4th European Geothermal PhD Day May 5 - 7, 2013 Szeged





Airborne EM survey and 3D Geological modeling for shallow geothermal assessment: an example from Sicily

<u>Alessandro Santilano¹,</u> A. Manzella¹, D. Montanari¹, A. Donato¹, A. Viezzoli², A. Menghini², E. Rizzo³, S. Maggi⁴

1. CNR-IGG email address <u>a.santilano@igg.cnr.it</u>

2. Aarhus Geophysics Aps,

3. CNR-IMAA,

4. CNR_IRSA



Consiglio Nazionale delle Ricerche Dipartimento Terra e Ambiente

www.v1gor-geotermia.it



Programma Operativo Interregionale ENERGIE RINNOVABILI E RISPARMIO ENERGETICO 2007.2013 Una scelta illuminata



THE VIGOR PROJECT

Evaluation of Geothermal Potential for the *Regioni Convergenza*



The VIGOR project is an agreement between the Italian Ministry for Economic Development and CNR (National Research Council) targeting at geothermal potential assessment of four southern Italian Regions and development of geothermal demonstration projects (power production and direct uses).

Puglia

Sicilia

Calabria

Campania





AEM METHOD FOR THE STUDY OF SHALLOW GEOTHERMAL RESOURCES

- As part of planned geophysical activities, Airborne EM survey has been carried out in Sicily, in late 2011, on two test sites, Termini and Western Sicily;
- The AEM survey was performed using SkyTEM system (SkyTEM Surveys Aps, Aarhus Geophysics Aps, CNR-IGG of Pisa);

www.vigor-geotermia.it

- 4580 line Km of data and up to 2000 km² have been explored;
- Investigation depth up to few hundred meters.

car Puglia Campania Celabria Sicilia





TERMINI AND WESTERN SICILY TEST SITES





•Western Sicily (~1500 km²)
Line Spacing 1 Km (regional scale)
100 m (infill areas "Montevago",
"Calatrasi" and "Terme Segestane")
•Termini area
(~300 km²)
Line spacing 150 m



Consiglio Nazionale delle Ricerche Dipartimento Terra e Ambiente







AEM DATA AND RESULTS

The geophysical results are composed by 3D cell distribution of resistivity (X,Y,Z, ρ). The AEM results from "Termini" and "Montevago" areas are shown.





RESULTS FROM MONTEVAGO SITE

100

1,000

Resistivity elevation map (from 130 to 140 a.s.l.)





Geological map modified from Di Stefano et alii 1993

10



Resistivity surface map (from 0 to 15 b.g.l.)



Resistivity elevation map (from 110 to 120 a.s.l.)





RESULTS FROM TERMINI SITE

100

1,000

Resistivity elevation map (from 360 to 370 a.s.l.)

Resistivity elevation map



(from 380 to 390 a.s.l.)

Geological map modified from Catalano et alii 2010-2011

10



Resistivity surface map (from 0 to 5 b.g.l.)



Resistivity elevation map (from 370 to 390 a.s.l.)





PROPOSED WORKFLOW FOR GEOLOGICAL-GEOTHERMAL INTERPRETATION

- 1. Integrated analisys of resistivity and geological-lithological data (on surface)
- 2. Picking out the resistivity values and definition of Litho-Electrical (LE) units
- 3. Building geological cross-section from interpreted resistivity profiles
- 4. 3D Modeling (using Petrel Software) of LE Units at depth grater than the achievable investigation depth based on resistivity volume distribution and geological data

Detection of anomalies within units that may be caused by the presence of hydrothermal fluids 5. Thermal properties characterization of rocks (from data literature and laboratory measurement)

Evaluation of the heat exchange potential for "direct uses" based on the 3D geological model (work in progress in collaboration with CNR-IGG of Padova).



TERMINI 3D GEOLOGICAL MODEL















TERMINI 3D GEOLOGICAL MODEL













TERMINI 3D GEOLOGICAL MODEL





CONCLUSIONS AND WORK IN PROGRESS

- Good match between resistivity and geological properties on a wide area characterized by a very complex geological setting (collisional setting);
- 3D resistivity distribution is a valid base for 3D geological modeling;
- The proposed workflow represent a good tool for geothermal direct uses assessment.
- A detailed thermal properties characterization have been down based on laboratory measurement and literature data. Now is under construction the evaluation of the heat exchange potential based on the 3D geological model (in collaboration with CNR-IGG of Padova).









Consiglio Nazionale delle Ricerche Dipartimento Terra e Ambiente



Programma Operativo Interregionale ENERGIE RINNOVABILI E RISPARMIO ENERGETICO 2007 2013 Una scelta illuminata