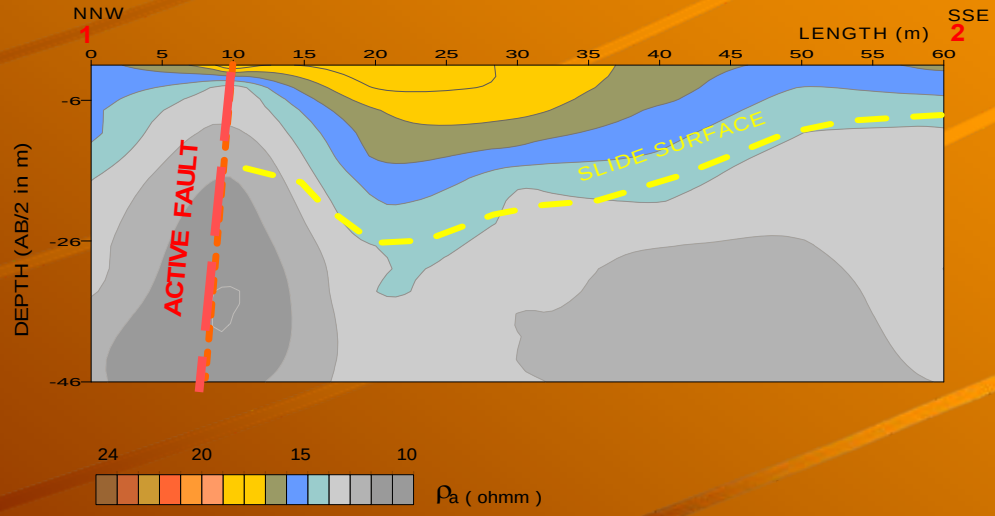
GEOELECTRICAL (RESISTIVITY) CROSS-SECTION

Profile 1 - Provita Valley



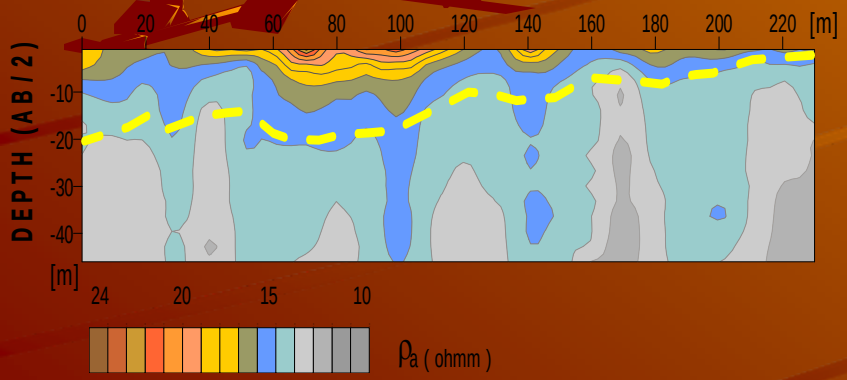
Geoelectrical cross-section

Profile 4 - Provita Valley

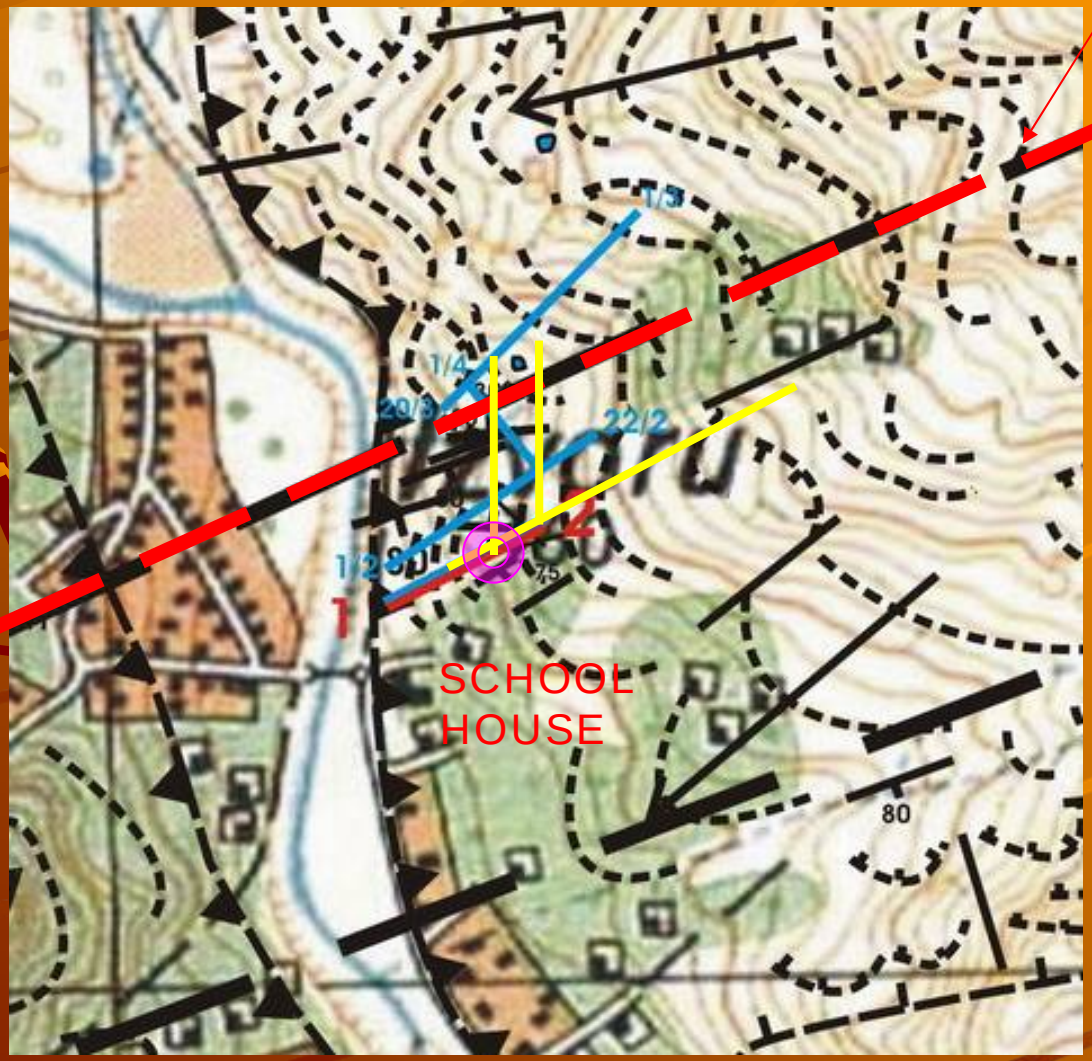


Geoelectrical (resistivity) cross-section

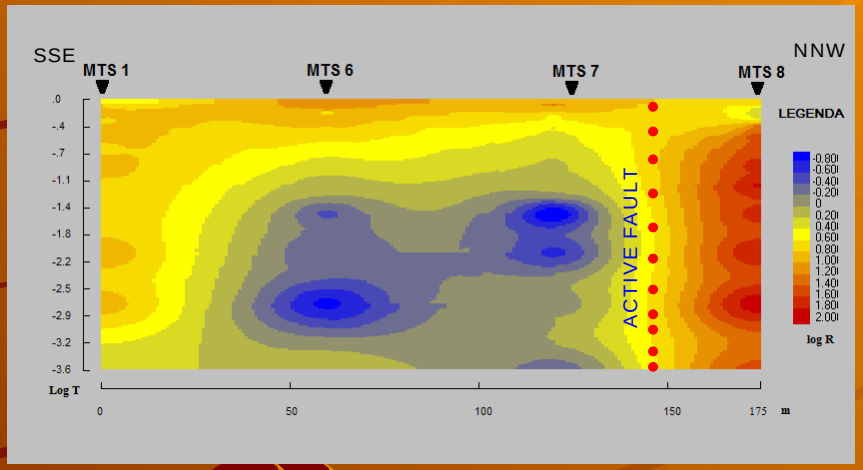
Profile 2 - Provita Valley

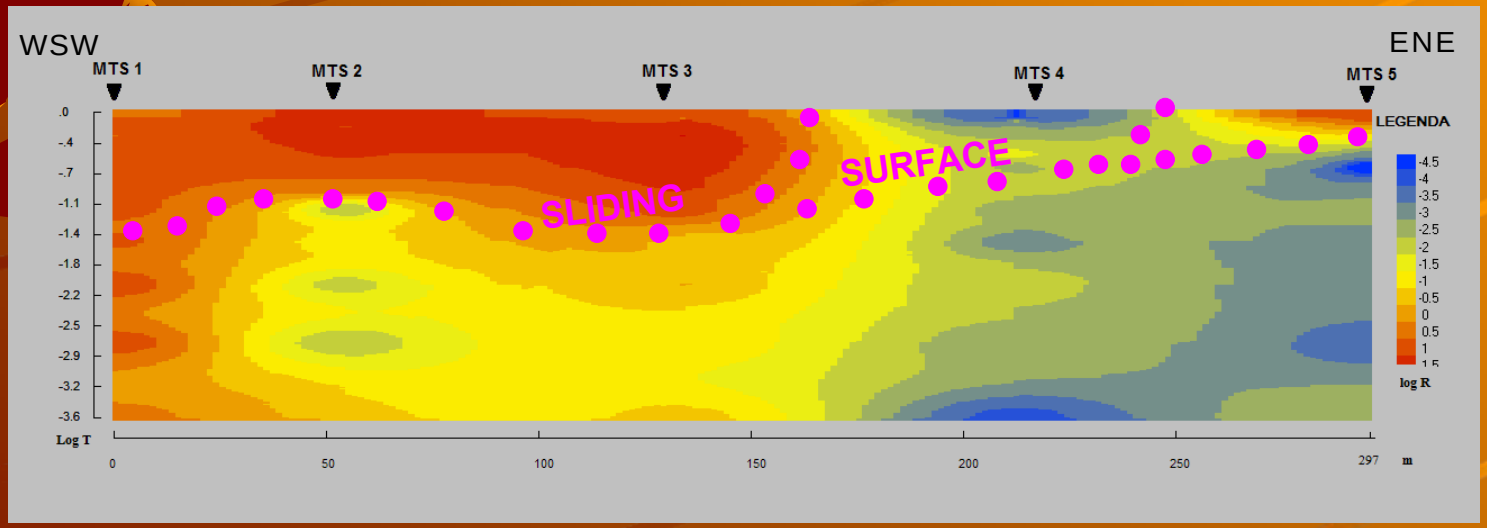


PROVITA DE SUS
- test site -
for monitoring of the typical landslides parameters



2D- tomographic images ($\rho_{\perp}$ B-polarized MODE)





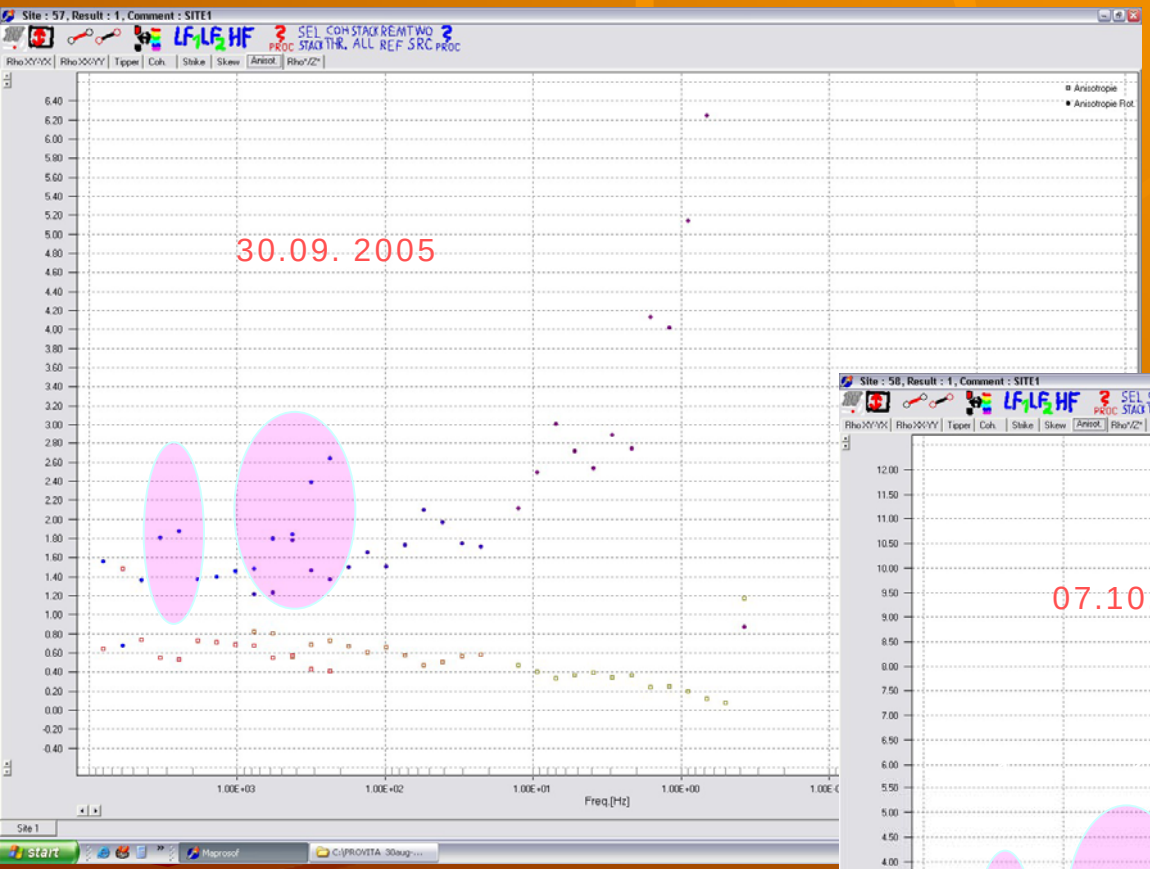
PROVITA DE SUS

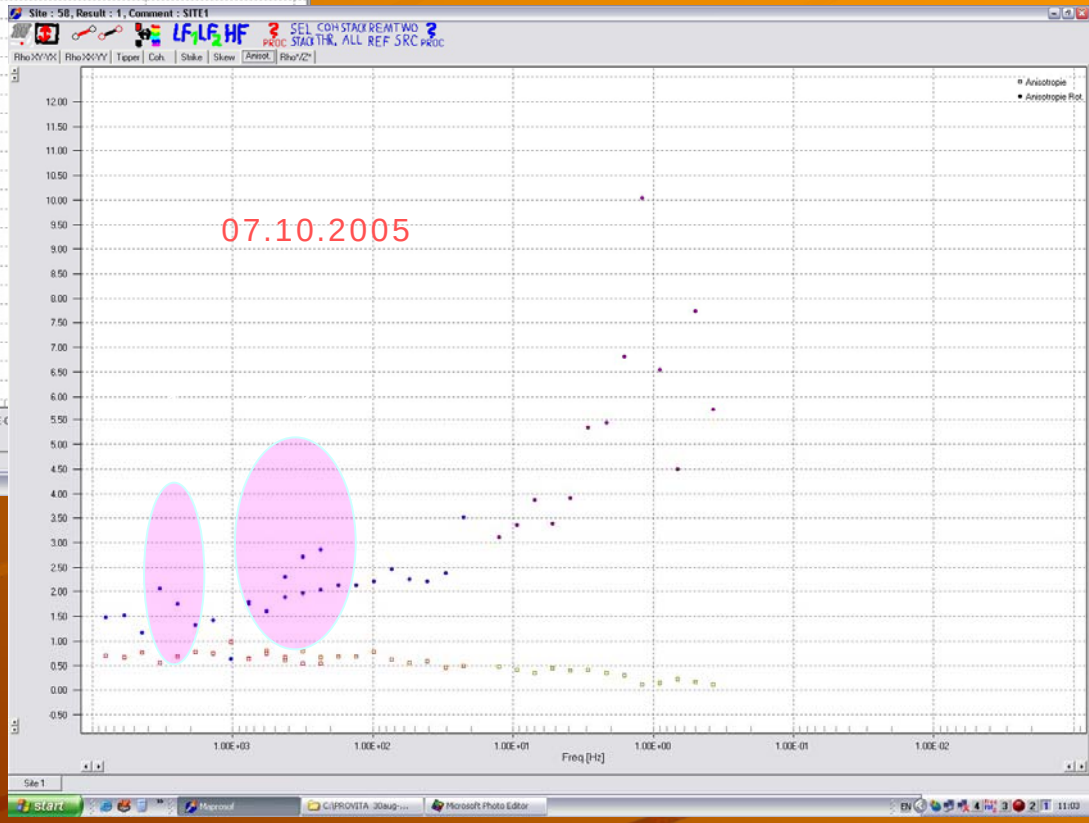
test site

ELECTRICAL ANIZOTROPY

$EA = |\rho_{xy}/\rho_{yx}|$ (normal field)

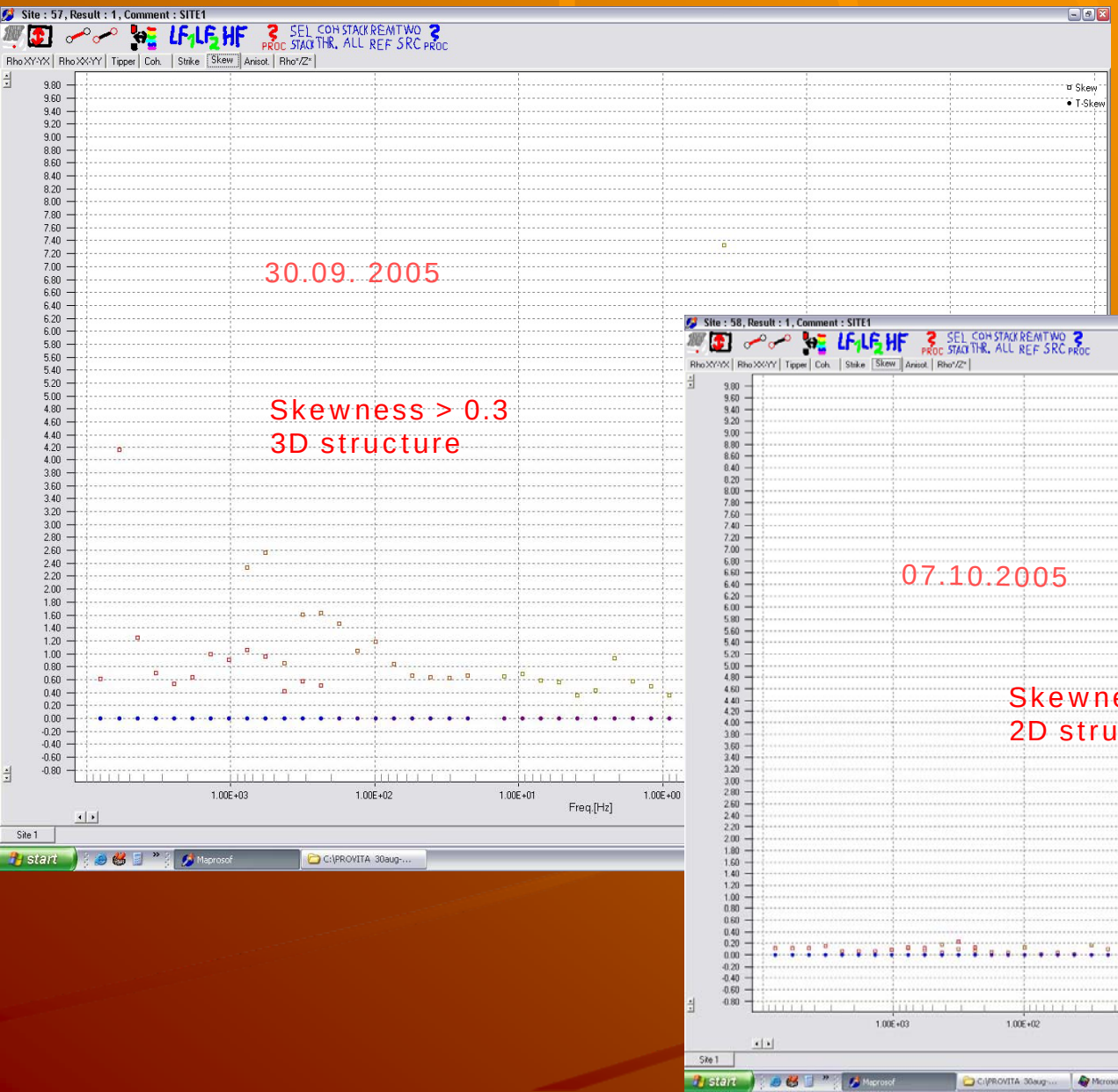
$EA = |\rho_{\perp}/\rho_{\parallel}|$ (rotated field)



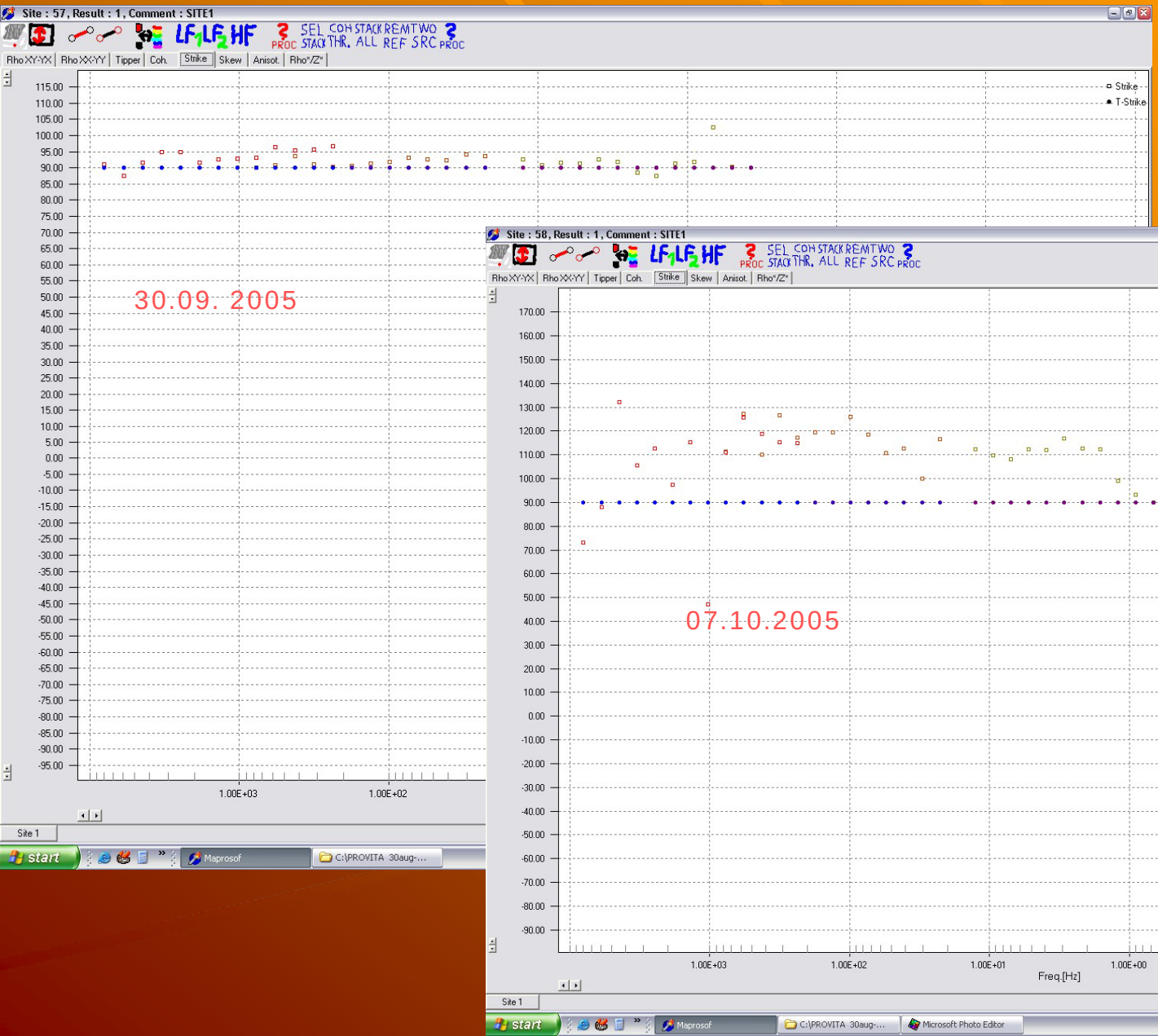


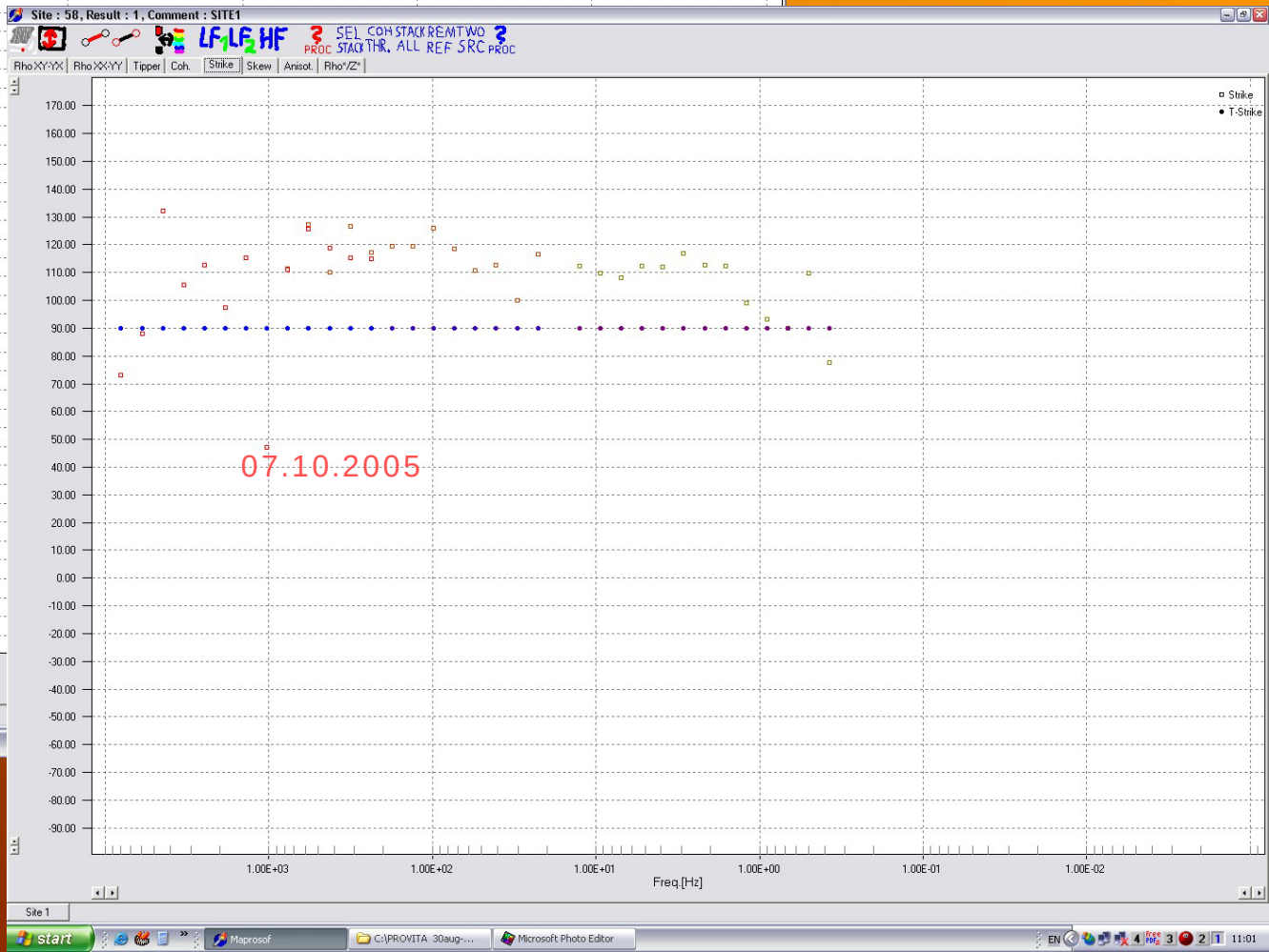
Skewness Parameter

$$\text{skewness} = \frac{\left|\left|Zxx + Zyy\right|\right|}{\left|\left|Zxy - Zyx\right|\right|}$$



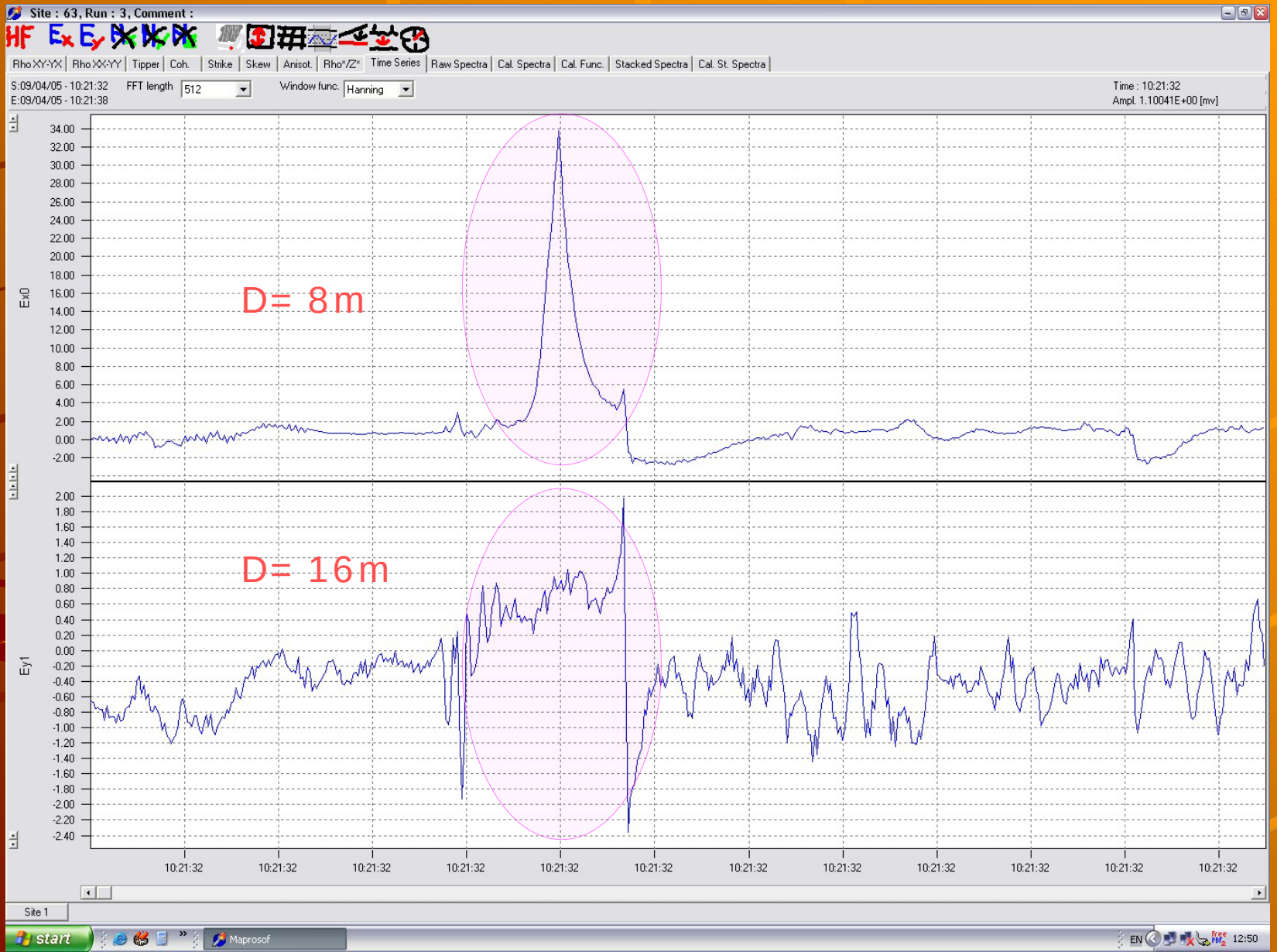
STRIKE PARAMETER





Low frequency electric signals "arriving" before the time derivative of the magnetic field, emitted prior the stress to reach a critical value

Low frequency electric signals "arriving" before the time derivative of the magnetic field, emitted prior the stress have reached a critical value



SUMMARY

Ground-base monitoring system is able to:

- Investigate shallow and deep structure in order to elaborate the adequate geodynamic models and electromagnetic tomographies;
- Detect the active faults, geodynamic sutures and to draw up the spatial distribution of the landslides;
- Evaluate the geoelectric pattern (before the stress reached a critical value) with the aim to identify the best placement for continuous monitoring;
- Reveal the short-term precursory phenomena/parameters of the possible landslide events.

THANK YOU !

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