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Geothermalism in the Province of Verona

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The authors, through analysis of several geological, chemical and historical data, studied the thermal waters of the province of Verona and provided new insights and interpretations on the hydrothermalism western of the Veneto, with the ultimate objective of permitting the rational use purpose energy.The preliminary research allowed to define areas of thermal springs divided into two main districts. Now it is possible to distinguish "hot areas" characterized by homogeneous geological and chemical conditions.The first district of the plain Eastern (A) is focused mainly in the neighborhood of Caldiero, but also brings together the towns of Belfiore, Colognola ai Colli, Lavagno, S. Martino Buon Albergo, S. Bonifacio, Zevio, Ronco all'Adige and Arcole. The temperature of the fluid takes on values between 20 ° C and 31 ° C and the peculiar hydrological conditions allow artesianesimo bubbling to the surface. In this area we can see the manifestation of the historical sources as Brentella spring.The second district, called District spa northern plain (B), distinguishes between two different sectors based on hydrogeological conditions: to the east, it includes the towns V.lla Sant'Ambrogio, San Pietro in Cariano, Pescantina while, to the west , thermal fields are found in the moraines of the municipalities of Pastrengo, Lazise, Bardolino, Peschiera d / G. and Castelnuovo d / G.Including also Sirmione (BS) we can see that the temperature of groundwater is decreasing from west (about 70 ° C-Sirmione) to the east (46 ° C-S.A.V.).In Saint Ambrose of V.lla water hot is been found in wells between -60 ÷ -130 m m from ground level while the temperatures vary between a minimum of 20 ° C to 46 ° C (Castellaccio & Zorzin, 2012).In the morainic, however, areas characterized by the presence of hot water at higher temperatures is between the villages of Colà di Lazise, Piovezzano and, especially, at around the same localities with the largest number of deep wells, ranging between -140 m and -240 m from the PC, with temperature values of water ranging from 35 °C and 52 ° C.Outside the spa districts, considered most important for the discovery of hot water, wells are isolated reports of possible thermal anomaly (20 ° C to 22 ° C). This situation testifies, on one hand the vast extent of the hydrothermal system and, secondly, the existence of complex hydrogeological phenomena. In the context of the Padana Plain and other areas located at the edges of the central and southern Apennines and Calabrian arc-Peloritano exist thermal waters whose genesis is related to circulation of fluids within carbonate structural clusters heated the normal geothermal gradient. The geothermal mapping of the Italian territory for that type of thermal spas shows a potential huge and easily available, which include the areas between Sirmione and the Adige Valley and the wide area around Caldiero. The low enthalpy of Verona spa is therefore a possible important source of energy for public environments (residential, industrial, hospital, sports, etc..), agriculture (greenhouses for vegetables and flowers, drying, pasteurization of milk , hydroponics, etc..) or for breeding (ittiocoltura of valuable species, incubation of eggs and poultry) or as a result of the presence of hot fluids in a favorable salt content, for the development of wellness centers and balneotherapy.

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GEOTHERMALISM IN THE PROVINCE OF VERONA

Lake Garda and Verona Province case studies

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1. Introduction

The presence of territories characterized by local temperature and heat flux anomalies, as the Southern Garda Lake and the Verona Province areas, is well known (Fig.1a;1b). They are found In the Po Plain, located in northern Italy between the Alpine and Apennine mountain ranges. The use of low and medium temperature geothermal resources enhances a sustainable development of the area, combined with significant energy and cost savings, as well as a substantial reduction of greenhouse emissions into the atmosphere. To promote a proper use of geothermal energy through direct uses of heat and by coupling with heat pump systems it is essential to characterize the geothermal reservoirs involved, taking into account the local differences related to geological, hydrogeological and thermal features.

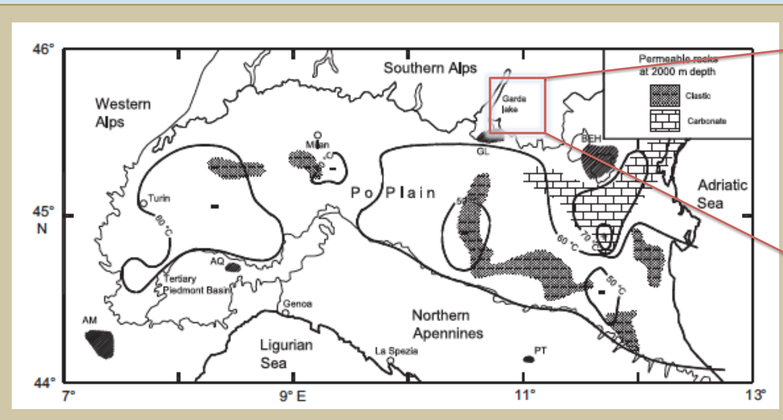


Fig.1a –Map of temperatures and permeable rocks in the Po Plain with main hydrothermal systems. (Pasquale,Verdoya and Chiozzi, 2014) In evidence Verona's Province (Fig.1 b)

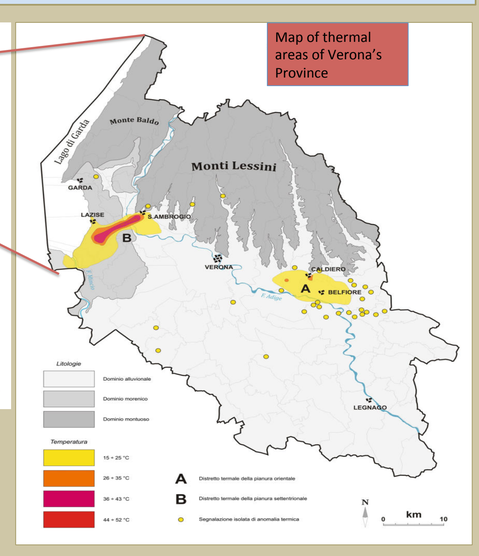


Fig.1b – Thermal district map of the Verona Province (Castellaccio and Zorzin 2012)

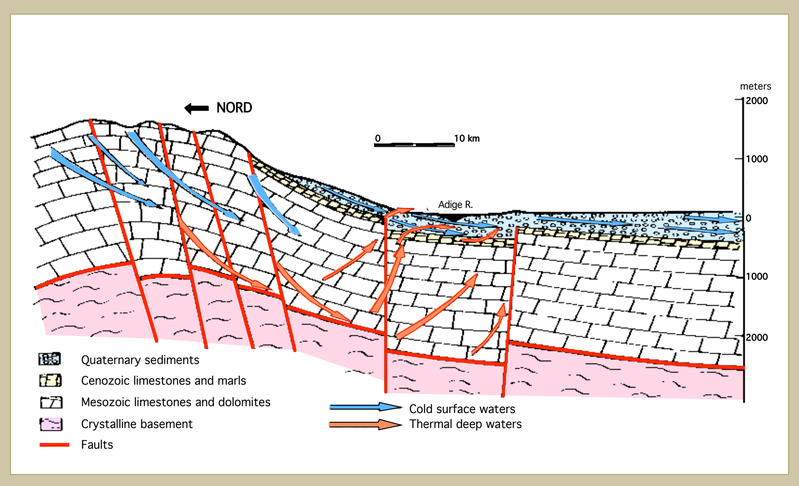


Fig. 2 – The hydrogeological background model of district A modified (Sorbini et al., 1984).

2.Tectonic and Structural Characteristic

The relationship between tectonic - structural characteristic, and the presence of thermal fluids is not clear and for this reason we are studying:

- the difference between the chemical-physical compositions of thermal groundwater of the two districts identified from literature (districts A and B in Fig.1b);
- the presence of thermal contamination within the Lake Garda;
- the hydrothermal circuits for assessing the geothermal resource renewability.
- In the past authors such as Sighinolfi and Sorbini (Fig. 2) helped produce geochemical and hydrogeological models that are still worthy of interest. The hydrogeological profile in the figure represents the thermal area of Caldiero called District A in Castellaccio e Zorzin, 2012. (fig.2)

3. Geochemical and Geological data

The groundwater geochemical characterization obtained from the screening of available literature (Castellaccio & Zorzin 2012; Sighinolfi et al., 1982) shows the presence of different geochemical facies. The Piper diagram of the districts highlights the existence of calcium and magnesium bicarbonate waters differentiated by their temperature level ranging between 24 and 31 °C for Caldiero groundwaters and 12 and 14°C for those belonging to the Lessinian mountains (Fig.3a). In the B district instead (Fig.3b), thermal waters, are divided into four groups according to their different temperature. In August 2013 Further analysis were carried out (put in evidence in Piper diagram, Fig.3a and 3b). At the end of september new isotopic geochemical data will be analyzed to complement previous studies.

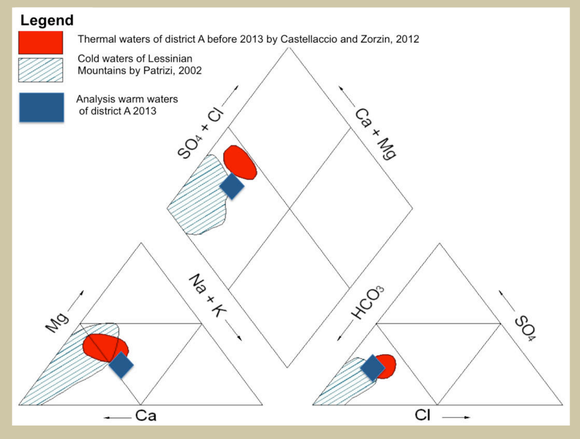


Fig.3a – Chemical analysis of wells and springs district A. In evidence the close correlation between analysis of Lessinian mountains cold waters and warm waters 2013 data

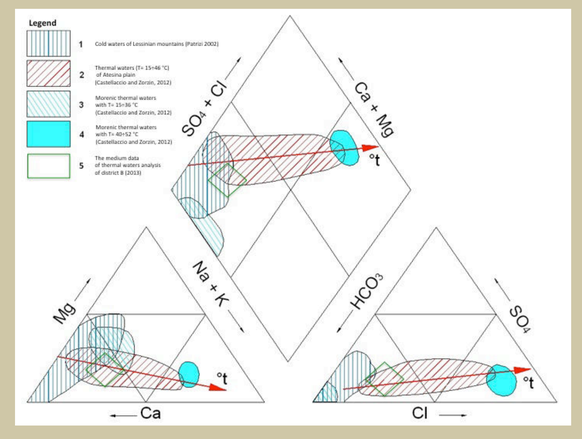


Fig.3b – Analysis of district B. Thermal waters with different temperatures are highlighted. The chemical analysis of 2013 are marked in green (Castellaccio and Zorzin,2012 modified by L.Agostini)

4.Methodology

Seismic Sounding and Remote Sensing, passive seismic survey as HVSR (Horizontal Vertical Spectral Ratio), analysis of satellite and terrestrial images LiDar) will be performed to improve the local knowledge of the geothermal resources.

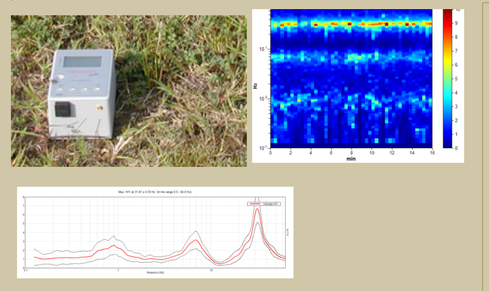
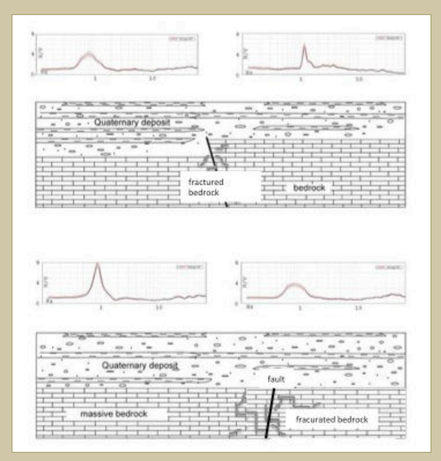


Fig.4a Tromograph and tromographic device for HVSR acquisition



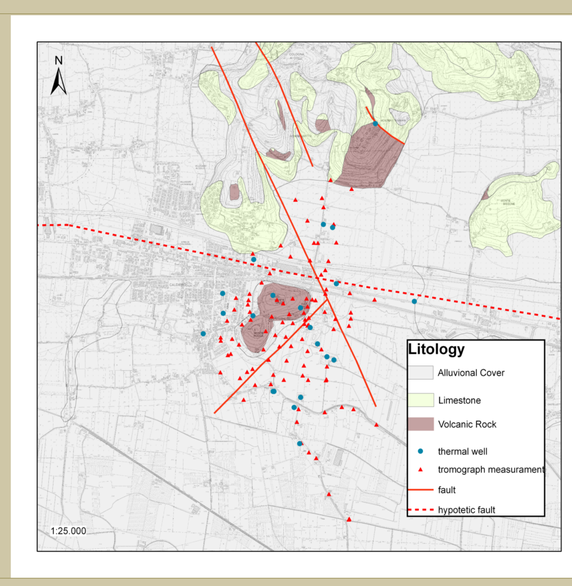


Fig.4.b Tromographic data in geological map. In evidence the Rocca hill and the Gazzo hill, whose origin is volcanic.

Fig.4.c Two examples of HVSR output of Giunone spa in Caldiero town. We can see a high peak when rock is compact and a large peak when rock is fractured such as near area volcanic (the Rocca hill and the Rocca hill in Caldiero- see Fig.4b)

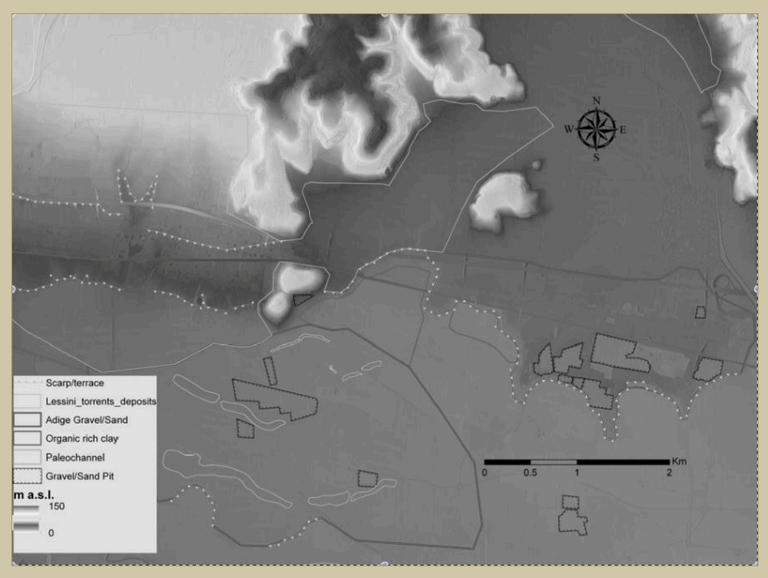


Fig.5 Image of Eastern Verona Province (LiDar Ministero dell'Ambiente e della Tutela del Territorio e del Mare) modified by A. Ninfo –Geosciences-UniPd

5. Further developments

In the research programme, some thermal analyses images have been performed to define the thermal characterization of the districts and a detailed investigation about the characterization of Caldiero thermal area with a tromograph (see Fig.4b). Terrestial thermography, seismic sounding and new geochemical analyses will be carried out in the lake area and the Verona Province to better define the hydrothermal circuit of the thermal areas and to foresee a rational and sustainable use of the resources.

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