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Abstract 1-13

Electrical Tomography for landslide monitoring: state-of-the-art and an overview of recent results in Southern Italy.

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Introduction

Recently, novel algorithms for tomographic data inversion, robust models for describing the hydrogeophysical processes and new sensor networks for the field data acquisition have rapidly transformed the geoelectrical methods in a powerful and cost-effective tool for geo-hazard monitoring. These technological and methodological improvements disclose the way for a wide spectra of interesting and challenging applications in geo-hazards monitoring: identification of fluid and gas uprising in volcanic areas; electrical imaging of seismic faults; reconstruction of landslide geometry etc.. [1,2,3]. The main geoelectrical methods are the Self-Potential (SP) and the Electrical Resistivity Tomography (ERT). To-date, these robust geoelectrical methods can be effectively applied to give contributes to the different phases of the disaster management cycle and can easily integrated with other in-situ (i.e. geomorphological, geotechnical) investigation and satellite based observations [4,5]. The sensor synergy and integration of a wide spectra of Earth Observation technologies is the key strategy for geo-hazard monitoring.

In this work we present a review of a complete case-histories of geoelectrical surveys carried for monitoring landslide instability phenomena in Southern Italy in the frame of international projects (FP6-Eurorisk/Preview, FP7-ISTIMES, FP7-DORIS).

An overview of recent results in Southern Italy

An overview of the more interesting results obtained in different areas of Lucanian Apennine chain representing a territory affected by wide and diffuse hydrogeological instability phenomena is presented and discussed. Basilicata region (southern Italy) exhibits the highest density of landslides, respect of the national average, with more than 27 landslide areas every 100 km^2. Such feature is related to predisposing conditions such as prevailing clayey materials as well as morphological setting of the slopes, and to determining conditions such as extreme rainfall events, human activity, deforestation and intense

urbanization and industrialization. In this area all typologies of landslide, markedly predisposed and tightly controlled by the geostructural characteristics, are found: rotational and translational slides; rototranslational slides; earth and mudflows as well as deep-seated gravitational slope phenomena with a predominance of rototranslational slides evolving as earthflow slides.

The geoelectrical methods have been applied during the pre and post landslide events with the aim to reconstruct the geometry of landslide bodies, individuate the sliding surface, estimate the thickness and the approximate volume of slide material and highlight the areas with a high water content. The interpretation of the ERT and SPT data was frequently supported by the comparison with stratigraphical data coming from boreholes performed in the same area (Fig.1).

In particular, the 2D electrical imaging provides useful data to be used during the pre-event and post-event phases of hydrogeological disaster management cycle [6,7,8]. Thanks to its capability of giving information both on the lithostratigraphic sequences and the geometry of the landslide body (lateral extension and thickness), the ERT is one of the key instrument for identifying the sliding surfaces between the slide material and the underlying bedrock and mapping high water content areas. Indeed, during the pre-event phase, it is a suitable tool to gather information on the geological setting of the potentially unstable area (electro-stratigraphy, tectonic lineaments, etc) and the presence of water tables that could trigger off the phenomenon. In the post-event phase the ERT technique is able to illuminate the geometry of the landslide body and estimate the volume of the slide material in order to plan the mitigation activities and interventions (drainage system installation, stabilization structures, etc).

Recently, the Self-Potential Tomography (SPT), a geoelectrical passive method based on the measure of the electrical natural fields on earth surface and a quantitative algorithm for data inversion, is currently applied for localizing electrical charge accumulation zones and groundwater paths in landslide bodies.

Conclusions and future challenges

One of the key challenges for the future will be the integration of active (Resistivity) and passive (Self-Potential) measurements for obtaining 2D, 3D and 4D (time-lapse) electrical tomographies able to follow the spatial and temporal dynamics of electrical parameters inside the landslide body [9]. The resistivity imaging can be applied for illuminating the sliding surfaces and for mapping the time-dependent changes of water content in vadose zones, while the Self Potential imaging could give a significant contribute for delineating the groundwater circulation patterns and to the early identification of triggering factors.

References

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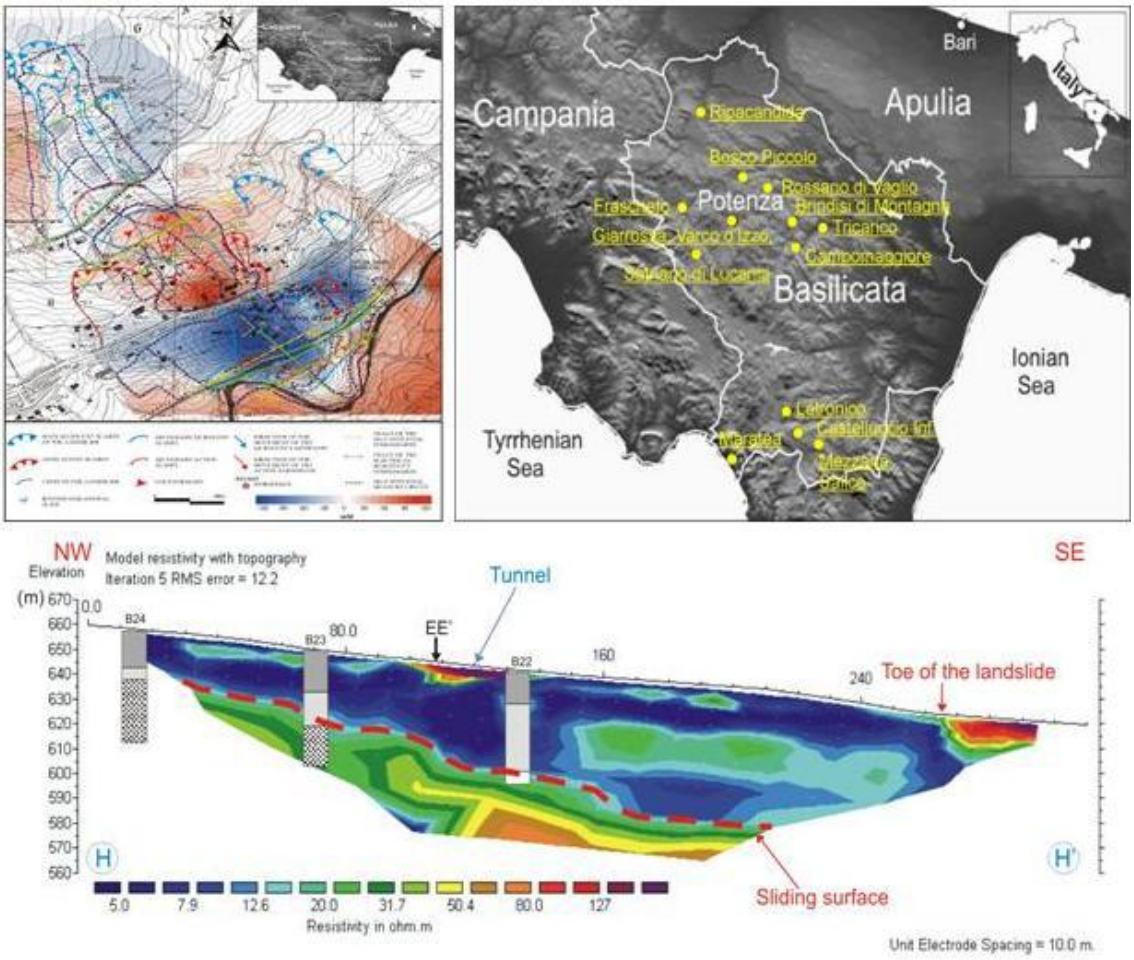

Fig. 1: The geographical distribution of the test sites in the Lucanian Apennine chain (Southern Italy) is reported on the left side of the figure. The SP map and the longitudinal 2D ERT carried out for the investigation of Varco Izzo landslide are showed on the right side and on the bottom part of the figure, respectively. The Varco Izzo landslide, located in the eastern part of the Potenza town, is a multiple and retrogressive rototranslational slide evolving in earthflow still active, developing in the structurally complex clayey-marly terrains associated to the Varicoloured Clays (Upper Cretaceous – Lower Oligocene).