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THE GEOPHYSICAL ELECTROMAGNETIC PROSPECTION IN THE SPATIAL LOCATION OF THE TRAVERTINE DEPOSITS OF THE BANYOLES DEPRESSION (GIRONA). GEOLOGICAL AND HYDROLOGICAL IMPLICATIONS.

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ABSTRACT

The results of the application of the geophysical electromagnetic prospection methods in the resolution of the problems of the spatial location of the travertine quaternary formations of the Banyoles depression are presented.

KEY WORDS: Banyoles, Geophysical electromagnetic prospection, Travertine.

1. INTRODUCTION

The travertine deposits of the Banyoles (Girona, Spain) depression constitute a deposit of complex geometry derived from the carbonic sedimentation processes associated with the resurgent zones of lowest altitude of the Lake System of Banyoles.

In this sector, the geometry of the travertine formations are characterized by having a flat, slightly inclined surface with rapid lateral variations (Brusi et al., 1997a). The impossibility of measuring with the desired precision, the volume of the deposits based on the surface data and the existing mechanical soundings, leads to the use of the geophysical prospection methods as a means of clarification. The geophysical electromagnetic prospection has been presented as a method of great usefulness and its results provide very valuable information that can be processed in the studies of regional geology, sedimentology and., especially, in the analysis of the proportions and characteristics of the aquiferous system that drains the subterranean lake zone of Banyoles.

2. GEOLOGICAL AND GEOMORPHOLOGICAL FRAMEWORK

The resurgent zone of the Banyoles Depression can be placed in a relatively simple geological context: quaternary materials related to the presence of the lake accumulated on eocene or neogene formations that act as a substrate.

This summarized description should not overshadow the absolute subordination of the resurgent activity of the peculiar dynamics of the aquiferous system that feeds it. The hydro-geological system of Banyoles-La Garrotxa (Sanz, 1985) shares, in its area of resurgence, the hydro-chemical characteristics and travertinizational systems of many other karstic systems. However, it is important to highlight that, from a geomorphological point of view and from a travertinizational study perspective, the phenomenon of the sinking of the topographic surface caused by the dissolution of the eocenic chalk subjacent to the zone (Brusi et al., 1987) and the disposition of the paleo-relief that contains the deposits are enormously influential.
In this context, the travertine formations that we have attempted to study belong to the quaternary, and their origin must be set in a period between middle Pleistocene to the present time (Brusi et al., 1997b).

3. METHODOLOGY

Among the numerous methods of geophysical exploration available, the equipment of electromagnetic (EM) prospection of low induction has proven to be the most adequate for our purpose. Seismic prospection was ruled out as a result of the interference produced by the "background noise" of the urban surroundings. The conventional electrical prospection of symmetrical Schlumberger devices was rejected, since it requires very extensive emission lines.

As it is known, and generally speaking, the electromagnetic methods of geophysical prospection are based on the generation of a primary magnetic field by an emitting antenna situated near the surface of the terrain. This primary magnetic field induces a secondary magnetic field situated underground. A reception antenna situated at a certain distance from the emitting one registers the measure of the relation between both, allowing for the evaluation of the electrical conductivity of the different geological masses of the subsoil (McNeil, 1980).

The equipment that was used for our study was the EM34-XL from Geonics. To operate this piece of equipment requires two operators with two antennas situated in different, preselected locations with alternating orientations (vertical and horizontal), allowing for information to be obtained of apparent conductivity of different depths of the subsoil.

4. RESULTS

The different campaigns of geophysical electromagnetic prospection carried out to date, have allowed for 265 soundings, structured in 27 profiles (Fig 1), in priorly selected zones.

From the analyzed data a set of conductivity values which characterize each of the geoelectrical units have been calculated:

1) Travertine materials: between 1 and 5 mmho/m
2) Eocene, loamy substrate: between 10 and 15 mmho/m
3) Eocene, sandy substrate: below 1 mmho/m
4) Pliocene, clay substrate: between 25 and 50 mmho/m
5) Edafic covering material: between 20 and 75 mmho/m

The important contrasts between the conductivity of the travertine materials of the area and the geological formations that constitute its substrate, have been determined by obtaining useful, interpretive results. It is also important to note that these values do not take into consideration the high conductivity which is characteristic of water with high levels of mineralization of subterranean aquifers. The geoelectrical levels of very high conductivity have been analyzed as aquifer groups.

With the information obtained from the analyzed soundings, 22 levels of geoelectrical correlation have been identified (Fig 1). It is commonly found that travertine formations derived from resurgent activity present a flood roof and a channelized base, with an average
depth of nearly 20 m. In the zone near Lake Banyoles, the depth can, in some areas, reach more than 70 m, coinciding with the mud fillings of old basins.

The carbonic deposits, oriented in a southeasterly direction, originate in the resurgent zone in the basin of Lake Banyoles, and gradually disappear in the area of Cornellà del Terri because of the progressively dominant terrigenous materials.

The travertine zone rests, preferably, on a clay substrate, and in its basal sector, behaves as a free aquifer receiving contributions of lake water and that also receives water coming from streams that feed superficially into the lake.

5. ACKNOWLEDGMENTS

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6. REFERENCES


FOOTNOTES

Figure 1. Situation of the studied zone with indications of the geophysical profiles and of the isopach lines of the deposits.
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Introduction

The travertine deposits of the Banyoles Depression are a deposit of complex geometry derived from the subaerial subaqueous region bordered by the emergent area of the Lake system of Banyoles (Fig. 1).

In this context, the geometry of the travertine formations are characterized by having a flat, slightly inclined surface with isolated clayey bodies (Brusi et al., 1997). The possibility of measuring the water table is the desired parameter, the volume of the deposits and the distribution of mechanical properties, such as the use of the geophysical methods for its characterization and classification. The geophysical investigations at the location of the travertine formations have been performed as a method of great usefulness and its results provide very valuable information that can be processed in the context of regional geology, hydrogeology and, especially, in the analysis of the properties and characterization of the aquifers system that drive the travertine deposits (Fig. 2).

GEOLOGICAL AND GEOFISIOLOGICAL FRAMEWORK

The travertine formations are placed in a relatively simple geologic context: a metamorphic complex that forms the foundation of the depression and the deposits of travertine formations that act as a substrate.

This summary description should not overshadow the absolute predominance of the regional activity of the travertine system that feeds it. The sum of the local effects can be summarized in the term “anticline” (Font, 1983). In its outer division, the hydro-chemical characteristics and the environmental system of water are suited to this system. However, it is important to highlight that, from a geophysical point of view and from a geomorphological study of the travertine formations, the linking of the topographic surface caused by the metamorphism of the calcareous formation to the depression (Brusi et al., 1997) and the deposition of the depression of the plateau that cover the travertine deposits are extremely influential.

In this context, the travertine formations, that have been attempted to study, must be set in a period between Middle Pleistocene to the present time (Brusi et al., 1997).

METHODLOGY

Among the numerous methods of geophysical exploration available, the equipment of electromagnetic (EM) prospecting of low induction has proved to be the most adequate for our project. Sensitive prospecting was used at a series of the Fig. 2. The equipment used for our study was the EM04-XL from Geometrics. The equipment used for our study was the EM04-XL from Geometrics.