

Spatial Data Infrastructures, Web Map Servers and Historical Patrimony: Project LIFE “Valle del Tiermes – Caracena”

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ABSTRACT

The present article deals with the application of Web Map Server technologies in the field of archaeology. Through the approval of the Project LIFE “Valle del Tiermes – Caracena” the administration and interoperability of the information generated by the project has been given special importance, which mostly has a spatial component for Web Map Servers. The main problem was the total lack of interoperability of the archaeological information for not being included in files of georeferenced format and the existence of data bases without spatial component, although they could have it without causing any disadvantage. The article points out the methodology applied to the data with the objective to obtain interoperability and thus being able to be included in Web Map Servers for visualization, search and queries.

INTRODUCCION:

The Project LIFE Tiermes [1] has been approved in September 2003 within the Program LIFE of the XI European Commission - Environment Directorate-General [2]. This project has as its objective the promotion of the southwestern area of the Province of Soria, located in the Community of “Castilla y León” in Spain. It has been developed within the geoeconomical framework of the municipalities of Montejo de Tiermes, Retortillo de Soria, Licerias and Caracena (Figure 1) being based on the capacities of its environmental values, their historical and archaeological patrimonial wealth and its tourist potential, mainly in relation with the excavations of Tiermes. [3]. Within the criteria of sustainable development the aim is to reverse the present tendency of depopulation, migration from the land and desertisation.

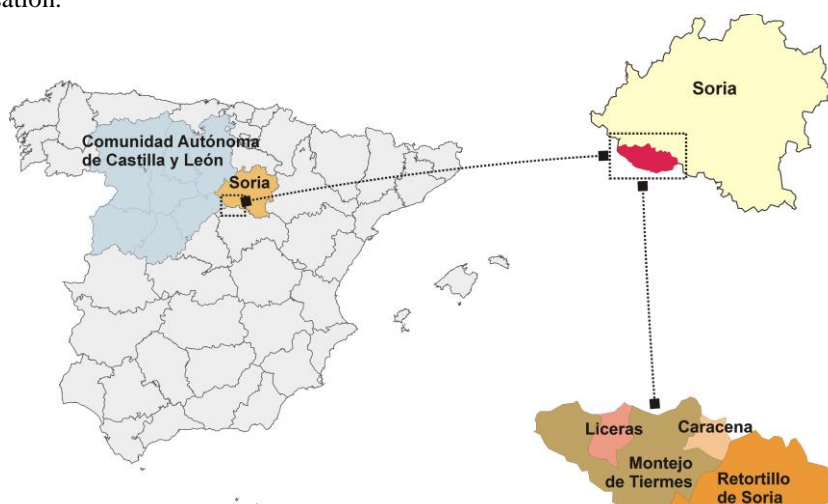


Figure 1. Geographic location of the region of Tiermes – Caracena

The tourism as a promoter of economy.

The tourism is one of the activities that is considered as a potential source of wealth generation [4], [5], within the process of economic diversification that is being observed in rural areas.

Within the province of Soria the southwestern area stands out for its historical-artistic wealth, its location and for its privileged natural places.

The archaeological excavations of Tiermes certainly belong to the most important touristical resources; This fact is complemented by the tandem formed by the patrimony and landscape which increases the attraction for tourists. However, right at the moment there is a lack of basic resources needed to increase and stabilize the population.

The association "Amigos del Museo de Tiermes", beneficiary of the Project LIFE Tiermes, raised a series of questions about performances that allow the growth towards a new situation of stabilization of the area and sustainable growth.

The actions include, among others, the aspects of:

- 1, Evaluation, protection and usage of the environment.
- 2, Evaluation, protection and usage of the historical, archaeological, cultural and social patrimony.
- 3, Promotion of the environmental and cultural knowledge of the area.
- 4, Estimation of the tourist potential of this area under the aspect of the new European tendencies of cultural and environmental tourism of a non seasonal character.

The global objective will be "*to promote an innovating system of management coordinated by different actors in order to obtain the protection of the ecosystem, the ordenation of territory and the valuation and sustainable development of the historical-natural complex of Tiermes*". [1]

1. A WEB MAP SERVER (WMS) AS A MANAGER OF INFORMATION.

During the Project (2003-2006) a huge amount of multiple information about the environment will be generated:

Among the obtained information will be environmental information of protected zones, information about tourist offers, ethnology, archaeological supply, etc. The mayor part will contain a spatial component. In order to administer the huge amount and diversity of the generated information there will be applied the Technology of Web Map Servers. [6].

This alternative was chosen rather than others, such as the traditional Geographic Information Systems, because it provides at the same time the administration and visualization of information as well as the publication of information of the archaeological excavations of Tiermes and its surrounding region, through Internet. The capacity of queries will be amplified through the interfaces of Web Feature Server [7], including specific queries created by the semantics of codification [8] of the Open Geospatial Consortium [9].

With this alternative also another initiative of the European Union is met: The Initiative INSPIRES [10], that has been developed in order to make available relevant, reliable and high quality geographic information, that allows the formulation, implementation, supervising and evaluation of impact or territorial dimension policies in the European Community. INSPIRE is a legal initiative that will establish standards and protocols of technical character, organizational and coordinative aspects, policies about the information that include the access to the data and the creation and maintenance of spatial information. It is the first step towards an multilateral initiative that initially will direct the interest about spatial information necessary for environmental policies and that will be available to satisfy the needs of other fields, such as agriculture and transport [11].

The Web Map Server will allow the visualization of all the information, which will be generated georeferenced by the project. The geographic area of the service will include the Region of Tiermes (Municipalities of Montejo de Tiermes, Retortillo de Soria, Caracena and Liceras) and will contain layers such as:

- Basic geographic information: Municipal and provincial limits, etc. contours, streets, rivers, cities and towns, cadastre, orthophotos, official cartography in format paper scanned at a scale of 1:100.000, 1:50.000 and 1:25.000, digital terrain models (resolution of 25m per pixel) and hypsometry of the relief.
- Information generated by Project LIFE Tiermes: Environmental information, touristical demand, touristical offer, ethnology, archaeology, etc.
- Information about the archaeological excavation of Tiermes: Information generated during the excavation campaigns: Planimetry of structures, stratigraphic units, photographs, etc.

In order to generate a WMS there will be used the software MapServer [12], the development of an Open Source [13], developed originally by the University of Minnesota [14] together with the NASA. At the moment the main actor in the development of the project is the group "Group DM Solutions [15]", that maintains and increases its functionality. MapServer fulfills the needs of the version 1,1,1 of the Specification of Implementation of Services of Web Map

Servers of Open Geospatial Consortium and of the version 1,0,0 of the Specification of Implementation of Web Feature Servers.

The present article deals with the generation and implementation of a Web Map Server corresponding to the third type of information stated before: *Information about the archaeological excavations of Tiermes*, that had as its main disadvantage the fact that the raw data available for the creation of a Web Map Server was **not interoperable**. For this reason it was necessary to find a methodology that made possible the interoperability, visualization and acquisition of this information through the Web.

2. PRESENTATION OF THE RAW DATA.

After finalizing the archaeological campaign in 2004 of the archaeological excavations of Tiermes there was obtained the following information:

- Planimetric drawings in FreeHand format [16]
- Non spatial data bases of stratigraphical units.

2.1. - *Planimetric drawings* made from hand-sketched drawings by archaeologists (Figure 2), scanned and digitized in FreeHand (Figure 3), which contain:

- The structures for each level of advance of the excavation (Stratigraphical Units)
- The type of material of the land (example: limestone, arenaceous material, tufa rocks, etc),
- The reference points,
- The numerical identification of the stratigraphical Units.

Other characteristics of these archives are:

- Scale: 1:50
- Format: fh8, which is the proper format of FreeHand
- System of reference: As almost all the programs of graphical design, FreeHand, do not support the georeferenciacion of their archives.

Therefore the problems for its inclusion as layers in Web Map Servers WMS are:

- Not georeferenced archives
- Partial drawings limited by the use of the size A4 at a scale of 1:50

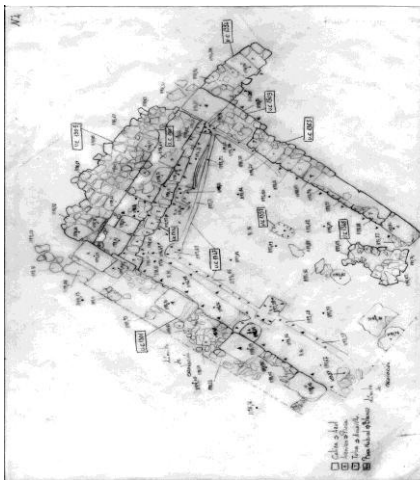


Figure 2. Planimetric design drawn by hand.

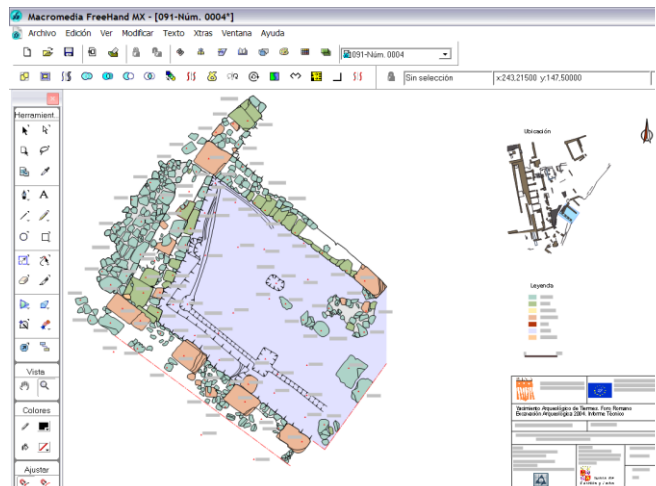


Figure 3. Scanner and edited planimetric design in FreeHand.

2.2.-*No spatial data bases in Microsoft - Access forma* (Figures 4 and 5). This data base contains the information that defines stratigraphical units (Extension of the surface of archaeological analysis at a determined time of the excavation), as there exists:

- consistency,
- color
- description,
- maximum and minimum levels,
- stratigraphical units which are cut or combined,
- materials, etc.

Other characteristics of these archives are:

- Format: mdb (data bases of Microsoft Access)
- System of reference: The data base does not have an assigned geometry.

Therefore origins the problem for its inclusion like associated attributes to geometries in Web Map Servers WMS:

- It does not have an assigned geometry, although it should be included.



Figure 4. Data Base in Access. Visualization of the Form

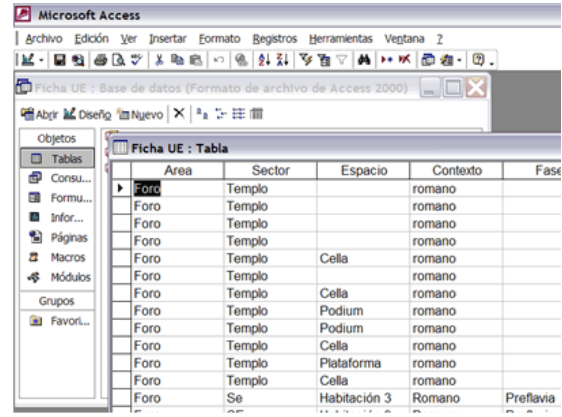


Figure 5. Base de Datos in Access. Visualization of the Table

3. METODOLOGIA FOR THE DATA PROCESSING TO OBTAIN INTEROPERABILITY

The first obstacle found, as mentioned previously, is the one of not having interoperable information. The lack of interoperability is obvious when trying to visualize all the data obtained from the graphical design program FreeHand with alphanumeric information stored in a MS-Access data base. At the moment the only possibility of working jointly with these two sources of information, is through the visual search of the number of stratigraphic unit in a planimetric drawing and, later on, to query the data base for the desired stratigraphical unit. This action lacks totally the automatization between both types of information.

In order to deal with the lack of interoperability and the deficiency of automatization the following methodology was developed:

3.A.- FROM FREEHAND TO SHAPEFILE

The objective consists of joining all fragments of planimetry (in our case more than 100 archives generated during the archaeological campaign in the year 2004) and including them in the Web Map Server.

The methodology is the following one:

3.A.1. - First it is necessary to georeferenciate each drawing. But for being able to do so points of spatial reference (coordinates) of the excavations will need to be identified in the drawings of planimetries. In order to fulfill this objective there has to be done a topographic map (Figure 6) by means of classic topography, with the following characteristics:

- Type of information that contains: Archaeological structures of the Roman Forum and Aqueduct and its reference points.
- Scale: 1:200
- Format: DXF
- System of reference: EPSG 23030 [17] (UTM - European Datum 1950 – Zone 30). Altitudes refer to the mean sea level in Alicante.



Figure 6: Topographic map with zones of intervention of the campaign July-December of 2004



Figure 7: Photographs of the excavations

Previous to the georeferenciacion it is necessary to make the following steps:

3.A.2.- Homogenization of layers in FreeHand: Each file of planimetry identifies different types of wall materials according to the colour that is assigned (limestone, tufa stone, arenaceous material, etc.). In the original archives these fillings are all found in one unique layer. A layer of information has to be created for each type of rock and each attribute (stratigraphical levels and units) (Figure 8). When exporting the file like Shp (shapefile), as an attribute there will be assigned the name of the layer to which it belongs.



Figure 8. The layers obtained in the archive of planimetries.

3.A.3.- From FreeHand to CorelDraw: In FreeHand the information has been exported as the interchange format Adobe Illustrator 5.x (*.ai) Corel Draw does read and export it in the interchange format CAD DXF. The names of the layers are maintained throughout the process. At that moment, yes, the information can be georeferenced:

3.A.4. - Georeferenciacion: The obtained data of the previous step is inserted as a block into the Topographic Map of AutoCAD, that contains the archaeological mapped structures. With the aid of the commando "ALIGN" two points of the planimetric drawing are identified that correspond with the topographic map. The drawing is transferred, rotated and scaled so that the points correspond (Figure 11), adjusting the planimetry to the topographic map. Other tools produce the deformation of the drawings forcing them to adjust to a high number of selected points. Since the archaeologists altogether have more precision in the drawing of small forms than in the drawing of several archaeological structures, it was preferred to give priority to the maintenance of the forms rather than an exact location. In addition since the planimetries on which the algorithm will be applied would be of small size (around the 100 m2) and as there do not have an influence other geodesic circumstances of the land the transfer, rotation, and change of size is considered more adequate than other complex polarimetric methods. Once the drawing is georeferenced it will be saved once more with the extension DXF.

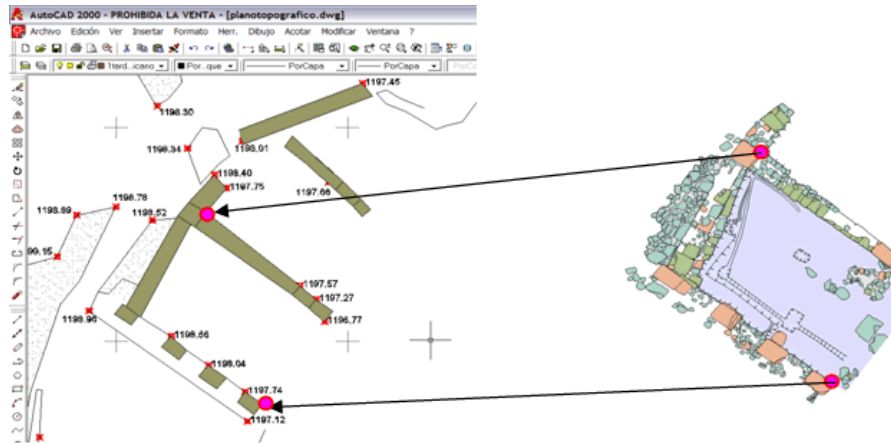


Figure 9. Correspondence between two points of planimetry and two points of the structure of a topographical map.

3.A.5. - Conversion of a ShapFile: Using the program "FME Universal Translator" [18] the file DXF will be transformed into shp (Figure 10), generating a file for each type of geometry: Points, lines and polygons. According to the correspondence the layers of information of the original file become attributes of the polygons, lines or points. Thus the type of fillings is included as an attribute of the polygons. The texts of stratigraphical units and levels of the drawings in FreeHand are included as attributes of the layer of points.

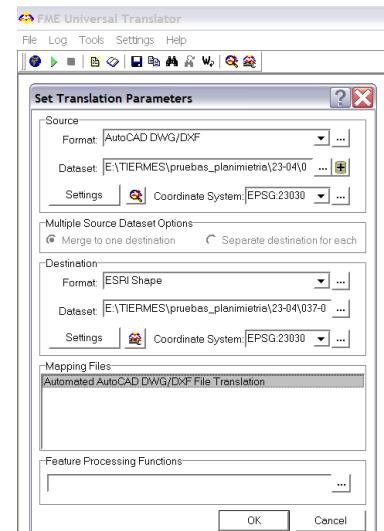


Figure 10. Interface of the FME Universal Translator.



Figure 11. Visualization of the union of several archives.

3.A.6- Union of all the individual ShapeFile archives: Finally a ShapFile file is generated by the union of all the fragmented drawings of planimetry on which the previous process has been applied (Figure 11). This step can be made without problems with georeferenced archives DXF. Afterwards the resulting file of the union is converted to shp.

The process of transformation of the archives of planimetry of FreeHand to shapefile is laborious in edition and it has to be special care to each one of its phases. This work has to be made by a person with knowledge in the archaeological cavings of Tiermes in order to be able to locate each planimetry in the corresponding ubication. The time of the process of each drawing is estimated in 20 minutes. This methodology to locate archives of graphical design programs in a Web Map Server in addition to archaeology can be applied to other fields, where the use of that type of software is needed to improve the visualization of cartography.

3.A.7.- Insertion of a planimetric map in a Web Map Server

In order to construct a Web Map Server with MapServer, the layers of information that will contain the service have been defined in the configuration file "*.map" [19], For each one it will have to be indicated the following information:

- Indications about the type of information of the layer e.g.: points, lines, polygono, anotation or raster
- The directory where the data or the URL of the remote servers are stored who are desired to be included,
- Its reference system and
- A style of visualization for each layer.

In our case a layer of information for each type of geometry is defined: Polygons, lines and points. The layer of polygons contains attributes like the type of materials of the stone walls and the land. With help of these attributes filters are constructed to assign a visualization style to each material. The layer of lines contains an outer limit of the structures and stone modifications. The layer of points is used to place texts of the stratigraphical units and the levels (layers of the type of annotations), that compose the attributes in the Shp file. Furthermore the aspect of a planimetry in FreeHand (Figure 12) is compared with the aspect obtained in the Web Map Server (Figure 13). It must be highlighted that not only the aspect is identical, but also exactly the same information is contained which means that there does not exist any loss of information with the applied methodology.

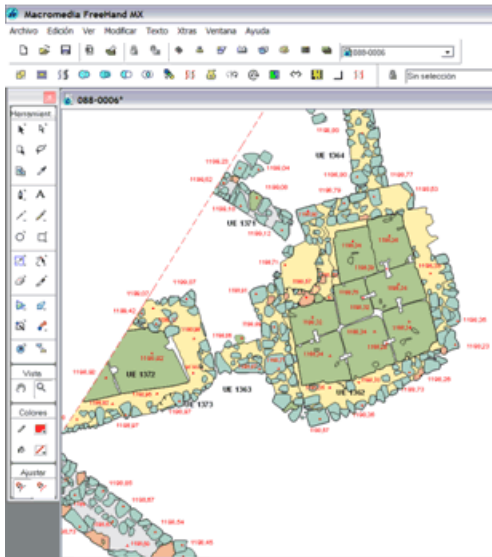


Figure 12. Visualization of style of the original file in FreeHand

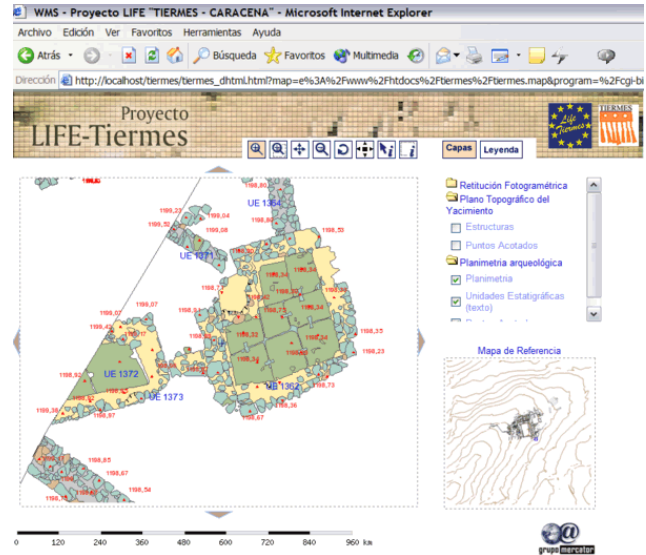


Figure 13. Visualization obtained by the Client WMS. <http://mapas.euitto.upm.es/tiermes>.



Figure 14. Visualization obtained by the Client WMS of Figure 11

3.B.- VINCULATION OF THE DATA BASE ACCESS WITH THE PLANIMETRY

The data base of information of the stratigraphical units, is not spatial, since it does not contain geometry, nor some space reference.

The only possible vinculation of the data base with planimetry (now already in format shp) is through the attribute of the "stratigraphical units" since:

- The base data Access has a field called "UE" that contains the identifier of the data base.
- The shp of generated points in the point A.5 contains a field called "LAYER" that contains two types of attributes: "COTAS " and "UE". In addition another field called "TEXTSTRING" contains the numerical values of the levels and the stratigraphical units corresponding to each point (Figure 15).

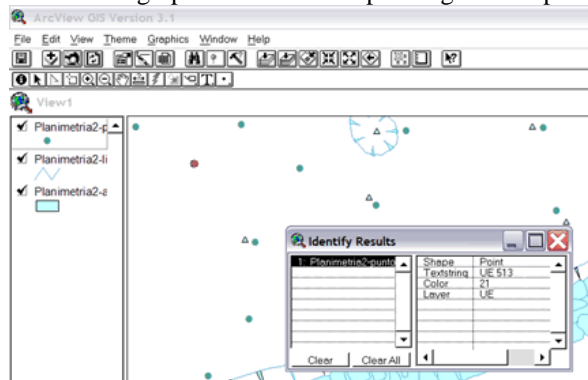


Figure 15. Attributes of points of the planimetries of the file shp.

The problem is simple and results from the combination of both data bases according to the common elements, which are the "UE". For doing so the following methodology is applied:

3.B.1.- Exportation to the Access data base in SQL and inclusion in the PostgreSQL [20] + PostGis [21]

3.B.2. - Transformation of the points of shp to SQL with the tool shp2pgsql.exe of PostGis. Inclusion of SQL in PostGis. The SQL contains precise geometry corresponding to the point of insertion of the text of stratigraphical units.

3.B.3. - Having the two tables loaded into the PostgreSQL (Information UE and points of planimetry) a query in SQL will be formulated in order to generate a new table that contains the union of the two previous tables. This means that the new table that will contain the information of each stratigraphical unit associated to a geometry.

The stratigraphical units always refer to an extension of surface like an area or polygon. But in this case due to the lack of homogeneity and integrity of the provided information, it was impossible to assign such geometry. There was only able to be generated a punctual geometry. As a consequence all stratigraphical units are referenced by means of an associated text to a point without knowing its extension.

3.B.4.- 3.B.4. - Insertion of stratigraphical units layers in a Map Server: Visualization and queries

The table of the spatial data base PostGis, generated as indicated in the previous paragraph, is included, as a layer of the punctual type. The visualization will be made through a point of text insertion for each stratigraphical unit. This point will allow the combination of visualization with the query. For doing so, when making a query about the UE in the client WMS, this will open a window in the browser with the information corresponding to this UE (Figure 16).

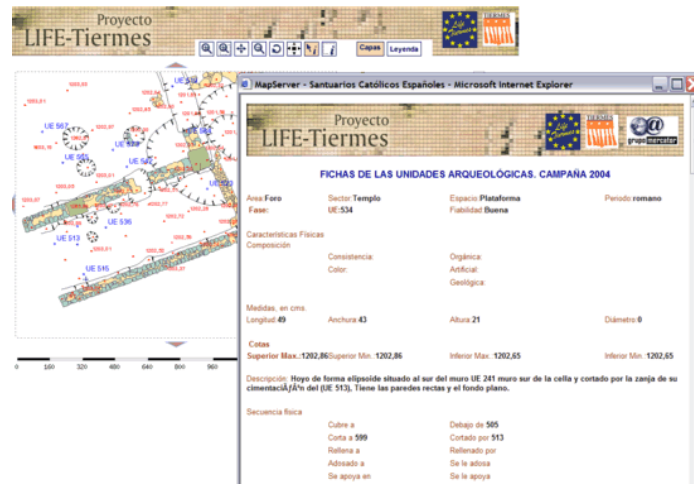


Figure 16. Query in the client WMS for gathering stratigraphic units information.

4.- CONCLUSIONS

There has been developed a method for converting graphical formats to georeferenced shapefiles that are not only used in architecture but although in other sciences. The same type of visualization may be obtained through a map server in Internet without losing any information.

The possibilities of visualization may go even further through the application of specifications in relation to the OGC styled layer descriptors [22].

There has been obtained an interoperability between the two types of information, which was impossible to achieve until now due to the format and the deficiency of spatial reference (in the case of planimetry) and due to the geometry (in case of a database of stratigraphic units).

The gathered information is georeferenced, interoperable, navigable and consultable through the interface of the Web Map Server and can be maintained and actualized by transactional workgroups. (WFS- whole group sessions).

The future outline will be a new methodology for the archaeological excavations in order to include directly the huge amount of information in the Map Server.

5.- Acknowledgements

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