



Universitat de Lleida

## The Ager valley historic landscape: new tools and quantitative analysis. Architecture and agrarian parcels in the medieval settlement dynamics

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## **TESI DOCTORAL**

**THE AGER VALLEY HISTORIC LANDSCAPE: NEW TOOLS AND  
QUANTITATIVE ANALYSIS. ARCHITECTURE AND AGRARIAN PARCELS IN  
THE MEDIEVAL SETTLEMENT DYNAMICS**

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## RECAP

This work deals with the analysis of the Ager Valley historic landscape through the methodologies of Landscape Archaeology. It uses several multidisciplinary sources as written documents, remote sensing images (mainly lidar and radar), parcels analysis, archaeological prospections and archaeological excavations. The main target has been obtaining the periodisation of the medieval settlement in the valley from the 5<sup>th</sup> to the 13<sup>th</sup> centuries. It analyses the structure of the agrarian parcel systems through the methodology developed in the Archaeogeographic studies and predictive archaeology (least cost path, viewshed analysis, site catchment analysis). It also uses the application of the Archaeology of Architecture in order to study the material evidences of the churches and the defensive towers of the valley. After the analysis of the different sources, it tries to develop a synthesis of the data following the chronological windows allowed by the sources. All the data have been used also to analyse the Landscape of Power and the Sacred Landscape in the valley during the Middle Ages.

## RESUMEN

Este trabajo trata de analizar el paisaje histórico del Valle de Àger (España) a través de múltiples fuentes, como las fuentes escritas, la teledetección, las fuentes arqueológicas, las arquitecturas históricas y los análisis del parcelario agrario, de la viabilidad y de la toponímica. El objetivo principal es el de analizar la periodización del asentamiento medieval de forma general y detallada a través del estudio del paisaje fortificado y del paisaje sagrado en una ventana cronológica que va desde el siglo 5 hasta el siglo 13. También se analizaron los elementos principales de las arquitecturas históricas disponibles mediante los métodos de la arqueología de la arquitectura. Otra aplicación metodológica fue la de la Archéogéographie Francesca a través de la cual es posible estudiar las estructuras del parcelario agrario y de la viabilidad. Todos los datos han sido sintetizados para obtener el cuadro general del asentamiento medieval en el valle.

## RESUM

Aquest treball exposa els resultats de la investigació doctoral sobre el paisatge històric de la Vall d'Àger amb l'aplicació de la metodologia de l'Arqueologia del Paisatge. S'han utilitzat diferents mètodes científics per obtenir informació heterogènia: des de la teledetecció (lidar i radar), els documents escrits, la prospecció i l'excavació arqueològica, fins a l'anàlisi de l'arquitectura i l'aplicació dels models de l'arqueologia predictiva (*least cost path*, *site catchment analysis*, *viewshed analysis* etc.). Els objectius consisteixen en la clarificació de les dinàmiques dels assentaments rurals en l'Edat Mitjana, des de el segle V fins al XIII, a través de l'anàlisi dels assentaments, de les vies de comunicació, del paisatge agrari i dels sistemes defensius i de l'estructura eclesiàstica. Aquest estudi ha demostrat que l'estructura del paisatge de la Vall d'Àger es genera amb un primer impuls entre els segles V i VII, i posteriorment experimenta un profund canvi a partir de finals del segle X.

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## INTRODUCTION

Archaeology is a teamwork. A PhD thesis is an individual work. A PhD thesis in Archaeology must conciliate both characteristics in order to be adequate for the scientific community and to comply with the institutional requirements. In this work, we will describe the results of a three-year research made of both individual and group work.

In the last 15 years, the historical archaeologists demonstrated a growing interest on Landscape Archaeology attempting to go beyond the site-centred view of the archaeological interpretation. Using methodologies that were traditionally associated to prehistoric studies as spatial analysis, paleo-environmental analysis, Geoarchaeology and predictive models, historical archaeologists widened their applications range. Associating these disciplines with the traditional analysis of Historical Archaeology as architecture analysis, interpretation of written sources and ancient topography, archaeologists created a model of Global Archaeology sometimes defined as Archaeology of Complexity. The result is an extended discipline whose main structure is

the work of several experts in each field of research and whose main challenge is the coordination of the heterogeneous data inside a general interpretive frame. Indeed, we must start with single class of data to analyse separately and to use for a holistic final interpretation. The present work can be located inside this wide line of research of multidisciplinary and interdisciplinary aggregation of expertise.

Starting from this theoretical base, we had to relate a short-term research to our own expertise trying to extend it through the continuous formation and at the same time complying with some short-term targets. This led to a work that we consider a starting point of a new way in which we approach the study of the ancient landscape and the relations between the human beings and their environment in the Ager Valley.

The work consisted in several phases:

- a) the first has been the retrieve of all information and study already available on the subject
- b) the second has been the shape of a theoretical framework in which insert the research and from which decide the methodology
- c) the third has been the acquisition of new data and the application of the chosen methodology

The phase c that corresponds to the applicative work of this thesis can be schematised in:

- 1) the remote sensing analysis
- 2) the archaeological survey
- 3) the archaeological excavation
- 4) the archaeogeographic analysis
- 5) the study of architectures
- 6) the analysis of different landscape typologies (defensive, sacred, etc.)
- 7) the synthesis of the results

We consider that this approach is the best choice for the overtaking of the site-centred archaeological approach, even if we are aware that we deal with a not uniform availability of data both in spatial and in chronological terms.

The remote sensing analysis was based especially on lidar-derived data at the landscape scale and it was based on ground penetrating radar analysis and electric tomography at the site scale.

The archaeological survey consisted especially of extensive survey even with the difficulty due to the intrinsic nature of the Ager Valley. Many areas resulted inaccessible for the prospection because of their dense vegetation canopy and the typology of cultivation applied, especially in the case of orchards.

The archaeological excavations consisted of two campaign at the Santa Coloma site in 2014 and 2015. At the same time, we were able to exploit unpublished data of archaeological excavations made in the hilltop of Ager since 1993 to 2009.

The archaeogeographic approach has been a task carried out in collaboration with the researches meet at the University of Rennes, and especially with Magali Watteaux whose specialisation is Archaeogeography. This approach consisted in the analysis of the road networks and the parcel systems of the Ager Valley related to their resilient characteristics.

The study of the architectures has been made using the methodology of the Archaeology of Architecture. Nevertheless, due to time-consuming tasks, we used the information about the architectures to define a general framework of architectural phases in the Ager Valley without entering in the specificity of each building.

The analysis of the different landscape typologies have been made using all the available data in order to obtain a framework of the organisation of the settlements, of the fortifications, of the churches in order to reconstruct a chronological sequence of the valley occupation. We carried out also some specific analysis of this area of research like the viewshed analysis, the site catchment analysis, the least cost path analysis, etc.

Finally, all these data and analysis results have been used to shape a general framework of the diachronic landscape organisation in the Ager Valley. We are aware that this work represents a starting point of a potential study that can only improve with the availability of new data.

## THE STUDY AREA

The Ager Valley is a Spanish valley located in the northern side of the Lleida province in the administrative region of La Noguera. From a geographic point of view, it is located in the pre-pyrenees stripe that consists of a middle-altitude mountain group with a range between 600 and 1600 metres above sea level. In the case of the Ager Valley, the maximum altitude is reached by the *Sant Alis* peak in the Montsec with an altitude of 1676 meters above sea level.

The Valley has a rectangular shape oriented in the east-west direction. It is closed at north by the *Montsec* and at south by the *Montclús* mountains. At east it is bordered by the *Noguera Pallaresa* River and at west it is bordered by the *Noguera Ribagorzana* River. In its southern portion it is crossed by the *Riu Fred* River that follows the main east-west direction of the valley. The actual geomorphology of the valley is generated by a group of alluvial fans that proceed from the Montsec towards south creating a central barely plain area. At the east and west sides of the valley the space is occupied by hills of middle altitude and the plain areas are scarcer. The east-west extension is approximately of 15 kilometres while the north-south extension reaches about 4.5 kilometres in the wider area.

The main settlements of the valley currently are *Ager*, *Agulló*, *Corçá*, *La Règola* and *L'Ametlla del Montsec*. They are disposed all along the central area of the valley and Ager dominates the central plain area from a little hill with an altitude of 600 meters above sea level. The main settlements of the region are Lleida and Balaguer and both are located at south. Balaguer is located at the border between the plain of Lleida and the beginning of the Pre-Pyrenees Mountains at approximately 35 Km and Lleida is located at approximately 50 Km south along the river Segre at the centre of the homonym plain.

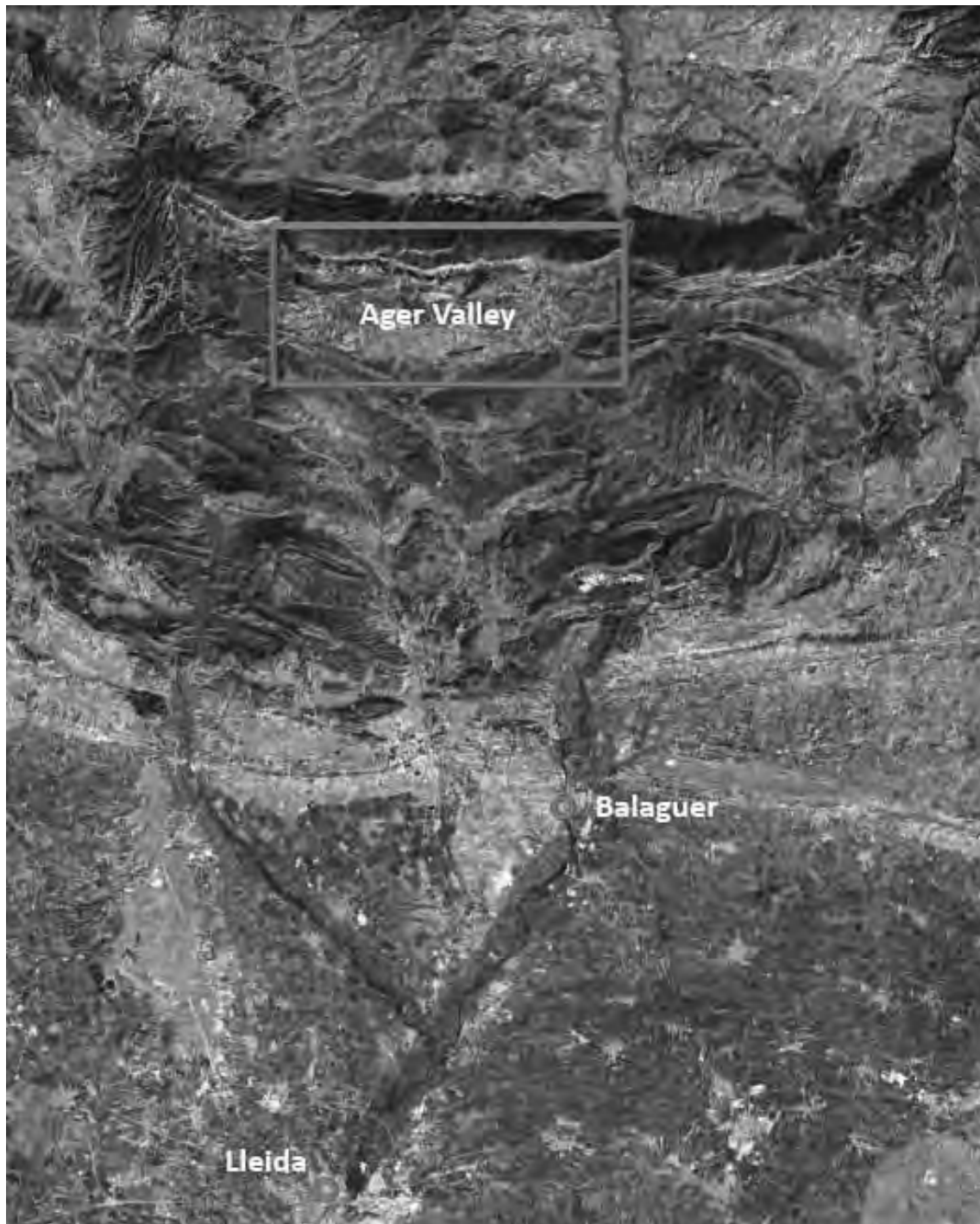
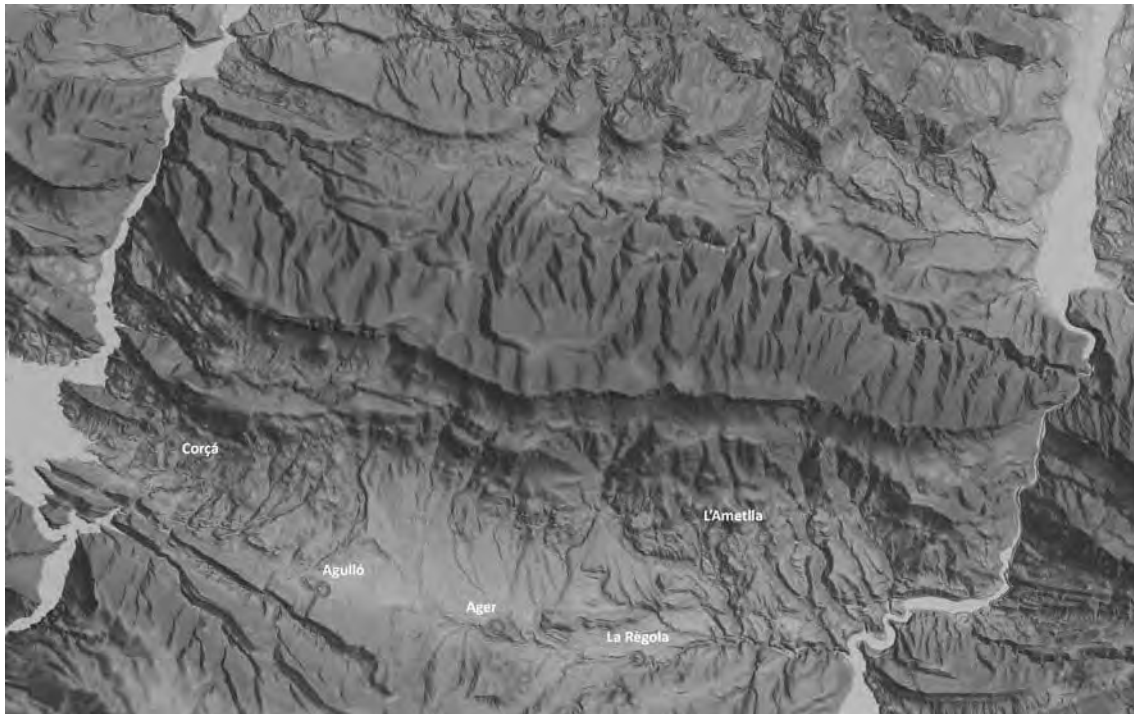


Figure 1. Localisation of the Ager Valley at north. (Source: Google Earth)



*Figure 2. Localisation of the main settlements in the Ager Valley over a lidar derived DTM.*





# 1

## HISTORY OF STUDIES AND HISTORIOGRAPHICAL DEBATE

### INTRODUCTION

This chapter is dedicated to the critical analysis of the publications in history and archaeology about the area of the Ager Valley, including the villages, the countryside and single monuments. The available bibliography can be categorised, for our purpose, in at least four groups based on the considered approach.

- a) Environmental – Naturalistic approach.
- b) Archival and Documentary approach.
- c) Artistic approach.
- d) Archaeological approach.

The major part of these studies deal with the village of Ager, meanwhile the other settlements of the valley are cited or approached with lower attention. Actually, Ager is still the main village of the valley and the major part of the available data refer to it.

Before our work, only two studies tried to afford the *long durée* history of the Ager valley and its surroundings<sup>1</sup> and both from a mainly documentary perspective.

### 1.1 ENVIRONMENTAL AND NATURALISTIC APPROACH

In the last four decades, the environmental safeguard of the natural spaces has been a main subject on the political and social debate. In the Ager Valley it has been encouraged through the promotion of its natural peculiarities from the geological and biological point of view. Several publications about these subjects have been produced<sup>2</sup> and they helped to foment the political debate on the creation of a Montsec Natural Park that included the Ager Valley<sup>3</sup>. The geologist Joan Rosell published a guide to the area geology<sup>4</sup>. In his work, he makes a good review of the peculiar characteristics of the valley and a description of the key areas useful to understand its evolution aspects. In the entire valley, a net of rural paths often retraces the ancient viability scheme passing through abandoned villages, towers, churches and other anthropic remains. The geomorphological aspects constrain, especially in the mountainous areas, the choice made by human actors, playing an important role on the evolution of a territory. It is evident that the environmental qualities must be taken into account by the archaeologists when approaching a diachronic analysis and when analysing the interactions between the human being and its environment. Indeed, in Landscape Archaeology it is necessary considering the environmental features as a constraining actor as well as a resource basin for human settlement. In this sense, the Ager Valley is rich of natural caves, refuges, springs, woods, pastures, but it has also areas with high flood risk, high steeped slopes and hostiles. Many scholars agree on the fact that the

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<sup>1</sup> The Works of Francesc Fité Llevot. *Reculls D'història De La Vall D'Ager. Període Antic I Medieval*. Ager: Imprenta Saladrígues, 1985 and Pere Sanahuja. *Història De La Villa De Ager*. Barcelona: Seráfica, 1961 that will be described in next paragraphs.

<sup>2</sup> For a general recap, see Josep de la Vega. *El Montsec I La Vall D'Ager*. Barcelona: Unió excursionista de Catalunya, 1998.

<sup>3</sup> The official documents are available at the web site of the *Consell Comarcal de La Noguera*: <http://www.ccnoguera.cat/index.php/arees-i-serveis>.

<sup>4</sup> Joan Rosell Sanuy, and Carme Llompart Díaz. *Guia Geològica Del Montsec I De La Vall D'Ager*. Barcelona: Montblanc-Martin, 1988.

environment has influenced human choices all throughout the history, even if we cannot agree to a complete environmental determinism.

## 1.2 ARCHIVAL AND DOCUMENTARY APPROACH SINCE THE 18<sup>TH</sup> CENTURY

We can locate the first modern historic attention for the Ager Valley with the interest on the archive of the collegiate church of *Sant Pere d'Ager* since the end of the 18<sup>th</sup> century. In 1763, the former archpriest of Ager asked the Premonstratensian Jaume Pasqual and Jaume Caresmar to compile an inventory of the archive documents. Jaume Caresmar published the result of his work in 1766 in two manuscripts that will be described in the next part of this chapter<sup>5</sup>. In addition, Jaume Pasqual in 1775 published some documents proceeding from the archive of the parochial church of *Sant Vicenç* in Ager, still unedited<sup>6</sup>. In 1821, Jaime Villanueva included the collegiate church of Ager in his visit of the Spain churches. In three letters addressed to his brother, he talks about the archive of the collegiate church and he makes a recap of the history of Ager since its origins<sup>7</sup>. The Villanueva's work will be very conditioning for the next generation of historians. Indeed, many of his assertion, as for example the roman origins of Ager or the hypothesis on the Islamic presence in the valley from an undefined period in the half of the 9<sup>th</sup> century to, at least the 1048, will be reused and taken for granted by historians like Francisco Codera and Pere Sanahuja<sup>8</sup>.

The documents of the archive of the collegiate church and the documents of the parochial church of Ager were used in historical, religious and law studies. Interesting examples come from the works concerning the jurisdictional disputes between the bishop of Urgell and the collegiate church of Ager. The latter between the 12<sup>th</sup> and the 13<sup>th</sup> centuries claimed to maintain its privileges obtained by Arnau Mir de Tost while the bishops of Urgell tried to impose their direct control, this dispute lasted from 1153 to

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<sup>5</sup> Jaume Caresmar. "Compendi De Tots El Instruments Antichs I Moderns Ques'troban En Lo Arxiu De La Molt Insigne Iglesia Colegiata De St. Pere De Ager Trasumtats De Orde Del Molt Illtre Sor. Dn Francisco Esteve, Arxipreste De Ella, En Lo Any Mdcclxxvi." Biblioteca de Catalunya, 1766.

<sup>6</sup> Jaume Pasqual. *Sacrae Antiquitatis Cataloniae Monumenta*. Biblioteca de Catalunya Ms. 729, 1775-1825.

<sup>7</sup> Jaime Villanueva. *Viaje Literario a Las Iglesias De España*. Vol. 9, Madrid - Valencia 1821.

<sup>8</sup> Francisco Codera Zaidín. "Límites Probables De La Conquista Árabe En La Cordillera Pirenaica." *Boletín de la Real Academia de la Historia* 48 (1906): 289-311.

Pere Sanahuja. *Historia De La Villa De Ager*. Barcelona: Seráfica, 1961.

1240<sup>9</sup>. Another example is the study made by Enric Moliné using the Synod Reports of Ager and Meia<sup>10</sup> and the studies regarding the *villanuevas* made by José Maria Font Rius<sup>11</sup>. It is important to remind that the Hispania Tarraconense was conquered by the Islamic forces around the 714 during the advance of the Muslims through the Via Augusta. During this period, the migration of Arab people to Al-Andalus created a situation of forced cohabitation between the Visigoths and the Muslims. After the conquest of Barcelona in 801 by the Christian counties forces, Andalusian society started an ambitious project of consolidation of the border with the Christian counties in the line from Saragossa to Lleida and Tortosa with urban development of these cities<sup>12</sup>. "In 922 Muḥammad ibn Lubb consolidated the fortresses of Monzon, Balaguer, Barbastro, Algerri, Montmagastre, Calasañç and others<sup>13</sup>" this was another attempt to definitively consolidate the border with the Christians counties. Parallel to this consolidation was the territorial cohesion, the countryside was characterised by a dense settlement around centres that became cities, such as Balaguer in the north of Lleida<sup>14</sup>. In the next century from the 1016 the border was controlled directly from Lleida that became the political centre of the Taifa<sup>15</sup>.

### 1.3 ARTISTIC APPROACH

The artistic growth in the Ager valley is concomitant with its political importance. After the conquest of Ager by the Christians county, completed permanently in 1048

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<sup>9</sup> Paul Freedman. "Jurisdictional Disputes over Sant Pere D'Ager (Catalonia) in Light of New Papal Documents." In *Proceedings of the Ninth International Congress of Medieval Canon Law. Munich, 13-18 July 1992*, edited by Peter Landau and Joers Mueller, 1-29. Città del Vaticano: Biblioteca Apostolica Vaticana, 1997.

<sup>10</sup> Enric Moliné. "Les Constitucions Sinodals D'Ager I Meià." *Revista d'història moderna* 13, no. 2 (1993): 163-69

<sup>11</sup> José Maria Font Rius. "Fundació i Enfranchiment De La Vilanova D'Ager (1315)." *Quaderns de la Selva* 13 (2001): 249-53.

<sup>12</sup> Jesús Brufal Sucarrat. "The Northeast Iberian Peninsula and Its Muslim Rulers (8th-12th Century)." In *The Crown of Aragon. A Singular Mediterranean Empire*, edited by Flocel Sabaté Curull. Leiden: Brill, in press.

<sup>13</sup> Jesús Brufal Sucarrat. "The Northeast Iberian Peninsula and Its Muslim Rulers..." p. 14.

<sup>14</sup> Jesús Brufal Sucarrat. "The Northeast Iberian Peninsula and Its Muslim Rulers..." p. 16.

<sup>15</sup> Felipe Mailló, ed. *La Caída Del Califato De Córdoba Y Los Reyes De Taifas (Al-Bayan Al-Mugrib)*. Salamanca: Universidad de Salamanca, 1993, p.186.

according to the traditional historiography<sup>16</sup>, a phase of reconstruction and settlement started. The Romanic churches, the villages and the defensive towers are the main evocative examples of this period. The building of the collegiate church of Sant Pere represented the definitive consecration of Ager by the Tost's family. The continuous endowments by the Tost's family to the collegiate church represents the economic and political efforts to assure the control of the entire valley. The scientific literature we dispose lacks of stratigraphic studies on the architecture in the valley. This means that it is more difficult to locate chronologically every one of these buildings before they are mentioned in the written sources.

#### 1.4 ARCHAEOLOGICAL APPROACH

The archaeological approach is perhaps the most promising one for the development of knowledge about the valley past. It can bring to a new point of view separated from the dictatorship of the written sources. It is interesting also because it can get to afford old themes with new approaches and to generate new questions about the past of this area. One of the objective of this work is to reorder what was made until now and to trigger new research approaches. In the valley during the last sixty years, there has been at least one archaeological intervention every ten years, comprising the two directed under this work in the area of Santa Coloma in 2014 and 2015. These excavations were in majority intervention of rescue archaeology and many of that are not published in scientific literature. At the end of this chapter the available information on the archaeological intervention in the Ager Valley will be described. The reports of the archaeological activities are available at the archive of the *Departament de Cultura - Serveis Territorial de Lleida*. We obtained the informations on the excavations made by Prim Bertran<sup>17</sup> in 1983-1984, the excavation inside the fortified enclosure of Ager directed by Montserrat

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<sup>16</sup> Francesc Fité Llevot. "Un Apropament a L'estudi Del Molins Del Montsec a La Vall D'Ager." *Acta Historica et Archaeologica Medievalia* 4 (1983): 207-38.

<sup>17</sup> Prim Bertran Roige, and Francesc Fité Llevot. "El Jaciment Arqueologic De Santa Coloma D'Ager (Provincia De Lleida)." In *Actas Del Primer Congreso De Arqueologia Medieval Española*, 203-20. Huesca, 1985.

Coberó between 1993<sup>18</sup> and 1998<sup>19</sup>, the excavations on the ancient road near Fontdepou made in 2002<sup>20</sup> and many others that will be described during this chapter. As it will result clear to the reader, the most important interventions have been made in the higher part of Ager, inside the fortification and the collegiate church of Sant Pere. The aim is to pay special attention to the material evidence and to reuse as much as possible all the archaeological information available to obtain “the big picture” of the history of the valley.

## 1.5 HISTORY OF STUDIES

This paragraph is intended to follow a barely chronological scheme starting from the most relevant works in the 18<sup>th</sup> century until nowadays. We can situate the starting point of the Ager historiography with the works of the Premonstratensians Jaume Pasqual and Jaume Caresmar. Both works are manuscripts written in the 18<sup>th</sup> century referring to the written sources available at the archive of the collegiate church of Ager. The work of Jaume Pasqual, *Sacrae Antiquitatis Cataloniae Monumenta*, is a more general collection composed of eleven volumes still unpublished<sup>21</sup>. In the volume nine, it contains the transcriptions of some documents of the parochial church of Ager. Jaume Caresmar, responding to a request by the archpriest of Ager Francisco Esteva, wrote a manuscript in 1766 in which he classified, summarised and partially copied the documents of the archive of the collegiate church of Ager<sup>22</sup>. In 1768 he was asked to make a summary, or at least an index of this work, for the *Real Cámara* of Madrid and he produced a second work that represents a recap of the first<sup>23</sup>. As we will see further,

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<sup>18</sup> Montserrat Coberó Farrés. *Memoria D'intervenció. Col·legiata De Sant Pere D'Ager (Nº 1477)*. Edited by Direcció General del Patrimoni Cultural Lleida: Manuscript, 1995.

<sup>19</sup> Montserrat Coberó Farrés. "Informe Campaña 1998 Del Recinte Fortificat De Sant Pere D'Ager. Precedents, Explendor Baix Medieval I Evolució Posterior." edited by Departament de Cultura. Serveis Territorial de Lleida. Vilanova del Camí, 1998.

<sup>20</sup> Alma María López Guerra. "Memoria De La Invernación En La Calzada De Fontdepou-Ager." edited by Proleg. Desenvolupament de patrimoni cultural. Lleida, 2002.

<sup>21</sup> Jaume Pasqual. *Sacrae Antiquitatis Cataloniae Monumenta*. Biblioteca de Catalunya Ms. 729, 1775-1825.

<sup>22</sup> Jaume Caresmar. "Compendi De Tots El Instruments Antichs I Moderns Ques'troban En Lo Arxiu De La Molt Insigne Iglesia Colegiata De St. Pere De Ager Trasumptats De Orde Del Molt Illtre Sor. Dn Francisco Esteva, Arxipreste De Ella, En Lo Any Mdcclxxvi." Biblioteca de Catalunya, 1766.

<sup>23</sup> Jaume Caresmar. "Resumen Del Archivo De La Insigne Iglesia Colegial De San Pedro De Ager En Cataluña Por El Que Lo Contenido De Todos Y De Cada Uno De Los Instrumentos, Documentos Y Papeles, Que En Aquell Se Hallan, Se Declara En Suma, Según El Orden De Su Antigüedad, Del Siglo X Hasta El Corriente Xviii.

Eduardo Corredera published the work of Caresmar in 1978<sup>24</sup>. It is interesting to notice that some of the documents described in the *Compendium* are now disappeared and we can only refer to the description made by Caresmar.

In 1821, Jaime Villanueva published the 9<sup>th</sup> volume of his work *Viaje literario a las Iglesias de España*<sup>25</sup>. In three letters, he wrote to his brother the information obtained during his visit to the village of Ager and its archive. It is very interesting to report the description made by Villanueva because here he pour the foundation of some concepts and interpretations that will remain unchanged until our days. Many researchers of the following generations that studied Ager or its territory, as Francesc Fité, will refer to Jaime Villanueva. First of all the roman presence in the valley is taken for granted by Villanueva even if there is no concrete evidence to support this<sup>26</sup>. Citing Jaume Caresmar and Juan Biclarense bishop of Girona, Villanueva asserts that Visigoths did not conquered the area of Ager before 574 A.D. Then he passes directly to the Middle Age stating that the “pacific reign of the Moresque” was interrupted by the aggressions of the Christians conquers headed by Arnau Mir de Tost at the beginning of the 11<sup>th</sup> century. The valley could have been already inhabited by Christians before 1036 (and according to Villanueva this is the period of the first conquest) and only in the 1048 it would have been a second Muslim incursion with a brief turnover in the control of the valley. After this second Muslim domain, the Christians of Arnau Mir de Tost would have reconquered definitively the village of Ager and the entire valley. These events are reported in the same way in some documents ascribed to Arnau Mir de Tost and to his wife Arsenda<sup>27</sup>. The remaining of this first letter is dedicated to the Tost’s family, its origins and its successors.

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Que De Encargo De La Rl Camara Ha Compuesto Y Ordenado Dn. Jaime Caresmar, Doctor Theologo, Canonigo Y Exabad Del Real Monasterio De Bellpuig De Las Avellanas." edited by Archivo Historico Nacional. Bellpuig de Les Avellanes, 1768.

<sup>24</sup> Eduardo Corredera Gutiérrez. *El Archivo De Ager Y Caresmar*. Balaguer: Artes Graficas Romeu, 1978. A description of the work made by Caresmar is also published in Eduardo Corredera. "Al Marge De Caresmar (Caresmar En Ager)." *Analecta Sacra Tarraconensia* (1974): 15-26.

<sup>25</sup> Jaime Villanueva. *Viaje Literario a Las Iglesias De España*. Vol. 9, Madrid - Valencia 1821.

<sup>26</sup> Jaime Villanueva. *Viaje Literario a Las Iglesias De España...* pp. 93-94.

<sup>27</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica De Sant Pere D'Ager Fins 1198*. 2 vols. Barcelona: Fundació Noguera, 2011, N22, pp. 227-229.

In the next letter, the number 75, Villanueva describes the origins of the collegiate church of Sant Pere and the relationship with the others churches in the valley. He clearly refers to the document sent by pope Nicolaus II in 1060 when Sant Pere of Ager is declared “abadia nullius<sup>28</sup>”. Again, Villanueva says a thing that will remain indelible for the next historians and that will be repeated until our days: he says that the Christians have “ancient roots” in the valley but during the Muslims domination, the Christian cult was interrupted. In this second letter Villanueva talks about the Muslim but in a different way from the first letter, he does not say the “pacific reign of the Muslims” as before but “brutal and unfaithful” during the second conquest of the village<sup>29</sup>.

In the third and last letter dedicated to Ager, the number 76, Villanueva describes the remains of the collegiate church, the materials, the furniture and the archive<sup>30</sup>. In this text, he cites the remains of a marble sarcophagus, considered of roman origin and used in that moment as baptismal font. He also describes the relics of Santa Sabina whose cult is not present before the 15<sup>th</sup> century. Finally, in his contribution Villanueva deals with some questions that persist in our days: a) the origin of the Ager place name, b) the origin of the village. He does not propose anything new but he just reports the interpretations made by Pièrre de Marca in the 17<sup>th</sup> century<sup>31</sup>. The most curious part is the interpretation made of the place name, indeed, he interpreted the origin of Ager from the name *Erga* cited in Ptolemais.

After Villanueva, the historiography arrives directly at the beginning of the 19<sup>th</sup> century. In 1900 and in 1906 Francisco Codera published two papers in the “Boletín de la Real Academia de la Historia” where he mentions the case of the Ager valley. The first paper is a sort of review of some monographies written by several authors<sup>32</sup>. Through the reviewed texts, there is a study on the Viscounty of Castellbó by Joaquim Miret Sans<sup>33</sup>.

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<sup>28</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica...* N44, pp. 266-268.

<sup>29</sup> Jaime Villanueva. *Viaje Literario a Las Iglesias De España...* p. 109.

<sup>30</sup> Jaime Villanueva. *Viaje Literario a Las Iglesias De España...* pp. 125-150.

<sup>31</sup> Pièrre de Marca. "Marca Hispanica, Sive Limes Hispanicus, Hoc Est Geographica Et Historica Descriptio Cataloniae, Ruscinonis Et Circumiacentium Populorum." Paris, 1688.

<sup>32</sup> Zaidín, F. C. (1900). "Monografías históricas de Cataluña." Boletín de la Real Academia de la Historia **36**: 410-417. The cited work here is by Sans, J. M. (1900). Investigación histórica sobre el vizcondado de Castellbó : con datos inéditos de los condes de Urgell y de los vizcondes de Ager. Barcelona, Imprenta La Catalana de J. Puigventós.

<sup>33</sup> Joaquim Miret Sans. *Investigación Histórica Sobre El Vizcondado De Castellbó : Con Datos Inéditos De Los Condes De Urgell Y De Los Vizcondes De Ager*. Barcelona: Imprenta La Catalana de J. Puigventós, 1900.



Citing this work Codera proposes a very interesting interpretation based on some documents mentioned by Miret Sans<sup>34</sup>. He sustains that it is possible that the Ager valley has not been conquered by the Muslims on a stable way. Only later, near the 11<sup>th</sup> century, it has been the set of raids and intrusions, in order to obtain spoils and to force the local population to pay a sort of tribute. On the second paper by Codera the same interpretation is supported with the written sources known until that period<sup>35</sup>. Resuming, the interpretation made by Codera is based on the dating of some documents. In particular, he considers that in 1035 the village of Ager was cited as populated by Christians, with a monastery and, at least, three churches more: Sant Pere, Sant Vicenç and Sant Salvador. In addition, it appears that in 1029 Arnau Mir de Tost owned properties in the *Cuenca de Tremp* (separated from the Ager valley by the Montsec) and that in 1034 he already owns many properties in the Ager valley itself<sup>36</sup>. It is difficult to place the date of the supposed conquest of the Ager valley. Remarkably, in 1035 Ermengol II and his wife Costance granted some privileges to the village of Santa Linya, placed at 20km south of Ager, this can guarantee that an extended part at south of the Montsec was already in Christian's hands<sup>37</sup>. It is sure that during these campaigns, Arnau Mir de Tost was only at the service of the Urgell's count and that his first possessions may have come as prize for raids. In the years between 1041 and 1061 it seems that Ager had suffered again a violent Muslim raid, reported in the written sources, and that allowed the second war campaign of Arnau Mir de Tost. Basing on these elements Codera thinks that the time from the first to the second is too short to think about a Christian conquest and a sudden consolidation of a Christian community. It must have existed in advance. Alternatively, the valley may have not durably conquered by the Muslim. As we see before, during the consolidation of the borders, the Muslims forces acted a plan of territorial cohesion and dense settlements that left their evidence until nowadays. This was the case of the area around Balaguer, about 35 Km south of Ager that was deeply influenced by the Muslim presence<sup>38</sup>. The Ager valley

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<sup>34</sup> Joaquim Miret Sans. *Investigación Histórica Sobre El Vizcondado...* pp. 67-75.

<sup>35</sup> Zaidín, F. C. (1906). "Límites probables de la conquista árabe en la cordillera pirenaica." *Boletín de la Real Academia de la Historia* 48: 289-311.

<sup>36</sup> Joaquim Miret Sans. *Investigación Histórica Sobre El Vizcondado...* p. 70.

<sup>37</sup> Joaquim Miret Sans. *Investigación Histórica Sobre El Vizcondado...* p. 71.

<sup>38</sup> Jesús Brufal Sucarrat. "The Northeast Iberian Peninsula and Its Muslim Rulers (8th-12th Century)." In *The Crown of Aragon. A Singular Mediterranean Empire*, edited by Flocel Sabaté Curull. Leiden: Brill, in press.

then may have been subjected to a formal domain based on economic tributes but not inhabited by Muslim community, or may have been victim of temporary raids from the south.

In 1909, Josep Puig Cadafalch published a huge work on Romanic architecture of Catalonia and dedicated some reflections to the monumental remains of the Ager valley<sup>39</sup>. In the first volume, the author lists Ager in the little villages of roman origins. He bases his assumption on the marble sarcophagus preserved in the Sant Vicenç church and on the constructive aspects of the fortification wall in the hilltop of the village<sup>40</sup>. In the second volume, the church of Sant Hoïme is presented as an example of rural church<sup>41</sup>. More interesting it is the mention about the cemetery of Santa Coloma<sup>42</sup>. Puig reports that the cemetery was discovered during agrarian works made on a vineyard by some peasants. In the third volume, he made some reference to other churches in the valley and to the collegiate church of Sant Pere describing its architectonic elements and some decorative aspects<sup>43</sup>.

As president of the *Mancomunitat de Catalunya*, in 1922 and 1923, Puig Cadafalch tried to resolve some problems related to the possible collapse of the bell tower and the rests of the collegiate church<sup>44</sup>. During the third Carlist War in 1872-1876 the Ager valley was affected by many destructions, some villages like Montlleó were definitively abandoned and the area of the collegiate church suffered additional damages<sup>45</sup>. Francesc Fité reported a Puig's letter of 1923 in which he explains the modality of the intervention in order to consolidate the tower and avoid dangers for the local houses<sup>46</sup>. This can be

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Jesús Brufal Sucarrat. "Ràpitas En El Límite Occidental Del Islam Medieval. Su Incidencia En La Configuración Del Paisaje Fronterizo En El Secotr Oriental Del Valle Del Ebro Altomedieval: La Ràpita (Lleida)." *Marq. Arqueología y museos* 07 (2016): 141-52.

<sup>39</sup> Josep Puig Cadafalch. *L'arquitectura Romanica a Catalunya*. Barcelona: Institut d'Estudis Catalans, 1909.

<sup>40</sup> Josep Puig Cadafalch. *L'arquitectura Romanica...* vol. 1, pp. 147-148.

<sup>41</sup> Josep Puig Cadafalch. *L'arquitectura Romanica...* vol. 2, pp. 262-286.

<sup>42</sup> Josep Puig Cadafalch. *L'arquitectura Romanica...* vol. 2, p. 413.

<sup>43</sup> Josep Puig Cadafalch. *L'arquitectura Romanica...* vol. 3, p. 208 for the church of Santa Maria and pp. 436-440 for the collegiate church. Other references to architectonic elements are at pp. 660,704 and 861.

<sup>44</sup> The Mancomunitat was an institution with administrative functions active during the beginning of the 20<sup>th</sup> century (1914-1924) that connected the provinces of Catalonia. Puig Cadafalch was its president from 1917 to 1924. For a bibliographic reference, see Albert Balcells, Jordi Sabater, and Enric Puyol. *La Mancomunitat De Catalunya I L'autonomia*. Barcelona: Proa, 1996.

<sup>45</sup> Some occurs of the Carlist War in Ager are described in the book by Eduard Gonzàlez Montardit. *Un Farmacèutic D'Ager En La Guerra Dels Carlins*. Bellpuig: BL, 2003.

<sup>46</sup> Francesc Fité Llevot. "Puig I Cadafalch I La Primera Intervenció a Sant Pere D'Ager (1922-1923)." *Lambard. Estudis d'art medieval* 22 (2011): 135-61.

considered, according to Fité, the first restoration of the collegiate church of Sant Pere in Ager. In this period, the interest of the restoration is not of historical or artistic nature but it is intended as reduce hazard for the population living under the historical area. After the Carline wars, despite this intervention, many decorative materials of collegiate church and of other churches in the valley disappeared. It is verisimilar that they were partially reused to reconstruct civilian buildings as demonstrates a recent article by Francesc Fité<sup>47</sup>. During the civil war of 1936-1939 the Ager hilltop was settled as a military fort with a barracks and a prison.

In 1929, Eduard Finestres Fosch published an article on the Ager Valley in the *Album Maravella*, a book that could be considered as a touristic guide of that time<sup>48</sup>. In his paper he wrote a synthetic description of the natural features of the valley and then he takes on the history of the village of Ager. With his words "*que amb els romans era Ager un centre importantíssim ho demostren les restes de muralla que tenim, i l'existència d'una sepultura romana, de gran valor arqueològic que serveix avui de batejadora a l'església parroquial*"<sup>49</sup>. He retrieves the information given by Puig and Villanueva but here this is taken for granted as a certainty and not as a hypothesis.

Undeniably, it is possible to notice that during years we assist at the formation and construction of a "traditional history" of the place that is not really supported by strength evidences but it is only based on weak evidences and on the words of two or three intellectuals.

The first monography that aspire to be an organized and complete history of Ager is the book of Pedro Sanahuja<sup>50</sup> posthumous published in 1961. This book gives a volume of information bigger than the previous works. In spite of that, in the references cited as models in the first pages, there are still Villanueva, Finestres and Puig. In the first chapter, he spends some pages to talk about the roman origins of Ager. He retrieve the information of his predecessors and, in addition, he cites for the first time a road

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<sup>47</sup> Francesc Fité Llevot. "Consideracions Sobre Les Fases Constructives De Sant Pere D'Ager." In *Catalunya Romanica*, edited by Fundació Enciclopedia Catalana, 132-33. Barcelona: Cayfosa indústria gràfica, 1994.

<sup>48</sup> Eduard Finestres Fosch. "La Vall'd'Ager." In *Album Maravella. Llibre De Belleses Naturals I Artistiques De Catalunya*, edited by Pere Pujol Casademont, 167-70. Barcelona: Ibérica, 1929.

<sup>49</sup> Eduard Finestres Fosch. *La Vall'd'Ager...* p.169.

<sup>50</sup> Pere Sanahuja. *Historia De La Villa De Ager*. Barcelona: Seráfica, 1961.

discovered in 1954 by José Tarragó Pleyan and interpreted as roman<sup>51</sup>. From the second to the fourth chapters Sanahuja affords the theme of the Islamic presence in the valley, reporting that Muslims established directly in the village of Ager. He brings some documents from the collegiate church archive, now lost, that should deny the Codera's thesis exposed before<sup>52</sup>. In addition, the author expresses a strong position about the thesis on the roman presence in the valley. On one side, he considers the roman presence in Ager to be possible but on the other side he ascribes the architectural remains of Ager to the Islamic period, without any demonstration and citing only written sources<sup>53</sup>.

Immediately, from the fifth chapter, Sanahuja concentrates on the personal life of Arnau Mir de Tost and his family. He already treated this argument in 1926<sup>54</sup> and in 1943 articles where exposed the same arguments about the origins of the Tost's family<sup>55</sup>. He deepens the sequence of events related to his sons, to the patrimony and the collegiate church of Sant Pere. It is a study based on the major part of the written sources available at the archives of the collegiate church and at the archive of the parish church of Ager that in part were used by Villanueva too. He also uses some sources from other archives such as the Lleida and the Tarragona one<sup>56</sup> until the 19<sup>th</sup> century. The Sanahuja's work has some imprecisions and some ideological positions that cannot be accepted anymore, as for example the representation of Arnau Mir de Tost as "caudillo de la Reconquista Cristiana<sup>57</sup>" or the interpretations made on the Muslims' conquest of the valley. Anyway, this work can be considered as the start of the contemporary historiography on Ager. Finally, it worth to notice that in this work there is no reference to the Ager valley as a whole and neither any word is said about the other villages nearby.

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<sup>51</sup> Pere Sanahuja. *Historia De La Villa...* p. 12.

<sup>52</sup> Pere Sanahuja. *Historia De La Villa...* pp. 16-30.

<sup>53</sup> Pere Sanahuja. *Historia De La Villa...* pp. 16-30.

<sup>54</sup> Pere Sanahuja. "Arnau Mir De Tost." *Revista de Catalunya* 4 (1926).

<sup>55</sup> Pere Sanahuja. "Arnau Mir De Tost, Caudillo De La Reconquista En Tierras De Lérida." *Ilerda* 1 (1943).

<sup>56</sup> Pere Sanahuja. *Historia De La Villa...* pp. 31 and following.

<sup>57</sup> Pere Sanahuja. "Arnau Mir De Tost, Caudillo De La Reconquista En Tierras De Lérida." *Ilerda* 1 (1943).

In 1967, Rodrigo Pita Mercé published a paper for the *Archivo Español de Arqueología* named *La Muralla Romana de Ager*<sup>58</sup>. Since the title, the Pita Mercé's interpretation about the roman origin of the Ager wall is manifest. He tries to demonstrate the roman origin analysing the material evidence of the wall. This paper is interesting mainly because in the first part the author does a review on the still unsolved historical questions about Ager. He refers to "the remains of a stone path, three meters wide, which could have been an ancient roman road, rebuild and reused during Middle Ages and that connected Ager to Balaguer"<sup>59</sup>. He also retakes the problem of the place name arguing that Ager may coincide to a roman town cited by Ptolemais, not *Ergia* as said by Pièrre de Marca, but *Gallica Flavia*. Then this name was changed to Ager during Middle Ages from the Latin word *agger*<sup>60</sup>. The rest of the article is dedicated to the analysis of the constructive techniques of the wall. At the end of the paper, he proposes the reconstruction of the original plan of the town. Pita Mercé asserts that the roman wall should have been located in the same place as the present wall, and that the towers, today circular, should be settled above the original squared towers. He takes as proof of this assertion the remains of a squared tower, the D tower, located at the north face of the town<sup>61</sup>. Finally, he proposes the reconstruction of other two lines of wall that surrounded the village and dates them respectively in the 16<sup>th</sup> and in the 18<sup>th</sup> century. For what concerns the origins of the town, Pita Mercé does not exclude the possibility of a roman origin for the fortification but he admits that there are no evidence that would make things easier and that the hypothesis are weak<sup>62</sup>.

An important contribution to the Ager historiography comes from Eduardo Corredera. In particular, with his work, he helped to understand better the role of the Monastery of the Avellanes<sup>63</sup> and the work that Jaume Pasqual and Jaume Caresmar did for the archive of the collegiate church of Ager. In 1978, Corredera published a summary of the

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<sup>58</sup> Rodrigo Pita Mercé. "La Muralla Romana De Ager." *Archivo Español de Arqueología* 40, no. 115-116 (1967): 104-09. The title of this paper can be translated as "The Ager roman wall".

<sup>59</sup> Rodrigo Pita Mercé. *La Muralla Romana...* p.104. Our translation from the spanish: "restos de un antiguo camino empedrado, de más de tres metros de ancho, que pudo ser una antigua via romana, reconstruida y reaprovechada en tiempos medievales y que servia para comunica Ager y Balaguer".

<sup>60</sup> Rodrigo Pita Mercé. *La Muralla Romana...* p.104.

<sup>61</sup> Rodrigo Pita Mercé. *La Muralla Romana...* p.106.

<sup>62</sup> Rodrigo Pita Mercé. *La Muralla Romana...* p.115.

<sup>63</sup>Eduardo Corredera. *La Escuela Histórica Avellanense*. Lleida: Instituto de Estudios Ilerdenses, 1971.

Caresmar's works of 1766 and 1768<sup>64</sup>. As Corredera says in the introduction of the book, he uses preferably the second work and only in case of doubt, he refers to the first<sup>65</sup>. In addition, his aim is to make a recap easy to use and to read, so that this is not a complete remake of the Caresmar's work but a selection of documents based on the author's interest<sup>66</sup>.

From the eighties until nowadays Francesc Fité is the referring researcher for the Ager Valley. Starting from the publication of his PhD thesis that recollects a review of the past works about Ager and try to extend it<sup>67</sup>. He also published during his academic career several articles regarding the archaeological and artistic approach to the valley<sup>68</sup>. During this period, the historical interest starts to move not only towards Ager but also towards the entire valley. This represents a change in the view of the phenomena that occurred between roman period and the early middle ages. I refer especially to the fact that the regional role played by seigniorial power of Tost's family and later by the viscounts of Ager was improved by the homogeneity of this territory. Even if Ager became formally a viscounty only some year before 1268 when the count Alvare died, it remained controlled by the county of Urgell since the XI century<sup>69</sup>.

Fité's work is structured, as in the case of Sanahuja, in a systematic and diachronic review of the events occurred in Ager from its origins. The major part of the book is dedicated to the 11<sup>th</sup> and 12<sup>th</sup> centuries. He lingers also on the person of Arnau Mir de Tost, as explicitly declared in the text<sup>70</sup>. There is a sort of mythology around the figure

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<sup>64</sup> Eduardo Corredera. *El Archivo De Ager I Caresmar*. Balaguer: Artes Gráficas Romeu, 1978.

<sup>65</sup> Eduardo Corredera. *El Archivo De Ager I Caresmar...* p. 23.

<sup>66</sup> Eduardo Corredera. *El Archivo De Ager I Caresmar...* p. 23. "A vista de estas dos obras nosotros hemos resumido el trabajo de Caresmar reduciéndolo a proporciones que hagan fácil su manejo y aprovechamiento. [...] Preferentemente hemos partido del segundo trabajo, que – en caso de duda – hemos explicado en base del primero".

<sup>67</sup> Francesc Fité Llevot. *Reculls D'història De La Vall D'Ager. Període Antic I Medieval*. Ager: Imprenta Saladrígues, 1985.

<sup>68</sup> Francesc Fité Llevot. "Arnau Mir De Tost I La Fundació De La Col·legiata De Sant Pere D'Ager." *Lambard. Estudis d'art medieval* 21 (2010): 117-48.

Francesc Fité Llevot. "El Lot De Peces D'escacs De Cristall De Roca Del Museu Diocesà De Lleida, Procedents Del Tresor De La Col·legiata D'Ager (Segle Xi)." *Acta Historica et Archaeologica Medievalia* 5-6 (1984): 281-312.

<sup>69</sup> Flocel Sabaté. "La Création De La Vicomté D'Ager." In *Figures De L'autorité Médiévale. Mélanges Offerts À Michel Zimmermann*, edited by Pierre Chastang, Patrick Henriot and Claire Soussen, 245. Paris: Publication de la Sorbonne, 2016.

Francesc Fité Llevot. *Reculls D'història De La Vall D'Ager. Període Antic I Medieval*. Ager: Imprenta Saladrígues, 1985, pp. 85-174.

of Arnau Mir de Tost, inherited by the nationalist historiography. He is often represented by locals, and in written sources, as a national hero who freed the valley from the Muslims oppression. He is also viewed as the lord who devoted his work to the repopulation and the economic improvement of the valley. In some cases, he is named even as the "Catalan Cid"<sup>71</sup>.

According to Fité, the evidence that could be useful to reconstruct the most ancient period of population of the valley (prehistory and ancient history) are lacking. In Fité's opinion this is due to the obvious lack of written sources and to the almost immobility of the archaeological research. The part that he pledges for the roman period and the Early Middle Ages, just repeats what was said by Villanueva and Sanahuja about the roman road, the sarcophagus and other small evidences that fomented that idea. In addition, for the Early Middle Ages even if it still maintained the conviction of a valley in the middle of a frontier and completely dominated by the Muslims, it lacks any strong evidence to support it, as well as an analysis of this process of change. Some improvements brought by Fité on the work of his predecessors are the publications of the results of two excavations made in the area of Santa Coloma where is located a cemetery with an extended chronology. As stated above, this area was already known by Puig after some local people reported it to him. Prim Bertran and Francesc Fité directed the excavation made during 1983-1984. It was located under a path that from the modern Ager cemetery brings to the Montsec. Under the path, they rediscovered some architectural structures interpreted as a church and some stone sarcophagi<sup>72</sup>.

Another approach parallel to this of the documentary research on the Ager Valley is centred on the juridical evolution of the community and the ecclesiastical administration. In particular, there has been a dispute between the bishop of Urgell and

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<sup>71</sup> Among several works dedicated to Arnau Mir de Tost and in addition to the cited works of Sanahuja and Villanueva, there is an updated biography of Francesc Fité and Eduard Gonzalez Montardit Francesc Fité Llevot, and Eduard González Montardit. *Arnau Mir De Tost: Un Senyor De Frontera Al Segle Xi*. El Comtat D'urgell. Lleida: Universitat de Lleida, 2010.

It also appeared an article of Flocel Sabaté in the biographyc dictionary of the Real Academia de la Historia in Flocel Sabaté. "Mir De Tost, Arnaldo." In *Diccionario Biográfico Español*. Madrid: Real Academia de la Historia, 2012, 35, p. 223-226.

<sup>72</sup> Prim Bertran Roige, and Francesc Fité Llevot. "El Jaciment Arqueologic De Santa Coloma D'Ager (Provincia De Lleida)." In *Actas Del Primer Congreso De Arqueologia Medieval Española*, 203-220. Huesca, 1985.

the church of Ager for the control of the parishes in the valley<sup>73</sup>. The article published in 1952 by José Maria Font Rius starts from the documentary sources of the commune ordinances to delineate the development of the municipal conscience of the community and, at the same time, to the detachment from the seigniorial impositions<sup>74</sup>. He affords also the problem of the new towns (*villanovas*) built during the Middle Ages all around the valley amongst that defined as Villanova d'Ager<sup>75</sup>. Another interesting part is about the village now called *La Règola*. According to Font Rius the entire village should be named as *San Julian de la Règola*. When Arnau Mir de Tost granted the cart of exemption to La Règola, the village is defined as follows:

*...quia facimus cartam franchitatis ad omnibus hominibus habitantibus qui sunt et erunt in villa Sancti Juliani quod vocatur Regulam, qui est infra terminos Castri Ageris...*<sup>76</sup>

As it is possible to read the document talks about a pre-existence of a village named *Regulam*. This is important for the knowledge of the village itself that could have an early origin. In addition, the place name *Regulam* can suggest a monastic foundation. We know that during early Middle Ages in the area of the pre-pyrenees one of the main way of establishment was the construction of a monastery, sometimes with a connected village<sup>77</sup>.

To conclude the excursus about the basis of the historiography regarding Ager and its valley, it is necessary to pass to the church history. The work of Enric Moliné analyse briefly the 114 synods constitutions of Ager<sup>78</sup>. The two sources date 1648 and 1665 and

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<sup>73</sup> Paul Freedman. "Jurisdictional Disputes over Sant Pere D'Ager (Catalonia) in Light of New Papal Documents." In *Proceedings of the Ninth International Congress of Medieval Canon Law. Munich, 13-18 July 1992*, edited by Peter Landau and Joers Mueller, 1-29. Città del Vaticano: Biblioteca Apostolica Vaticana, 1997. This question will be deepen in the next section of this chapter.

<sup>74</sup> José Maria Font Rius. "Notas Sobre La Evolución Juridico-Publica De Una Comunidad Local En El Pirineo Catalan: Ager." *Actas del primer congreso internacional de estudios pirenaicos. San Sebastián 1950* 6 (1952): 67-85.

<sup>75</sup> José Maria Font Rius. "Fundació I Enfranchiment De La Vilanova D'Ager (1315)." *Quaderns de la Selva* 13 (2001): 249-53.

<sup>76</sup> Cited in José Maria Font Rius. "Notas Sobre La Evolución Juridico-Publica De Una Comunidad Local En El Pirineo Catalan: Ager." *Actas del primer congreso internacional de estudios pirenaicos. San Sebastián 1950* 6 (1952), p.72 note 17.

<sup>77</sup> Jordina Sales Carbonell, and Natalia Salazar Ortiz. "The Pre-Pyrenees of Lleida in Late Antiquity: Christianisation Processes of a Landscape in the Tarraconensis." *Revista d'Arqueologia de Ponent* 23 (2013): 27-44.

<sup>78</sup> Enric Moliné. "Les Constitucions Sinodals d'Ager I Meià." *Revista d'història moderna* 13, no. 2 (1993): 163-69.



they give information until the 13<sup>th</sup> century. The author analyse the power of the “almost-diocese” of Ager basing his work on the reports of the synods celebrated in the collegiate church of Sant Pere of Ager. Actually, synods were exclusively and peculiarity of a diocese and were called only by bishops. In this case then we assist to an exception due to the independent situation of the collegiate church of Ager from the nearby dioceses and a direct dependence from the diocese of Rome<sup>79</sup>.

This unusual situation caused a dispute between the dioceses of Lleida and Urgell to assure themselves the control of the churches that were under the control of the canonical church of Ager. In 1962 Johannes Von Bauer analyse this phenomenon and the difficulty emerged after the church reform<sup>80</sup>. Paul Freedman in 1997 also talks about this dispute publishing the letters of the bishops and the answers from the popes. The dispute lasted dozens of years also because “the dispute shows the persistence of litigants and the obstacles for Rome in making its will effective<sup>81</sup>”. Finally as asserted by Freedman the pope decided to assign the control of the canonical church of Ager and its possessions to the bishop of Lleida.

## 1.6 THE HISTORIOGRAPHICAL DEBATE

In spite of being only a village of three hundreds of people (five hundred considering the entire valley), Ager still raises interest on researchers. An example may be this same doctoral thesis. It is possible to say that compared to others centres in the pre-Pyrenees it had an important role especially from the 8<sup>th</sup> to the 16<sup>th</sup> centuries. The monumental remains, still visible in the whole valley and the homogeneous extent of the territory testify this fact. Ager was not only a referring point to the transition from the plane of Lleida to the mountains of the Pyrenees but it had also an important political role.

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<sup>79</sup> Enric Moliné. "Les Constitucions Sinodals d'Ager ... p. 165.

<sup>80</sup> Johannes Joseph Von Bauer. "Sankt Peter Zu Ager. Zur Kanonikerbewegung Und Kirchenreform in Der Zwei Hälfte Des 11. Jarhunderts." *Spanische Forschungen Der Görresgesellschaft* 12 (1962): 99-113.

<sup>81</sup> Paul Freedman. "Jurisdictional Disputes over Sant Pere D'Ager (Catalonia) in Light of New Papal Documents." In *Proceedings of the Ninth International Congress of Medieval Canon Law. Munich, 13-18 July 1992*, edited by Peter Landau and Joers Mueller, 1-29. Città del Vaticano: Biblioteca Apostolica Vaticana, 1997.

Moreover, this role went further the simple local administration as demonstrated by the long lasting ecclesiastic disputes mentioned above.

From the critical review of the publication about the Ager valley described until now, it is possible to pinpoint the main themes where the historiographical debate developed:

- a) The origin of Ager
- b) The etymology of its place name
- c) The evidence of a roman and Visigoth phases
- d) The Muslim's presence and the cohabitation with Christians communities
- e) The frontier and the conquest of the Christian seigniorial
- f) The changes occurred in the political administration during the internal fight of the Urgell County – that is the naissance of the Vicecomity of Ager.

These historiographical themes appeared during different periods and some were interpreted on the basis of the local historical tradition without any deeper research evaluation, like for the roman presence or the border position. Others are more recent and they are linked to the archaeological interventions made in the valley<sup>82</sup>. The more recent points of debate derives from the influence of some European research lines such as a) the transformation of the Western Europe after the political disaggregation of the roman empire; b) the looking for evidences on the early Middle Ages political and social organisation; c) the cohabitation of Christians and Muslims from the 8<sup>th</sup> century.

#### 1.6.1 THE ORIGIN OF AGER: FROM IBERIAN TO ROMAN

The origin of Ager has been discussed since the work of Villanueva and Pièrre de Marca but, until now, all the interpretations are based on suppositions and traditional history. The conjectures, made by the antiquarians and by local intellectuals, fossilized during time becoming acceptable without any need of additional investigation. The main proof of this is the discourse we introduced about the supposed roman settlement. There is no confirmation but only sporadic evidence: the sarcophagus, the place name, the path. The sarcophagus, as well as a little crystal cup, can be the result of an importation.

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<sup>82</sup> See further on this chapter.

Indeed, it was a normal practice to use roman artworks as symbol of prestige by seigniorial families as noticed by Serafín Moralejo in 1984<sup>83</sup> and Fité in 2011<sup>84</sup>. About the path, there is no proof of roman techniques used to build the road. During the construction of the new road C-12 there has been an emergency excavation but the reports simply confirmed that the ancient road constructive techniques are not comparable to the one of a main roman road and that it misses all the standard characteristics to date it as roman<sup>85</sup>. On a recent paper published in 2016, I tried to reconstruct the path of this road from the plain of Balaguer to Ager using predictive models and least cost path techniques. I cited the road as supposed to be roman but again there is no evidence to discuss its chronology<sup>86</sup>. In addition, there are no roman sources, no roman epigraphs and no roman stratigraphic context to certify this assumption. Philippe Araguas<sup>87</sup> and Josep Giralt<sup>88</sup> first definitively excluded the possibility that the castle of Ager were of roman origins dating it from the end of the 8<sup>th</sup> century and the first quart of the 9<sup>th</sup>.

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<sup>83</sup> Serafín Moralejo. "La Reutilización E Inflyuencia De Los Sarcófagos Antiguos En La España Medieval." In *Colloquio Sul Reimpiego Dei Sarcofagi Romani Nel Medioevo*, 187-203. Marburg-Lahn: Verlag des Kunstgeschichtlichen Seminars, 1984.

About this theme it exists a huge bibliography. For a general view see Richard Brilliant, and Dane Kinney. *Reuse Value. Spolia and Appropriation in Art and Architecture from Constantine to Sherrie Levine*. Farnham: Ashgate, 2011.

<sup>84</sup> Francesc Fité Llevot. "Arte Y Poder: Obras De "Prestigio" Y Símbolos De Poder. Algunos Ejemplos Catalano-Ribagorzanos." In *Imágenes Del Poder En La Edad Media*, edited by Etelvina Fernández González, 195-211. León: Universidad de León, 2011.

<sup>85</sup> Alma Lopez Guerra. "Memoria De La Intervención En La Calzada De Fontdepou-Ager." edited by Pròleg - Desenvolupament de Patrimoni Cultural. Lleida, 2002.

<sup>86</sup> Antonio Porcheddu. "Predicting and Postdicting a Roman Road in the Pre-Pyrenees Area of Lleida (Spain)." Paper presented at the CAA2015 KEEP THE REVOLUTION GOING, Proceedings of the 43rd Annual Conference on Computer Applications and Quantitative Methods in Archaeology, 2016, p. 599-604.

<sup>87</sup> Philippe Araguas. "Les Chateaux Des Marches En Catalogne E Ribagorce (970-1100)." *Bulletin Monumental* 173, no. 3 (1979): 205-24.

The same concept were then repeated in Philippe Araguas. "Les Chateaux D'arnau Mir De Tost. Formation D'un Grand Domaine Féodal En Catalogne Au Milieu Du Xie Siècle." In *106e Congrès National Des Sociétés Savantes. Perpignan 1981*, 61-76. Paris: Bibliothèque nationale, 1984.

In other publications the theme about a Muslim Ager is taken for granted: Manuel Acien Almansa. "Los Rebeldes Del Tagr." In *El Islam Y Cataluña*, edited by Institut Català de la Mediterrània. Barcelona: Institut Català de la Mediterrània, Lunwerg, Museu d'Història de Catalunya, 1998.

and also in Joan García Biosca. "La Creación De Una Frontera: Al-Tagr Al-A'lá." In *El Islam Y Cataluña*, edited by Institut Català de la Mediterrània, 57-63. Barcelona: Institut Català de la Mediterrània, Lunwerg, Museu d'història de Catalunya, 1998.

<sup>88</sup> Josep Giralt. "Fortificacions Andalusines a La Marca Superior D'al Andalus: Aproximació a L'estudi De La Zona Nord Del Districte De Lleida." In *La Marche Supérieure D'al Andalus Et L'occident Chrétien*, edited by Philippe Sénac. Madrid: Casa de Velázquez, 1991.

### 1.6.2 THE ORIGIN OF THE PLACE NAME OF AGER

The origin of the place name of Ager is a theme of debate still nowadays. At a first sight, it seems that would be useless to discuss it. Indeed, Joan Coromines in his dictionary of catalan toponymy gives to Ager a clear origin from Latin, probably related to the geomorphology of the place. He makes it derive from the term *agger*, -*ĕris* that signifies earthwork, embankment, upland, shelter or protection<sup>89</sup>.

Nevertheless, many researches discuss and deny the possibly Latin origin of the place name. For example, the historian Miquel Barceló together with other researchers studied for a long period the Muslim settlement in Catalonia<sup>90</sup>. In particular, he theorised the presence of a community of Berbers formed by pacific peasants that would have been victims of the feudal expansionism in the 11<sup>th</sup> century. The proof of these assertions are, for Barceló, in the philology and in the recognition of place names of Berber origin in Catalonia. Inside this historiographical theory is the work of Xavier Puigvert who put the origin of the place name of Ager from the Berber toponym *Agíra*<sup>91</sup>. Nonetheless, the first who considered *Agíra* as the original place name for Ager was again Pita Mercé in 1972<sup>92</sup>. Puigvert writes that after being attributed to Ager the place name "was accepted and taken for grant in the majority of works regarding the distribution of Andalusian settlements in this area<sup>93</sup>". From the cited works that Puigvert brings to support his theory there is also the work of Francesc Fité. This is clearly a bit of a stretch, because Francesc Fité never sustained the idea of the Berber origin of the Ager place name neither from the *Agíra*, he just listed it as a variant in the debate<sup>94</sup>. Furthermore, Puigvert, to prove the origin of Ager from *Agíra* makes a parallel with a place in the northern Maghreb of Tunisia called *Aggar*<sup>95</sup>. The information obtained about the place regards only oral sources meanwhile the settlement is nowadays

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<sup>89</sup> Joan Coromines. *Onomasticon Cataloniae*. Vol. 2, Barcelona: Cural Edicions Catalanes, 1994.

<sup>90</sup> Xavier Ballestín, Helena Kirchner, Miquel Barceló, and Felix Retamero. *Musulmans I Catalunya*. Barcelona: Empúries, 1999.

<sup>91</sup> Xavier Puigvert. "Ager Un Topònim Berber a La Marca Superior D'al-Andalus." *Faventia* 16, no. 1 (1995): 73-85.

<sup>92</sup> Rodrigo Pita Mercé. "El Distrito De Lérida En La Frontera Superior Musulmana." *Ilerda* 33 (1972): 213-14.

<sup>93</sup> This is my translation from the Catalan: "*així a estat acceptat i recollit a la majoria de treballs que, posteriorment, han tractat sobre la distribució dels assentaments d'època anadalusina en aquesta zona*". Xavier Puigvert. "Ager Un Topònim Berber..." p.74.

<sup>94</sup> Francesc Fité Llevot. *Reculls D'història De La Vall D'Ager. Període Antic I Medieval*. Ager: Imprenta Saladrígues, 1985, p. 45.

<sup>95</sup> Xavier Puigvert. "Ager Un Topònim Berber..." p.80.

abandoned. Supporting this theory then Puigvert sustains that in this case, the place name Ager, indicates the name of a Berber tribe and then all the similar place names found in the Iberian Peninsula must be related to that tribe and to their displacements around Spain. Now we arrive to a non-secondary fact: in the Tunisian settlement of *Aggar* is proven a roman presence. The village of *Aggar* was born as a roman colony with settlement continuity to the Byzantine epoch and during the early middle ages<sup>96</sup>. Only when the Bedouins invaded the northern Africa in the 11<sup>th</sup> century, they forced the Berbers to immigrate to the interior and to abandon the city<sup>97</sup>. Then is not to exclude the possibility of an Arabization of a Latin toponym, even if Puigvert does not consider this option.

The Islamist historian Pere Balaña, wrote about the same place name. Even if he does not deny the possibility of a Berber presence in Catalonia, he asserts that if Ager would be interpreted as an Arab derived toponym, it should be derive from *Hàjir* that is not compatible to the toponym *Agíra* from the Muslim chronicles and considered by Puigvert and Pita Mercé<sup>98</sup>.

In addition, a philologist, Dolors Bramon, proves that it is not possible deriving Ager from *Agíra*<sup>99</sup>. The researcher proposes an Arab text date 25 May 922 that describes some fortresses consolidated by Mohammad b.Lubb and in particular the fortifications of Montsó, Balaguer, Barbastre and *Agíra*. Bramon considers that the last one should be considered as the actual town of Algerri, next to Balaguer, and not as Ager. Bramon argues her proposal underlining some philological details. In particular, she asserts that passing from *Agíra* to Ager the tonic syllable of the first name the /i/ should pass back to the /à/, which is difficult to accept in philology<sup>100</sup>.

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<sup>96</sup> Mahmed Assine Fantar. "Aggar." In *Encyclopedie berbère*, 251-54. Aix en Provence: Edisud, 1985.

<sup>97</sup> Ahmed Ennabli. "Aggar (Henchir Sidi Amara) Tunisia." In *The Princeton encyclopedia of classical sites*, edited by Richard Stillwell, William L. MacDonald and Marian Holland McAlister. Princeton N.J.: Princeton University Press, 1976.

<sup>98</sup> Pere Balaña. *Els Noms De Lloc De Catalunya: Aproximació Al Coneixement Geogràfic-Històric Dels Municipis I Comarques Del Principat*. 1 vols. Barcelona: Generalitat de Catalunya. Departament de la Presidència, Departament de Governació, 1990, p. 153.

<sup>99</sup> Dolors Bramon. *De Quan Érem O No Musulmans: Textos De 713 Al 1010*. Barcelona: Institut d'Estudis Catalans, 2002, p. 267.

<sup>100</sup> Dolors Bramon. *De Quan Érem O No Musulmans ...* p. 267-268.

It appears clear then that this is not only an historian-archaeologist debate but even between philologists. The only part in which they concords is that the interpretation of Puigvert cannot be accepted. Actually, the solution to this discussion is probably the one that seemed from the first sight the simplest and that Coromines already noticed. The geographical position and the settlement conformation caused the origin of the place name of Ager from *agger*, *-ĕris*. The only thing that we cannot precise is the period in which this toponym born because the Latin was used from the roman period to the entire Middle Ages<sup>101</sup>.

### 1.6.3 THE ISSUE OF THE MUSLIM CONQUEST AND THE CHRISTIAN COMMUNITY

It is clear that the discussion made until now extends over a wider horizon, which is the presence of Muslims in Catalonia and the material evidence of these actors. The archaeology then must consider these factors and it must define the material identity and the evolution processes of the settlement, to bring a new point of view useful for the historical interpretation.

It is evident that for Ager the debate about this subject is very limited. Basing it only on written sources comported that the information brought by Villanueva were identically reused by Sanahuja and then by Fité. These researchers then just added some documents and extended the description of the events. Actually, what appeared clear to me, reading their works, is that the final interpretation remains the first one made by Villanueva. Both Sanahuja and Fité then converge on the reconstruction of the biography of Arnau Mir de Tost and his family. This is due, especially, on the “dictatorship” that the documentary sources exerts on the reconstruction of the Ager history. Indeed, the major part of the documents refers to Arnau Mir and his family, and a very poor information can be obtained about contextual aspects. In addition, the documents are useless for the period before the 11<sup>th</sup> century because there is no text that can certify the origins of Ager, the roman pre-existence or the Christian-Muslim cohabitation before Arnau Mir de Tost’s conquest.

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<sup>101</sup> Albert Benet Clará. "Una Comunitat Mossàrab a La Vall D'Ager. Estudi Antroponímic." *Butlletí de la Societat d'Onomàstica* 13 (1983): 3-7.

Ager is often cited by historians in assertion made about the frontier between Christians and Muslims in the Middle Ages, as one of the boundary reached by the Urgell County in the 11<sup>th</sup> century<sup>102</sup>. Inside this context, a debating theme is the material presence of Muslim communities in the Ager territory and its visibility on the archaeological record. Nowadays it seems that the historians converge on the fact that the valley and Ager remained for a long while, at least from the 8<sup>th</sup> to the 11<sup>th</sup> century, under the direct control of the Muslims whose main centre in the nearby was the Pla d'Almatá next to Balaguer<sup>103</sup>. For the Ager territory the Archaeological contribution to this problem is scarce until now, as is shown next in this chapter.

The historian Philippe Sénac for example tried to review the question about the frontier of the Marca Superior in an article published in 1988<sup>104</sup>. Here he considers the interpretation of some place names in order to find the Islamic fortification cited in the work of some Muslim geographers, like Al-Idrisi. For Ager he considers the already discussed interpretation of the toponym Agíra that until the publication of Bramon cited above was considered as Ager. Anyway, this error is repeated by Sénac in the work published in 2000<sup>105</sup>, despite the 12 years of difference, when talking about the Ager valley the text seems to be copied and pasted exactly equal in the new book, so it continues to bring the same error of interpretation. The other works cited in the text of Sénac refer to an old historiography and to authors as Pita Mercé who based his interpretations on the first works of Villanueva<sup>106</sup>.

The last question that could associate an Arab presence or influence in the Ager valley is the existence of a Mozarabic community. The only researcher who followed this line of research is the historian Albert Benet that published two articles on the theme<sup>107</sup>.

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<sup>102</sup> For a good review on this argument, see the still valid book Sabaté, Flocel Sabaté. *L'expansió Territorial De Catalunya (Segles IX-XII): Conquesta O Repoblació?* Lleida: Universitat de Lleida, 1996.

<sup>103</sup> Marta Monjo, Carme Alós, and Eva Solanes. *El Pla D' Almatá (Balaguer, La Noguera): Vint Anys De Recerda Arqueològica*. Balaguer: Pagès Editors, 2009.

<sup>104</sup> Philippe Sénac. "Note Sur Les Husūn De Lérida." *Mélanges de la Casa de Velázquez* 24 (1988): 23-69. This position was recently retrieved by Llevot, Francesc Fité Llevot, and Cristina Masvidal. "Restes Subsistents Del Recinte Fortificat Del Castell D'Ager, D'època Andalusina." *Revista d'Arqueologia de Ponent* 25 (2015): 205-23.

<sup>105</sup> Philippe Sénac. *La Frontière Et Les Hommes (VIIIe-XIe Siècle) : Le Peuplement Musulman Au Nord De L'ebre Et Les Débuts De La Reconquête Aragonaise*. Paris: Maisonneuve et Larose, 2000.

<sup>106</sup> Philippe Sénac. "Note Sur Les Husūn De Lérida..." p. 60-61.

<sup>107</sup> Albert Benet Clará. "Una Comunitat Mossàrab a La Vall D'Ager. Estudi Antroponímic." *Butlletí de la Societat d'Onomàstica* 13 (1983): 3-7.

Benet analyse the anthroponomy of some documents retrieved from the Archive of the Collegiate Church where he finds possibly the evidence of a Christian community that could have been living in the Valley before the fact of conquest narrated by the sources. This can have two interpretation for our case: a) the Christians may have cohabited the valley with the Muslims paying a tax to maintain their religion, as was usual in the Al-Andalus. b) The Muslim cultural influence can have come from the south but there was not a Muslim stable habitation in the valley. Anyway, Benet considers that this community was absorbed when Arnau Mir de Tost promoted his plan for repopulating the valley during his seigniorial control<sup>108</sup>.

The period after the 11<sup>th</sup> century may appear a bit clearer than the previous. We have the certitude that Arnau Mir de Tost and his family governed the whole area of Ager during the next centuries<sup>109</sup>. We have many archaeological remains, especially of architectures as churches and towers that were built from the 11<sup>th</sup> century. We have also the sources about the Collegiate Church of Sant Pere and a framework of its controlled parishes and rural churches<sup>110</sup>. A debating theme about this period is the independence of the valley from the Urgell County. The Catalan historiography often imagined a linear process of creation of the Viscounty of Ager as an independent juridical and administrative entity. As reported by Francesc Fité who followed this line, this process was a result of the expansion of the Urgell County to the southlands<sup>111</sup>. Armand de Fluvià defined later this area *Baix Urgell*<sup>112</sup> to formalize this supposed peculiarity. It is actually true that from a certain period the Ager territory, as an homogenous area, starts to be named Viscounty of Ager but as Flocel Sabaté remarked on a recent article, at a first time, it was only an emphatic habit and the title of Viscount were not used in

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Albert Benet Clará. "Els Mossàrabs a Catalunya. El Cas De La Vall D'Ager." In *Catalunya Romanica*, edited by Fundació Enciclopèdia Catalana, 28-31. Barcelona: Cayfosa: Industria Gràfica, 1994.

<sup>108</sup> Albert Benet Clará. "Els Mossàrabs a Catalunya..." p. 31.

<sup>109</sup> We have several information from the written sources and especially from the Archive of the Collegiate Church of Sant Pere d'Ager published in many works, amongst others in the works of Francesc Fité Llevot. *Reculls D'història De La Vall D'Ager. Període Antic I Medieval*. Ager: Imprenta Saladrígues, 1985.

<sup>110</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica De Sant Pere D'Ager Fins 1198*. 2 vols. Barcelona: Fundació Noguera, 2011.

<sup>111</sup> Francesc Fité Llevot. *Reculls D'història De La Vall D'Ager. Període Antic I Medieval*. Ager: Imprenta Saladrígues, 1985... p.203.

<sup>112</sup> Armand de Fluvià. "Los Vizcondes De Urgell, Después Llamados Del Alt Urgell, Y Finalment De Castellbó Y Los Vizcondes Del Baix Urgell, Después Llamados De Áger ". *Hidalguía* 28, 159 (1980) p. 159.



the official documents<sup>113</sup>. Only later, during the risk of disaggregation of the Urgell County, the count Alvare struggled for the future of his younger child decided to give to Ermengol the title of his successor and to Alvare the title of Viscounty of Ager before 1268, it is only in this moment that the Viscounty of Ager was officially created<sup>114</sup>.

## 1.7 BRIEF REVIEW OF THE ARCHAEOLOGICAL INTERVENTIONS IN THE AGER VALLEY

It has been shown that the debate is based mainly on the documentary sources. The archaeology sporadically entered some fundamental questions, but as we will see, the nature of the archaeological sources and the way in which they have been used until now, did not permit them to play a central role. The archaeology may pose some specific questions from the material point of view. In particular, the interest can be concentrated in:

- a) confirm the presence/absence of a roman phase in the valley
- b) try to quantify the influence of the Muslim period and the cohabitation with the Christians
- c) shaping the landscape of power after the consolidation of the seigniorial domain
- d) reflect on the economic possibilities of the valley analysing the natural resources

We have some information about the first “archaeological excavation” made in Ager from the *Centre Excursionista de Catalunya*<sup>115</sup> in 1886 and the excavation of Joan Colominas and later an intervention guided by Puig in the crypt of Sant Pere church between 1922 and 1923<sup>116</sup>. These first attempts of archaeological intervention in Ager concentrated, as could be expected, on the most important monumental complex, the Collegiate Church of Sant Pere and the annexed buildings. The results, from an archaeological point of view, are reduced to an important work of selection and

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<sup>113</sup> Flocel Sabaté. "La Création De La Vicomté D'Ager." In *Figures De L'autorité Médiévale. Mélanges Offerts À Michel Zimmermann*, edited by Pierre Chastang, Patrick Henriot and Claire Soussen, 245. Paris: Publication de la Sorbonne, 2016.

<sup>114</sup> Flocel Sabaté. "La Création De La Vicomté D'Ager ... p. 248.

<sup>115</sup> "Visita a Ager." *L'excursionista. Butlletí mensual de la Associació catalanista d'excursions científicas*, 30 September 1886, p. 554-555.

<sup>116</sup> Francesc Fité Llevot. "Puig I Cadafalch I La Primera Intervenció a Sant Pere D'Ager (1922-1923)." *Lambard. Estudis d'art medieval* 22 (2011), p. 155.

inventory of the stones removed from the area that collapsed during time and events<sup>117</sup>. The main target of Puig's intervention was to restore the bell tower and the dangerous part of the complex that could have collapsed directly on the houses of the village. It is clear that an emergency issue animated the intervention more than a scientific interest<sup>118</sup> and that is why we can consider these interventions outside the planned research.



*Figure 3. The apse of the collegiate church of Sant Pere d'Àger in the years of Puig restoration interventions. (Source: Institut d'Estudis Ilerdencs photographic archive)*

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<sup>117</sup> Francesc Fité Llevot. "Puig i Cadafalch i La Primera Intervenció..." p. 158.

<sup>118</sup> Josep Puig Cadafalch. *Memories*. Barcelona: Publicacions de l'Abadia de Montserrat, 2003.

See also Laureá Soler. *Per a La Conservació De La Col·legiata De Sant Pere D'Ager*. Barcelona: Imprenta Ribó, 1923.

To see a new excavation in the Ager Valley we have to wait until the eighties. Between 1983 and 1984, the municipality of Ager decided to restore a road that goes from Ager to the top of the Montsec. These works rediscovered a structure and some burials that were excavated by Prim Bertran and Francesc Fité in two campaigns<sup>119</sup>. The structure, found by Bertran and Fité, was interpreted as the rest of a rural church and it was dated approximatively at the early middle ages. Several stone sarcophagi made by local stone composed the burials but no human remains were found inside the sarcophagi. They could not be dated in a more precise way also because they have not any decoration or dating element. Puig already mentioned these kind of sarcophagi in his work after a warning made by some locals. He dated them at the IV or V century during the paleo-Christian age<sup>120</sup>. Instead, Fité and Bertran preferred to postpone the date of the sarcophagi at the VII century<sup>121</sup> comparing them with the ones found in the site of "El Bovalar<sup>122</sup>". Other human remains found during the excavation were then analysed and dated at the 7<sup>th</sup> century<sup>123</sup>. In 1997 during the construction of a warehouse, about 200 meters south of the site of Santa Coloma, several burial emerged. This confirms the huge extension of the necropolis of Santa Coloma near the supposed church. We do not have information about the dating of the individual buried and about the general chronology of the graves, no information have been published until now. Our research group also made two campaigns of excavation in the area of Santa Coloma in 2014 and 2015 that will be described more in depth in next chapters.

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<sup>119</sup> Prim Bertran Roige, and Francesc Fité Llevot. "El Jaciment Arqueologic De Santa Coloma D'Ager (Provincia De Lleida)." In *Actas Del Primer Congreso De Arqueología Medieval Española*, 203-220. Huesca, 1985.

<sup>120</sup> Josep Puig Cadafalch. *Anuari De L'institut D'estudis Catalans*. Vol. 7, Barcelona: Institut d'Estudis Catalans, 1921-26.

<sup>121</sup> Prim Bertran Roige, and Francesc Fité Llevot. "El Jaciment Arqueologic De Santa Coloma d'Ager..." p. 212.

<sup>122</sup> Pere de Palol. *El Bovalar (Seròs; Segrià) : Conjunt D'època Paleocristiana I Visigòtica*. Barcelona: Departament de Cultura, 1989.

<sup>123</sup> Domingo Campillo, and Francesc Fité. "Estudio Paleopatológico De Un Individuo Del Siglo Vii, Exumado Junto a La Iglesia De Santa Coloma (Ager, La Noguera) (398 - Lp)." In *Actas del II Congreso Nacional de Paleopatología*, edited by Asociación Española de Paleopatología and Universitat de Valencia, 79-84. Valencia: Universitat de Valencia, 1996.

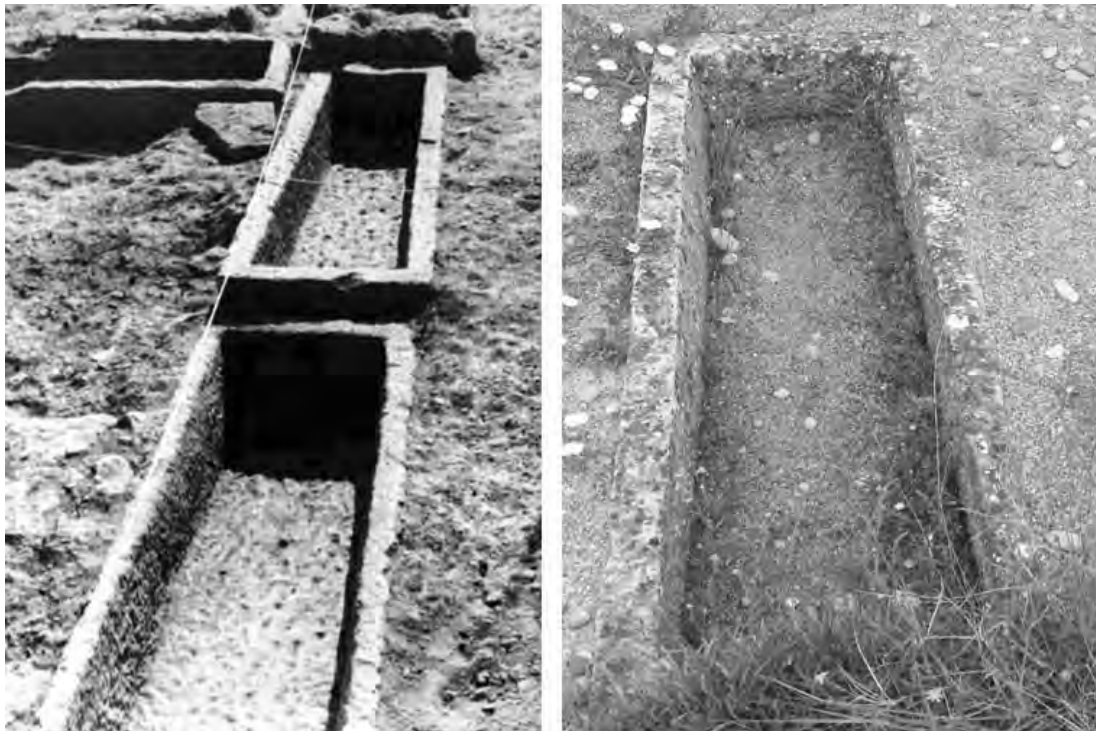


Figure 4. At the left side an image of the sarcophagi excavated by Prim Bertran in 1984. (Source: Prim Bertrán). At the right, side an image of a sarcophagus of the El Bovalar complex. (Source: Antonio Porcheddu)

Continuing during the eighties, few works were made on the archaeological remains of other sites of the valley. In 1983, Francesc Fité published an article about the mills of the Ager valley<sup>124</sup>. This article is explicitly presented as a preliminary work but in it, Fité retrieves useful information about the documentary sources used to identify the mills and the analysis of the most interesting remains of these structures in the Ager valley. Especially in the south part of Ager alongside the river called now *Riu Fred*<sup>125</sup>.

The archaeological activity of Fité and Bertran continues in these years in another site, the castle of Sant Llorenç d'Ares<sup>126</sup>. The work made here by Bertran and Fité consists of a general clean of the area of the castle, the architectural and topographical relief and the analysis of some wall surfaces.

<sup>124</sup> Francesc Fité Llevot. "Un Apropament a L'estudi Del Molins Del Montsec a La Vall D'Ager." *Acta Historica et Archaeologica Medievalia* 4 (1983): 207-38.

<sup>125</sup> Francesc Fité Llevot. "Un Apropament a L'estudi Del Molins..." p. 209.

<sup>126</sup> Prim Bertran Roige, Joan Cabestany Fort, and Francesc Fité Llevot. "Primera Aproximació Al Jaciment Fortificat De Sant Llorenç D'ares (Ager, Lleida)." *Acta Historica et Archaeologica Medievalia. Annex 3: Fortaleses, torres, guaites i castells de la Catalunya medieval* (1986): 41-51.



Figure 5. The castle of Sant Llorenç d'Ares seen from the hilltop. (Source: Antonio Porcheddu)

Finally, Betran and Fité made an analysis of another castle in the valley, the castle of Oroners<sup>127</sup>. In this case, it is again just an approach to the archaeological site. The interest concentrates on the medieval pottery found in the surface and on some graffiti still visible in the wall surfaces that represent scenes of dancing and knights.

We do not know why Fité and Bertran did not continued these inputs of works in the following years. Their contribution for the archaeology of the Ager valley finishes here with many approaches and interesting information but with any more concrete action and no further excavations.

During the nineties, there has been an intense season of excavations concentrated in the hilltop of the Ager centre, in the area occupied by the collegiate church and enclosed by the first circle of walls. Between 1993 and 1994 Montserrat Coberó was charged with analysing the archaeological stratigraphy in the hilltop of Ager. The work consisted in making thirteen squared-pit of 1.5 meters<sup>128</sup> to survey the stratigraphic potential in

<sup>127</sup> Prim Bertran Roige, and Francesc Fité Llevot. "Primera Aproximació a La Ceràmica Grisa I Als <Graffiti> Del Castell D'oroners (Ager, Lleida)." *Acta Historica et Archaeologica Medievalia* 5-6 (1984-1985): 387-418.

<sup>128</sup> Montserrat Coberó Farrés. *Memoria D'intervenció. Col·Legiata De Sant Pere D'Ager (Nº 1477)*. Edited by Direcció General del Patrimoni Cultural Lleida: Manuscript, 1995, p. 19.

order to support the work of restoration of the collegiate church and the annexed buildings. As Montserrat Coberó explains in the memory presented at the *Departament de Cultura* office, the intervention lasted three month from January to march of 1993 and, because of the good results of the excavation, they prepared a project named “*Recinte Fortificat de Sant Pere d’Ager. Precedents, esplendor Baix-Medieval i evolució posterior*” with the Department of History and Geography of the University of Lleida for the years 1994-1996<sup>129</sup>. In the surveys, named survey A and survey C some interesting material were found and especially Islamic ceramics<sup>130</sup>. In general, Coberó says that a portion of the archaeological material, even the pieces that could be dated in the early middle ages or identified as Muslim, are located as residual in stratigraphic units that are certainly of a modern and contemporary period<sup>131</sup>. We will see next that the Islamic pottery was consistent with some Islamic stratigraphy; this makes an uncompromising point in the discussion of the Muslim presence in Ager. These evidences can be easily related to the town of Balaguer, at only 30 km south from Ager. It was an important Islamic town and the presence of ceramics in Ager can be interpreted as the propagation of the Islamic frontier until this area. I think that this is also the reason of why Coberó proposed a more extended project with the Department of Geography and History of the University of Lleida: in order to have a clear view of the stratigraphic situation in the hilltop of Ager.

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<sup>129</sup> Montserrat Coberó Farrés. *Memoria D'intervenció. Col·legiata De Sant Pere D'Ager...* p. 5, 54 and 55.

<sup>130</sup> Montserrat Coberó Farrés. *Memoria D'intervenció. Col·legiata De Sant Pere D'Ager ...* p. 23 and 26.

<sup>131</sup> Montserrat Coberó Farrés. *Memoria D'intervenció. Col·legiata De Sant Pere D'Ager...* p. 46.



Figure 6. Plant of Montserrat Coberó excavation in the Ager hilltop with the sectors of intervention.  
(Source: Coberó 1993)

It is known that from 1995 to, at least, 2001, six excavation campaigns followed the first two mentioned above. Montserrat Coberó directed them with the collaboration of Francesc Fité of the University of Lleida and the architect Melito Camprubí. Presently we dispose of two reports dated 1996 and 1998 that Montserrat Coberó provided to the *Departament de Cultura* archive<sup>132</sup>.

In the 1996 document Montserrat Coberó reports the archaeological activities made during the campaigns of 1994, 1995 and 1996. In the premises of her project, Coberó describes a flat area inside the fortification where could be conserved remains of a significant archaeological stratification filled up by ruins and deposits<sup>133</sup>. Again, as in the first two archaeological interventions of 1993 and 1994, the objectives of this project are mainly two: a) to support the architectonic restorations in the hilltop of Ager and b)

<sup>132</sup> Montserrat Coberó Farrés. "Informe D'intervenció Arqueològica Dins Del Recinte Fortificat d'Ager." edited by Departament de Cultura. Serveis Territorial de Lleida. Vilanova del Camí, 1996.

Montserrat Coberó Farrés. "Informe Campaña 1998 Del Recinte Fortificat De Sant Pere D'Ager. Precedents, Explendor Baix Medieval I Evolució Posterior." edited by Departament de Cultura. Serveis Territorial de Lleida. Vilanova del Camí, 1998.

<sup>133</sup> Montserrat Coberó Farrés. "Informe D'intervenció Arqueològica Dins Del Recinte... p. 11.

to obtain precise archaeological data. In particular, she tried to deepen the question about the Bronze Age and the Iberian presence in the hilltop, verify the theory about a roman origin of the Ager fortification, the start of the Muslim occupation and the Christian occupation<sup>134</sup>. During these three campaigns, the areas of intervention were four, named as A, B, C and D following the scheme of the 1993 campaign.

The area A may be the most interesting excavated part. It is a large area located between the access to the fortification and the cloister<sup>135</sup>. The area B is located in the norther part of the fortification and the C and D areas are related to the Romaic church. Coberó listed approximatively three hundreds of stratigraphic units and divided the chronological results of the three campaigns in seven phases. For the first phase, she dates some pits to the bronze age and Iberian period basing herself on the ceramic evidence<sup>136</sup>. She also detected a second phase named as Andalusian and dated in the 10<sup>th</sup> and the first half of the 11<sup>th</sup> centuries. The third phase is dated between the 11<sup>th</sup> and the 14<sup>th</sup> century just before the construction of the gothic cloister that is the fourth phase. A fifth phase from the 16<sup>th</sup> to the 19<sup>th</sup> centuries and the last two phases in the 20<sup>th</sup> century<sup>137</sup>.

The latest official document presented by Montserrat Coberó and available at the archive of the *Departament de Cultura* is a report dated 1998<sup>138</sup>. In this document, there is a summary of the archaeological activities made in 1997 and 1998 in the same area of the hilltop of Ager. In this document, there is a description of the activities planned for the renewed project named "Recinte Fortificat De Sant Pere D'Ager. Precedents, Explendor Baix Medieval I Evolució Posterior" and planned from 1997 to 2001. Of all these years we only dispose of the first report dated 1998 that concludes the availability of archaeological reports for the 20<sup>th</sup> century. We don't have any information about the conclusions of this project and the final results have not been published. During the campaign of 1998, the fifth official archaeological intervention directed by Coberó, they

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<sup>134</sup> Montserrat Coberó Farrés. "Informe D'intervenció Arqueològica Dins Del Recinte... pp. 47-49.

<sup>135</sup> Montserrat Coberó Farrés. "Informe D'intervenció Arqueològica Dins Del Recinte... pp. 60-61.

<sup>136</sup> Montserrat Coberó Farrés. "Informe D'intervenció Arqueològica Dins Del Recinte... p. 64.

<sup>137</sup> Montserrat Coberó Farrés. "Informe D'intervenció Arqueològica Dins Del Recinte... p. 65-67.

<sup>138</sup> Montserrat Coberó Farrés. "Informe Campanya 1998 Del Recinte Fortificat De Sant Pere D'Ager. Precedents, Explendor Baix Medieval I Evolució Posterior." edited by Departament de Cultura. Serveis Territorial de Lleida. Vilanova del Camí, 1998.



intervened in the area of the gothic cloister<sup>139</sup>. The conclusions and the information obtained during this campaign relates to the constructive phases of the gothic cloister and are dated from the 14<sup>th</sup> to the 16<sup>th</sup> centuries<sup>140</sup>.

The first fifteen years of the 21th century represented another intense season of archaeological interventions in the Ager valley. Twelve reports of archaeological excavation are available at the archive of the *Departament de Cultura* from 2001 to 2015. The majority of these interventions were made as a support to other activities. For example, during the improvement of the C-12 road made between 2002 and 2007, or during some works of restoration in the historical centre of Ager in 2011 and 2012. Others excavations continued the work of Montserrat Coberó in the hilltop of Ager supporting the interventions of architectural restoration of the collegiate church and its musealization and they were made between 2003 and 2009.

From 2001 to 2003, Josep Vila directed three excavation in the area of the collegiate church. In 2001, the excavation concentrated in two areas, one inside the cloister and one in the central part of the church<sup>141</sup>. The author confirms in his report the presence of a cemetery dated to the first Carlin War and a primitive constructive phase of the church with the hypothesis of a different plan of the original church<sup>142</sup>.

The second and the third campaigns were made between October and December 2002 and between February and Mars 2003 and are described on a single report<sup>143</sup>. In these interventions, that continue the work started in 2001, the investigated areas were a) the northern part between the cloister and the fortification wall at the north side, including the excavation of the squared tower and b) the southern part between the south fortification wall and the church side making seven survey pits. The results of these campaigns described in the report confirmed some of the conclusions proposed by Cobero on the frequentation phases of the hilltop since the Iberian period<sup>144</sup>. In

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<sup>139</sup> Montserrat Coberó Farrés. "Informe Campanya 1998 Del Recinte Fortificat... pp. 5-12.

<sup>140</sup> Montserrat Coberó Farrés. "Informe Campanya 1998 Del Recinte Fortificat... pp. 5-12.

<sup>141</sup> Josep Vila Carabasa. "Memòria De La Intervenció Arqueològica Realitzada a La Col·legiata De Sant Pere D'Ager." edited by Arqueociència Serveis Culturals S.L. Lleida, 2001, pp. 27-29.

<sup>142</sup> Josep Vila Carabasa. "Memòria De La Intervenció Arqueològica... p. 30.

<sup>143</sup> Marta Maragall Moreno, and Josep Vila Carabasa. "Memòria De La Intervenció Arqueològica Realitzada a La Col·legiata De Sant Pere D'Ager (Ager, Noguera) 7 D'octubre a 31 De Desembre De 2002 17 De Febrer a 16 De Març De 2003." edited by Arqueociència Serveis Culturals S. L. Lleida, 2003.

<sup>144</sup> Marta Maragall Moreno, and Josep Vila Carabasa. "Memòria De La Intervenció Arqueològica... p. 47.

addition, for the northern side of the hilltop, Vila proposes a reconstruction of the various constructive phases around the fortification wall. For the southern part, the best results comprise the founding of a series of structures and walls that redesigned the topography of the area around the collegiate church that were associated to different period of occupation and to a possible church dated to the 11<sup>th</sup> century<sup>145</sup>.

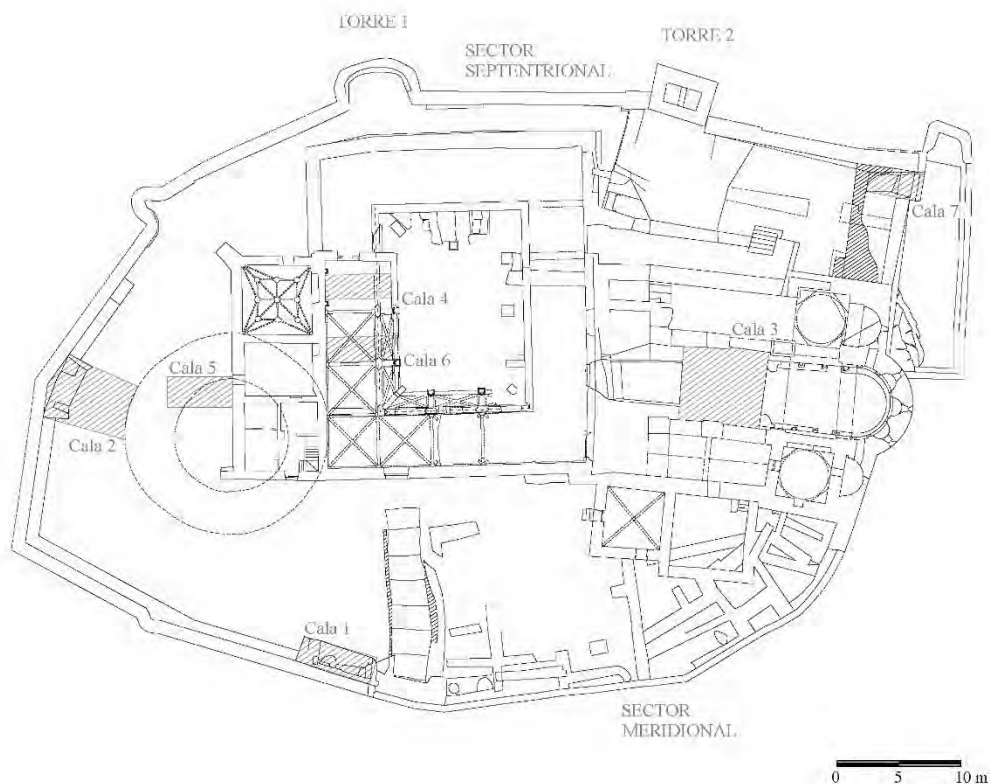


Figure 7. This map shows the areas of intervention during the campaigns of 2001-2003. (Source: Vila 2003)

The last intervention in the area of the collegiate church that we know about was carried out in 2009 and it was directed by Jordi Morera<sup>146</sup>. In this campaign the objective was to retrieve information about the roof covering of the apsis of the church of Sant Pere.

<sup>145</sup> Marta Maragall Moreno, and Josep Vila Carabasa. "Memòria De La Intervenció Arqueològica... pp. 52-73.

<sup>146</sup> Jordi Morera Camprubí. "Memòria De La Intervenció Arqueològica a La Col·legiata De Sant Pere D'Ager." edited by Arqueociència Serveis Culturals S. L. Manresa, 2009.

The archaeologist realized five pits in the concrete cover of the roof and they unveiled the original stone cover<sup>147</sup>.

Another series of excavation were carried out from 2002 to 2008 during the work of improvement of the regional road C-12. The first intervention around Ager was made between July and October 2002 during the enhancement of the part between Fontdepou and the Port d'Ager. In this occasion after a prospection, a part of an ancient road was rediscovered and excavated. The archaeologist Alma Lopez Guerra compiled the report held in the archive of the *Departament de Cultura*<sup>148</sup>. Concluding its work the archaeologist writes that the ancient road is constituted by at least two different parts with different constructive techniques<sup>149</sup>. In addition, the analysis made in the constructive techniques led the archaeologist to discard the possibility that the road was of roman origin. Even citing the indirect finding of a roman coin, not during the campaign, the evidences are too weak to support the hypothesis of a roman road<sup>150</sup>. It is definitely impossible to assign a chronology to the path considering that it was reused continuously still the sixties of the 20<sup>th</sup> century. It may have an Iberian or a roman origin with continuous rebuilding and maintenance.

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<sup>147</sup> Jordi Morera Camprubí. "Memòria De La Intervenció Arqueològica a La Col·legiata... pp.33-35.

<sup>148</sup> Alma Lopez Guerra. "Memoria De La Intervención En La Calzada De Fontdepou-Ager." edited by Pròleg - Desenvolupament de Patrimoni Cultural. Lleida, 2002.

<sup>149</sup> Alma Lopez Guerra. "Memoria De La Intervención En La Calzada De Fontdepou-Ager... p.23.

<sup>150</sup> Alma Lopez Guerra. "Memoria De La Intervención En La Calzada De Fontdepou-Ager... pp.23-24.



Figure 8. Excavation of the ancient road around Àger considered as roman. (Source: López 2002)

Other interventions made during the improvement of the C-12 road were a) an archaeological prospection in 2006 directed by the archaeologist Cristina Benet of the *CODEX – Arqueologia i Patrimoni* enterprise<sup>151</sup>. The results of the prospection highlighted the presence of two limekilns of unprecise chronology<sup>152</sup>. A third element found during the prospection is a Masia, a rural construction common in Catalan countryside, of unprecise chronology<sup>153</sup>. During 2006 the same Masia was documented and in 2007 removed to allow the construction works. These operation are reported in two informs by José Benitez and Francesc Giral of *Arqueoponent* enterprise<sup>154</sup>.

Another remarkable intervention made in the Ager valley, in the locality of Santa Maria del Pla, was carried out in February 2011 by the *Arqueociència Serveis Culturals* and

<sup>151</sup> Cristina Benet. "Memòria De La Intervenció Arqueològica Al "Projecte Constructiu De Millora General. Condicionament. Eixamplament I Millora De Traçat. Carretera C-12. Pk 201+000 Al 212+230. Tram: Ager-Cruïlla C-13 (La Passarel·la) (Ager, Noguera)". edited by CODEX Arqueologia i Patrimoni. Barcelona, 2006.

<sup>152</sup> Cristina Benet. "Memòria De La Intervenció Arqueològica Al "Projecte Constructiu... pp. 18-22.

<sup>153</sup> Cristina Benet. "Memòria De La Intervenció Arqueològica Al "Projecte Constructiu... pp. 24-25.

<sup>154</sup> José Antonio Benitez Morón. "Memòria D'intervenció Arqueològica. Seguiment Arqueològic Obres Carretera C-12. Tram Ager-Cruïlla C-13.", edited by Arqueoponent scp. Barcelona, 2006.

Francesc Giral Royo. "Informe-Memòria D'intervenció Arqueològica. Eliminació D'estructures. Obres Carretera C-12. Tram Ager-Cruïlla." edited by Arqueoponent scp. Barcelona, 2007.

directed by Òscar Trullàs<sup>155</sup>. The Mas del Serret that was built using the remains of the church of Santa Maria del Pla, less than a kilometre far from the area of Santa Coloma necropolis. This excavation was a rescue intervention made during the restoration of a private house. In the basement were found several sarcophagi similar to those of the Santa Coloma necropolis and dated between the 7<sup>th</sup> and 12<sup>th</sup> centuries<sup>156</sup>.

The most recent archaeological excavation carried out in the Ager valley are the remote sensing prospection made for our work, the excavation of Santa Coloma in 2014 and 2015 directed by Jesús Brufal and Antonio Porcheddu and the geophysical prospection made in 2016 in the same area. The results of these interventions will be exposed all throughout this work.

## 1.8 CONCLUSIONS

As we have seen, the historiography of the Ager Valley depends especially from the studies made around its main centre, the village of Ager. Anyway, the first generation of historic writers, like Villanueva and Sanahuja influenced these studies very deeply and their assumptions remain today as preconceptions. Nevertheless, starting from their works others historians built very weak hypothesis that were justified with the historical tradition in spite of bringing new proofing evidence. All these speculations were based on few documents, especially those regarding Arnau Mir de Tost and his successors. Therefore, it is possible to observe a sort of sedimentation of these conjectures, mainly about the roman and Islamic phase that, during years, became to form part of the normally accepted reconstruction. The archaeology, from its part, did not give a correct direction to the questions discussed above. First, because the majority of excavations were essentially of rescue archaeology and they had not continuity in years. Second, because a consistent part of the data from the excavations made in the Ager valley have not been published and cannot be considered in further studies, as the few pottery findings and the biological evidences. Third, because the rest of the valley was almost

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<sup>155</sup> Òscar Trullàs Ledesma. "Memòria De La Intervenció Arqueològica Realitzada a L'església De Santa Maria Del Pla, Mas Serret. Ager, La Noguera. 14 De Febrer - 18 De Febrer 2011.", edited by Arqueociència Serveis Culturals S. L. Lleida, 2011.

<sup>156</sup> Òscar Trullàs Ledesma. "Memòria De La Intervenció Arqueològica Realitzada a L'església De Santa Maria Del Pla... p. 37.

completely ignored from the research except from the unique attempt made by Fité and Bertran in the eighties.

All the available data must be reconsidered from another point of view, that of the landscape archaeology. This not pretend to solve all the questions or problems stated above but to achieve a different sight for a homogeneous object of study, the Ager Valley. The landscape archaeology uses the data available from spot interventions, such as excavations or prospections, to read them in their contextual framework and get the “big picture”. To achieve this, the work has been based mainly in extensive prospection and reuse of available unpublished archaeological data. The attitude chosen is archaeological and then the questions are mainly archaeological too. This means that the target may differ from the documentary historian point of view. The interest is based on the archaeological potential of the valley, the settlement organisation, the resources management and the administrative control of the valley during the period of the Christian county.

# 2

## LANDSCAPE ARCHAEOLOGY: SOME CONTEMPORARY THEORETICAL AND METHODOLOGICAL FRAMEWORKS

### INTRODUCTION

This chapter is intended to be a general view of some approaches to Landscape Archaeology that constituted the theory basing this work. This is not, obviously, a full exhaustive discussion on all the possible existing approaches that would be impossible to accomplish. Also considering that since the relativist and phenomenological approaches, the views on landscape studies are almost countless. Indeed, the interest is to focus a general attention to those aspects that will be useful in the present work.

To define and understand Landscape Archaeology it is necessary to analyse separately the two terms that form its name. As it will be shown, the idea of Landscape Archaeology is highly varied across the world and it is deeply conditioned by the notion of landscape itself. In our days, the term landscape is very popular in academic research, in public debates and in politics. There has been a growing conscience on the double way relation between human being and its surrounding. Until the half of the 20<sup>th</sup> century, the environment intensely influenced human life and their choices. Undeniably, the climate, the orography and several others environmental factors shaped human life and they still do in many parts of the world. Focusing on the West Europe we can say that from the 50's of the 20<sup>th</sup> century the human being became capable of modify his surrounding in

a more deep and lasting way in order to achieve unthinkable targets and apparently reducing the power that the environment had on societies. A clear example can be seen definitely in the countryside. The economic expansion and the mechanization of agriculture started a deep change of the rural landscape. Many of the long lasting agricultural parcel disappeared in order to facilitate the use of bigger machines and reduce time-consuming activities. At the same time, many areas with a low revenue, as terraces, were abandoned all through the Mediterranean hills. In the general use, the word landscape has a simple and positive significance that could be recap as “good view”. In archaeology or in anthropology this significance becomes more complex considering the presence of the human being and then the interaction of culture with nature.

## 2.1 THE CONCEPT OF LANDSCAPE

The word landscape appears daily in our lives. It is a very familiar word but at the same time, it leaves a sense of vagueness. It is possible to have the intuition of its meaning but a shaped definition is unattainable. In general, the way the landscape is approached depends on the way it is conceived. This is why an archaeologist approaches landscape differently from an architect, a geographer, a writer or a lawyer. The approach also changes in space, from the West to the East of the world.

A provocative statement of a geographer asserts: “Comme le mot région, le mot paysage finit par ne rien signifier”<sup>157</sup>. To this statement, it follows the assertion that, etymologically, the landscape is “ce qui se voit”<sup>158</sup>. Actually, the French word *paysage* from which come the words in Spanish *paisaje*, in Italian *paesaggio*, in Portuguese *paisagem* and in Catalan *paisatge*, is defined as “étendue de pays que l'oeil peut embrasser dans son ensemble”<sup>159</sup>. This definition was used already in the 16<sup>th</sup>

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<sup>157</sup> As the word *region*, the word *landscape* ends up with meaning nothing. Roger Brunet. "Analyse Des Paysages Et Sémiologie. Éléments Pour Un Débat." *L'Espace Géographique* 3, no. 2 (1974): 120.

<sup>158</sup> *The thing that you see*. Roger Brunet. "Analyse Des Paysages..." p. 125. Our translation. the thing that you see

<sup>159</sup> *A part of a country that it is possible to grab with a look*. Author's translation from the french dictionary Trésor de la Langue Française informatisé. (Université de Lorraine); <http://www.tresor-de-la-langue-francaise-informatise.fr>



century.<sup>160</sup> For the Anglophone and other countries, the word landscape comes from the Nederland 17<sup>th</sup> century word *landschap* that became in German *landschaft*, in Norwegian *landskapet* and in Swedish *landskapt*.

It is possible that both etymologies have born as technical words used by painters and meaning the part of a natural scenery, a land with its own characteristics, represented in a paint<sup>161</sup>. During centuries, the abstractness of this word allowed to use it in many others disciplines like geography, jurisprudence, architecture, engineering, history and archaeology. We are in a situation in which there is standing observer and a scenery or object observed (the landscape). In the landscape, the most important qualities are then its spatiality and its visibility<sup>162</sup>. There is, then, a positive dimension of an artistic view of the world.

Indeed, in Art History the concept of perception and the aesthetic significance of the landscape are the main interest. For artists the landscape is a composition of different objects perceived through the filter of human eye. This go beyond the mere pragmatic approach and moves to a phenomenological significance of human sensitivity and emotion.

It is necessary to add another concept next to the landscape: identity. Since Hegel, the landscape is the symbol of the identity and the result of the interaction between the space and society. This conception allows relating the landscape not only to the physical environment but also to history and culture<sup>163</sup>. In addition, from the definition of cultural landscape made by the geographer Carl Sauer, it is possible to associate the landscape to the dimension of the phenomenological, not only in art but also in geography and others social sciences. Carl Sauer reports that "the cultural landscape is made by a cultural group starting from a natural environment. Culture is the agent, the

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<sup>160</sup> Definition de Paysage. Trésor de la Langue Française informatisé. (Université de Lorraine); <http://www.tresor-de-la-langue-francaise-informatise.fr>

<sup>161</sup> Online Etymology Dictionary, [www.etymonline.com](http://www.etymonline.com). c. 1600, "painting representing natural scenery," from Dutch *landschap*, from Middle Dutch *landscap* "region," from land "land" (see land) + -scap "-ship, condition" (see -ship). Originally introduced as a painters' term. Old English had cognate *landscipe*, and compare similarly formed Old High German *lantscaf*, German *Landschaft*, Old Norse *landskapr*. Meaning "tract of land with its distinguishing characteristics" is from 1886.

<sup>162</sup> Policarpo Sánchez Yustos. "Las Dimensiones Del Paisaje En Arqueología." *Munibe Antropologia-Arkeologia* 61 (2010): 139-151.

<sup>163</sup> Policarpo Sánchez Yustos. "Las Dimensiones Del Paisaje..." p. 141

natural environment is the tool and the cultural landscape is the result”<sup>164</sup>. In this way, it is possible to define the double nature of landscape: space and place. The space is the sum of the measurable parts and the place is the way the inhabitants intend their space and the result of the interaction between the two agents, nature and culture.

In addition, it is interesting to analyse the meaning of landscape in a juridical framework and especially in the European Landscape Convention (ELC). The law, as intended in jurisprudence, rules the life of human being and so it represents a kind of reflexion of the society who made it in that particular period. Starting directly from the ELC is a choice that allows reflecting in general about the notion of cultural landscape spacing in the entire Europe. The ELC has been signed in 2000 and it is currently adopted by 18 states. It is the result of the European debate on the landscape started after the Second World War. Nevertheless, the Convention is not a definitive document but it is considered to be still in progress.

The aim of the Convention is described in its preamble and in the third article. It is interesting to highlight some expressions in order to discuss them. In particular, the “landscape has an important public interest role in the cultural, ecological, environmental and social fields, and constitutes a resource favourable to economic activity and whose protection, management and planning can contribute to job creation”. In addition, it continues, “the landscape contributes to the formation of local cultures and [...] it is a basic component of the European natural and cultural heritage, contributing to human well-being and consolidation of the European identity”<sup>165</sup>. In the first article of the text, there is also an explicit definition of landscape: “means an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors”<sup>166</sup>.

In these statements, all the words that we already used when introducing the landscape in the former paragraph appear: environment, perception, culture, society, identity. It

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<sup>164</sup> Carl Sauer. "Cultural Geography." In *Readings in Cultural Geography*, edited by Philip Wagner and Marvin Mikesell, Chicago: University of Chicago Press, 1971, pp. 30-34.

<sup>165</sup> European Landscape Convention. Preamble. The third article also states: “The aims of this Convention are to promote protection, management and planning, and to organise European co-operation on landscape issues.”

<sup>166</sup> European Landscape Convention. Art. 1.

is interesting to note that the text is an arrival point and it is deliberately generalist because it should fit every reality for the whole continent. There is a huge amount of guidelines for the countries to better interpret and apply the treaty. As professor Michel Prieur, one of the juridical experts who participate to the writing of the Convention, stated during a conference hold at the University of Rennes 1 in 2016, this document was clearly influenced by the scientific experts who participated to the committee and that collaborated with local people. Geographers, Geologists, and Ecologists wrote the draft of the convention working with local people. Therefore, it has been a scientific document that only at its final stage was “translated” into a juridical text<sup>167</sup>. From this, it is important to retain some points:

- a) The local sensibility forged the document
- b) The landscape represents a local identity and that set of local identities form the general European identity
- c) The character of the landscape is the result, still ongoing, of the interaction of multiple factors
- d) There is a perception of the landscape that can be different even for the same area and that depends on who is watching and on what his or her cultural background and personal relation with that area is

What appears very clear from these definitions is that the landscape is a cultural object and it retains in itself the characters of a social group that inhabits it and forges it. The landscape is also a product changing continuously during time and influenced by human factors and natural phenomena.

## 2.2 THE LANDSCAPE AS AN OBJECT OF STUDY IN ARCHAEOLOGY

The archaeologists inherited the concept of landscape from geographers, anthropologists and ecologists. Together with the concept, they also inherited the

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<sup>167</sup> Michel Prieur. "La Mise En Oeuvre De La Convention De Européenne Des Paysages En France." In *Paysages en Europe : de la Convention européenne des paysages à sa mise œuvre*, 15 Mars 2016, conference talk, Observatoire des sciences de l'univers. Université de Rennes 1, Rennes, 2016.

approaches and some lines of research. For example from the geographers, they acquired the concept of spatial analysis<sup>168</sup> and from agrarian historians the study of the agrarian parcels and the agrarian production<sup>169</sup>. Since the work of the geographer Carl Sauer they received also the phenomenological dimension of landscape<sup>170</sup>. The ecologists considered Landscape Archaeology as a regressive and deductive history of the ecosystems as expressions of different social groups<sup>171</sup>. Agreeing with Sánchez Yustos<sup>172</sup>, under these kind of influences, the Landscape Archaeology developed in at least two theoretical (and then methodological) mainstreams: the economic and the symbolic studies, supported by the two core theoretical positions in Archaeology, processualism and post-processualism.

#### 2.2.1 THE ORIGINS OF LANDSCAPE ARCHAEOLOGY

The origin of modern Landscape Archaeology can be settled in the following decades of the Second World War between the fifties and the seventies of the 20<sup>th</sup> century. Those were years of a general framework of reorganisation of the archaeology and other disciplines such as geography and social sciences. In this context, it is possible to place the origin of the *new* Archaeology or Processual Archaeology that represents the bulk from where it developed many archaeological different lines of research together with the Landscape Archaeology.

Matthew Johnson dedicated an entire book to the defining of Landscape Archaeology. He explicitly asserted that theory is almost absent from every debate on Landscape Archaeology and daily underestimated. In particular, "Landscape Archaeology remains firmly in the grip of the most unreflective empiricism in which "theory" is a dirty word and the only reality worth holding on to is that of muddy boots – a direct, unmediated

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<sup>168</sup> Ian Hodder, and Clive Horton. *Spatial Analysis in Archaeology*. New Studies in Archaeology. Cambridge: Cambridge University Press, 1979.

<sup>169</sup> Gérard Chouquer. *L'étude Des Paysages: Essais Sur Leurs Formes Et Leur Histoire*. Paris: Edition Errance, 2000.

<sup>170</sup> Carl Sauer. "Cultural Geography." In *Readings in Cultural Geography*, edited by Philip Wagner and Marvin Mikesell, 30-34. Chicago: University of Chicago Press, 1971.

<sup>171</sup> Karl Butzer. *Archaeology as Human Ecology: Method and Theory for a Contextual Approach*. Cambridge: Cambridge University Press, 1982.

<sup>172</sup> Policarpo Sánchez Yustos. "Las Dimensiones Del Paisaje..." p. 144.

encounter with the real world<sup>173</sup>. It is easy to understand that when Johnson refers to empiricism and to “real world” he criticizes especially the processual archaeologists. His book is centred on “ideas” of landscape and then it supports more the perceptive trend of studies. The most suitable thing is about the, probably true, state of paralysis of the processual Archaeology theory, even if it continues its evolution in parallel to the post-processual one. From the processual point of view, many works methods and theories are unchanged since the seventies of the 20<sup>th</sup> century. For example in the works made by ancient topographers in Italy there is a sort of marked path that remains firmly followed by researchers without any kind of new experimentation<sup>174</sup>. At the contrary on the post-processual side, there has been the development of a huge amount of theories out of control and with a high specificity. Armando Deguio already reported this phenomenon in the nineties, writing about the theoretical panorama, he asserted “Un tale scenario appare, però, di accesso esplanatorio quasi proibitivo. Si tratta, in effetti, di una galassia – o meglio nebulosa – di estrema complessità, in continua e ormai incontrollata espansione, affetta da sistematica, endemica metastabilità, se non volatilità”<sup>175</sup>. Resuming, the extreme relativistic approach to the archaeologic landscape brought to the born of many micro-disciplines, often even difficult to understand, fragmented in very limited applications, sometimes bringing to individualism.

Matthew Johnson also expresses a critic to the post-processual archaeologist saying that trying to face always-new approaches to the landscape they forgot the strong tradition to give significance to local landscapes through traditional forms of history and landscape archaeology<sup>176</sup>.

The New Archaeology often renamed as Processual Archaeology started its spreading from the United States and it was deeply conditioned by the scientific thought of anthropology. In Europe it is difficult to find Archaeology associated to Anthropology. In the Mediterranean countries, for a long while, Archaeology was considered a history-

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<sup>173</sup> Matthew Johnson. *Ideas of Landscape*. Oxford: Blackwell, 2007, p. 1.

<sup>174</sup> Emeri Farinetti. *I Paesaggi in Archeologia: Analisi E Interpretazione*. Roma: Carocci Editore, 2012., pp.13-14.

<sup>175</sup> Armando DeGuio. “"Archeologia Della Complessità" E Calcolatori: Un Percorso Di Sopravvivenza Fra Teorie Del Caos, "Attrattori Strani", Frattali E... Frattaglie Del Postmoderno." In *Archeologia Del Paesaggio*, edited by M. Bernardi. Firenze: All'insegna del Giglio, 1992, p.307.

<sup>176</sup> Matthew Johnson. *Ideas of Landscape*... p. 1.

subordinated discipline. Its main role was to make the historical facts have a concrete, material shape and to serve as history “hand-worker”. During this period, the main purpose for archaeology was to give some descriptive explanation to facts starting from the hypothetical framework built by the historians.

Nowadays, at the contrary, every scholar converges in considering Archaeology as an autonomous discipline with its own questions, and which answers can be often face the historian’s explanations. They sometimes can also confirm the hypothesis based on the historical traditions<sup>177</sup>.

In the United States, as stated by Lewis Binford, the most important object of study is not the single fact but the evolution of human nature and to what Archaeology can contribute to explain cultural changes and evolution<sup>178</sup>. The first proposals made by Lewis Binford in the sixties of the 20<sup>th</sup> century, to renew the archaeological approach to human being, started from a critical analysis to American Archaeology. Binford’s proposals followed the statements of two others American archaeologists Gordon Willey and Philip Phillips. They considered that American Archaeology could not separate from Anthropology. In addition, they considered that until that moment Archaeology had not furnished any significant contribution to the explanation of the main objectives of Anthropology<sup>179</sup>. Willey and Phillips blamed Archaeology to study artefacts for the reconstruction of specific events as “identical traits” and comparable at the same level, following a unique interpretive model. Every change inside this model was interpreted using the concept of influence, stimulation or migration from a separate cultural unit. This is a brief synthesis of what can be named the Normative History<sup>180</sup> that new archaeologists tried to face with their new proposals.

For the understanding of Landscape Archaeology is very useful to analyse the challenges that new archaeologists proposed to change the normative view of history. One of the

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<sup>177</sup> Matthew Johnson. "Archaeological Theory: An Introduction." London-New York: John Wiley & Sons, 2011.

<sup>178</sup> Lewis Binford. "Archaeology as Anthropology." *American Antiquity* 28, no. 2 (1962): 217.

<sup>179</sup> Gordon Willey, and Philip Phillips. *Method and Theory in Archaeology*. Chicago: University of Chicago Press, 1958.

<sup>180</sup> For a formal definition see Gertrude Jaeger, and Philip Selznick. "A Normative Theory of Culture." *American Sociological Review* 29, no. 5 (1964): 653-69. For a synthesis in Archaeology see Robert Lee Lyman, and Michael O’Brien. "A History of Normative Theory in Americanist Archaeology." *Journal of Archaeological Method and Theory* 11, no. 4 (2004): 369-96.

innovations was to introduce the concept of system. They proposed to consider archaeological data inside a systemic framework where every element constitutes a subset or a class of the main class, the culture. Binford brought some example of this subclasses or subsets: the subset of technology, the subset of society, the subset of ideology<sup>181</sup>. It is clear that these kind of subsets can be reused into a landscape perspectives imaging the main set to be the landscape and formed by several subsets of architecture, parcels, roads and connections, visibility and so on. They will be examined in depth later<sup>182</sup>. Following the path marked by New Archaeology, we have to add another useful influence to Landscape Archaeology: the Cultural Ecology. Binford used the Julian Steward's definition of Cultural Ecology<sup>183</sup> where culture is considered the human being ecosystem and where the relations between human being and environment occurs. It can be argued that this concept is similar to the definition of environmental determinism but actually, there is a difference. This variance between environmental determinism and cultural ecology stands in the role of culture. In the environmental determinism culture is a variable inside the system of relations between human being and environment. Instead, in cultural ecology, the culture is the main system and the environment potential and/or limits are the variables. The target is to understand and explain the processes of cultural change and evolution occurred in different geographical areas with different environmental variables. Inside this context, it becomes clear that the historical fact turns out to be only a mechanism of development for the process. It is from here that it comes the name of Processual Archaeology. For Binford, considered the father of Processual Archaeology, it is important not only to describe the mechanism through which cultural processes occurred, as historical archaeology did. It was important also to understand why they occurred in order to explain the process itself<sup>184</sup>. Binford sustains that the only way to explain, and not only to describe, it is to build sets of historical events inside the cultural system and compares these sets instead of single facts<sup>185</sup>.

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<sup>181</sup> Lewis Binford. "Archaeology as Anthropology... p. 218.

<sup>182</sup> See paragraph 2.3.

<sup>183</sup> Julian Steward. *Theory of Culture Change*. Urbana: University of Illinois Press, 1995.

<sup>184</sup> Lewis Binford. "Archaeology as Anthropology... p. 218.

<sup>185</sup> Lewis Binford. "Archaeology as Anthropology... p. 218.

The contribution made to New Archaeology from European studies comes especially in the United Kingdom. An important actor who participated the change in archaeology was David Clarke whose thought is synthetized in the paper published in the *Antiquity* Journal on 1973, "Archaeology the Loss of Innocence"<sup>186</sup>. The review of Binford's work made by Clarke helps to clarify some aspects and to introduce the New Archaeology in Europe. For Clarke New Archaeology is the answer to years of development of regional archaeologies that isolated themselves. It explains that New Archaeology is not new only for the technological upgrade but also for the need of a unity in Archaeology itself in order to escape the regional path. Finally, he says that the New Archaeology is not a uniform and linear evolution of past Archaeology but he considers it as the main structure of more lines of research. Said with his word "Archaeology is, after all, one discipline and that unity largely resides in the latent theory of Archaeology – that disconnected bundle of inadequate sub theories within an articulated and comprehensive system; a common theoretical hat-rack for all our parochial hats"<sup>187</sup>.

This kind of pluralism inside New Archaeology comes from a series of different development and several philosophies that created an international relation between Europe and United States, running out the previous regionalisms. This pluralism of approaches to the new is fundamental for Landscape Archaeology because it allows approaching landscape in different ways in order to adapt the study to the context and to the interests of the research team.

New Archaeology became mainly a new way to observe qualitatively and quantitatively the problems of Archaeology and it allowed the possibility to pose new questions and to abandon eventually old questions. This represents a deep rupture with the past, and this not occurred, for example, during the born of Post-processual Archaeology in the nineties. For Clarke the new way of seen the human past is made possible thanks to technology and new approaches. These come in particular from Mathematics, Biology, Chemistry, and Engineering. From these disciplines, Archaeology gained the contribution of the computer and the isotopic dating<sup>188</sup>.

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<sup>186</sup> David Clarke. "Archaeology: The Loss of Innocence." *Antiquity* 47 (1973): 6-18.

<sup>187</sup> David Clarke. "Archaeology: The Loss..." p.18.

<sup>188</sup> David Clarke. "Archaeology: The Loss..." p. 8.



It is important to discuss the influence of New Archaeology on landscape studies. It is, at first, the construction of a theoretical model well defined and a clear methodology based on the positivist *modus operandi*. The consequences of the cultural ecology and the relation between human being and environment also comported an interest on natural aspects. There are, in every geographical area, variables of potentiality and limits that human being faces trying to obtain the best benefit in terms of adaptation. This produced an interest for archaeologist in understanding environmental components where cultural systems developed. The clear methodology tried to give to Archaeology a scientific method and this led to an increased attention to data collection with higher precision. It also produced an overture of other disciplines methodologies as Geography, Biology and Geology. In addition, it caused the orientation towards a diachronic evolution of the landscape. It is interesting to notice that the classificatory nature of this New Archaeology brings to consider sites as a category of human activity and from here the analysis of spatial relations between sites over a region or a landscape context that becomes a study object in itself. In addition, the sets can be considered on a multi-scalar form and so, spatial analysis can be applied inside a single site using a high scale level or between site regions reducing the scale level.

As stated before, there is not a unique and general theory for Archaeology at this moment. Clarke classify five theoretical moments that must be common to the entire Archaeology during data interpretation<sup>189</sup>:

- 1) The pre-depositional and depositional theory based on the existence of human activity on a specific place and whose traces are deposited in the surface.
- 2) The post-depositional theory that consider the effects of times over the human traces from the deposition still today.
- 3) Recovery theory based on data collection and related to the strategies and choices of samples.
- 4) Analytical theory, the way in which data are processed. It includes the choices about models, testing, conservation and publication.

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<sup>189</sup> David Clarke. "Archaeology: The Loss... p. 17.

- 5) The interpretive theory, the possibility to predict behaviour and pattern of the past based on the results of the data analysis. From this the possibility to interpret the processes that caused these data.

These five points are definitely useful for the developing of Landscape Archaeology. A work on Landscape Archaeology uses and manipulates several heterogenetic data and it is important to consider all the effects described above. The pluralism of New Archaeology, that we said some lines above, persists in landscape studies. The contemporary landscape is a set of signs, some partial, as the sign of human activities deteriorated by post-depositional processes. This is why deciphering and study these signs is not achievable exhaustively. This phenomenon brings the researchers to an imperfection of knowledge and it forces to talk about **choice** and **multi-criteria**. This kind of research it is possible only through a **pluralist approach** in the research. The French geographer encountered at the beginning of this chapter also wrote, "En vérité, nombre d'analyses «de paysage» ne sont que des analyses de phénomènes particuliers, ou de caractères choisis (plus ou moins arbitrairement), dont certains ne sont même pas apparents dans le paysage; elles ne se distinguent en rien d'autres analyses «multicritères», traitant des groupes de données sélectionnées"<sup>190</sup>. This phrase can be synthetized as follows: the works that pretend to be analysis on landscape rarely are. We can add that this occurs because of the intrinsic nature of landscape. As demonstrated in this chapter the concept of landscape can suppose different interpretations and it depends on the observer.

New Archaeology tried to give the landscape a material significance and to study only its measurable nature, the space. This is why from this period several analysis developed with the aid of computer and GIS related to the economy and the landscape exploitation. In Archaeology, the landscape is approached using the entire possible instruments that researchers dispose: excavation, analysis of natural resources, analysis of morphology, paleo-environmental analysis, study of the communication patterns, study of the architectures and predictive models.

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<sup>190</sup> Actually, several analysis on landscape are analysis about particular phenomena or chosen characters (more or less arbitrarily), where some are not even explicit in the landscape; they cannot be distinguished from others "multi-criteria" analysis over selected databases. Roger Brunet. "Analyse Des Paysages... p. 120

### 2.2.2 THE POST-PROCESSUAL INFLUENCE ON LANDSCAPE ARCHAEOLOGY

As mentioned before, the post-processual theory in Archaeology tried to overtake the processual materialism. The symbolic dimension intends to surpass the merely economic view of the landscape as a basin of natural resources. Some representative scholars on these subjects, as Ian Hodder<sup>191</sup> and Chris Tilley<sup>192</sup>, stated the importance of material culture as a product of society thought. They try to interpret the social codes hid under the materiality of space in order to reach the real significance of the physical world. From this point of view, many kinds of approaches were developed by archaeologists in order to understand the non-material significance of the landscape. Analysis like visibility, identity and rituality of landscape are used in order to understand how the society expressed itself in the landscape.

As it clearly appears, it is difficult to give to these interpretations a measurable standard to understand if they are more or less corrects. They are based especially on the subjectivism of the interpreter and this makes the interpretation weaker. Especially when written evidences cannot support the analysis, it is almost impossible to define a verisimilar interpretation. This issue forces to produce very generalists and vague interpretations to avoid triviality. Often the aid of the Ethnoarchaeology can be useful to understand some particular aspects of symbolic life, but while in Anthropology this is a usual methodology because of the interests in living societies, in Archaeology it leaves always a state of doubt.

In other cases, some kind of analysis, like visibility, can be very useful. The need of visibility is still present nowadays and we can understand it very easily. From the megalithic constructions to the churches or tower inside the urban and rural landscape, we can find the need to be visible and to exhibit the power, the prestige or the identity of a society. This kind of analysis can be accompanied by spatial analysis and it is possible to conjugate the two aspects very straightforwardly.

In this work, the phenomenological aspects of the landscape of Àger will be not afforded. Recalling Matthew Johnson's work cited some lines above<sup>193</sup>, he correctly

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<sup>191</sup> Ian Hodder. *Symbolic and Structural Archaeology*. Cambridge: Cambridge University Press, 2007.

<sup>192</sup> Christopher Tilley. *A Phenomenology of Landscape: Places, Paths, and Monuments*. Oxford: Berg, 1994.

<sup>193</sup> Matthew Johnson. *Ideas of Landscape...* p. 3.

stated that the two main sets, Processual and Post-processual Archaeology, where many ideas of archaeologist are tagged, are still living in parallel, even if in an open contrast. The only suitable approach is to take what we need from the one or the other because not all the landscapes can be studied at the same way.

### 2.2.3 A DEFINITION FOR LANDSCAPE ARCHAEOLOGY

Using the premises discussed above, it is now possible to precise the expression “Landscape Archaeology” as it is conceived in this work. From the definition of landscape that was given before, the landscape appears as a complex object where the historical presence of human being must be considered<sup>194</sup>. The human being acted as transformer of the natural space and at the same time as observer and interpreter of the product derived from the interaction between human being and nature. The landscape archaeology, as many other social sciences, positions itself in the context of a space where a cultural dimension is added. Then, it is not a work on landscape in itself but an analysis on the relation that human being had with his surroundings. This relation is visible, primarily, into the archaeological sites left on the ground. Concerning these sites, there are several “semi-hidden” features and archaeologists use them to define a more global panorama. For “semi-hidden” features, we intend the cultural characteristics of the sites that overtake the simple material visibility allowing a wider interpretation to social, economic and environmental questions. For example a simple defensive tower in itself has a poor potential to explain the interest in fortifying a landscape by a seigniorial power, but a net of towers and fortifications tell us more about not only the intentions of that power but also about their economic and social strength. This is obviously related with the concept of scale and we are dealing now with the scale of the landscape and not with the scale of a single site.

A second point to consider is that in Landscape Archaeology the landscape is a whole. As Tiziano Mannoni already noticed at the end of the eighties of 20<sup>th</sup> century, the only reason to study a region or a precise historical period is the interest of the researcher

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<sup>194</sup> Emeri Farinetti. *I Paesaggi in Archeologia...* p. 9.

and the data availability<sup>195</sup>. There is no an intrinsic reason in the landscape that justify choosing an area or another but only the decision of the researcher. This unity in space and time justify the fact that the landscape is only an object of the present days and that the diachronic approach in the research is necessary to retrieve its past through the signs of the past activities. Studying the landscape diachronically means finding the continuity elements that cross the different periods through the past like the paths, the hydrography and the canalisations, the structures of topographic modelling (terraces and agrarian forms), and so on.

The third point concerns the aim of Landscape Archaeology. As introduced by the processual archaeologists, the main objective of Landscape Archaeology is not simply descriptive. It is necessary to find the processes that caused the landscape transformations during time. This concept implies that the archaeologists should consider every available trace of human activity as evidence. It could be achieved only with an interdisciplinary connection with geography, geology, history, biology etc.

It is clear that Landscape Archaeology deals with several aspects of the landscape in its natural and cultural dimension. It is also obvious that not all these elements are available in the landscape at the same time and in the same place. This is the main reason why Landscape Archaeology produced several approaches to the landscape, in order to adapt itself to the specificity of the area and to the interest of the researcher. This is the reason why, since the nineties, some researchers talk about multiple landscapes and not a unique landscape<sup>196</sup>. A unique landscape can contain different landscapes that are shaped by the interest and the perception of the observer. Even if the landscape is a unique block in its materiality, multiple approaches are possible.

While some theories like the Global Archaeology<sup>197</sup> and the Archaeology of Complexity<sup>198</sup> proposes the study of a whole archaeological context in its totality, this is

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<sup>195</sup> Tiziano Mannoni, Danilo Cabona, and Isabella Ferrando. "Archeologia Globale Del Territorio: Metodi E Risultati Di Una Nuova Strategia Della Ricerca in Liguria." In *Structures De L'habitat Et Occupation Du Sol Dans Les Pays Méditerranéennes: Les Méthodes Et L'apport De L'archéologie Extensive*, edited by Ghislaine Noyé, 43-58. Roma-Madrid: Casa de Velázquez, 1988.

<sup>196</sup> Franco Cambi, and Nicola Terrenato. *Introduzione All'archeologia Dei Paesaggi*. Roma: La Nuova Italia Scientifica, 1994.

<sup>197</sup> Tiziano Mannoni, Danilo Cabona, and Isabella Ferrando. "Archeologia Globale Del Territorio... pp. 43-44.

<sup>198</sup> Robert Chapman. *Archaeology of Complexity*. London: Routledge, 2003.

actually a rarely affordable approach. This is why, during time, Landscape Archaeology accommodated many approaches at its bosom.

### 2.3 METHODOLOGICAL FRAMEWORKS FROM THEORY

Starting from the concepts of choice and multi-criteria stated above it is possible to introduce some contemporary practical approach to the studies in Landscape Archaeology. Since Binford, the proposal of dividing the archaeological data in subset of cultural elements under the main class of culture was reused over a landscape perspective. Under the main class of the landscape, it is possible to define two interconnected classes that constitutes the skeleton of the landscape: nature and culture. This apparent dichotomy allowed the specialization of some disciplines that derived from other sciences in order to improve the quality of the collected data. The first set is the analysis of the environmental component of the landscape. It is not possible to study a landscape without knowing about its natural component. Indeed, the environmental peculiarities influence the life of human being. We are not proposing an environmental determinism like in the first years of processual archaeology, but it is unquestionable that the environment, in which the human being settles, influences more or less deeply humane lifestyle. The adaptation to the natural framework and the modelling of the environment to adapt it to human needs are the main processes analysed by Environmental Archaeology and Geoarchaeology<sup>199</sup>. The environmental archaeology whose main objective is to study the physical and biological perspective of the landscape uses methodologies and techniques derived from the natural sciences. This is the main difference from the Landscape Archaeology because it focuses more on the point of view of the natural science with the objective of reconstructing the paleo-environment using data coming from paleoecology<sup>200</sup>. It is interested more in the organic remains of vegetation, fauna and paleo-climate analysis. The part of its approach that it is possible to consider closer to Landscape Archaeology is the land suitability

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<sup>199</sup> Tim Denham. "Environmental Archaeology: Interpreting Practice-in-the-Landscape through Geoarchaeology." In *Handbook of Landscape Archaeology*, edited by Bruno David and Julian Thomas, 469-81. London-New York: Routledge, 2012.

<sup>200</sup> Terry O'Connor. "Environmental Archaeology: A Matter of Definition." *Environmental Archaeology. The Journal of Human Palaeoecology* 2, no. 1 (1997): 1-6.

analysis. This approach, that will be tested in the next chapters for the Àger Valley, is the analysis of the potential agrarian productivity of a territory or others economic activities, like the pastoralism and the wooden areas exploitation. This specific analysis is deeply connected with the analysis of the so-called landscape of productivity. This definition allows introducing the practical approach to the several typologies of landscape discussed above.

### 2.3.1 ANALYSIS OF RURAL LANDSCAPE

The analysis on the rural landscape bases its target on the fact that the past civilizations had mainly a countryside economy. It is common sense to consider also our European society as a rural based society until the industrial revolution in the 18<sup>th</sup> century. Some areas remained deeply related to the countryside economy at least until the first half of the 20<sup>th</sup> century, especially in the Mediterranean area.

Indeed, the analysis of the rural dimension of the landscape marks a crucial role in the study of past societies. The interest for archaeologists is wide and concerns the settlement system, the typologies of rural exploitation and the study of the relations between cities and countryside. This kind of analysis are possible especially with the survey, because it is uncommon that the rural buildings of production are excavated, because of their poor monumental interest for the funding institutions. In addition, the survey allows studying these structures in their context of relation with the cities and detecting changes during time.

On a general view, the rural landscape is a net of relations between productive and living settlements. This means that they are composed of several others typologies of sites that reveals the complexity of its structure: churches, towers, roads, land divisions, necropolis, caves, walls, terraces, water channels and all the non-material organization of the landscape, such as the division between different areas of exploitation.

The study of rural landscape in archaeology is deeply related to archeogeography<sup>201</sup> that will be deepen later. It consist in the study of the landscape shapes from the agrarian

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<sup>201</sup> It is a free translation from the original Word in French “archéogéographie”.

parcels to the road system and the channel system. This should allow unifying all the different components of the landscape cited before and building a sort of relative chronology amongst the components.

The spatial organization gives useful information about ancient societies. Some models of organization are commonly accepted, like the model of Thiessen Polygons or the Von Thünen model, that according to the site position and the intra-site distance, give information about the type of cultivation or the area that could have been exploited by a given settlement.

### 2.3.2 SACRED LANDSCAPES

For sacred landscapes are intended those landscapes in which the religious, symbolic and sacred elements are considered. The sacred places have two dimensions in its analysis that must be considered: the material and the symbolic. For the Àger Valley we are dealing especially with the Middle Ages when the Christian community played a central role. Indeed, the positioning of the churches and necropolis in space has a crucial interest for the understanding of a territory organization. It is common that churches were positioned in areas next to the major communication roads and next to areas that needed to be “protected” as in the case of the walls of a town<sup>202</sup>.

Sacred landscapes had a political role either. As said, in the Middle Ages the Christians played a central role and, in Western Europe the transition after the collapse of the Roman Empire, or the conflicts in Spain against the Muslims, were stimulated inside a religious address. Christianity rebuilt the social organization of the Early Medieval Europe, especially in the countryside. Building a church or establishing a monastery was an economic operation to save seigniorial property from disaggregation, but also a way to exhibit personal power over a society<sup>203</sup>.

From the symbolic point of view, same places were more suitable for a sacred place than others were. In the mountains, for example caves and isolated areas were used since

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<sup>202</sup> Alexandra Chavarría. *Archeologia Delle Chiese*. Roma: Carocci Editore, 2009.

<sup>203</sup> Gian Pietro Brogiolo, and Alexandra Chavarría. *Aristocrazie E Campagne Nell'occidente Da Costantino a Carlo Magno*. Firenze: All'Insegna del Giglio, 2005.



prehistory to practice the worship. It is not difficult to find a continuity of sacredness in some places from pagan to Christianity<sup>204</sup>.

The analysis of sacred landscapes that are of interest for this work are based mainly on the spatial organization of the sacred sites, in particular churches and necropolis. Their relations with the settlements, the road network and the natural landscape. In the landscape, the sacred sites have a multiple role, a sacred role and a social role. Some may signify the border of an area or a place of social meeting<sup>205</sup>.

### 2.3.3 LANDSCAPE OF PRODUCTION

The analysis of the landscape of production comes from the interest for the exploitation of natural resources by a society. It concentrates on the study of the other ways of the economy beyond agriculture. All the production activities of past societies are of interest for this analysis. This contributes to complete the economic framework and to have a more general idea of the economic potential of the landscape. Mining activity, quarries, metals production, textile, glass and pottery manufacture are the most common production activities of past societies. Studying the landscape of production, it means making an inventory of all the activities founded over an area, for example during survey, and linking them in the complexity of the relations.

Indeed, around the production sites there is a complex of structure related to them, like roads, temporary structures, settlements and other sites connected to the production sites. The study concentrates on the distribution of these productive sites and on the analysis of the production processes. The study of the materials produced in these areas, especially the pottery, can help researchers to correlate the production areas with areas of exchange and commerce where these products were used and traded.

A typical analysis applied in the study of the landscape of production is known as Site Catchment Analysis. With it, it is possible to determine the area and the characteristics

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<sup>204</sup> Carole Crumley. "Sacred Landscapes: Constructed and Conceptualized." In *Archaeologies of Landscape: Contemporary Perspectives*, edited by Wendy Ashmore and Bernard Knapp, 269-76. New York: Wiley-Blackwell, 1999.

<sup>205</sup> Emeri Farinetti. *I Paesaggi in Archeologia: Analisi E Interpretazione*. Roma: Carocci Editore, 2012, p. 45.

of a resource basin. It was used for the first time during the seventies of the 20<sup>th</sup> century, in the context of the processual archaeology, to determine the extension of an exploited area by a single settlement. Its details will be explained in the application to the Àger Valley sites.

#### 2.3.4 LANDSCAPES OF POWER AND FORTIFIED LANDSCAPES

The landscape of Power is the landscape where it is possible to discern the elements that represents the political and the social power. A fortified landscape is the landscape formed by elements of fortification that make the landscape an entire fortification in itself. The two elements are related because the major representation of the power during the Middle Ages is made by fortified and monumental structures like towers, castles and churches.

The study of the Landscape of Power is the result of the analysis of these elements considered in their geographic and social contexts. It deals with the relations between the fortified sites, the landscape and the social and political context of the society that built and used them.

As it will be shown for the Àger valley, from the 11<sup>th</sup> century the Urgell County and the Tost family seigniorial power will start a work of fortification and politicization after their expansion to southern lands.

Researching and studying the fortified landscapes can help to understand the management and the defensive system of an area, as well as the existing connection with other areas and power centres. For example, the analysis of the visibility area from the various defensive structures could show the strategical points of a territory such as the areas of transit and the highly protected regions.

It is very frequent that these kind of landscapes are built in mountainous areas where the natural conformation of a landscape can help to the fortified result. Usually these areas were also areas of borders and frontiers between different social groups. This can be related, then, to the analysis of another typology of landscape, the marginal and frontier landscapes.

### 2.3.5 MARGINAL AND FRONTIER LANDSCAPES

Landscape Archaeology, because of its intrinsic epistemology, spreads its interest not only to those areas where the signs of a human presence are clear, such as the densely populated areas of flatlands or the rich hills of rural life, but also to mountainous and low inhabited areas. In the common imagination, these areas are perceived as wild territories with no owner and no interest, and they are related to economic activities of scarce importance such as pastoralism. It has been noted that these areas were common lands in the past. For example under the Roman Republic and the Roman Empire, after the centuriation of an area there was usually a "*saltus*", formed by wooded areas or mountainous areas or insalubrious zones that could be used by every colon for their economic activities<sup>206</sup>. Also during the Middle Ages, we have several example from every part of Europe of laws and ordinances that regulated the use of common lands. For example for the Àger Valley the information about the use of the common lands can be obtained from the written sources of the *ordinacions* published by Francesc Fité<sup>207</sup>. Despite of this status of no-one-lands, the mountainous and marginal territories were areas of high economic potential. Actually only since the interest for this area showed by landscape archaeologists it has been demonstrated that the highlands areas can be as important areas as the flatlands of the big cities. A recent project in Italy afforded the issue of the archaeology of the mountains and demonstrated that the highlands archaeological sites have a great potential for the understand of the diachronic evolution of societies<sup>208</sup>. Following the Italian example the University of Granada headed another project called Mediterranean Mountainous Landscapes, approved by the European Commission, it was developed between Spain, Italy and other European countries<sup>209</sup>. The movement of transhumance generated a net of viability and related places such as chapels, cemeteries and architectonical constructions related to the passage of the pastoral communities. It has been shown, during years of study, that the

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<sup>206</sup> Emilio Gabba. *Misurare La Terra: Centuriazione E Coloni Nel Mondo Romano*. Vol. 1, Modena: Franco Cosimo Panini, 2003.

<sup>207</sup> Francesc Fité Llevot. *Reculls D'història*...pp. 327-339.

<sup>208</sup> Gian Pietro Brogiolo. "Nuovi Sviluppi Nell'archeologia Dei Paesaggi: L'esempio Del Progetti Apsat (2008-2013)." *Archeologia Medievale* 41 (2014): 11-22.

<sup>209</sup> Mariano Castro Valdía. "Proyecto Memola. Paisajes Mediterráneos De Montaña: Una Aproximación Histórica Al Patrimonio Cultural Basada En Los Agrosistemas Tradicionales." *Agua y Territorio* 4 (2014): 146-48.

wood was not left in a wild status but it was actually cultivated to extract products such as charcoal, resins, tar and all the wood related materials<sup>210</sup>.

These areas were also associated to marginal territories and frontiers. The frontiers are clearly a social construction but the marginal areas, located at the extremity of the territory controlled by a social group and between different communities, were often located in the mountains that offered a natural predisposition to marginality and to separation. It is important to remind that the marginality is a condition that could vary in time. Indeed, an area that is considered as a margin during a particular moment may become a central place during another period, and vice versa. In the Ager Valley this happens from the 11<sup>th</sup> century when Àger became the central place of a newly conquered territory by the Christian forces.

As we said in the definition of landscape at the beginning of this chapter, the landscape is not divisible by its intrinsic nature but only making some social or cultural choices. The frontier then is included in the landscape and it becomes part of it because a social group perceive it as a frontier and it uses that part of land as frontier. The frontier and the marginal areas are also characterised by a religious dimension. During Middle Ages were built churches for protection not only near the wall of a city but also at the extremity of a territory to protect the limit from the enemy forces. In the case of the Àger Valley, it is possible to find churches as *Mare de Deu de la Pertusa* located in the western extremity of the valley, where still today, once a year there is a mass celebration for the protection of the valley and the prosperity of the rural production<sup>211</sup>.

### 2.3.6 LANDSCAPES OF MIND

The idea of a landscape of mind comes from the post-processual thought<sup>212</sup>. It is based on the personal perception that a community has on the territory that it inhabits. The perception can be also of single person varying across different ages or different social

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<sup>210</sup> Maria del Carmen Zamora. "Aprovechamientos Forestales En La Comarca Del Campo De Cartagena Durante La Edad Media." *Scripta Nova: revista electrónica de geografía y ciencias sociales* 1 (1997): 1-13.

<sup>211</sup> Joan de Porcioles. *Notes Folkloriques De La Vall D'àger (1899)*. Barcelona: Garsineu Edicions, 2005. According to Francesc Fité these traditions continues still nowadays.

<sup>212</sup> Christofer Tilley. "Phenomenological Approaches to Landscape Archaeology." In *Handbook of Landscape Archaeology*, edited by Bruno David and Julian Thomas, 271-76. London-New York: Routledge, 2012.

role. Then, for the post-processual archaeologists, the landscape is perceived only through a filter shaped by the cultural background<sup>213</sup>. At this point, it rises a problem that hits directly the researcher interested in past landscapes, how to determine the point of view of past societies and how not to be conditioned by the personal filter of each researcher<sup>214</sup>. Clearly, this unattainable target brings researches to relativism and in some cases, to excessively subjective interpretations<sup>215</sup>. For Emeri Farinetti it is possible trying to achieve a barely objective interpretation basing it not on a single individual but on a social group and a community<sup>216</sup>.

There is a way in which it is possible studying the landscape of mind without collapsing in the extreme relativism. As we said some paragraphs above, the perception on the landscape brings a difference between the space and the place, where the space is a measurable entity and the place is a cultural dimension, it is the significance given by a social group to the landscape. It is possible to interpret this significance by analysing the names given to place. Then, the examination of the toponymy can be used to determine the uses and the significance given to some spaces. It is natural to think that

For the Àger Valley the analysis of the toponymy will comprise the attempt to locate the influences of various cultures and the uses made of the several parts of the valley by the social groups that inhabited it. Also, the analysis of the visibility and the analysis of the movement can be used to give some interpretation to the use and perception of the landscape.

### 2.3.7 LANDSCAPE ARCHAEOLOGY AND PREDICTIVE MODELLING

In many researches of Landscape Archaeology, the survey strategy is fundamental to assure the quality of collected data and information. When working on an extended area it is impossible to survey the entire area with a high intensity details<sup>217</sup>. Anyway, there

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<sup>213</sup> Robert Johnston. "Approaches to the Perception of Landscape.". *Archaeological dialogues* 5, no. 1 (1998): 54-68.

<sup>214</sup> Julian Thomas. "Archaeology, Landscape and Dwelling." In *Handbook of Landscape Archaeology*, edited by Bruno David and Julian Thomas, 301-05. London-New York: Routledge, 2012.

<sup>215</sup> Matthew Johnson. *Ideas of Landscape...* p. 3.

<sup>216</sup> Emeri Farinetti. *I Paesaggi in Archeologia...* p.70.

<sup>217</sup> Thomas Richards. "Survey Strategies in Landscape Archaeology." In *Handbook of Landscape Archaeology*, edited by Bruno David and Julian Thomas, 551-61. London-New York: Routledge, 2012.

are some methods like aerial photography and lidar that help the researcher to narrow the area of intensive survey avoiding time consuming. In addition, the predictive models, since the seventies, based their development on the fact that, on a deterministic approach, it is possible to determine the probability to find archaeological sites through the analysis of environmental and archaeological data. It is an approach that involves quantitative methods, statistics and probability in order to model the owned data, as environmental and archaeological data, and to predict the probability of archaeological findings (archaeological potential) over unexplored areas. This discipline was associated also to the management of the archaeological risk in a territory in order to help the administration managing the cultural heritage and planning the sustainable development of an area.

Currently there is a part of researches that do not think that Predictive Archaeology should be based only on a deterministic approach. There are some methodological experiments made to fit the results of a prediction comparing them with the data obtained with the survey. This approach is called “postdictivity” and instead of just look for new archaeological sites in a territory, the researchers try to explain the reasons of a certain type of results, especially using the approach by trial and error<sup>218</sup>.

In the Àger Valley the application of predictive models produced the production of archaeological potential maps. These maps are mainly tools for the planning of survey strategies and for the research development. Also other techniques were applied in the Àger Valley, as the Least Cost Path analysis to show the movement basin and to predict the position of the ancient pathways. Finally another application of the predictive models will be the study of the land suitability in order to analyse the resources basin and to evaluate data about the population sustainability in the valley.

### 2.3.8 ARCHEOGEOGRAPHY: A *TRAIT-D'UNION*

The *Archéogéographie* is a French-born discipline developed in the context of the agrarian history, ancient topography and geography studies since the seventies of the

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<sup>218</sup> Antonia Arnoldus-Huyzendveld, and Carlo Citter. "Site Location and Resources Exploitation: Predictive Models for the Plain of Grosseto." *Archeologia Medievale* 41 (2014): 65-78.

20<sup>th</sup> century. Even if the researchers of this discipline consider it as an independent branch of knowledge, it can be easily inserted in the context of landscape study, and then connected to Landscape Archaeology.

Gerard Chouquer defines Archaeogeography as the study of the space of past societies, in all its dimensions, specifying rural and urban space<sup>219</sup>. From a practical point of view, Archaeogeography is the study of the shapes of the landscape as the product of the actions of humane being in the earth's surface. These shapes can be then materialised by roads, plots of lands, networks of settlements, artificial limits made by vegetation and hydrographic channels<sup>220</sup>. Sandrine Robert in his handbook of Archaeogeography cites the concept of dissociation of shape and function. This concept allows to develop the main concept of interpretation used by archaeogeographers, the transmission of shapes during time<sup>221</sup>. They become then fossilized shapes that can be reused by following generation even with other uses. The most spectacular example of this concept is the transmission in the urban topography of the ancient theatres shapes where the houses built in the centuries after the abandonment of the theatre follow the shapes of the theatre itself. There are many examples of this event in former roman towns in Italy and in France<sup>222</sup>. This concept can be applied also to the analysis of the land plots and roads.

For the Àger Valley the methodology of Archaeogeography has been used to study the parcels, the terraces and the roads that cross the valley. Then the specific methodology used by archaeo-geographers will be described in the part dedicated to this analysis. It is just interesting remind that the path of an analysis in archaeogeography starts from a GIS database in which all the information about the space is collected and modelled. This procedure, called "*carte compilée*" by French researchers, allows to have all the information at the same time and to connect the shapes to other information as archaeological sites, roads, channels, settlements and so on, in order to create new "objects" from the interpretation of these connections in time and space. This

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<sup>219</sup> Gérard Chouquer. *L'étude Des Paysages: Essais Sur Leurs Formes Et Leur Histoire*. Paris: Edition Errance, 2000.

<sup>220</sup> Sandrine Robert. *Sources Et Techniques De L'archéogéographie*. Besançon: Presses Universitaires de Franche-Comté, 2011.

<sup>221</sup> Sandrine Robert. *Sources Et Techniques De L'archéogéographie...* p. 8.

<sup>222</sup> Carlo Sometlla, and Fulvio Cairoli. *La Pianta Di Lucca Romana*. Milano: De Luca Editore, 1974.  
Jean Claude Golvin, and Jean Hiernard. "D'un "Palais Galien" À L'autre. Nouvelles Recherches Sur L'amphithéâtre De Poitiers (Limonum Pictorum)." *Revue d'Études Anciennes* 88, no. 1 (1986): 77-108.

procedure allows also to identify the morphogenetic objects of the landscape shapes and to use them for the interpretation of the different typology of landscape discussed above. This is why archaeo-geographers consider their discipline as a *trait-d'union* between all the several approaches to the landscape described above<sup>223</sup>.

#### 2.3.9 HISTORIC LANDSCAPE CHARACTERIZATION

At the end of the nineties of the 20<sup>th</sup> century, in the United Kingdom was developed the method called Historic Landscape Characterization. It was proposed in order to give to the archaeologists “a tool for interpreting and mapping the wider historic landscape<sup>224</sup>”. This method is used for landscape research but was also developed for planning and management. The procedure consist in using a database of sites and monuments to form an inventory of archaeological sites. Starting from this base the researchers that apply the Historic Landscape Characterisation method choose the areas of landscape that they consider of historic interest. They map coherent areas basing their interpretation on the archaeological database information and on other features that usually are not described in the database, as land plots boundaries, roads and other elements having a historic interest<sup>225</sup>. They consider a finite number of characters that could be applied to the target area, basing them on their knowledge about the region. The result is the homogeneous mapping of areas (and not individual sites) that are related in its chronology and in its functionality. It is evident that the work of the archaeologist is fundamental to give the interpretation and the relations based on the observation of the landscape. In addition, a single area can have multiple characters so that the interpretation is not definitive.

The product of the Historic Landscape Characterisation is a thematic map where the characters of the landscape are described and linked on a general view. The obtained map is not a high detailed map and it can be used for large regions that cannot be

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<sup>223</sup> Magali Watteaux. "Parcellaires Et Chemins Une Relecture Archéogéographique.". *Les Dossiers d'archéologie* 344 (2011): 38-41.

<sup>224</sup> Sam Turner. "Historic Landscape Characterization: An Introduction to Methods and Applications for Historical Research." In *Territori I Societat: El Paisatge Històric. La Caracterització Del Paisatge Històric*, edited by Jordi Bolòs Masclans, 17-39. Lleida: Universitat de Lleida, 2010, p.17.

<sup>225</sup> Sam Turner. "Historic Landscape Characterization... p. 19.



studied entirely with traditional methods of intensive survey. Using the words of Turner the Historic Landscape Characterisation "is useful only for addressing a particular range of problems" and the obtained maps "can be used to present generalised interpretations of landscape in the past"<sup>226</sup>.

In a recent paper, Turner proposed a connection between Archaeogeography and the Historic Landscape Characterisation methodology. He proposed a combined use of both the context of Landscape Archaeology<sup>227</sup>.

For the Àger Valley it would be interesting to apply this methodology in order to interpret the several characters of its landscape. Even if the territory of Àger can be considered as a marginal area, it is interesting to experiment the Historic Landscape Characterisation in order to distinguish the relations that occurred with other landscapes. We will use this methodology combined with Archaeogeography, setting up several landscape units we will analyse them in detail applying the archaeogeographic methods.

## 2.4 CONCLUSIONS

The Landscape Archaeology flourished constantly since the end of the 20<sup>th</sup> century. In this chapter we have seen that since the Processual Archaeology the landscape ceased to be a merely surround of the archaeological sites. Since Clarke there is a conscience that the Landscape Archaeology has not an unique tradition in Europe but it is formed by a series of approaches related under the same big name.

The difficulty in understanding properly what Landscape Archaeology is, it is due to the discussed heterogeneity and to the different significance that archaeologists gave to it during time and in different contexts. The connotation gave to the landscape in the seventies envisioned the Landscape Archaeology as the study of the interaction between human being and natural environment. From the beginning of the eighties of the 20<sup>th</sup> century, this concept was extended with the technological and methodological

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<sup>226</sup> Sam Turner. "Historic Landscape Characterization... p. 28.

<sup>227</sup> Sam Turner. "Paysages Et Relations: Archéologie, Géographie Et Archéogéographie." *Études Rurales* 188, no. 2 (2011): 143-54.

enhancement and the attention was directed to the accumulation of quality data to use with the GIS predictive modelling and statistical analysis of materials patterns and archaeological sites patterns as interpretive models. All these approaches were related to the concept of subsistence and procurement and data were interpreted on a deterministic way, especially when applying predictive models. Finally, the definition of Landscape Archaeology was deeply influenced, in the nineties, with the emerging conscience that the landscape is not only the natural environment but also the set of places that are significant for the people that live in them.

The Landscape Archaeology then can be considered as a conceptual framework that allows the archaeologists studying human past with several different approaches, renewing Archaeology itself. It became the Archaeology of place and not only the former Spatial Archaeology. From this starting point, several approaches developed during the last two decades adapting themselves with the target of the research. The important fact to consider is that it is possible to analyse in the same space different topographies, a spatial topography in the traditional sense, but also cultural and social topographies. From this, it is possible to analyse how people choose to manipulate its space and the social groups will to manifest their power, their social hierarchy, their control over a territory, their use of space for religion, movement and others aspects.

With these premises, it is possible to approach the study of the ancient landscapes applying the several methodologies derived from the different approaches. The objective analysis of a landscape in its diachronic evolution is an unattainable target because, for different periods, there is a different quality of the sources. The most effective work would be to adapt the research of a particular period to the most relevant sources available. Indeed, it is possible to reconstruct single sceneries by the decomposition of the landscape by themes. For example, it is possible to create single snapshots from every source category, such as written sources, cartography, archaeological sources, predictive modelling, archaeogeography, etc. The second step would be to recompose the single snapshots synchronically using the interrelation between them. The last step, useful to study a landscape in the *long-durée* is to make progressive approximations of the obtained sequences.

# 3

## IL METODO DI INDAGINE

### INTRODUZIONE

Questo capitolo è dedicato alla descrizione dei metodi di indagine e le tecniche utilizzate per le diverse fasi della ricerca. Tutti i dati utilizzati in questa ricerca sono stati elaborati tramite il sistema informativo geografico, GIS, di cui verranno descritte in seguito le caratteristiche. I dati sono stati quindi modellati con delle schede apposite in una base di dati informatizzata. Tutte le successive analisi quantitative di archeologia predittiva sono state eseguite con gli stessi software GIS, così come la creazione delle mappe tematiche. Allo stesso modo il GIS è stato utilizzato per l'elaborazione dei dati da *remote sensing* e per lo studio delle forme del particellare agrario. Il GIS è risultato essere pertanto lo strumento centrale con cui si è svolta questa ricerca.

### 3.1 IL SOFTWARE

Il software principale strumento di questa ricerca è la suite ArcInfo del produttore americano ESRI<sup>228</sup>. Al momento risulta essere il riferimento commerciale principale per i software di analisi spaziale e sistemi informativi geografici. Con ArcGIS è stata implementata la base di dati alfanumerica e le cartografie principali, oltre ai risultati delle analisi fatte con altri software. Infatti, sono stati utilizzati altri GIS di tipo *open sources* per specifiche attività o moduli particolari come SAGA-GIS<sup>229</sup>, GRASS-GIS<sup>230</sup> e QGIS<sup>231</sup>. Il primo di questi tre è un software open source inizialmente sviluppato dall'Università di Göttingen e utilizzato ormai nell'intera comunità internazionale. In questo caso è stato utilizzato soprattutto per l'elaborazione delle immagini e l'applicazione degli algoritmi per la visualizzazione dei modelli digitali del terreno che verranno descritti più avanti in questo stesso capitolo. Esso infatti dispone di moduli di facile utilizzo che permettono di impostare i parametri base e di applicare gli algoritmi di *image processing* più diffusi come *slope*, *aspect*, *hillshading*, *sky view factor*, *openness* etc<sup>232</sup>.

GRASS-GIS (*Geographic Resources Analysis Support System*) nacque negli anni 80 come prodotto dell'*US Army Corp of Engineering Research Laboratory* ed è oggi un software di pubblico dominio per l'analisi spaziale. Nell'ambito di questa ricerca è stato utilizzato soprattutto per la produzione di *raster* derivati dalle analisi spaziali e applicati ai modelli predittivi quali superfici di costo, percorsi di minimo costo, accessibilità, uso del suolo etc<sup>233</sup>.

QGIS (Quantum GIS) è un software GIS di dimensioni minori che è stato usato come complemento per eventuali prove e controlli delle tecniche applicate con i software

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<sup>228</sup> Per informazioni dettagliate si veda il sito web del produttore.

<https://www.arcgis.com/features/index.html> (visualizzato il 14-01-2017).

<sup>229</sup> System for Automated Geoscientific Analyses. <http://saga-gis.org/en/index.html> (visualizzato il 14-01-2017).

<sup>230</sup> Geographic Resources Analysis Support System. <http://grass.osgeo.org/> (visualizzato il 14-01-2017).

<sup>231</sup> <http://qgis.org/en/site/>

<sup>232</sup> Per la descrizione di questi algoritmi si veda più avanti in questo capitolo.

<sup>233</sup> Queste metodologie verranno spiegate in maniera approfondita nella parte riguardante i modelli predittivi applicati al caso della Valle di Àger.

descritti in precedenza. La versione utilizzata in questo lavoro è la 2.14 denominata “Essen”.

### 3.2 LE TECNICHE DI REMOTE SENSING

La disponibilità di rilievi da laser scanner aereo (LAS) per l’Archeologia ha segnato indubbiamente un punto di svolta, paragonabile per certi versi a quello che provocò l’utilizzo della fotografia aerea a partire dagli anni 20 del XX secolo<sup>234</sup>. Per la prima volta è stato possibile avere un rilievo della superficie terrestre ad elevato dettaglio che permettesse, a seconda della qualità del dato, di ricavare anche un’approssimazione della superficie del suolo sotto la vegetazione, rappresentando una ricca fonte di nuove informazioni. L’utilizzo a più grande scala è senz’altro quello fatto dall’allora *English Heritage Trust* (oggi *Historic England*) il cui progetto di mappatura dei siti archeologici dell’Inghilterra a partire dagli anni 2000 rappresenta un esempio delle enormi potenzialità che questa tecnologia ha prestato all’Archeologia<sup>235</sup>. Molto velocemente e in corrispondenza di una disponibilità di dati sempre maggiore, gli archeologi di tutto il mondo hanno deciso di affiancare alle loro ricerche l’uso del lidar o meglio, dei prodotti derivati dalle prospezioni eseguite con il lidar. In Europa è stato utilizzato con successo non solo in applicazioni passive<sup>236</sup>, ma è ben testimoniato uno sforzo nella ricerca di modalità apposite di processo dei dati per l’uso archeologico. Esempi della fertilità di

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<sup>234</sup> Osbert Crawford. *Air Survey and Archaeology*. London: HM Stationery Office at the Ordnance Survey, 1924.

Osbert Crawford, and Alexander Keiller. *Wessex from the Air*. Oxford: Clarendon Press, 1928.

<sup>235</sup> Il lidar è stato aggiunto alle tecniche di remote sensing utilizzate per il survey e l’inventario dei beni archeologici del paese. Simon Crutchley, and Peter Crow. *The Light Fantastic. Using Airborne Lidar in Archaeological Survey*. Swindon: English Heritage, 2010.

<sup>236</sup> Per applicazione passive intendo qua l’uso dei dati già processati senza una ulteriore elaborazione, e in particolare l’uso di rilievi effettuati per il *general purpose*.

queste ricerche si trovano nel Regno Unito<sup>237</sup>, in Austria<sup>238</sup>, in Slovenia<sup>239</sup>, in Italia<sup>240</sup>, in Francia<sup>241</sup>, in Belgio<sup>242</sup>.

Di seguito sono descritte le tecniche di elaborazione dei dati lidar maggiormente citate nella letteratura e utilizzate anche nel corso di questo lavoro. Ne vengono date, inoltre, delle valutazioni qualitative sul caso specifico della Valle di Àger. Dall'esperienza empirica è evidente che la maggior parte delle tecniche di *image processing* (elaborazione delle immagini) non danno risultati standard a livello qualitativo. Sebbene gli algoritmi operino sempre in modo deterministico, il risultato è necessariamente dipendente dalla qualità del dato in input, pertanto l'applicazione di un certo algoritmo di elaborazione non garantisce sempre gli stessi risultati in termini di qualità. Per questo motivo verrà fatta, innanzi tutto, una descrizione dei dati disponibili e, in seguito, delle comparazioni in termini di output rispetto all'applicazione di differenti algoritmi di elaborazione di immagini. Sebbene si parli di lidar è giusto parlare di elaborazione di immagini perché nella maggior parte dei casi il prodotto con cui opera l'archeologo è un

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<sup>237</sup> David Cowley, ed. *Remote Sensing for Archaeological Heritage Management. Proceedings of the 11th Eac Heritage Management Symposium, Reykjavik, Iceland, 25-27 March 2010*. Edited by Europae Archaeologia Consilium, Eac Occasional Paper N° 5 in Collaboration with Aerial Archaeology Research Group. Brussels: Archaeolingua, 2011.

Alend Rowlands, and Apostolos Sarris. "Detection of Exposed and Subsurface Archaeological Remains Using Multi-Sensor Remote Sensing." *Journal of Archaeological Science* 37, no. 5 (2007): 795-803.

<sup>238</sup> Ralph Hesse. "Lidar-Derived Local Relief Models. A New Tool for Archaeological Prospection." *Archaeological Prospection* 17, no. 2 (2010): 67-72.

Michael Doneus. "Openness as Visualization Technique for Interpretative Mapping of Airborne Lidar Derived Digital Terrain Models." *Remote Sensing* 5, no. 12 (2013): 6427-42.

Michael Doneus, Christian Briese, Martin Fera, and Martin Janner. "Archaeological Prospection of Forested Areas Using Full-Waveform Airborne Laser Scanning." *Journal of Archaeological Science* 35, no. 4 (2008): 882-93.

<sup>239</sup> Benjamin Stular. "The Use of Lidar-Derived Relief Models in Archaeological Topography the Kobarid Region (Slovenia) Case Study." *Arheološki vestnik* 62 (2011): 393-432.

Benjamin Stular, Ziga Kokalj, Kristof Ostir, and Laure Nuninger. "Visualization of Lidar-Derived Relief Models for Detection of Archaeological Features." *Journal of Archaeological Science* 39, no. 11 (2012): 3354-60.

<sup>240</sup> Rachel Opitz. "Integrating Lidar and Geophysical Surveys at Falerii Novi and Falerii Veteres (Viterbo)." *Papers of the British School at Rome* 77 (2009): 1-27.

Annalisa Colecchia, and Paolo Forlin. "Visibilità E Interpretazione Del Record Archeologico in Aree D'altura: Le Potenzialità Dell'analisi Del Lidar Dtm." *APSAT - European Journal of Post Classical Archaeology* 2 (2013): 41-60.

<sup>241</sup> Laure Nuninger, Rachel Opitz, and Catherine Fruchart. "Thinking Topographically About the Landscape around Besançon (Doubs, France)." In *Landscape Archaeology Conference, Amsterdam (Pays Bas)*, 395-412. Amsterdam: Amsterdam University Press, 2010.

<sup>242</sup> Ilke Werbrouck. "Digital Elevation Model Generation for Historical Landscape Analysis Based on Lidar Data, a Case Study in Flanders (Belgium)." *Expert Systems With Applications* 38, no. 7 (2011): 8178-85.

modello ricavato dal dato originale, chiamato grid o raster, che viene modificato tramite le tecniche di *image processing*.

### 3.2.1 IL LIDAR

Il lidar, acronimo di *Light Detection and Ranging*, definisce una tecnica ad impulsi luminosi (laser) utilizzata per ottenere un rilievo indiretto di oggetti in tre dimensioni tramite misurazioni di tempi, distanze e angoli. I primi utilizzi in Archeologia risalgono agli anni 90. Nel 1994 la NASA collaborò con Payson Sheets per sperimentare delle tecniche di telerilevamento in un contesto di villaggi preistorici in Costa Rica. Con un volo equipaggiato con vari strumenti tra cui un laser scanner si effettuarono dei rilievi da cui furono ottenuti dei risultati di visibilità archeologica al di sotto della cappa vegetazionale<sup>243</sup>. Naturalmente i costi non sostenibili a causa della necessità di un aeroplano apposito l'hanno resa una tecnica poco utilizzabile finché non sono intervenuti i committenti pubblici per l'acquisizione di scansioni tridimensionali per finalità non archeologiche ma che producevano dati riutilizzabili dagli archeologi. È quindi solamente nel nuovo millennio che l'utilizzo del lidar in archeologia si è intensificato. Le prime pubblicazioni in Europa sono apparse nel 2004 con il lavoro di Sittler sui *Ridge and Furrows* dei campi inglesi<sup>244</sup> e di Doneus e Briese che nel 2006 ne fanno un'introduzione generale<sup>245</sup>.

Nel suo acronimo sono contenuti tutti gli elementi utili per capirne il funzionamento teorico. Lo strumento attraverso il quale viene effettuato il rilievo è detto *laser scanner* e consiste in un emettitore di luce laser che viene riflessa e recuperata dallo stesso strumento per misurarne il tempo di percorrenza, gli angoli di ritorno e l'intensità. Dai

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<sup>243</sup> Brian McKee, Thomas Sever, and Payson Sheets. "Prehistoric Footpaths in Costa Rica: Remote Sensing and Field Verification." In *Archaeology, Volcanism and Remote Sensing in the Arenal Region, Costa Rica*, edited by Payson Sheets and Brian McKee, 142-57. Austin: University of Texas Press, 1994.

<sup>244</sup> Benoit Sittler. "Revealing Historical Landscapes by Using Airborne Laser Scanning." In *Laser-Scanners for Forest and Landscape Assessment : Proceedings of the Isprs Working Group Viii/2*, edited by Michael Thies, 258-61. Freiburg: Forest Growth, 2004.

<sup>245</sup> Michael Doneus, and Christian Briese. "Full-Waveform Airborne Laser Scanning as a Tool for Archaeological Reconnaissance." In *From Space to Place : 2nd International Conference on Remote Sensing in Archaeology : Proceedings of the 2nd International Workshop, Cnr, Rome, Italy, December 4-7, 2006*, edited by Stefano Campana and Maurizio Forte, 1568-99. Oxford: Archaeopress, 2006.

primi due dati si ricava in maniera generale la distanza tra lo strumento e la superficie di contatto.

*-Light:* la luce costituisce il mezzo attraverso il quale vengono effettuate le misure, si tratta di luce laser generata da un emettitore. La luce laser è un tipo di radiazione luminosa ad alta emissione di energia, la sua concentrazione permette di ottenere delle misure estremamente precise. Il fatto che sia generata appositamente da un emettitore classifica questo tipo di tecnica come attiva, cioè una tecnica che genera da sé la radiazione necessaria al suo funzionamento. Per comprendere meglio questo concetto si può considerare come passiva una tecnica che sfrutta le onde elettromagnetiche emesse dagli oggetti stessi e quindi il fenomeno di assorbimento e riflessione della radiazione solare. Un esempio di tecnica passiva è la fotografia tradizionale ma anche il funzionamento dello stesso occhio umano.

*-Detection:* oltre che da un emettitore lo strumento è formato da un ricevitore che registra la quantità di luce laser che viene restituita dall'oggetto, il tempo di ritorno dell'impulso e l'angolo. A seconda dello strumento possono essere registrati diversi tipi di ritorno dell'impulso, chiamati in ordine numerico primo, secondo e ultimo ritorno. Ognuno di questi può fornire informazioni utili alla restituzione dettagliata dell'oggetto scansionato.

*-Ranging:* la distanza è il risultato di questa tecnica. In effetti, tutto si può ricondurre a una misurazione di distanze relative, tra lo strumento e l'oggetto, per ogni punto corrispondente a un impulso laser, ottenute a partire dal tempo di ritorno dell'impulso e dall'angolo di riflessione. È facile intuire che l'unione di tutte queste misurazioni genera una superficie discontinua di punti in tre dimensioni, la cosiddetta nuvola di punti, in cui ogni punto è costituito da tre coordinate (x,y,z) rispetto a un sistema di riferimento.

Questo concetto di base può essere pertanto applicato a diverse scale di utilizzo. Lo strumento principale, il laser scanner, può avere dimensioni e utilizzi diversi a seconda del tipo di oggetto che debba essere rilevato. Il più noto utilizzo del laser scanner è probabilmente quello fatto per l'analisi delle architetture, non solo in campo



archeologico<sup>246</sup>. Il laser scanner è comunque utilizzato in innumerevoli tipi di applicazioni dalla medicina all'ingegneria, alla storia dell'arte.

Negli ultimi quindici anni anche l'Archeologia del Paesaggio si è avvalsa dell'uso del laser scanner, specialmente dei dati utilizzati in applicazioni di tipo ambientale. L'uso principale del lidar infatti si deve a studi di tipo geomorfologico e agrario. La scala del paesaggio è tale da necessitare l'installazione dello strumento su un aeromobile (*airborne lidar*). Si crea pertanto un sistema di rilevamento leggermente più complesso rispetto al laser scanner terrestre, in quanto lo strumento non si trova in un punto fisso ma si muove insieme all'aeromobile. Lo scanner pertanto è correlato da altri strumenti che permettono di relativizzare la posizione di ogni impulso in un dato istante di tempo: la IMU<sup>247</sup>, e il GPS<sup>248</sup>. La IMU è uno strumento legato direttamente all'aeromobile, attraverso il quale è possibile registrare i movimenti inerziali di quest'ultimo dovuti agli effetti della rotta, ad esempio gli sbalzi di quota per stratificazioni d'aria e così via. Il GPS è un sistema di posizionamento basato su triangolazioni di un punto sulla superficie effettuate attraverso la posizione di appositi satelliti situati nell'orbita terrestre. Il sistema di posizionamento globale è l'applicazione che fornisce in ogni momento la posizione dell'aeromobile (e quindi dello strumento) rispetto alla superficie rilevata. In sintesi, un sistema di rilevazione lidar che abbia come oggetto del rilievo il paesaggio è formato da almeno 4 elementi: a) un aeromobile, b) un laser scanner, c) un GPS, d) una IMU.

#### 3.2.1.1 L'ACQUISIZIONE DEL DATO

Se volessimo simulare sinteticamente, e in forma semplificata, l'acquisizione delle informazioni di un rilievo effettuato attraverso il lidar aerotrasportato (ALS) seguiremmo i seguenti passi:

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<sup>246</sup> Daniela Peloso. "Tecniche Laser Scanner Per Il Rilievo Dei Beni Culturali." *Archeologia e Calcolatori* 16 (2005): 199-224.

<sup>247</sup> Inertial Measurement Unit.

<sup>248</sup> Global Positioning System.

- a) In ogni istante di tempo il laser scanner emette un fascio di luce laser ad una certa frequenza e con una certa angolazione che colpisce la superficie sottostante.
- b) Il fascio viene rifratto dalla superficie colpita e ritorna al sensore in maniera frazionata e con diverse angolazioni. Per ogni impulso inviato possono esserci diversi ritorni, chiamati appunto primo, secondo e ultimo ritorno.
- c) Una volta che l'impulso è restituito al sensore, questi ne misura il tempo di ritorno, l'angolo e l'intensità finale. È possibile ottenere il valore di variazione dell'intensità per ottenere alcune proprietà chimiche della superficie colpita.
- d) La differenza tra l'istante di emissione e l'istante di ritorno dell'impulso viene correlata all'angolo di rifrazione e permette di calcolare la distanza del punto dal sensore.
- e) L'unione delle informazioni sulla posizione dello strumento e sulla distanza del punto permettono di ottenere le tre coordinate che posizionano ogni punto rispetto al sistema di riferimento scelto.
- f) I punti sono raccolti in tabelle che costituiscono il dato grezzo del rilievo.

Questi passi rappresentano il modello di un rilievo lidar che viene ripetuto milioni di volte durante un volo. A seconda della densità dei punti raccolti possono essere immagazzinati centinaia di milioni di coordinate attraverso le quali si ottengono i prodotti successivi (superfici derivate dall'interpolazione dei punti) che costituiscono l'oggetto più utilizzato dall'archeologo. È però importante comprendere che ciò che si maneggia è il frutto di una interpolazione, si tratta appunto di un modello e non del dato originale in senso stretto.

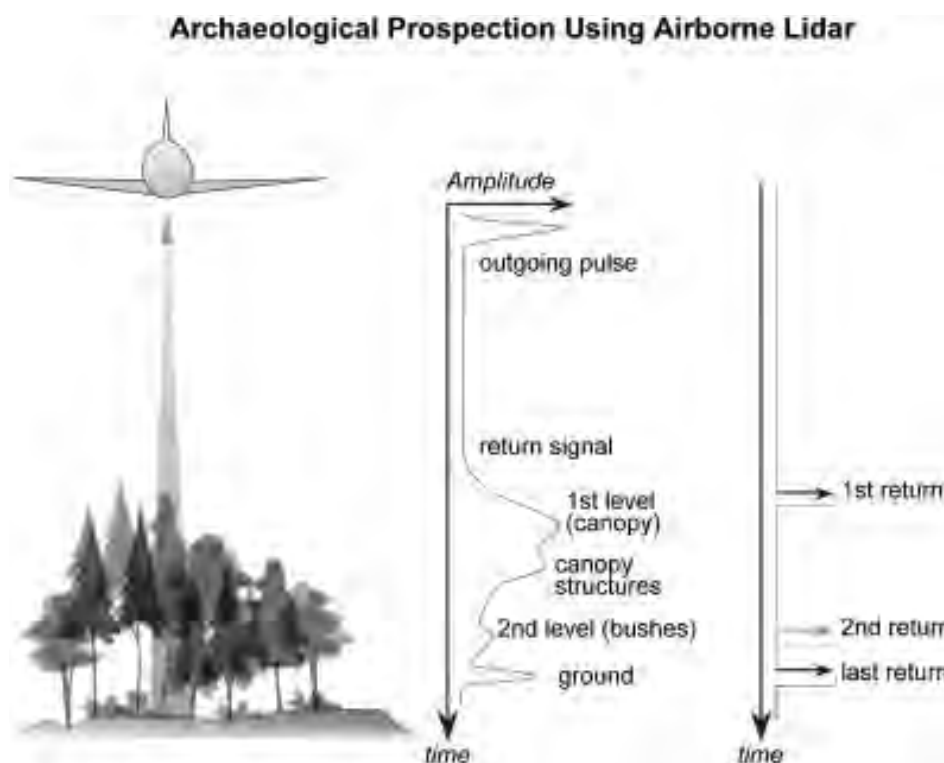


Figure 9. Lidar data acquisition scheme. (Source: Challis 2010)

### 3.2.1.2 L'ELABORAZIONE INIZIALE DEL DATO GREZZO

L'oggetto più semplice producibile da un rilievo lidar è la cosiddetta nuvola di punti (*point cloud*). La nuvola di punti è la visualizzazione in un sistema a tre dimensioni della posizione di ogni punto ottenuto da una misurazione effettuata con il laser, compresi gli errori dello strumento. Si tratta quindi di una rappresentazione asettica delle coordinate raccolte in una tabella alla quale è necessario attribuire un significato. Il primo significato, e quello più importante, che è possibile attribuire a una nuvola di punti è la classificazione. Consiste in una separazione dei punti in classi determinate a partire da precise caratteristiche che possono essere intrinseche o naturali, ad esempio in base al valore di intensità (*intensity*) o alla posizione spaziale (ad esempio si cerca di separare vegetazione da edifici e dal suolo). Si tratta di un processo che normalmente viene eseguito in forma (semi)automatizzata attraverso degli algoritmi di classificazione che si basano, a loro volta, su analisi statistiche.

Un articolo di Sithole e Vosselman riporta i risultati di un test di comparazione di otto algoritmi di classificazione per l'estrazione del terreno da una nuvola di punti ottenuta da lidar<sup>249</sup>. Sebbene si tratti di un articolo del 2004, il suo contenuto è ancora valido per mostrare le differenze che intercorrono tra i diversi approcci nella classificazione (e filtraggio) di una nuvola di punti e quanto possano incidere sul risultato finale. Inoltre, espone interessanti problematiche legate alla stessa interpretazione dei punti, come, ad esempio, una definizione condivisa di cosa sia il suolo terrestre e come lo si debba classificare rispetto agli altri oggetti. Gli stessi autori rimarcano alcune caratteristiche dei filtri (o algoritmi per il filtraggio/classificazione) che vale la pena riportare. Questi algoritmi sono costruiti tramite la combinazione di differenti elementi tra cui<sup>250</sup>:

- a) La struttura dei dati
- b) L'intorno e il numero di punti classificati alla volta; La classificazione può essere eseguita in vari modi:
  - punto-a-punto (vengono comparati 2 punti e classificato uno)
  - punto-a-punti (vengono comparati più punti rispetto a un punto di interesse, e ne viene classificato solo uno)
  - punti-a-punti (vengono classificati più punti alla volta)
- c) Misura della discontinuità
- d) Concetti astratti della classificazione rispetto, ad esempio, ad una superficie parametrica
- e) Sviluppo iterativo o ricorsivo dell'algoritmo
- f) Sostituzione o Eliminazione; (I punti classificati possono essere eliminati o restituiti in un'altra forma)
- g) Uso dei diversi ritorni dell'impulso registrati dal sensore

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<sup>249</sup> George Sithole, and George Vosselman. "Experimental Comparison of Filter Algorithms for Bare-Earth Extraction from Airborne Laser Scanning Point Clouds." *Journal of Photogrammetry and Remote Sensing* 59 (2004): 85-101.

<sup>250</sup> Una descrizione più dettagliata è data nell'articolo e nella bibliografia citata in George Sithole, and George Vosselman. "Experimental Comparison of Filter Algorithms..." pp. 89-91.

Come si può evincere da questa sintesi, esistono diversi parametri che devono essere presi in considerazione quando si utilizza un algoritmo per il filtraggio dei punti. Inoltre, a seconda del tipo di terreno su cui questo viene applicato e sulle sue caratteristiche locali, il risultato può non essere all'altezza delle aspettative. Sempre gli stessi autori riportano alcuni esempi di situazioni in cui gli algoritmi testati non hanno risposto alle previsioni come nel caso di oggetti complessi molto grandi o molto piccoli che possono essere confusi con la superficie del suolo, oggetti a diretto contatto con il suolo o bassa vegetazione e discontinuità come ad esempio salti o terrazzi ripidi<sup>251</sup>. Le conclusioni generali dell'articolo indicano comunque che l'efficienza e la precisione degli algoritmi varia a seconda dell'oggetto di analisi e che quindi è inevitabile la presenza di errori.

A questo punto è abbastanza immediato riconoscere le conseguenze con cui gli archeologi devono fare i conti quando utilizzano questo tipo di dato. In particolare il filtraggio automatico su un dato che non è stato pensato per scopi archeologici, con una risoluzione al di sopra del metro e che si decide comunque di utilizzare per la ricerca archeologica.

Innanzitutto, bisogna considerare la natura degli oggetti di interesse archeologico che si possono trovare sulla superficie terrestre. A meno di rari casi eccezionali gli oggetti che ci si aspetta di trovare possono essere delle piccole emersioni in superficie di strutture architettoniche che generano dei micro-rilievi o la presenza di canalizzazioni o superfici stradali che possono generare sia micro-rilievi che micro-depressioni nel terreno. Il resto di elementi che rendono interessante l'uso del lidar sono i *"pattern"* nascosti dalla vegetazione e non visibili da altri supporti quali la fotografia aerea. È evidente che la presenza di elementi archeologici nel sottobosco può essere assimilata a quella di una vegetazione bassa e anche qui si può perdere informazione al momento di una classificazione automatica. Ulteriore elemento non banale da considerare è la mancanza di informazione dovuta a zone con pendenze scoscese o ad aree densamente vegetate che non permettono al laser di superare la copertura della vegetazione e di raggiungere il suolo generando dei veri e propri *"buchi"* nell'insieme dei dati. La quantificazione di tutti questi elementi sarà fondamentale per stimare la qualità del dato

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<sup>251</sup> George Sithole, and George Vosselman. "Experimental Comparison of Filter Algorithms..." pp. 91-98.

e per ribadire l'impossibilità del cosiddetto survey totale, cioè dell'impossibilità di incontrare ogni singola evidenza archeologica in un territorio.

### 3.2.1.3 DAI PUNTI ALLE SUPERFICI

Dopo che i punti sono stati classificati secondo le necessità di chi li deve adoperare, si passa, solitamente, alla loro regolarizzazione. I punti vengono organizzati attraverso delle matrici regolari (*grid*) con celle di misure predefinite in modo che possano essere trattati in maniera più agevole in uno spazio a due dimensioni. Questo è di solito il primo passo per la creazione di superfici in due dimensioni (immagini *raster*) che costituiscono gli oggetti più frequentemente maneggiati dagli archeologi. In questo paragrafo dunque segue una breve trattazione dei più comuni tipi di superficie derivati da nuvole di punti utilizzati anche per gli scopi di questo studio. Questa operazione chiamata anche *gridding* è utile innanzi tutto per poter facilitare la visualizzazione dei dati e favorire l'extrapolazione delle informazioni.

A loro volta le superfici vengono riprocessate con algoritmi specifici di visualizzazione per ottenere informazioni di dettagli ancora maggiori (ecco perché parliamo qui direttamente di *image processing* anche riferendoci al lidar).

I prodotti principali di una nuvola di punti sono detti modelli digitali di elevazione (DEM) perché sono il risultato, appunto, di una interpolazione dei punti della nuvola, da cui ne deriva una superficie che è a sua volta un modello della realtà, nel nostro caso specifico un modello delle quote di elevazione della superficie terrestre. A sua volta il DEM può rappresentare diversi oggetti, i più noti sono il modello digitale della superficie (DSM) e il modello digitale del terreno (DTM) di cui si parlerà più volte in questo capitolo. Il primo è una rappresentazione digitale ottenuta con l'operazione di interpolazione di tutti i punti di una nuvola di punti (esclusi evidentemente i punti classificati come errori filtrati già nella fase di *pre-processing*). Il secondo è prodotto dall'interpolazione di punti che sono stati classificati come superficie terrestre in senso stretto, e ne esclude, pertanto, tutti gli oggetti al di sopra del livello del terreno (vegetazione, edifici e altri artefatti).

#### a) TIN – Triangulated irregular network

Il modo più classico per ottenere una superficie da una nuvola di punti è la rete di triangoli irregolari. Il metodo viene introdotto nel 1975 da un gruppo di studiosi canadesi<sup>252</sup> e viene considerato un modo valido ancora oggi per rappresentare una superficie in maniera più accurata possibile e sfruttando l'elaborazione automatica<sup>253</sup>. Questo modello è basato su una struttura dati con specifiche relazioni topologiche tra i punti vicini. In particolare la rete di triangoli dipende dalla variazione della superficie che rappresenta. Laddove la variazione è minima, i triangoli sono più grandi mentre dove vi è maggior variazione, i triangoli sono più densi. Questo tipo di visualizzazione di una superficie è probabilmente la più fedele interpolazione della nuvola di punti<sup>254</sup> ma è di difficile interpretazione per le analisi di interesse archeologico.

#### b) DSM – Modello digitale della superficie

Il modello digitale della superficie è un prodotto di interpolazione della nuvola di punti in cui vengono rappresentati tutti gli elementi presenti sulla superficie rilevata. Escludendo i punti generati dagli errori dello strumento, tutti i punti vengono interpolati senza nessun filtraggio in modo da ottenere una rappresentazione tridimensionale e fedele di tutto ciò che è rilevabile sulla superficie. Questo prodotto è sufficiente nella fase di prospezione archeologica, nei casi in cui il terreno rilevato non presenti un'eccessiva densità di vegetazione e quindi permetta di avere una visualizzazione fedele del terreno senza l'inconveniente della perdita di informazioni potenzialmente utili dovute al filtraggio eseguito per il DTM.

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<sup>252</sup>Thomas Peucker, and Nicholas Chrisman. "Cartographic Data Structures." *The American Cartographer* 2, no. 1 (1975): 55-69.

<sup>253</sup> Thomas Peucker, Robert Fowler, and James Little. "The Triangulated Irregular Network." *American Society of Photogrammetry* 516, no. Proceedings of the Digital Terrain Model Symposium (1978): 532-40.

<sup>254</sup> Simon Crutchley. "Using Airborne Lidar in Interpreting Archaeological Landscapes." In *Detecting and Understanding Historic Landscapes*, edited by Andrew Reynolds and Alexandra Chavarria, 67-92. Cremona: SAP, 2015.

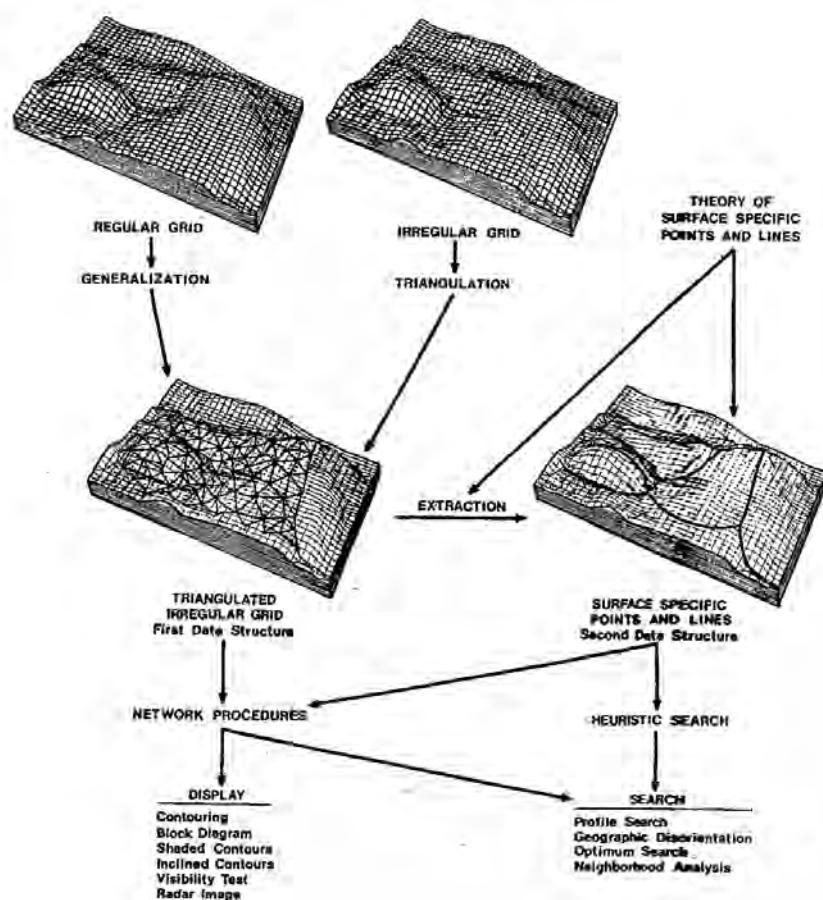


Figure 10. Triangulated Irregular Network processing. (Source: Peucker 1975)

### c) DTM – Modello digitale del terreno.

Il modello digitale del terreno è il prodotto maggiormente utilizzato nel caso del rilievo archeologico per il fatto che possiede delle caratteristiche interessanti tra le quali la più importante è senza dubbio il filtraggio della vegetazione. È anche un prodotto che può variare notevolmente in qualità, non solo a causa della risoluzione, ma anche a causa della classificazione dei punti e del conseguente filtraggio. Il DTM, infatti, si ottiene dopo una classificazione di tutti i punti della nuvola che, nella maggior parte dei casi, data la mole notevole di punti, avviene in maniera automatica con l'uso di algoritmi appositi. Per semplicità si può dire che l'algoritmo utilizzato, in generale, decide quali punti facciano parte del terreno e quali no sulla base della loro posizione relativa. Una volta che i punti sono stati classificati come non facenti parte del terreno vengono filtrati, cioè



eliminati dalla nuvola di punti e gli elementi restanti vengono interpolati per creare una superficie che rappresenta il modello digitale del terreno.

È evidente che l'interesse principale che suscita questo prodotto è quello di poter "vedere" al di sotto della vegetazione e di poter visualizzare facilmente elementi che sarebbero impossibili da cartografare nella fotografia aerea o satellitare. Il termine virgolettato "vedere" indica un diffuso fraintendimento sulla modalità di ottenimento del DTM. Per questo motivo ho voluto spendere tante pagine a descrivere con dettaglio le procedure di acquisizione dei dati e il loro processo di elaborazione, perché il lidar non permette di vedere sotto la vegetazione come spesso si sente ripetere da non professionisti. È la conformazione stessa del laser che consente di raggiungere alcuni punti del suolo senza che il fascio venga respinto dalla vegetazione, passando negli interstizi della vegetazione stessa. Quando questi punti sono interpolati danno l'impressione di "vedere" al di sotto della vegetazione ma si tratta pur sempre di un'approssimazione.

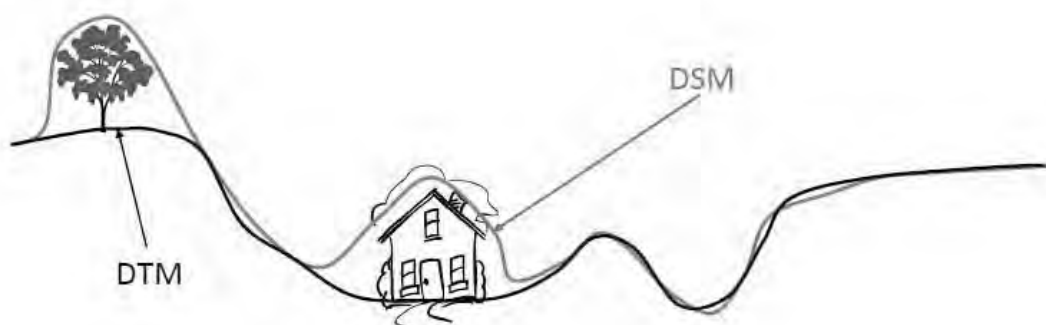


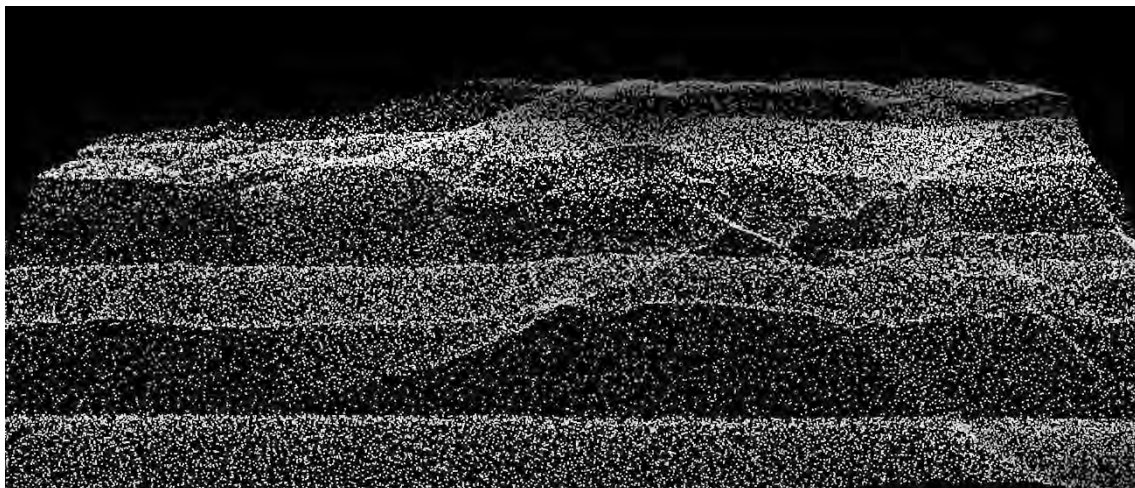
Figure 11. DTM and DSM surfaces. (Source: CCM License)

### 3.2.2 IL DATO LIDAR DELL'ISTITUTO CARTOGRAFICO CATALANO (ICGC)

I dati dell' *"Institut Cartogràfic i Geològic de Catalunya"* sono stati acquisiti nel progetto LIDARCAT tra il 2008 e il 2011. Si tratta di rilievi non eseguiti per specifiche finalità archeologiche ma destinati ad un uso di tipo generico, prettamente cartografico. La densità dei punti è diversa tra le varie zone a seconda dei periodi di acquisizione ma presenta, secondo la descrizione dello stesso fornitore, una densità minima di 0.5 punti al metro quadrato. Nonostante ciò la densità media dei punti nell'area della Valle di Àger

è di circa 1 punto al metro quadro come si può vedere dalla scheda di distribuzione della densità fornita dallo stesso istituto. Questo consente di produrre un modello digitale del terreno con una risoluzione massima di 2 metri per cella.

Bisogna pertanto discutere, già da ora, sulle potenzialità e aspettative di fruizione di questo tipo di dato per finalità archeologiche. Proprio a causa del valore di densità di punti, si frappongono dei limiti di usabilità per il nostro scopo. Non è inverosimile ritenere che per individuare degli oggetti di interesse archeologico, alla scala di un paesaggio, attraverso un modello di superficie derivato da un rilievo lidar, sia necessario disporre di una densità di punti che permetta di “visualizzare” elementi di dimensioni maggiori o uguali di un metro. Il metro è generalmente la misura accettabile per consentire l’individuazione della maggior parte delle anomalie del terreno. Ossia è necessario avere un modello digitale del terreno che abbia una risoluzione geometrica di almeno un metro, e ovviamente meglio se maggiore. Tuttavia, come si vedrà in seguito, il prodotto fornito dall’ICGC permette in ogni caso di individuare delle features interessanti nel paesaggio, soprattutto sotto le aree oggi coperte da vegetazione. Il paragrafo successivo unisce la spiegazione delle tecniche di elaborazione del DTM con il loro apporto nel caso specifico di Àger e prosegue con l’enumerazione degli elementi di interesse archeologico visibili grazie al lidar nella valle.



*Figure 12. Density differences in the point cloud. Example from the Àger Valley area. (Source: Antonio Porcheddu)*

### 3.3 IL DATO RADAR

Le immagini radar sono, nel panorama di ricerca archeologica, una recente acquisizione. I motivi principali degli esperimenti fatti negli ultimi anni con l'uso di immagini ottenute da sensori radar sono dovuti ad un abbassamento dei costi e a un miglioramento della risoluzione. Soprattutto il secondo aspetto è fondamentale per l'uso del radar in Archeologia, in quanto una risoluzione superiore ai 2 metri non sempre può essere utilizzata per gli scopi della ricerca. Così come il lidar anche il radar è una tecnica attiva che può funzionare in qualsiasi condizione ambientale di luminosità e meteorologica. La miglior promessa che riguarda l'uso di immagini radar in Archeologia è quella di poter raggiungere un livello di penetrazione del suolo, esattamente come accade per il normale GPR (*Ground Penetrating Radar*) utilizzato nelle prospezioni intensive. Tuttavia ciò che condiziona i risultati del rilievo radar è la composizione del suolo. Non è un caso che i migliori risultati siano stati ottenuti in situazioni di suolo secco e sabbioso, il deserto appunto<sup>255</sup>.

Il radar utilizzato in questo studio è definito SAR, radar ad apertura sintetica, che opera nella parte dello spettro elettromagnetico delle microonde con lunghezze d'onda che variano dai 10 metri a 1 millimetro a seconda della frequenza considerata. Inoltre rispetto radar ad apertura reale, questo tipo di radar simula una lunghezza maggiore dell'antenna per aumentare la risoluzione sfruttando il movimento del sensore e, per questo motivo, producendo immagini distorte<sup>256</sup>. Questo tipo di radar fornisce informazioni discriminanti sul tipo di superficie colpita, in particolare sulla rugosità, la geometria e l'assorbimento di radiazione. La lunghezza d'onda influenza sia il livello di penetrazione nel terreno sia la risoluzione geometrica, per questo motivo la scelta della frequenza deve essere fatta in base all'obiettivo della ricerca. Onde lunghe 10 metri, ad esempio, penetrano maggiormente nel sottosuolo ma non danno informazioni geometriche su oggetti di dimensione inferiore a tale misura. In Archeologia, com'è noto, le risoluzioni ideali per il telerilevamento sono attorno al metro, per questo motivo

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<sup>255</sup> Farouk El-Baz, Cordula Robinson, and Turki Al-Saud. "Radar Images and Geoarchaeology of the Eastern Sahara." In *Remote Sensing in Archaeology*, edited by James Wiseman and Farouk El-Baz, 47-70. New York: Springer, 2007.

<sup>256</sup> Derrold Holcomb, and Irina Lita Shingiray. "Imaging Radar in Archaeological Investigations: An Image Processing Perspective." In *Remote Sensing in Archaeology*, edited by James Wiseman and Farouk El-Baz, 11-46. New York: Springer, 2007.

la capacità di penetrazione del radar può essere limitata. In ogni caso i fattori circa la composizione del terreno citati sopra possono concorrere a creare situazioni ottimali in cui si ottenga sia una risoluzione accettabile che una buona penetrazione del sottosuolo.

In questo tipo di rilievo il fascio di onde elettromagnetiche che viene inviato sulla superficie da rilevare non è zenitale, come nel caso del lidar, ma obliquo. L'angolo di incidenza quindi è molto importante per il riconoscimento degli oggetti sulla superficie. In particolare a seconda del tipo di superficie ci possono essere diversi fenomeni di riflessione. Una riflessione perfetta si ha solo su una superficie speculare e questo è un caso ideale possibile praticamente solo in laboratorio. In generale nei casi interessanti per l'Archeologia i tipi di riflessione possono essere di *back scattering*, o di *volume scattering*. Nel primo caso il fascio incidente che colpisce una superficie ruvida viene riflesso in più fasci a diverse angolazioni che formano il cosiddetto rumore (*speckle*). Il *volume scattering* è una diffusione omogenea del fascio di radiazione luminosa con una minore dispersione.

Come si è visto quindi è necessario modulare al meglio la lunghezza d'onda e l'angolo di incidenza durante l'acquisizione del dato per poter ottenere i migliori risultati a seconda di quale sia l'obiettivo da raggiungere.

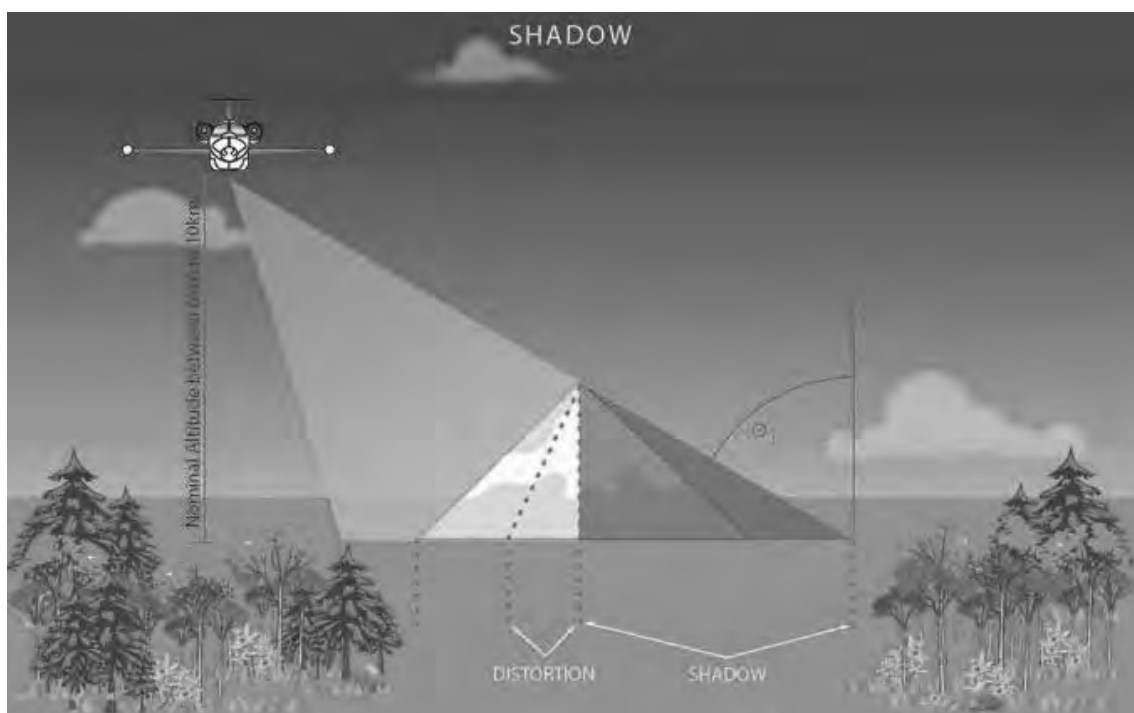


Figure 13. Radar acquisition scheme. (Source: InterMap)

### 3.3.1 L'ELABORAZIONE DEL DATO RADAR

Rispetto alle nuvole di punti derivate dai rilievi lidar, i dati grezzi del radar sono, come si evince dalla descrizione della tecnica, più complessi da elaborare e soprattutto da interpretare. La principale causa di tale difficoltà è data da due cause principali a) la distorsione causata dall'angolo di incidenza del fascio di onde elettromagnetiche, b) il rumore (*speckle*) generato dalle acquisizioni con il SAR.

Le distorsioni geometriche sono dovute ovviamente alla differenza tra l'angolo di incidenza del fascio e le pendenze del suolo, per questo motivo è necessario elaborare le diverse distorsioni digitalmente in modo da ridurre gli effetti sul prodotto finale. In particolare sono stati definiti tre tipi di distorsioni geometriche<sup>257</sup>, a) Foreshortening causato dalla presenza nella stessa cella di risoluzione di una porzione di rilievo dolce e di una parte di rilievo con maggiore pendenza; b) il layover che è senza dubbio l'anomalia più ricorrente in presenza di pendenze elevate, questo provoca uno spostamento della topografia del suolo rispetto alla sua reale posizione, in quanto la pendenza elevata riduce la distanza del fascio tra la base e il picco del rilievo; c) shadowing e contrasti pronunciati esistono sempre a causa della differenza di topografia del suolo rilevato causando delle parti in ombra e ad alto contrasto visivo.

Il rumore o *speckle* è dovuto alla variazione dell'intensità dell'immagine attorno a un punto. Visivamente questo provoca nell'immagine l'effetto sale e pepe, ossia la presenza limitrofa di punti ad alta intensità (bianchi) e punti a bassa intensità (neri) che rendono ulteriormente difficile la lettura visiva dell'immagine.

I problemi geometrici vengono risolti normalmente direttamente dal fornitore del dato quindi l'archeologo non deve intervenire nella georeferenziazione o nell'orto-rettifica delle immagini. Visivamente il foreshortening provoca, al momento della correzione, delle zone bianche dovute alla distensione dell'immagine che sono chiamate nel gergo tecnico "denti di squalo" a causa della loro forma. Questo tipo di anomalie sono state riscontrate anche nel caso del dato della Val d'Àger.

La attenuazione del rumore viene invece eseguita applicando dei filtri spaziali all'immagine, ad esempio filtri di *smoothing* o di *frost*. Si tratta di filtri che utilizzano i

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<sup>257</sup> Derrold Holcomb, and Irina Lita Shingiray. "Imaging Radar in Archaeological Investigations..." p. 13.

dati statistici dell'immagine ed eseguono delle attribuzioni di nuovi valori, ad esempio di media, su una porzione predefinita di celle del raster. In ogni caso c'è da considerare che più si procede all'applicazione di questo tipo di filtri e maggiore è la perdita di dettagli spaziali e quindi di risoluzione dell'immagine.

### 3.3.2 IL RADAR DELLA VAL D'ÀGER

Il prodotto acquisito per la Val d'Àger è un'immagine ORI (*Orthorectified Radar Image*) prodotta da Intermap. La risoluzione dichiarata è di 1,25 metri per cella e l'accuratezza dichiarata è di 2 metri. Il dato è prodotto usando un radar interferometrico ad apertura sintetica (InSAR) in cui l'intensità delle celle viene calcolata per ogni pixel utilizzando le differenze di fase, cioè le differenze tra l'impulso radar di andata e l'impulso radar di ritorno. Nel caso del prodotto Intermap il sensore è montato su un aeromobile. In questo caso il produttore dichiara che il prodotto ORI rappresenta la prima superficie riflessa dal radar e quindi si tratta di un prodotto senza penetrazione nel sottosuolo. Questo aspetto sarà fondamentale al momento di interpretare eventuali anomalie.

I dati acquisiti nella Val d'Àger sono datati al febbraio 2008, in un periodo in cui la vegetazione non era alla sua massima densità, al contrario di quanto detto sul rilievo lidar effettuato nei mesi estivi in cui il fogliame vegetale raggiunge la sua massima espansione.

L'utilizzo di questo dato per la Vall d'Àger pertanto, viste le sue caratteristiche, è quello di essere affiancato al lidar nella creazione di modelli digitali del terreno per migliorare la capacità di identificare elementi di variazione del microrilievo che possano avere interesse archeologico. Bisogna tuttavia tenere presente che l'interpretazione del radar è visivamente più difficile per le cause sopra citate e che può portare quindi alla visualizzazione di falsi rilievi, illusioni ottiche o inversioni topografiche che devono essere valutate tramite la comparazione del dato con supporti più affidabili come la fotografia aerea.

### 3.4 ORTOFOTOGRAFIA AEREA

Delle diverse fonti di telerilevamento di cui dispone l'Archeologia, la fotografia aerea è senza dubbio la più classica e la più utilizzata, sia per il basso costo sia per l'alta disponibilità. Oggi infatti è possibile sia in Italia che in Spagna, ma in quasi tutti i paesi occidentali, disporre di ortofotografie ad alta risoluzione ed aggiornate.

Nel caso della Val d'Àger disponiamo di numerosi prodotti aerofotografici di discreta utilità per l'analisi archeologica. In primis l'ortomosaico di fotografie aeree vigenti, cioè le ultime riprese disponibili, datate al 2015 e aventi una risoluzione geometrica di 0,25 metri. Queste riprese permettono di osservare la superficie terrestre ad un livello di dettaglio molto alto e di poter mappare con precisione ogni elemento che si ritenga necessario. Le ortofoto nel caso della Val d'Àger sono disponibili direttamente e gratuitamente prelevandole dalla rete tramite il servizio WMS oppure tramite il download dal portale dell'Istituto Geologico e Geografico della Catalogna (ICGC<sup>258</sup>).

Contestualmente alle riprese ottiche, cioè le normali fotografie aeree, sono presenti anche dei rilievi nella lunghezza dell'infrarosso (IR) disponibili sempre alla stessa risoluzione. Queste foto permettono di realizzare delle elaborazioni sugli indici di crescita vegetazionale (NDVI) che fanno risaltare le differenze nella crescita della vegetazione. Questa tecnica è stata una delle prime utilizzate dagli archeologi per individuare eventuali elementi di interesse archeologico nel sottosuolo quali strade, muri e canalizzazioni<sup>259</sup>.

Un ulteriore utilità viene fornita dalle fotografie aeree storiche e in particolare da quelle del 1945 e del 1956. Queste foto sono di bassa qualità dal punto di vista della risoluzione ma costituiscono uno strumento molto utile per confrontare i cambiamenti avvenuti nel paesaggio negli ultimi 60 anni. Anche queste foto sono disponibili già georeferenziate tramite il sito web dell'Istituto Geologico e Cartografico della Catalogna.

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<sup>258</sup> Il sito che permette di scaricare le ortofoto e gli altri prodotti è un web-gis disponibile, alla data in cui si scrive, all'indirizzo <http://www.icc.cat/vissir3/>.

<sup>259</sup> Stephen Leisz. "An Overview of the Application of Remote Sensing to Archaeology During the Twentieth Century." In *Mapping Archaeological Landscapes from Space*, edited by Douglas Comer and Michael Harrower, 11-20. New York: Springer, 2013.

In generale per la Val d'Àger l'uso di fotografie aeree è stato limitato alla comparazione delle *features* con i modelli digitali del terreno. Inoltre è stata eseguita un'aerofotointerpretazione delle aree adiacenti ai siti archeologici di interesse. Alcune porzioni che verranno illustrate nelle parti successive di questo lavoro, sono state trattate con gli algoritmi di elaborazione immagini che verranno descritti di seguito e che sono gli stessi utilizzati anche per i dati del lidar. Inoltre le fotografie aeree storiche degli anni 1945 e 1956 sono state utilizzate per una comparazione della trama del particellare agrario della valle al fine di identificare i cambiamenti più recenti e ricostruire la rete stradale principale prima delle modifiche agrarie più invasive occorse negli ultimi decenni.

### 3.5 ELABORAZIONE DELLE IMMAGINI (*IMAGE PROCESSING*)

Le tecniche descritte in seguito sono state applicate ai prodotti raster utilizzati nel corso di questo studio. In particolare sono tutti accomunati dal fatto che utilizzano i valori originali di intensità dei pixel per ottenere delle riorganizzazioni degli stessi secondo il tipo di algoritmo. Infatti, ogni pixel ha un'informazione di intensità costituita da un numero, nel caso del modello digitale del terreno questo costituisce la quota sul livello del mare mentre nel caso dell'ORI costituisce il valore dell'impulso di ritorno del radar. Nella fotografia aerea ogni pixel è costituito da tre valori di intensità rispettivamente di rosso, verde e blu nel caso delle foto a colori, e un valore di intensità di grigio nel caso delle foto in scala di grigi.

Tutti gli algoritmi sono pensati per rimodellare questi valori seguendo delle caratteristiche particolari con la finalità di evidenziare certi aspetti dell'immagine al fine di facilitarne l'interpretazione visiva per l'occhio umano. Per questo motivo tali applicazioni vengono definite anche di miglioramento (*image enhancement*).

#### 3.5.1 SLOPE E ASPECT

Lo slope è la traduzione inglese del termine pendenza. Questo algoritmo si applica nel nostro caso, al modello digitale del terreno affinché i pixel ricevano un valore rispetto

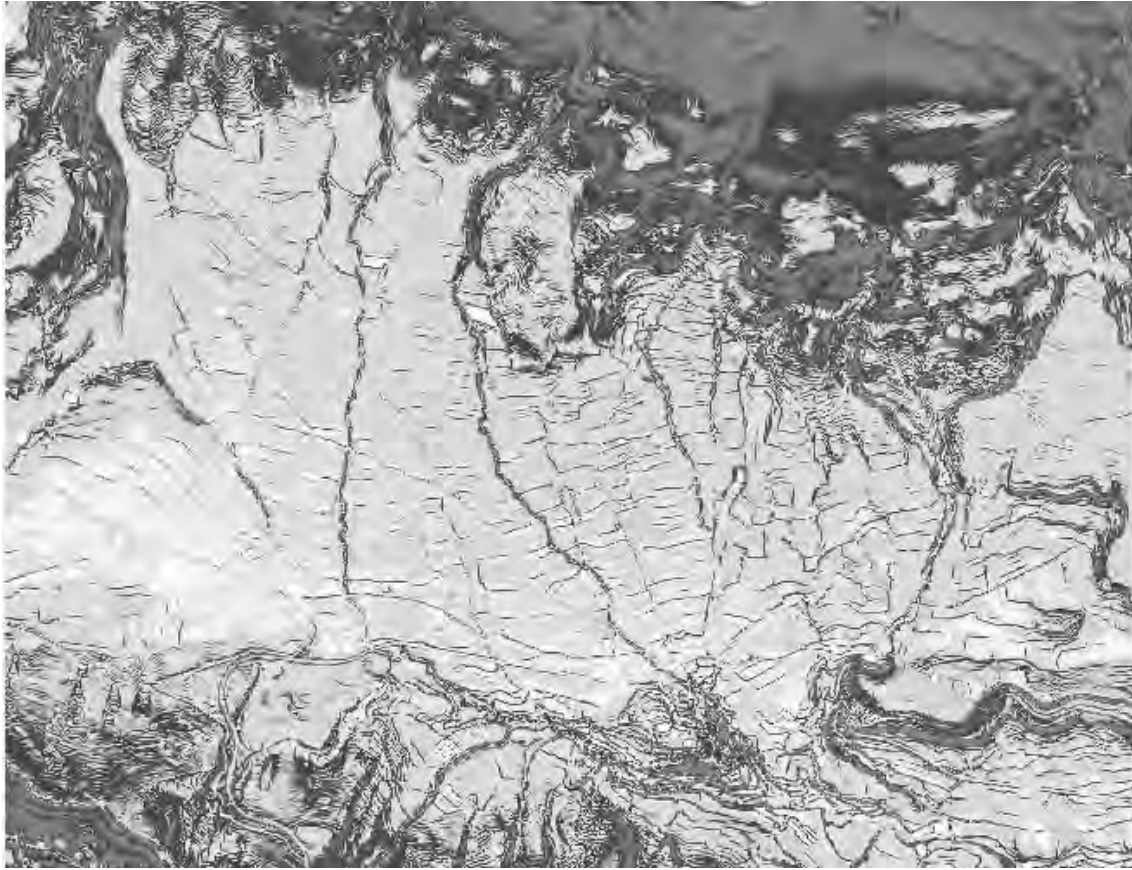


alla pendenza assunta lungo una certa direzione. I punti con maggiore pendenza appariranno più scuri mentre i punti con minore pendenza o piani saranno chiari. Questo tipo di visualizzazione è utile per aumentare la visibilità delle pendenze del terreno. In particolare bisogna tener presente che i valori visualizzati non corrispondono all'esatta topografia ma sono valori di pendenza quindi serve per dare un'idea delle aree che sono effettivamente dei salti e delle soluzioni di continuità nel terreno come fosse e terrazzi, così come per esaltare il bordo di alcuni oggetti come strade e divisioni particellari.

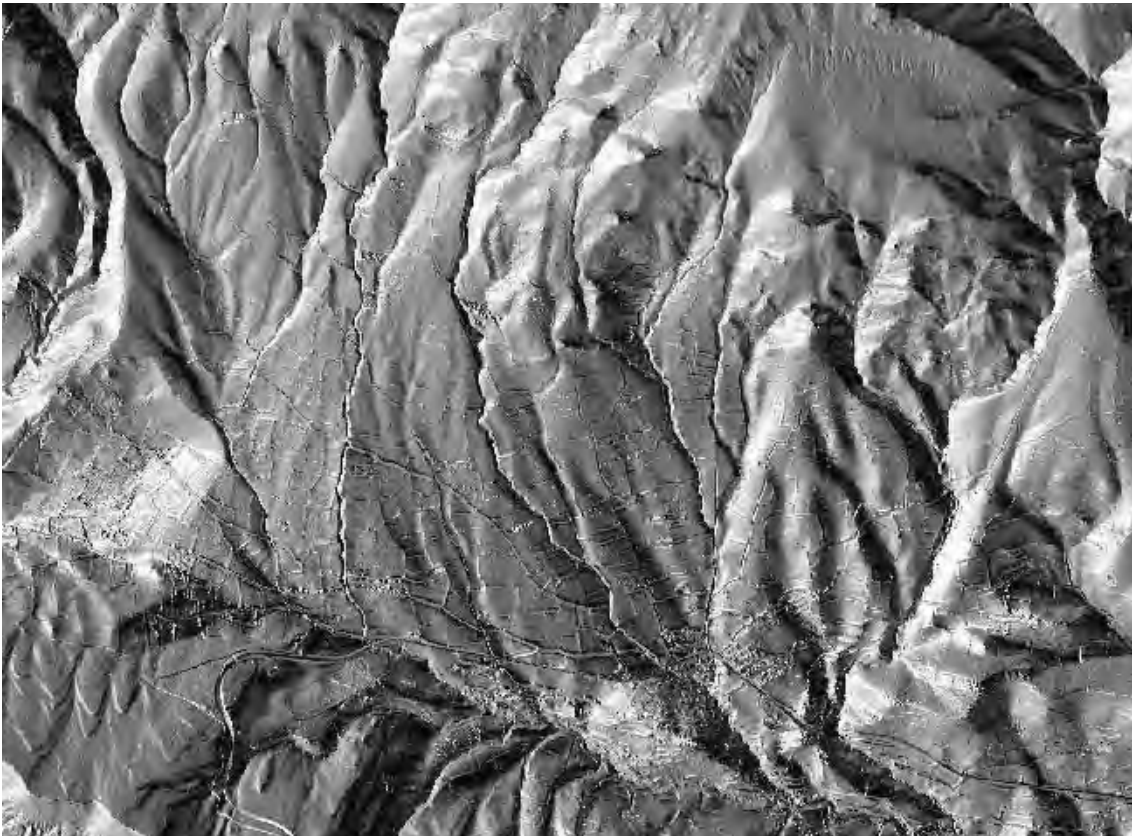
Anche l'aspect è un'elaborazione legata alla pendenza. In questo caso però l'algoritmo calcola e permette di visualizzare con diversi colori l'andamento delle pendenze secondo la loro direzione. Questa informazione è interessante sia per la visualizzazione del raster, perché aiuta l'occhio umano a visualizzare i diversi andamenti delle pendenze, anche se talvolta necessitano di attenzione per essere interpretati. Inoltre è utile per definire alcuni aspetti che riguardano l'insolazione e quindi la diversa esposizione della superficie terrestre alla luce solare. Questo può essere utile nel caso di analisi sull'uso del suolo e sul posizionamento di certe sistemazioni agrarie e colture<sup>260</sup>.

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<sup>260</sup> Entrambe le tecniche sono citate nel manuale utilizzato come riferimento in questo lavoro Rafael Gonzalez, and Richard Woods. *Digital Image Processing*. New Jersey: Prentice Hall, 2007.



*Figure 15. Slope degree Image represented with a classified colour palette of the Landscape Unit 1, Ager Valley.*



*Figure 14. Aspect Image represented with a greyscale palette of the Landscape Unit 1, Ager Valley.*

### 3.5.2 COLOUR MAPPING O COLOUR CONSTRAINT

La colorazione “ristretta” è una tecnica piuttosto semplice e immediata, e spesso di grande efficacia, per la visualizzazione di dettagli in un DTM. È facile intuire il suo funzionamento dato che, anche nelle carte geografiche a colori, diverse quote sono spesso colorate con differenti colori, un marrone più scuro per le montagne più alte e un verde per le colline. Spesso questi colori non rappresentano esattamente tutte le quote ma delle classi di valori attraverso le quali vengono interpolate o sfumate. Nel nostro caso, utilizzando il GIS, è possibile selezionare automaticamente o manualmente un intervallo di elevazione e assegnargli una *palette* di colori. Applicandola ad un intervallo di quote sufficientemente piccolo, è possibile far risaltare micro-variazioni di elevazione e visualizzarle agevolmente acquisendo un alto grado di dettaglio. Questa tecnica è risultata molto efficace soprattutto nelle aree di pianura che hanno piccolissime variazioni di altitudine, come in un sito della pianura Padana in Italia, dove ha permesso di individuare un antico lago citato in epoca romana e attorno al quale si erano sviluppati dei luoghi di culto<sup>261</sup> o nella stessa porzione pianeggiante della Val d’Àger.

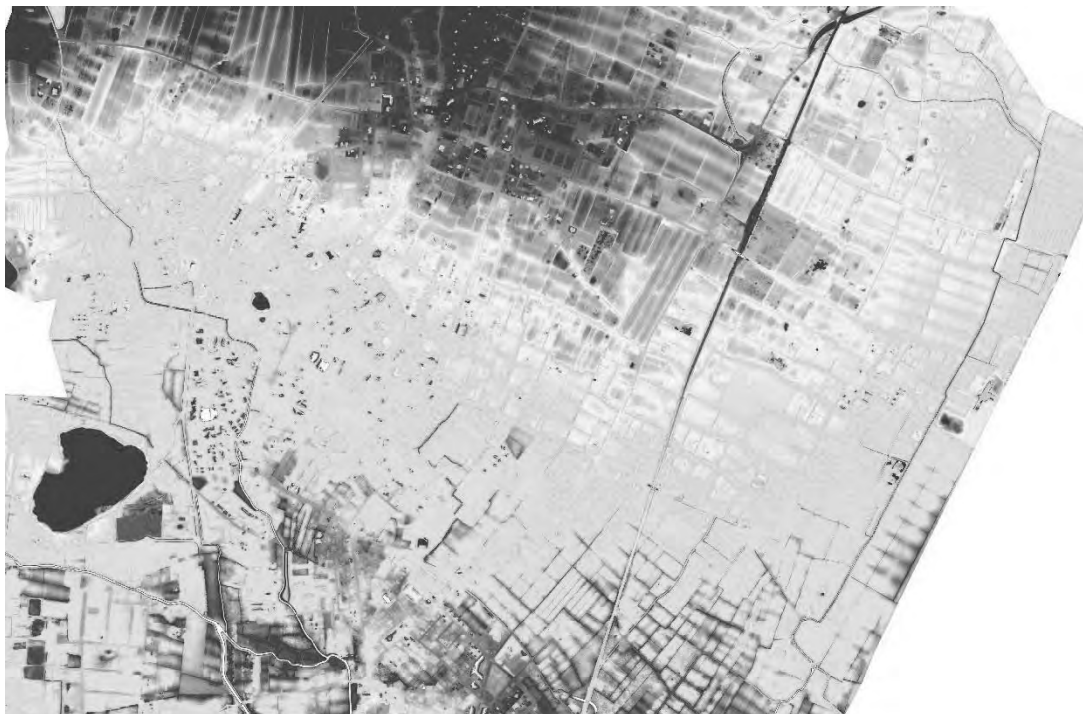


Figure 16. Colour constraint in the Padova plain. (Source: Antonio Porcheddu)

<sup>261</sup> Gian Pietro Brogiolo, and Armando De Guio. "Cartografia Storica E Remote Sensing (Lidar) Nello Studio Dei Paesaggi Di Montegrotto Terme." In *Aquae Patavinae. Montegrotto Terme E Il Termalismo in Italia. Atti Del Ii Convegno Nazionale (Padova 2011)*, edited by Maddalena Bassani and Francesca Ghedini, 15-53. Padova: Padova University Press, 2012.

### 3.5.3 ANALYTICAL HILL SHADING (SHADED RELIEF) O RILIEVO OMBREGGIATO

In questa tecnica il modello digitale di elevazione viene “illuminato” da una sorgente virtuale di luce diretta. Lo scopo principale è quello di rendere plastica la superficie interessata in modo da ottenere una visualizzazione più realistica tramite le differenze di illuminazione, e quindi di intensità di grigio, alternando parti ombreggiate a parti esposte alla luce. Questa tecnica si chiama anche *cosine shading*<sup>262</sup>. Grazie a questo effetto è possibile rendere più simile alla realtà l’illuminazione della superficie. Quando un oggetto viene illuminato con un certo angolo questo forma dunque un’ombra che permette all’occhio umano di distinguerlo dal suo intorno.

Con il GIS è possibile realizzare questa illuminazione artificiale usando degli algoritmi, ormai presenti in tutti i più diffusi software GIS, e modificare l’angolo di incidenza della luce in modo da avere differenti scenari di illuminazione e, quindi, maggiori possibilità di riconoscere degli elementi sulla superficie. Si possono anche creare delle illuminazioni irrealistiche con la proiezione dell’ombra verso sud che possono creare una superficie rovesciata (ad esempio facendo percepire le depressioni come rilievi) ma che all’occorrenza può rivelarsi utile.

Per quanto riguarda l’applicazione nel rilievo archeologico, l’illuminazione verticale può essere sufficiente in zone con pendenze scoscese mentre in pianura è più utile una luce radente, quindi un angolo di illuminazione basso, per permettere di scorgere le piccole variazioni topografiche. Vi sono anche delle caratteristiche svantaggiose in questa tecnica. Ad esempio, il fatto che sia necessario cambiare più volte l’angolo di incidenza per vedere gli elementi orientati in modi diversi, rende difficile un’interpretazione immediata di certi dettagli. Infatti, gli oggetti lineari orientati parallelamente al fascio incidente non sono visualizzati in quanto non generano ombre. Questo richiede di dover impostare la direzione di provenienza della luce lungo tutto il percorso di 360 gradi. Un altro punto a sfavore, che spesso viene citato nella letteratura<sup>263</sup>, è il fatto di creare delle

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<sup>262</sup> Infatti, da un punto di vista del modello matematico, l’intensità di illuminazione diffusa è calcolata tramite la legge del coseno di Lambert. Questa legge dice che l’intensità luminosa diffusa osservata su una superficie riflettente è direttamente proporzionale al coseno dell’angolo  $Q$  compreso tra la direzione della luce incidente e la normale alla superficie. La versione più semplice di questa legge è scritta con la formula:  $I = kd \cos \theta$  in cui  $kd$  è il coefficiente di riflessione che dipende dal tipo di superficie.

<sup>263</sup> Keith Challis, Ziga Kokalj, Andy Howard, Derek Moscrop, *et al.* "Airborne Lidar and Historic Environment Records." *Antiquity* 82, no. 318 (2008): 1055-64.

aree ad alto contrasto fra le intensità, cioè aree molto chiare e aree molto scure che riducono la visibilità e la percezione di eventuali oggetti.

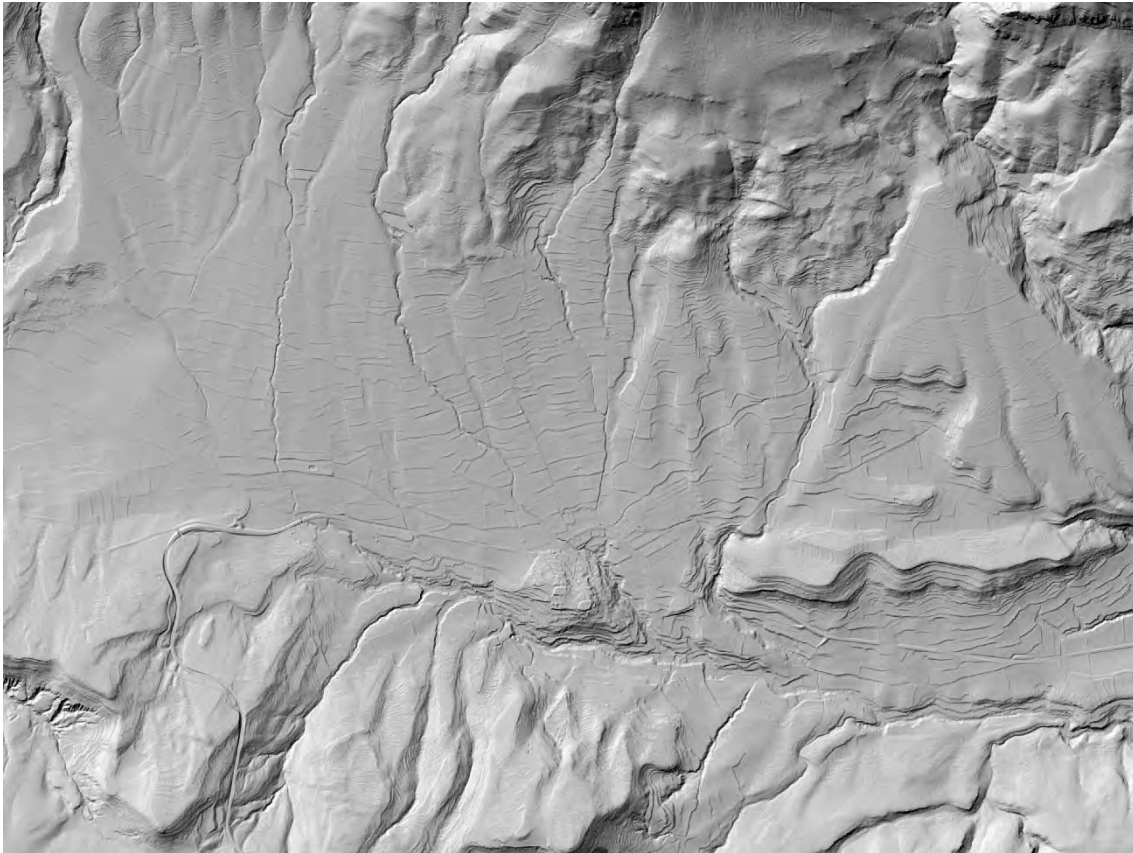


Figure 17. Analytical Hill Shading of the Landscape Unit 1, Ager Valley. (Source: Antonio Porcheddu)

#### 3.5.4 ANALISI DELLE COMPONENTI PRINCIPALI (*PRINCIPAL COMPONENT ANALYSIS*)

La *Principal Component Analysis* applicata alle superfici DTM è, in un certo senso, la risposta alle problematiche insite nell'*Hill Shading*. La sua finalità principale è quella di avere un'unica immagine raster (composita) in cui siano visualizzati la maggior parte degli elementi percepibili su uno *Shaded Relief*. Questo è possibile naturalmente solo se gli oggetti hanno un angolo di illuminazione appropriato per la loro visibilità.

La proposta fatta da Devereux nel 2008 è quella di avere un'illuminazione da almeno 16 angolazioni diverse<sup>264</sup>. È evidente che questo crea 16 immagini di *Hill Shading* con una parte di informazioni ridondante. Le immagini sono, infatti, estremamente relazionate fra loro e porterebbero a un'alta difficoltà nell'interpretazione reale. Il metodo che

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<sup>264</sup> Barry Devereux, and Peter Crow. "Visualisation of Lidar Terrain Models for Archaeological Feature Detection." *Antiquity* 82, no. 316 (2008): 470-79.

Devereux ha proposto per primo in applicazione alla visualizzazione del lidar fa uso dell'analisi delle componenti principali. Si tratta di una procedura di statistica multivariata in cui le informazioni contenute sulle 16 immagini originali vengono ridistribuite in 16 nuove immagini in modo che il minor numero di immagini contenga il maggior numero possibile di informazioni, mentre nelle altre rimanga la differenza o il rumore<sup>265</sup>. Questo significa che le prime componenti possono sostituirsi all'intera base di dati con una perdita di informazioni accettabile e stimata attorno al 5%<sup>266</sup>. In questo caso quindi i 360° della superficie illuminata sono divisi in 16 diverse immagini illuminate da altrettante direzioni diverse che una volta trasformate possono contenere più del 95% delle informazioni originali. Si vede pertanto che combinando solo due o tre delle immagini processate è possibile mantenere l'opportunità di vedere la maggior parte degli elementi sulla superficie. Ovviamente non mancano i problemi legati all'interpretazione, soprattutto perché l'occhio umano non è abituato a percepire questo tipo di illuminazione, è quindi opportuna una certa esperienza di lavoro del ricercatore per ottenere i massimi risultati.

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<sup>265</sup> Per rumore si intende, generalmente, un segnale di disturbo rispetto al segnale principale su cui si sta operando. In questo caso si può considerare come rumore l'insieme di errori generati dallo strumento di rilievo o gli elementi che non trovano alcuna correlazione con il resto del loro intorno.

<sup>266</sup> Barry Devereux, and Peter Crow. "Visualisation of Lidar Terrain Models..." p. 475.

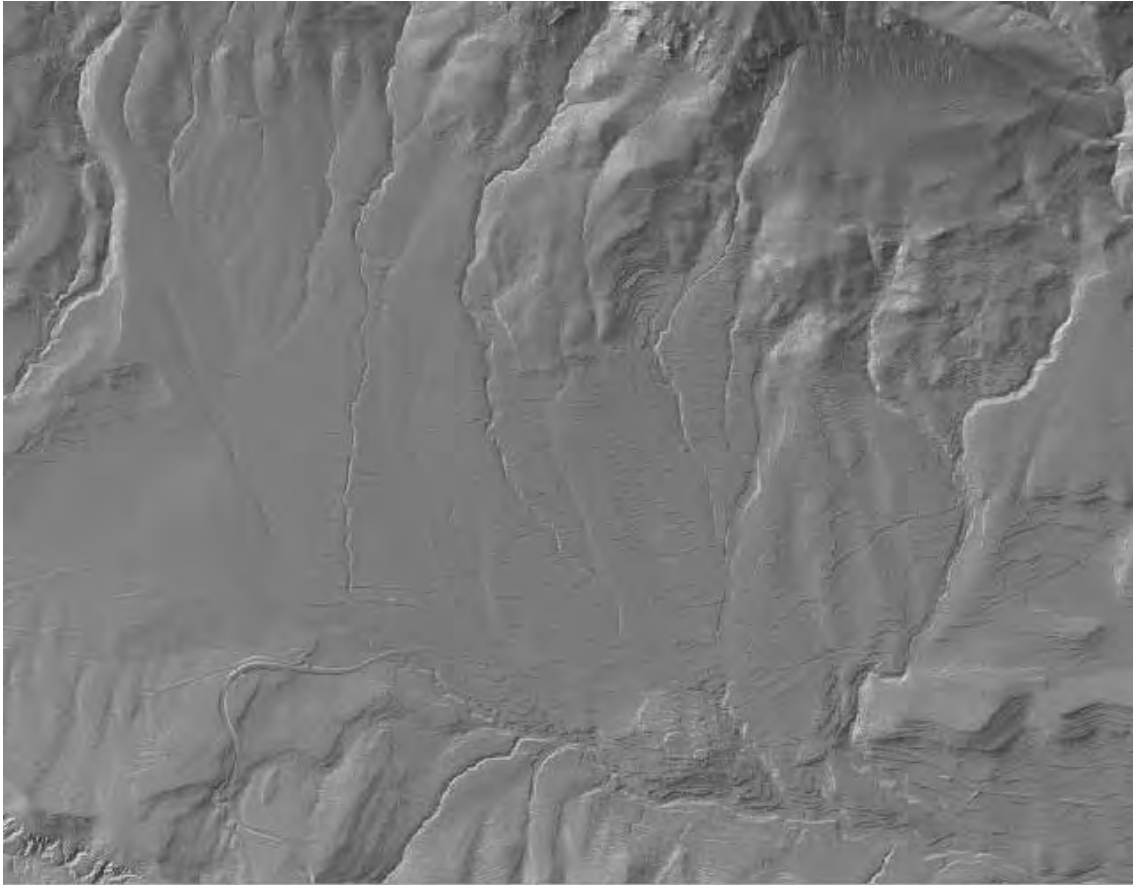


Figure 18.. *Principal Component Analysis of Landscape Unit 1, Ager Valley.* (Source: Antonio Porcheddu)

### 3.5.5 OPENNESS – LUCE DIFFUSA

Rispetto all'*Hill Shading* basato su una luce direzionale, cioè da una fonte luminosa posta in un punto ben preciso, la *Openness* è basata sul concetto di luce diffusa, cioè con illuminazione da ogni punto della scena. Questa tecnica è stata presentata per la visualizzazione di modelli digitali del terreno nel 2002<sup>267</sup>. È utile spendere qualche riga a descrivere la teoria che sta dietro questa tecnica, sebbene sia abbastanza semplice, perché è necessaria una comprensione dei principi di funzionamento al momento di utilizzare il software e di impostare i parametri per creare l'immagine.

Per capire come viene ottenuta la superficie *Openness* ci può riferire a dei calcoli trigonometrici. Il primo passo è il calcolo di tutti gli angoli di elevazione  $Q$  tra un punto scelto  $A$  e uno dei punti  $B$  della superficie posti lungo una certa direzione  $D$  a una

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<sup>267</sup> Ryuzo Yokoama, Michio Shirasawa, and Richard Pike. "Visualizing Topography by Openness: A New Application of Image Processing to Digital Elevation Models." *Photogrammetric engineering and remote sensing* 68, no. 3 (2002): 257-66.

distanza L. Applicando il teorema di Pitagora moltiplicato per una costante di spazio M, che corrisponde alla distanza fissa tra ogni punto, si ottiene la distanza orizzontale tra i due punti. Da qui, per ottenere il valore dell'angolo di elevazione Q, basta calcolare l'arcotangente del rapporto tra la differenza delle quote DH e la distanza orizzontale P. Per ogni direzione D a una distanza L quindi esiste un angolo di elevazione massimo e uno minimo. Questi due valori vengono utilizzati per calcolare l'angolo zenit<sup>268</sup> ( $90 - \text{il valore dell'angolo di elevazione massima}$ ) e l'angolo nadir ( $90 + \text{il valore dell'angolo di elevazione minima}$ ).

La superficie Openness si ottiene quindi dividendo l'arco di  $360^\circ$  in 8 parti e calcolando a partire dal punto scelto gli angoli di zenit e nadir rispetto ad ognuna delle 8 direzioni e in seguito facendone la media. Esistono due tipi di Openness una positiva e una negativa<sup>269</sup>. La positiva corrisponde alla media degli otto angoli zenit visti sopra la superficie lungo ogni direzione fino alla specifica distanza L. Allo stesso modo la negativa è la media degli otto angoli nadir visti sotto la superficie rispetto al punto A lungo ogni direzione D e distanza L.

È chiaro che le due tipologie esaltano diversi aspetti della superficie, quella positiva è influenzata dalla conformazione del terreno ed esalta l'espansione di un terreno posto in rilievo quindi tende a far esaltare le convessità; quella negativa analogamente tende a far risaltare le concavità. Come riportano gli autori dell'articolo citato "the resulting maps of openness superficially resemble digital images of shaded relief or slope angle, but emphasize dominant surface concavities and convexities<sup>270</sup>."

Lo stesso tema è stato ripreso recentemente come applicazione specifica ai dati derivati da lidar mentre nell'esempio precedente si parlava di DTM generato da qualsiasi tipo di strumento. I maggiori benefici secondo la discussione fatta da Doneus<sup>271</sup> per questa

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<sup>268</sup> L'angolo zenit e l'angolo nadir sono definiti nell'articolo di Yokoyama (pag. 258) come, rispettivamente, l'angolo massimo verticale sotteso tra un punto selezionato e uno dei punti visti dall'alto della superficie lungo una certa direzione D a distanza L e l'angolo massimo sotteso allo stesso punto e un punto visto dal basso della superficie lungo la stessa direzione D e distanza L.

<sup>269</sup> Ryuzo Yokoama, Michio Shirasawa, and Richard Pike. "Visualizing Topography by Openness... p. 259.

<sup>270</sup> Yokoyama, Ryuzo, Michio Shirasawa, and Richard J. Pike. "Visualizing topography by openness: a new application of image processing to digital elevation models." *Photogrammetric engineering and remote sensing* 68.3 (2002): p. 257.

<sup>271</sup> Michael Doneus. "Openness as Visualization Technique for Interpretative Mapping of Airborne Lidar Derived Digital Terrain Models." *Remote Sensing* 5, no. 12 (2013): 6427-42.



tecnica verrebbero da una semplificazione dell'individuazione dei bordi per i singoli oggetti da cartografare. Inoltre esistono delle riflessioni applicative che è necessario fare prima di utilizzare questa tecnica e che giustificano la spesa qui fatta per delinearne a fondo le sue caratteristiche. I risultati sono influenzati da parametri e in particolare la determinazione del raggio L della semisfera su cui impostare il calcolo, il numero di direzioni verso le quali calcolare gli angoli di zenit e nadir.

### 3.5.6 SKY VIEW FACTOR

La Sky View Factor (SVF) è molto simile alla Openness appena descritta. È stata proposta nel 2011 da un gruppo di ricercatori sloveni che ne hanno esaminato le specifiche applicazioni in ambito archeologico<sup>272</sup>. Viene intanto proposta l'illuminazione diffusa a partire dall'alto di una semisfera che rappresenta il cielo sopra la superficie, centrata nel punto illuminato. Vi sono poi alcune assunzioni da fare per il calcolo: a) che la semisfera abbia la stessa intensità di luce lungo tutta la superficie e b) tralasciare il fattore di curvatura terrestre per superfici sufficientemente piccole.

Il valore della quantità di cielo visibile<sup>273</sup> sarà compreso tra 0 e 1 (2 se viene considerata l'intera sfera) in cui i valori prossimi a 1 determineranno la visibilità di tutto l'emisfero e i valori prossimi allo 0 l'occlusione del cielo visibile. Come riportano gli autori, questo tipo di misurazioni derivano dagli studi fatti sulle variazioni di temperatura di una superficie a causa della sua esposizione all'irraggiamento solare. Nel nostro caso questo valore viene usato per dare alla superficie diverse intensità di grigio e metterne in risalto le caratteristiche morfologiche<sup>274</sup>. Ancora una volta è importante conoscere questi dettagli per meglio sfruttarli al momento di processare i propri dati. Infatti la *Sky View Factor* dal punto di vista interpretativo è abbastanza intuitiva perché impostando un orizzonte limite di calcolo, quello della semisfera, fornisce una visualizzazione più

<sup>272</sup>Klemen Zakšek, Christof Oštir, and Žiga Kokalj. "Sky-View Factor as a Relief Visualization Technique." *Remote Sensing* 3, no. 2 (2011): 398-415.

Žiga Kokalj, Klemen Zakšek, and Krištof Oštir. "Application of Sky-View Factor for the Visualisation of Historic Landscape Features in Lidar-Derived Relief Models." *Antiquity* 85, no. 327 (2011): 263-73.

<sup>273</sup> La formula matematica per calcolare s, cioè la quantità di cielo visibile da un punto, è definita come:

$$s = 1 - \frac{\sum_{i=1}^n \sin \gamma_i}{n}$$
 dove n è il numero di direzioni e  $\gamma$  l'angolo di elevazione dell'orizzonte.

<sup>274</sup> Klemen Zakšek, Christof Oštir, and Žiga Kokalj. "Sky-View Factor as a Relief Visualization..." p. 403.

naturale dei rilievi rispetto alla Openness. Per quanto riguarda il numero di direzioni da impostare nella ricerca e il valore del raggio di ricerca, gli autori mostrano delle analisi in cui sono sufficienti da 8 a 32 direzioni di ricerca per ottenere un risultato ottimale<sup>275</sup>. Il raggio da usare, invece, dipende maggiormente dalla risoluzione del dato su cui si sta lavorando e dalla dimensione degli oggetti che si vogliono visualizzare. Anche in questo caso il risultato migliore si ottiene nella visualizzazione di depressioni nel terreno come per l'Openness.



*Figure 19. Sky View Factor of the Landscape Unit 1, Ager Valley. (Source: Antonio Porcheddu)*

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<sup>275</sup> Klemen Zakšek, Christof Oštir, and Žiga Kokalj. "Sky-View Factor as a Relief Visualization..." p. 407.

### 3.5.7 MODELLO DEL RILIEVO LOCALIZZATO (*LOCAL RELIEF MODEL*)

Il Local Relief Model “represents local, small-scale elevation differences after removing the large-scale landscape forms from the data”<sup>276</sup>. Questo metodo è basato sulla tecnica del *Trend Removal* applicato per esaltare le deviazioni rispetto alla superficie terrestre, siano esse positive che negative<sup>277</sup>. Come si intuisce dal nome si basa su una procedura statistica di cui però interessano i residui e viene rimosso, appunto, il trend, cioè l’andamento principale dei dati, in questo caso dei valori di elevazione delle celle. Il processo consiste nell’eliminare gli oggetti a grande scala e di mantenere gli oggetti a piccola scala, quello che viene definito il rilievo residuo o modello locale del rilievo<sup>278</sup>. L’algoritmo, per creare questa superficie, consiste di alcuni passaggi fondamentali che constano nell’applicare un filtro di *smoothing*<sup>279</sup> al raster DEM originale in modo da ottenere una superficie più omogenea. L’immagine processata viene a sua volta sottratta dall’immagine originale tramite una semplice operazione algebrica che, cella per cella, sottrae il nuovo valore dalla sua cella corrispondente nell’immagine originale. Si ottiene in questo modo il prodotto grezzo del Local Relief Model. Questo viene ulteriormente raffinato creando dei contorni in modo da individuare le anomalie positive e quelle negative, cioè quelle che stanno al di sopra e al di sotto del trend, producendo una nuova superficie interpolata ripulita. In alcuni casi questa nuova immagine viene comparata con il modello digitale della superficie <sup>280</sup>(DSM).

Il risultato è un’immagine che esalta le particolarità del rilievo e le sue relazioni con la superficie circostante. Come è intuibile questo prodotto presenta alcune difficoltà di interpretazione dovute ad artefatti e ad illusioni ottiche che ingannano l’occhio umano.

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<sup>276</sup>Ralf Hesse. "Lidar-Derived Local Relief Models—a New Tool for Archaeological Prospection." *Archaeological Prospection* 17, no. 2 (2010): 67-72.

<sup>277</sup> Rafael Gonzalez, and Richard Woods. *Digital Image Processing*. New Jersey: Prentice Hall, 2007.

<sup>278</sup> Astrid Humme, Roderik Lindenbergh, and Chris Sueur. "Revealing Celtic Fields from Lidar Data Using Kriging Based Filtering." In *Proceedings of the Isprs Commission V Symposium*, edited by Hans-Gerd Maas and Danilo Schneider. Dresden: ISPRS, 2006.

John Kennet Hillier, and Mike Smith. "Residual Relief Separation: Digital Elevation Model Enhancement for Geomorphological Mapping." *Earth Surface Processes and Landforms* 33 (2008): 2266-76.

<sup>279</sup> È un tipo di algoritmo che per attribuisce ad una cella il valore medio delle celle del suo intorno che dipende da una matrice di azione scelta. Il risultato è quello di far apparire la superficie più omogenea nelle aree di maggiore estensione, cioè nei poligoni interpolati di dimensione maggiore.

<sup>280</sup> David Novák, Local Relief Model (LRM) Toolbox for ArcGIS, unpublished. Si tratta di una guida all’applicazione del processo LRM usando il software ArcGIS.

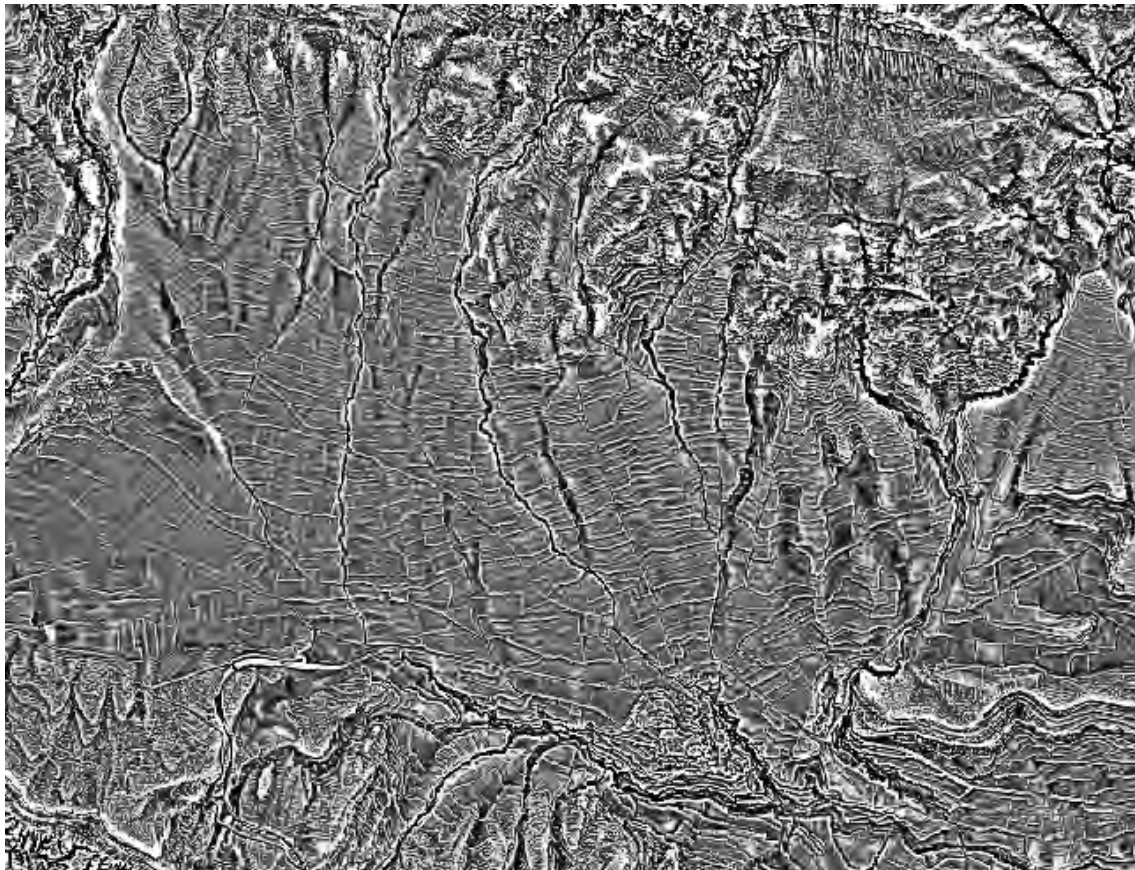


Figure 20. Local Relief Model of the Landscape Unit 1, Ager Valley. (Source: Antonio Porcheddu)

### 3.5.8 VIEWSHED ANALYSIS

La *Viewshed Analysis* è un modo per calcolare per ogni cella del raster il grado di pendenza a cui un ipotetico osservatore posto su un punto, guarda il suo intorno. Questa tecnica è piuttosto basica e si applica facilmente utilizzando qualsiasi sistema GIS che lo implementi. Per il suo calcolo è necessario che partendo da un punto venga interpolata una retta lungo ogni direzione verso tutte le celle del raster. Si calcola dunque se l'altitudine di ogni cella sia superiore all'altezza della linea retta che origina nel punto scelto, questo implica che si creino o meno ostruzioni visive tra un punto e un altro del DEM. Il valore calcolato per ogni cella del raster cresce per i rilievi e diminuisce per le depressioni. Oltre a permettere di fare valutazioni qualitative sul territorio indagato è anche possibile attribuire una palette di colori di visualizzazione per far risaltare piccoli rilievi sul terreno o piccole depressioni.

In certi casi è inoltre possibile calcolare lo stesso *viewshed* considerando più siti archeologici e sommare tali raster per verificare quali siano le aree maggiormente visibili e quelle meno visibili in generale in una determinata area<sup>281</sup>.

### 3.5.9 CUMULATIVE VISIBILITY

Questa tecnica è, in un certo senso, una categoria più generale della *Viewshed*<sup>282</sup>. Consiste nel determinare con il computer quale sia l'area da cui un punto è visibile ad un osservatore posto ad una certa altezza. Dunque, anziché utilizzare solo una linea orizzonte per calcolare la visibilità, l'obiettivo di questa tecnica è di modellare una superficie. Si tratta di una tecnica utilizzata in molte applicazioni dall'architettura, all'urbanistica alla gestione delle risorse<sup>283</sup>. Nonostante questi utilizzi, può essere utile anche per visualizzare in un certo modo la topografia in un DEM e di far risaltare alcune delle sue peculiarità. Un esempio può essere quello di visualizzare il posizionamento dei siti archeologici rispetto al terreno circostante così come la possibilità di interpretare con più facilità la lettura del modello digitale del terreno<sup>284</sup>.

### 3.5.10 ACCESSIBILITÀ

Anche questa tecnica non nasce specificamente per l'elaborazione delle immagini ma per considerazioni sulla topografia di uno spazio. In questo caso un algoritmo determina per ogni cella il raggio massimo della sfera che può essere posizionata in quel punto senza incontrare nessun impedimento dall'intorno, all'interno di una porzione di superficie determinata. In questa tecnica si decide fin dall'inizio il raggio della sfera che si vuole applicare sulla superficie in modo che questi valori non siano computati in

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<sup>281</sup> David Wheatley. "Cumulative Viewshed Analysis: A Gis-Based Method for Investigating Intervisibility, and Its Archaeological Application." In *Archaeology and Geographical Information Systems: A European Perspective*, edited by Gary Lock and Zoran Stancic, 171-85. Boca Raton: CRC Press, 1995.

<sup>282</sup> Douglas Caldwell, Mike Mineter, Steve Dowers, and Bruce Gittings. "Analysis and Visualization of Visibility Surfaces." In *Proceedings of the 7th International Conference on Geocomputation*, edited by David Martin. Southampton: Published in CD-ROM, 2003.

<sup>283</sup> David Kinder, Philip Rallings, and Andrew Ware. "Parallel Processing for Terrain Analysis in Gis: Visibility as a Case Study." *Geoinformatica* 1, no. 2 (1997): 183-207.

<sup>284</sup> David Wright, Scott MacEachern, and Jaeyong Lee. "Analysis of Feature Intervisibility and Cumulative Visibility Using Gis, Bayesian and Spatial Statistics: A Study from the Mandara Mountains, Northern Cameroon." *Plos One* 9, no. 11 (2014): 1-15.

maniera arbitraria. Secondo la letteratura, questa tecnica può essere applicata per scopi di visualizzazione del DEM ed è preferibile per incrementare la visibilità di oggetti in depressioni, come buchi nel terreno, ed oggetti posti nei pendii come terrazzi, mentre è considerata meno utile per la visualizzazione del micro rilievo<sup>285</sup>.

Nel caso delle applicazioni in questo lavoro, questa tecnica è stata utilizzata solo in caso di comparazioni in quanto altre tecniche come la Sky View Factor e la Openness forniscono risultati già abbastanza soddisfattori per gli scopi di questa tesi.

### 3.5.11 MULTI-SCALE INTEGRAL INVARIANTS (MSII)

Tra gli algoritmi maggiormente specializzati vi è la multi-scale integral invariants utilizzata nel contesto delle sperimentazioni di grafica digitale per la visualizzazione di scritture su pietre incise e su tavolette cuneiformi.

Questa tecnica è stata presentata ad una sessione della simposio internazionale sulla realtà virtuale dedicata all'archeologia e al patrimonio<sup>286</sup>. È stata poi ripresa da Ralph Hesse nel suo blog per una possibile applicazione nell'ambito della visualizzazione di DEM<sup>287</sup>.

Secondo la descrizione di Hesse, l'algoritmo piazza una serie di sfere di diverso diametro (da cui multi-scalare) in ogni pixel e calcola quanta porzione di questa sfera si trova al di sopra e al di sotto della superficie della cella. Il risultato è quello di ottenere un numero di valori di porzione di sfera sopra la superficie; tali valori sono interpretati come vettori n-dimensionali. Utilizzando un sistema di coordinate si può calcolare la distanza dei vettori n-dimensionali da un vettore di riferimento. Il valore di tale distanza è quindi assegnato alla cella corrispondente e si ottiene così una superficie con delle celle di determinati valori che possono essere visualizzate come un raster in scala di grigi.

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<sup>285</sup> Gavin Miller. "Efficient Algorithms for Local and Global Accessibility Shading." In *Siggraph '94 Proceedings of the 21st Annual Conference on Computer Graphics and Interactive Techniques*, edited by Dino Schweitzer, Andrew Glassner and Mike Keeler, 319-26. New York: ACM, 1994.

<sup>286</sup> Mara, H., Krömker, S., Jakob, S., Breuckmann, B., 2010. GigaMesh and Gilgamesh – 3D Multiscale Integral Invariant Cuneiform Character Extraction, in: A. Artusi, M. Joly-Parvex, G. Lucet, A. Ribeus, D. Pitzalis (eds), *The 11<sup>th</sup> International Symposium on Virtual Reality, Archaeology and Cultural Heritage VAST* (Paris, France, 2010), 131-138.

<sup>287</sup> Ralph Hesse. "Dem Visualisation Techniques: Multi-Scale Integral Invariants." <https://blog23d.wordpress.com/page/2/>.

Questo permette pertanto anche la visualizzazione di DEM con le relative peculiarità. Un approccio simile a questo era inoltre già stato presentato nel 2002 sempre in relazione a delle tavolette cuneiformi<sup>288</sup>. In questo caso lo scopo era quello di estrarre da un modello digitale della tavoletta cuneiforme il micro-rilievo in modo da ottenere una miglior visualizzazione della scrittura. La stessa tecnica è possibile applicarla nella visualizzazione di un modello digitale del terreno per enfatizzare il micro-rilievo.

Nel caso della Val d'Àger questa tecnica è compatibile con la tecnica di Local Relief Model e quindi è stata utilizzata solo quando necessario per effettuare dei confronti e delle comparazioni in situazioni di dubbio interpretativo dell'immagine.

### 3.6 INTENSITY DATA

Questo argomento viene lasciato per ultimo nel capitolo in quanto rappresenta un surplus nei rilievi lidar che spesso viene ignorato da chi maneggia questo tipo di dati in archeologica. Alcuni studi hanno però dimostrato che l'uso del dato di intensità può avere una buona utilità anche in Archeologia<sup>289</sup>.

Le immagini di intensità sono anch'esse un prodotto derivato dal rilievo lidar. Durante il processo di rilievo, infatti, alcuni strumenti registrano l'intensità di restituzione dell'impulso laser riflesso dall'oggetto colpito. Con questo dato è possibile ottenere un'immagine della riflettività degli oggetti nei punti di contatto con la superficie. Spesso vengono rappresentate come immagini molto simili alla fotografia aerea all'infrarosso in scala di grigi, sebbene il dato visualizzato sia appunto quello derivato dall'impulso del laser. Tuttavia è opportuno notare che esistono delle sostanziali differenze di valori a seconda del tipo di strumento che viene utilizzato. Challis e Howard fanno notare come a seconda del produttore del laser scanner il tipo di dato potrebbe favorire o meno l'utilizzo per la ricerca archeologica<sup>290</sup>.

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<sup>288</sup> Sean Anderson, and Marc Levoy. "Unwrapping and Visualizing Cuneiform Tablets." *IEEE Computer Graphics and Applications* 22, no. 6 (2002): 82-88.

<sup>289</sup> Keith Challis, and Andy Howard. "The Role of Lidar Intensity Data in Interpreting Environmental and Cultural Archaeological Landscapes." In *Interpreting Archaeological Topography*, edited by Rachel Opitz and David Cowley, 161-70. Oxford: Oxbow Books, 2013.

<sup>290</sup> Keith Challis, and Andy Howard. "The Role of Lidar Intensity Data..." p. 163.

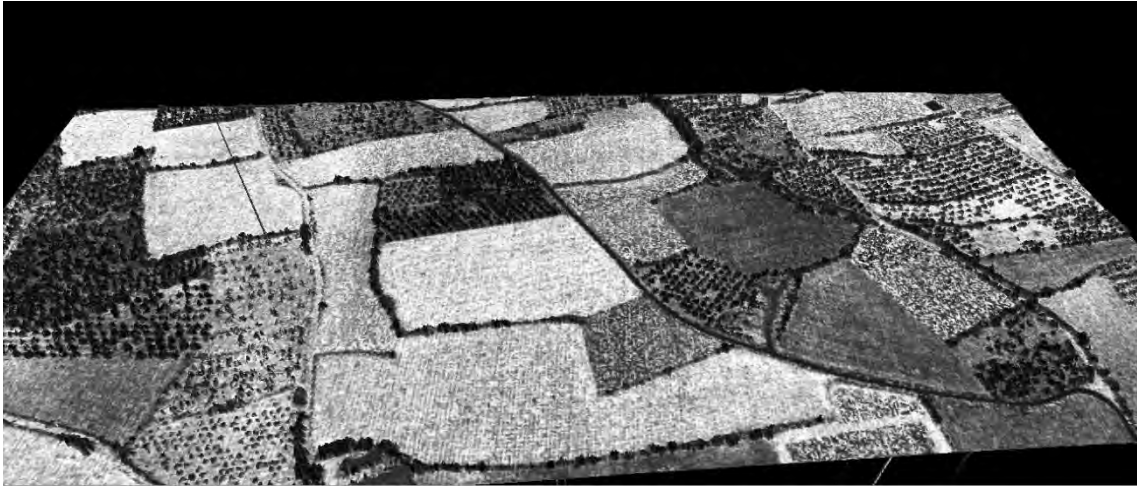
Nel corso degli anni questo tipo di immagini sono state utilizzate soprattutto per determinare da remoto le composizioni biologiche delle coperte vegetazionali oppure i diversi tipi di sedimento o formazioni geologiche presenti in una certa area.

Rispetto agli altri prodotti lidar, l'immagine di intensità può fornire informazioni non solo geometrico-spaziali sulla visualizzazione ma anche informazioni qualitative sulla composizione degli oggetti rilevati.

Questo tipo di dato può essere fornito insieme ai file della nuvola di punti in cui oltre alle coordinate xyz già viste sopra vi si aggiunge un altro valore per ogni punto, quello della *i* di *intensity*. Da questi dati è possibile ricavare direttamente delle immagini interpolate in scala di grigi o visualizzarli in relazione alla nuvola di punti.

In generale è possibile rilevare che l'elaborazione di questi dati ha un potenziale per consentire l'interpretazione più accurata del paesaggio oggetto di studio. Infatti oltre alle definizioni di suoli, sedimenti e vegetazione può essere utilizzato per correlare le variazioni di queste con il potenziale archeologico. L'interpretazione di questo dato è molto simile a quello della fotografia area dove variazioni tonali e forme definite rappresentano potenziali punti di interesse archeologico. Tuttavia al contrario della fotografia area, questo dato è spesso ignorato dai ricercatori e sono pochi gli studi disponibili al giorno d'oggi per valutarne una standardizzazione dei parametri, ossia, come nel caso della fotografia area, un'applicazione che faccia corrispondere un oggetto a un determinato tipo di anomalia.





*Figure 21. Lidar Intensity data of a portion of the Ager plain visualised in 3D. The peaks are usually errors of the sensor that should be removed in the data processing. (Source: Antonio Porcheddu)*

### 3.7 CONCLUSIONI

Riassumendo, le principali tecniche di telerilevamento che verranno utilizzate a supporto di questa ricerca sono i modelli digitali del terreno derivati dal lidar, l'immagine di intensità sempre derivata dal lidar, le immagini estratte dal radar interferometrico e le aerofotografie aree attuali e storiche.

Negli scopi della ricerca di Archeologia del Paesaggio questi strumenti vengono utilizzati principalmente per

- Mappare la topografia del terreno
- Mappare i particellari e la viabilità
- Individuare le caratteristiche del micro rilievo
- Individuare eventuali anomalie interessanti al di sotto della cappa di vegetazione
- Interpretare eventuali anomalie tonali o geomorfologiche
- Ridurre la dimensione delle aree su cui concentrare la prospezione
- Utilizzarle come base per la cartografia archeologica
- Effettuare analisi spaziali sulle superfici raster

La conoscenza approfondita delle tecniche di elaborazione delle immagini è necessaria per poter sfruttare al meglio le potenzialità di questi dati, per questi motivi si è visto che sono possibili numerosi applicazioni di *image enhancement* al fine di aiutare il ricercatore a migliorare la visibilità e l'interpretazione delle immagini. Ognuna di queste tecniche possiede le sue peculiarità e i suoi vantaggi allo stesso modo che i suoi limiti. L'applicabilità è dunque dipendente dalle necessità e dal tipo di dato posseduto per questo motivo non può esistere una tecnica standard valida o perfetta. Per esempio, alcune caratteristiche del modello digitale del terreno come il micro rilievo possono essere evidenziate maggiormente dalla tecnica del *Local Relief* mentre in alcuni casi è sufficiente una visualizzazione dello *slope*, molto più rapida da computare, se si vogliono semplicemente tracciare i limiti della viabilità, oppure l'uso della *sky view factor* per evidenziare le depressioni e gli avvallamenti nel terreno. La conoscenza di cosa fa ciascuna tecnica è dunque fondamentale per poter scegliere al momento opportuno quale applicare.

# 4

## THE ARCHAEOLOGICAL INFORMATION SYSTEM

### INTRODUCTION

This chapter exposes the methodology used to handle and analyse the archaeological data available through GIS technology that we call here Archaeological Information System. This expression was already used in the past to explain the adaptation of GIS to the archaeological context<sup>291</sup>. The production of archaeological cartography nowadays strictly depends on the massive use of geographical information systems (GIS) to handle all the available data and to produce new cartography through spatial analysis or image interpretation. The challenge that scholars affords is to digitally model archaeological data for a better handling without losing any detail or any data. For an archaeological context this became a tough dare and the complexity of tangible and intangible data must correspond to a linear modelling of the informatics system. This situation forces the designer to make choices considering the target of the research and the data availability in order to obtain a simple but complete and efficient system.

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<sup>291</sup> Geoff Carver. "Archaeological Information Systems (Ais). Adapting Gis to Archaeological Contexts." In *Archäologie Und Computer 2004 - Workshop 9: Kulturelles Erbe Und Neue Technologien*, 3.-5. November 2005, edited by Stadtarchäologie Magistrat d. Stadt Wien - MA 7, 1-53. Wien: Phoibos Verlag, 2005.

## 4.1 PRELIMINARY CONCEPTS

The Archaeological Information Systems is a dynamic object and its main target is supporting the archaeological investigation and store its results. Such kind of system could also apply to support not only the scientific investigation but also the handling and management of cultural heritage and landscapes.

Formerly, all archaeological researches began with the use of an archaeological map intended as an inventory of archaeological sites or findings sorted by administrative borders as points on a map. The major part of these publications are paper made and rarely accompanied by a topographic map to explain the sites position. Then, it is difficult to update them and they became obsolete in few years. In this way, their support to scientific research and to administrative decisions cannot be fully accomplished. In addition, for every use, it is necessary to republish a new version of the map. It seems that even if, since the eighties, the use of GIS in archaeology is not new, the concept of an archaeological map has not changed with the development of the available technologies.

If we compare, for example, the archaeological inventory of Sardinia produced by Antonio Taramelli between 1929 and 1940 and the archaeological map produced by the administration of the Veneto region in 1994, we notice that nothing changed, except the language style or the typographic rules<sup>292</sup>. Both are conceived as maps with points representing sites and they are separated from its context. Analysing deeper the newest archaeological maps such as the Catalonia one published on the internet, it is possible to notice again that the support changed, passing from paper to digital, but the intrinsic concept between data and their relationships did not change<sup>293</sup>.

By intrinsic concept between data and their relationships, we intend the way in which we consider the archaeological sites connected to the landscapes. In the past chapter, we saw how the notion of archaeological landscape changed the way in which sites are

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<sup>292</sup> Loredana Capuis, Giovanni Leonardi, Stefania Pesavento, and Guido Rosada. *Carta Archeologica Del Veneto*. Vol. 4, Modena: Panini, 1993.

Antonio Taramelli. *Edizione Archeologica Della Carta D'Italia Al 100.000*. Firenze: IGM, 1940.

<sup>293</sup> <http://invarque.cultura.gencat.cat/>

considered and inserted in their environmental context. Indeed, the context became the important aspect when outlining the role of each site.

This change in the paradigm, from the seventies, brought to the creation of new instruments easier to manage based on the practice of rescue archaeology and successively of the preventive archaeology<sup>294</sup>. The second especially benefited from the use of GIS and predictive archaeology that was developing mainly in Holland during the seventies<sup>295</sup>. In forty years of research, Predictive Archaeology developed and it became less determinist in order to better model the human behaviour. In the search of the best predictive modelling, the predictive archaeologists started taking concepts from the Landscape Archaeology including not only punctual-sites or findings but also extensive areas of archaeological interests classified by its functionality.

Two more concepts to consider when analysing the needs of a modern archaeological map are the similar notions of Global Archaeology and Archaeology of Complexity. Global Archaeology, already cited in the previous chapters, took its fundamentals from the consideration that every element should be taken into account for an archaeological research, even the contemporary ones<sup>296</sup>. The only choice made during an investigation should be based on the scholar interest or on data availability. The use of the word 'global' is intrinsically connected to the fact that when considering an archaeological context every material evidence must be registered with all its connections to the intangible world, regarding for example space organisation. Very similar concepts are expressed by the theory of the Archaeology of Complexity recently re-examined by GianPietro Brogiolo for a project on mountainous archaeological landscape<sup>297</sup>. The complexity of the archaeology stands in the reflection on the polyhedral nature of the

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<sup>294</sup> Jones Barri. *The Story of Rescue Archaeology*. München: Heinemann, 1984.

<sup>295</sup> Juan Manuel Vicent García. "Theoretical Remarks on Predictive Models in Landscape Archaeology." In *Predicting Prehistory. Predictive Models and Field Research Methods for Detecting Prehistoric Contexts*, edited by Giovanna Pizziolo and Lucia Sartri, 25-34. Firenze: Bandecchi & Vivaldi, 2015.

<sup>296</sup> Tiziano Mannoni, Danilo Cabona, and Isabella Ferrando. "Archeologia Globale Del Territorio: Metodi E Risultati Di Una Nuova Strategia Della Ricerca in Liguria." In *Structures De L'habitat Et Occupation Du Sol Dans Les Pays Méditerranéennes: Les Méthodes Et L'apport De L'archéologie Extensive*, edited by Ghislaine Noyé, 43-58. Roma-Madrid: Casa de Velázquez, 1988.

<sup>297</sup> The Project is the APSAT cited above which aims are summarised in the paper Gian Pietro Brogiolo. "Nuovi Sviluppi Nell'archeologia Dei Paesaggi: L'esempio Del Progetti Apsat (2008-2013)." *Archeologia Medievale* 41 (2014): 11-22.

The manifest of the Archaeology of Complexity is described in the paper Gian Pietro Brogiolo. "Dall'archeologia Dell'architettura All'archeologia Della Complessità." *Pyrenae* 38 (2007): 7-38.

Archaeology as science dealing with material evidence, historical problems and social organisation<sup>298</sup> from which it is possible to shape the living, working and symbolic places. Consequently, all these data must be interpreted in rapport with the economic and social networks for goods movement and exchange, material connections such as road networks connecting different places and symbolic influences to the landscape.

Using these concepts, we see that the usual archaeological inventories and maps are not adequate to register all the relationships described above and then they result fruitless. The archaeological maps lack of environmental data, historical relationships, archaeological parcels, soil use and historical roads networks. All the sites are completely unattached from their context and then impossible to understand.

At the same time, the cartography must guarantee an easy readability and the dynamic response to a specific scientific question. This means that currently it is impossible to continue using paper-made archaeological cartography but only numerical maps. The digital products anyway are poorly planned and often limited to the context of a single research making its reusability more difficult. Indeed, the reusability is a key concept in developing digital products and should be taken into account also when designing digital archaeological information systems. This would avoid loss in resources and time-consuming operations such as the rebuild of a similar project but it could also be achieved only with an institutional intervention from universities, research centres and general administrations.

All these considerations imply rejecting the former idea of static archaeological cartography and they mean the need of a digital shift. This shift does not mean the simple passage from sterile paper cartography to sterile digital cartography but a reasoned passage from a former static and sterile cartography to a responsive and more complete digital information system for the archaeological research mainly based on GIS technology and object-oriented paradigm.

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<sup>298</sup> Gian Pietro Brogiolo. "Dall'archeologia Dell'architettura... p. 30.

## 4.2 THE ARCHAEOLOGICAL INFORMATION SYSTEM FOR THE ÀGER VALLEY

According to these premises, it was developed an experimental digital archaeological cartography for the Àger Valley based on GIS technology. The Geographical Information System is a software instrument that allow the user to acquire, store, analyse and visualise spatial data. This choice is still facing a problem that has been recently reported<sup>299</sup> which is the lack of specific development of information technology for Archaeology. Indeed many disciplines like biology, medicine or even economics and geography have their own typologies of software meanwhile the poor diffusion of informatics in the formation of the new archaeologists reduce the dialog between software developers and archaeologists that then remains relegated to the interest of the individual.

An information system is by definition an integrated set of components that collect, organize, store, process and display information in all its forms (raw data, interpreted data, knowledge and expertise) and formats (text, video and voice)<sup>300</sup>. In our case, and in most cases nowadays, it is impossible to overlook from the informatics to build an information system and this means, for important projects, a huge time-consuming work and justify the need of an accurate project phase. In particular, it is necessary to think how the database will be used to answer particular questions and problems to solve. It is important considering:

- a) the data acquisition
- b) the data processing
- c) what kind new information will be built
- d) the data storage
- e) the data presentation

In this sense, our archaeological information system could be intended as an advanced GIS that will contain spatial and non-spatial data such as historical sources that sometimes cannot be properly placed in space, dates and so on.

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<sup>299</sup> Roberto Bagnara, and Giancarlo Macchi Jànica. *Open Source, Free Software E Open Format Nei Processi Di Ricerca Archeologici Atti Del I Workshop. (Grosseto, 2006)*. Firenze: Centro Editoriale Toscano, 2007.

<sup>300</sup> Vladimir Zwass. "Information System." In *Encyclopedia Britannica*, 2016.

Our main question to model the archaeological information system is how to model the archaeological landscape. As the archaeological landscape is not a static scenery where there are fixed points sorted by hierarchy or typology but it actually is the whole generated by them, it is difficult to model it in a static object like a set of tables and columns. The attempts made in this research are to reproduce not only the individual site but also the entire set of relations that occurs. The choice of the area of interest is purely arbitrary and it depends on the interest of this research and on the natural homogeneity of the valley.

Data are represented as vectors and raster grids. Usually the raster grids represents the aerial photographs, maps, and surfaces created for the spatial analysis like cost surfaces. With the vectors, we use the three typologies of representation points, lines and areas, to draw the several features of interest classified in feature class such as roads, rivers, parcels, place names, interpretation of homogeneous areas, etc.

#### 4.3 THE DATABASE SCHEMA

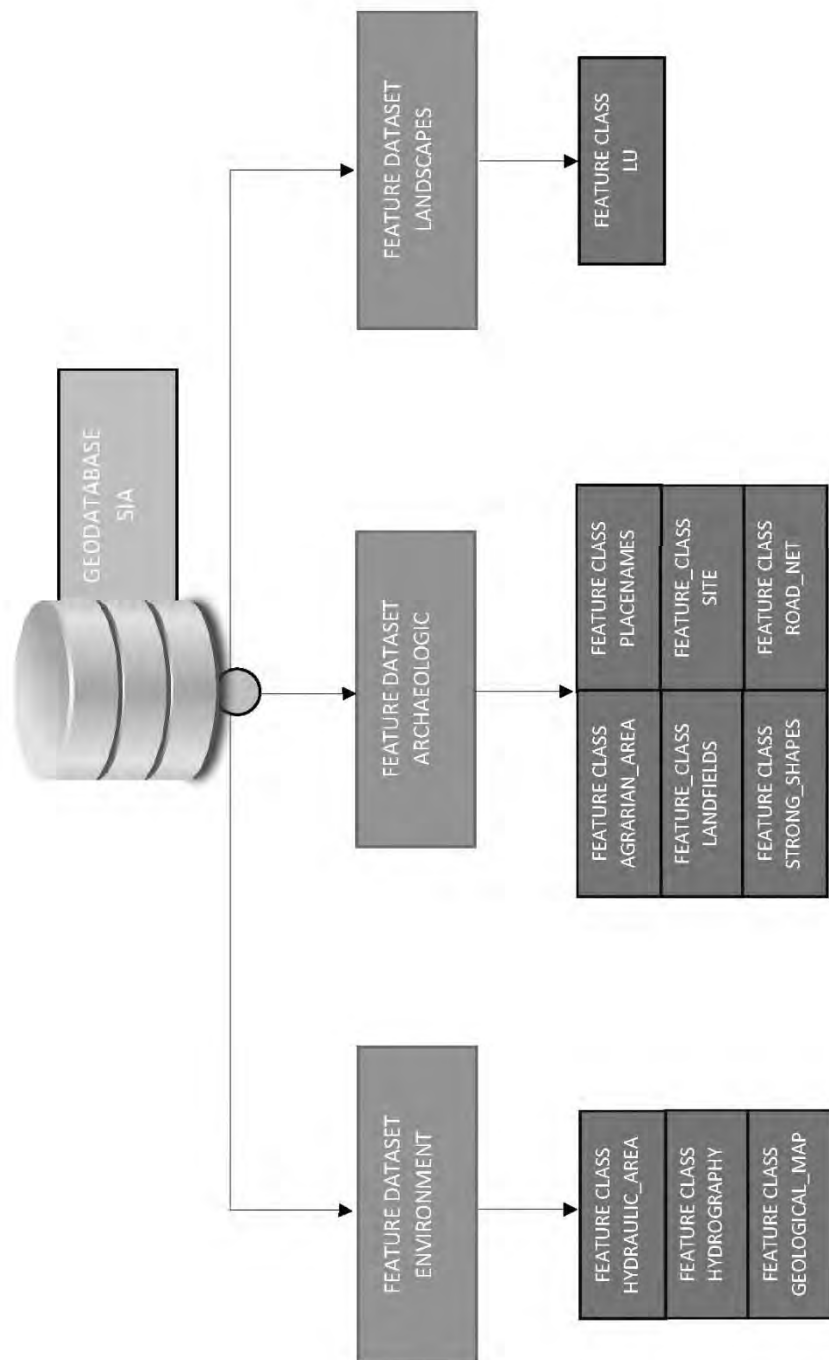
The database named SIA presents three feature datasets named “environment”, “archaeologic” and “landscapes”. The first contains the feature classes related to the natural environment a) the linear hydrography, b) the areal hydrography and c) the geology. The second contains a) the sites, b) the areal parcels, c) the linear parcels d) the place names, e) the road network and f) the strong limits of the parcels. The third features dataset contains the landscape units as the result of the interpretation of the different landscapes. Domains and typologies specify every feature class.

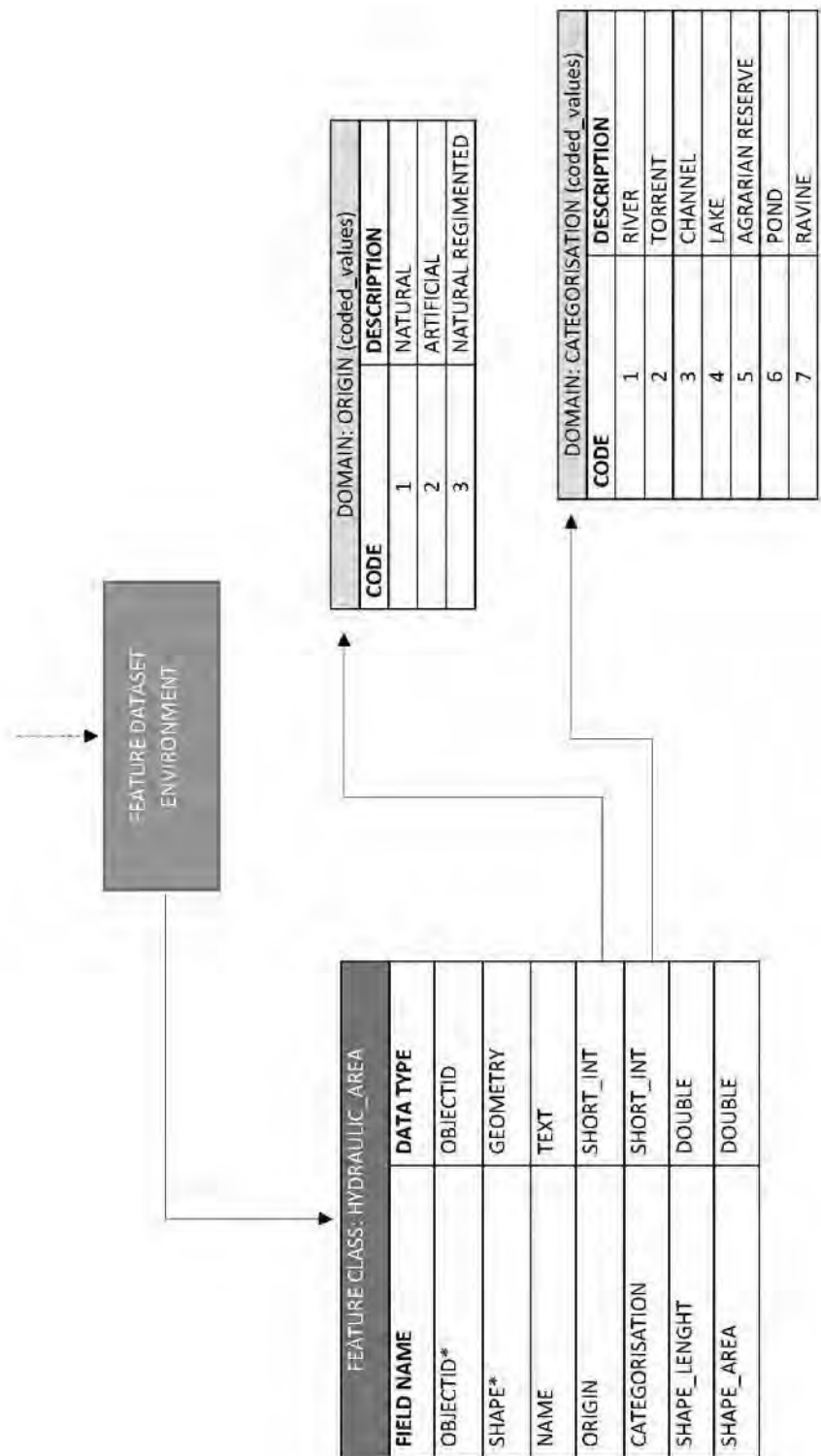
This schema is designed to store and manage data coming from the several sources interpretation (lidar, radar and aerial photographs) in order to directly store the features of interest and compare them with the other sources. The modelling of the environmental data, such as the geological map and the hydrography, helps relating the environmental information of the Àger Valley with the archaeological data and the landscape features. In this way, sites, road networks and agrarian features are connected with their environmental background. The dataset named “landscapes” instead contains the results of the interpretations based on landscape characterisation



in different landscape units that represent homogeneous areas from an archaeological point of view.

The use of domains for many data fields has an efficiency reason, it allows simplifying queries in the database with a standard nomenclature and obtaining a fast categorisation.



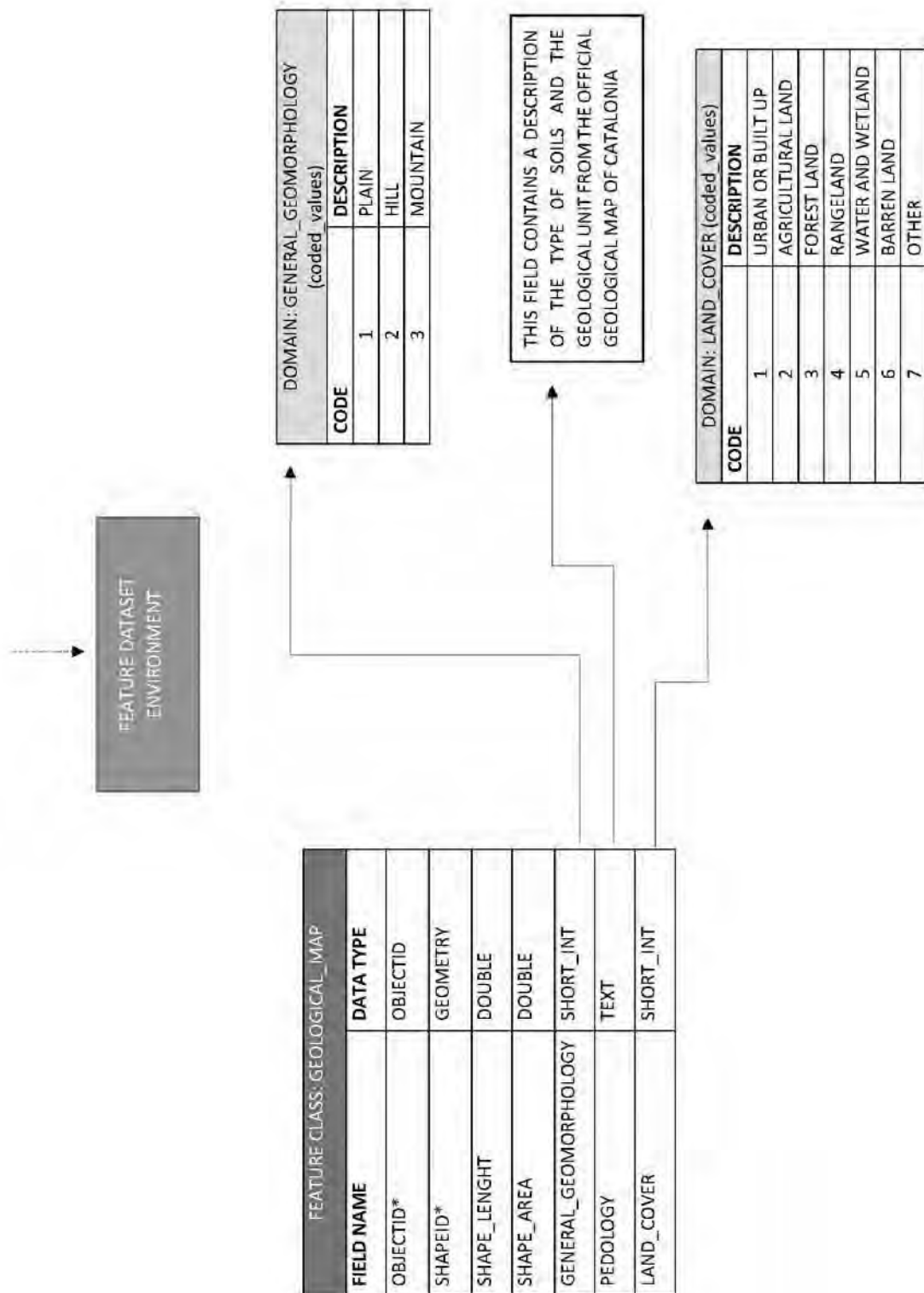


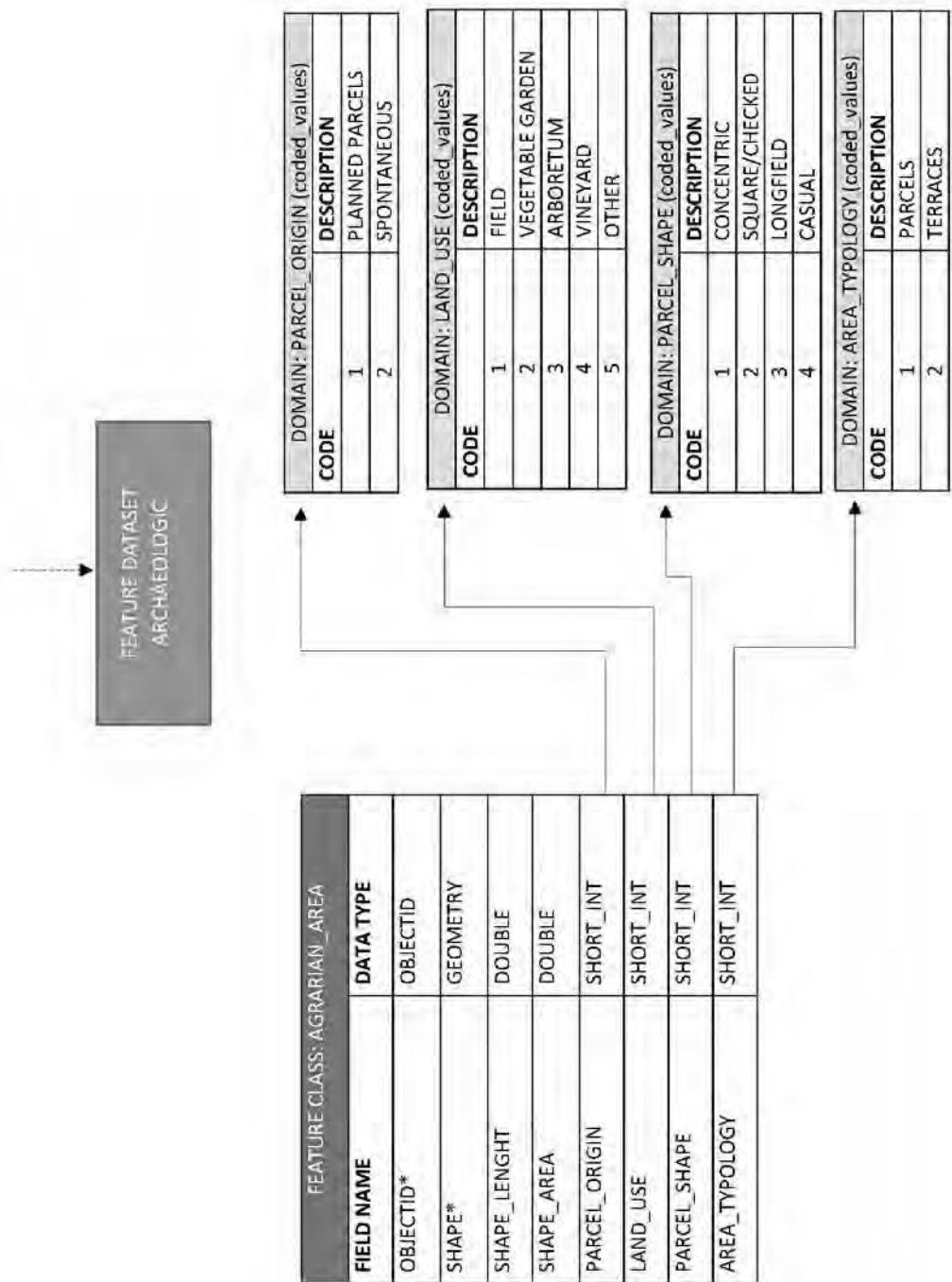


FEATURE CLASS: HYDROGRAPHY	
FIELD NAME	DATA TYPE
OBJECTID*	OBJECTID
SHAPE*	GEOMETRY
SHAPE_LENGTH	DOUBLE
NAME	TEXT
ORIGIN	SHORT_INT
CATEGORISATION	SHORT_INT

DOMAIN: ORIGIN (coded values)	
CODE	DESCRIPTION
1	NATURAL
2	ARTIFICIAL
3	NATURAL REGIMED

DOMAIN: CATEGORISATION (coded values)	
CODE	DESCRIPTION
1	RIVER
2	TORRENT
3	CHANNEL
4	LAKE
5	AGRARIAN RESERVE
6	POND
7	RAVINE







FEATURE CLASS: LANDFIELDS	
FIELD NAME	DATA TYPE
OBJECTID*	OBJECTID
SHAPE*	GEOMETRY
SHAPE_LENGTH	DOUBLE
PARCEL TYPOLOGY	SHORT_INT
SHAPE_SOURCE	SHORT_INT
SHAPE_MATERIAL	SHORT_INT
ASSIGNED_CHRONOLOGY	TEXT

DOMAIN: PARCEL TYPOLOGY (coded_values)	
CODE	DESCRIPTION
1	PLANNED PARCELS
2	SPONTANEOUS

DOMAIN: SHAPE_SOURCE (coded_values)	
CODE	DESCRIPTION
1	CADASTRE/MAP
2	AERIAL PHOTOGRAPH
3	LIDAR
4	RADAR
5	OTHER SOURCE

DOMAIN: SHAPE_MATERIAL (coded_values)	
CODE	DESCRIPTION
1	ROAD/PATH
2	CHANNEL/WATER
3	TREES
4	HEDGE/WALL
5	MIXED/OTHER

THIS FIELD CONTAINS AN ASSIGNED CHRONOLOGY BASED ON THE RELATIONS WITH OTHER EVIDENCE SUCH AS ROADS, ARCHAEOLOGICAL SITES, ARCHAEOLOGICAL MATERIALS.



FEATURE CLASS: STRONG_SHAPES	
FIELD NAME	DATA TYPE
OBJECTID*	OBJECTID
SHAPE*	GEOMETRY
SHAPE_LENGTH	DOUBLE
STRONG_SH_TPOLOGY	SHORT_INT
GENERAL_ORIENTATION	SHORT_INT

DOMAIN: STRONG_SH_TPOLOGY (coded_values)	
CODE	DESCRIPTION
1	ROAD/PATH
2	CHANNEL/RIVER
3	FIELD BORDER
4	MIXED/OTHER

DOMAIN: GENERAL_ORIENTATION (coded_values)	
CODE	DESCRIPTION
1	NORTH-SOUTH
2	WEST-EAST
3	NORTHWEST-SOUTHEAST
4	NORTHEAST-SOUTHWEST

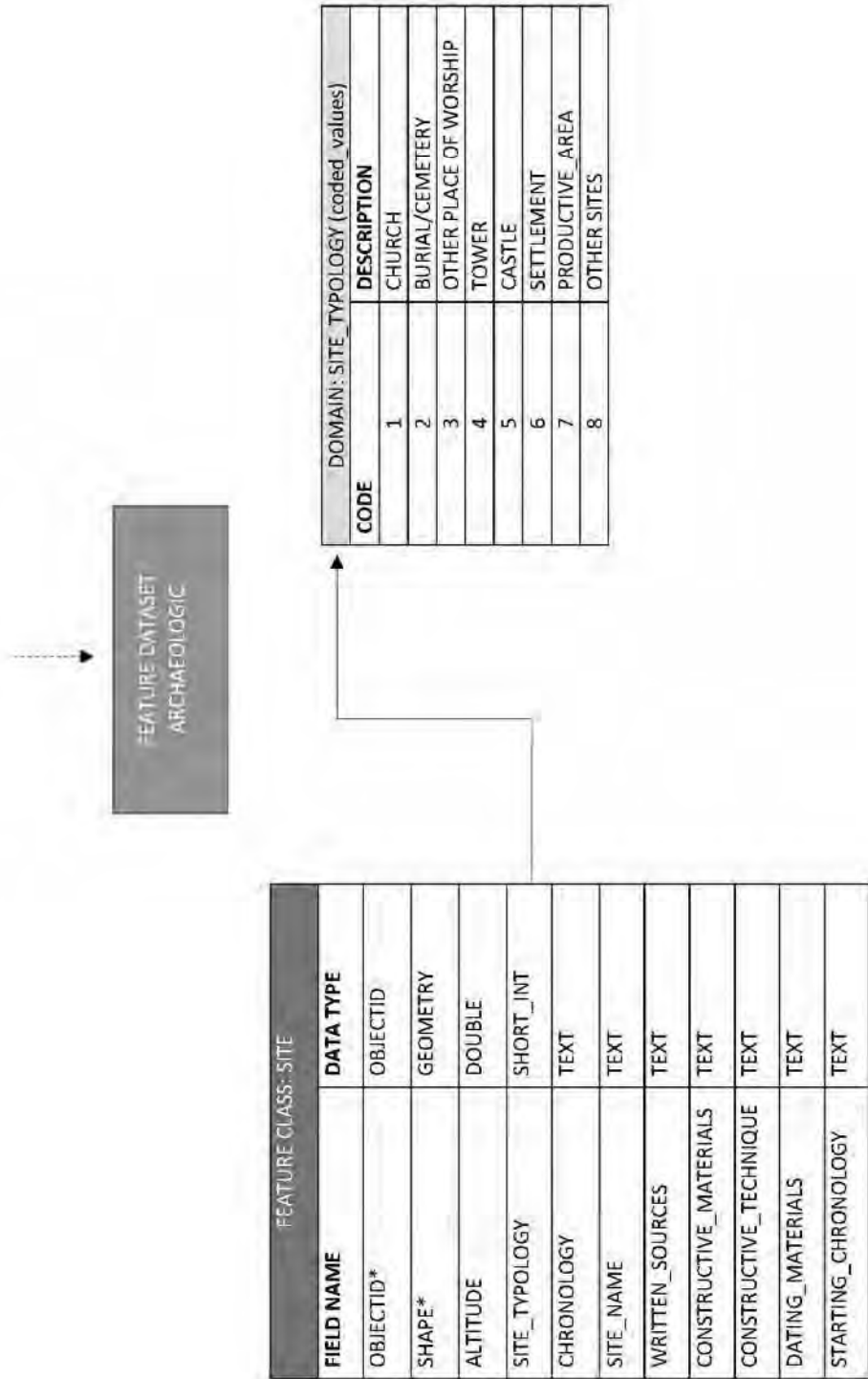


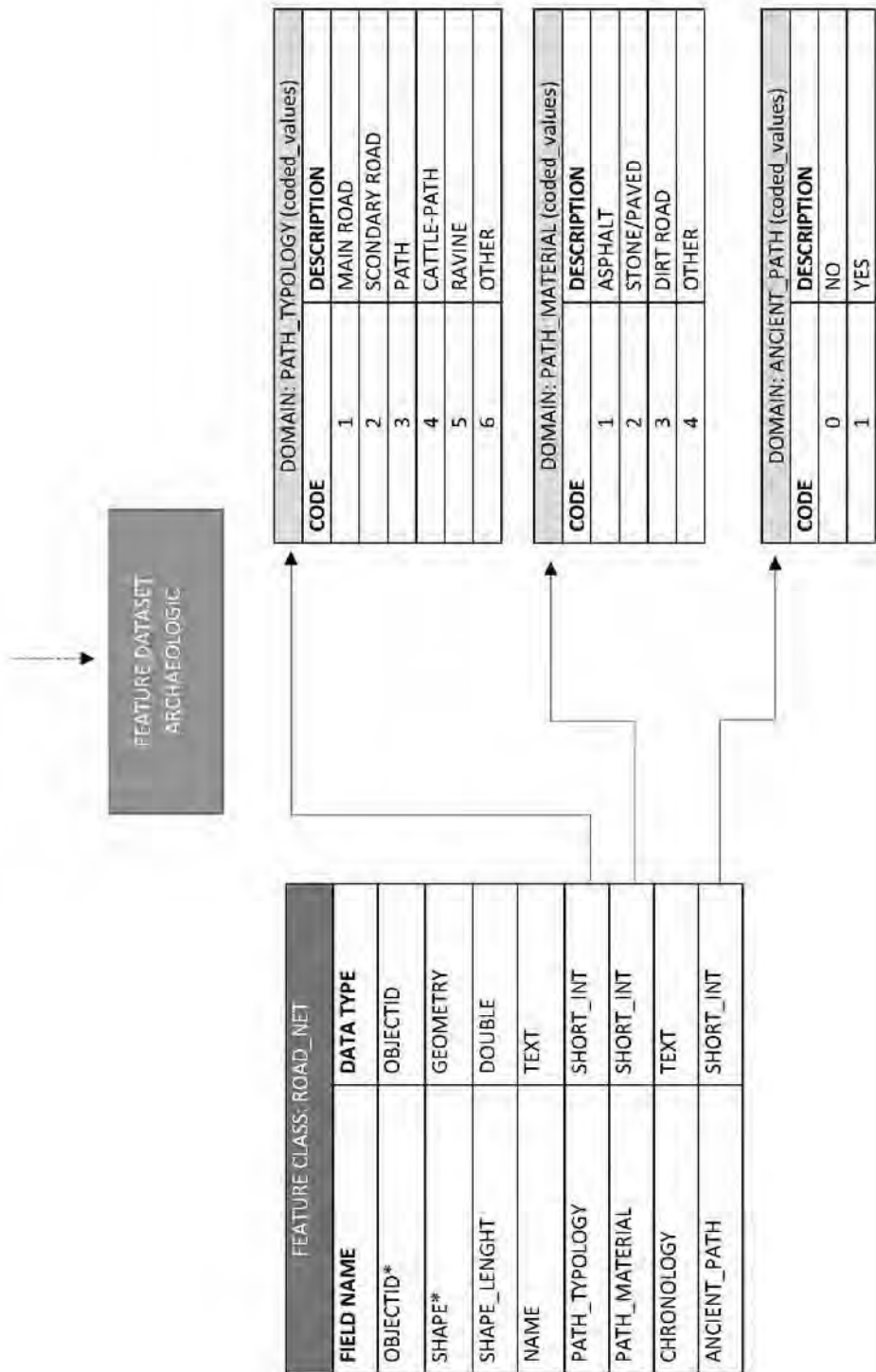


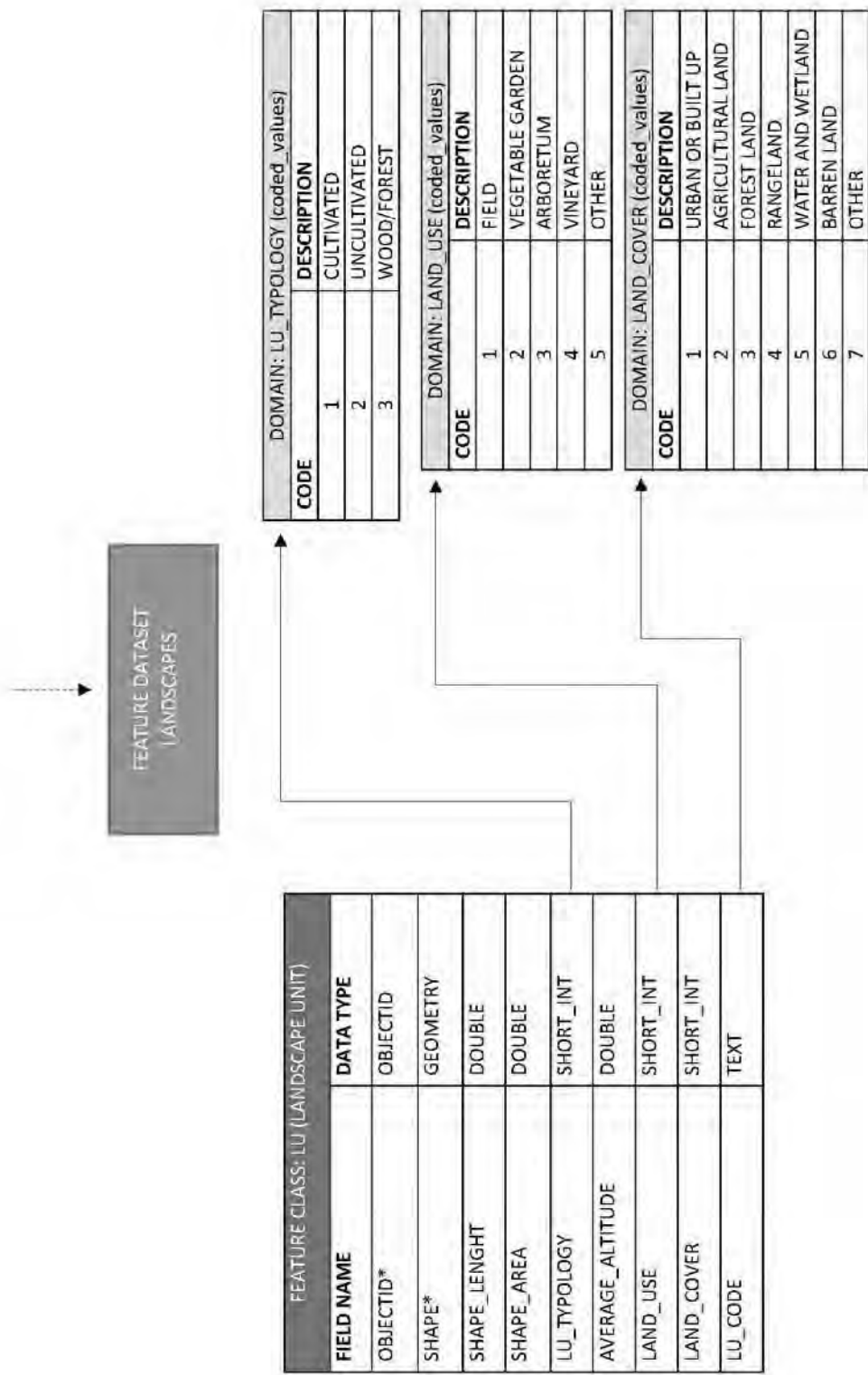
FEATURE CLASS: PLACENAMES	
FIELD NAME	DATA TYPE
OBJECTID*	OBJECTID
SHAPE*	GEOMETRY
PLACE_NAME	TEXT
OTHER_NAMES	TEXT
ETYMOLOGY	SHORT_INT
ETYMOLOGY_TYPE	SHORT_INT

DOMAIN: ETYMOLOGY (coded_values)	
CODE	DESCRIPTION
1	IBERIC
2	LATIN
3	ARAB/BEREBER
4	OTHER

DOMAIN: ETYMOLOGY_TYPE (coded_values)	
CODE	DESCRIPTION
1	ENVIRONMENTAL/DESCRIPTIVE
2	FAMILY NAME/PREDIAL
3	ETHNIC
4	AGIOTOPONIMO (NAME OF SAINT)
5	FUNCTIONAL
6	OTHER







#### 4.4 CONCLUSION

Handling data for an archaeological research is a complex task and there are multiple choices that can be made in designing and managing an information system. The archaeological information system presented here is an experiment over a little project of doctoral research but could also be applied on a wider scale because it contains a complete set of elements useful for handling and analyse archaeological landscapes from the theory guidelines.

Usual problems on these products are the lack of standardisation and the semantic compatibility of platforms. The first is a wide range problem existing in every field of science and it can be taken on only by an administrative central action advised by expert scholars. For the second problem, there are projects on course that try to minimise the compatibility issues between databases with mark-up languages<sup>301</sup>.

Finally, in the humanities research field we deal with the fact that not everything can be modelled into a database. Intangible elements of the landscape are the result of an interpretation made of connections of the elements considered. The settlement-relational scenery or the economic and geopolitics sceneries are not made of materials but are the results of the interpretation and then they can hardly represented. This problem stands not only for the space but also for the time. We choose, in this case, not to model the time flow but to assign only a static chronology to avoid consequent complexities and considering that the available data in the Àger context rarely have multiple chronologies. We only assigned a starting chronology field to the site feature class in order to model these sporadic events. The diachronic considerations are left to interpretation task and with apposite queries in the database.

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<sup>301</sup> Ceri Binding, Keith May, and Douglas Tudhope. "Semantic Interoperability in Archaeological Datasets: Data Mapping and Extraction Via the Cidoc Crm." In *International Conference on Theory and Practice of Digital Libraries*, 280-90. Berlin Heidelberg: Springer, 2008.

# 5

## FROM ANCIENT AERIAL PHOTOGRAPHS TO LIDAR: LOOKING FOR PAST LANDSCAPES IN THE AGER VALLEY

### INTRODUCTION

As it was already mentioned in the chapter above, the use of aerial images, sar and lidar in Archaeology has a high potential not only in findings new archaeological sites, which is often the hardest part of the work, but also in describing the landscape from different perspectives and highlighting specific details for each source. This chapter enters the general analysis of Ager Valley landscape based on the sources heavily described before and applying the image processing techniques in order to obtain the best details possible about the landscape surface and morphology. The main aim is to give a meaning to the structure of the territory, to “create” the historic landscape by interpreting the material signs visible on the surface. Once the patterns are detected, they are interpreted with the methodology of the Archaeogeography.

## 5.1 THE AERIAL IMAGERY OF 1945 AND 1956

The very first aerial photographs we dispose are two production of the U.S. Air Force, the American flight of 1945-46 called A-Series and the American flight of 1956-57 called B-Series. The A-Series has a scale of 1:10000 and the second 1:5000, which means that every centimetre of the photographs is representing respectively 50 and 100 meters of the earth surface. Experimental measurements made with GIS proved that in the A-Series photographs it is very difficult for the eye to distinguish objects that are smaller than 4 or 5 meters, even if they can be perceived by comparison with the surround. For example, the contrast between a road that is approximatively 4-5 meters wide and the terrain, makes it easy to recognise its pattern. Instead, it is harder to identify the edges of a building roof or the pattern of a cultivated field, as well as some field boundaries. In the B-Series the situation improves a little, it is easier to identify objects that are approximatively 2-meters wide, such as pedestrian paths, and it is also easier to distinguish field boundaries and buildings shape.

It is important to make other considerations of these series of photographs. In particular that they have been computerised and may have suffered of inevitable degradation during their use. Then the quality of objects visibility in the surface could depend also from the degradation of the portion of photograph considered and some errors in the phase of computerising. Finally others factors that could affect the visual quality of the photographs are the time of data capture and the weather.

Even with these limits, the ancient aerial photographs are a very important source for the historic study. In fact, they have been captured in the forties and fifties of the 20<sup>th</sup> century, just before a period (the sixties and the seventies of the 20<sup>th</sup> century) in which in almost entire Europe the mechanisation of agriculture, the building of infrastructures and the economic expansion, procured heavy changes in the rural landscapes. Even if these photographs can be considered recent, compared to the archaeological chronology, they are a very important historic document and they helped us to have a snapshot of a completely different period. In fact, it has been proved in other similar areas of Europe comparing the ancient cadastre of the beginning of the 18<sup>th</sup> century to the aerial photographs of the fifties, that the major change in the landscape occurred only after the sixties and during the seventies of

the 20<sup>th</sup> century<sup>302</sup>. Until then, the landscape remained almost unchanged in its shape for centuries<sup>303</sup>.



*Figure 22. A-Series aerial photograph above vs B-Series aerial photograph below, on a general view over Ager.*

This does not mean that for two centuries there had not been changes at all in the fields but, at the contrary, it means that a huge work has been made to maintain the structure of the landscape against the nature forces of water and vegetation. Just thinking about how much time consuming is the building of terraces or water channels without any mechanical help let us understand how important was to

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<sup>302</sup> The so-called teresian cadastre or Carl VI's cadastre is the cadastre map of the Milan duchy produced between 1718 and 1760 and preceding the most famous Napoleonic cadastre of the 1807-1816 and the Austrian cadastre of the 1840's.

<sup>303</sup> Antonio Porcheddu. "Morfologia E Metrologia Dei Particellari Post-Classici: Trasformazioni Nella Centuriazione a Nord Di Cremona." *European Journal of Post Classical Archaeologies* 4 (2014): 297-314.



maintain unchanged a working structure. This tendency of the landscape to maintain its shape during the pass of time is called resilience and we will see its consequences along this chapter.

Finally, only the mechanisation of agriculture and the need of a more competitive economy produced heavy changes in the landscapes of Mediterranean area and those changes are all related to economic sustainability (loss of hand-worker and cost reducing production) to compete in the emerging economic world of the final decades of the 20<sup>th</sup> century.

Considering these premises, the ancient aerial photographs of the Ager Valley can be used as a sort of ancient cadastre to reconstruct the road network, the ancient field boundaries the hydrography and the land use of the first half of the 20<sup>th</sup> century. In addition, it is not a nonsense to consider that the main structure of the landscape seen in the aerial photographs could be transposed some centuries backward.



*Figure 23. In this picture, it is possible to appreciate better the different resolution of the A-series above and the B-series below. The shape of buildings, roads and field boundaries is more visible in the B-series. The third picture represents the 2016 orthoimage. (Source: Catalan Institute of Geology and Cartography)*

## 5.2 CONTEMPORARY AERIAL IMAGERY

The most recent aerial images available for general purpose are the “*Ortofoto de Catalunya 1:2.500 vigent*” and the “*Ortofoto infraroja de Catalunya 1:2.500 vigent*”, respectively the visible-light orthorectified aerial photograph and the infrared orthoimage, both available at a scale of 1:2500.

Of course, in these products, there is a significant quality improvement given by the newest technologies of data acquisition. The most important side to consider is that we can dispose of a high quality base to compare the lidar precise data for the morphological analysis.



Figure 24. In this figure are well evident the traces of soil marks with the movement of water from north to south that creates movements of soil and those particular traces.

Another interesting aspect of these products is the possibility of see traces as cropmarks and soil marks in the landscape surface. In the plain and cultivated area of the Ager Valley there is a consistent amount of cropmarks visible through infrared image but also with visible-light image. These are mainly of geomorphological nature and especially river paleo-channels and water movements.

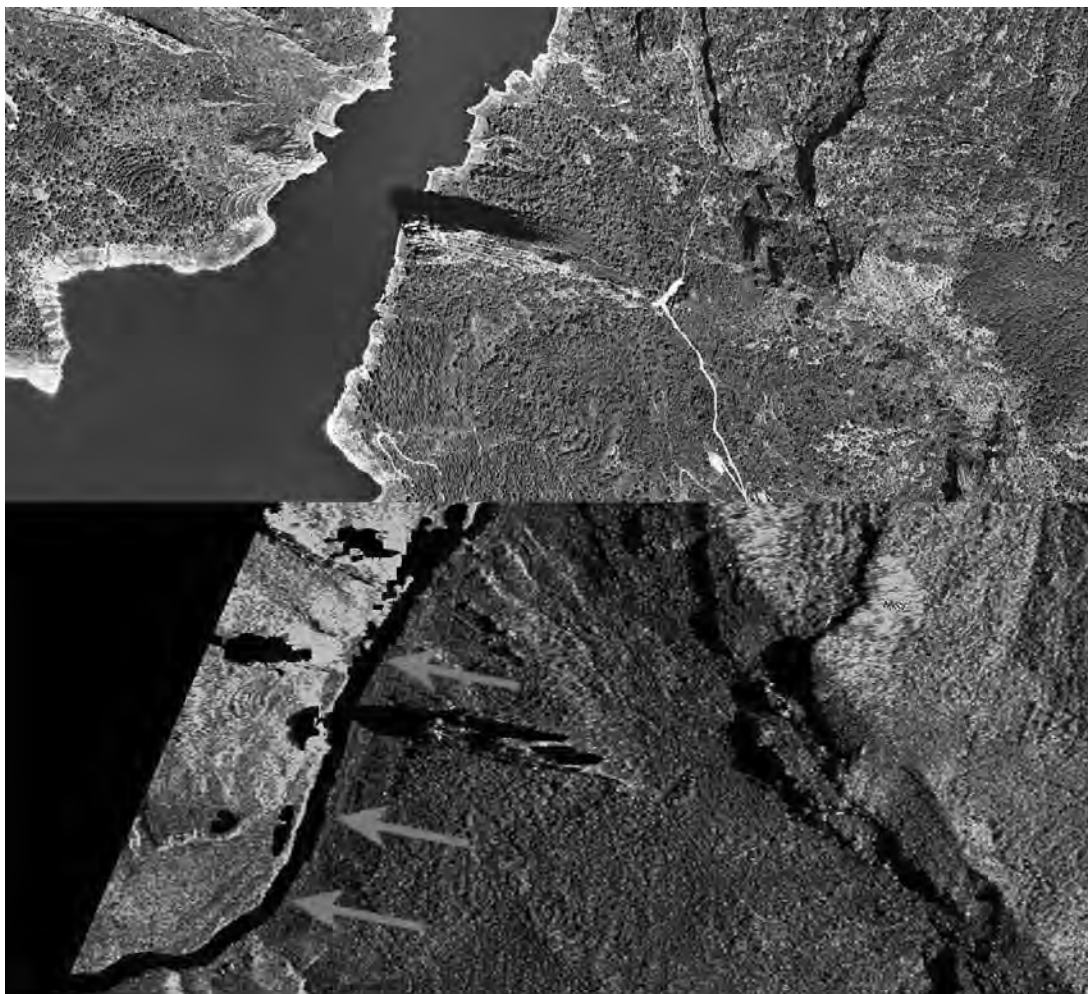
The potential visibility of underground archaeological features is less suitable because the resolution of 2.5 meters per pixel is not enough to represent small structures. Anyway, we not exclude that it would be possible to identify areas of interest by tone-contrast and image enhancement. In addition, the dense vegetation canopy in non-cultivated areas, which are the majority of the hillsides, makes more difficult to read the landscape topography from the aerial photographs.

### 5.3 THE SYNTHETIC APERTURE RADAR IMAGES

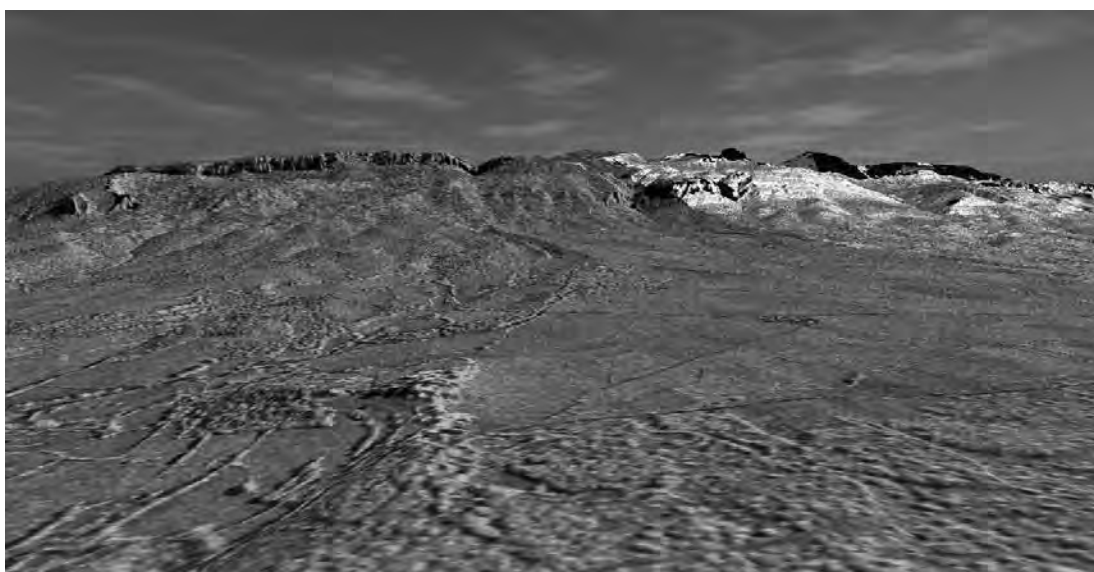
The synthetic aperture radar (SAR) is an instrument still on test by archaeologists. As described in the chapter of remote sensing, the particular product available for the Ager Valley can be used as a support for the analysis with the lidar derived terrain models. In addition, the image processing techniques helped to improve the visibility of field boundaries and colour variation due to micro relief. The superposition of the ORI image to the lidar model allowed to use the DEM quotas to create a 3D shape of the radar image to better visualise the altitude variation.

Despite many radar products can use the particular nature of microwave to penetrate the ground and obtain information about the subsoil, the product available for the Ager Valley cannot penetrate the terrain. Instead, it has been shown that the ORI image that we dispose has been very useful to determine the original path of the rivers and hydrography of the valley thanks to its penetration through water.

Even if radar image has been available for archaeologist for a long time, its only recently that the improvement of resolution made it useful for the detecting of potential archaeological features and the analysis of archaeological topography at a landscape scale.



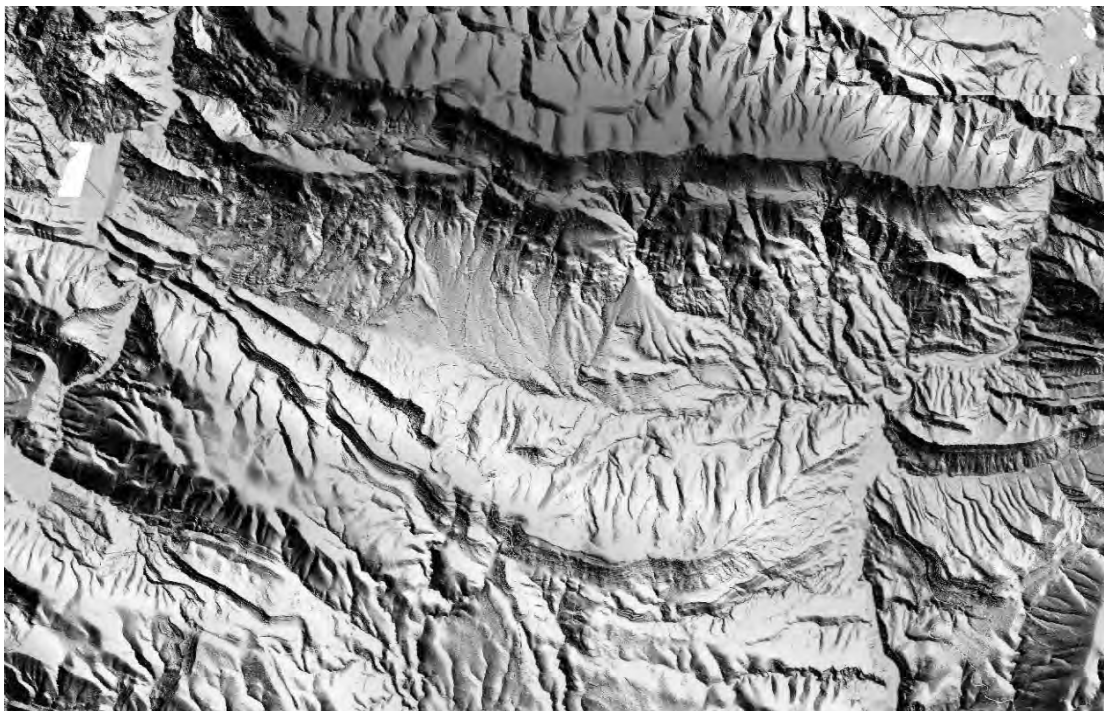
*Figure 25. Above, the Noguera Ribagorçana river that represents the current situation after the building of the dam. Below it is represented the same area seen from the Orthorectified Radar Image with a clear visibility of the former path of the river.*



*Figure 26. A 3D rendering of the ORI image near the area of Agulló (Ager) facing the Montsec at north.*

## 5.4 THE LIDAR DERIVED ELEVATION MODELS

The lidar derived elevation models are the main products that we used in this work because, thanks to their precision, they are suitable for many procedures. One application is the visual inspection of lidar data. This application consists of screening systematically the whole dataset in order to visualise features that may have some interest for the research. In wide area, this approach could be a very time-consuming task. The solution to this approach could be a semi-automatic feature extraction procedure that helps to extract features automatically but that need a supervision of the operator in order to review the suitability of features extracted. In any case, the visual approach must be preceded by an image enhancement process, as described deeply in the chapter of remote sensing, in order to increase the probability of visualising the major part of features and details of the digital model. It is important to consider that a key to interpretation comes from the user experience and that it is statistically impossible to extract every possible feature. The best analytical level comes from the comparison of sources with topographical information and a multi-scalar approach from macro to micro level.



*Figure 27. DTM of the Ager Valley from the Lidar point cloud.*

A second approach was made using the digital elevation models as a base for further operations. First, the creation of contours lines to detect small changes in altitude and isolate the micro relief and the altitude variation. Second, the analysis of the slope variations and the slope exposition through the calculation of slope degrees. This allows the recognition of homogeneous morphological systems inside the landscape surface that have been related to different parcel systems.

The overall view of the lidar derived DTM allows a general understanding of the valley morphology. The valley has an asymmetrical organisation. At the centre there is a wide area characterised by gentle slopes that create a barely plain area. A series of ravines and paleochannels point towards the southeast of the plain where, above a hill, it stands the Ager settlement. The eastern side of the valley is dominated by steep slopes connected to the southern wall of the Montsec. Finally, in the west area the plain portion of the territory starts to narrow until it arrives to the river Noguera Ribagorzana that constitutes the west border.



## 5.5 COHERENT LANDSCAPE UNITS

After the comparison between morphology and parcel systems, using all the available topographic sources, we divided the landscape into eleven coherent units following the techniques of landscape characterisation described in chapter 2. In those areas the agrarian parcel systems, the morphology and the land use are strictly connected and they form macro homogeneous areas.

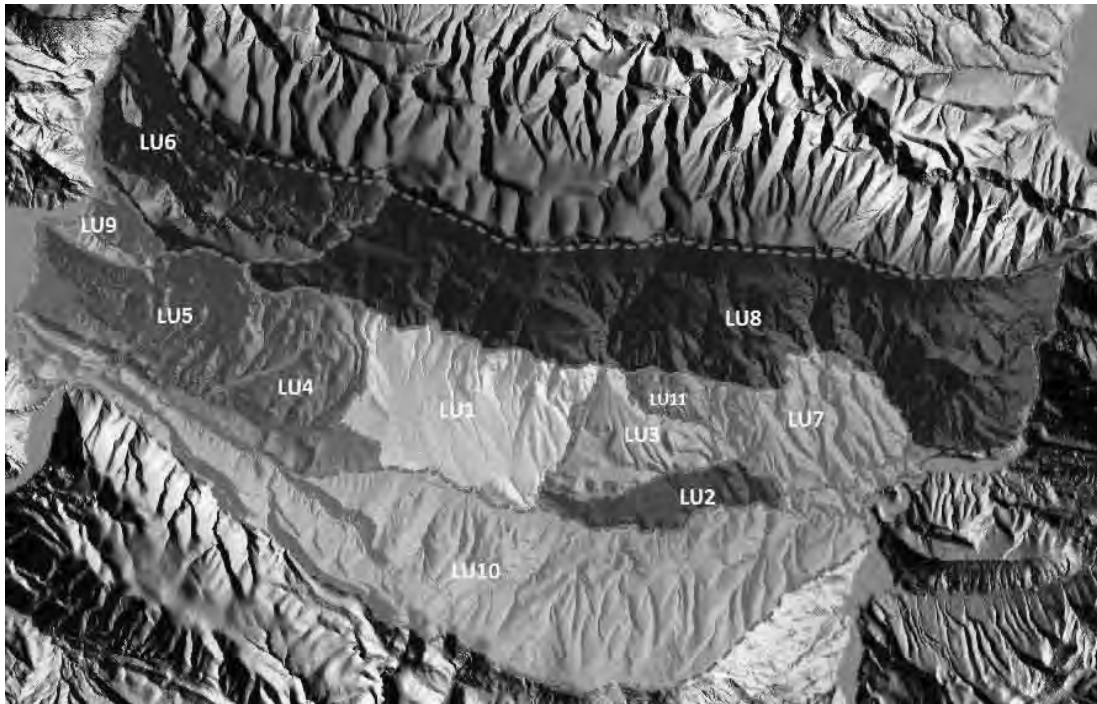


Figure 28. The Landscape Units chosen in the Ager Valley are the result of the comparison of morphology, parcel systems and hydrographic characters.

As it appears, the landscape units are arbitrarily chosen and each of them is a selection made by certain characters that could have more or less weight for each choice. It means that while the LU1 has been chosen especially for its geomorphology and for its hydrography pattern, the LU8 and LU6, that are very similar in geomorphology, have been separated for the historical interest on the *Sant Llorenç* castle in the LU6. It means also that the geomorphology is not the only parameter used in choosing the landscape units. Because of this choice, after the specific analysis of every landscape units, the results will be reunited in a comprehensive view of the landscape complexity.

The first landscape unit, LU1, is the plain under the village of Ager. In this area, the parcels follow the pattern of the alluvial fans and they converge to Ager forced by the road network and the hydrography. The LU2 is a narrow and long stripe of parcels



that have at their centre the village of *La Règola*, it forms a corridor that connects the centre of the valley with the east part and it stands between two slopes at north (LU3) and at south (LU10). The LU3 is formed by a single alluvial fan located between the LU1 and LU2. Its parcels have a pattern that follow the direction of the alluvial fan and it converges to the corridor of *La Règola*. The LU 4 is the area around the village of *Agulló* at 1km east from Ager. A homogeneous parcel system converges to the centre of the village. In addition, at the north side of this landscape unit the church of *Sant Père Martir* attracts the local roads to form a radial pattern. From the LU4 to the LU5 the landscape morphology changes and, moving to west, the plain area becomes narrow and steep and it is dominated by the settlements of *Corçà* and *Claramunt* that generates the parcel and road system of the LU5. At the northwest side of the valley, the mountains of the *Serra de Cantaperdius* separate the LU5 from the LU6 where the landscape converges to the castle and the abandoned village of *Sant Llorens del Montsec*. Here the centre of *Sant Llorenç* dominates the entire landscape system and in particular the roads that bring to the other side of the river *Noguera Ribagorzana*. The LU7 is the area around the village of *L'Ametlla Del Montsec*, this area is characterised by steep alluvial fans that forms a discontinued area from the LU3, the LU2, the LU8 and the LU11. The LU8 is the mountainous band of the Montsec that closes at north the entire valley from east to west. The LU9 is a small area between the LU5 and the LU6. It is a homogeneous parcel system around the ancient castle of *La Pertusa* that also represents another point of passage between to the west side of the *Noguera Ribagorzana* river. The LU10 is the analogue mountainous band that closes the valley at the south border named *Serra de Monclús*. In this area stand several villages and fortification towers. The entire area is characterised for an intense organisation in terraces visible from the lidar source. The LU11 is the area around the village of Colobor. From a morphological point of view, it is separated by the LU3 and the LU7 and it has also a different parcel system. All these areas will be analysed in details in order to show the peculiar aspect of each and highlight the elements useful for the successive historical analysis of the next chapter.

## 5.6 THE ARCHAEOGEOGRAPHIC APPROACH

The Archaeogeographic approach consists of analysing the parcel system morphology, the road network and the hydrography in order to understand the dynamic of the landscape related to the geomorphology of the area. As it was already stated in the chapter 2, the archaeogeographic analysis it is not a matter of giving a precise dating for the parcel systems (that would be impossible without an explicit archaeological or historical evidence). At the contrary, using the words of Robin Brigand it is a study “open towards the complexity of the phenomena of transmission and hybridisation of forms in space and time<sup>304</sup>”. The approach we use here is also strictly morphological, it means that the interest is concentrated on the shapes visible on the landscape surface and not on their materiality. A road, a river or a field boundary made of trees, walls or hedges is considered only for its shape and not for its use.

The observation of the shapes allows distinguishing some patterns created by the anthropic organisation of the landscape. The most relevant shapes derived from human action are the planned parcel systems that are often interpreted as the intervention of a power in managing the landscape in a precise moment. Outstanding examples of planned parcels are the roman centuriation, the rectangular parcels of the “longfields” often associated to a new foundation in the Late Middle Ages (*villanova*) or the land reclaims occurred from the 18<sup>th</sup> century. Other typologies of pattern are associated to non-planned organisation and they are known as auto-organised (or formed) shapes. This kind of patterns may be generated by several factors: the adaptation to the morphology of the terrain, the response to the hydrography management, the polarisation around a settlement or other kind of site, the land use, etc.

The analysis of the roads has an important role in the archaeogeographic approach. As we will see, it is based on itineraries that connect more points of interest. The

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<sup>304</sup> Robin Brigand. "Archaeogeography and Planimetric Landscapes." In *Detecting and Understanding Historic Landscapes*, edited by Alexandra Chavarría and Andrew Reynolds, 173-208. Mantova: SAP Società Archeologica, 2015, p. 173.

importance of the road is also morphological, because roads are the main generators of parcel systems in the landscape.

### Landscape Unit 1

The landscape unit 1 (LU1) constitutes the central area of the Ager Valley at north of the village of Ager. It is characterised by an apparently flat shape even if by contour lines it is possible to detect a variation in altitude of about 100 meters in 1.6 Km of amplitude.

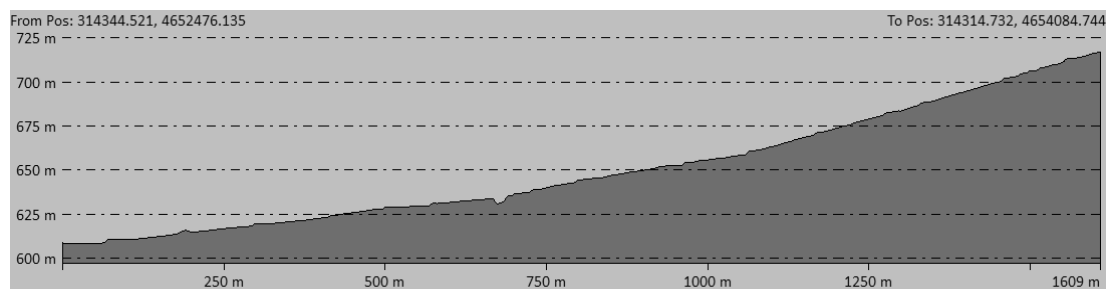


Figure 29. A profile of 1.6 Km from the proximity of Ager to north shows the gently variation in altitude of the central area of the valley.

This large distribution of the altitude variation generates a very gently and continuous slope that make the area to be locally perceived as flat. Only considering large portion of the territory it is possible to detect the actual orography.

It is interesting to notice that the area we chosen as LU1 has a notable corresponding partition in the geological map<sup>305</sup>. Indeed, the almost totality of the LU1 is constituted by gravels, sands, clays and stones forming the alluvial fan. It is a typical sedimentary deposit of the quaternary. In the LU1, we also included two more areas that we interpreted as related to the parcel system of Ager and that, in the geological map, are constituted by limestone and marlstone formed in the Mesozoic Era. These different compositions in lithology correspond to differences in the morphology of the landscape that become more steep and on land use. Anyway, the morphology of

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<sup>305</sup> The geological map that we used in this work is the one available on a web service from the ICGC – (the catalán institute of geology and cartography) at a scale of 1:50000. The direct website is [http://betaportal.icgc.cat/visor/client\\_utfgrid\\_geo.html](http://betaportal.icgc.cat/visor/client_utfgrid_geo.html)

the higher surface, in which the parcel system has been created, seems not to be highly influenced by these differences.



*Figure 30. The LU1 shape in red drawn up the geological map. The dark green area is the representation of the quaternary deposit. The fluo-green is the area with limestones and the blue are the area of the marlstone.*

From the aerial photographs in visible light and in false colour infrared, the visibility of this area is good because of the scarce vegetation canopy. Some remarkable features are the cropmarks and soil-marks formed by the movement of the humidity and type of soils that are visible in almost every agrarian parcel. It is possible to distinguish several soil marks but the majority of them can be organised in four categories by their direction: a) the north-south linear marks and b) the east-west linear marks c) circular-like marks, d) squared-like marks.

Generally, the nature of the majority of cropmarks visible in this area can be detected without the ground verification. For example, most of the north-south lines, the a) typology, are the result of the water movement due to the slope direction of the terrain. In fact, the alluvial fan that we are considering collects all the water from the mountain to the *Riu Fred* river that cross the centre of the valley. These movements generates a huge amount of cropmark and their detection is an easy task because

they are generally linear features hundreds of meters long and they cross many parcels.

(b) The second typology of cropmarks can be easily associated to ancient field boundaries that have been destroyed merging the parcels together after the mechanisation of the agriculture in order to simplify the work. The nature of these cropmarks can be verified comparing the present aerial photographs with the A-Series and B-series of 1945 and 1956. In the case of the LU1 we are dealing with a flat area where the development of the agriculture had a major impact on the organisation of the field boundaries. Comparing this area using the IR aerophotograph and the 1956 aerophotograph it is possible to notice that many parcels have been merged to ease the agricultural works and the signs of the past boundaries are in many cases visible as cropmarks in the present aerophotographs.



*Figure 31. This Picture shows the visibility of paleo-channels in the Landscape Unit 1.*

The c) and d) typologies are the most interesting for the archaeological purpose and have been catalogued and verified by the comparison with the lidar microrelief model

and by a ground prospection when possible. Unfortunately, this kind of traces are also the fewest in the LU1, and in general in the entire valley.



*Figure 32. This Picture shows the visibility of the a) typology of cropmarks and soilmarks that represent paleo-channels in the Landscape Unit 1.*

In particular, we found four anomalies that have been verified by ground prospection. The first of them is a square-like anomaly of about 20x19 meters in a parcel next to Agullò. The ground survey showed the presence of post-medieval and contemporary pottery fragments. It has been interpreted like a possible agrarian farm of the modern centuries, but no further investigation were carried out.



*Figure 33. An example of a) and b) type features. The b) features can be verified using a comparison between the IR aerophoto and the B-series 1956 aerophoto (below in the image)..*

The second anomaly is another squared feature visible from the IR aerial photograph in a parcel of the *Pla de la Cerdanya* at north of the LU1. It is about 17x18 meters with a not perfectly squared shape. During the ground survey no pottery or other findings have been encountered and the anomaly has been interpreted as an artefact produces by the fieldwork machines.

The third anomaly is a circular feature located in a *Pla de La Cerdanya* parcel few hundred meters from the second one and from the fourth one. In the ground

prospection, it has been interpreted as an artefact created by fieldwork machines and no pottery has been found.

The fourth anomaly is a pentagon-like feature with 25 meters length per side and located at less than 100 meters west from the third and the survey revealed that it is a sand lens in the soil surface.



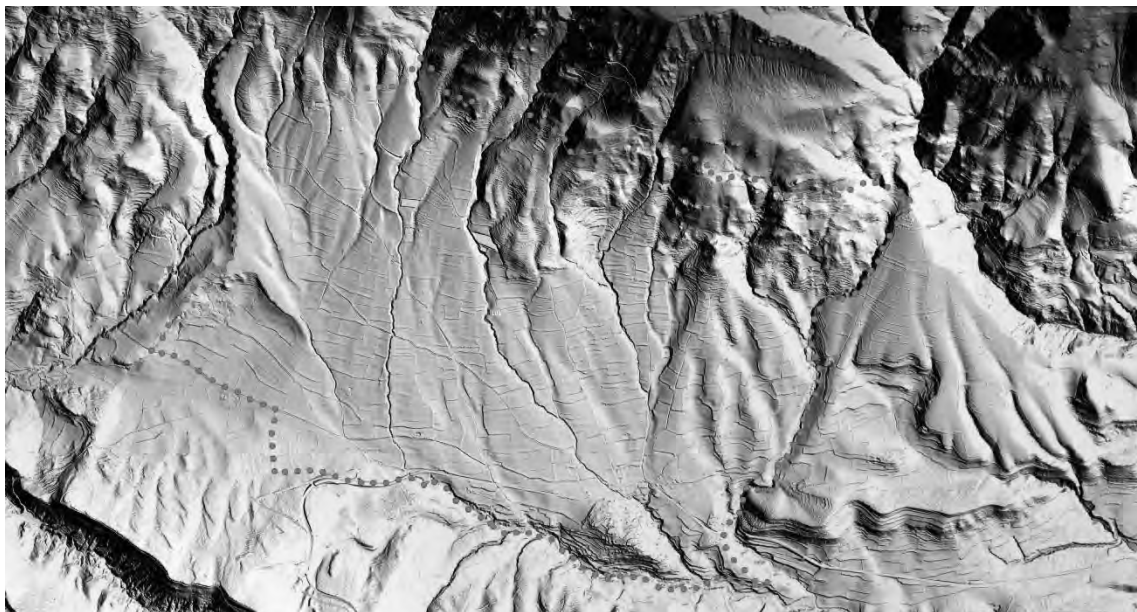
Figure 34. The figure shows the parcels with the traces of anomalies prospected in the LU1.

From the Lidar survey of the LU1, it was possible to observe the landscape without the presence of buildings and vegetation. As said, in the LU1 the presence of wild vegetation is scarce meanwhile a high number of parcels are used to cultivate fruit plants like olive trees, vineyard, hazelnut trees and almond trees. This make the readability of this area easier from lidar because of a minor loss of data after filtering.



The analysis of the micro relief using the local relief model algorithm allowed to better detecting the characteristics of the field boundaries. It is interesting that in the case of the LU1 the field boundaries act as little barriers creating large terraces that represent the small variation in altitude of the area even if the perception when walking is of a flat area. This may be a factor that makes the horizontal boundaries (with an east-west direction) more durable than the vertical ones (with a north-south direction) because they act as support for the parcel as if it would be an extended terrace. The vertical boundaries of the parcels are also less visible from the DTM because of their materiality, in particular plants and trees that make them more subjected to changes. Indeed, roads, water channels and ravines create the most visible vertical features that act as field boundaries.

In addition, from the lidar DTM observation has been possible to extract the topography of some group of agrarian terraces abandoned under the vegetation canopy in the north side of the LU1 and in correspondence with the areas constitute by limestone and marlstone in the geological map.



*Figure 35. A hill shaded image of the LU1 in where it is possible to appreciate the morphological structure and the field boundaries.*

## Analysis of the parcels morphological units of LU1.

The first step of the morphological analysis of the parcels system is to define the morphological units of the considered area. The morphological units are groups of parcels that are chosen for their coherent pattern. Following the description that Magali Watteaux made in her PhD thesis, the morphological units are on a middle-range level from the parcel masses and the strong axis that organise a territory in its entirety<sup>306</sup>. Their visibility is due to the emphatic contrast produced by their morphology and the general organisation of the landscape pattern.

In the LU1 we identified some circular morphological units, radial units often associated to a pole, and striped groups of parcels that are generated around the path of a river. Here it will follow the description of the most significant of them.

An interesting example of striped parcels generated near the bed of a river is the MU1 (morphological unit) located near the southern side of Ager next to the *Riu Fred* river. The parcels are of small dimension and very regular in their shape. They follow the patterns that the river excavated during its course creating a sort of three levels slope where the parcels are arranged. Even if the river crosses the entire valley, this kind of arrangement is seen only in other two occasions and in every case near a settlement (Agullò and La Règola). In the case of the MU1 the parcels dimension varies between 6.0 meters and 7.0 meters of wide (east-west) meanwhile the dimensions in length (north-south) are more variable and depend especially from the largeness of the terrace. In this case, it is very difficult to talk about a planned parcelling even considering the possibility of geometrical errors made during the relief due to the low resolution of the aerial photograph. We can associate this parcel morphology to the presence of water and then to hypothesize the use of this area for irrigated agriculture as gardens.

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<sup>306</sup> Magali Watteaux. "La Dynamique De La Planimétrie Parcellaire Et Des Réseaux Routiers En Vendée Méridionale. Études Historiographiques Et Recherches Archéogéographiques." Université Paris 1 Panthéon Sorbonne, 2009, p. 371.



Figure 36. The morphological unit 1 shows the presence of parcels of small and regular dimension near the river *Riu Fred* and next to the Ager settlement.

The MU2 is of the same typology of MU1. This unit is located at the east side of Ager and it is constituted by parcels of small dimension and regular shape. Again, it is located next a water channel, in this case is a channel that takes the water from the *Riu Fred* and it stops its course at the main spring of the village, the Font del Pedró. As in the MU1, the dimensions of the parcels vary between 6 and 7 meters in wide and 20 and 35 meters in length. Again we cannot interpret this morphologic unit as a planned parcel system because of the variability in dimension and the unprecise shape. Nevertheless, it is possible to assume that this typology of parcels is related to the presence of water and dedicated to the same use as the MU1.

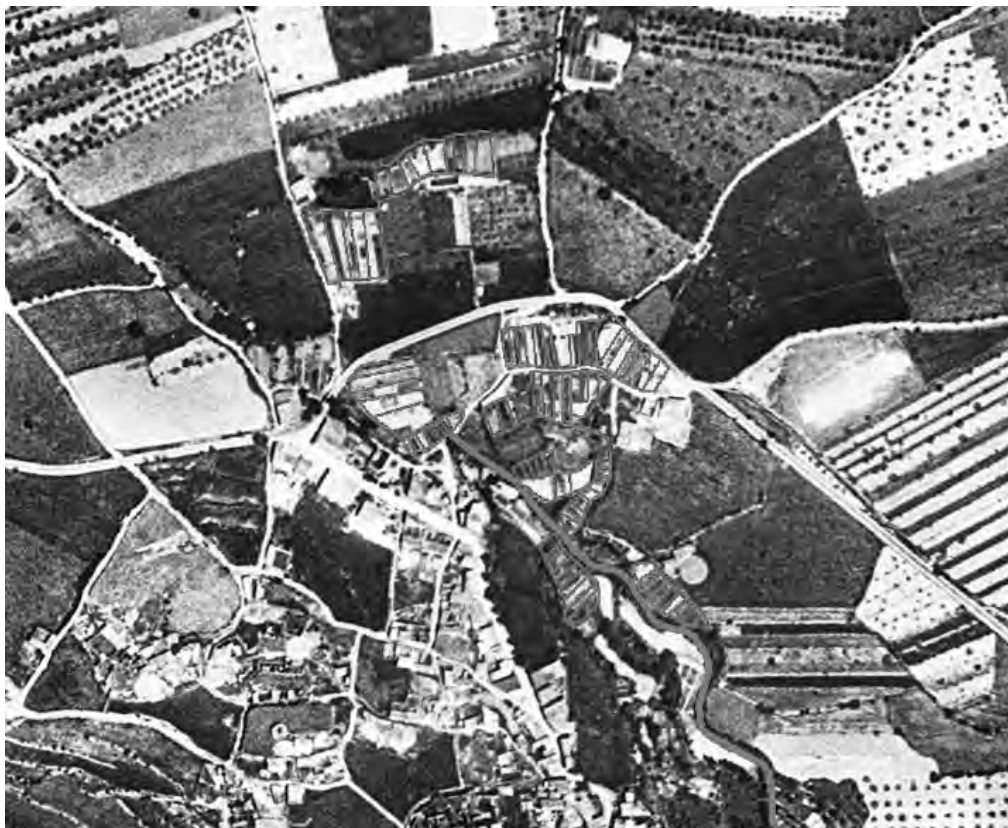
The other morphologic units that we relieved in the LU1 are of circular and curved shape and we propose here the description of three of them, the MU3, MU4 and MU5.

The MU3 is located about 1km far from the centre of Ager in north-west direction and just 100 meters north from the medieval site of *Santa Coloma d'Ager*, an early middle ages church and burial ground whose study will be deepen in the next chapters. The area is approximatively 65000 square meters it has an elliptical form

and it is 350 meters long in its centre. In addition, the considered unit is constrained between the ravine named *Barranc de les Fontetes* and the road *Camí de Plandemates* that follows in that sector the curved path.



*Figure 37. The MU3 is the first of the Semi-circular morphological units considered. Its interpretation cannot be associated to the geomorphology and it becomes more difficult.*



*Figure 38. The MU2 is similar to the MU1 and it is located next to the Riu Fred and to the main spring of Ager. The parcels are of small dimension and follow a different pattern than their surround.*

The parcels are arranged between two semi-circular paths and their limits follow a radial movement. The interpretation of the morphogenesis of this unit cannot be associated to the geomorphological background. Indeed, seeing the digital terrain model it is possible to appreciate that the slope and the morphology of the terrain is uniform all around the area of the UM3. The literature in Archaeogeography normally consider this kind of elliptical morphologies as the result of a wood clearance. We can also hypothesize that the presence of the church of Santa Coloma, demolished in the 18<sup>th</sup> century, could have attract the road from its “natural” direction and then we could relate the origin of this shape with the origin or the lifetime of the church. Anyway, if this would explain the origin of the external curved path, it would not for the inner one. Indeed, when analysing the road path at the end of this chapter we will notice that this path “cuts” several parcels without provoking any variation on the general parcel morphology.

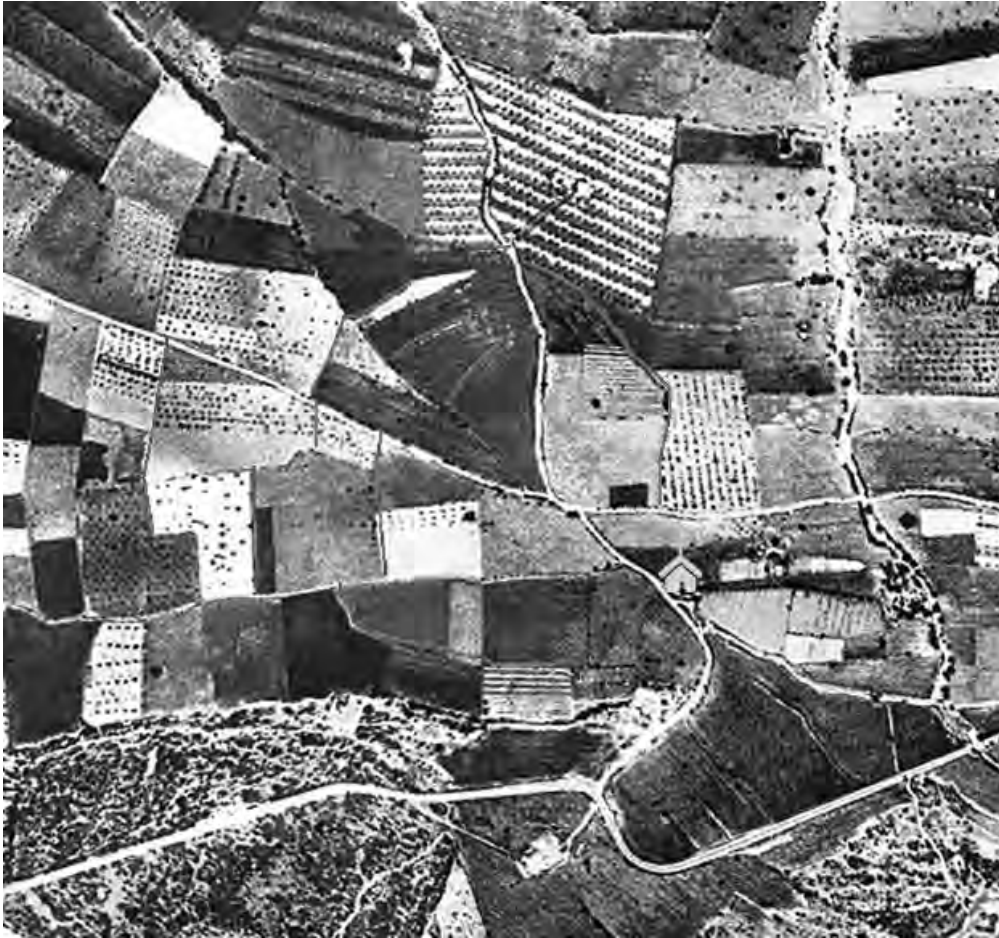
The MU4 is located approximatively 1.5 km west from the MU1 in an open area without any settlement but next to a rural church named Santa Helena and dated at the 15<sup>th</sup> century<sup>307</sup>. It has a rounded shape and its diameter is approximatively of 360 meters in the longest part (east-west). As in the case of the MU3, the interpretation of this feature cannot be ascribed to a geomorphological constraint. The comparison with the digital terrain model shows that the slope from west to east remains stable and, from north to south, it follows the trend of the rest of the LU1. In addition, there are no ravines, rivers or other natural features that may have constrained the shape of this morphological unit. The interpretation we give for the origin of this morphological unit is similar to the one given for the MU3. The presence of the church may have act as attractor for the road paths proceeding from Agulló and Corçá generating a radial road pattern that helped this parcels arrangement.

The MU5 is located 200 meters north to the MU4. As in the last two example, it is a rounded shape unit with a diameter of 500 meters. The area where the unit is located is called *Pla de la Cerdanya* and it is a barely flat area but with a cone of an alluvial fan that generates a terrace of 20 meters of difference in height. In our

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<sup>307</sup> Francesc Fité Llevot. *Reculls D'història De La Vall D'ager...* p. 74.

interpretation, this difference in geomorphology may have contributed to the genesis of the shape of the considered morphological unit.



*Figure 40. This image shows the relief of the MU4 over the B-Series 1956 aerial photograph. It is possible to appreciate the radial pattern of the roads and the point of the church of Santa Helena.*



*Figure 39. This image shows the MU5 relieved on the B-Series 1956 aerial photograph and the DTM from lidar survey. It is possible to appreciate the geomorphology of the area that we considered to interpret the origin of the shape.*

## Landscape Unit 2

The landscape unit 2 is a long and narrow area that connects the LU1 to the LU7. It has a length of approximately 5 Km and a width varying between 350 meters and 700 meters. This area has been isolated as LU2 especially because of its morphological characteristics. Indeed, its shape remembers a corridor formed by a plain area and constrained by two terraces, the LU3 border at the northern side and the LU8 at the southern side. It is possible to see clearly this phenomenon analysing a profile traced in the LU2 that crosses a part of the LU3 and LU8. Is easy to see the concave shape of the LU2.

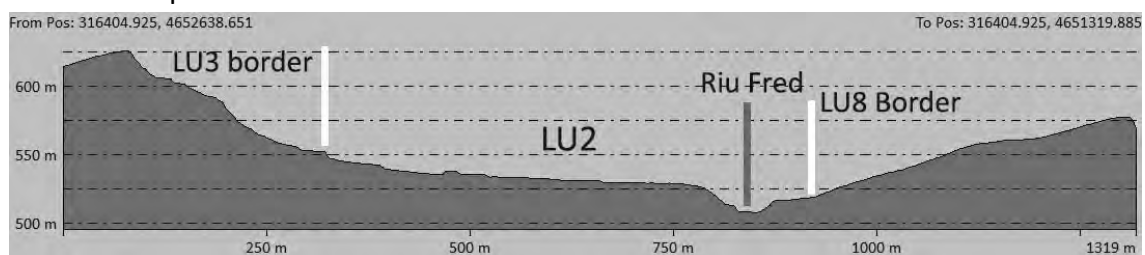


Figure 41. This image represents a profile from the LU3 through the LU2 to the LU8, from north to south. It is visible the flat conformation of the LU2 and the marked borders of the LU3 and LU8 that constrain the LU2 like a corridor. It is also possible to notice the presence of the Riu Fred riverbed.

This difference can be appreciated also from the geological map. The terraces of the LU3 are marked as an outcrop of the Cenozoic era constituted by sedimentary rocks of marlstone. The area of the LU8 is also from the Cenozoic era but with a different composition made of clays and limestones. The central area that constitutes the LU2

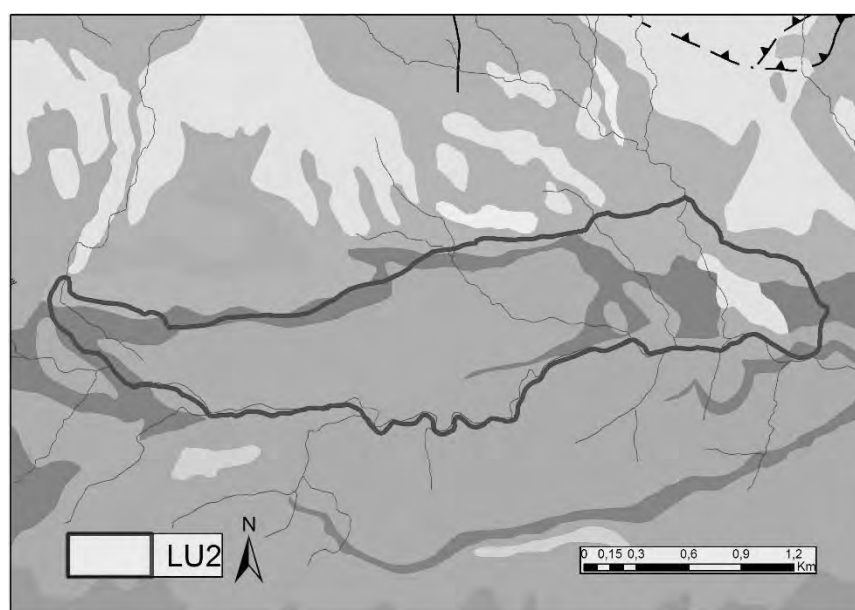


Figure 42. This image shows the borders of the LU2 over the geological map of the Catalan Institute of Cartography and Geology.



has the same composition as the LU1 and represents a sort of deposit of gravels, sands, clays and stones from the quaternary era.

As in the case of LU1, the visibility of the terrain surface is good from the aerial photographs because of the scarce high vegetation due to the land use. The plain trend of the terrain make possible its use for cereal cultivation improving the potential visibility of cropmarks. The typology of cropmarks identified for the LU2 are water cropmarks with linear anomalies proceeding from north to south, and ancient field boundaries disappeared after the merging of some agrarian parcels. As made for the precedent landscape unit, these kind of cropmarks have been verified without the ground prospection because of their intrinsic nature. They have been compared with the 1956 aerial photograph to confirm the presence of former field boundaries. Unfortunately, no cropmarks that could have been associated with archaeological features are visible in these aerial photographs.

From the lidar prospection, the manipulation of the DTM allowed to better interpret the topography of the area. The area is divided in two parts by the passage of the C12 road and the front of the LU3 that constitutes the limit of the LU2 is organised in terraces covered by uncultivated woods. From the DTM the field boundaries were perfectly mapped and, as it was for the LU1, we notice an important difference between the limits with east-west direction and the limits with north-south direction. The first category act as micro-terrace walls for the difference of slope that gradually occurs from north to south. The vertical field boundaries, at the contrary, are less visible because of their different materiality, these boundaries are also the most subjected to change during time because of their weakness.

#### Analysis of the parcels morphological units of LU2.

The reduced extension of this landscape unit make it easy to analyse the morphological units of the parcel system. In this area, the parcels are organised following the direction of the corridor from west to east direction and there are not curved or circular morphologies as signs of polarisations. At the same time we did not detected any particular arrangement that could be associated to a planned parcel

system. The only morphological unit that we are describing here is the MU6 similar to the MU1 and MU2.

The MU6 is located at 500 meters west from the village of *La Règola*, that stands at centre of the LU2 along the course of the *Riu Fred* river. The parcels of this units are of small dimension and with a very regular shape along the right side of the *Riu Fred* river. Their dimension vary between 12 and 18 meters in wide and between 30 and 50 meters in length. We cannot interpret this unit as a planned because the dimension are not regular but we can interpret the difference of morphology from the rest of the LU2 as a different land use, for irrigated agriculture. Observing them from the lidar derived DTM it is possible to see that they also follow the local micro topography laying above the terraces excavated by the river.



Figure 43. This image shows the relief of the MU6 next to the RiuFred near Agulló. The DTM image below shows the particular configuration of the geomorphology due to the passage of the river.

### Landscape Unit 3

The landscape unit 3 is located at the east of the LU1 and between LU2 and LU11. It was chosen especially for its geomorphological characters and for the arrangement of the parcel system that follows the pattern of the alluvial fan that forms the LU3. We used the ravines named *Barranc de Menàrguens* as the east border and the

*Barranc de Colobor* as the west border. This landscape unit is characterised by the absence of large settlements, it hosts only few contemporary farms. In addition, the only archaeological site attested in this area is a XII century defensive tower named from a farm that reused the location of the tower, *Mas del Mingereixo*.

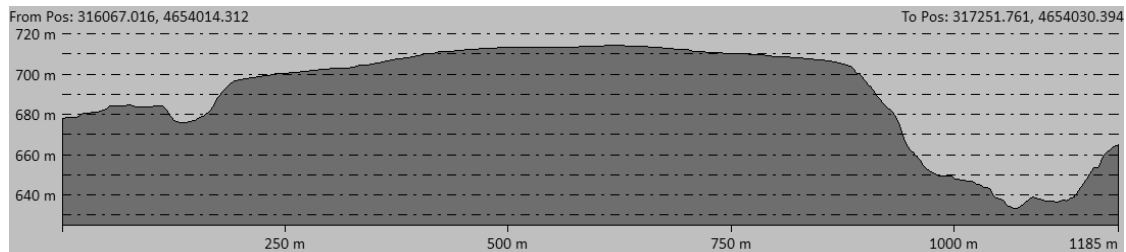


Figure 45. The transversal profile of the area shows the conformation of its plain shape with a variation in altitude of less than 20 meters. The limits of the area are well visible.

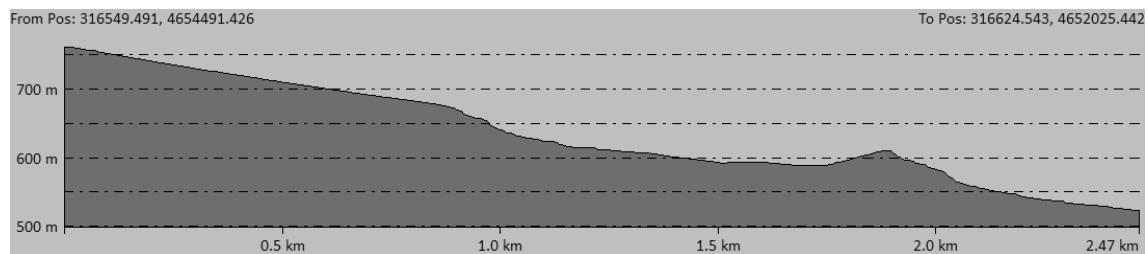


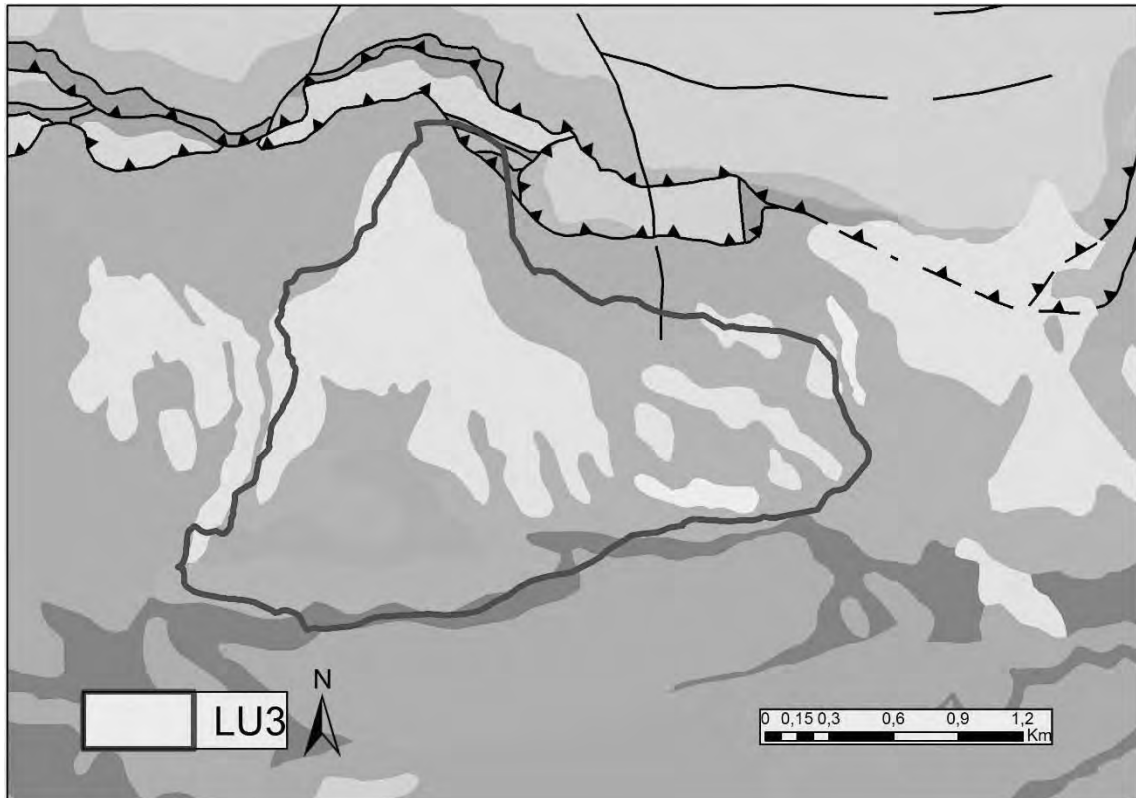
Figure 44. In this image is well visible the slope direction of the area that becomes more gentle in the centre.

Its topography is typical of the alluvial fan already seen for the LU1, with a gentle slope that increases in altitude from south to north giving a perception of a flat area. The only difference is the geological composition of the terrain and the presence of few steps with terraces that mark the limits with the LU2 creating the aforementioned corridor. From the north-south profile of this area with a vertical exaggeration, it is possible to appreciate these phenomena and visualise the growing of the micro relief.

The geological composition of this area is different from the LU1 even if the shape is perfectly similar and of the same geological era. It is formed especially by sands, graves and limestones and it changes after the first group of terraces that are visible in the profile. The second part is composed more by marlstone.

As in the case of LU1 and LU2, the general plain area facilitate the cereal cultivation, then the visibility of cropmarks is possible from the aerial photographs. Only the

areas with a higher difference in height next the south border are covered by woods. The nature of cropmarks observed here is the same as for the LU1 and LU2, in particular there cropmarks of hydrogeological nature and inactive agrarian parcel limits.

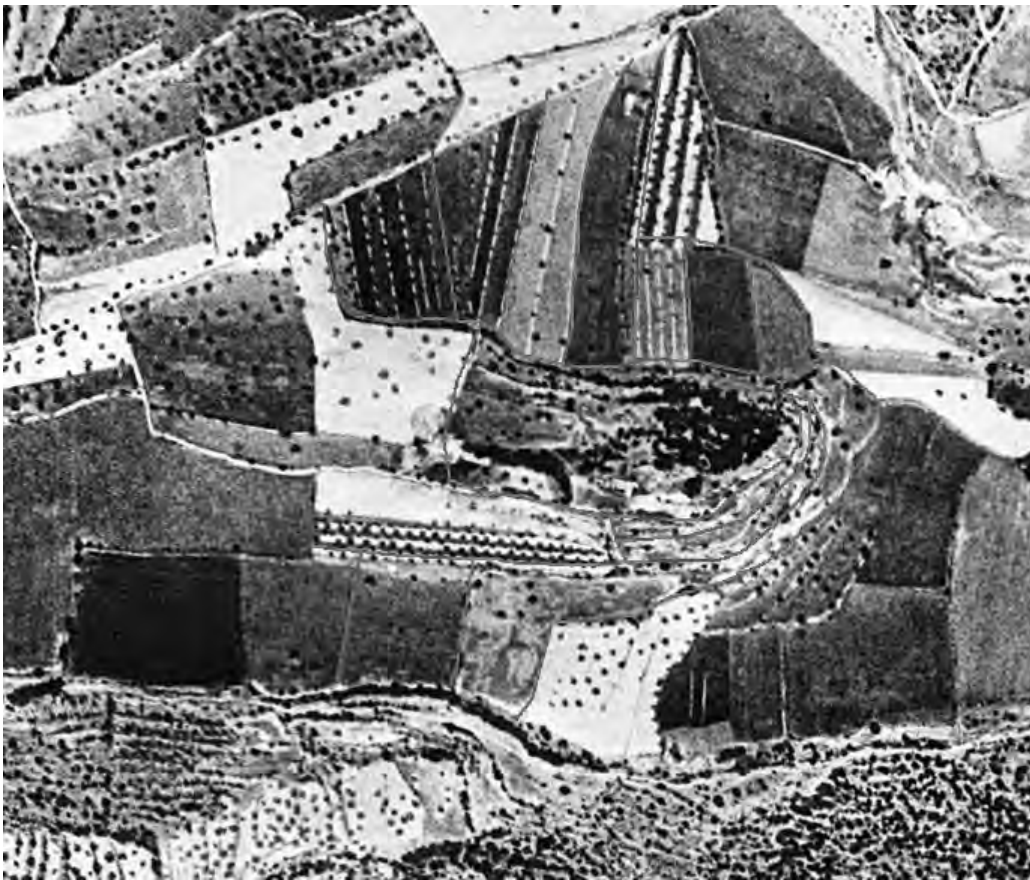


*Figure 46. The geological map of the LU3 shows the particular shape of the alluvial fan that constrains all the geomorphology of this area. The red part corresponds to the step seen in the profile of the image 23.*

The reading of the DTM showed the presence of abandoned terraces along the border of the LU3 with 5 levels of terraces that have been mapped with the aid of vegetation canopy removal. The micro relief analysis showed the presence of micro morphological accidents that influenced the parcel morphology in the south part of the area.

### Analysis of the parcels morphological units of LU3

The analysis of the parcels morphology revealed a general regular trend of rectangular parcels distributed following the geomorphology of the alluvial fan with the creation of large horizontal terraces that structure the landscape along east-west direction. This cannot be interpreted as a planned parcel system. At the south part of the area, the MU7 appears to have a different pattern from the general arrangement. It is an elliptical unit with an extension of 450 meters with a group of parcels disposed radially. The interpretation of this morphological unit has been associated to the local micro relief.



*Figure 47. Image of the MU7 over the B-series aerial photograph. The elliptical shape of the microrelief produces a different arrangement of the parcels around it.*

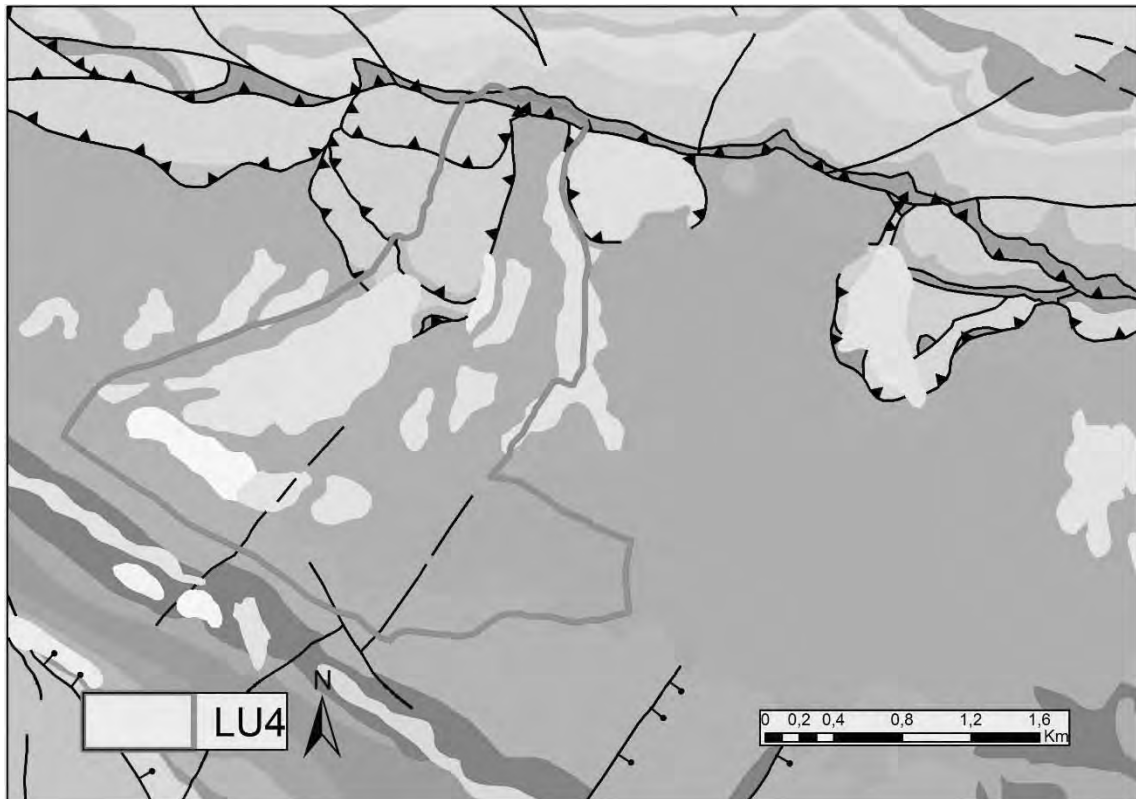
### Landscape Unit 4

The Landscape Unit 4 comprises a part of the west plain of the LU1 near the settlement of Agulló. It is closed at south by the mountains named *Serra de Millá* and it continues at north following a ravine that separate it from the territory of *Corçá*.

Because of the similar geomorphology and geology with the territory of Corçá (LU5), this area has been selected especially for the pattern of its parcels and because it represents the main point of passage from the centre of the valley to the west. The general geomorphology of this area is constituted by two main groups of patterns. At one side near the settlement of Agulló there is a persistence of the plain typical of the LU1 that was separated because its place name is *Pla de Agulló* and the parcel system is not polarised toward Ager, as in the case of LU1, but in the direction of Agulló. At the other side, going to north, the gentle slope that we saw in the LU1 and LU3 caused by the alluvial fans becomes sharper and it provokes a sensible change in the pattern of the landscape. The geological composition of this area varies in function of the parts the we described above, the plain of Agulló has the same composition of the LU1 alluvial fans, meanwhile the northern part is composed especially by graves and conglomerates.

The difference in composition and in geomorphology is reflected also in the land use. From the aerial photographs, it is possible to appreciate that this area starts to have more vegetation canopy than the ones analysed until now. In the plain areas, still cultivated with cereals, there are many cropmarks interpreted as the hydrographic movement through the slope and the signs of “fossil” parcel limits. No other kind of cropmarks have been detected in the available photographs.

The lidar derived DTM allowed to detect a well-organised system of terraces under the vegetation canopy. The majority of these terraces are now abandoned but they covers the entirety of the slope until about 950 meters of altitude.



*Figure 48. LU4 over the geological map. From here the formation of the valley changes significantly and the alluvial fan that created the plain of Ager in the LU1 finishes in the plain of Agulló. From here the valley becomes more narrow and with sharper slopes.*

### Analysis of the parcels morphological units of LU4

The analysis of the parcels morphology revealed three interesting morphological units. The MU8 is a semi-circular morphological unit of 375 meters of amplitude in its largest side. It is located in the plain named *Pla d'Agulló* next to the village of Agulló. The parcels of this MU are arranged in a semi-circular pattern from east to west and the internal limits form a radial pattern. Analysing the lidar of this area, it is possible to see a slight difference in height of approximately 3 meters distributed in the 375 meters of extension of the area. This micro relief variation is obviously invisible at naked eye but may be associated to the shape of the area. It is difficult to say if the shape has been created by the geomorphology or vice-versa. An archaeological survey made here had no results in terms of archaeological evidences; in addition, the area that stands at the centre of the MU is currently urbanised and impossible to survey.

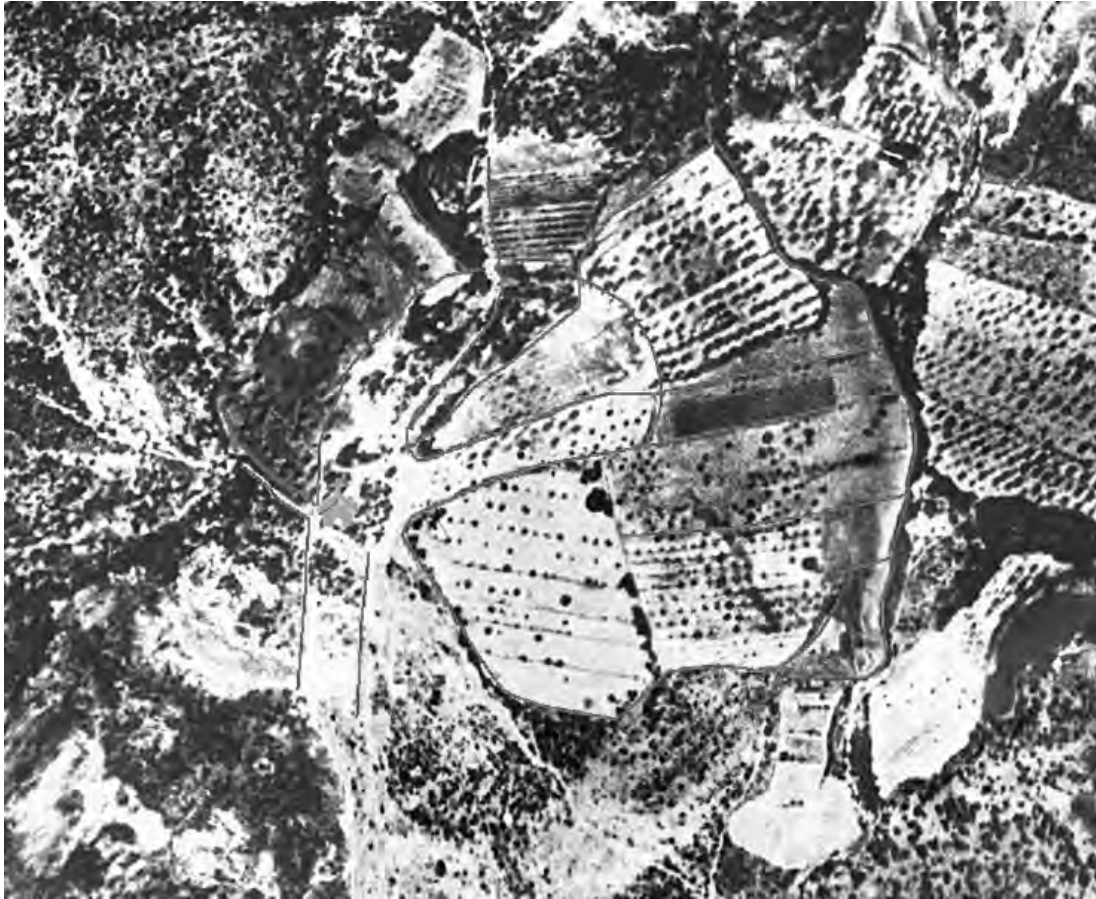


The MU9 is located at approximately 1km north from Agulló and it has a circular-like morphology and a diameter of approximately 400 meters. The area is barely flat but the parcels around have not a regular organisation, like in the plain of Agulló, and it is mainly covered by woods. The morphological unit is constituted by an arrangement of parcels that are constrained by a radial concentration of five different paths. An interesting thing for the interpretation of this pattern is the presence, just at the centre of this crossroad, of the church of *Sant Pere Màrtir*. The temple is currently of modern appearance, it was restored at the beginning of the 20<sup>th</sup> century, but there are archaeological evidences of sarcophagi dated at the 5<sup>th</sup> century of the same typology from the burials of Santa Coloma. Even if we cannot give a sure archaeological proof of continuity from the 5<sup>th</sup> to the 20<sup>th</sup> century, we can give an time interval of frequentation of this area that could have been the cause of the polarisation of the road networks and, consequently, influenced the parcels morphology.



*Figure 49. The MU8 is a circular unit in the plain of Agulló. In this image there is the comparison between the aerial photograph B-Series of 1956 and the lidar derived DEM in 3D. It is very clear the presence of microrelief that draws a semicircular pattern. The survey here has been impossible for the scarce visibility due to current land use.*

The MU10 has a morphology that we already encountered in the LU1 and LU2. It is located the village of Agulló along the course of the *Riu Fred* river. It has a linear



*Figure 50. In the MU9, at the centre of the crossing there is a church named to Saint Peter. The prospection revealed a Christian frequentation since the 5th century.*



*Figure 51. The image shows the MU10 next the village of Agulló. It is positioned in the middle of two small rivers, the southern is the Riu Fred proceeding from Ager.*

extension of 500 meters and it follows the path of the river. It is constituted by parcels of small dimension and rectangular shape as in the case of MU2 and MU6. The interpretation remains the same as the one given before, the presence of the river facilitated the practice of irrigated agriculture and this was transmitted to the shapes of the parcels used as gardens.

## Landscape Unit 5

The landscape unit 5 is located at the west side of the Ager Valley. It corresponds to the territory of the village of Corçá and the abandoned village of Claramunt. In this area the flat portion of the valley becomes narrow until it just denotes the proximity of the Riu Fred. The rest of the area is constituted by sharp hills and canyons created by the ravines coming from the south side of the *Serra de Cantaperdius* Mountains.

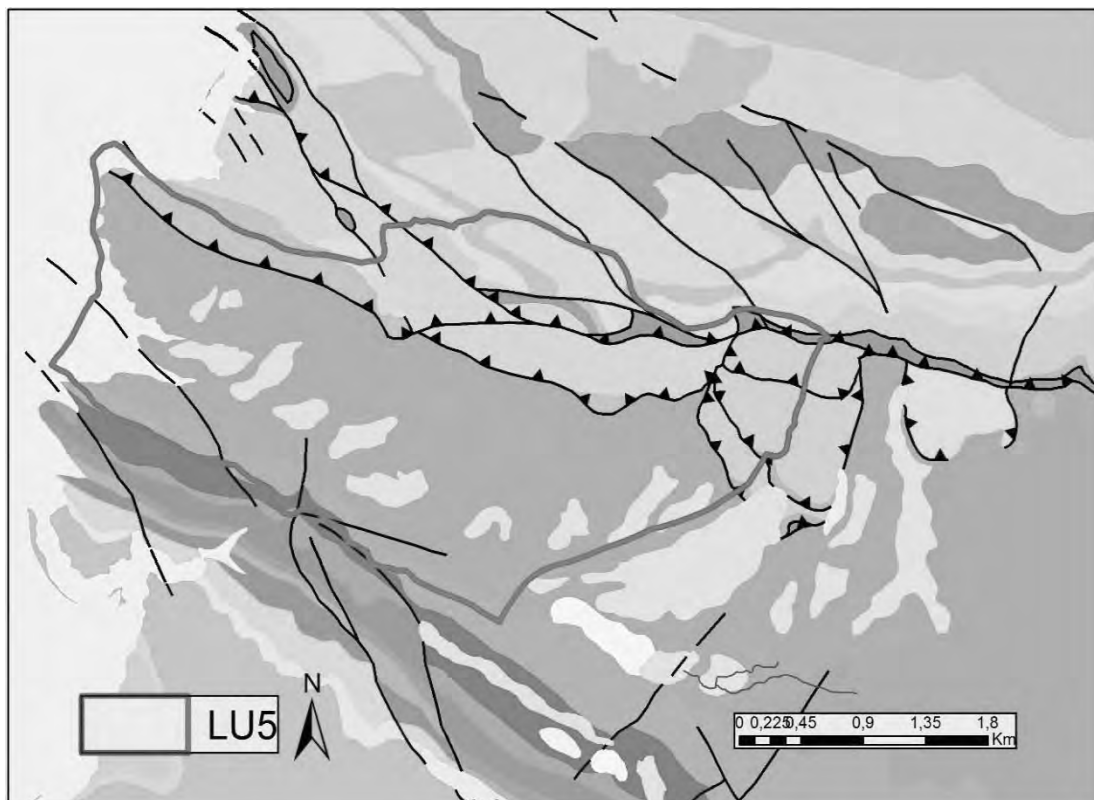


Figure 52. This image show the location of the LU5 above the geological map. This area is quite uniform and it is very visible the separation from the upper area of the Montsec where the slope increase dramatically marked by the line with triangles.

The geological map shows that this area is mostly composed by formations of the Eocene era, constitutes by graves, conglomerates and lutite sedimentary rocks. The area occupied by the hills is constituted especially by marlstone and limestone.

The reading of the aerial photographs were, as expected, poor of information because a dense vegetation canopy covers the main part of this landscape unit. The only cropmarks visible are located in the southern part of the area, where the merging of the parcels left the traces of the past parcel boundaries. The most interesting features are visible from the lidar DTM and the radar image. From the lidar derived DTM it has been possible to extract and map all the terraced systems of the area hidden by the vegetation canopy.

#### Analysis of the parcels morphological units of LU5

The analysis of the morphological units of this area did not show parcel systems that contrast the general pattern of the landscape. As said, in this area there is a main settlement named Corçá and an abandoned castle with a village named Claramunt. Both are positioned on a raised location and they are surrounded by several groups of terraces that follow the geomorphology of the hills and that are currently abandoned. The terraces are built until an altitude of approximately 800 meters and they are clearly related to both settlements. It is not a nonsense to think that these systems, considering the diachronic period may have had an important impulse for its construction during the 11<sup>th</sup> and 12<sup>th</sup> century. The pottery found during the survey attested an important frequentation of these terraces and not only of the castles, during the mentioned centuries. These assertions will be analysed deeper in the next chapter dedicated to the medieval organisation of the landscape.

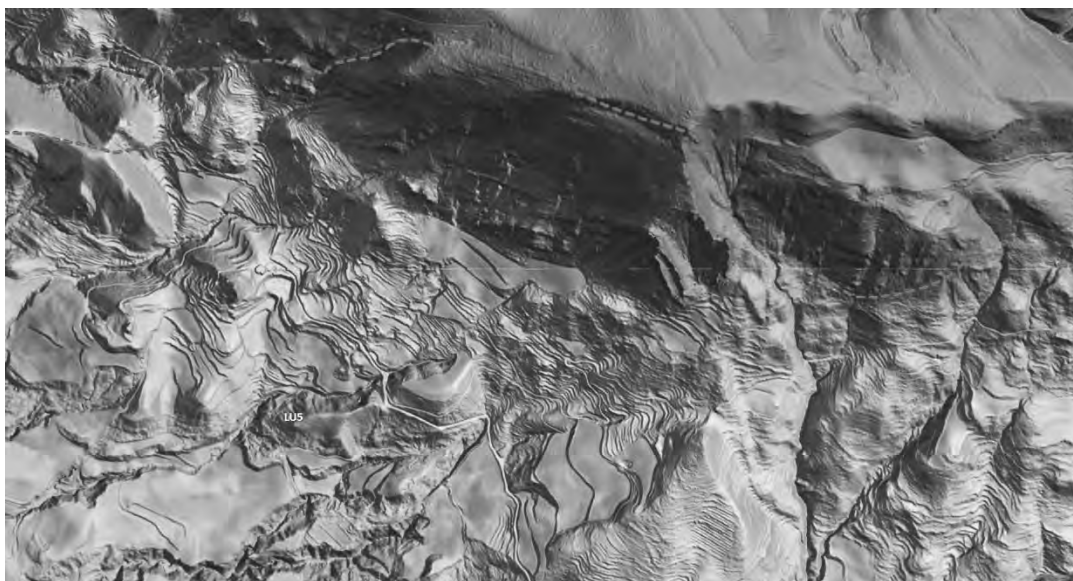


Figure 53. The terraces of the northern area of the LU5 viewed from lidar derived DTM.

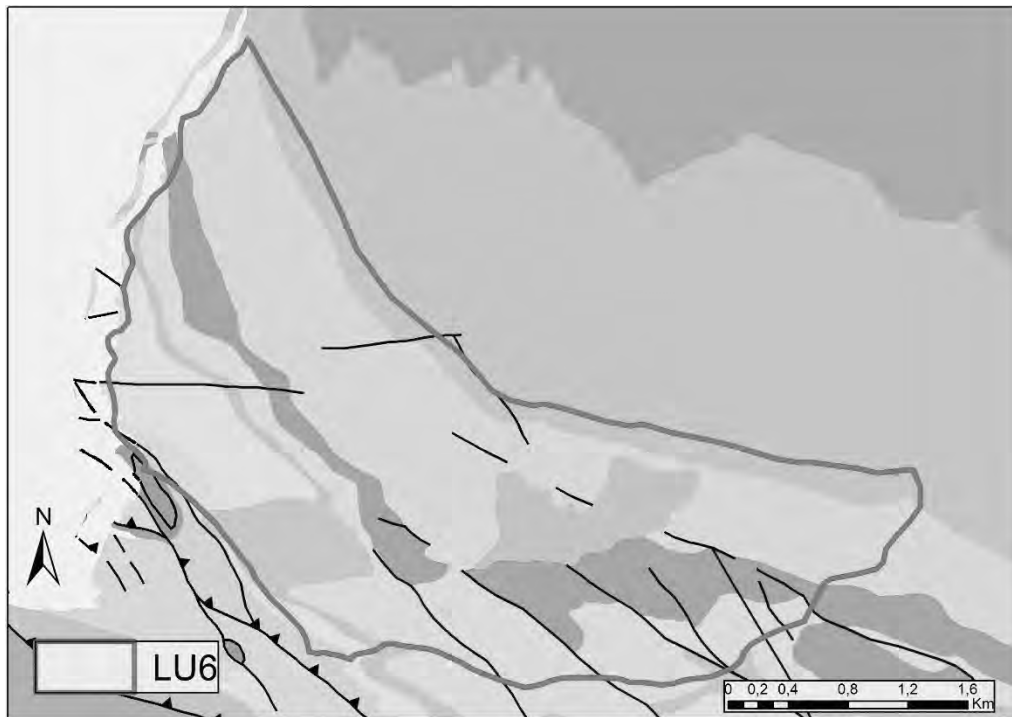
## Landscape Unit 6

From the geomorphological point of view the LU6 is the same unit as the LU8, the highest part of the Montsec that surrounds the valley. We decided to separate it from the LU8 because of its historical peculiarity. The presence of the castle and the abandoned village of *Sant Llorenç d'Ares* together with the main roads that pass through the *Noguera Ribagorçana* River, make us choosing to separate it as an individual landscape unit.

The geological composition of the area is the same of the LU5 for the other side of the *Sierra de Cantaperdius* mountains constituted by marlstone and limestone. The central part of the area where is located the site of *Sant Llorenç* is formed by loams and sands and it corresponds with the more cultivated area. The remaining areas and in particular the southern side of the Montsec is constituted by marlstone, limestone and bioclastic sedimentary rocks.

The aerial photographs for this area cannot be very useful for the observation of the surface morphology. All the mountainous area here are completely covered by woods and the clean agrarian parcels are very few. The most useful support was the lidar derived dtm that allowed to detect an extended system of agrarian terraces all

throughout the mountains until an average altitude of 1150 meters that is an unusual altitude for agriculture that generally do not exceed 1000 meters.



*Figure 54. The Landscape unit 6 in the geological map. It is clear that it exists a geological uniformity with the LU8 and the division was made only for our specific interest.*

### Analysis of the parcels morphological units of LU6

As said the majority of the area is covered by woods and all the agrarian parcels concentrate next to the castle of Sant Llorenç and more at north next to the medieval church of Santa Maria d'Ares. Beyond the agrarian terraces we noticed two other typologies of parcels of small extension and with no coherent organisation. The first type are circular or elliptical parcels that are randomly positioned in the area and are the results of woods clearance. In many cases this parcels continue to be cultivated meanwhile their surrounding has been abandoned. The second typology are the squared parcels arranged around the site of the castle that do not follow the geomorphology of the area but are oriented following the polarisation of the archaeological site. The survey of this area revealed the same period frequentation of the LU5. Many traces of 11<sup>th</sup> century pottery were found in the castle and in the surrounding terraces and agrarian parcels.

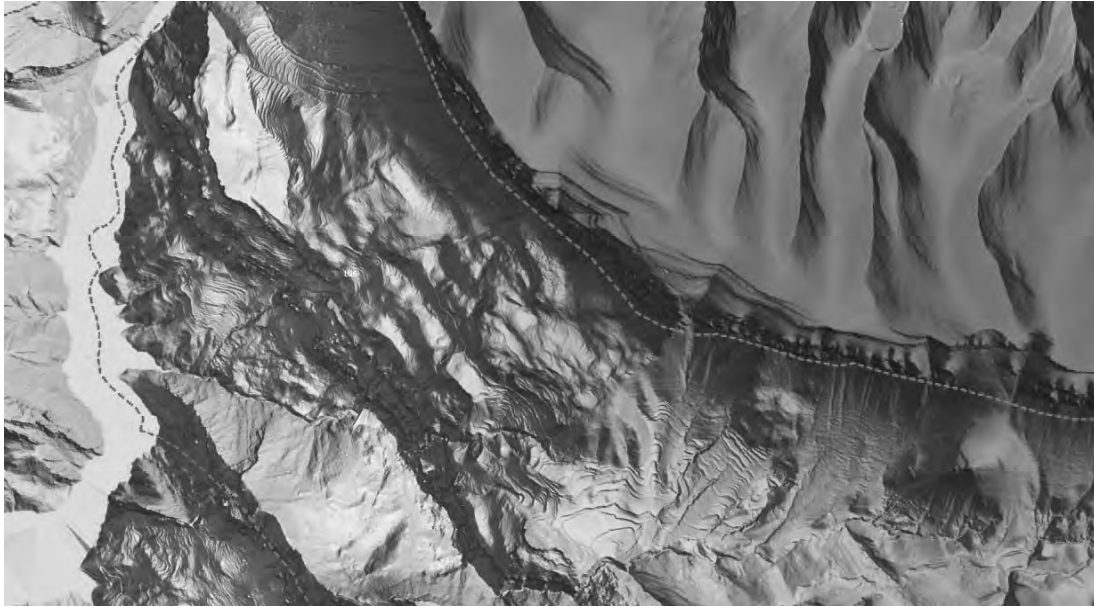


Figure 55. View from the lidar derived DTM of the terraces and the parcels in the Landscape Unit 6.

## Landscape Unit 7

The landscape unit 7 is located at the east side of the Ager Valley. It can be considered the analogous of the LU5 for its geomorphology with sharp hills generated by alluvial fans and crossed by ravines. The main settlement of the area is the village named *Ametlla del Montsec* and no archaeological sites are attested in the surrounding.

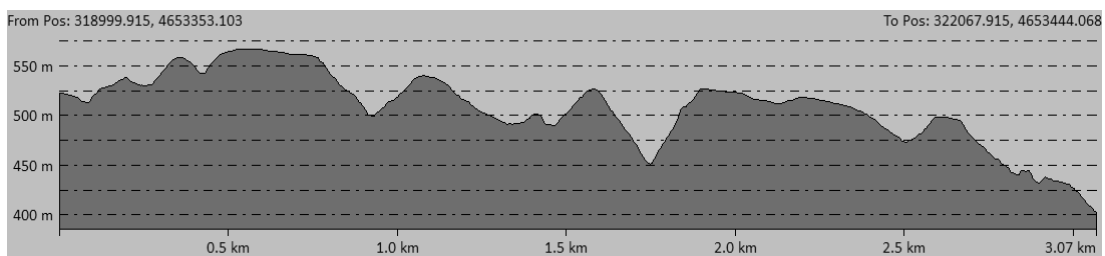


Figure 56. East to West profile of the landscape unit 7. It shows the very irregular shapes of the area that causes the irregular parcel system and a high portion of the area covered by woods.

The geological map reports the same composition of the LU5 with marlstone, limestone and loam. Analysing the cross profile of the area is possible to see that the surface is mainly irregular and this is reflected to the organisation of the parcels and the land use. In the north-south direction three small alluvial form a more gentle slope. These areas are the only parts not covered by woods meanwhile the rest of



the landscape unit presents a dense vegetation canopy. In the aerial photographs of 1956 the land use appears more dense with less wood cover, meanwhile in the more recent aerial photographs the wooden area correspond to the abandoned agrarian terraces of the hills. All these terraces have been mapped using the lidar derived DTM but due to the steep slope, they arrive until an altitude of approximately 650 meters.

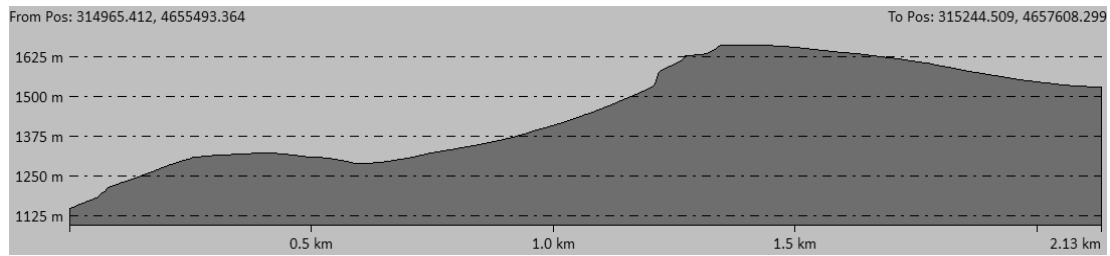


Figure 57. The South-North profile of the LU7 shows the dramatic variation in slope with an altitude varying from 1250 meters to 1600 in 500 meters of longitude.

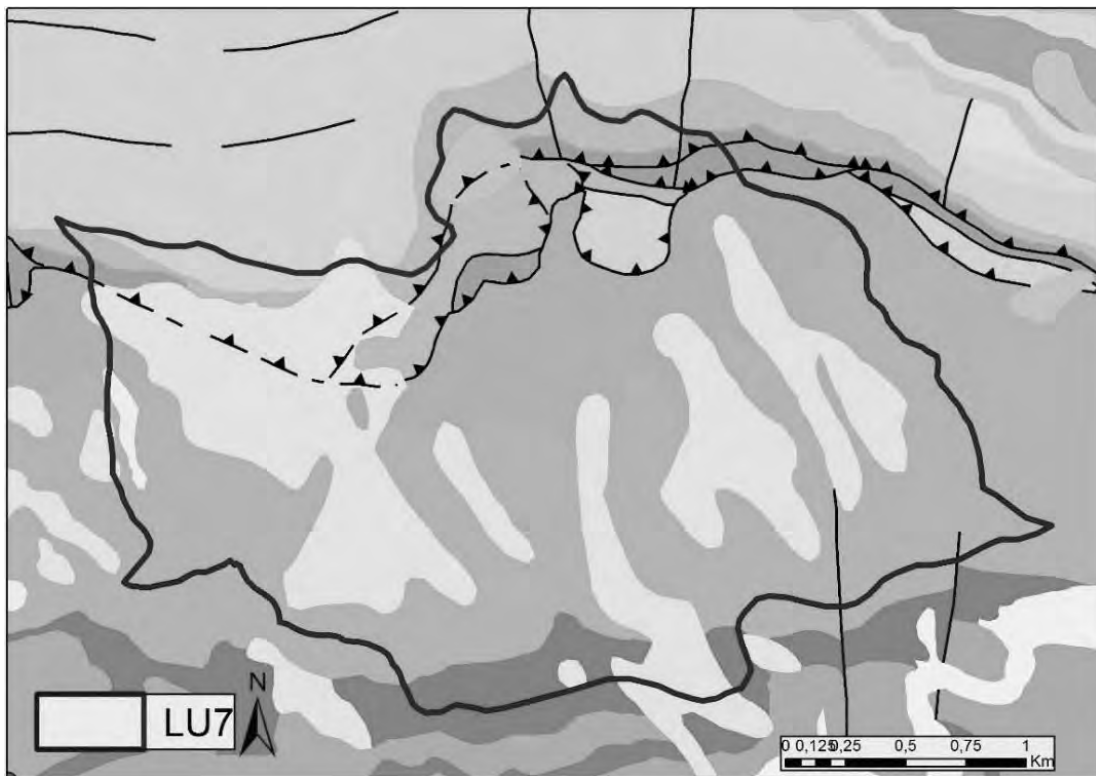


Figure 58 The landscape unit 7 compared to the geomorphological map. The irregularity of the profile is caused by the presence of the limestone marked in pale blue.

## Analysis of the parcels morphological units of LU7

Again, in the LU7 the parcel structure is very irregular and it was impossible to detect a dominating pattern and consequently some morphological units outstanding that pattern. Due to the geomorphology of the area, the parcels are arranged following the terrain slope and the shape; only three parcel typologies can be detected. The first is constituted by the shapes of the agrarian terraces that cover the entire slope in the area. The second is made by squared-shape parcels that have been created along the alluvial fans and that follow the direction east-west. A third typology is constituted by parcels of round shape located through the wooden areas. That last typology can be interpreted as the result of the clearance of the most accessible areas in order to regain more space for agriculture. Presently, these areas are mostly abandoned and the recent aerial photographs show the proliferation of woods and wild vegetation.

The archaeological survey of the area reported no significant concentration of material in order to detect an archaeological site. Fragments of pottery have been found throughout the parcels and the terraces and their chronology spreads from the 11<sup>th</sup> century to present day.

## Landscape Unit 8

The landscape unit 8 is the mountainous zone formed by the southern side of the Montsec and that surround the valley. This area starts from an altitude of approximately 900 meters until the up of the Montsec, at about 1600 meters.

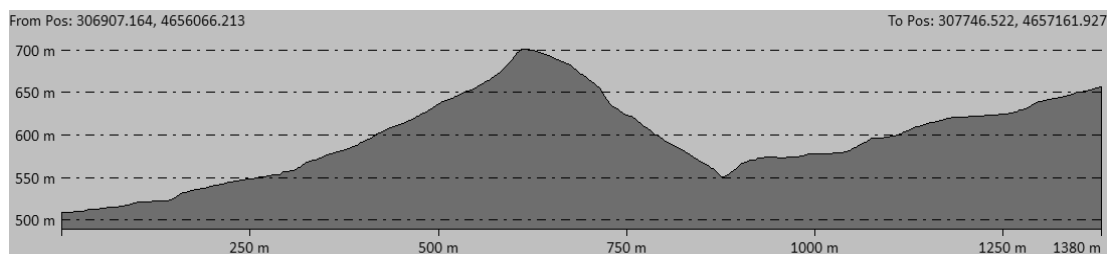


Figure 59. Profile of the LU 8 from north to south.

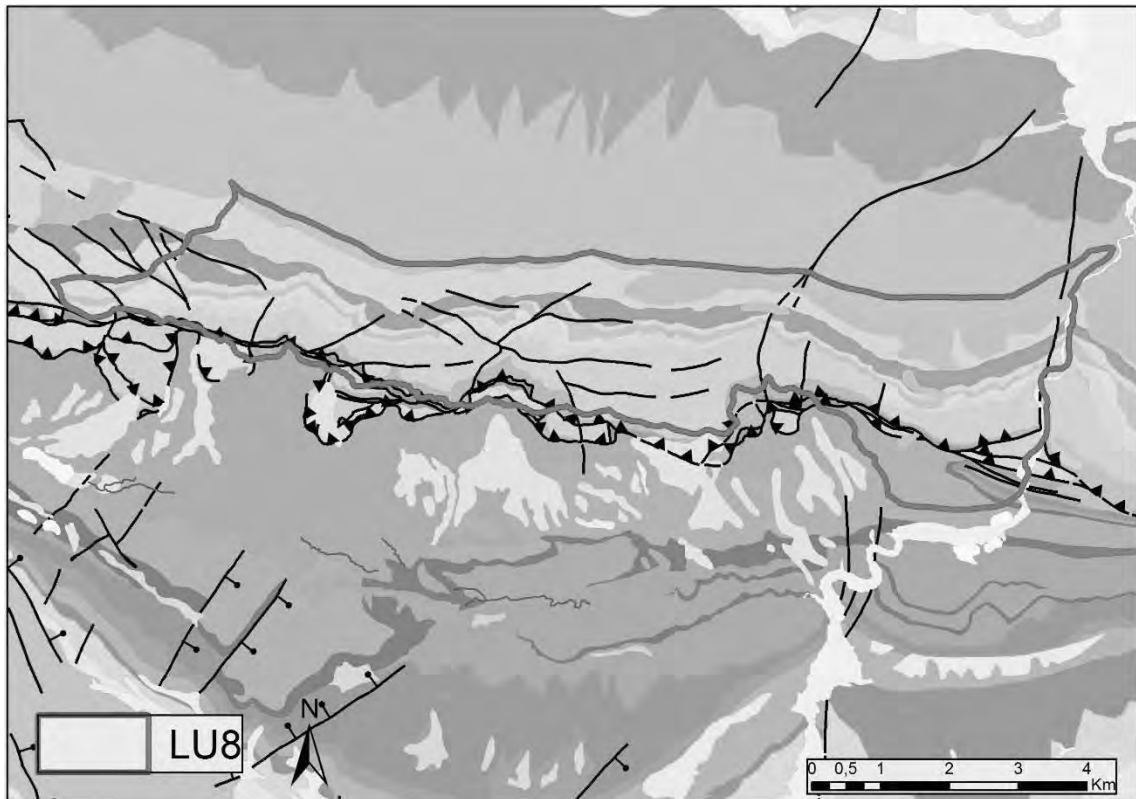


Figure 60. The geological map shows very well the separation between the LU8 and the others landscape unit of the Valley. This mountain belt represents also the boundary with the cultivated area.

The geological composition is made of dolomite at a middle eight, limestone and marlstone with parts of bioclastic rocks as in the case of the LU6. This area is characterised by a very steep slope, more than 50% of declivity, and without any sign of agricultural practice. Presently the area is almost completely covered by medium-eight vegetation with some empty arid areas. The lidar shows a completely smooth surface under the vegetation canopy with the exception of the road paths.

Along the line of the 900/1000 meters there are some archaeological sites. Several of them are related to a fortification like the castles of *Pedra*, *Colabor*, *Mallabecs* and *Escumó*. Annexed to the castles we found also the correspondent churches and a tower (*Mallabecs*). All these sites can be dated between the 11<sup>th</sup> and the 13<sup>th</sup> centuries as we shall see in the next chapter. The parcel system of this area is inexistent because they were areas occupied only by woods. There are some

exception at the east side, where the altitude falls to 900 meters and where we encountered some agrarian terraces.

### Landscape Unit 9

The landscape unit 9 is a small area situated on the west border of the valley, it corresponds to the area around the castle of *La Pertusa*, point of passage across the *Noguera Ribagorzana* River. From a geomorphological point of view, it continues the morphology of the LU5 but it is separated by the mountain named *Serra del Castell de Corçá*, forming a micro-valley in itself. This area was selected separately for its close relation with the archaeological site of *La Pertusa*, indeed this represented the access gate from west to the Ager Valley and a point of passage to the northern side of the Montsec too.

The geological map shows no difference with the LU6 composition, it is formed mostly by limestone and claystone. Due to the vegetation canopy no traces of cropmarks or soilmarks have been found in the area. The most useful support was again the lidar derived DTM that allowed the mapping of many agrarian terraces system around the archaeological site. Also the radar image provided a detailed

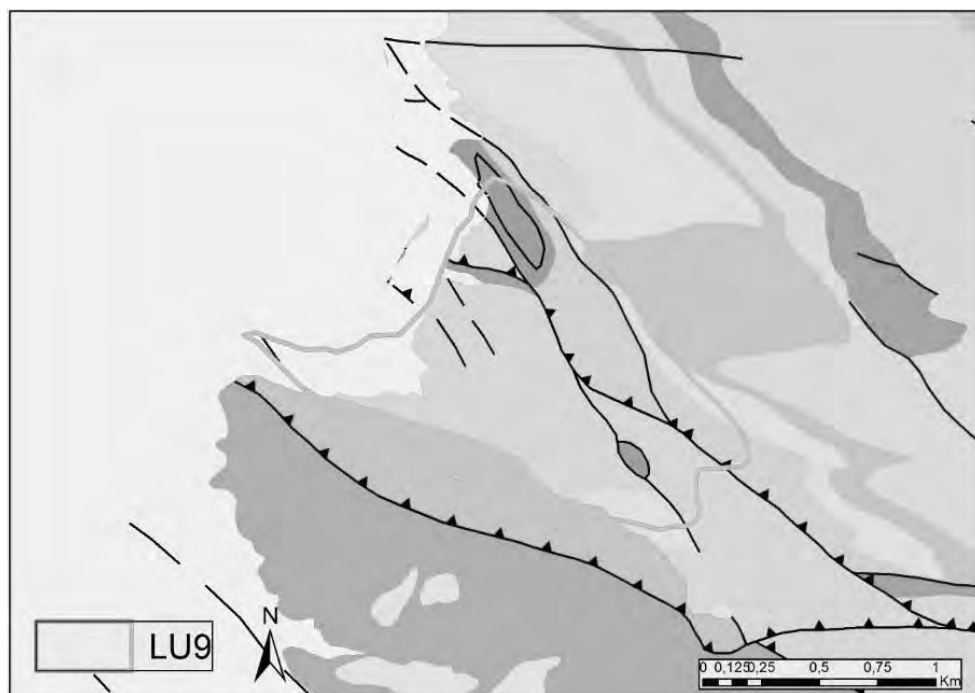
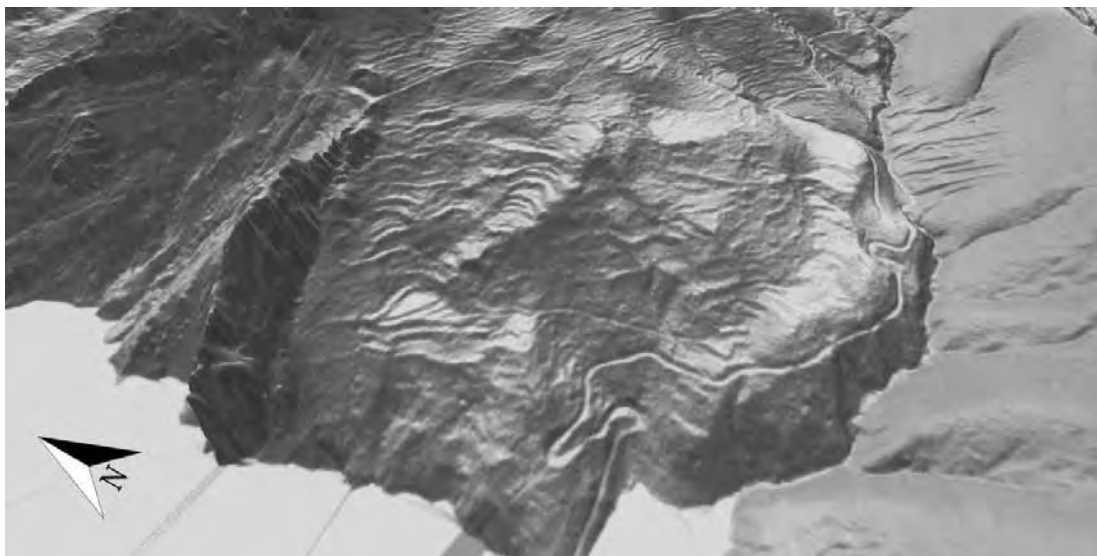


Figure 61. From the geological point of view, the landscape unit 9 has no evident differences with the surrounding. We chose it because of its peculiar role of guard of the ford.

reconstruction of the river profile, with a more precise geometry that in the ancient aerial photograph.

### Analysis of the parcels morphological units of LU9

The considered landscape unit is mostly mountainous and covered by a dense vegetation canopy. At the same time around the castle of *La Pertusa* there is an extended system of agrarian terraces oriented to west, the side of the river, that continue in the landscape unit but oriented to south. The archaeological prospection along the terraces near the castle showed remaining of pottery dating from the 11<sup>th</sup> century. Indeed, the interpretation given to this agrarian terraces system can be associated to the medieval archaeological site.



*Figure 62. 3D visualisation of terraces in the Landscape Unit 9 from lidar derived DTM.*

### Landscape Unit 10

The landscape unit 10 is the unit that surrounds the Ager Valley in its southern side and it corresponds to the Montclus Mountains. Its shape is narrow at the west side of the valley while it becomes wider at the centre in correspondence with the Port

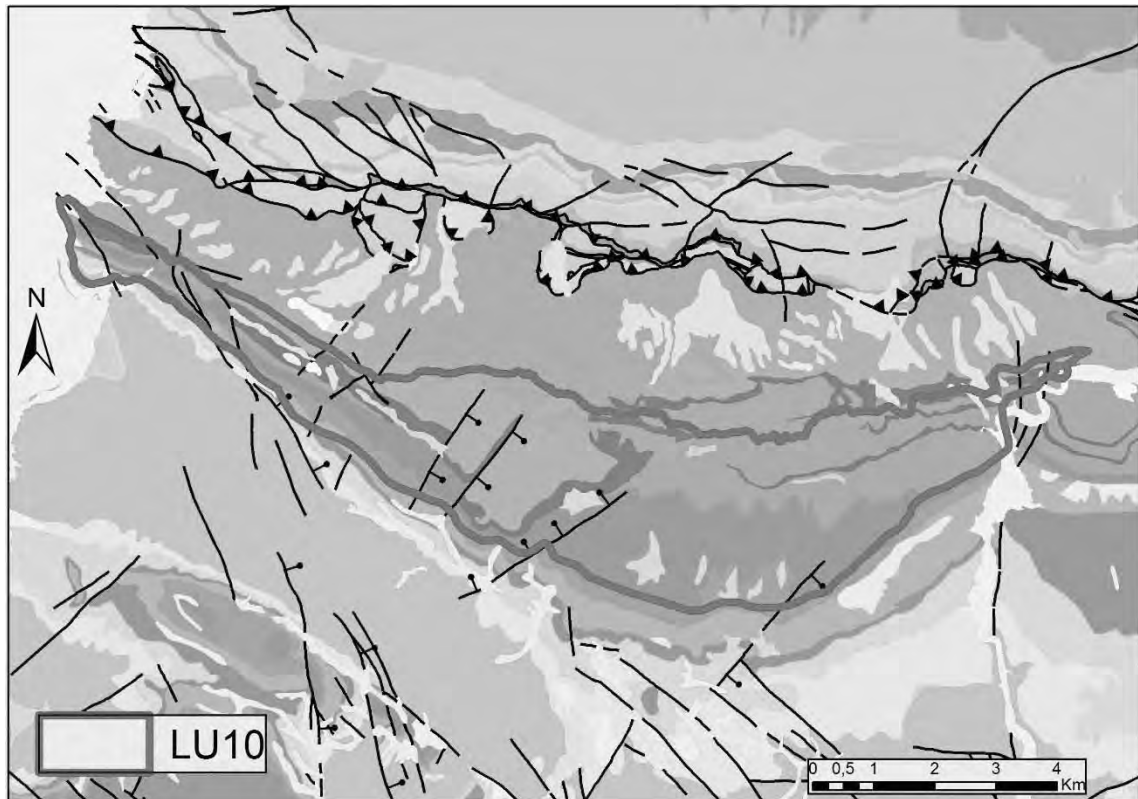


Figure 63. The landscape unit 10 is a uniform belt (represented in purple) that surrounds the valley from south. We also included in the unit the alluvial fans generated towards north.

d'Ager where is located the main access road for the valley from south. It is constituted by gently sloped alluvial fans that proceed from south to north and reaching the bed of the *Riu Fred* River. The geological map shows a homogeneous composition from west to east made of limestone, graves and claystone. At approximately the centre of the landscape unit, next to the LU1, there is also a notable presence of loam. This geological characteristic and the fact that the slope becomes less steep, make this central area be the only cultivated part of the landscape unit with many abandoned agrarian terraces visible from the DTM. The rest of the unit is almost completely covered by woods and, under the vegetation canopy, the lidar-derived terrain model shows no signs of anthropic arrangements. This is due also to the fact that this side of the mountain faces to north being less suitable for agriculture.

## Analysis of the parcels morphological units of LU10

Beyond the alluvial fans, visible in the digital terrain model, the surface of this landscape unit is completely homogeneous with no signs of parcel division. The only exception, as stated above, is the group of agrarian terraces visible in the central part of the unit next to an area called *Planella* (little plain) and next to the medieval church of Santa Eugènia. Other agrarian terraces are located around the abandoned village of Montlleó and around the village of Millà but both face the southern part of the mountain that it is outside the considered area of study. Along the LU10 there are many archaeological sites dated from the 11<sup>th</sup> century and confirmed by the prospection. Many of them, like *Cas*, *Montesquiú*, *Cogul*, *Millà* and *Conclues* are located in the higher part of the LU10 and, according to their parcel system, they seem to be referred toward the south and not to the Ager Valley. These assertions will be better described in the next chapter with the spatial analysis of the archaeological sites.

## Landscape Unit 11

The landscape unit 11 is a very small landscape unit located between the LU3 and the LU7. It has been chosen on a second time and separated from the LU3 for the presence of two archaeological sites: the tower and abandoned village of *Conill* and the castle of *Sant Miquel de Montaspre* with its church. From the geological point of view no description are needed because the composition in the same of the LU3. Today the area is almost completely covered by vegetation and the lidar revealed a system of small agrarian terraces oriented in the direction west-east.

## Analysis of the parcels morphological units of LU11

The parcel shape of this area are different from the morphology of the LU3. The alluvial fan that constitutes the LU3 is cut by a ravine and the parcels are disposed as agrarian terraces around the slope. In the southern part of the unit, only few parcels are visible and with an irregular morphology often elliptical. This situation can be interpreted as the consequence of a wood clearance and the search for the maximum

exploitation of the area. The interest for this unit is due to the presence of two castle in a very close position. After the survey, the pottery findings related both sites from the 11<sup>th</sup> century onwards.



## 5.7 THE PREVAILING LANDSCAPE PATTERN

The second step of the morphological analysis is the study of the general pattern that structures the landscape. Here, we are going to reduce the scale of analysis considering the plain area of the valley in its entirety (LU1, LU2, LU3, LU4) and using all the visible shapes, not only agrarian but also roads and paths, to detect the structuring pattern of the landscape and its arrangement on a network of shapes.

To accomplish this target we are going to isolate the objects that present a coherent morphology and an isocline orientation. It is important to notice that several networks could exist at the same time crossing or overlapping themselves.

We can confirm already that in the studied area, there are no planned parcels systems like a roman centuriation or a medieval longfields system but we are dealing with a landscape auto-organised around a main structure. We tried to identify this structure considering the local dominant pattern and then associating it to the context of the entire analysed area. After the relief of these elements they have been compared with the hydrography and the road network in order to identify the morphogenetic elements and the discontinuities. This methodology has been already applied successfully in the thesis of Magali Watteaux, directed by Gerard Chouquer, entirely dedicated to the Archaeogeography from which we took the methodological procedures<sup>308</sup>.

## 5.8 THE AUTOMATIC CALCULUS OF ORIENTATIONS THROUGH GIS

The first passage for the analysis of the orientation of the parcels is the relief of the “strong limits” from the B-Series 1956 aerial photograph. The strong limits are the elements that structure the landscape and have a coherent movement along a specific direction. This means that there is not a standard rule for selecting all these features but the archaeologist decides following his or her interpretation. The only recommendation for a correct procedure has been to select only the linear features that include two or more parcels in order to avoid excessive fragmentation.

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<sup>308</sup> Magali Watteaux. "La Dynamique De La Planimétrie Parcellaire Et Des Réseaux...", p. 406-407.

After the digital draw of these features on a shapefile, we decided to apply a built in script within the ArcGIS software tools, the “Add Geometry Attributes” tool. This algorithm creates one or more new fields in the attribute table, depending on the selected parameters, in which it adds the result of the analysis. In our case, we used the function *Line\_Bearing* that adds an attribute that stores the bearing of the line calculated from the starting point to the end point. The result is a series of values ranging from 0 to 360 that represents the angle variation from the north having a value of 0.

The results of this analysis were processed to create a frequency function histogram reported in the image below. The values are grouped in 16 classes corresponding to 20 degrees each. The figure 42 shows that the frequencies are concentrated in two main areas, the first going from 60 to 89 and from 90 to 119 and the second going from 160 to 179 and from 180 to 199. The second part of the graph can be ignored because the values that exceed 180 degree can be associated to their corresponding values of the other side of the goniometric circumference. For example, the values from 340 to 360 are the corresponding of the values from 0 to 20, and so on.

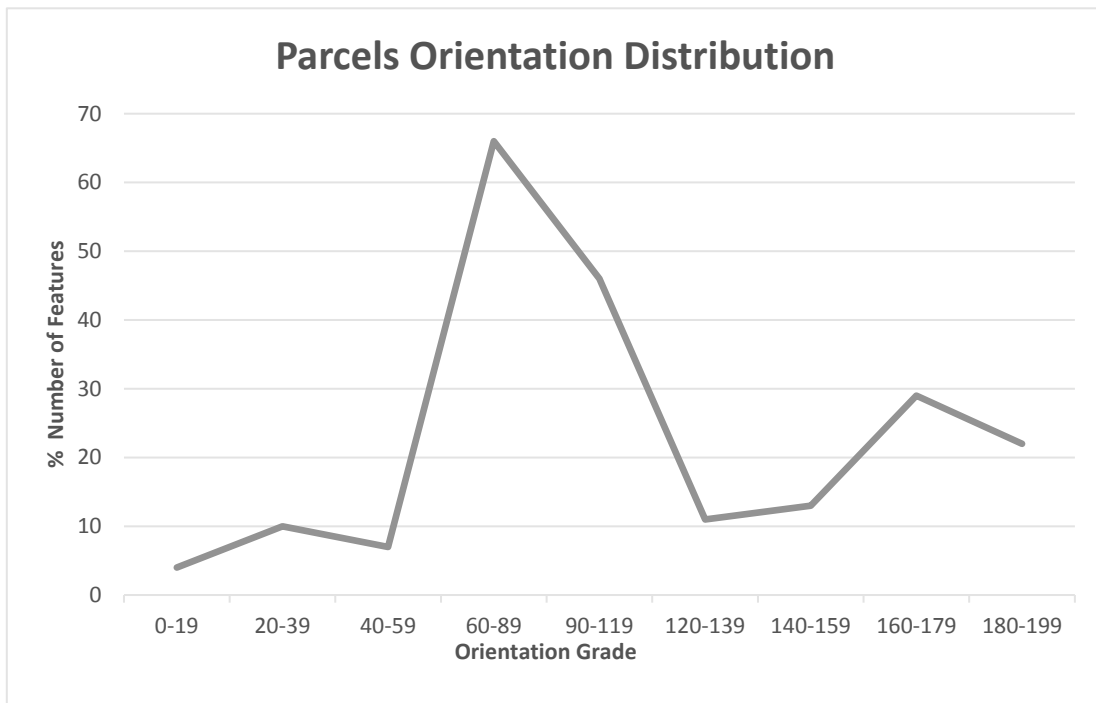


Figure 64. This graph shows the distribution in percentage of the orientation of the parcels relieved from the B-series aerial photograph of 1956. The peak of the values 60-89 represents the parcels oriented from east to west. The peak of 160-179 represents the north-south orientation.

Reading these results, we can conclude that in the plain of Ager, at a small scale, there are two groups of prevailing orientations. The first group of measurements ranges from 60 to 90 degrees and from 90 to 120 degrees that correspond to an orientation from west to east with few degree deviations that tends to northwest and to southeast. The second group of measurements values range from 160 to 180 degrees and from 180 to 200 degrees. These values correspond to an orientation perpendicular to the first group, from north to south that tends from northeast to southwest.

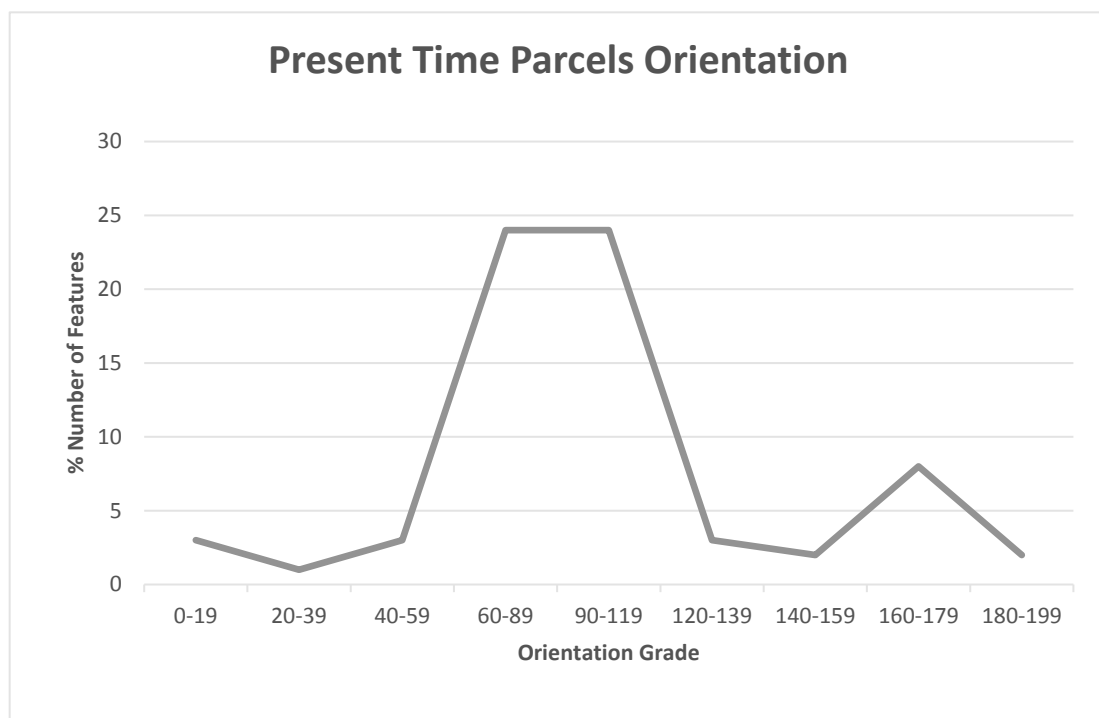


Figure 65. This graph shows the distribution in percentage of the orientation of the parcels relieved from the current year aerial photograph. The peaks are slightly different from the ones observed in the figure 42. We can note a relative diminishing percentage of the vertical limits due to the parcel merging.

If we observe the landscape surface at a bigger scale, these differences are less visible and many typologies of orientation emerges from the general pattern with small variation in degrees. When comparing the parcels of the 1956 aerial photograph with those of 2015 aerial photograph, it is possible to perceive the general evolution of the morphology. We applied the same automatic calculus for the current parcel morphology relieved from the 2015 aerial photograph and compared the result.

It seems that the parcel morphology is less variable and that the quantitative difference between the east-west orientation and the north-south augmented. This means that during time the morphology of the parcel system tends to stabilise in those main orientation and creating a dominant orientation.

From these bases, we can assert that the absence of a morphometric pattern with a standard module and orientation can exclude the presence of a planned parcel system either roman or medieval.

## 5.9 AN AUTO-ORGANISED PARCEL SYSTEM

The typology of morphology system that we identify in the Ager valley is called in the archaeogeographic literature a “formed system” or “formed network”. This typology has been discussed since the nineties by Gerard Chouquer<sup>309</sup> who separated the ideas of founded systems (planned) and formed systems (auto-organised). The first are “thought” systems, the expression of a voluntary arrangement started by a power on a certain moment. The second is the result of an auto-organisation and, as described by Claire Marchand, it is the result of a selection, transmission and transformation of shapes in order to strengthen the shapes following a main orientation<sup>310</sup>. This typology of shapes has a geometric pattern but they miss the regular metrology for being classified as founded systems.

Finally, as Magali Watteaux remembers talking about the plain of *Vendée* in France, it is important to consider that both typology can be merged and that the presence of one does not exclude the presence of the second<sup>311</sup>. Also in the Ager Valley, we think that inside a general pattern made by formed shapes there are some punctual planned system, and we are referring especially to the morphological units 1 and 2 where the planned parcels are inserted in a wider context of auto-organised shapes. They, in this case, are representing an exception from the general pattern. At the

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<sup>309</sup> Gerard Chouquer, ed. *Les Formes Du Paysage. L'analyse Des Systèmes Spatiaux* Vol. 3. Paris: Editions Errance, 1997.

<sup>310</sup> Claire Marchand. "Des Centuriations Plus Belles Que Jamais ? Proposition D'un Modèle Dynamique D'organisation Des Formes." *Etudes Rurales* 167-168 (2003): 93-114.

<sup>311</sup> Magali Watteaux. "La Dynamique De La Planimétrie Parcellaire Et Des Réseaux Routiers... p. 412.

same time, there are cases, like in the centuriation of northern Italy, where the planned system shapes hold at their bosom the presence of shapes that deviate from the general pattern in order to adapt themselves to the particular geomorphology<sup>312</sup>.

As said, the extension of this formed system is perceived especially in the centre of the Ager Valley while the orientations continue, even if less evidently, throughout the entire valley from west to east. We think that the variability of density of the parcels is due to both the geological composition of the terrain and the geomorphology. The LU1, LU2, LU3, LU4 are all composed by quaternary alluvial fans with sands and loam and their imperceptible slope do not constraint the development of the parcel system. At the contrary, the “periphery” of the valley, has a more irregular geomorphology that reduce the density of the parcels but it does not change the orientation.

Finally, we compared the orientation of this parcel system with the orientations in the outside areas of the valley. It appears that in the Meià Valley, around the town of *Villanova de Meià* the direction of the parcels system is completely different, even standing the same geomorphological background due to the prosecution of the Montsec at east. At west, beyond the river Noguera Ribagorzana, the Montsec has a minor length and there are not alluvial fan formation but steep mountains so that the territory has no parcels shapes.

## 5.10 COMPARING THE PARCEL SYSTEM WITH THE ROAD AND HYDROGRAPHIC SYSTEMS

We applied the automatic calculus of orientation to the shapes of the hydrography in order to verify the influence of the water on the morphology. The results, described in the graph of the figure, show that the main orientation of the hydraulic system follows the north-south and the northwest-southeast directions corresponding to 90-120 degrees. A significant percentage of features are oriented also with a bearing of

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<sup>312</sup> Robin Brigand. "Centuriations Romaines Dans La Plaine Alluviale Du Brenta (Vénétie)." *Etudes Rurales* 2 (2011): 19-37.

46-60 degrees from southwest to northwest direction. Another interesting data is the low representation of the east to west orientation with 160-180 degrees.

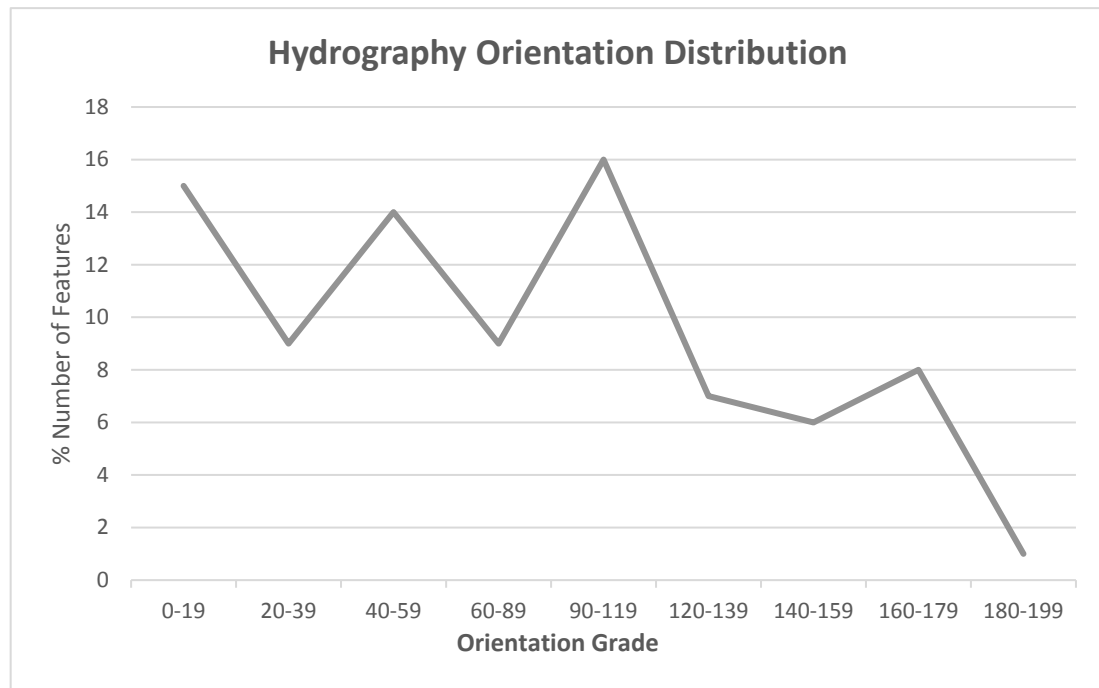


Figure 66. This graph shows the distribution of the orientation of the hydrography network. As it clearly appears, the distribution is more uniform than in the case of the parcels boundaries, the peak in the position 0-19 and 160-179 have the same vertical orientation and can be summarised in a single data. We can conclude then that the percentage shows an big number of vertical orientation while the horizontal lines are less. This is not surprising because the major part of the hydrography is constituted by rivers and channels that flow from the mountain of the Montsec at north to the centre of the Valley at south. Only the Riu Fred and few others channels represents the horizontal hydrography.

These results explain the morphology of the valley, the water flows mainly from northwest to southeast and it is recollected at the bottom of the valley in the *Riu Fred* river. These movements excavated the ravines over the alluvial fans splitting the areas in several sectors. Surprisingly, the direction of the water flow from north to south did not prevent the formation of the perpendicular agrarian shapes that act as obstacle for the water, reducing its drainage. In the cropmarks analysis from the remote sensing sources, we saw that the water movements are well visible inside the parcels because they are not regulated by channels or other typologies of works. Furthermore, this is confirmed by the low percentage of features oriented in west-east direction.

The graph of the automatic calculus of orientation of the roads shows a point of relative maximum in correspondence of the 90-120 degree orientation, which corresponds to west-east direction with a tendency to southeast. This result tells us that the road network follows the east-west direction that is the same direction of the valley extension. Indeed, when we see the complete analysis of the road pattern at the end of this chapter, it will be clear that the main axis of viability develop from a side to another of the valley. From a quantitative point of view, the roads existing in the area of the analysed plain, corresponding to the LU1, LU2, LU3 and LU4, are less in percentage because the territory corresponds to 1/3 of the entire valley. This could led to an under-interpretation of data. Nevertheless, if we consider the interval from 160 to 240 degrees we see that, in this range, the value of the function increases at 180-199 and it has a point of relative maximum around 200-219. Comparing these data with the data of the graph representing the parcels orientation, both in 1956 and in 2015, we see that in the same area the graph has a significant decrease. This means that the dominant orientation of the parcels limits is the west-east and that the low quantities of perpendicular limits represented for the parcels are complemented by the road network that act as vertical boundaries for a consistent part of the parcels.

Definitely, we observe a strong correlation between the parcel system and the road network in terms of orientation. In the archaeogeographic literature, this phenomenon constitutes an important element of the “radio-squared” parcel system.

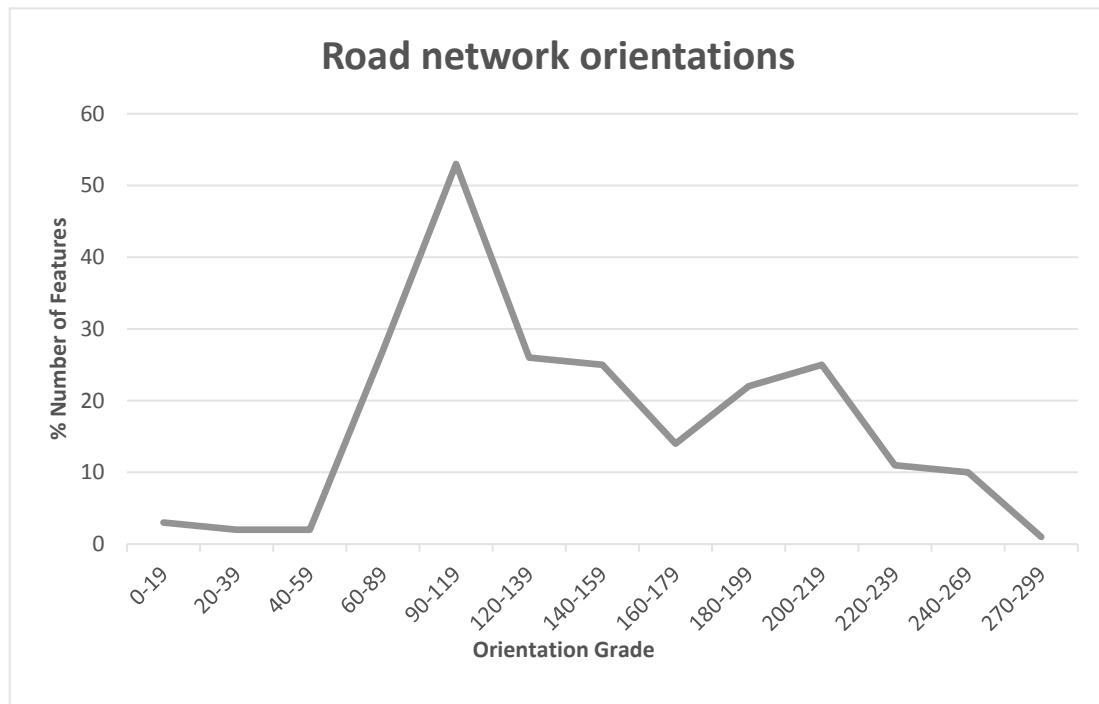


Figure 67. This graph shows the distribution in percentage of the roads orientation. The main peak corresponds to the interval of 90-119 degrees, which is the west-east orientation. At the same time, the northern orientation represented by the intervals 0-19 and 160-179 is very low in comparison to the other values. This demonstrate that the major part of road networks develops along the west-east direction, which corresponds to the valley main shape.



### 5.11 THE RADIO-SQUARED PARCEL SYSTEM OF THE AGER VALLEY

The structure that we described above can be separated in two morphological sectors. The first comprehend the morphology derived from the parcels and the second the morphology derived from the roads. The polarisation boosted by the settlements influences the road pattern that, in proximity of the settlements, assumes a star-shaped morphology. Inside the spaces of these axis, the second level acts with the parcel morphology but the morphology is not properly concentric but it remains squared. The parcel shape is the result of an adaptation to the morphology and the natural environment, in this case two main alluvial fans and the ravines going approximatively from north to south. At the same time the roads do not follow the natural morphology but are heavily attracted by the poles. These self-organised systems are the result of a long lasting process of adaptation in which the morphology is forced by all the component of the landscape.

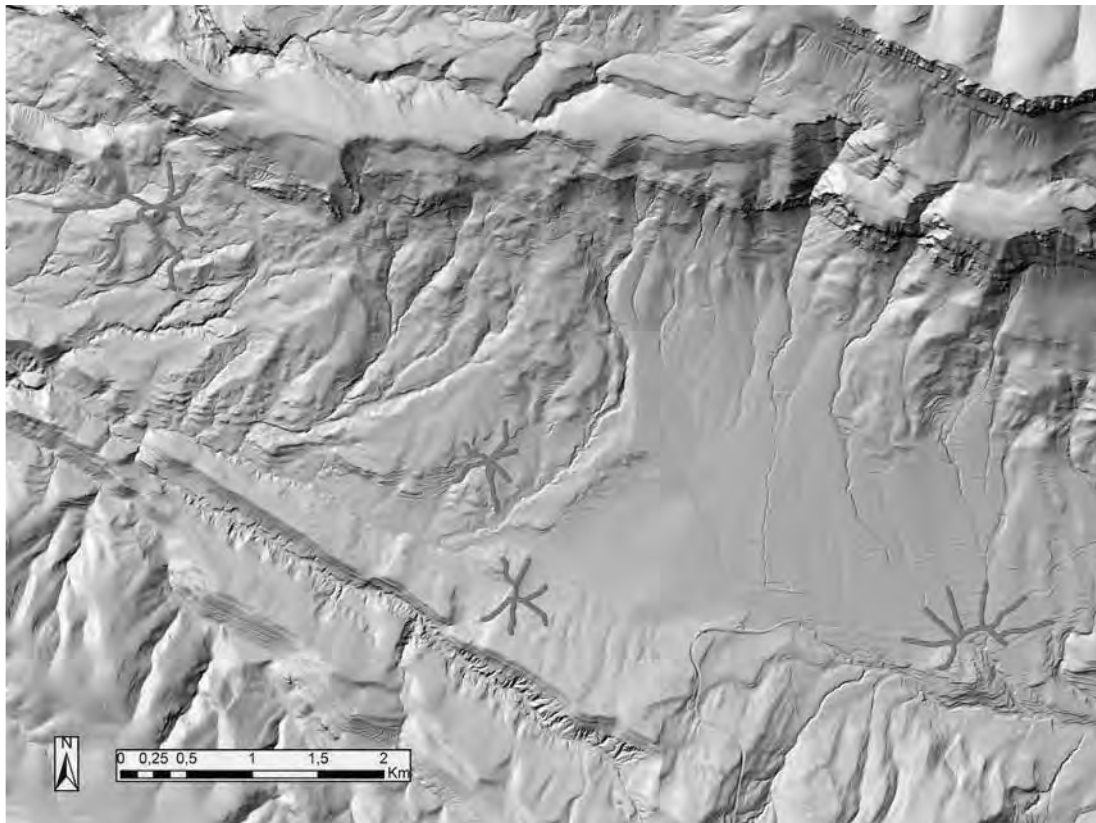
In the Archaeogeography literature, they are called radio-squared parcel systems<sup>313</sup> and this is an answer to the classical modelling of ancient morphology that attributes in a determinist way a radio-concentric scheme to a medieval foundation and a squared scheme to a roman planning. Meanwhile the planned parcel systems are often interpreted as the representation of an explicit power or an organised project over a territory, the non-planned systems, because the difficult for their categorisation, were often superficially interpreted by researches.

The terminology radio-squared means that we are in front of a system where it appears a squared pattern with no morphometric precision that is frequently "cut" by radial axis that usually represents path that are attracted by a general point of interest, typically a settlement. In addition, only in the proximity of the attractive point, the parcels assume a barely concentric pattern and they tend to dispose around the settlement.

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<sup>313</sup> Magali Watteaux. "Le Plan Radio-Quadrillé Des Terroirs Non Planifiés." *Études Rurales* 167-168 (2003): 187-214.

This situation has been observed in many areas of the Ager Valley, next to castles and settlements but also next to areas that are morphologically oriented to generate this situation like the areas around hills and mottes. This system is the main arrangement that we observed in the plain area from Agulló to Ager and La Règola.



*Figure 68. Representation of the star shaped viability in the west side of the Ager Valley.*

## 5.12 SOME QUESTIONS ABOUT DATING THE PARCEL SYSTEMS

We started this chapter asserting that the diachronic analysis of the landscape with the methodology developed by archaeogeographers is centred on the understanding of the transformation and the transmission of the shapes during time and that this phenomenon is always a long lasting process that could be hardly associated to a precise moment in time and space. The sources that we are used to manage in History and Archaeology have a complete different nature because they are the reflex of a precise moment in time that could be a day, a year or a century but it does not

cover a very large period. It remains also inscribed into a very small extension in space. For this reason in the past many ancient topographer tried to associate a shape to a particular period influencing the reading of the landscape morphologies until the present day. For example, very often the squared and regular morphologies of a plain were associated to a roman centuriation, the concentric shapes to a medieval foundation and the large and irregular shapes to the iron or bronze age. Another difficult concept for historians and archaeologists is to separate the material nature of an object to its representation. This is what happens precisely with the archaeogeographic approach; indeed, the object of study is not the materiality of the shape but it is what the shape represents beyond its materiality. For this, a shape cannot be dated only from a morphological basis, as it happens for example for the pottery or other material elements of dating in archaeology. In Archaeogeography the same shape may continue to exist with different materiality, a form can be, for example, a hedge, then a channel or a road, then can remain inactive for a period and be reactivated on a second time with another materiality. Definitely, we have no elements to conclude that a particular shape could be associated with a precise historical period, neither the centuriation or the concentric shapes around a settlement. Gerard Chouquer developed these consideration startint from the basis that the landscape we see everywhere is only the present landscape<sup>314</sup>. This means that its materiality is always contemporary and only the form could be, through resilience, inherited from the past but this does not mean that the form could be precisely dated. The only possibility is to interpret a moment of impulse given to the general structure of the landscape by a power or an administration. For example, the foundation of a new settlement could set the main axis of roads around which it develops the parcels arrangement. Only in very rare exception, we assist to a complete organisation of a parcel system with a precise morphometry. Nevertheless, these are sporadic events with a small extent and they could be dated only with explicit written sources. Even for the roman centuriation it has been suggested that the main axis were drawn by the *agrimensores* meanwhile the internal organisation

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<sup>314</sup> Gérard Chouquer. *L'étude Des Paysages: Essais Sur Leurs Formes Et Leur Histoire*. Paris: Edition Errance, 2000.

of the main parcels, called *centuriae*, lasted many years to be fully generated in their materiality<sup>315</sup>.

Even if the parcel systems cannot be dated basing the assumption only on its morphology, the analysis of the forms helps, as we have seen throughout this chapter, to give a comprehension of the relations between the networks of parcels, the roads, the settlements and the geomorphology and hydrography of the landscape and from this base it is possible to hypothesize a historical period of development.

To give a periodisation to the parcel systems it is necessary to cross data from other sources, especially from paleo-environmental and archaeological studies. Gerard Chouquer warned about the possibility of giving to the source an over-interpretation<sup>316</sup>. For example dating a parcel system from an archaeological site suppose comparing the scale of the archaeological site to the scale of the parcel system, which is not always possible. For Chouquer it is necessary to give to the archaeological fact its intrinsic historical importance without trying to insert at every cost the archaeological data into the landscape network<sup>317</sup>. For example, it is difficult dating the parcels of an entire plain from the information derived from a single trench or pit if this is not substantial for the context, while it is more natural when comparing the axis of a settlement with the rest of the landscape at the same scale.

A further question is the need of validation for the sources by the archaeology and vice versa. This problem is often afforded in the archaeological theory and in spite of the independent status that characterize Archaeology, History and other disciplines, a very common attitude consists of the needing of confirmation by one to another. It is important, inside this discourse, to remember, as Magali Watteux says well, that it is not necessary for the archaeological interpretation to be validated or contradicted by the historical sources as well as the archeogeographical interpretations do not need to be validated or negated by Archaeology<sup>318</sup>. It does not exist a hierarchical

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<sup>315</sup> Robin Brigand. "Centuriations Romaines Dans La Plaine Alluviale Du Brenta (Vénétie)." *Etudes Rurales* 2 (2011): 19-37.

<sup>316</sup> Gerard Chouquer, ed. *Les Formes Du Paysage. L'analyse Des Systèmes Spatiaux* Vol. 3. Paris: Editions Errance, 1997, p.23.

<sup>317</sup> Gerard Chouquer, ed. *Les Formes Du Paysage. L'analyse Des Systèmes Spatiaux* Vol. 3. Paris: Editions Errance, 1997, p.23-24.

<sup>318</sup> Magali Watteux. "La Dynamique De La Planimétrie Parcellaire Et Des Réseaux...", p. 199.

relationship between these disciplines but, when it is the case, only complementarity. These theoretical positions should be considered when approaching an analysis on Archaeogeography.

In the next chapter, we will analyse the organisation of the landscape in the Middle Ages. We will try to associate the parcel systems to a certain periodisation but always considering what has been stated here. In particular, we are aware that the scale of an archaeological site is very large respect to the scale of a landscape, especially when considering a single building. Nevertheless, if we consider a more extended archaeological site, like a settlement, then it is possible to reason at the same scale of the landscape and of the parcel systems.

### 5.13 THE ANALYSIS OF THE ROAD NETWORK: A MULTIDISCIPLINARY PERSPECTIVE

In this section, we are going to discuss the structure of the road network approaching it from the archaeogeographic methodology. We are following the methodology described by Magali Watteaux in her PhD thesis where she retrieve a methodology developed by several French scholars including Gerard Chouquer and Sandrine Robert<sup>319</sup>. We decided to use this methodology because Magali Watteaux proved that it is a consolidated praxis in the archaeogeographic studies and we would like to apply it to the Ager Valley in order to experiment by ourselves its validity.

On a second part, we decided to approach the road networks from the perspective of Predictive Archaeology. While the archaeogeographic approach is based on the reading of the forms in the cartography and in the aerial photographs, the Predictive Archaeology approach is based on the models of surface costs, mobility basins and least cost path computation whose utilities will be described below. Finally, we will make some assumption based on the postdictive analysis that corresponds to an alternative view of the Predictive Archaeology based on the works of Carlo Citter<sup>320</sup>

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<sup>319</sup> Magali Watteaux. "La Dynamique De La Planimétrie Parcellaire Et Des Réseaux...", pp. 231-234.

<sup>320</sup> Carlo Citter, and Antonia Arnoldus-Huyzendveld. *Uso Del Suolo E Sfruttamento Delle Risorse Nella Pianura Grossetana Nel Medioevo. Verso Una Storia Del Parcellario E Del Paesaggio Agrario*. Roma: Artemide Edizioni, 2013.

and Giovanna Pizziolo<sup>321</sup>. At the end of this part we will see that these approaches can be complemented and all used to make some consideration about the ancient landscape routes in the next chapter.

#### 5.13.1 THE ARCHAEOGEOGRAPHIC APPROACH. THEORETICAL BASES FROM THE WORKS OF SANDRINE ROBERT AND MAGALI WATTEAUX

The archaeogeographic reasoning about the road networks stands on the premise that the roads are lines used to connect points. The points are places of interest, mainly settlements. Both depend on one another, when points appear or disappear this inevitably influences the network. When points change their role, losing or acquiring importance, this also influence the network. Similarly, when new roads are built, for example to serve a different scale settlement (like two big cities), the new road may influence the displacement of intermediate villages and cause the abandonment of other tracks.

The roads are inseparable from the agrarian structure and they have a relationship that could be seen as stratigraphic in terms of anteriority, contemporaneity or posteriority. At the beginning of the studies of the road networks, these relationships were set basing the interpretation on the morphology. The geographer Marcel Gautier describe these phenomena<sup>322</sup>. For example, to interpret a road that precede an agrarian system, it is necessary that the parcels respect the bearing of the road with a coherent pattern organisation. The roads contemporary to a parcel division are built simultaneously, often in a territory that has been cleared by woods. The posteriority of a road to a parcel system is proved when the road morphology cuts the parcel system, which is when the respective morphologies are not coherent, for example in an oblique pattern.

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<sup>321</sup> Giovanna Pizziolo, and Lucia Sartri, eds. *Redicting Prehistory. Predictive Models and Field Research Methods for Detecting Prehistoric Contexts*. Firenze: Bandecchi & Vivaldi, 2015.

<sup>322</sup> Marcel Gautier. "Pérennité Ou Caducité Des Chemins Ruraux." In *Colloque De Géographie Agraire*, edited by André Meynier, 69-79. Rennes: Imprimeres Réunies, 1963, p.71.

Nevertheless, this schematisation is not free of weakness, indeed it is evident that the anteriority or posterity is not so easy to detect, also because a road that respects the morphology of a parcel system could be also posterior to the system itself.

A further concept useful in the analysis of road networks is the notion of flux vs materiality. According to Sandrine Robert, the contrast of flux and materiality is a key to understand the dynamics of the road networks<sup>323</sup>. The flux is the quantity of movement that proceeds from a point to another. For example, between two small villages the flux may be small but if a road that connects two small villages is part of a bigger itinerary that connects two large towns, then the flux is bigger. The flux is reflected to the materiality of roads, for small flux, for example few animals or walking people, the materiality of the road should be modest. When the quantity of flux changes during time it causes changes to the materiality of the roads, this, according to Sandrine Robert, is the main reason for the resilience of the road networks. When the flux is excessive, the road transforms itself becoming bigger or changing its path. When the flux decreases, the roads are abandoned and reduced in dimensions.

An important distinction should be made by track and itinerary. The itinerary is the connection that occurs between two points, while the track may comprehend more itineraries and it represents the material use of a road. The track may change during time, due to many reasons (the flux that we already saw but also geomorphological and historical reasons) but the itinerary can remain materialised with other tracks. An itinerary then may be represented by a group of track going parallel in the same direction but with different length or pattern inside an explicit buffer of extension. It is clear that this is an important consequence for the study of the chronology, what is important is not dating a single track but understanding the itinerary and its permanence in time.

As we saw in the chapter describing our Archaeological Information System, we used a typical categorisation of roads made by levels. We have also levels of itineraries from a regional scale passing through a local scale to a microscale. The first level, the

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<sup>323</sup> Sandrine Robert. "La Résilience Des Réseaux Routiers : L'exemple Du Vald'oise." *Bulletin AGER* 15 (2005): 8-14.

regional, is not used in the case of the Ager Valley, because our area of study is too small to consider these kind of roads. Nevertheless, this not exclude the passage of regional itineraries through the valley and we are going to see some example. The local scale is the main scale represented in the Ager Valley these roads connect small villages each other. The microscale is the level of a single archaeological site and again this level is few represented in the Ager Valley.

Resuming, we are exposing the notions that Magali Watteux showed in her PhD thesis on Archaeogeography and that at the same time she took by Sandrine Robert<sup>324</sup>. The road networks are studied by archaeogeographers like morphogenetic elements of the landscape for the parcel systems and they have a main relation with the settlements that allow their resilience. The resilience causes the auto-organising nature of the road paths that transform their shape following the needing of each period, but maintaining the itinerary. The change in pattern is due to several attractors that act as pole for the road network at different scales.

#### 5.13.2 METHODOLOGY OF ARCHAEOGEOGRAPHIC ANALYSIS OF ROAD NETWORKS

We integrated the study of road networks in our Archaeological Information System making the most of the work with the ArcGIS software. We started from the available cartography at the Institute of Catalan Geology and Cartography, and with the aerial photographs of the A and B series of 1946 and 1956. We created a shapefile for each itinerary including all the tracks that we interpreted as pertaining to the same itinerary, also including the strong limits of parcels that we considered may have been part of an ancient track. On a second step we built a map of local road networks selecting all the radial patterns departing from the villages. These typical pattern have been often associated to a medieval origin, especially to the 11<sup>th</sup> century. Scholars following a current theory assert that this pattern may have been reinforced during the 11<sup>th</sup> century but that it is the result of a longer period of transformations<sup>325</sup>.

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<sup>324</sup> Magali Watteux. "La Dynamique De La Planimétrie Parcellaire Et Des Réseaux...", p. 268.

<sup>325</sup> Magali Watteux. "La Dynamique De La Planimétrie Parcellaire Et Des Réseaux...", p. 272.



After the phase of relief, we compared the data with the settlements and with the point of interest standing near the tracks, with the agrarian morphology, the geomorphology and the hydrography network ,with the archaeological sites and historical information.

Finally, we tried to assign to every itinerary a periodisation. The difference between dating a parcel system and dating a road stands on the intrinsic nature of the objects. While the parcel system has an extension in space, the roads are connection between points. Then even if it is not possible to date specifically every track that compose an itinerary, it is possible to use the chronological information of the points to hypothesize a period of development for the itinerary.

### 5.13.3 REGIONAL SCALE ITINERARIES

As stated above, even if the Ager Valley is a territory too small to detect a regional itinerary fully included in it, it is possible to assume that some regional itinerary may have crossed it, like in present day it happens with the C12 regional road. We considered two main itineraries crossing the Ager Valley, a north-south one that we called IT1, and a west-east one named IT2.

#### IT1 From the Lleida plain to the Pyrenees

On a recent paper published in 2016, we hypothesised the path of a road going from the Lleida plain to Ager<sup>326</sup>. Using the local historical tradition, we did not reject the hypothesis of a roman origin of this road because the aim of that work was to test a predictive model to find a least cost path over a cost surface. We propose here the analysis of the path that crosses the Ager Valley and climb the Montsec. We will consider also the data obtained from the archaeological excavations that were made in 2002 in some portion of this track around Fontdepou and the Port d'Àger.

The IT1 marked in the figure 46 has a length of about 13 Kilometres and an approximate orientation from south-east to northwest. We isolate two possible variables or this track in the south part before Ager and in the Ager plain. Is evident that every track could be a variant of the itinerary but we chose what seem to be straighter. In addition the itinerary passes near the churches of Santa Maria del Pla and in the second variant near the necropolis and the church of Santa Coloma.

The historical information about this itinerary are very scarce. In the written sources we read that the eastern border of the territory of the Sant Llorenç castle was "*de parte horientis in strata publica qui pergit de Ager in Paliare*<sup>327</sup>" and that climbed the Montsec. We think that this portion of road could correspond to the track visible

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<sup>326</sup> Antonio Porcheddu. "Predicting and Postdicting a Roman Road in the Pre-Pyrenees Area of Lleida (Spain)." Paper presented at the CAA2015 KEEP THE REVOLUTION GOING, Proceedings of the 43rd Annual Conference on Computer Applications and Quantitative Methods in Archaeology, 2016.

<sup>327</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica De Sant Pere D'àger Fins 1198*. 2 vols. Barcelona: Fundació Noguera, 2011.

from the aerial photograph of 1956, indeed this is the only pass of the Montsec in the area.

From the archaeological point of view, a track of this itinerary has been analysed during a rescue campaign in 2002 near the village of Fontdepou and the Port d'Àger due to the works made in the regional road C-12. From the archaeological report signed by Alma Lopez we know that the archaeologists made several survey pits 2.5 meters deep in order to analyse the constructive technique of the track<sup>328</sup>.



*Figure 69. Intervention on the ancient track of the IT1, near Fontdepou locality. (Source: López 2002)*

In addition, the archaeologists detected at least two different constructive techniques between the two excavated portions. While the plot near Fontdepou seems to have a good quality, the northern portion near Port d'Àger seems to be different in quality and structure<sup>329</sup>. Finally, they do not consider that the structure and the constructive technique could be ascribed to a roman road due to the lack of the most basic component that characterised these constructions<sup>330</sup>. Nevertheless

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<sup>328</sup> Alma María López Guerra. "Memoria De La Invernación En La Calzada De Fontdepou-Àger." edited by Proleg. Desenvolupament de patrimoni cultural. Lleida, 2002, p. 6.

<sup>329</sup> Alma María López Guerra. "Memoria De La Invernación En La Calzada...", p.23.

<sup>330</sup> Alma María López Guerra. "Memoria De La Invernación En La Calzada...", p.23.

Alma Lopez did not proposed an alternative chronology and supported the hypothesis of a roman road even if all the excavated data did not confirm it<sup>331</sup>.

Many authors, as Francesc Fité, considered the hypothesis that this could have been a roman road because of the findings of two roman coins near the road<sup>332</sup>. We think that this cannot be an acceptable evidence to date the origin of this road. In our opinion considering the lack of structural evidence, the lack of a roman phase in the hilltop of Ager and the presence of an Iberian settlement in the same place, this road may have been originated in the Iberian period. Finally, every scholar agrees on the fact that the visible remains are probably the results of multiple restorations and that they could be dated from the 11<sup>th</sup> century to the 19<sup>th</sup> century. As we have seen until now, roads are resilient features and it is not important to date precisely its material composition, unless it is very clear, but it is important to understand the context that could have generated and modified the itinerary.

## IT2 The east-west axis

The east-west itinerary crossed the Ager Valley through its longitude with a length of approximately 18 Kilometres from the Congost de Terradet to La Pertusa. Ager is located at its centre and we think that from this point the itinerary could have had many variants. We marked an important variant for the west side that passed near the church of Sant Pere Màrtir or more at south, nevertheless both tracks reunite in the proximity of Corçá. A third variant passes in front of the castle of Sant Llorenç using a portion of the IT1 and reaching La Pertusa from north.

Unfortunately we do not have any archaeological excavation along this itinerary. On a document of 1048 there is the mention about a road that “ ducit viatores ab Ager ad flumen Nogerola et ad castrum Bellum Montem” and it refers to a road that crossed the river Noguera Ribargorçana<sup>333</sup>. A later document of 1134 describes a road

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<sup>331</sup> Alma María López Guerra. "Memoria De La Invernación En La Calzada...", p.24.

<sup>332</sup> Francesc Fité Llevot. *Reculls D'història De La Vall D'àger...*, p. 52.

<sup>333</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica De Sant Pere...* p.227.

that arrives under the castle of La Pertusa and that passed the river Noguera, it may refers to the same point that we marked in our interpretation<sup>334</sup>.

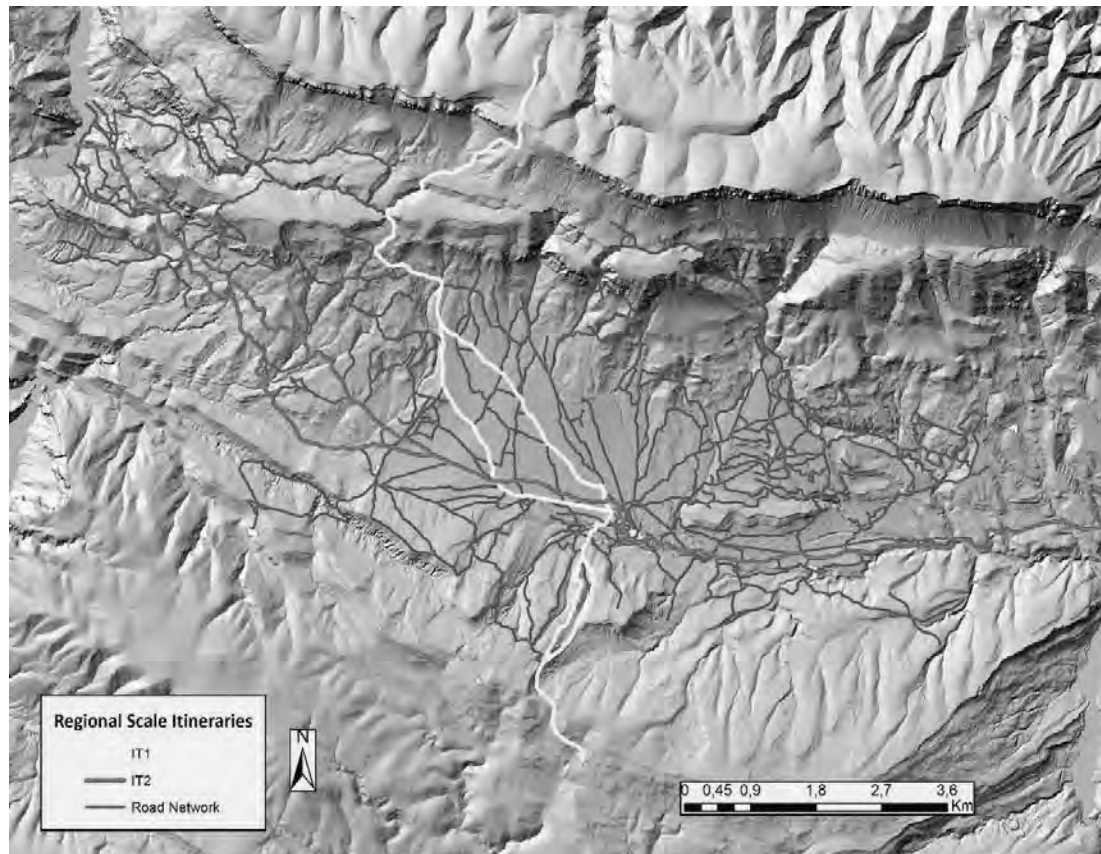


Figure 70. Reconstruction of the two main itineraries that crossed the Ager Valley.

<sup>334</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica De Sant Pere...* p.573.

#### 5.13.4 LOCAL SCALE ITINERARIES

In this paragraph, we will analyse the local scale itineraries detected from the aerial photographs, topographic maps and parcels alignments. As in the case of the regional itineraries, we are dealing exclusively with the shape and not with the materiality of each track. The tracks are grouped and numbered separately for each itinerary and sometimes a single portion of a track may be used by two or more track as a junction.

##### LI1 Ager-La Règola

The Local Itinerary number 1 connects the village of Ager to the village of La Règola. The linear distance is approximately of 2.5 Kilometres. In this itinerary, we isolated four tracks within a buffer of about 800 meters. These tracks are all included in the plain corridor that we described in the Landscape Unit 2 and that forces the tracks to move along the direction east-west. Only the track number 4 seems to bypass the corridor climbing in the hills at south. The track 2, 3 and 4 are coherent with the parcels morphology and they can be considered as the morphogenetic features of the agrarian system of the LU2. At the contrary the track number 1 has some straight parts and it seems to cut the agrarian systems diagonally from north-west to south-east.

The track 1 is well visible from the aerial photographs of 1956 and in the topographic map by the *Instituto Geografico Militar* of 1925; nevertheless, we may suppose that this is the most recent of the group. Indeed it correspond to a portion of the IT2 regional itinerary discussed above.

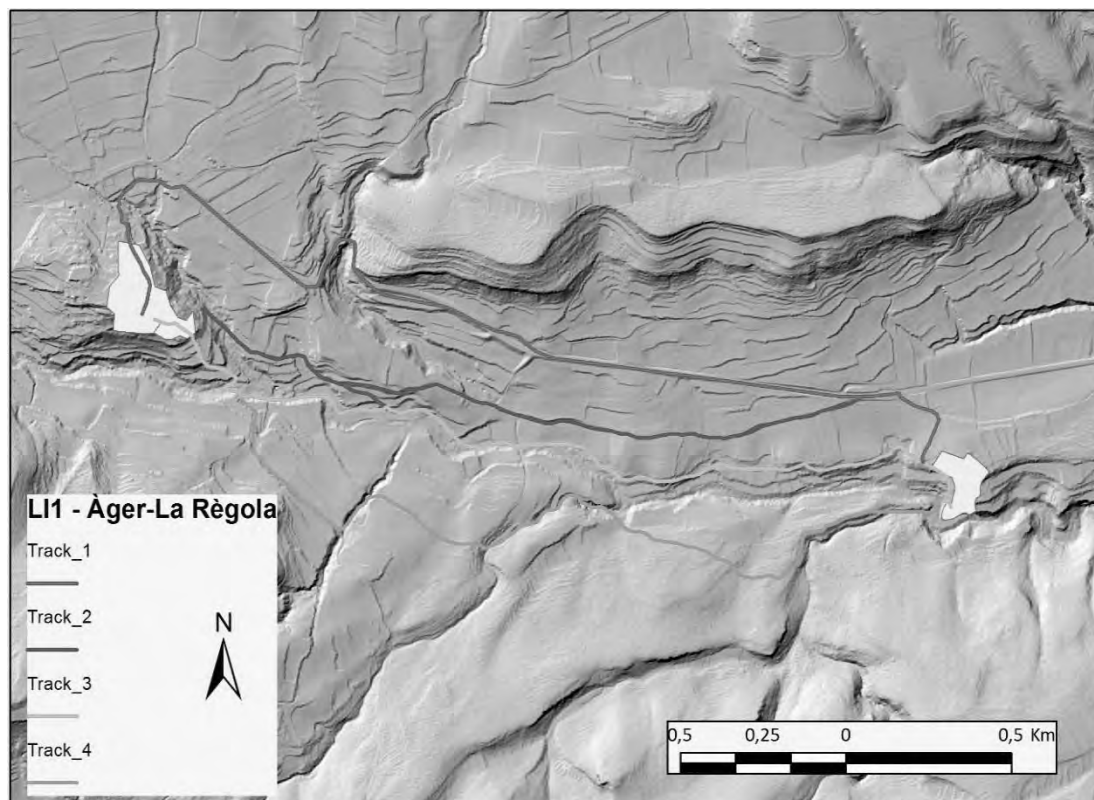


Figure 72. Image of the four tracks selected from Ager to La Règola



Figure 71. The area of the local itinerary 1 from the topographic map made by the Instituto Geografico Militar. The purple ellises highlights the area of the track 1 attesting its existence before in 1925.

The track number 2 seems to be an alternative to the number 1. Indeed, analysing the aerial photograph we see many vertical junction between the two tracks until, in the proximity of La Règola they merge themselves in a unique track.

In our interpretation, the track number 3 is the most ancient and the most important for the connectivity of the two villages, because it is more direct and because it passes next to the morphological unit MU3. Currently this track is abandoned as well as the agrarian parcels of the MU3 and the main route is currently the track 1 corresponding to the C12 regional road.

Finally, the track 4 seems to be the less important for the connection between Ager and La Règola, it crosses the hill area of the LU2 and pass through a terraced area. It may have been a service road for the cultivated areas with no predominant role.

We do not have any historical information about these roads and our chronological interpretation can be made only from the basis of the two connected settlements. In particular, we are interest in the track 3 that we think is the most ancient of the group for the reasons said above. It starts from the southern door of Ager and arrives to the south of La Règola next to the ancient water spring, bordering the Riu Fred River. We think that the presence of the river facilitated the creation of the path and that the intensification of cultivation near the area made it as the most important point of passage. From the written sources, we know that La Règola received a tax exemption (*carta franchitatis*) from Arnau Mir de Tost in 1049 and this could have encouraged the formation of the village around the monastic foundation augmenting the flux between Ager and La Règola<sup>335</sup>. Considering that a religious foundation could have been existed before the conquest of the Valley we could place the use of this itinerary before the 10<sup>th</sup> century.

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<sup>335</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica De Sant Pere D'ager Fins 1198*. 2 vols. Barcelona: Fundació Noguera, 2011, p. 238.



## LI2 Ager-Pedra

The local itinerary number 2 connects Ager to the disappeared village of Pedra, of which it remains only the church of Mare de Déu. It is composed by two main tracks with an approximate distance of 3.2 Km as the crow flies and a physical length of about 4.3 Km for the track 1 and 3.1 Km for the track 2. The tracks are comprised in a buffer of about 500 meters and the track 2 joins the track 1 in correspondence of the church, while the track 1 continues to the area of the castle.

The track 1 is visible in the B-series aero photo of 1956 and it is a path that follows the ravines crossing from north to south in the the LU1. In addition, the track 1b is a variation that follows the path of a ravine. We think that this could have been the most ancient track due to its natural accessibility. Indeed, it is almost completely a natural path going from the plain of Ager to the *Mare de Déu* church.

The track 2 starts with no constraint in the Ager plain, differently from the track 1 it is almost completely an artificial path. This means that it follows a direction unconstrained by natural geomorphological features. It heads to the church of Mare de Déu once arrived to the hills where it follows the geomorphological slope. We think that this road may be an important path since the 11<sup>th</sup> century because it is clear from the parcel morphology that it generates a very regular, but not planned, parcel system just in front of Ager but in our opinion it cannot be the most ancient because of the more direct and simple path of the track 1.

We also marked a junction between the path 1 and 2 that we called track 2b. It is a simple junction that exploits the natural geomorphology to cross a steep hill. Finally, the track 1c is an alternative to track 1 for reaching the area of the castle. It is well visible in the ancient aerial photograph but it is currently partially disappeared and unused.

From documentary sources, we know that the castle of Pedra was held by the seigniorial family of Exabel and probably it existed before the conquest of the valley

by the county of Urgell<sup>336</sup>. A chronological window of these connections can be hypothesized between the 10<sup>th</sup> and the 11<sup>th</sup> century.

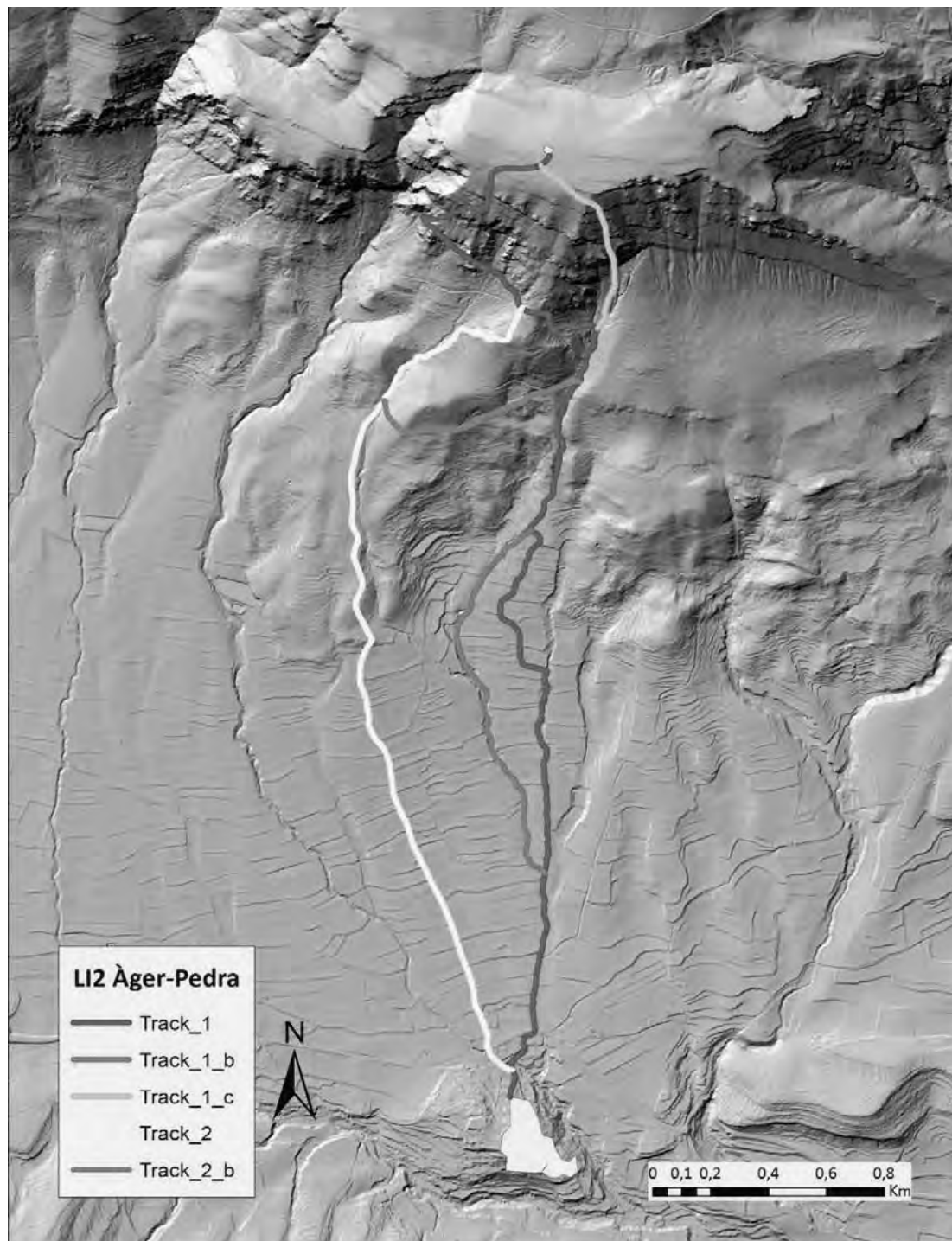


Figure 73. The image shows the reconstruction of the tracks from Ager to the castle of Pedra. The northern point of junction between the track 1 and the track 2 is the location of the church name to Mare de Déu.

<sup>336</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica De Sant Pere...* p. 217.

### LI3 Ager-Agulló

The local itinerary number 3 connects Ager to Agulló located just at the border of the LU 4 and at the ending zone of the major plain area. For this itinerary, we interpreted two possible main tracks with several variants. The track 1, represented in green in the figure 49, has a length of about 3.5 Km passing in the centre of the bundle of patterns.

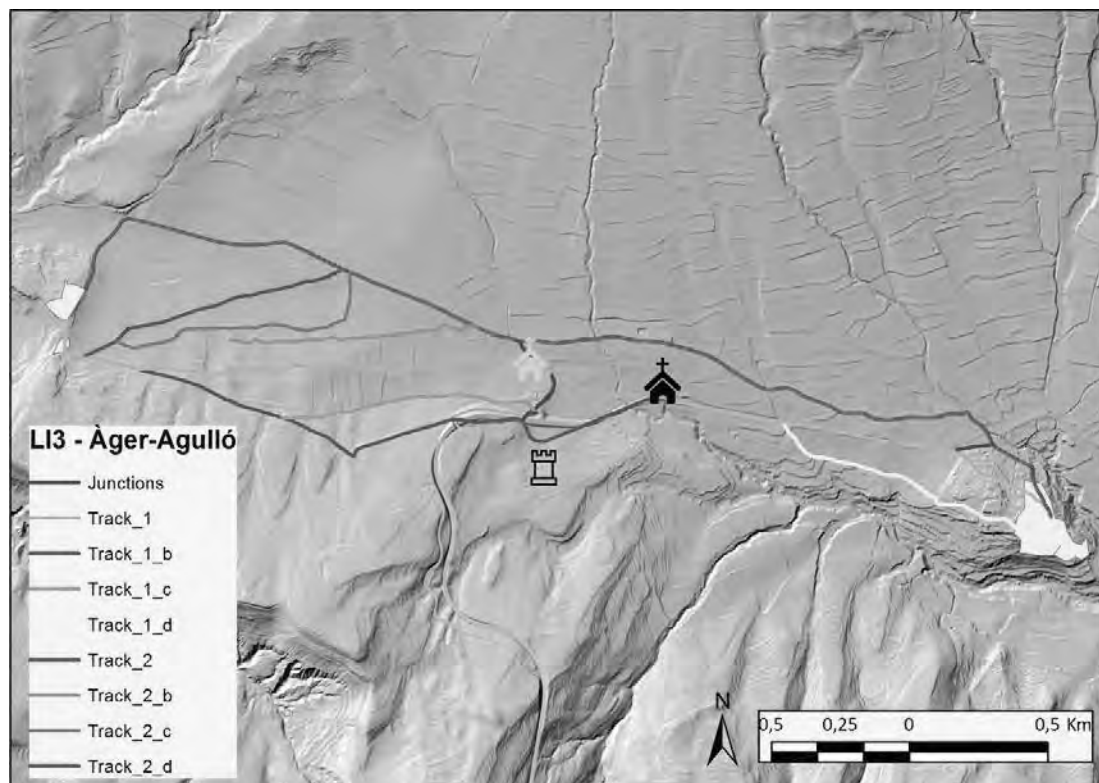


Figure 74. The figure shows the bundle of tracks that we interpreted in the itinerary from Ager to Agulló. The most interesting of them is the track 1 represented in green. In addition, the track 2b has an interesting pattern, indeed, it goes directly towards Agulló but it is now interrupted. We interpreted this fact as the possible ancient origin of this track abandoned after the creation of the red track. In yellow the position of the church of Santa Helena, in black the church of Santa Maria del Plá.

The track 1 is the most interesting because it is the more direct and it passes near the church of *Santa Helena*, positioned approximatively in the middle of the itinerary and already mentioned when describing the LU4. Another interesting fact is that at the starting point of the variant 1b, represented in brown, there is another important monument, the former church of *Santa Maria del Plá* (Saint Mary of the plain) now used as private house and where during an excavation were found burials dated from

the 5<sup>th</sup> century, as described in the chapter 1. The track 1b is clearly newer and it is not supported by any agrarian system. In addition, it passes very next to the tower of *Sanui* now completely englobed into a private house. The track marked as 1c is a variation of the track 1b and it passes down a little hill crossed by the track 1b. The track 1 d is a variation of the track 1 and it comes from another door of Ager.

The track 2 passes at the very north of the bundle and it has several variants. The most interesting are the variant 2b and 2d. The first is an abandoned path that cross the little plain of Agulló and it is perfectly harmonised to the parcel system. In the aerial photograph of 1956 it was already interrupted but observing its orientation it may virtually join the track 2c towards Agulló. The track 2d is also interesting because it crosses diagonally the plain of Agulló heading to the village but it does not “cut” the parcel system but the parcels are well organised around it. This could be interpreted as a mark of its antiquity.

In our interpretation the most ancient path should be the track 1 for its direct approach to Agullo but especially because it passes near the church of *Santa Maria* that is a remarkable site in the area since the 5<sup>th</sup> century.

#### LI4 La Règola-L’Ametlla

The itinerary between the settlements of La Règola and L’Ametlla del Montsec is a path of 3.7 Km of length. As it appears in the figure, in the central part of the path we did not find any significant variation to the main track, while in the first and last portion there were multiple possibilities that we marked as tracks 1c and 1d. In addition, it is not a “natural” itinerary because it has to cross a sloped irregular area. Therefore, not surprisingly, the possibility of variation decrease as to the plain area. The absence of many different tracks may also signify that this itinerary was not important in terms of flux as discussed above.

The only interesting variation is the track 1d where the road passes next to the church of *Trinitat de La Règola*. The evidences about this church show that it is a late Middle Age church but no deep researches have been made in its surrounding area.

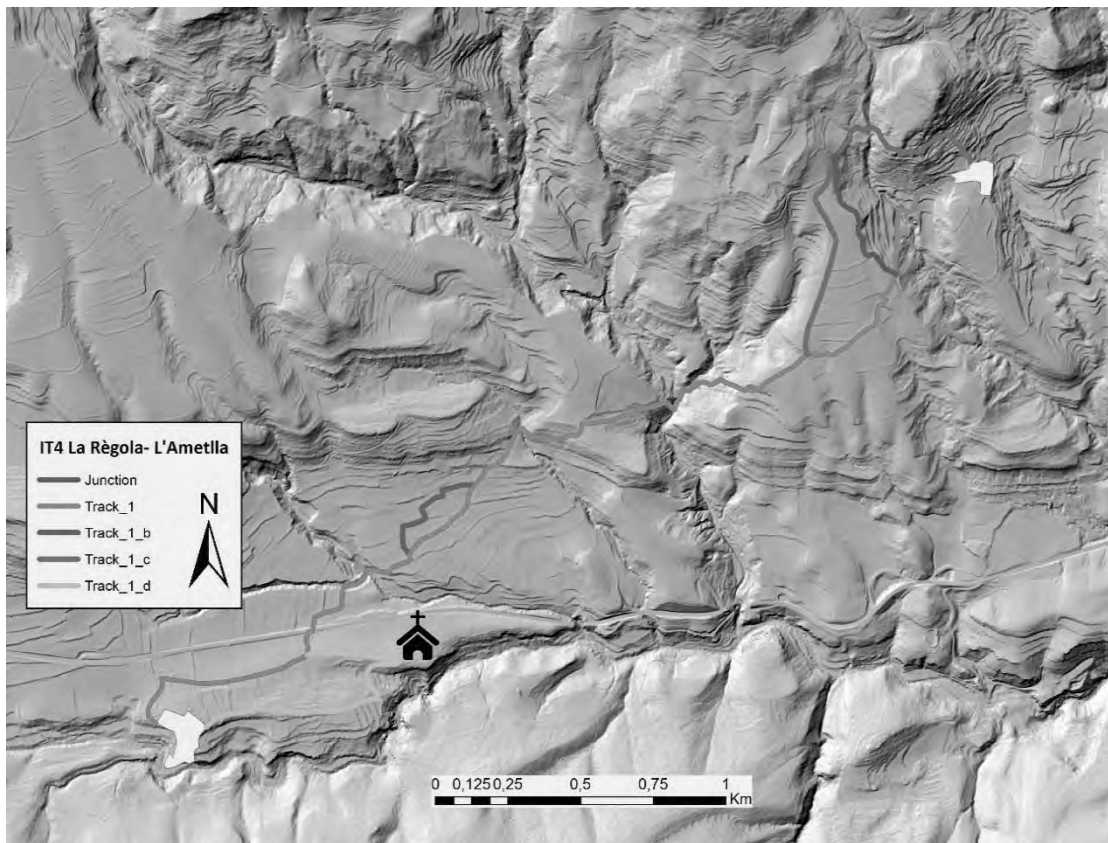


Figure 75. In the figure are represented the tracks interpreted for the itinerary between La Règola and L'Ametlla. The black mark indicates the position of the church of La Trinitat de la Règola.

The track 1c is a variation of the last portion of the itinerary, it is not a direct track and this could mean that it is not a main path for this itinerary. It develops along the alluvial fan and it enters the village of L'Ametlla from the northern side.

#### LI5 Pedra-Colobor

The abandoned villages of Pedra and Colobor are both located in the hills of the southern side of the Montsec seen in the LU1 and LU11. The village of Colobor is located at an approximate altitude of 1000 meters as well as the church of Pedra. The interpreted location of the castle of Pedra is 300 meters higher than the church. The locations are joined by two main tracks of around 2.7 km one passing north and one south.

The track 1 has a minor variation in slope in its first portion and it descends next to Colobor. The track 2 at the contrary passes from the down part of the hill and then it climbs to Colobor. The total distance of both tracks is nearly the same. No parcel systems are developed around these tracks and it is difficult to make an interpretation neither a relative periodisation. We already cited above the chronological data of the castle of Pedra and the village of Colobor is mentioned later from the 12<sup>th</sup> century<sup>337</sup>. We can suppose that this track was used during the period of coexistence of both settlements but we know that at the end of the 14<sup>th</sup> century, in 1375, the village of Colobor was already abandoned<sup>338</sup>. Both track 1 and 2 are currently abandoned and the church of Colobor can be reached through a more recent road that does not appear in the aerial photograph of 1956.

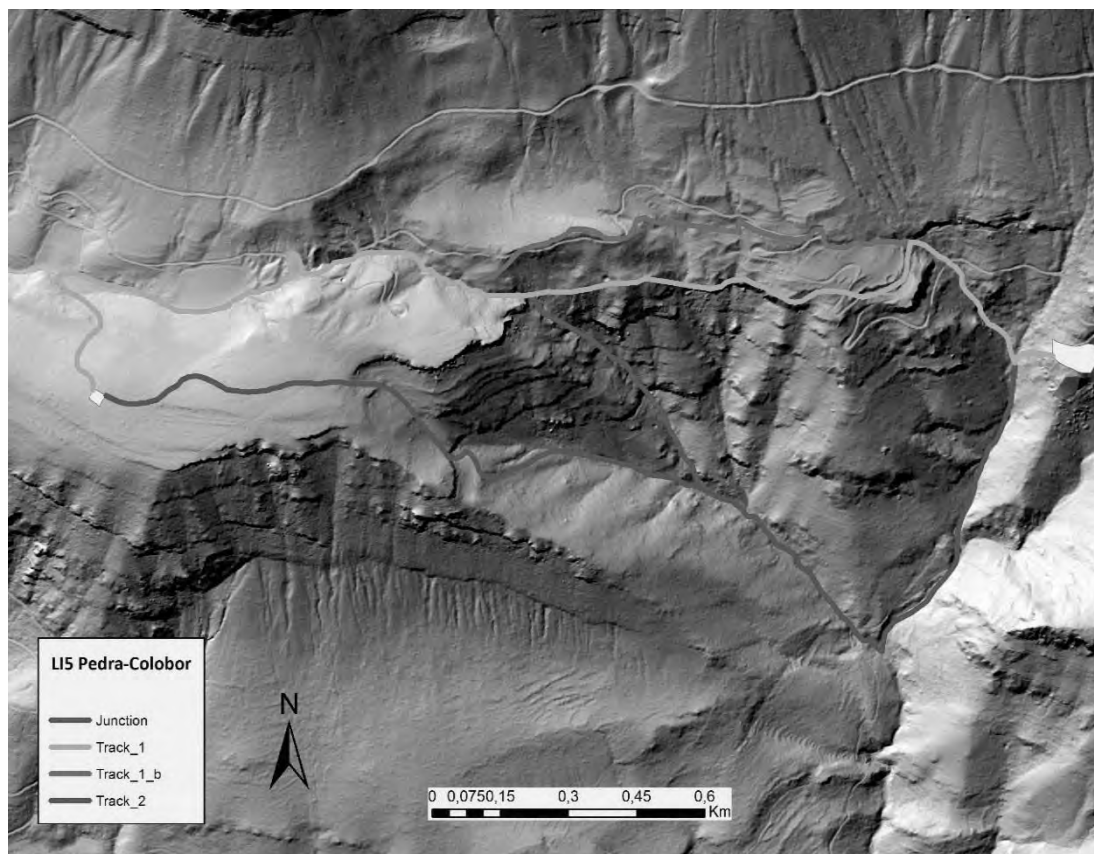


Figure 76. Pedra and Colobor are located at the same altitude in the hills of the southern side of the Montsec. Nevertheless, they are joined also by the track2 that follows the pattern of the ravines.

<sup>337</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica De Sant Pere...* p. 689.

<sup>338</sup> Francesc Fité Llevot. "Conquesta I Repoblació a L'alta Noguera." In *Catalunya Romanica*, edited by Fundació Enciclopèdia Catalana, 31-34. Barcelona: Cayfosa: Industria Gràfica, 1994.

## LI6 Colobor-Mallabecs

The situation between this two settlement is similar to the situation of the LI5. Both are in the same linear wall of the Montsec and are connected by a straight track with few variations. Also in this case the chronology of the settlements is different because the area of Mallabecs is inhabited since the first conquest of Arnau Mir de Tost, then it is earlier than Colobor<sup>339</sup>. Again this mountainous area does not leave space for agrarian arrangements and the absence of agrarian terraces is not surprising because of the high altitude. We think, as stated in the next chapter, that these could have been only fortified sites for defence and that their position led to an early desertion after the consolidation of the power in the valley.

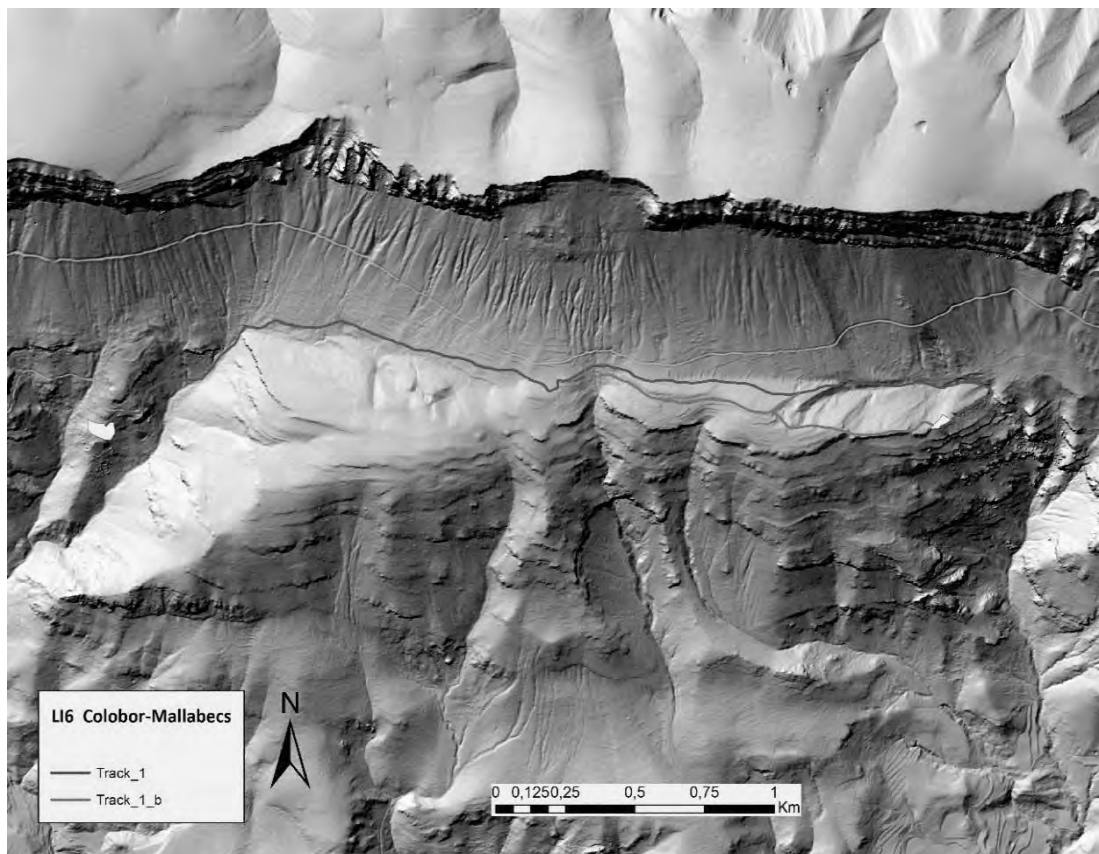


Figure 77. This image shows the relief of the itinerary from Colobor to Mallabecs.

<sup>339</sup> Ramón Chesé Lapeña. *Col·Lecció Diplomàtica De Sant Pere...* p. 318.

## LI7 Mallabecs-Escumó

The local itinerary 7 completes the itineraries of the northern part of the valley, in this strip that we defined to be not suitable for the agriculture because of the altitude and we interpreted as an area of control and defence.

In this itinerary, we identified a main track, the track 1, with a variation at its final portion. The only track visible in the area can be explained with the small dimension of the areas and maybe the small importance of this flux during time. In addition, the geomorphological constraints may have played a crucial role in determining the paths. The site of Escumó is a defensive settlement cited in the sources of the definitive conquest of the valley by Arnau Mir in 1068 and then it is contemporary to Mallabecs<sup>340</sup>.

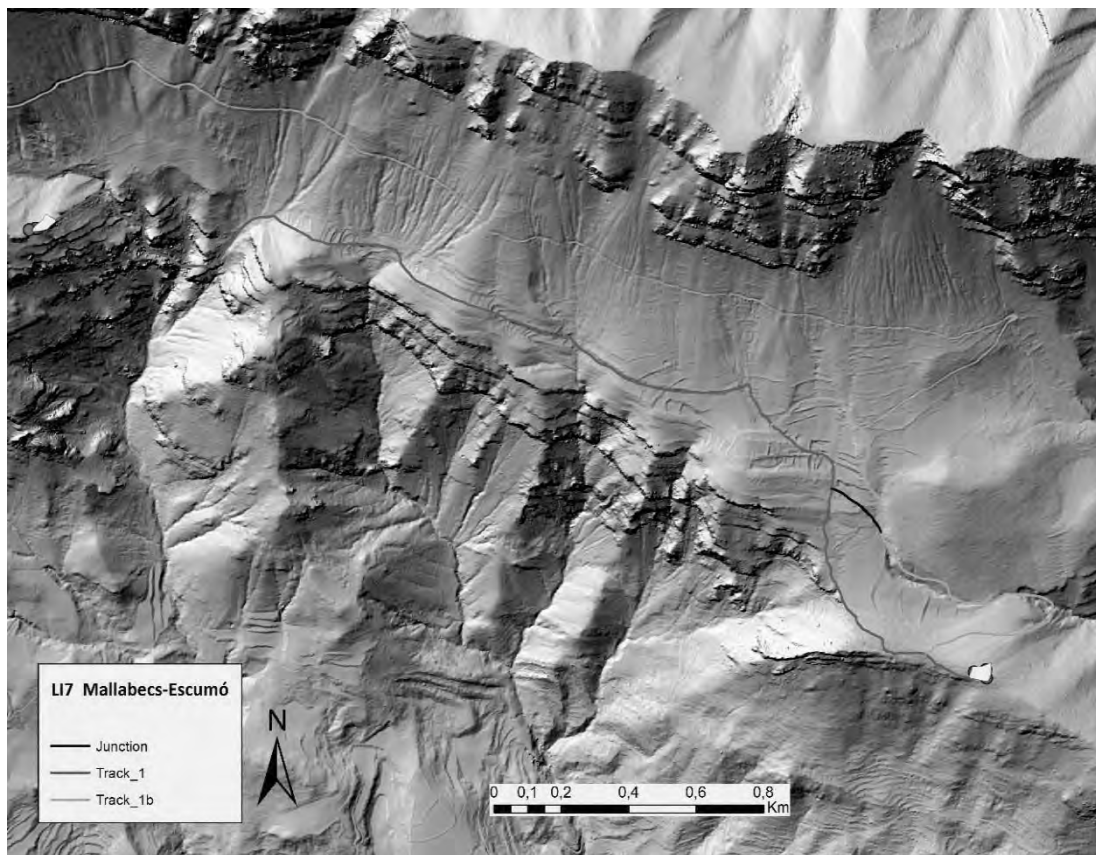


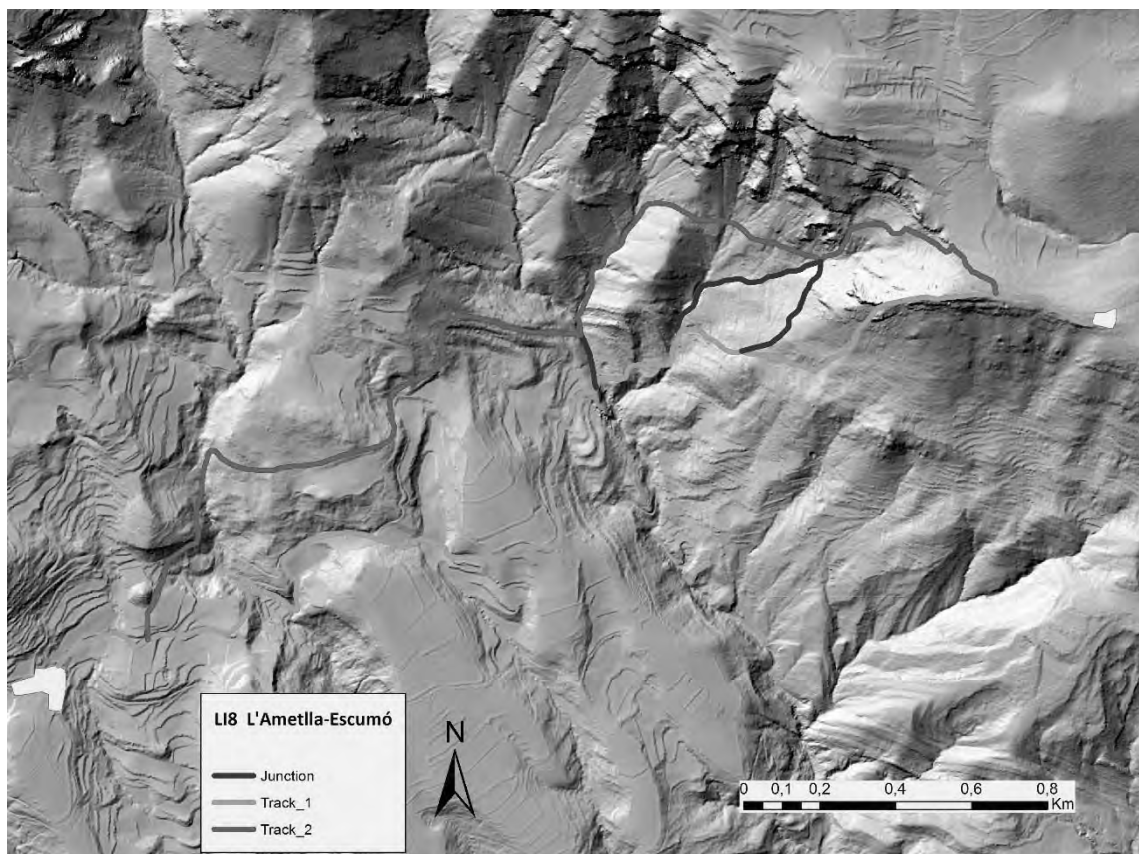
Figure 78. This image shows the track from Mallabecs to Escumó over the hillshaded lidar derived DTM. It is clear that the absence of agrarian terraces and the geological composition saw in the description of the LU8, make this area unsuitable for agriculture. The main hypothesis is that this area was dedicated to defence and control.

<sup>340</sup> Ramón Chesé Lapeña. *Col·Lecció Diplomàtica De Sant Pere...* p. 318.



## LI8 L'Ametlla-Escumó

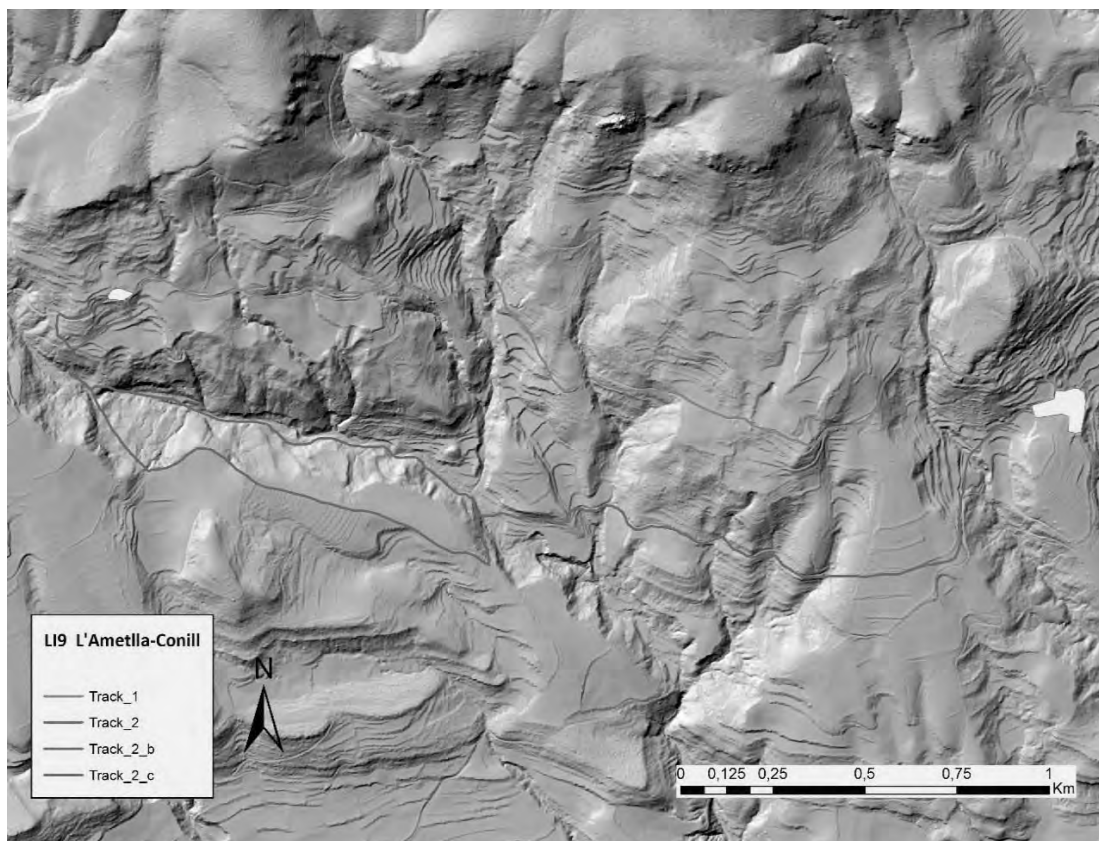
The local itinerary from L'Ametlla to Escumó virtually continues the itinerary started from La Règola to L'Ametlla crossing diagonally the eastern part of the valley. It has a length of about 3.6 Km and it can be split in two main tracks both visible in the aerial photograph of 1956. The track 1 is the most direct and it is mainly conditioned by the slope. The track 2 passes at the northern side and can be considered as an alternative to the track 1. Both are joined by many junctions especially in the final portion of the track. The discourse about the chronology remains the same as the LI7 and LI6, we think that this itinerary could have not played a important role in the viability network of the valley and this may be the primary reason for the lack of alternatives for the track.



*Figure 79. The figure shows the tracks identified in the itinerary from L'Ametlla to Escumó. We think that the slope may have played a crucial role for the development of these tracks and few agrarian systems are connected to them, especially in the starting and middle portion.*

## LI9 L'Ametlla-Conill

The itinerary from L'Ametlla to Conill has a length of about 3 Km. We relieved two main tracks from the aerial photograph. The track 1 passing through the northern side arrives to Conill crossing many parcel systems especially agrarian terraces. The track 2 pass through the southern side, it crosses also terraces in the first portion while when approaching Conill pass through a ravine. We identified also two variants of the track 2, the most important of which is the 2b because it is an alternative to the ravine. We think that this track could have been used in case of an inundation of the ravines that are actives during the autumns and spring months. Another interpretation could derive from the slope, indeed the track 2 with a slope with a mean value of 13% may have been used for the passage of animals and small vehicles while the track 2b with a gentler slope is more suitable for vehicles.



*Figure 80. Itinerary from L'Ametlla (east) to Conill (west). We decided to mark the itinerary in the east-west direction because of the main importance of the settlement of L'Ametlla. Obviously, this is irrelevant from a user point of view.*

The presence of the village of Conill is known since the 1164 from the will of Bernat de Colobor, during the prospection we did not found any superficial evidence that

could refer to a previous chronology. Nevertheless, we think that the flux between these two villages was not regular and that the track we marked in the map were used especially to serve the agrarian settlement.

### LI10 Ager-Montlleó

The itinerary from Ager to Montlleó has a north-south direction. Montlleó is an abandoned village located near the locality named *Port d'Ager*. The distance from Ager is about 3Km and we identified two main tracks with two important variants. All the tracks that we detected starts at the Sant Martí door of Ager and they continue toward south with few adjustments. The track 1 is at the centre of the bundle and it is the more direct path towards Montlleó. It has a variant that we called 1b that pass through the centre of another alluvial fan avoiding a ravine. The most interesting track is probably the 2 that exploit a portion of a bigger itinerary. It is considered to be a roman itinerary from the roman Lérida towards the Pyrenees. We already studied <sup>341</sup>this itinerary from a predictive point of view trying to reconstruct the main track. We did not discussed in deep the roman attribution but we think that there are no evidence neither archaeological or historical to support the roman origin of this itinerary that could be even more ancient. We know that the actual materiality of the path can be addressed to a modern arrangement with a stone pave that it is possible to see also in the proximity of Ager and La Règola.

Montlleó is a village that was active since the 12<sup>th</sup> century while its church was frequented until the 18<sup>th</sup> century<sup>342</sup>. We are not able to give a definitive chronology of the itinerary but we can hypothesize that during the active period of the settlement of Montlleó the flux between the two centres make necessary to have alternative paths.

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<sup>341</sup> Antonio Porcheddu. "Predicting and Postdicting a Roman Road in the Pre-Pyrenees Area of Lleida (Spain)." Paper presented at the CAA2015 KEEP THE REVOLUTION GOING, Proceedings of the 43rd Annual Conference on Computer Applications and Quantitative Methods in Archaeology, 2016.

<sup>342</sup> Francesc Fité Llevot. *Reculls D'història De La Vall D'àger...* p. 83.

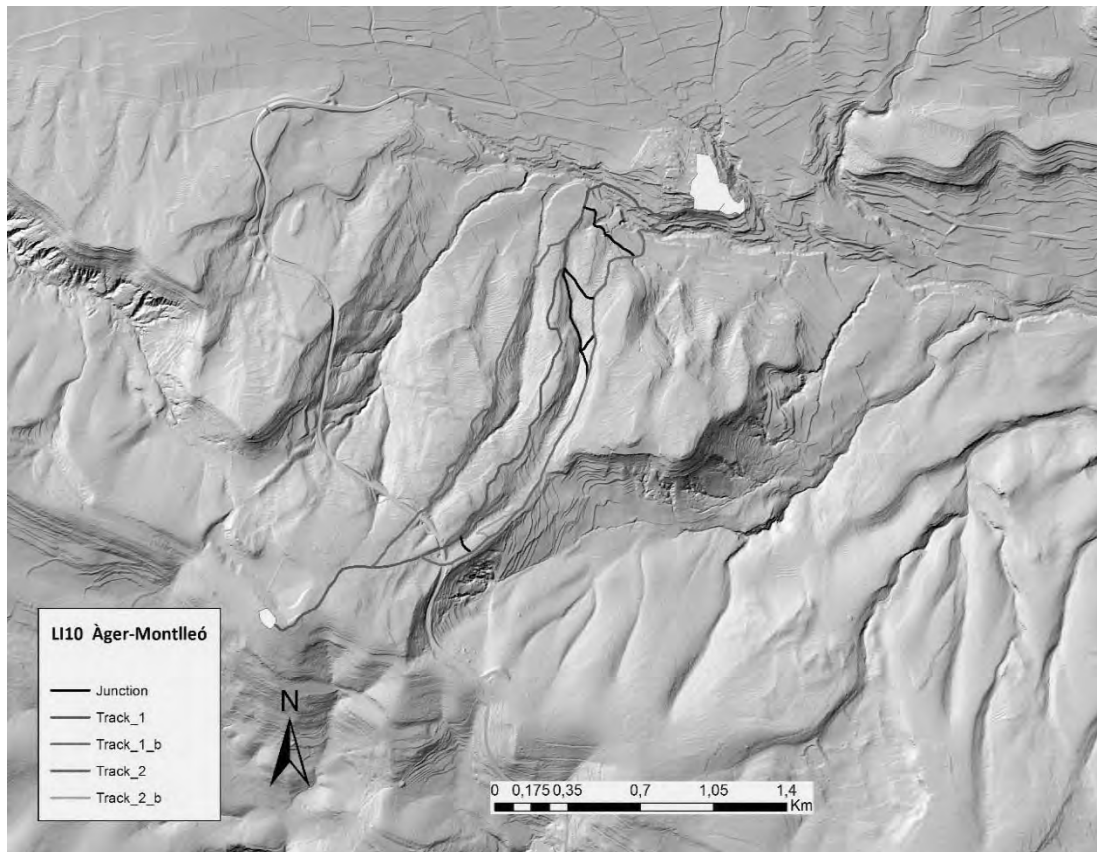


Figure 81. The itinerary from Ager to Montlleó is composed by two main tracks. The track 2 is a portion of a greater itinerary directed to the plain of Lérida at south and toward the Pyrenees at north.

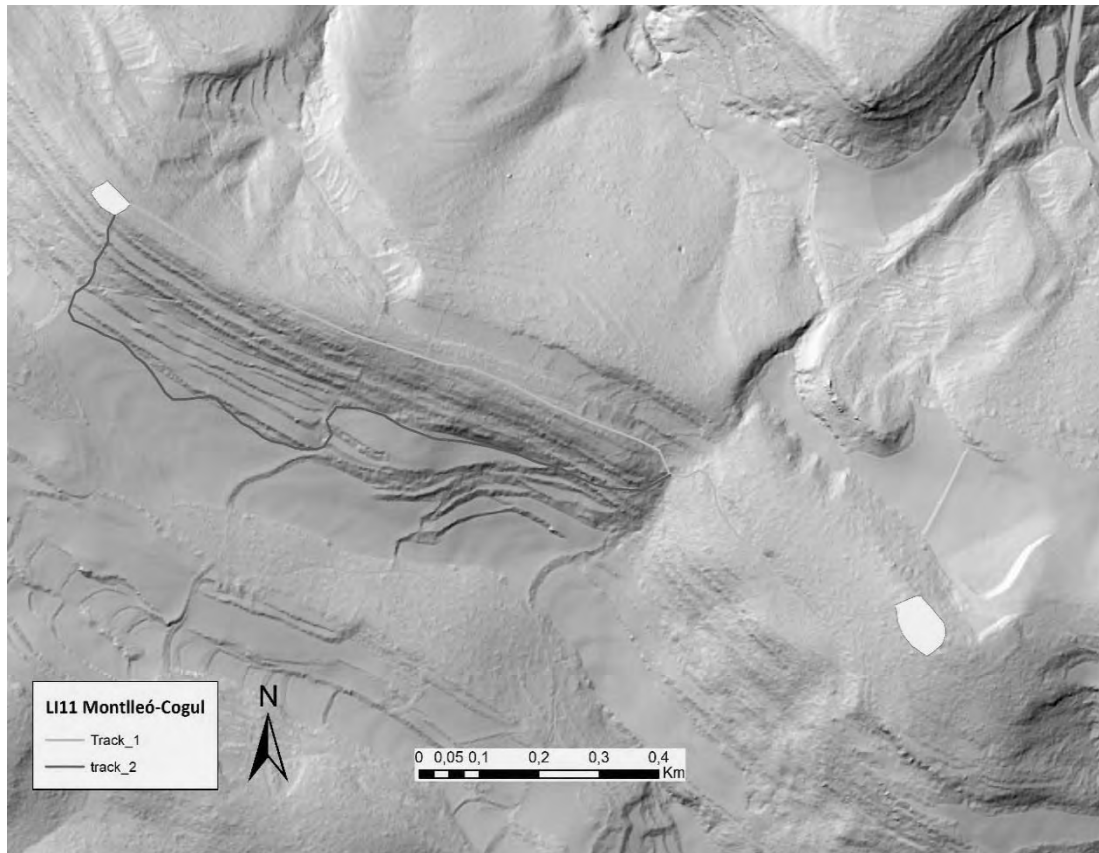
### LI11 Montlleó- Cogul

The castle of Cogul was a defensive settlement cited in the written documents since the XII century<sup>343</sup> and located at the same altitude of Montlleó and in the same mountainous closing belt of the Ager Valley that we described in the LU10. The connection between Montlleó and Cogul is made through a linear itinerary of which we detected two tracks. The first passing through the north of the mountain and the second passing through the southern part. The distance between the settlements is about 1.5 Km.

We think that this itinerary had a marginal role in the flux and because of its local nature it did not generate many variants. Along its path there are many agrarian terraces facing south and during the survey we found evidence of a frequentation

<sup>343</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica De Sant Pere...* p. 626.

since the 11<sup>th</sup> and the 12<sup>th</sup> centuries. The defensive nature of the settlement of Cogul and the scarce economic possibility made this to be a marginal site.



*Figure 82. The itinerary from Montlleó to Cogul was a local itinerary that served as generator for a group of agrarian terraces.*

## L12 Cogul-Millà

The discourse about this itinerary is very similar to the previous because of the nature of Cogul. We are in front of a simple itinerary with a length of 2Km and a very simple track mostly direct and influenced only by the slope. We detected a main track named track 1 passing through an agrarian area that faces south with a small variable. A second track was detected to pass through the centre of a group of agrarian terraces. We could not make intensive prospection of this area because of the heavy vegetation cover, but we found evidence of pottery dating to the 12<sup>th</sup> century.

The settlement of Millà is more ancient than Cogul, in the written sources where it is mentioned since the 1066 with a castle in the 12<sup>th</sup> century. We will analyse more in

deep the role of this settlement in the next chapter. Here we can suppose only that the connection with Cogul depends then on the Cogul chronology, then it was built at least a century later than the foundation of Millá. No archaeological sites were detected along this itinerary.

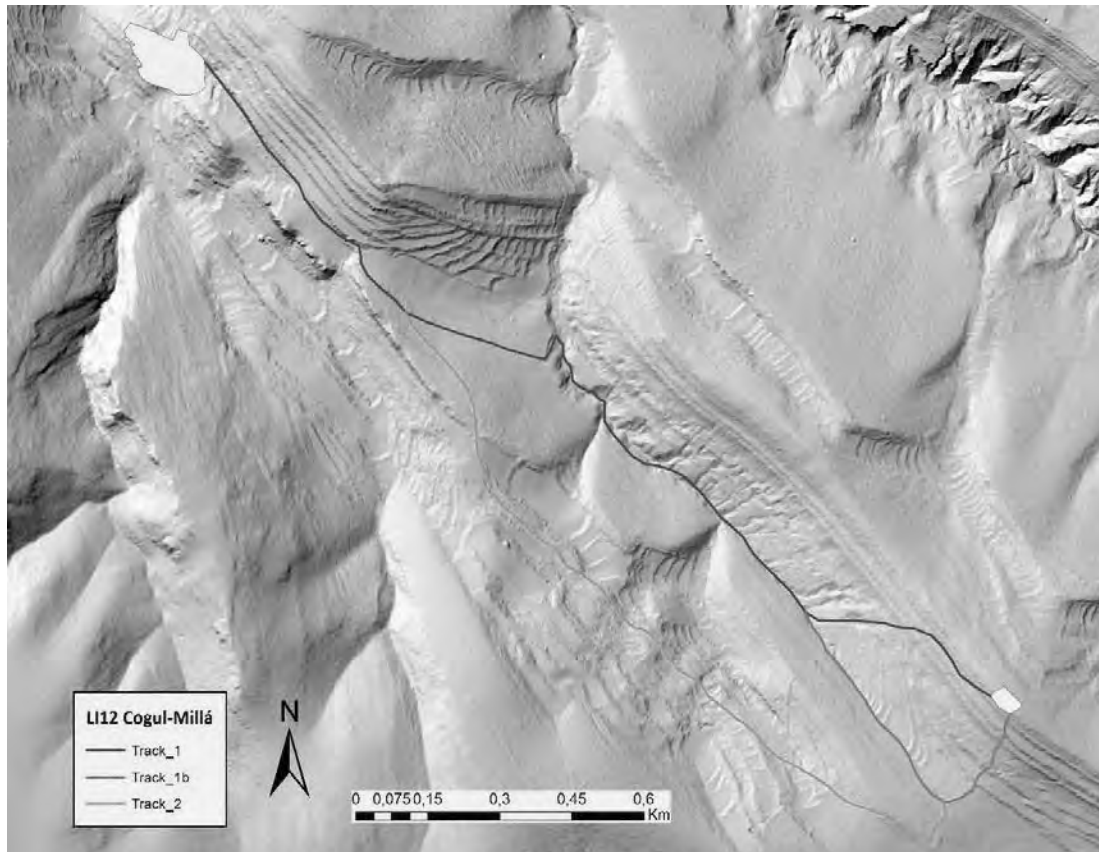


Figure 83. This figure show the simple tracks between Cogul and Millá. As it appers at a quick sight the tracks are influenced only by the geomorphology.

### LI13 Agulló-Millá

The itinerary from Agulló to Millá is very constrained by the geomorphology. Despite the importance of both settlements, we identified only a single track that partially is retraced by the current road that connects the two settlements. Only in the final portion we identified some little variations to the main track explained with the improving status of the terrain.

As it is visible already from the image, the settlement of Millá is not referred towards the Valley but towards south, because of obvious issues of solar exposition that

affects the agriculture production. Then the track do not generates any kind of agrarian parcel systems except those in the plain near Agulló.

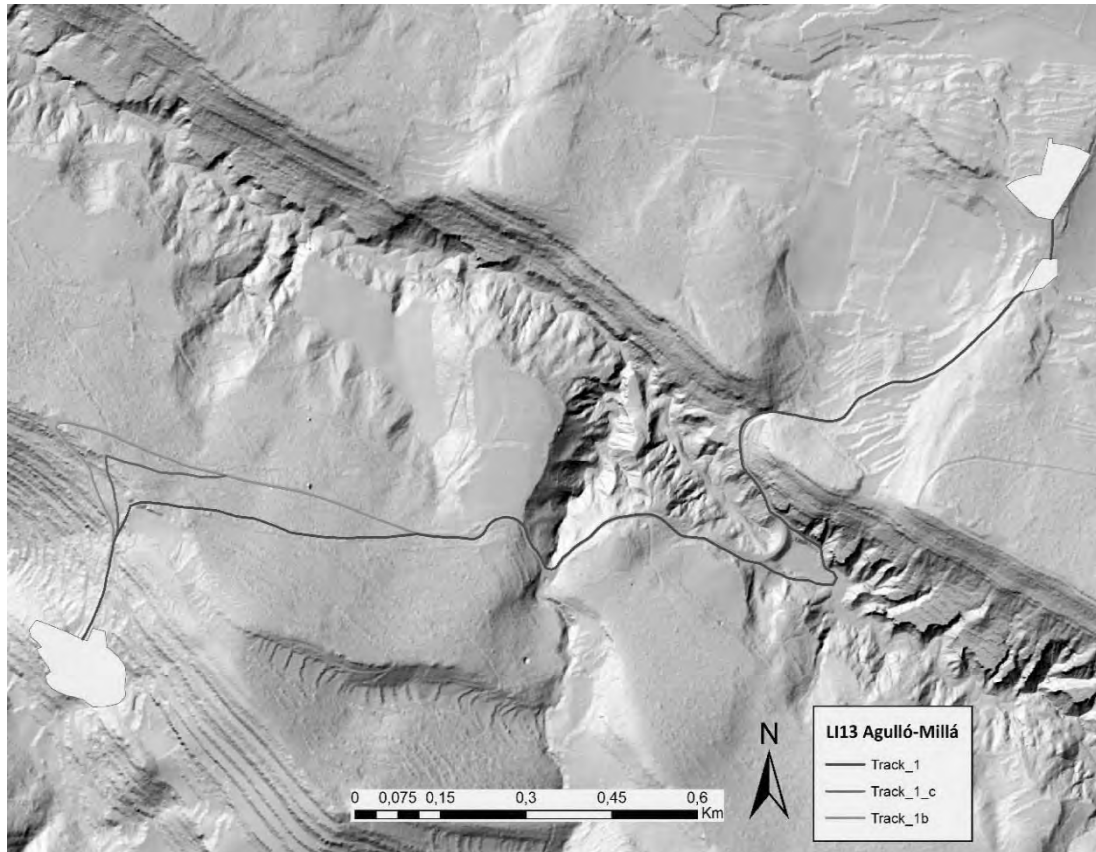


Figure 84. This figure shows the detected itinerary from Agulló in the right side to Millá in the left side of the image.

#### LI14 Agulló-Corçá

With this itinerary, we enter the west side of the valley where the main settlement is Corçá. The logical itinerary is to connect Agulló, at the border of the plain, to Corçá at the centre of the west side of the valley. This is an interesting itinerary especially in its first portion because of the presence of the intersection described in the MU9 (?) where is located the church of Sant Pere Martir.

The distance of Agulló from Corçá is about 4.5 Km and it is the largest itinerary that we detected in the valley. Indeed, there are no other settlements along this itinerary neither archaeological sites nor abandoned settlements.

From the aerial photograph of 1956, we detected two main tracks that form the LI14. The track 1 marked in red in the figure, is more direct and it is the shortest path. It exploits the low slope of the east area of Agulló and then it crosses the hills towards northwest. The track 2 passes through the northern side and reaches the crossroad of the MU9 from where it continues toward Corçá. In the central part of the itinerary, where the two tracks are more distant, we detected some direct junction that connect the tracks.

As remembered above, Agulló stores evidences of frequentation since the 5<sup>th</sup> century as well as the church of Sant Pere Martir. Corçá is cited in the earliest written sources that we have for the Ager Valley, in 1048 in the occasion of the consecration of the church of Sant Salvador d'Ager. No archaeological excavation have been carried out in the village and we do not know anything about previous frequentations of the site. Presently only remains of a 12<sup>th</sup> century castle are visible.

The data we possess are useful to open a chronological window of existence of this itinerary from the 5<sup>th</sup> century for the first part that connects Agulló to the church of *Sant Père*, but we cannot move back from the 11<sup>th</sup> century for the rest.

Finally, this itinerary is also an important portion of the IT2 that passes through the Valley from east to west and brings to the passage of La Pertusa. This makes this itinerary having a bigger flux than the normal flux of connecting two single settlements.



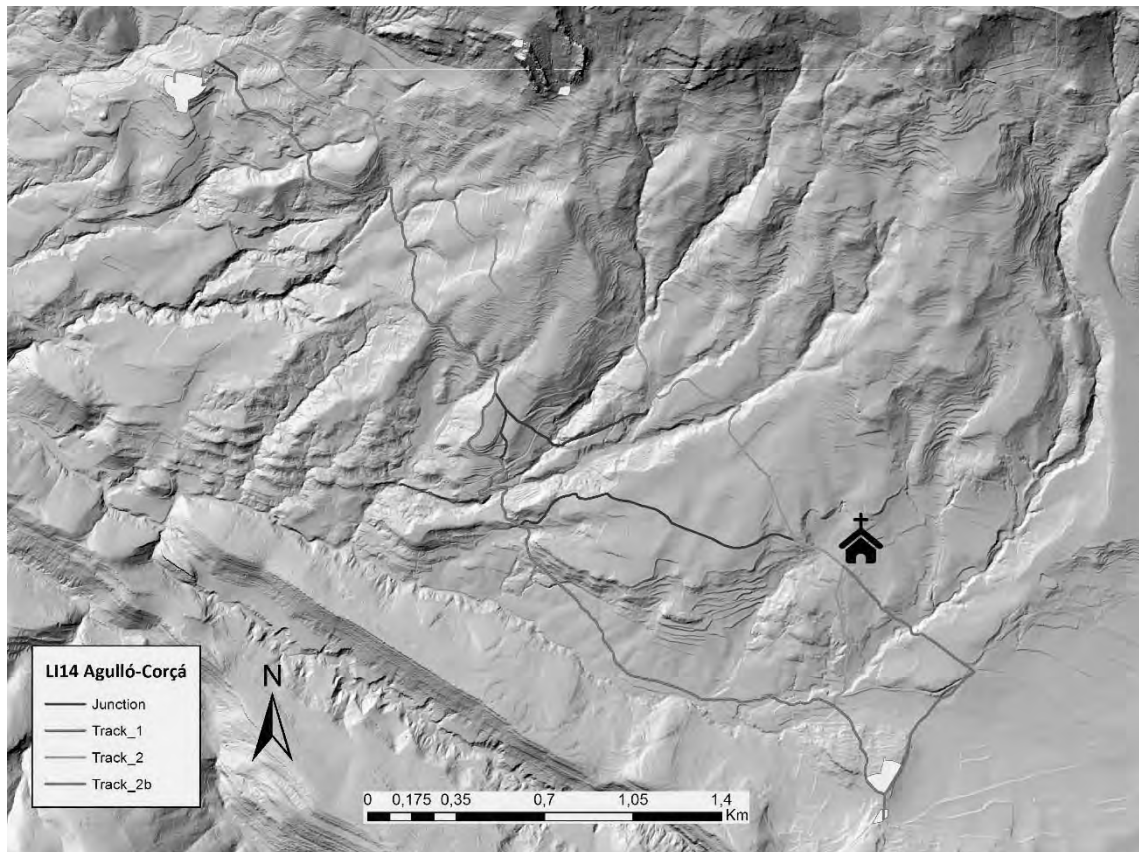


Figure 85. In the figure are drawn the tracks detected in the aerial photographs of 1956. The black point represents the location of the church of Sant Pèrre Martir.

### LI15 Corçá-Claramunt

The local itinerary 15 is a small itinerary that connects Corçá with the settlement of Claramunt. The length is of about 1.5/1.7 Km and the settlements are positioned at the same altitude in a linear direction east-west.

From the aerial photograph, we detected a unique track materialising this itinerary, with two variations. The track seems to follow the shape of geomorphology and it passes through a dense system of agrarian terraces. The track 1b is actually a variation that overtake the terraces more at north. An interesting and necessary variation is the 1b that allows connecting the upper part of the settlement, where the remaining of the castle and the church of *Santa Maria* are located, with the church of *Sant Bartomeu* located down the hill. Both churches are mentioned in the written sources in a very close interval of time: *Santa Maria* in 1042 and *Sant Bartomeu* in 1048. While Corçá is a “big” settlement in proportion of the rest of the valley, the

castle of Claramunt may have played, from a spatial point of view, a defensive role and be a sort of peripheral area of Corçá. As we will see in the next chapter from an historical point of view, Claramunt is more connected to Pedra than to Corçá because, in the 11<sup>th</sup> century, it was owned by the same seigniorial family<sup>344</sup>.

Looking at the morphology of both tracks, we notice that they were used not only to connect two settlements but also to assist a complex system of agrarian terraces, possibly managed by Corçá and Claramunt. In addition, as already noticed for other itineraries, we see here that the variation of the track 1b may be a complementary access area that, in case of inundation of the ravine exploited by the track 1, can be used to connect both nodes.

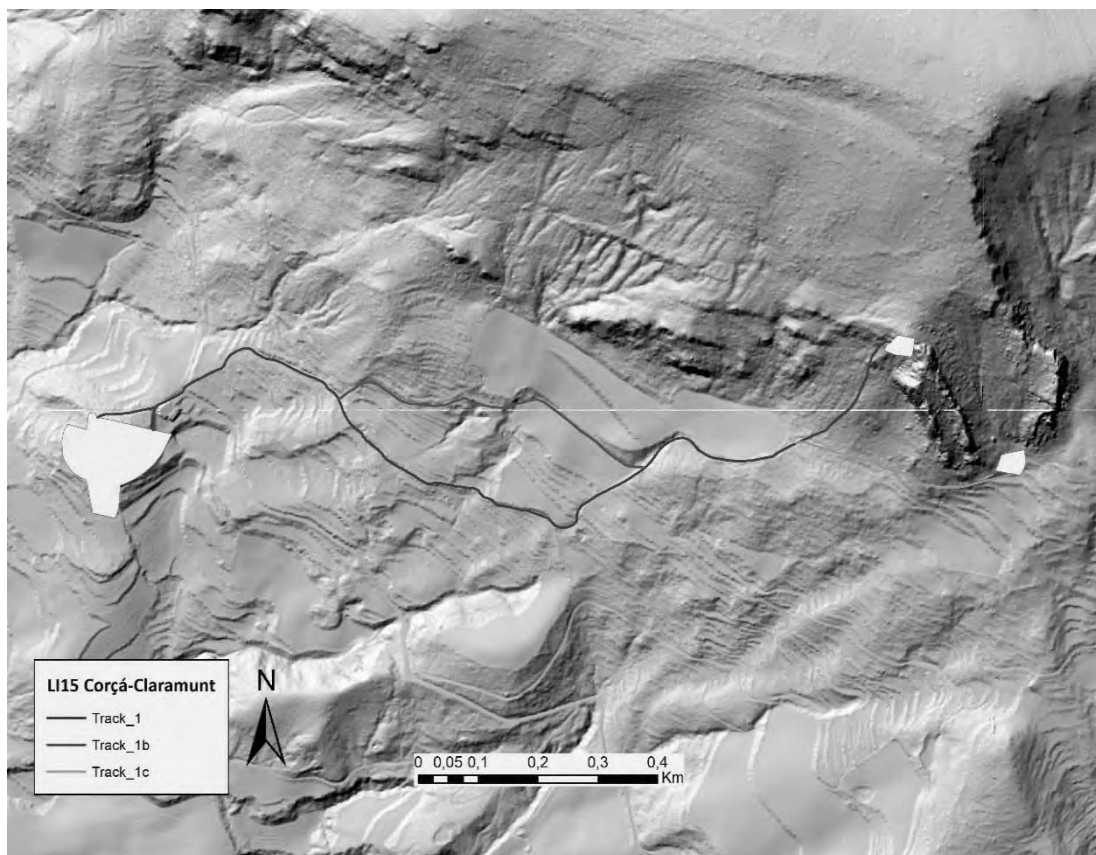


Figure 86. The track from Corçá to Claramunt. In the right side of the image the green areas represent the position of the castle with few other structures above and the church and the abandoned village below.

<sup>344</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica De Sant Pere...* p. 217.

## LI16 Corçá-La Pertusa

The local itinerary 16 connects Corçá to the abandoned site of La Pertusa. The distance between the two settlements is of about 2.8 Km for the track 2 and 2.3 Km for the track 1. We detected these two main tracks and several variations and junctions that exploit the ravines and the characteristics of the geomorphology to create connections between the two main paths.

The track 1 and the track 1b are the most direct paths and they arrive at the entering side of La Pertusa. The track 2 is currently incomplete because its last portion is submerged by the water of the Noguera Ribagorçana River since the creation of the closure in the 1960's.

We already mentioned the chronological data about Corçá, meanwhile the site of La Pertusa was an important defensive castle mentioned in the written sources since 1060 as belonging to the abbey of Ager recently instituted by Arnau Mir de Tost<sup>345</sup>. The church of *Mare de Dèu* and the several evidence of pottery found in the terraces around the hill of La Pertusa, suggest that it was not only a defensive settlement but that it was densely inhabited at least since the 11<sup>th</sup> century. This itinerary then should have been available since this period but we cannot exclude its anteriority because of the "natural" importance that it had for the regional movement along the east-west direction. In the aerial photographs of 1945 and 1956 it is still visible the former course of the river and the bridge that crossed it.

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<sup>345</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica De Sant Pere...* pp. 269-273.

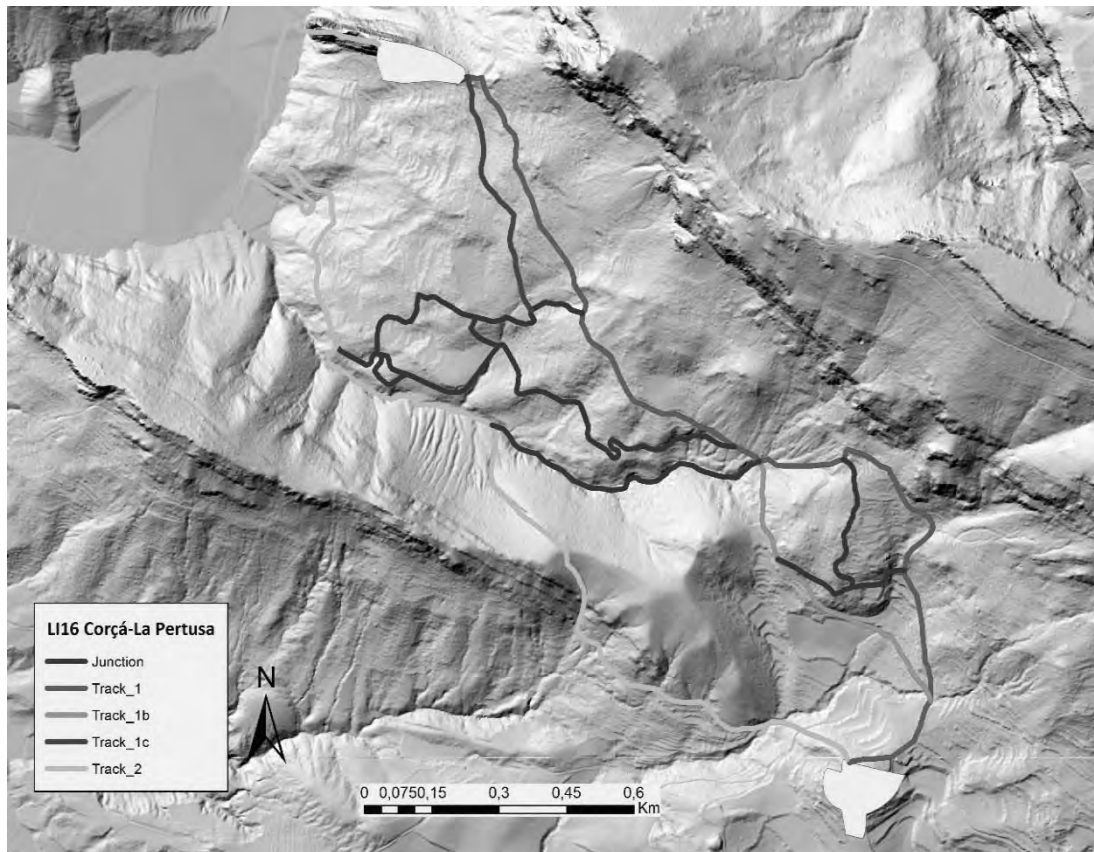


Figure 87. Itinerary from Corçá to La Pertusa. It is visible the several number of junctions between the two detected tracks that exploit the presence of ravines and canyons to create passages. It is also visible above the part of the track 2 that is now submerged by water.

### LI17 Corçá-Sant Llorenç

The local itinerary 17 connects Corçá to the settlement of Sant Llorenç. We identified one main track with some variation of a total length of about 3 Km. The particular situation of the topography is a clear constraint for the development of tracks in this area. Indeed this track climbs the mountain currently named Serra de Cantaperdius to reach directly the site of Sant Llorenç. The analysis of the slope values in percentage of incline showed that this is not a suitable track for vehicles but only for animals or walking people. For this reason, we think that the main track that connected these two destinations must have passed through other nodes, like Claramunt or La Pertusa, in order to move around the obstacle of the mountain. Nevertheless, we decided to map this itinerary because, as explained in the methodology discussion, we connected the sites only in couple of two settlements

for each itinerary. With the variation of the tracks 1b and 1c the grade of inclination was reduced consistently.

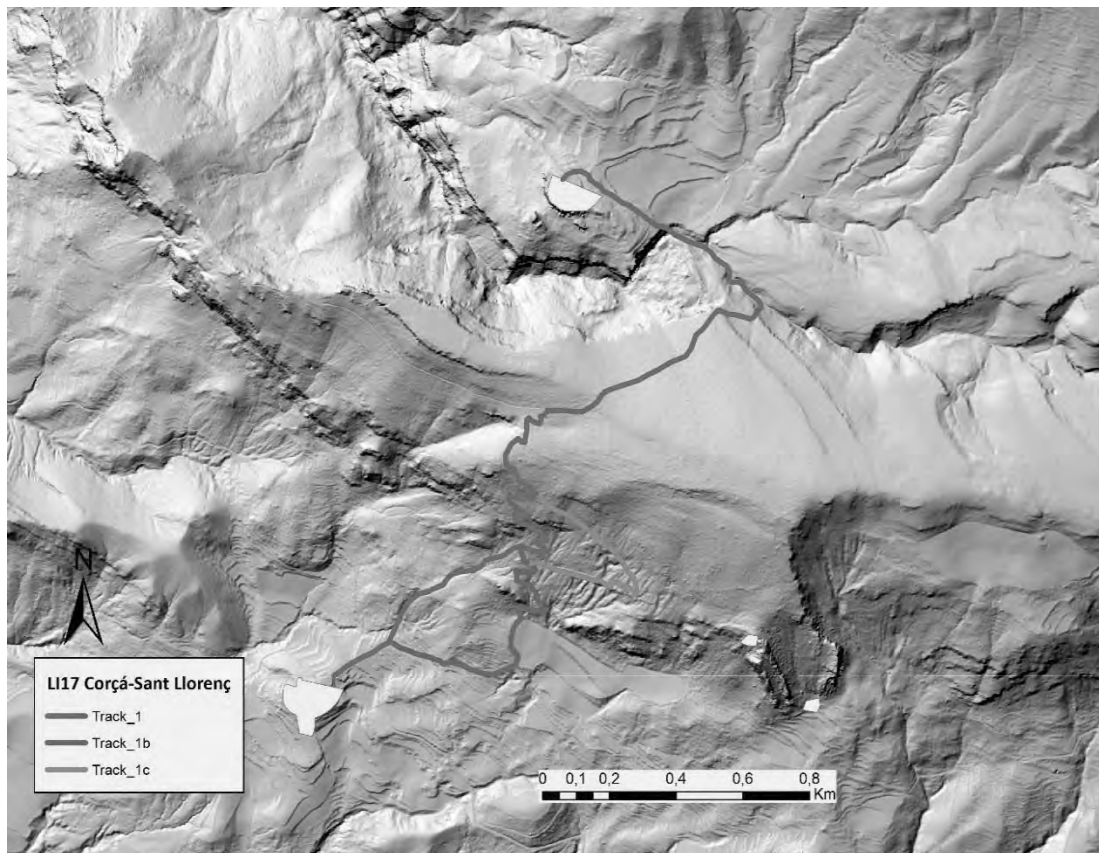


Figure 88. The detected track from Corçà to Sant Llorenç.

### LI18 La Pertusa- Sant Llorenç

The last local itinerary considered in our analysis connects La Pertusa to Sant Llorenç. We think that this was a more suitable path also to connect Corçà to Sant Llorenç. We identified two tracks with a mean length of 3.4 Km.

The track 1 has a path that starts from the south area of La Pertusa going towards north-west. It reaches Sant Llorenç passing around the mountain of Cantaperdius and entering a ravine until the plain around the castle. This track is now disappeared due to the increased water level. The track 2 is a more direct path that climb the mountain of Cantaperdius in a gentle area and then descend until it reaches a ravine passing through the south side of the castle and, in the final portion, it moves around the rock where is sited the castle.

As described in the next chapter the Castle of Sant Llorenç is a formidable defensive place from where it is possible to control a much-extended area in the northwest of the Montsec. Nevertheless, the presence of a discrete amount of agrarian fields, allowed the development of a settlement around the castle. The castle could have been inhabited very early because we know from the written sources that in 1044 this place was sold by the count of Pallars to Arnau Mir de Tost<sup>346</sup>.

The survey carried out in this area did not showed evidence that could be dated before the 11<sup>th</sup> century. The grey pottery, which is a common mark all around the valley, has not be studied in deep in Catalonia to propose a more precise periodisation. Finally, La Pertusa and Sant Llorenç formed a very strong defensive system and the connection between then must have been contemporary to their establishing.

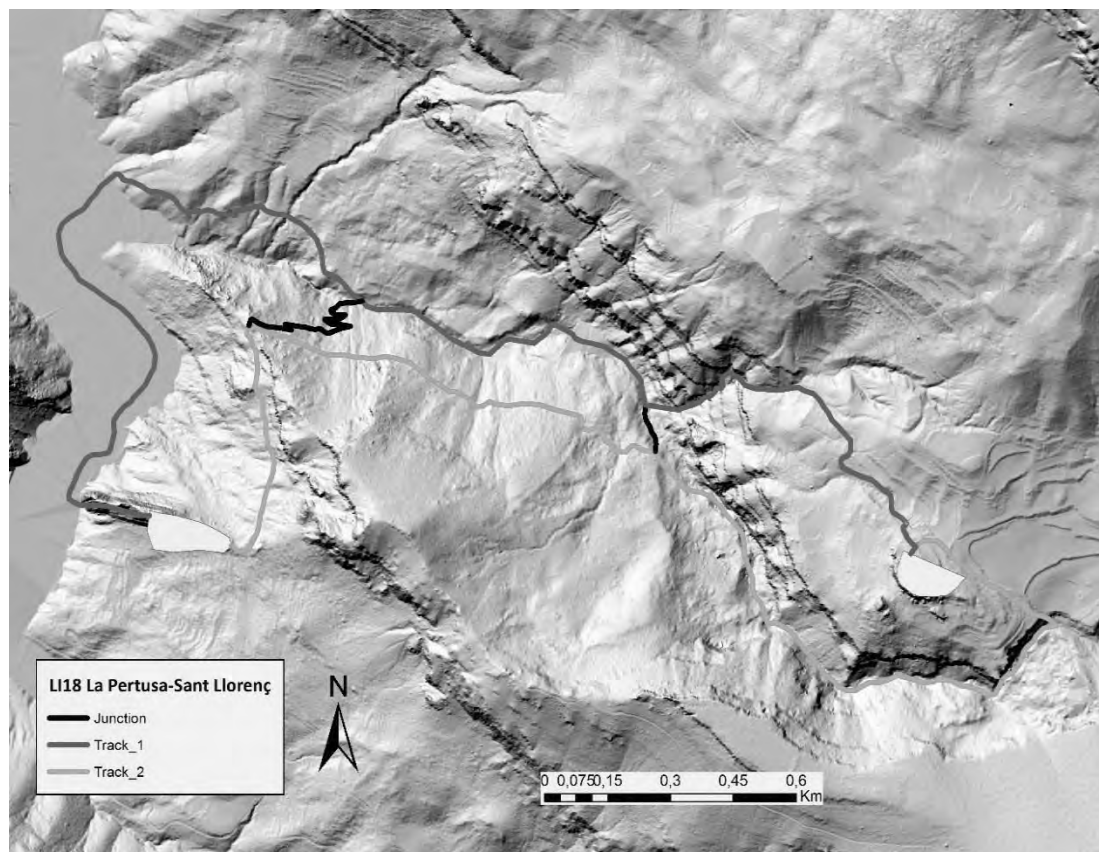


Figure 89. This figure shows the two tracks detected in the 1956 aerial photograph. The track 1 is now partially submerged, as it is possible to realize from the image.

<sup>346</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica De Sant Pere...* pp. 221.

#### 5.14 AN INTERMEDIATE RECAP

Before proceeding to the final part of this chapter, we should take stock and see what has been analysed and detected until now. We started dividing the area of the Ager Valley in landscape units basing our decision on several criteria as the parcels morphology, the presence of significant archaeological sites, the geology etc. For each area, we analysed the agrarian parcels morphology and detected some “anomalies” that we presented as morphological units. We used this information to compare the settlements with their agrarian surroundings, the orientation of the parcels with the hydrography and the roads with the objective of detecting the most important factors that could have affected the morphogenesis of the landscape morphologies. We observed how the chronology of the parcel system does not depend from a particular shape but is a long lasting process that can receive impulses from external situation and, in the case of Ager, is a mainly autonomous process. Indeed, to get a chronological periodisation for the parcel systems we decided to study the main morphogenetic elements of the landscape, the roads. As the roads are connection between fixed points their resilience is higher and their chronology mainly depends on the chronology of the points that they connect. We saw that in the valley there are two main patterns of movement, as predictable, an east-west pattern and a north-south one, with the east-west prevailing in quantitative terms. The major part of the itinerary had a strong impulse since the 11<sup>th</sup> century but we found that some pathways could be dated backwards, especially those passing through Ager, Agulló and La Règola.

Nevertheless, the mobility network of the valley is not reduced to the tracks that we presented in the itineraries. There is a dense network of paths and roads relieved from the sources and that connect the settlements locally to the fields, the farms, the rural churches, the castles and the towers. These paths also serve the parcel morphogenesis and structure of the landscape. On these concepts is based the definition of morphologic resilience, the ability of the shapes to overcome their materiality in order to rebuild themselves continuously maintaining their presence in the long term. In addition, the definition of the itineraries resilience, the ability of the

itineraries to maintain a connection between two nodes during time even changing the concrete path.

The approach that we are going to apply in the next section is different from the archaeogeographic one because is based mainly on the ability of the environment to affect the results and the changes. This is more general and susceptible of several criteria.

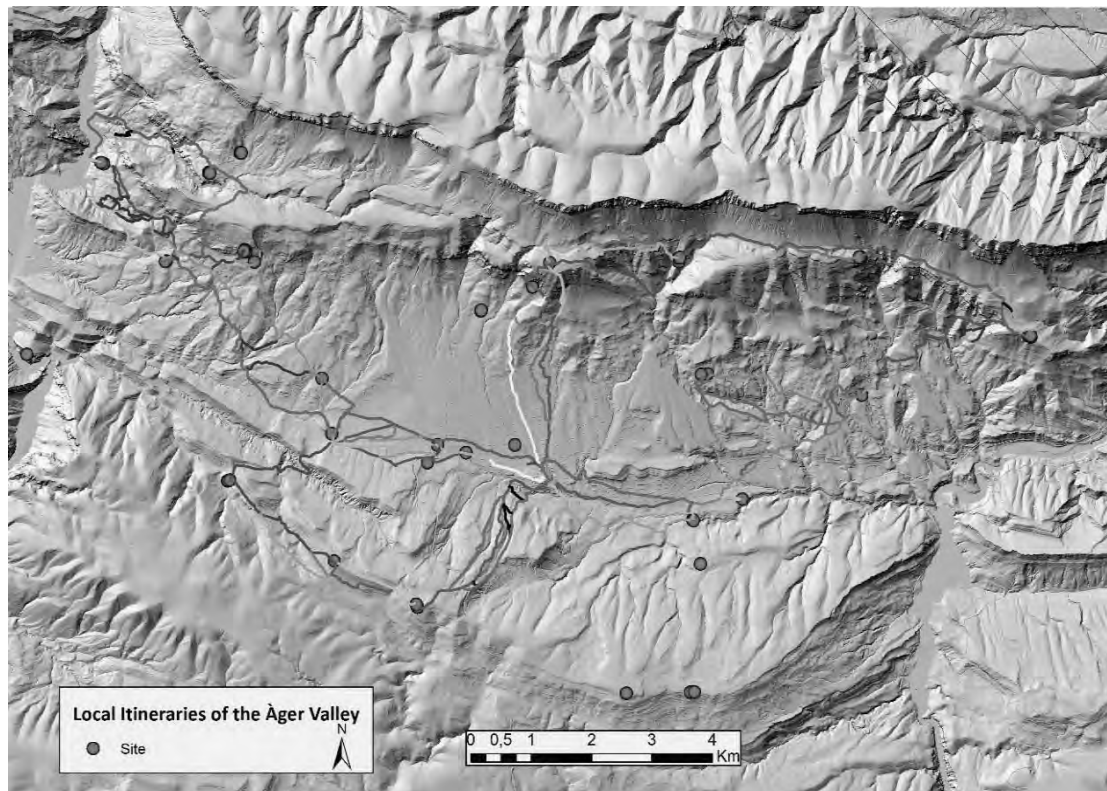


Figure 90. In this figure, it is showed the network of studied itineraries related to the archaeological sites.

## 5.15 THE PREDICTIVE ARCHAEOLOGY APPROACH TO ANCIENT MOBILITY

Since the paper of Marcos Llobera in 2000, the study of ancient mobility through digital models had a crucial shift<sup>347</sup>. He proposed a theoretical model to explore the movement over a non-urbanised landscape, which means the countryside, starting from two main statements: a) the needing of an understanding of the general

<sup>347</sup> Marcos Llobera. "Understanding Movement: A Pilot Model Towards the Sociology of Movement." In *Beyond the Map: Archaeology and Spatial Technologies*, edited by Gary Lock, 65-84. Omsa: IOS Press, 2000.



patterns of movement inside a basin and b) the use of these non-binding data to reflect about their social consequences.

Indeed, nobody can assert that the predictive models applied in Archaeology give a complete and definitive answer to a problem, especially because we are dealing with human behaviour. The risk is to fall into a deterministic vortex of cause-effect produced by the applied algorithms. Indeed, the tools used for these predictions are often derived by other disciplines, like hydrography or geomorphology, where the deterministic approach makes sense because of simple mathematical and physical laws. Human's behaviour, as said, cannot be predicted even if, thanks to statistics, it is possible to determine some trends that become more valid using a large population of data, for example the data derived from a social network or a web search engine. Infact, it is necessary to make a compromise between the method and the interpretation of the results. Considering that archaeologists deal with societies and not with simple individuals, the behavioural trends could be seen as the archaeological interpretation to the description obtained by the predictive models. We should look at the predictive results as the general description of a general model useful to generate new questions and not to give a definitive solution.

Another warning we should make before entering the analysis is of technical nature. Our results were obtained using standard scripts available in the ArcGIS 10.2 software both to create the cost surface and to explore it. As every archaeologist working with predictive models knows, using standard algorithms is not a cause of standardisation of results. Indeed, the most affecting factor for the results is the "arbitrariness" in the choice of parameters. For example, when deciding the weights assigned to the group of slope values or even the number of categories to group the values, the user has a very large liberty of choice. This problem has been overtaken calculating the energy expenditure of a human being in different situation and associating it to the model of the cost surface<sup>348</sup>. Nevertheless, this approach has many problems of application

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<sup>348</sup> Michele De Silva, and Giovanna Pizziolo. "Setting up a "Human Calibrated" Anisotropic Cost Surface for Archaeological Landscape Investigation." In *Computing Archaeology for Understanding the Past. Caa 2000. Computer Applications and Quantitative Methods in Archaeology. Proceedings of the 28th Conference, Ljubljana, April 2000*, edited by Zoran Stančič and Tatjana Veljanovski, 279-88. Oxford: Archaeopress, 2001.

because every human been depending on his or her physical status has a different way to expend energy, and many function of cost energy have been developed during time<sup>349</sup>. In any case, we do not agree with the deterministic application of an energy cost function because of the several parameters involved and because we are not considering only the pedestrian path but all the potential path, then we chose not to apply to our cost surface a function of energy cost.

We are going to approach the study of mobility from two perspective, the modelling of mobility basins with the extraction of natural pathways and the least cost path. We intend a mobility basin as an area that could be accessed after crossing a node where the node is the point of departing of a flow of movement possibilities<sup>350</sup>. The least cost path is, briefly, an algorithm that computes the path from a starting to an ending point where the cost for the passage in each cell is minimum<sup>351</sup>. In both cases, we must start from a common base, the cost surface. The cost surface is a raster file in which every cell represents a value of cost. It is obtained from the accumulation of several cost categories chosen by the user, and from a cost value assigned to every group of values for each category. For example, the slope is a cost category and the values of slope have been grouped in several intervals. To every interval of values of the slope has been given a value of cost.

#### 5.15.1 THE EXTRACTION OF NATURAL PATHWAYS

The extraction of natural pathways has been done implementing the model proposed in 2001 by Gino Bellavia<sup>352</sup>. This model was proposed in order to analyse the potential

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<sup>349</sup> Martijn Van Leusen. "Viewshed and Cost Surface Analysis Using Gis (Cartographic Modelling in a Cell-Based Gis li)." In *New Techniques for Old Times. Caa98. Computer Applications and Quantitative Methods in Archaeology. Proceedings of the 26th Conference, Barcelona, March 1998*, edited by Juan Antonio Barceló, Ivan Briz and Assumpció Vlla, 215-24. Oxford: Archaeopress, 1999.

<sup>350</sup> Marcos Llobera, Pedro Fábrega-Álvarez, and Cristina Parcero-Oubiña. "Order in Movement: A Gis Approach to Accessibility." *Journal of Archaeological Science* 38 (2011): 843-51.

<sup>351</sup> Philip Verhagen. "On the Road to Nowhere? Least Cost Paths, Accessibility and the Predictive Modelling Perspective." In *Proceedings of the 38th Annual Conference on Computer Applications and Quantitative Methods in Archaeology, Caa2010*, edited by Francisco Contreras, Mercedes Marjas and Javier Meleros, 383-90. Oxford: Archaeopress, 2011.

<sup>352</sup> Gino Bellavia. "Extracting "Natural Pathways" from a Digital Elevation Model. Application to Landscape Archaeological Studies." In *Archaeological Informatics: Pushing the Envelope. Caa 2001 Computer Applications and Quantitative Methods in Archaeology. Proceedings of the 29th Conference, Gotland, April 2001*, edited by Göran Burenhult, 5-12. Oxford: Archaeopress, 2002.

relationships between archaeological sites and pathways. The model consists on the generation of a cost surface based on the characteristic of the landscape that the researcher consider more important for the landscape he or she is analysing. The algorithms applied are derived from the analysis of the hydrologic flow that could be compared to the natural development of paths<sup>353</sup>. The criteria we applied for the case of the Ager Valley are the slope, the land use, the rivers and the geology. All the different raster are unified and reclassified in order to give a homogenous set of values, mainly decided following the intuition of the researcher. For example the value of slope in percentage that are more suitable for a path do not go beyond the 20% of inclination. The following step of the model are described in the diagram below. After the creation of the cost surface it follows an application of an algorithm for the filling of sinks in the cost surface. Indeed the depression could create an area of accumulation of the flow that should be avoided in order to prevent anomalies in the accumulation. On a following step, to the produced surface the algorithm of flow direction and flow accumulation are applied. Finally, the results are classified applying a threshold of value giving the value 100 to all the cells that exceed this value and 0 to the others. The result is a path vector file that shows the accumulated flow and that can be seen also as the representation of natural pathways.

We applied the model to the Ager Valley using the ArcGIS 10.2 software built-in toolboxes. Looking at the results we noted that the geomorphology of the Ager Valley plays a crucial role, the mayor part of the streams were captured by the existing ravines and inclination of the slopes. Comparing the results with the DEM and the relief of the road network from the B-Series aerial photograph we noticed that many roads cuts the flow networks and are positioned perpendicularly to the modelled natural paths. Finally we think that this kind of analysis is not suitable for the Ager Valley and the obtained results are not satisfactory. A further problem is the resolution of the DTM. While a low resolution DTM, for example 20 meters per cell, produce a low quantity of streams as result, making simpler the reading of the map, it make also the results less reliable. The DTM of 2 meters per cell that we used in our analysis, is more suitable for a topographic reliability but the results are less readable

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<sup>353</sup> Gino Bellavia. "Extracting "Natural Pathways"...", p. 7.

for the huge amount of stream calculated. This problem should be considered in deep when applying these models to a lidar derived DEM.

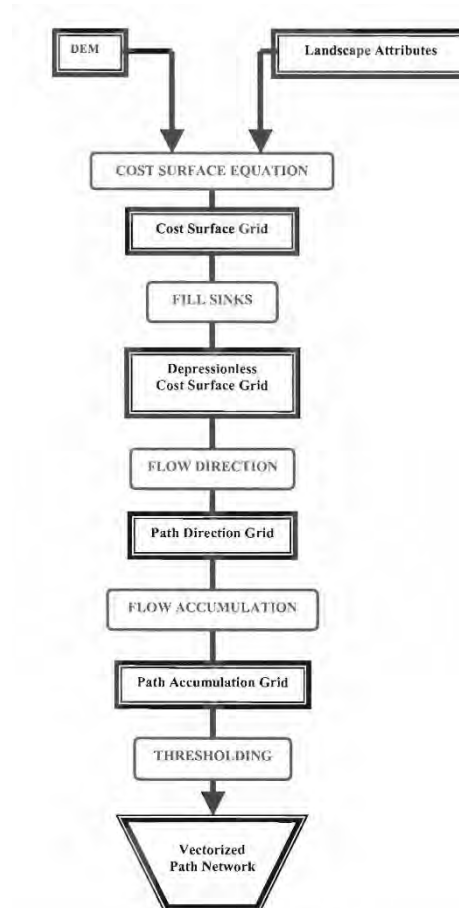


Figure 91. Image of the flow diagram of the natural pathways extraction model from Bellavia 2002, Fig.1



Figure 92. This image shows the result of the Natural Pathways extraction compared with the local road network in the Ager plain.

### 5.15.2 THE LEAST COST PATH ANALYSIS

The least cost path analysis is the application on a cost surface of an algorithm that detects the path with the minimum cost from a starting point to an ending point. This technique is largely used in GIS application for the detection of suitable path for several contexts, from the building of pipelines, powerlines or roads to the analysis of the movement of animals<sup>354</sup>. In Archaeology, it is interesting its application for the analysis of the anthropic movement over a cost surface that helps a) the detection of unknown ancient tracks or potential itineraries in a particular area or b) it helps

<sup>354</sup> There is a huge bibliography referring to the application of the least cost path in multiple disciplines. For a general view we found the paper of David Douglas. "Least-Cost Path in Gis Using an Accumulated Cost Surface and Slope lines." *Cartographica: the international journal for Geographic Information and Geovisualization* 31, no. 3 (1994): 37-51.

An example of its application for the road planning comes from the paper of Chaoqing Yu, Jay Lee, and Mandy Munro-Stasiuk. "Extensions to Least-Cost Path Algorithms for Roadway Planning." *International Journal of Geographical Information Science* 17, no. 4 (2003): 361-76.

As example of its application in ecology we found the paper of Lang Wang, Wesley Savage, and Bradley Shaffer. "Landscape Genetics and Least-Cost Path Analysis Reveal Unexpected Dispersal Routes in the California Tiger Salamander (*Ambystoma Californiense*)." *Molecular Ecology* 18, no. 7 (2009): 1365-74.

understanding the meaning of the position of ancient tracks in the landscape. In the first case, it is based on the exploration of an unknown area to detect possible passages used by human being to move through a specific area, in this sense there are interesting examples of the studies made to explore the human movement on the mountainous areas and detect potential archaeological sites<sup>355</sup>. In the second case, the methodology can be applied to understand the reasons of the location of known ancient sites or paths using the criteria of attractors and detractors<sup>356</sup>.

The cost surface we used in the calculus of the least cost paths is the same as the natural pathways extraction. We applied the least cost path algorithm to the three main itineraries of the plain (Ager-La Règola, Ager-Agulló and Agulló-Corçá) and to the two regional itineraries described in the archaeogeographic analysis (Ager-Montsec and Mont Rebei – Terradets). In addition we compared the results with the hypothesis made from the archaeogeographic analysis in order to discuss the similarity and differences.

The first least cost path of the itinerary going from Ager to La Règola resulted superposed mainly to the track\_1 that we considered as the most recent of the group. This is not an unexpected result because in this case we did not consider the attractors of the river Riu Fred as the mills positioned along this course.

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<sup>355</sup> Stefanie Rogers, and Philippe Curdy. "Least Cost Path Analyses for Predicting Glacial Archaeological Site Potential: Scale and Parameter Investigations." In *Predicting Prehistory. Predictive Models and Field Research Methods for Detecting Prehistoric Contexts*, edited by Giovanna Pizziolo and Lucia Sarti, 49-64. Firenze: Bandecchi & Vivaldi, 2015.

<sup>356</sup> Emeri Farinetti. "Modelling Regional Landscape through the Predictive and Postdictive Exploration of Settlement Choices: A Theoretical Framework." In *Caa2015 Keep the Revolution Going, Proceedings of the 43rd Annual Conference on Computer Applications and Quantitative Methods in Archaeology*, edited by Stefano Campana, Marianna Cirillo, Gabriella Carpentiero and Roberto Scopigno, 647-58. Oxford: Archaeopress Archaeology, 2016.

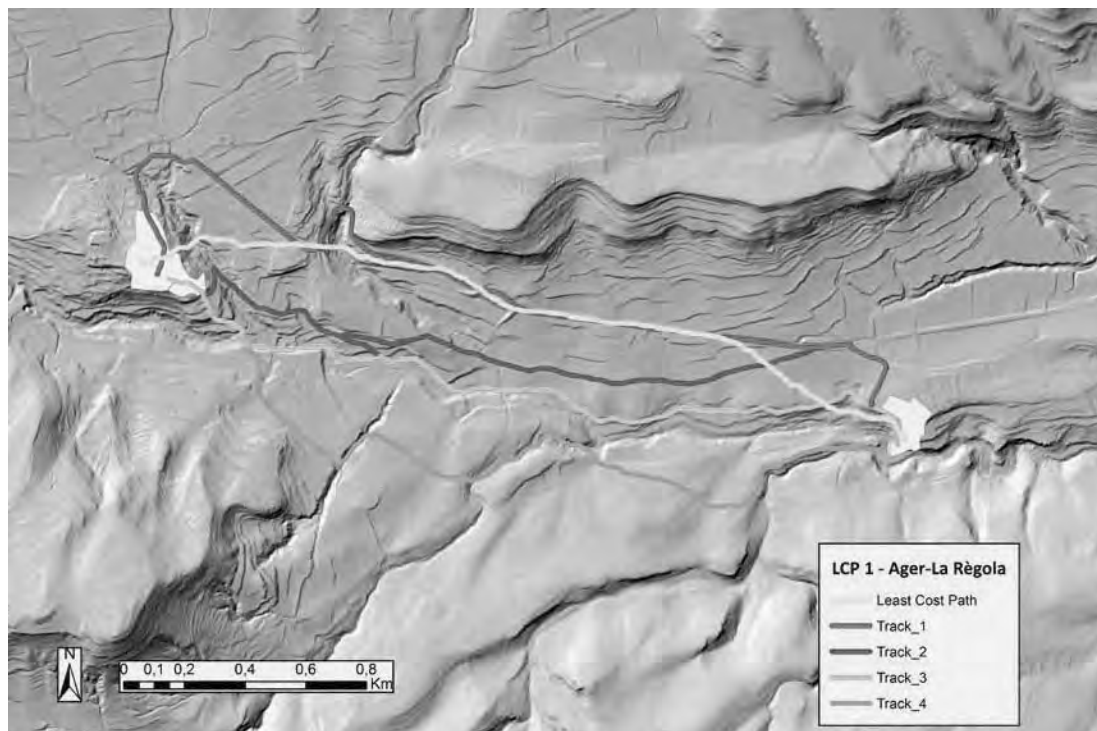


Figure 93. Results of the Least Cost Path calculated on the itinerary from Ager to La Règola.

The results of the least cost path applied to the second itinerary, from Ager to Agulló, were more interesting than the first case. As it is visible from the image the track generated by the least cost path algorithm passes through the centre of the track bundle. In the first half of the track it follows the track 1d and the track 1, while in the second portion it passes very near the tracks 2b and 2c. It is very interesting to notice that this track passes very close to the churches of *Santa Maria del Pla* and *Santa Helena* and over an area that is well visible from the tower of *Sanui*, as we will explain in the next chapter when analysing the visibility of the defensive system.

The third analysis from Agulló to Corçá showed another interesting situation. On the first portion of the least cost path, the track follows a straight direction cutting the smooth surface around the track 1. When arriving at the second portion of the itinerary, the path starts following a well-defined direction clearly constrained by the geomorphology of the area and almost superposing the track 1. In general, it seems that the entire track is more similar to the track 1 than the track 2. It is possible that the track 2 responds to the attraction generated by the church of *Sant Pere Martir* that polarised the movement toward north.

Finally, the results of the least cost path analyses made to the two regional itineraries showed an interesting scenario. Comparing the results of the analysis with the tracks marked from the aerial photographs, we see that the results are very similar, especially for the IT2. In the area around Corçá and La Régola the tracks are almost entirely superposed while near Ager the track passes a bit norther. At the contrary, the IT 1 seems to have a different path in the climbing part of the Montsec where it goes straight to the hill. This difference might be provoked by the polarisation that the site of Claramunt exercised on the track and that we did not consider in this case. Another interesting fact is that the two tracks cross just in the point of the positioning

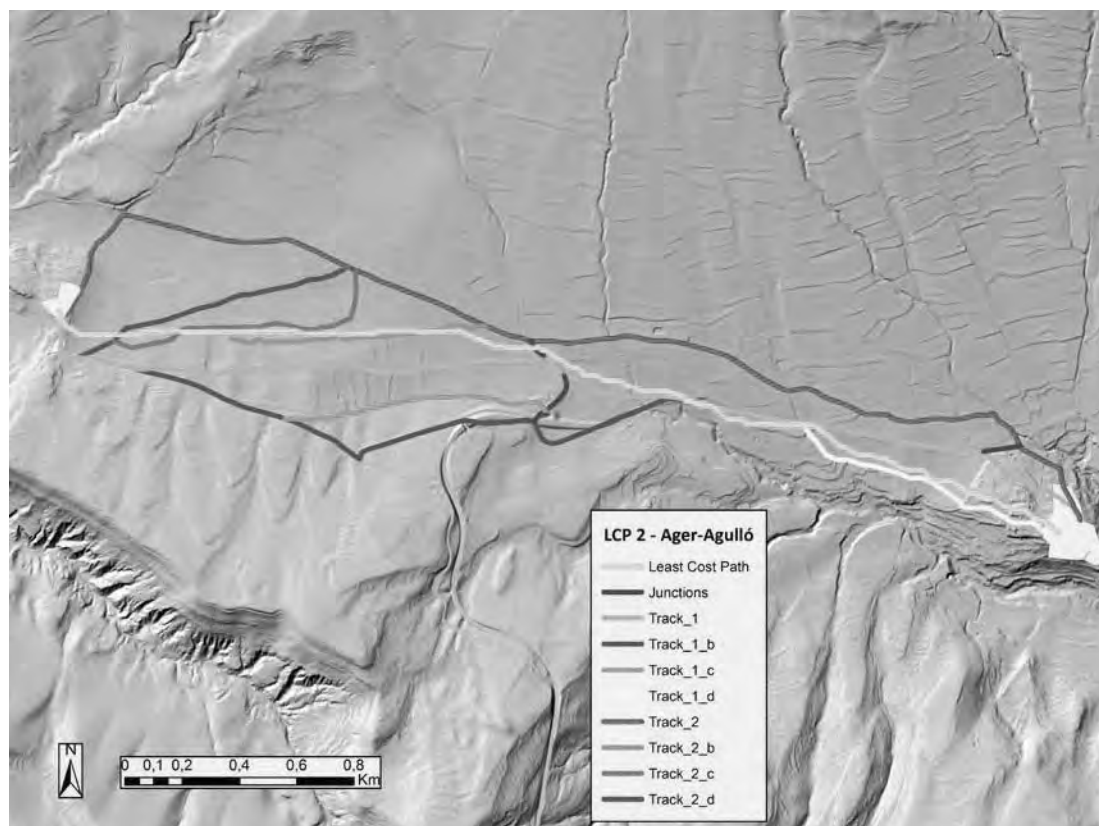


Figure 94. Results of the Least Cost Path calculated on the itinerary from Ager to Agulló.

of the Santa Coloma church. This is interesting to justify the strategic position of the church for the plain area of Ager.



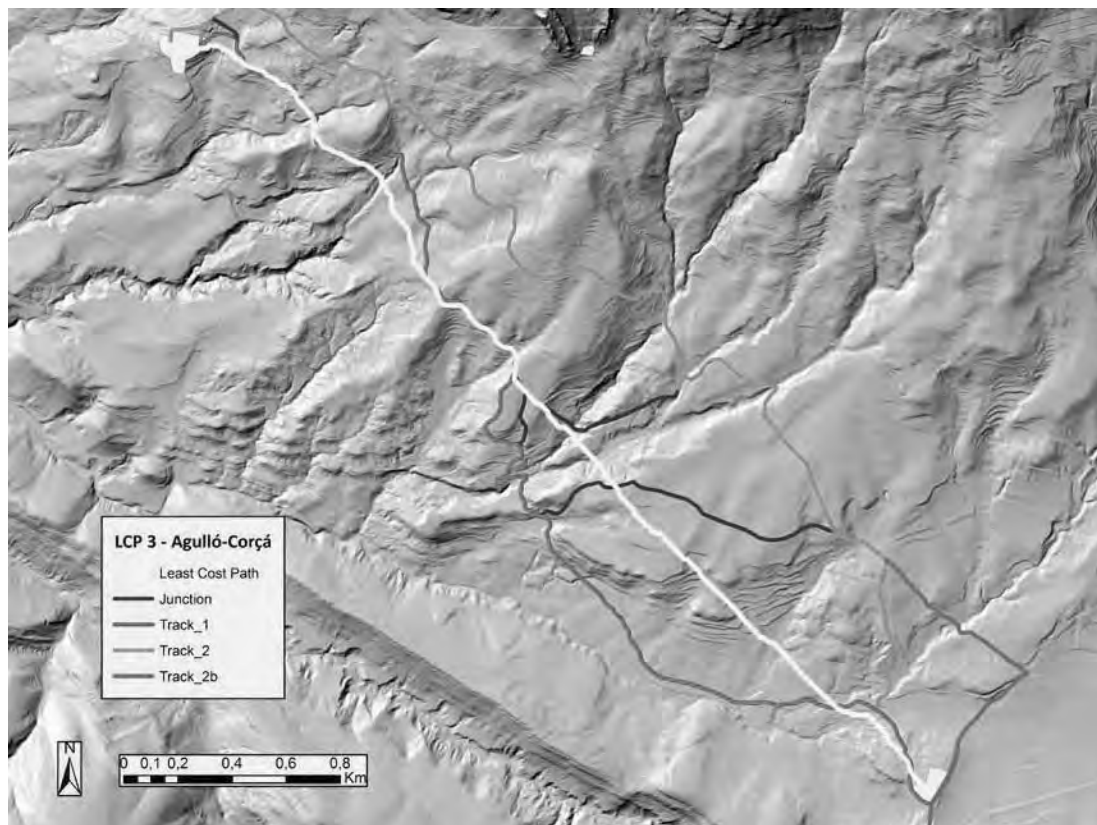


Figure 95. Results of the Least Cost Path analysis applied to the third itinerary from Agulló to Corçá.

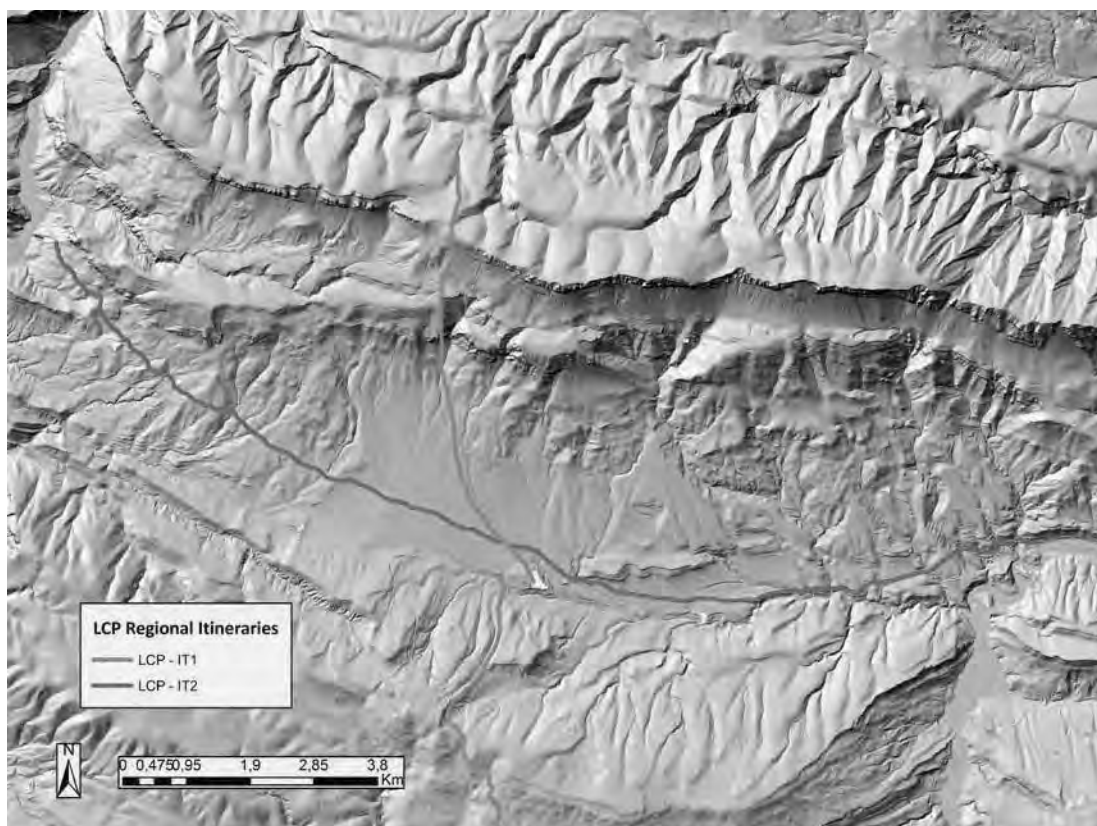


Figure 96. Results of the Least Cost Path analysis applied to the main regional itineraries. The crossing point corresponds to the location of the church of Santa Coloma.

## 5.17 CONCLUSIONS

In this chapter, we dealt with the structure of the ancient landscape of the Ager Valley approaching it from the aerial images, the cartography and the remote sensing sources. We analysed the structure of the landscape applying the historic landscape characterization based on the geomorphological, geological and historical characters of the different areas of the valley. We tried to detect the main structure of the landscape analysing the parcel systems morphology, the morphological units and their relations with the road network. We approached it from both Archaeogeography and Predictive Archaeology methodologies comparing the different results in order to detect the validity of the methods and to perceive the peculiarity of the landscape structure.

Even if we have evidences of the presence of Iberian settlements in the Valley, it was more difficult to associate to this period a parcel system or a landscape particular configuration. More research should be made in this sense in collaboration with specialists of the Iberian period. Finally, we were able to support the hypothesis of the Iberian origin for the main route from the plain of Lleida to Ager and toward the Montsec named IT1.

We saw that the organisation of the Ager Valley parcel system can be ascribed to the landscape reorganisation occurred in the turn of the 1<sup>st</sup> millennium after the conquer of the Valley by the Christian counties. The major part of the archaeological evidences and written documents confirm this chronological attribution and the relations between the parcel morphology, the road networks and the settlement position seem to point towards a general structuring impulse promoted between the 10<sup>th</sup> and the 11<sup>th</sup> century.

In the following chapter, we will use these information to relate the structure of the landscape to the settlements, and the main archaeological sites of the valley in order to get a more precise definition of the chronologies and of the periodisation of the medieval settlement of the Valley.

# 6

## DEVELOPMENT AND ORGANISATION OF THE AGER TERRITORY IN THE MIDDLE AGES: LANDSCAPES, SETTLEMENTS AND ARCHITECTURES

### INTRODUCTION

The approach followed in this part offers a general interpretative framework of the Ager Valley territory between the 5<sup>th</sup> century and the 14<sup>th</sup> century. The common ground of this research is the use of multiple sources:

- a) The edited written sources
- b) The results of the archaeogeographic analysis
- c) The place names
- d) The archaeological data from the architectures, the excavation and the survey as well as from the published works and the reports made by other archaeologists.

We are aware that this approach may entail several constraints because of multiple factors. The surveys we made in the territory of the valley have been not systematic because many areas of interest are urbanised, other are occupied by the woods and inaccessible, and other areas are cultivated as orchards and having a high level of grass that reduced visibility. Another important issue we had to face is that not all the used sources are located in the same chronological window. For example, for the

architectures, we can start approximately from the 10<sup>th</sup> century, for the written sources we have to start from the 11<sup>th</sup> and 12<sup>th</sup> centuries and a higher quantity of documents is available only from the 13<sup>th</sup> century. For the archaeological excavation, we have scattered data from the 5<sup>th</sup> to the 18<sup>th</sup> centuries. Finally, both written and archaeological sources are punctual data over the space-temporal continuum of the landscape. As we have seen for the archaeogeographic analysis, the shapes of the landscape have a resilient nature, they depend on many factors and it is almost impossible to determine a starting or ending point without an explicit data coming from archaeology or a written source.

Considering these limits at an interpretive and chorological level, the global approach to the landscape has been based on “windows” of different informative potential that have been joined to form a global approach. Even with its complexity we tried to abandon the classical view based on the single site and to afford a discourse of global archaeology that proceed towards a new direction for the archaeological questions that the scientific community is affording since a decade<sup>357</sup>. Nevertheless, the complexity of this approach and the different quality of data leave many questions and unsolved problems, as we will see at the end of this chapter.

## 6.1 THE SETTLEMENT SYSTEM

In this subchapter, we are going to face an interpretation of the settlement of the Ager Valley during the Middle Age using some tools of the spatial analysis and referring to the archaeological evidences and the written sources. Before entering this, we are going to make some brief considerations about the earlier chronology, the Iberian and Roman periods.

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<sup>357</sup> An important review of the last approaches tested by medievalist scholars are in Gian Pietro Brogiolo, ed. *Apsat 3. Paesaggi Storici Del Sommolago*. Mantova: SAP Società Archeologica, 2013, and from the french part in Joëlle Burnouf. "La Nature Des Médiévistes." *Études Rurales* 167-168 (2003): 215-26.

### 6.1.1 THE IBERIAN AND ROMAN PHASES: A DARK ERA?

From an archaeological point of view, the research on the Iberian and Roman frequentation of the valley represented a critical point due to a physiologic lack of evidences. Currently, delineating the settlement organisation of these periods is a very tough task. We should start analysing the evidences proceeding from Ager, the main settlement of the valley.

The finding of a coin already reported by Francesc Fité thirty years ago was the first hint of a possible Iberian frequentation<sup>358</sup>. According to the archaeological evidence, it is known that the hilltop of Ager was frequented since the Bronze Age and during the Iberian period<sup>359</sup>. The archaeologist Montserrat Coberó that guided several archaeological excavation in the hilltop since 1993 affirmed, in the report of the first excavation, the finding of Bronze Age and Iberian pottery as residual material inside modern stratigraphic units<sup>360</sup>. During the following excavation, in 1994, 1995 and in 1996 the presence of an Iberian frequentation of the area was confirmed, indeed the excavation of some pits revealed in their filling a consistent amount of pottery that Coberó dated to the Iberian period until the 2<sup>nd</sup> century BC. More recently in 2002 and 2003 the archaeologist Vila directed two other campaigns of excavation in the hilltop of Ager. He confirmed the presence of Iberian pottery but in addition revealed some structures located near the current bell tower<sup>361</sup>. Both the works of Coberó and Vila are still unpublished but thanks to the file retrieved in the archive of the *Departament de Cultura* we can be certain of an Iberian settlement.

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<sup>358</sup> Francesc Fité Llevot. *Reculls D'història De La Vall D'ager...*, p.38.

<sup>359</sup> The first report of a Bronze Age frequentation is the Coberó's second report of 1995. Montserrat Coberó Farrés. "Memòria D'intervenció. Col·legiata De Sant Pere D'ager (Nº 1477)." edited by Direcció General del Patrimoni Cultural. Lleida: Manuscript, 1995. More data are reported in Josep Maria Vila Carabasa. *Memòria De La Intervenció Arqueològica Realitzada a La Col·legiata De Sant Pere D'ager...*, p.27.

<sup>360</sup> Montserrat Coberó Farrés. "Memòria D'intervenció. Col·legiata De Sant Pere D'ager (Nº 1477)..." p. 53.

<sup>361</sup> Josep Maria Vila Carabasa. *Memòria De La Intervenció Arqueològica...*, pp. 64, 65, 73.

This should confirm what archaeologists researching on the Iberian society affirmed about the extension of the *Iltrida* (Lleida) district towards the Montsec mountains that may have been used as the northern border<sup>362</sup>. Unfortunately, these are all the

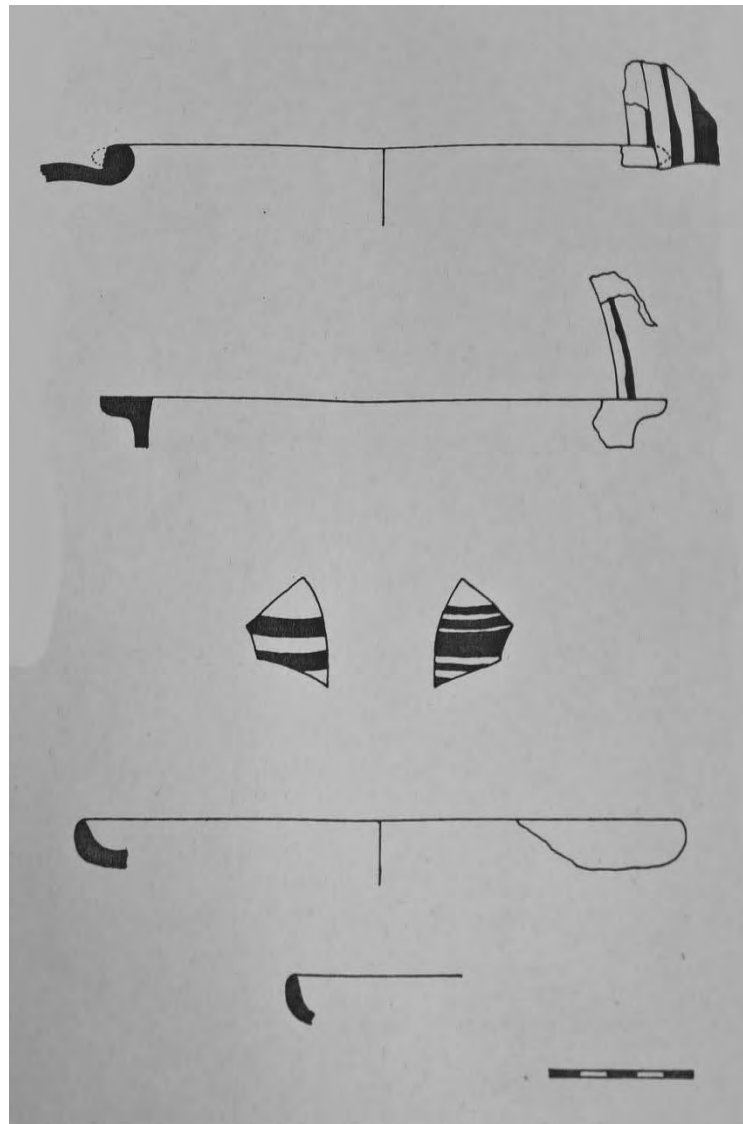


Figure 97. Iberian pottery found in the Coberó's excavation of 1994. The archaeologist interprets the chronology around the 2nd century BC. (Source: Coberó 1995)

evidence of Iberian frequentation that we know in the valley and that can be addressed to a stable settlement.

If the Iberian situation of the valley seems difficult to understand, for the roman period the information are possibly worse. In addition, this work, in a certain manner,

<sup>362</sup> Joan Sanmartí. "La Conformación Del Mundo Ibérico Septentrional." *Palaeohispanica* 5 (2005): 333-57.

contributes to reject the already few references that scholars, mainly historians, used during the 20<sup>th</sup> century to propose Ager as a roman settlement.

We already mentioned, in the first chapter, the questions about the Ager place name concluding that it is very clear its descriptive origin as well as the absolute exclusion of a Berber derivation. In addition, we saw that the etymology is not enough to prove a Roman origin of the site, considering that it could also have a derivation from a Medieval Latin as explained by the cited philologists.

From a material point of view, both the supposed "roman road" and the sarcophagus cannot be accepted as evidence to justify a roman settlement. We saw that the excavation of the road did not confirmed a roman origin and we also saw that there is a good reason to think that the path could have been marked since the Iberian period, according to the early archaeological phase of the Ager settlement. Finally, as Francesc Fité stated many times in his publications, the sarcophagus can be seen as an object imported to Ager for its prestige<sup>363</sup>. In the Montserrat Coberó's report of 1996 very few fragments of pottery were interpreted as roman and in the pottery file of the excavations are often marked as "small fragment" or "high deteriorated fragment" of difficult interpretation. No other archaeological evidences even of successive excavations can be associated to a roman phase of Ager.

An important evidence often used to justify a roman origin of Ager is the northern wall of the hilltop of Ager, with the squared tower and with the rest of the wall throughout the base of the hilltop. Since the assertion of Puig Cadafalch and Pita Mercé a part of scholars consider this wall of roman origin and use it to justify the presence of a roman *castellum* in the Ager location<sup>364</sup>. The most recent publication on this subject was the Francesc Fité and Cristina Masvidal publication of 2015 where the wall was considered as pertaining to an Islamic settlement<sup>365</sup>.

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<sup>363</sup> Francesc Fité Llevot. "Arte Y Poder: Obras De "Prestigio" Y Símbolos De Poder. Algunos Ejemplos Catalano-Ribagorzanos." In *Imágenes Del Poder En La Edad Media*, edited by Etelvina Fernández González, 195-211. León: Universidad de León, 2011.

<sup>364</sup> As we will see we not consider the squared tow

<sup>365</sup> Francesc Fité Llevot, and Cristina Masvidal. "Restes Subsistents Del Recinte Fortificat Del Castell D'ager, D'època Andalusina." *Revista d'Arqueologia de Ponent* 25 (2015): 205-23.

As expected, in our analysis of the architecture of the wall we identified several phases of construction and restoring. The most surprising fact is that the evidences used to identify a unique circle of wall built around the hilltop during the phase adscribed to the squared tower, the supposed roman phase, actually have at least two different constructive schemes. Two identified in the northern side, and one in the west side of the wall circle. As visible from the image, the first constructive phase of the tower is constituted by large block of sandstone mainly rectangular and set with lime. The other portions of the northern block of the wall can be associated to this constructive phase. At contrary, the technique used in the west part of the wall is characterised by smaller and squared blocks of sandstone. Then we can hypothesize a different constructive phase for this portion of the wall that do not correspond to the northern one. Comparing this second portion of the wall with the constructive techniques of the wall of *Pla d'Almatà*, 30 Km south from Ager, we found many similarities respect to the squared tower. In our opinion, the northern tower is not a roman building *strictu sensu* but could have been built during the Iberian period and in particular around the 4<sup>th</sup> - 2<sup>nd</sup> century BC that correspond to the Iberian evidence of frequentation in Ager exposed by Coberó's work. Instead, the west portion of the wall may correspond to an Islamic phase with the reutilization and expansion of the existing wall in the 8<sup>th</sup> century. As we will see along this chapter, the presence of an Islamic settlement in the hilltop of Ager is almost certain from the archaeological evidences.

In 2002 the archaeologist Josep Vila excavated a portion of the northern squared tower, in particular the only investigated portion was the block corresponding to the second building phase of the tower. The filling material of this portion of the tower was dated to the 16<sup>th</sup> century with a coin and the pottery evidence<sup>366</sup>.

During our work, we made an analysis radiocarbon dating of the lime filling the surface of the tower in order to identify a possible chronology. Unfortunately, the absolute chronology given by the analysis did not solve the problem because it gave

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<sup>366</sup> Josep Maria Vila Carabasa. *Memòria De La Intervenció Arqueològica...*, p. 44.



a reference to the 16<sup>th</sup> century. It may be associated to a restoration of the tower made in the external surface of the wall.



*Figure 98. The two main constructive phases of the northern square tower.*

Finally, all the evidences exposed until now reject the hypothesis of a roman settlement of Ager while they reveal a certain Iberian frequentation of the hilltop. In our opinion, the configuration of the village of Ager started during this period with an abandonment occurred in the 1<sup>st</sup> century BC. The reading of the archaeological stratigraphy suggest that after the abandonment the hilltop was reoccupied in the 8<sup>th</sup> century from an Islamic community. We have a significant hiatus in the chronology

but this is not an exceptional situation. In the West Mediterranean panorama, it is common to find a prehistoric and protohistoric occupation over a hilltop with an abandonment during the roman period and a reoccupation in the medieval centuries. Many examples of this phenomenon are detectable from Italian<sup>367</sup> and Spanish<sup>368</sup> archaeology.

We started this subchapter with a question and we can certainly assert that we are not dealing with a dark age. We possess the evidences to base our interpretation of an Iberian starting point and a successive abandonment. Nevertheless, it is clear that in the archaeological science nothing is definitive and only excavating all the settlement will be possible to depict a more precise frame.

Even if we observe a significant stop in the occupation of the hilltop of Ager, we are not concluding that the valley was completely abandoned during the roman centuries. In our opinion, a community of scattered settlement remained to work in the plain of Ager, Agulló and La Règola and became the basis for the early medieval settlement.

#### 6.1.2 THE EARLY MEDIEVAL SETTLEMENT. A MONASTIC COMMUNITY?

After the excavation that we carried out in the site of Santa Coloma, 1Km from Ager, we had a more certain evidence of the population of the valley during the 5<sup>th</sup> and 6<sup>th</sup> centuries. We correlated the data of the excavation with other archaeological remains to depict a hypothesis of settlement in the early medieval centuries before the advent of the Islamic power.

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<sup>367</sup> Matteo Frassine, Guido Rosada, Marco Fabris, Vincenzo Achilli, *et al.* ""Mura Della Bastia" - Onigo Di Pederobba (Treviso). Ricerche Archeologiche, Rilievo 3d Laser Scanning E Anastilosi Virtuale in Un Castello Del Pedemonte Trevigiano." *Archeologia e Calcolatori* 19 (2008): 301.

<sup>368</sup> Juan Antonio Quirós Castillo. "L'eccezione Che Conferma La Regola? L'incastellamento Nella Valle Dell'ebro Nel X Secolo: Il Castello Di Treviño." *Archeologia Medievale* 38 (2011): 122.

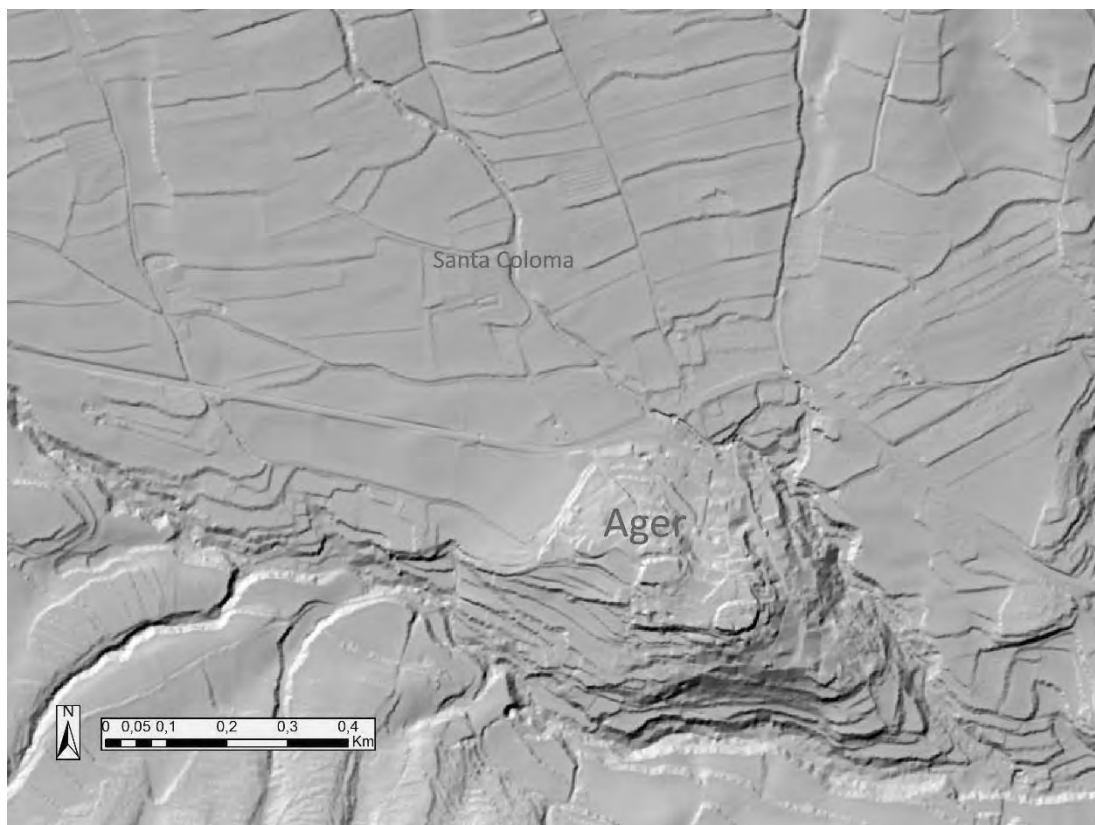


Figure 99. Santa Coloma Location.

Until now the theories of a population were based on supposition and comparison of sporadic evidences with the archaeological Paleo-Christian (or Late Antique) sites excavated in Catalonia, in particular the site of *El Bovalar* excavated during the 20<sup>th</sup> century until 1987<sup>369</sup>. This work represented during the last 30 years a referring point for the researches about the paleochristian and visigotic settlements.

These evidences were noted in the Ager Valley for the first time at the beginning of the 20<sup>th</sup> century. As we reported in the first chapter, the architect Joan Puig while working on the hilltop of Ager for securing the structures of the collegiate, reported an advisory from a local people who found the remaining of some stone sarcophagi in a vineyard in the area named Santa Coloma<sup>370</sup>. These evidences were not investigated until the excavation of 1983 and 1984 when during the construction of a road other examples of the some empty stone sarcophagi were discovered<sup>371</sup>.

<sup>369</sup> Pere de Palol. *El Bovalar (Seròs; Segrià): Conjunt D'època Paleocristiana I Visigòtica*. Barcelona: Departament de Cultura, 1989.

<sup>370</sup> Josep Puig Cadafalch. *L'arquitectura Romanica...* vol. 2, p. 413.

<sup>371</sup> Prim Bertran Roige, and Francesc Fité Llevot. "El Jaciment Arqueologic De Santa Coloma....

During this excavation were also identified the remains of a church. The interpretation made by the archaeologists who excavated the site of Santa Coloma were based on the comparison with the structures of *El Bovalar*, in particular the sarcophagi were dated to the 7<sup>th</sup> century according to the material similarity.

In 2014 and in 2015 due to interests for the Ager valley in our research group, it was decided to start a campaign of excavation in the site of Santa Coloma. The excavation was carried out at the end of the 2014 and in summer 2015 and they lasted in total 7 weeks. During the first campaign we decided to restart from the excavation of 1984 even if we did not have the exact location of the previous work due to the impossibility in retrieving the original reports. Nevertheless, thanks to the indication of the former archaeologists we realised four pits in the supposed location.

In the first campaign, it was found a strong evidence of the frequentation of this area, a sarcophagus of the same typology of the ones described above with a buried person still on its place. Even if the bones recovered were in a very degraded condition we could obtain a sufficient portion to make a 14C analysis and obtain an absolute chronology between the years 428 AD and 499 AD with a 38% of probability and between the year 500 AD and 601 AD with a probability of 61%. The second probability is larger because also the time interval is larger then there is a major probability to ascertain the right year, but if they are analysed in the right proportion the probability are very close. Then, we must locate the death of this individual between the end of the 5<sup>th</sup> and the 6<sup>th</sup> centuries. This is a very important result because it allows connecting the typology of the burial to a more secure chronological period.

During the 2015 campaign, the excavation area was extended to south. In this area, we excavated some architectural structures, mainly wall foundations, located at a higher altitude from the structures of 2014. Also in this campaign we found several burials, one was located in a stone sarcophagus of the same type as the 2014 one, but it was missing the cover and it probably was a reuse because as seen from the anthropological analysis the buried individual could not fit correctly. Another burial, only partially excavated was located in an earth grave and a third typology constituted by a stone sarcophagus bigger than the other two and with a different

plain cover that was not open due to the lack of time. Resuming we found at a same level three typologies of burial in a very limited space. We expected to excavate it in the 2016 campaign, but due to lack of funding, we were forced to cancel the entire campaign.

The individuals founded during the 2015 campaign were studied with multiple methodologies. The good conservation of the bones allowed an anthropological analysis made by the anthropologist Izaskun Ambrosio<sup>372</sup>. The chronological test also in this session gave very interesting results. The individual buried in the sarcophagus was dated with high probability between 684 AD and 779 AD. A low probability of only 20% was assigned to the years 789 AD and 873 AD. We should locate the date of death of this individual between the end of the 7<sup>th</sup> and the beginning of the 8<sup>th</sup> centuries. This chronology corresponds to the stratigraphic data, with the difference of altitude and the reutilisation of the burial.

The anthropological analysis revealed interesting data about the buried individuals. The first important information came from the analysis of the sarcophagus that revealed the presence of fragments ascribed to two more individuals. This data confirms the reutilisation of the burial at least two more times. The main individual



*Figure 100. 2014-2015 excavated area in Santa Coloma. (Source: Antonio Porcheddu)*

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<sup>372</sup> Izaskun Ambrosio. "Informe Antropològic De Santa Coloma D'ager (La Noguera) ", unpublished, 2016.

was preserved at 95.5% and it was a man aged approximately 45 years old and an approximate height of 162 cm. The burial ritual is related to the Christian tradition and it is oriented from west to east. The individual was characterised by degenerative pathologies like arthrosis and almost completely loss of dentition. Other pathologies are related to the overload of the spinal column like hernias and vertebral arthrosis. Many other details visible in the report are a fracture of the right femur that caused a lameness. Finally, the health situation of this individual allows to think of a advance age or an intense physical activity.

An important conclusion of the anthropological analysis is that all the buried individuals studied until now, including an individual studied in 1996 from the excavation of 1984<sup>373</sup>, were men. This may let think that in this necropolis were buried only masculine individuals.



Figure 101. Excavated area in Santa Coloma. (Source: Antonio Porcheddu)

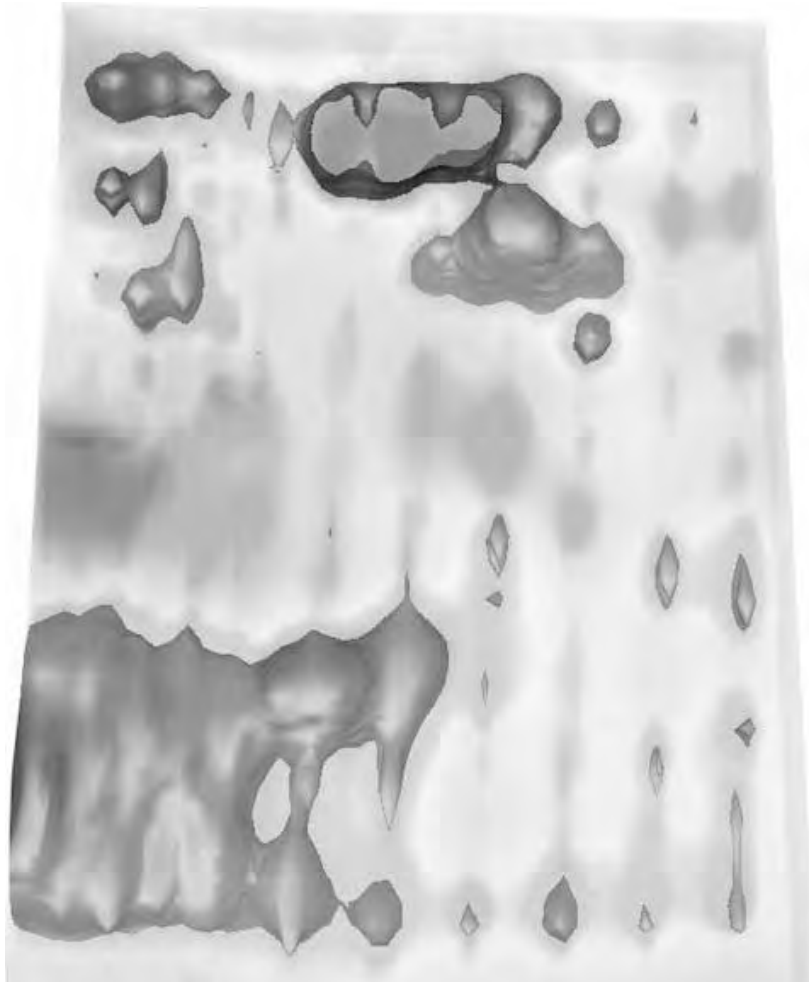
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<sup>373</sup> Domingo Campillo, and Francesc Fité. "Estudio Paleopatológico De Un Individuo Del Siglo VII, Exumado Junto a La Iglesia De Santa Coloma (Ager, La Noguera) (398 - Lp)." In *Actas del II Congreso Nacional de Paleopatología*, edited by Asociación Española de Paleopatología and Universitat de Valencia, 79-84. Valencia: Universitat de Valencia, 1996.



*Figure 102. Santa Coloma sarcophagus excavated in 2015. (Source: Antonio Porcheddu)*

Finally, in autumn 2016 we made a geophysical prospection of the surrounding area of Santa Coloma site to detect its possible extension. The used techniques were electrical tomography and ground penetrating radar. The results from both techniques are very similar and allowed to detect some anomalies at a deep of 90 centimetres from the surfaces. Two of them have been interpreted as possible walls while other anomalies are more similar to burials. The interpretation has been possible thanks to the comparison between the anomalies produced by the excavated portion and the anomalies visible in the surrounding area. The detected structures continue the west-east orientation of the excavated ones while it does not seem that the architectures extends towards the south. In addition, the burials are interesting data and seems to continue the orientation of the excavated ones, from west to east.



*Figure 103. Electrical Thomography results in the southern area of Santa Coloma excavation. The first line of the anomaly corresponds to the excavated area while the second and the third line have been interpreted as structures comparable to the excavated ones.(Source: Antonio Porcheddu)*



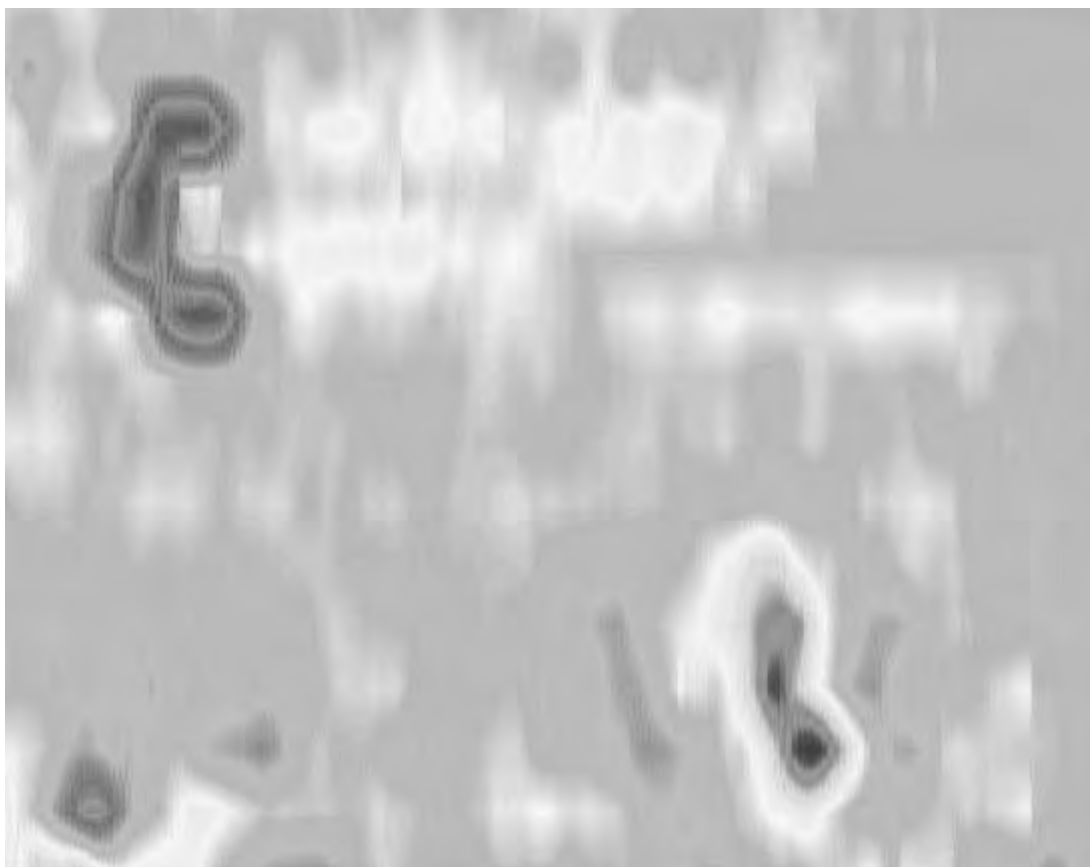


Figure 104. Ground Penetrating Radar in the area of Santa Coloma. There are some anomalies that can be interpreted as burials.

Using the new data obtained by these studies is now possible to associate the similar evidences to a defined chronology and delineate a framework of occupation between the 5<sup>th</sup> and the 8<sup>th</sup> centuries. Indeed, in the valley we have four sites more where there are evidences of stone sarcophagi burials. In addition, all are located around the plain of Ager and Agulló marking the border of this area. The site of Sant Pèrre Martir of Agulló is an important example. We encountered this site when analysing the morphological unit 9, indeed this site is located in a crossroad of five itineraries going to Ager, to Corçá, to Agulló and to the north of the valley. According to the archaeological information in these area have been found the rest of a necropolis with sarcophagi similar to those found in Santa Coloma<sup>374</sup>.

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<sup>374</sup> Francesc Fité Llevot. "Sarcòfags De Sant Pere Màrtir D'agulló." In *Catalunya Romana*, edited by Fundació Enciclopèdia Catalana, 142. Barcelona: Cayfosa: Industria Gràfica, 1994.

Another site of interest is the necropolis located near the 11<sup>th</sup> century tower named Torre del Negre located at the northern border of the Ager plain and in the direction of the site of Pedra. Also in this area we can found a group of stone sarcophagi of the same typology of the Santa Coloma and still in situ even if without the human remains. There is no information about a possible village or church directly associated to this burial ground but only of a church associated to the tower that has a later chronology. During the survey that we made in this area, we found a significant number of pottery, mainly of common typology, that can be associated to an early medieval chronology.

A fourth site of interest is the former church of Santa Maria del Pla excavated in 2011. Santa Maria del Pla has was a church mentioned in the written sources since the 11<sup>th</sup> century and located in the southern limit of the Ager plain and near the plain of Agulló and the road of access to the Ager Valley. During the excavation were found several burials and amongst them two sarcophagi of the Santa Coloma typology, with one having few human remains in it. Once more, this area can be dated from the 5<sup>th</sup> century onwards as the archaeologist who excavated it proposed in their report<sup>375</sup>.

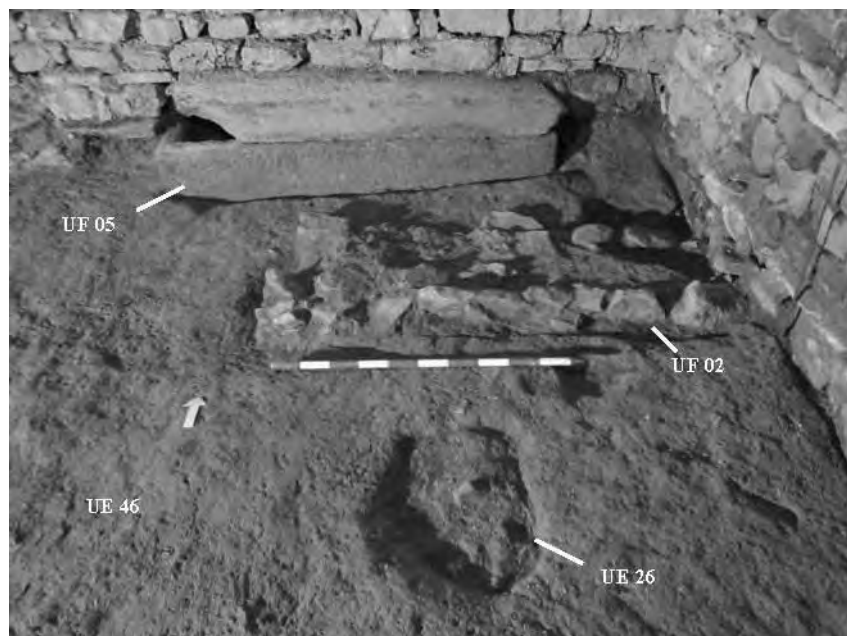


Figure 105. Sarcophagus found in the area of Santa Maria del Pla inside the current building. (Source: Trullás 2011)

<sup>375</sup> Òscar Trullás Ledesma. "Memòria De La Intervenció Arqueològica... pp. 37-38.

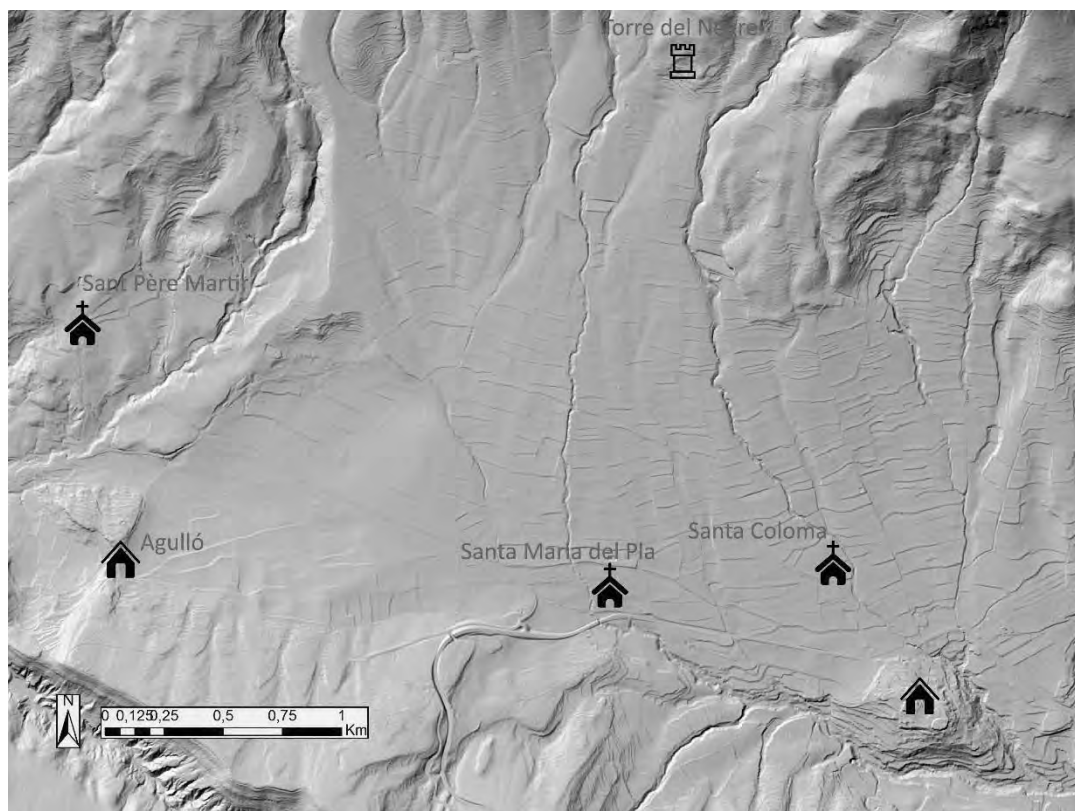


Figure 106. Location of the main sites ascribed to the Early Middle Ages phase.

Thanks to all these data is possible to delineate a framework of a population in the plain area of the valley during the early middle ages. In our opinion throughout this period the settlement was mainly scattered in the plain area and built with low quality materials, this should explain the lack of architectural evidences. The churches with the annexed necropolis were positioned at the points of passage throughout the plain and between the plain and the mountains creating a relative dense network in the landscape. Both in the excavations of Santa Coloma and Santa Maria del Pla the lack of pottery of this period reflects a different economic panorama as it happens in the entire West Europe between the 5<sup>th</sup> and the 7<sup>th</sup> centuries. The archaeological literature propose for this period some main interpretive models that refer to the general situation of the West Europe between the Late Antique and the Early Middle Ages<sup>376</sup>. The demographic crisis, the changes in the economic structure and a new

<sup>376</sup> Marta Sancho Planas. "Aldeas Tardoantiguas Y Aldeas Altomedievales En La Sierra De Montsec (Prepirineo Leridano): Hábitat Y Territorio." In *The Archaeology of Early Medieval Villages in Europe*, edited by Juan Antonio Quirós Castillo, 275-87. Bilbao: Documentos de Arqueología e Historia, 2009.

model of social organisation based on the Christianisation are the main point of debate.

To understand better the configuration of this area we should enlarge our look on the Ebro Valley and especially on the course of the Segre and Noguera Pallaresa rivers. As has been recently noticed, along this axes of communication there are two important archaeological sites considered on a preliminary way as Visigoth monasteries<sup>377</sup>, the site of *El Bovalar*, already mentioned, and the site of *Morulls* that have very similar characteristics, as well as the typical stone sarcophagi deeply discussed above. According to the interpretation of Jordina Sales, the sites were located on a monastic route of Christianisation that used the connectivity of the river to enter the mountain and that has been associated to the transhumant routes from the plain of Lleida to the Pyrenees<sup>378</sup>. Following this interpretation and looking to our data, we think that the economic flux between the plain and the mountain may have facilitated the spreading of the Christianity with the establishment of monastic settlements also in the Ager Valley. This would also explain the prevalence of masculine individuals found in the analysed necropolis, these might have been associated to monastic churches of Visigoth culture. If we look outside the valley at the northern side of the Montsec we see that other two sites interpreted as Paleo-Christian monastic sites were recently excavated, *Sant Martí de les Tombetes* and *Els Altimiris*. Both are located on a strategic position, Els Altimiris at the passage of the Montsec from the Noguera Ribagorçana river while Sant Martí at the opposite side near the Noguera Pallaresa river. The first is dated between the 5<sup>th</sup> and the 9<sup>th</sup> century<sup>379</sup>AD while the second is occupied from 5<sup>th</sup> to 13<sup>th</sup> century<sup>380</sup>. This situation then confirms the landscape organisation of the area during the early middle ages

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<sup>377</sup> Jordina Sales Carbonell, and Natalia Salazar Ortiz. "The Pre-Pyrenees of Lleida in Late Antiquity: Christianisation Processes of a Landscape in the Tarraconensis.". *Revista d'Arqueologia de Ponent* 23 (2013): 27-44.

<sup>378</sup> Jordina Sales Carbonell, and Natalia Salazar Ortiz. "The Pre-Pyrenees of Lleida in Late Antiquity...", p. 40.

<sup>379</sup> Marta Sancho Planas. "Els Altimiris." In *Villa 3. Histoire Et Archéologie Des Sociétés De La Vallée De L'ebre (Viie-Xie Siècles)*, edited by Philippe Sénac, 67-90. Toulouse: Presse Universitaires du Mirail, 2003.

<sup>380</sup> Walter Alegría, and Isabel Hidalgo. "Els Materials Ceràmics Dels Altimiris I Sant Martí De Les Tombetes, Dos Jaciments Tardoantics I Altmedievals Al Prepirineu De Lleida." In *V Congrés D'arqueologia Medieval I Moderna De Catalunya. Barcelona 22-25 De Maig De 2014*, edited by Josep Maria Vila Carabasa, 1041-56. Barcelona: Ajuntament de Barcelona, 2015.

and it configure the plain of Ager as an essential point of passage inside the “big picture”.

This discourse partially answers to the initial question. We think that the main settlement in the Ager valley during the Early Middle Ages was structured around a skeleton of monastic establishments of Visigoth culture that served as organisational points for the valley. We think that it is not a casual fact that the main sites of this period are located around the plain area and not in the hills, because this was, and it still is, the major productive area of the entire valley.

### 6.1.3 THE ISLAMIC CONQUEST: THE (RE)BIRTH OF THE FRONTIER?

The Islamic question of the Ager Valley is a very long lasting debate that can be summarized with two interrogations: was Ager an Islamic hisn? Was the Ager Valley holding a stable Islam community comparable to the central and southern areas of the Lleida district? Our answer to these questions are yes and not.

To support our hypothesis it is enough to look at the archaeological record. We must return to the hilltop of Ager and to the excavations made by Montserrat Coberó in the nineties. During the excavation of 1993, she already noticed the presence of Andalusian materials as residues of the more recent stratigraphy<sup>381</sup>. During this research, the possibility of an Andalusian settlement in the Ager hilltop was still a very hard hypothesis to demonstrate. Fortunately, in the following years the excavation exposed a clearer panorama in multiple points of the investigated area.

In the A sector of the Coberó excavation, corresponding to the current area of entrance to the hilltop, she excavated several pits that were filled with Iberian materials. The covering stratigraphic units of these pits revealed a dense presence of Andalusian pottery<sup>382</sup>. In the reports of 1996 she catalogued several typologies of Andalusian pottery recovered from the A sector as well as from multiple parts of the hilltop: not only glazed but also common typologies. According to the interpretations

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<sup>381</sup> Montserrat Coberó Farrés. "Memoria D'intervenció. Col·legiata De Sant Pere D'àger (Nº 1477)...", p.47.

<sup>382</sup> Montserrat Coberó Farrés. "Informe D'intervenció Arqueològica Dins...", p. 65.

made by Coberó, these materials are dated between the 9<sup>th</sup> century to the first half of the 11<sup>th</sup> century<sup>383</sup>. In addition, the stratigraphic units referring to these materials were associated to two small structures that Coberó interpreted as proceeding from a domestic context due to its constructive techniques and the used material. The first was interpreted as a basement of an adobe wall, while the second also as a basement of a vertical structure, both have been associated to the Andalusian occupation<sup>384</sup>.

During the following excavation on the hilltop in 2001, 2002 and 2003, directed by Josep Vila, the presence of an Islamic settlement was confirmed. In particular, the Vila excavated both the northern and the south sectors of the hilltop making some pits. He detected two more structures referable to the Islamic phase, a pit and a masonry wall<sup>385</sup>. We cannot agree with the Vila's interpretation of the northern tower as an Islamic building considering also that he did not found any reference to an Islamic stratigraphy in the building foundation<sup>386</sup>. He also confirmed the presence of a significant amount of Islamic pottery until the stratigraphy of the 12<sup>th</sup> century<sup>387</sup>.

Even if the northern tower is not directly related with an Islamic foundation, we have another part of the defensive wall of the hilltop that can be referred to the Islamic settlement. It is a basement located in the west side of the hilltop and its conformation is clearly different from the northern portion. As mentioned in the paragraph regarding the Iberian occupation, this portion can be ascribed to a different constructive phase that we think should be the Islamic one. We observed in certainly dated Islamic buildings of the district of Lleida the same techniques used to structure the base of a wall. Squared blocks of stone of medium dimension, and surely smaller than the ones of the northern side, worked with a good quality. Over this portion, it stands the current defensive wall with signs of multiple restoration until the present time. In our opinion, this shred should be the remaining portion of an Islamic wall built to defend the hilltop in the west side during the Islamic occupation of the area between the 9<sup>th</sup> and the 10<sup>th</sup> centuries. Finally, the excavation

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<sup>383</sup> Montserrat Coberó Farrés. "Informe D'intervenció Arqueològica Dins...", p. 65.

<sup>384</sup> Montserrat Coberó Farrés. "Informe D'intervenció Arqueològica Dins...", p. 66.

<sup>385</sup> Josep Maria Vila Carabasa. *Memòria De La Intervenció Arqueològica...*, p. 118.

<sup>386</sup> Josep Maria Vila Carabasa. *Memòria De La Intervenció Arqueològica...*, p. 48 and 117.

<sup>387</sup> Josep Maria Vila Carabasa. *Memòria De La Intervenció Arqueològica...*, p. 118.

of Vila confirmed the presence of Islamic materials in this side of the hilltop, in addition the Islamic pit found here was cut by a medieval wall not far from this area<sup>388</sup>. We are led to think that the Islamic topography of the hilltop was not exactly the same of the present day and that the contemporary arrangement was configured only after the 11<sup>th</sup> century, as we will see in the next subchapter.



*Figure 107. Basement of the west portion of the fortification wall in the hilltop of Ager. The constructive technique is different from the one of the squared tower. (Source: Antonio Porcheddu)*

Until this point, we answered to the first question that we introduced at the beginning of this subchapter, it is certain from the archaeological evidence that Ager has been an Islamic settlement and that it was also a fortified place with a defensive role. We do not know the exact dimension of the establishment nor the chronological interval but, analysing the evidence of the pottery encountered in the 11<sup>th</sup> century stratigraphy by Vila and trusting the written sources, we should located the abandonment of the area by the Islamic power at the beginning of the 11<sup>th</sup> century.

While the archaeological data are clear enough for the hilltop of Ager, they are less explicit for the rest of the valley. This is due mainly to the scarce archaeological activity in the other settlements around Ager and to the difficult in detecting archaeological evidence in the landscape surface. During our survey we did not

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<sup>388</sup> Josep Maria Vila Carabasa. *Memòria De La Intervenció Arqueològica...*, p. 118.

evidenced any significant data that could help the reconstruction of the Islamic settlement in the plain area or in the surrounding hills of the valley. The material evidence like pottery or architectures seem to be scarce in the rest of the valley, these missing data and the written sources, currently, describe us an interesting scenario.

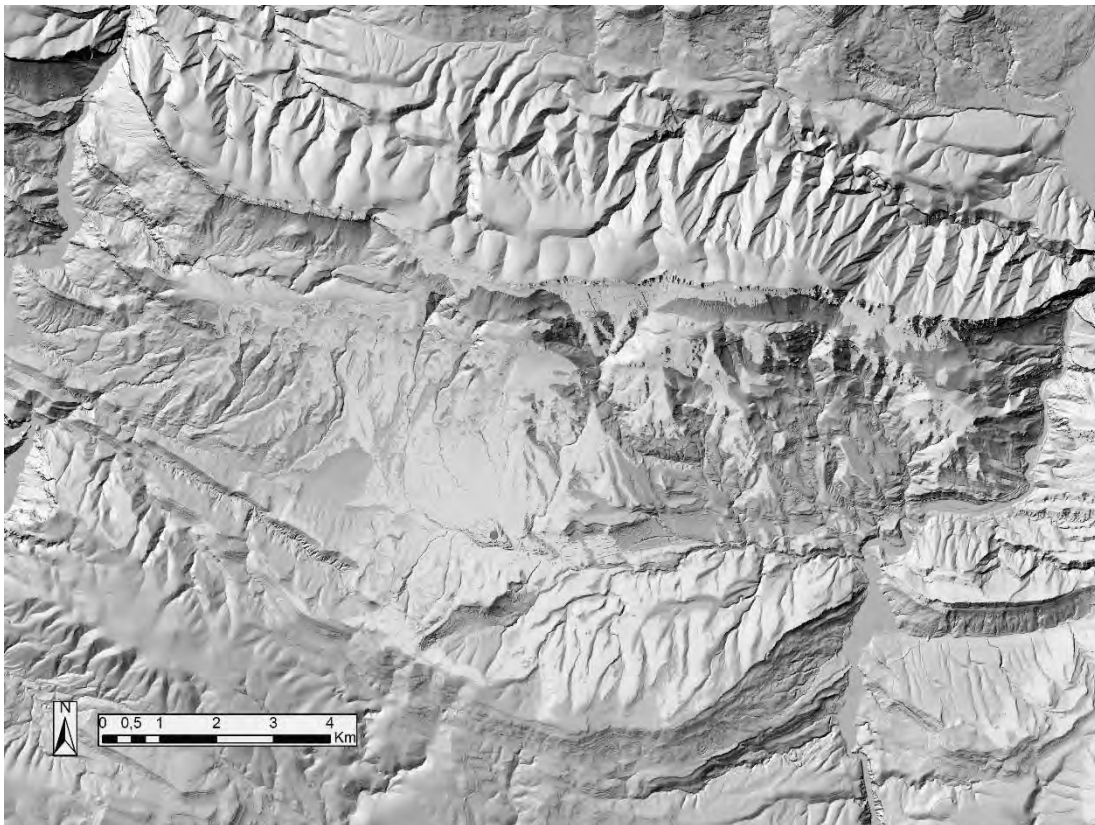
If we observe the position of Ager from a wider perspective, we see that it is located, since the Iberian period, in a strategic point of passage from the plain to the Pyrenees. The passage through Ager is an alternative to the other two ways represented by the rivers Noguera Pallaresa and Noguera Ribagorçana. The two passages of these rivers across the Montsec through the *Congost de Mont Rebei* at west and through the *Congost de Terradets* at east represented also the border points of the counties of Ribagorza and Pallars. All these observations suggest that during the Islamic control, the role of Ager may have been of an extreme outpost without an explicit interest for the local settlement but only with a first defensive role. This should explain the lack of other Islamic settlements in the area.

If we compare it with the area around Balaguer and the *Serra Llarga* mountains, we notice a very different impact on the landscape by the Islamic settlement. As outlined in the first chapter, since the 922 the interest for the Islamic power was to consolidate the line that physically followed the topography of the *Serra Llarga* mountains from the village of Monzón to Balaguer. This meant to increase the settlement in that area creating a significant impact on the landscape. At this same chronology, the fortified settlement of Ager may have played the role of first defensive outpost due to the easy communication with the central place of Balaguer. Its central position helped also to observe easily the sides of the rivers. The viewshed analysis revealed a good visibility for the east side of the valley and the passage around the river Noguera Ribagorçana at about 20 while the west side and the passage through the river Noguera Pallaresa is not well visible from the hilltop of Ager. Only the area around the tower of Portaclusa has a bit of visibility from Ager. Nevertheless, we are aware that Ager was not the only observation and defensive outpost of this higher frontier and that the areas not visible from here were certainly controlled by other outposts



located in the other side of the Noguera Ribagorçana river, as was the settlement of Benabarre<sup>389</sup>.

Resuming we think that the role of Ager in the larger context of the Islamic frontier was of simple outpost to observe the frontier and guarantee a fast communication with the power centre. We think that there has never been a dense Islamic community living in the valley and we agree with the position of Albert Benet about a Christian community persisting in the valley under the Islamic power<sup>390</sup>.



*Figure 108. Viewshed Analysis from the Ager hilltop. The green area corresponds to the visible surface.*

<sup>389</sup> For a general outline about the interpretation of the frontie see Josep Giralt. "Fortificacions Andalusines a La Marca Superior D'al Andalus..." and for an updated report see Jesús Brufal Sucarrat. "Ràpitas En El Límite Occidental Del Islam Medieval..." p. 143.

<sup>390</sup> The first version of this study was published in Albert Benet Clará. "Una Comunitat Mossàrab a La Vall D'ager. Estudi Antroponímic; and then updated in the paper published in the Catalunya Romanica series: Albert Benet Clará. "Els Mossàrabs a Catalunya. El Cas De La Vall D'ager...", p.28.

#### 6.1.4 THE CHRISTIAN CONQUEST: THE REBIRTH OF THE GROUPED SETTLEMENT

With this part, we enter a better-known historical period because of the growing availability of written sources and the clear archaeological remains spread in the entire valley. During this period, Ager remained the central place of the valley and possibly incremented its role after the seigniorial establishment.

From the excavation made in the hilltop of Ager, we are able to make some considerations about the sequence of occupation between the 11<sup>th</sup> and the 20<sup>th</sup> century. In this chapter, we are interested in the medieval occupation so that the post-medieval periods will be not considered<sup>391</sup>. According to the archaeological evidences described in the reports of Coberó<sup>392</sup>, Vila<sup>393</sup> and Morera<sup>394</sup>, it is possible to delineate a general schema of the evolution of the settlement. These two phases may be concentrated around the building of two churches, the church of Santa Maria La Vella and the church of Sant Pere. In our opinion, these two buildings are the main representation of two phases of organisation of the hilltop occurred between the 1030's and the 1090's and demonstrated the consolidation of the Christian power in the entire valley. According to the interpretation of Francesc Fité the church of Santa Maria that corresponds to the actual crypt of the Sant Pere church, has to be placed chronologically between 1034 and 1041, especially for its constructive techniques even considering that the style of the building is very archaic and may correspond to the tradition of the 9<sup>th</sup> and 10<sup>th</sup> centuries<sup>395</sup>. For the second church Fité proposes a chronology between the 1060 and the 1094 considering the stylistic organisation but also the evidence of the written sources<sup>396</sup>.

An important group of walls has been detected as the primary wall built in the same chronological phase as the church of Sant Pere. They have been interpreted as the

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<sup>391</sup> The information of the post-medieval period of occupation of the hilltop are well documented in the reports of Montserrat Coberó from 1993 to 1998, Josep Vila from 2001 to 2003 and Jordi Morera in 2009.

<sup>392</sup> Montserrat Coberó Farrés. "Informe D'intervenció Arqueològica..." p. 98.

<sup>393</sup> Josep Maria Vila Carabasa. *Memòria De La Intervenció Arqueològica...*, p. 118.

<sup>394</sup> Jordi Morera Camprubí. "Memòria De La Intervenció Arqueològica a La Col-Legiata De Sant Pere D'àger." edited by Arqueociència Serveis Culturals S. L. Manresa, 2009.

<sup>395</sup> Francesc Fité Llevot. "Consideracions Sobre Les Fases Constructives De Sant Pere D'àger." In *Catalunya Romanica*, edited by Fundació Enciclopedia Catalana, 132-33. Barcelona: Cayfosa indústria gràfica, 1994.

<sup>396</sup> Francesc Fité Llevot. "Consideracions Sobre Les Fases Constructives..." p. 126.

original defensive wall of the southwest area of the hilltop, a squared tower and some rooms associated to the church and possibly referring to the abbey accommodation<sup>397</sup>. The materials recovered in this area attest the occupation during the 11<sup>th</sup> and 12<sup>th</sup> centuries with an altitude of circulation very low (more than 1meter) compared to the current level.



*Figure 109. The wall excavated near the current defensive wall of the Ager hilltop and interpreted by Vila as a former defensive wall. (Source: Vila 2003)*

A very interesting structure was excavated in 2002 in the southern sector of the hilltop. This structure corresponds to a wall with a semi-circular closure oriented toward east. It was cut by the construction of the carline wall and it has been not

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<sup>397</sup> Josep Maria Vila Carabasa. *Memòria De La Intervenció Arqueològica...*, pp. 54-59.

possible to excavate the northern area of the structure. In addition, due to the destruction operated by the carline wall construction, in the inside of the structure no significant materials were found. The archaeologist described it as Romanic temple for its constructive technique and the high quality of the masonry. In addition, this structure is not related to the wall encountered near the church of Sant Pèrre<sup>398</sup>.



*Figure 110. The structure with an apse excavated near the defensive wall of the hilltop of Ager. (Source: Vila)*

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<sup>398</sup> Josep Maria Vila Carabasa. *Memòria De La Intervenció Arqueològica...*, p. 71.

Another important construction was detected during the campaigns directed by Coberó. It is the base of a circular tower of massive dimension if compared with the others tower of the valley. It is located partially below the buildings of the gothic cloister and its perimeter was excavated completely in the 2000's interventions. During the 2003 campaign a pit survey was excavated in the insight of the tower in order to detect its chronology, according to the report of the excavation no significant data were found but the constructive technique allow to think to a 11<sup>th</sup> century chronology<sup>399</sup>. This building with the semi-circular shape in the south sector that could refer to the primitive church of Sant Pere built before the definitive conquest of the settlement by the Christians, and then it could be dated between 1034 and 1046.

Finally, in the northeast portion of the hilltop a survey revealed other structures that the archaeologist Vila interpreted as a possible noble residence dated to the 11<sup>th</sup> century, it is considered the seigniorial residence since the first years of the Christian occupation. Indeed, also this structure seems to destroy and occupy a portion of Iberian chronology<sup>400</sup>.

Resuming, the major archaeological results for the medieval period were obtained during the campaign of 2002 and 2003. Many pits excavated as survey in multiple part of the hilltop seems confirming that in the 11<sup>th</sup> century the major part of the existing structures, especially those originated in the Iberian period, were demolished to reorganise the area with a new wall and new buildings. Even if an extensive excavation of the hilltop will be necessary to detect every single building and the complete topography of the area, all the evidences unearthed until now seem converge to this theory.

In our opinion, in contemporaneity with the organisation of the central place of Ager between the 11<sup>th</sup> and the 12<sup>th</sup> centuries, the plain and the entire valley received a major impulse to the definition of its structure. The analysis of the available documentary sources, the results of the archaeological surveys and the excavation of

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<sup>399</sup> Josep Maria Vila Carabasa. *Memòria De La Intervenció Arqueològica...*, p. 105.

<sup>400</sup> Josep Maria Vila Carabasa. *Memòria De La Intervenció Arqueològica...*, p. 110.

the central place help to define a precise development strategy acted by the Tost's seigniorial family and composed of five important points:

- A) The foundation of new settlements
- B) The strengthen of the existing settlements
- C) The creation of a church network
- D) The capillary control of the territory
- E) The agrarian takeover of new spaces

All these points are strictly related and we are going to analyse them and make some considerations in order to interpret the landscape organisation of the valley during the Middle Ages. In our opinion, this represented the turning point that shaped the landscape and that originated the general structure that maintains some of its characteristics until present day.

When we talk about the foundation of new settlements, we intend the passage from a scattered settlement system to a grouped one. Between the 11<sup>th</sup> and the 12<sup>th</sup> centuries the valley appears populated by several villages, most of which with a castle or a defensive tower and located in a raised position. In the analysis of their spatial organisation through the valley, we identified three different sections of settlements that correspond to three different chronological period of the settlement.

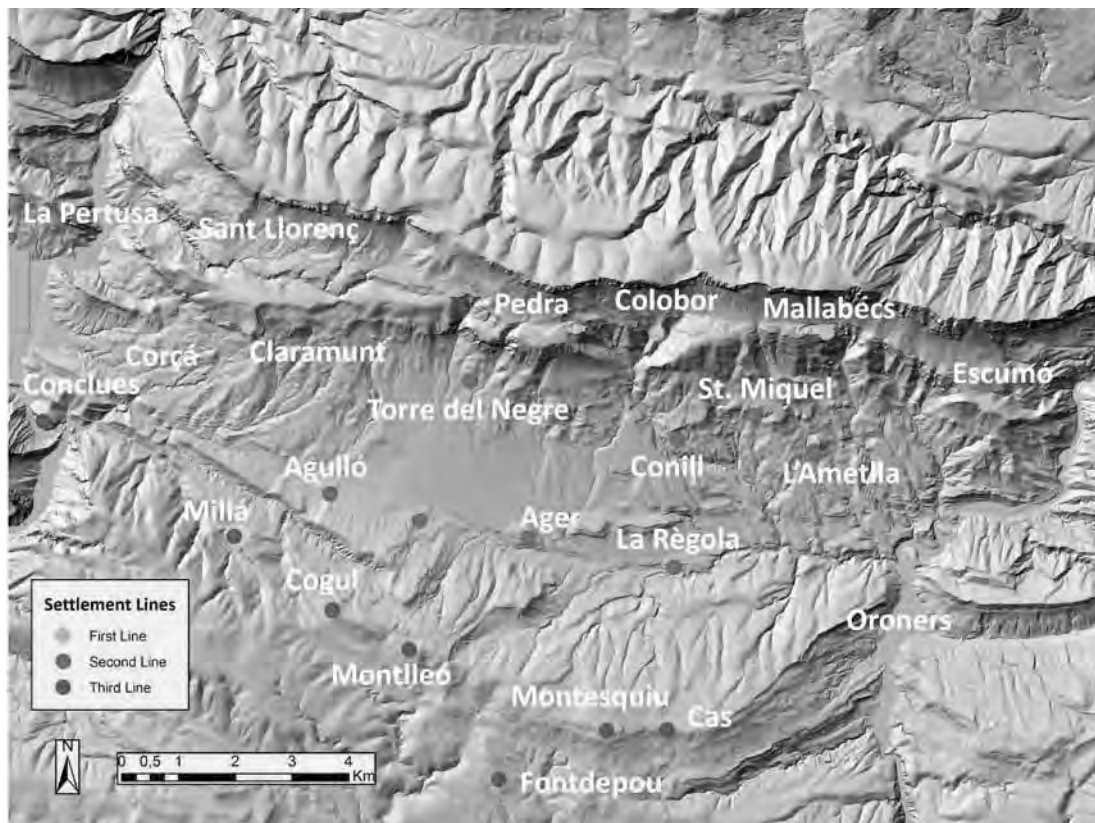


Figure 111. Lines of Settlement in the Ager Valley.

The first line corresponds to the settlements located in the southern side of the Montsec and in the nearby hills and peaks: La Pertusa, Sant Llorenç d'Àres, Corçà, Claramunt, Pedra, Mallabecs and Escumó. All these settlements are cited in the earlier written sources of the first half of the 11<sup>th</sup> century.

The settlement of La Pertusa is a castle cited in the written sources since 1060 and located in the west extreme of the Ager Valley<sup>401</sup>. As the site of Portaclusa, also, La Pertusa was a control point of the river but it controlled also the passage from the Ager Valley to the west. Actually, the visible remains are a portion of the castle and the church of Mare de Deu. The presence of the church and also the results of our survey, testify that this settlement was not a simple defensive place but also a village. Indeed from the lidar prospection we found an extended system of agrarian parcels around the site. The ground survey finally showed a significant presence of pottery mainly of common type with a chronology between the 11<sup>th</sup> and the 13<sup>th</sup> centuries.

<sup>401</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica De Sant Pere...*, p. 269-273.

This settlement was very important for the defence and the control of the valley because, as we will see next, with the castle of Sant Llorenç and Portaclusa it controlled all the access roads to the valley. The church of Mare de Deu will be analysed in the section dedicated to the church network.

The castle of Sant Llorenç d'Àres is a very interesting settlement. It is the last settlement that we can find in the northwest sector of the valley before the border of the Montsec and the Noguera Ribagorçana river. From the written sources, we know that it was a property of the count of Pallars and it was sold in 1044 to Arnau Mir de Tost<sup>402</sup>. From an archaeological point of view, it represents one of the most interesting location because of its high level of preservation. During the 1980's Prim Bertran and Francesc Fité conducted a survey and an architectonic relief<sup>403</sup>. They detected the entire topography of the settlement and dated its construction to the beginning of the 11<sup>th</sup> century. The preserved architectures have a very uniform status and they seems to have been built with a good quality of the masonry and in a single phase. The actual status of dense vegetation covering the wall surfaces did not allowed a detailed study of the architecture, especially for the outside defensive wall. Our survey just confirmed the presence of a dense quantity of pottery from the 11<sup>th</sup> and 12<sup>th</sup> century not only in the proximity of the castle but also in the surrounding fields where is it located the church of Santa Maria d'Àres dated at the 13<sup>th</sup> century.

The settlement of Corçá is cited as *Curciano* since the 1048 in the document of the consecration of the church of Sant Salvador d'Ager<sup>404</sup>. Its situation is very similar to that of Ager, indeed, it is located over a hilltop where the peak was used as the seat of the castle and around it developed a village. There are no data from archaeological excavation in this area and the only data we dispose are the pottery evidence from the surface that we detected during the survey of the area. As it was expectable, the pottery confirms a frequentation of the area since the 11<sup>th</sup> and 12<sup>th</sup> century, in addition we found the grey typology of pottery across the fields and the terraces that surround the area of Corçá. We do not know anything about of the pre-medieval

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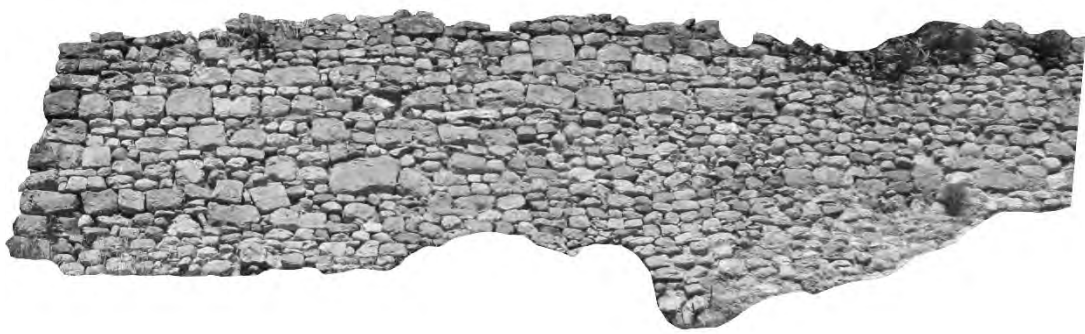
<sup>402</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica De Sant Pere...*, p. 221-223.

<sup>403</sup> Prim Bertran Roige, Joan Cabestany Fort, and Francesc Fité Llevot. "Primera Aproximació Al Jaciment Fortificat De Sant Llorenç D'Ares...", p. 1.

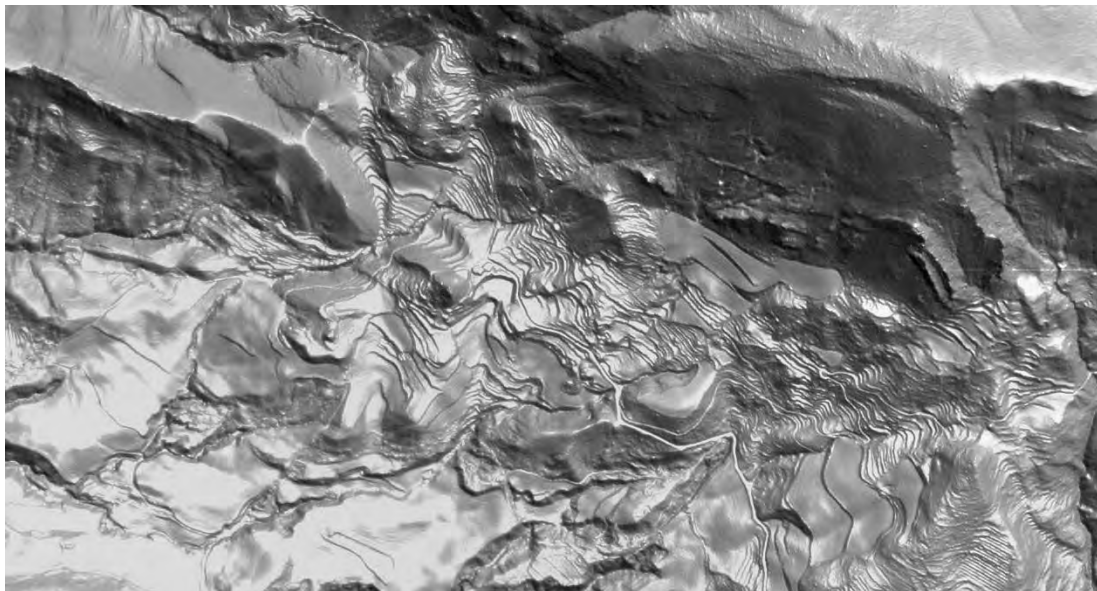
<sup>404</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica De Sant Pere...*, p. 229-232.



settlement in the hilltop of Corçá, for this reason we cannot exclude it. Nevertheless, with the data that we dispose, we can interpret the born of this settlement in the 11<sup>th</sup> century as the aggregation of the scattered settlement of this area around a defensive place of which we have archaeological evidence. At the same time, we expect from this period the start of the intensification of the agrarian exploitation not only in the plain area but also in the near hills with the construction of the agrarian terraces.



*Figure 112. The prospect of the southern wall of the Corçá castle. It is clearly visible that it is a wall built with reused materials with a non uniform texture. (Source: Antonio Porcheddu)*



*Figure 113. Terraces around the area of Corçá seen from lidar derived DTM.*

Claramunt was another settlement raised around a fortification. It is located very close to Corçá, at approximately 1.5 Km, and it is divided in two portion with the fortification and the church located in a peak and the rest of the village at the base of the hill. This fortification is dated from the 11<sup>th</sup> century and it is mentioned in the written sources since the early Christian conquest in 1042<sup>405</sup>. Also in this area the scenario is very similar to the other settlements with the significant presence of 11<sup>th</sup> century pottery and a system of agrarian terraces in the nearby. No other archaeological data are available for this settlement due to the lack of excavation, all the information that we have come from the ground survey.

We have very few archaeological information about the castle and the settlement of Pedra, even its precise location is under uncertain but some scholars like Francesc Fité think that it should be located in the hill above the present church of Mare de Deu de Pedra<sup>406</sup>. From the lidar derived DTM we tried to analyse the area in order to find some hints for a possible location of the castle. Comparing the supposed area with the locations chosen for the other similar settlements, we noticed that in this area there are no signs of past agrarian activity as agrarian terraces, and that the area that could be used as cultivated field are very scarce. We cannot exclude that the castle was separated from the village like in the case of Claramunt. Nevertheless, the location of the village seems to be an additional problem. Comparing the altitude position of the other villages in the nearby and referring to our ground survey, we may locate approximately in the area between the actual church of Pedra and the tower named *Torre del Negre*. We consider this area very interesting from an archaeological point of view. During the survey, we found a very dense quantity of pottery that can be dated, at a first sight, from the 10<sup>th</sup> and 11<sup>th</sup> centuries to the 19<sup>th</sup> century. These evidences show a large continuity in the occupation of the area, and added to the evidence about the early middle age sarcophagus that we described above, they reflect the importance of the area.

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<sup>405</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica De Sant Pere...*, p. 217-219.

<sup>406</sup> Francesc Fité Llevot. "Conquesta i Repoblació a L'alta Noguera." In *Catalunya Romanica*, edited by Fundació Enciclopèdia Catalana, 31-34. Barcelona: Cayfosa: Industria Gràfica, 1994, p. 32.

From the written sources, we know that this area was under the control of the seigniorial family of Pedra to whom Arnau Mir de Tost granted an economic exemption (*carta franchitatis*) in 1042 in change of the acceptance of his role as the unique authority of the valley<sup>407</sup>.

The castle of Mallabecs is a fortress located almost at the west side of the valley in the southern side of the Montsec. Its position is in the border of the geological terrace described in the landscape unit 8 and that surround the north of the valley at approximately 1200 meters of altitude. According to the interpretation of Fité its constructive technique should be very archaic, it means that its chronology may be placed around the 10<sup>th</sup> century. The archaeological survey here did not revealed traces of pottery ascribable to the 10<sup>th</sup> century but there is a significant presence of the well-known grey pottery dated between the 11<sup>th</sup> and the 12<sup>th</sup> century. The presence of the church of Sant Miquel demonstrate that it was not a simple defensive tower but a castle with a possible settlement around. The lidar derived DTM did not showed the presence of agrarian terraces, this can be explained with the geological conformation of the area as noticed for the entire landscape unit 8. Nevertheless, not far from the castle toward east, some plain natural terraces has been used for agriculture and its use is still visible in the aerial photographs of 1956.

The castle of Escumó has a similar situation to the castle of Mallabecs even if its altitude is a bit lower, around 900 meters. It is located at the east extreme of the valley over the same geological terrace described for Mallabecs. Its first documentary citation is dated at the 1068 in a document related to the Sant Pere d'Ager patrimony<sup>408</sup>. The constructive technique is very simple and also reflects the archaism of the remaining structures of Mallabecs. From the lidar derived DTM it is possible to detect some field used for agriculture, in addition the presence of a church suggest the location of a settlement in the nearby. The survey evidenced the presence of pottery dated from the 11<sup>th</sup> century but the constructive techniques of the area bring us to think that, as in the case of Mallabecs, this area could have been inhabited also in the previous centuries. At the contrary, the remaining walls of the

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<sup>407</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica De Sant Pere...*, p. 217.

<sup>408</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica De Sant Pere...*, pp. 320-325.

church suggest a constructive technique typical of the 11<sup>th</sup> and 12<sup>th</sup> century and its structure is comparable to the church of Sant Llorenç d'Àres and other churches in the valley.

The second line is constituted by the settlements located in the central axe of the valley: Les Conclues, Agulló, Ager, La Règola, Conill, Colobor and Sant Miquel de Montaspre.

The site of Les Conclues represents a strategic settlement for the control of the Noguera Ribagorçana river. We think that its citation in a document of 1043 as *Portaclusa* can be relate this area to the first phase of protection of the valley<sup>409</sup>. Its position near a vertical cliff testify the role of observation and defence point near the river. The archaeological survey that we did in this area showed a frequentation from the 11<sup>th</sup> and 12<sup>th</sup> century with the presence of the medieval grey pottery especially in the area around the building. Nevertheless, the visible remains of the building show a later architecture, from the 12<sup>th</sup> to the 13<sup>th</sup> century.

The settlement of Agulló has been partially discussed in the chapter above due to its possible paleochristian origins. It is cited in a 1048 document as the hill of *Agulio*<sup>410</sup>. Its placename is cleary a description of the natural location of the settlement.

The settlement of La Règola is still one of the most important in the valley because of its proximity to Ager. From the written sources, we know that this settlement benefitted of an exemption privilege since 1049<sup>411</sup>. At the moment we do not have information about archaeological interventions made in this area and we cannot determine the precise chronology in which this settlement originated. The archaeological survey showed the presence of the common grey pottery of the 11<sup>th</sup> and 12<sup>th</sup> century but no more evidences have been detected. From the lidar derived DTM it is possible detecting a dense system of parcels around the river, which we already described in the Archaeogeography chapter, and a system of terraces near the area of church of Santa Eugenia. The analysis of the constructive techniques of

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<sup>409</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica De Sant Pere...*, p. 219.

<sup>410</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica De Sant Pere...*, p. 228.

<sup>411</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica De Sant Pere...*, pp. 237-238.

this church was impossible due to the restoration made recently that hid the ancient portion of the walls.

Another point of debate of La Règola is about its place name. In the document of 1049 is cited as the village of Sant Julià and the name *Regulam* is described as a popular name. Francesc Fité supposed that the name Regulam might refer to a primitive monastic settlement<sup>412</sup> around which was created the village encouraged by the exemption privilege. We think that there is also the possibility that this area may have been occupied during the late antique period in contemporaneity with the settlement of Santa Coloma, Sant Pèrre Martir and the other settlements described in the paragraph of the Paleochristian period. Then there is the possibility that this placename was created during this period and then remained until the Middle Ages. At the contrary, we exclude the hypothesis based on the presence of a roman villa in the area because of the land suitability and the natural exposition this area could be more appropriate for the livestock than for agriculture, as we will see next in this chapter.

The village of Conill is located in the middle way between the settlement of La Règola and the Montsec southern side, in the landscape unit 13. We dedicated a single landscape unit to this settlement because the area form a system of agrarian terraces that are separated from the alluvial fan of the landscape unit 3 and are separated also from the area of Sant Miquel de Montaspre. From a document of the 1176 we know that the area was exploited since the 11<sup>th</sup> century but we do not know if the grouped settlement existed already or if there were only scattered agrarian settlements<sup>413</sup>. The pottery findings during the survey confirmed the frequentation since the 11<sup>th</sup> century but no other archaeological remains can be dated to this period. Indeed, a wall considered as the remaining of the fortification of Conill cannot be dated to this period as Francesc Fité confirms<sup>414</sup>. We think that this village can be a later settlement and we should date it from the end of the 12<sup>th</sup> century and the 13<sup>th</sup>

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<sup>412</sup> Francesc Fité Llevot. *Reculls D'història De La Vall D'ager...*, p. 89.

<sup>413</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica De Sant Pere...*, pp. 826-828.

<sup>414</sup> Francesc Fité Llevot. "Vilatge De Conill." In *Catalunya Romanica*, edited by Fundació Enciclopèdia Catalana, 145-46. Barcelona: Cayfosa: Industria Gràfica, 1994.

century in contemporaneity with the village of Colobor. Indeed the written evidences attest a major activity of this village from the end of the 12<sup>th</sup> century<sup>415</sup>.

In our opinion, the castle of Colobor is contemporary to the castle of Conill. The most important written document that attest the existence of this castle is the testament of its castellan Bernat de Colobor<sup>416</sup>. The presence of a church also in this area bring to think to the possibility of a village associated to the castle. During the survey of the area we identified a possible location of the settlement between the remaining of the church and a water spring. The pottery evidenced in the surface can be dated mainly to the 13<sup>th</sup> and 14<sup>th</sup> centuries while we did not found evidence of an earlier frequentation. From the historical sources we also know that the area resulted abandoned in 1375<sup>417</sup>. The architectonic analysis of the church of Santa Maria de Colobor has not been possible due to the status of conservation of the building. Indeed, the external walls are covered by plaster as well as an important portion of the interior. The church was annexed to the building of a hostel in the second half of the 20<sup>th</sup> century.

Sant Miquel de Montaspre is located in the south side of the Montsec between the settlements of Conill and L'Ametlla. It is cited as a castle with multiple churches in a document of 1048 where Arnau Mir de Tost donate the property of this area to the abbey of Sant Pere d'Ager<sup>418</sup>. The remaining of a church and partially of the castle are still visible in the area. The site is located in a peak around which are located a series of agrarian terraces. The survey shows the frequentation of the area since the 11<sup>th</sup> century onwards with evidence of grey pottery but we did not found evidence of earlier frequentation. Nevertheless we suppose that the castle and the church might have been generated also a settlement now disappeared because in the south area from the castle we found also many other evidence of frequentation.

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<sup>415</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica De Sant Pere...*, p. 689-690.

<sup>416</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica De Sant Pere...*, p. 689-690.

<sup>417</sup> We could not read the original document but it was breafily cited by Francesc Fité in the Fundació Enciclopèdia Catalana. *Catalunya Romanica*. Vol. 17, Barcelona: Cayfosa: Industries Gràfiques, 1994, p. 42.

<sup>418</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica De Sant Pere...*, p.228.

A third axe of settlements is made by Cas, Montlleó, Cogul and Millá and it corresponds to the south closure of the valley.

The castle of Cas is located in the Montclús mountains in the group of elevations that surround the Ager Valley from south. Its existence is documented in the written sources in the second half of the 11<sup>th</sup> century since the 1054<sup>419</sup>. We have the remains of a tower and some defensive walls that surround the area. The tower has been restored in the nineties and the analysis of the architectures did not show multiple phases associated to this building. It can be dated between the 11<sup>th</sup> and the 12<sup>th</sup> centuries. The survey made in the area did not provided any evidence of pottery ascribable to the 11<sup>th</sup> or the 12<sup>th</sup> century while a dense concentration of late medieval pottery has been found in the surrounding area of the castle. The church named to Sant Jaume is located few meters west from the main tower. Its structure shows multiple constructive phases, the area of the apse is the most ancient area, it is visible a second phase when the central nave was prolonged toward west and a third phase of reparation of the nave.

The castle and village of Montlleó are located few hundreds of meters from the Port d'Ager, in the Serra de Montclús mountains. The written sources locate them at the end of the 12<sup>th</sup> century and in the 13<sup>th</sup> century<sup>420</sup> and already abandoned in the 14<sup>th</sup> century<sup>421</sup>. The surface survey that we made in this location gave few evidence of pottery but a huge amount of worked stone are located throughout the whole area and may correspond to the destroyed remains of a tower and other buildings. Nevertheless, the walls of the church dedicated to Santa Maria are well preserved except for the roof. The inside of the building is filled almost completely by ruins and the external wall are covered by vegetation. The visible portions of the architectures evidence a building of the end of the 12<sup>th</sup> century and the sections of the roof show multiple interventions of restoration, in the southern side is visible also a buttress

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<sup>419</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica De Sant Pere...*, pp. 245-248.

<sup>420</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica De Sant Pere...*, pp. 776-778.

<sup>421</sup> Francesc Fité Llevot. "Castell I Vilatge De Montlleó." In *Catalunya Romanica*, edited by Fundació Enciclopèdia Catalana, 157-58. Barcelona: Cayfosa: Industria Gràfica, 1994.

added on a different phase. The lidar derived DTM evidence the presence of some terraces in the hill, in these terraces we also find remains of buildings and rooms.

Cogul is a disappeared settlement cited in the written sources as a tower since the second half of the 11<sup>th</sup> century, in 1057<sup>422</sup>. It is located between the castle of Montlleó and the castle of Millá in the same line of the Serra de Montclús mountains. In the ground survey we did not find any significant evidence of the settlement and we think that it could have been a simple defensive tower with a scattered settlement. The observation made from the lidar derived DTM showed no agrarian structures towards the south direction and few terraces with an unusual north-south orientation.

The settlement of Millà is the extreme southwest site near the Serra de Montclús mountains closing the Ager Valley from south. It is located in a natural point of passage between the valley and the area named as Les Aspres at south. The placename is cited in the written sources since the 1066 as pertaining to the abbey of Sant Pere d'Ager. In addition, in this area, no archaeological excavation have been carried out and we cannot establish the actual naissance of the fortified settlement. The ground survey made in this area evidenced few data of the 12<sup>th</sup> and 13<sup>th</sup> centuries with the grey common pottery and other later typologies while more evidence of late medieval and modern age pottery have been found.

#### 6.1.5 DISCUSSION: THREE PHASES OF SETTLEMENT BETWEEN THE 10<sup>TH</sup> - 13<sup>TH</sup> C.

The data exposed until here allow making some reflections about the sequence of the settlement in the Ager Valley. The main typology of settlement that we can find in the Ager Valley between the 10<sup>th</sup> and the 13<sup>th</sup> century are villages of small dimension associated to a fortification. In addition, we consider three settlements as the most important of the valley, Ager, Corçá and Sant Llorenç d'Àres. In our opinion, these three settlements have the role of central places in their respective sector of

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<sup>422</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica De Sant Pere...*, pp. 251-254.



the valley, the plain for Ager, the east sector for Corçá and the northern border for Sant Llorenç.

a) The phase of the frontier

From a chronological point of view, we identified three groups of settlements. The first group as cited above is formed by the settlement of Sant Llorenç, Claramunt, Pedra Mallabecs and Escumó. From the data that we have, we consider that these settlements could have formed a first line of supervision and defence of the northern Christian counties since the 10<sup>th</sup> century. We can call this the phase of the frontier. From a spatial point of view, all these sites are located in the mountainous stripe that we evidenced with the landscape units 6 and 8 at an altitude between 1000 and 1200 meters above sea level. This area is a sort of extended natural terrace that looks at the valley from north and that is repaired by the Montsec side at its south. Due to a lack of excavation data we cannot precise the exact moment of creation for these structures but we can make some hypothesis based on the available evidences. As we described above, in the area of the castle of Sant Llorenç there was a castle before the arrival of the Tost's seigniorial family that was owned by the count of Pallars and at the half of the 11<sup>th</sup> century, it was sold to Arnau Mir de Tost and his wife. Even if the remains that we see today in the area are ascribable to the 12<sup>th</sup> century, we can suppose the presence of a former fortification in the same area then substituted by the visible constructions.

The second settlement is the castle of Pedra. From the sources we know that the Exabel family had the possessions of Pedra, Claramunt and that their territory faced the territory of Sant Llorenç d'Àres at west. According to the interpretation made by Francesc Fité this family may have been a local seigniorial family that after the occupation of the valley by the Tost family<sup>423</sup>, accepted to support Arnau Mir de Tost in his control of the area. This is explained in a document dated to 1042 where Arnau Mir de Tost conceded a tax exemption to Exabel lord of Pedra demanding their

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<sup>423</sup> Francesc Fité Llevot. "Conquesta i Repoblació a L'alta Noguera... p. 32.

acceptation of him as unique lord of the valley<sup>424</sup>. Finally the study by Albert Benet of the Christian community living in the Ager Valley under the Islamic power. He detected from some written documents the name of Exabel as one of the most evident proof of the existence of a Christian community in the valley during the 10<sup>th</sup> century<sup>425</sup>.

Finally the sites of Mallabecs and Escumó. As said above the written sources cite these locations only in the second half of the 11<sup>th</sup> century. Nevertheless, analysing their constructive techniques we saw that these fortification are very different from the other fortifications built in the valley in the 11<sup>th</sup> century. The hypothesis of an earlier chronology is based especially on their archaeological remains and it could be confirmed only with an excavation.

#### b) The phase of the planning

The second group of settlements is constituted by the major part of the valley settlements. The sites of Les Conclues, Corçá, Agulló, Ager, La Règola, Conill, Colobor and Sant Miquel de Montaspre forms the settlements of the valley central stripe. We included in it Ager because the reorganisation of the hilltop that we described above comported an entire reform of the settlement. These settlements can be grouped into a chronology between the 1034 and the 1065, as seen above they are all already cited in the written documents dating the second third of the 11<sup>th</sup> century.

In our opinion, this group of sites represents the phase of planning of the valley organisation. During this period and especially after the 1046, the Tost seignury make its efforts in order to affirm its power in the valley, to control the territory and to reinforce the economical tissue. It is not a casual fact that in this period we found many documents of donation for the churches and exemptions for the settlements. The efforts for the foundation of the abbey of Sant Pere d'Ager and the existing documents of the exemptions made to La Règola and Pedra are example of the socio-

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<sup>424</sup> Ramón Chesé Lapeña. *Col·lecció Diplomàtica De Sant Pere...*, pp. 217-218.

<sup>425</sup> Albert Benet Clará. "Els Mossàrabs a Catalunya. El Cas De La Vall D'ager..." p. 31.

political and economical strategy of this period. We will analyse more in deep the economic panorama of the valley later in this chapter.

c) The phase of the consolidation 1065 - 1094

The third group is composed by the southern settlements of Cas, Montesquiu, Montlleó, Cogul and Millá as well as other settlements outside the valley like Vilamajor, Fontdepou etc. not described above. This group of settlements represents the defensive closure of the Ager Valley and the projection towards the south area of Les Aspres. As we saw in the descriptions made above, these sites were mentioned in the second half of the 11<sup>th</sup> century in the written sources and they might have developed during the second half until the beginning of the 12<sup>th</sup> century. We consider these locations as the representation of the last phase of the settlement of the Ager Valley used to reinforce the seigniorial domains. We think that these sites had a main defensive nature because they were located along the peaks of the Serra de Montclús that naturally closes the valley but that has not a good suitability from the economical point of view. From the lidar derived DTM there are some agrarian terraces that could be associated to these settlements but their extension is limited. This could have been one of the reasons, added to the known crisis of the late medieval world, why the majority of them (Cas, Montesquiu, Montlleó, Cogul) resulted abandoned already in the 14<sup>th</sup> century, with a life of just two centuries. The conclusion of this third phase is related chronologically to the finishing of the works in the Ager hilltop with the construction of the church of Sant Pere d'Ager that Fité locates around the 1094<sup>426</sup>. With the Christian conquest of Balaguer in 1106 the role of the Ager Valley was not more of a political frontier and the area can be considered as the starting point of what will become the viscounty of Ager at the end of the 13<sup>th</sup> century.

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<sup>426</sup> Francesc Fité Llevot. "Consideracions Sobre Les Fases Constructives..." p. 126.

## 6. 2 THE CHURCH NETWORK AND THE SACRED LANDSCAPE BETWEEN 10<sup>TH</sup>-13<sup>TH</sup> C.

In the paragraph dedicated to the early medieval settlement, we delineated the framework of a paleochristian community probably originated during the Visigoth domain as a propagation of the main monastic foundations of the plain areas between the 5<sup>th</sup> and the late 7<sup>th</sup> centuries. For the successive period, in which we identified an Islamic presence in the valley between the 9<sup>th</sup> and the 10<sup>th</sup> centuries, the information about the religious framework are inexistent. We can suppose the presence of a mosque in the hilltop of Ager used by the living community but no Islamic burials have been found until now in the entire valley. We know from the studies made in the southern Spain that normally the Islamic burial grounds were positioned outside the settlements and possibly near a water source due to the needs of the funerary rituals<sup>427</sup>. It would be interesting for the future proposing an archaeological survey near the area of the Riu Fred at the southern side of Ager, indeed this would be a preference location for this typology of cemeteries.

A document dated April 1068 and signed by Arnau Mir de Tost and Arsenda<sup>428</sup> explain very clearly the political intention of the family regarding the organisation of the churches in the Ager Valley and its implication on the material properties of the seigniorial power. All throughout the years of his domination, Arnau Mir de Tost granted to the abbey of Sant Pere many privileges and properties in the valley and, amongst them, the control over the several churches of the territory. The church network developed between the 11<sup>th</sup> and the 13<sup>th</sup> centuries should be analysed together with its landscape context and in particular with a) the road network, b) the villages and c) the scattered settlement.

### 6.2.1 CHURCHES AND ROAD NETWORK

When analysing the churches and their relation with the road network in the Ager Valley we should think about the two levels of roads that we described in the chapter

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<sup>427</sup> Ana Valdiviesos Ramos, María Teresa Casal García, Alberto León Muñoz, Patricio José Soriano Castro, *et al.* "Espacio Y Usos Funerarios En La Qurtuba Islámica." *Anales de Arqueología Cordobesa* 17, no. 2 (2006): 257-90.

<sup>428</sup> Ramón Chesé Lapeña. *Col·Lecció Diplomàtica De Sant Pere...*, pp.320-325.

5. At a higher level, we consider the regional itineraries that cross the valley from south to north and from east to west. A second level of road is constituted by the local roads that connects villages, castles and the scattered agrarian settlement. In both cases, the churches and the roads seem to be strictly related but confirming an important attractive role of the churches for the roads. Nevertheless, it would be an ingenuity considering the presence of the road as the main reason for the existence of a church in a certain place. This is a possibility only when we consider large itineraries that cover interregional connections, like along the ancient roman roads<sup>429</sup> or along the paths of transhumance. It is necessary reversing the line of reasoning, which means considering that the roads follow a certain itinerary because the church, amongst many other attractors, act as point of polarisation. At the same time, the typologies of church that we encounter in the Ager Valley are strictly related to the settlement. Often the churches are the unique element that survived after the abandonment of the settlement becoming rural churches and allowing the permanence of the road. Interesting examples of the permanence of a church after the abandonment of the related settlement are the church of Mare de Deu de Pedra and the church of Mare de Due de La Pertusa. In the first case the church of Mare de Deu de Pedra is the only site in its area that justify the permanence of the itinerary after the abandonment of the castle. At the contrary La Pertusa is located near the main point of passage of the Noguera Ribagorzana river and this could justify the permanence of the church in this place even after the abandonment of the settlement. At the same time, the churches of Santa Coloma, Santa Maria del Pla and Santa Helena and Sant Pere Martir are not directly related to a grouped settlement or a village. We can associate these churches to the main itinerary of the valley that goes from Ager toward the Serra de Montgai mountains and then as churches strictly related to a larger itinerary and for the service of the agrarian scattered settlement. Santa Maria del Pla and Santa Coloma are positioned in a linear direction from east to west but if we analyse the south-north itinerary we find that Santa Coloma can be also related to the itinerary going to the north of the valley. In addition, it is

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<sup>429</sup> Gisella Cantino-Wataghin, Vincenzo Fiocchi-Nicolai, and Giuliano Volpe. "Aspetti Della Cristianizzazione Degli Agglomerati Secondari." In *La Cristianizzazione in Italia Tra Tardoantico E Alto Medioevo. Atti Del IX Congresso Nazionale Di Archeologia Cristiana (Agrigento, 20-25 Novembre 2004)*, edited by Rosa Maria Bonacasa-Carra and Emma Vitale, 85-134. Palermo: Saladino, 2007.

important to recall that these churches are associated to the early medieval period, while we do not have information about an early chronology for the church of Santa Helena. These churches might be associated also to the scattered settlement of the plain of Ager and Agulló. Finally, the church of Santa Eugènia de La Règola, of a 12<sup>th</sup> century chronology is located in the northern side of the Montclús mountains without a local settlement associated. It can be placed along the itinerary going from La Règola to Cas.

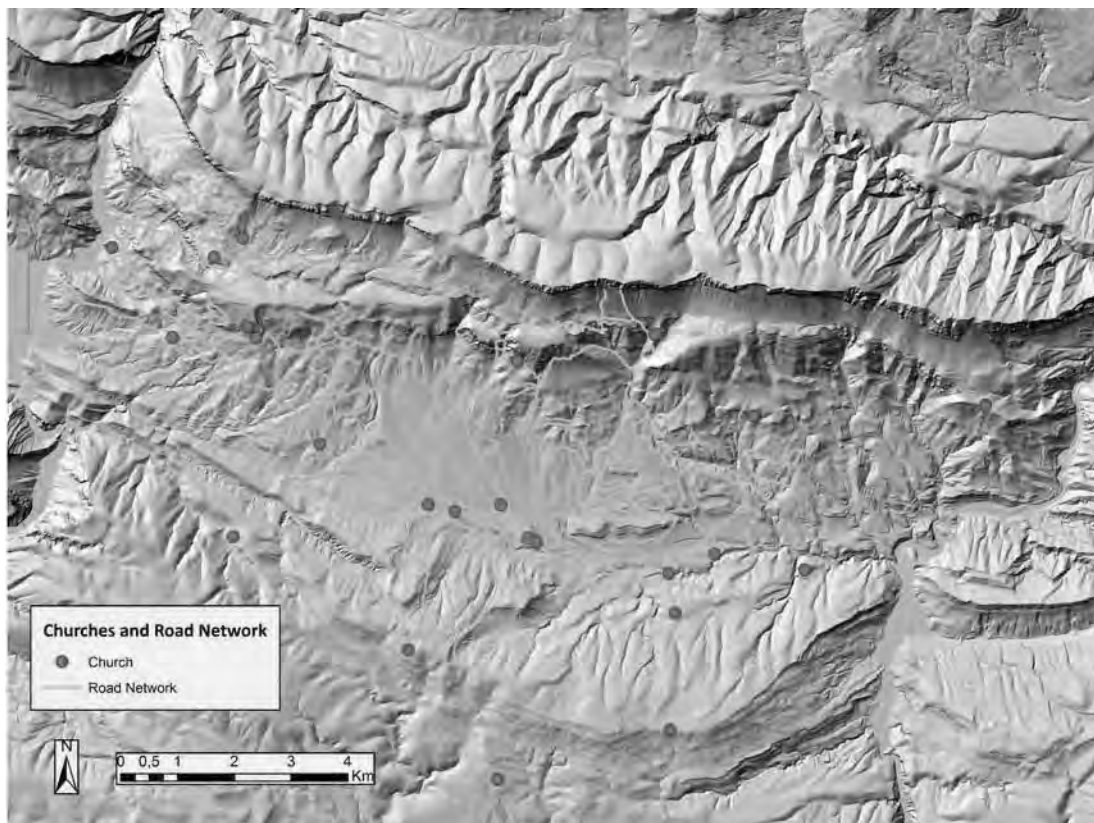


Figure 114. Location of the churches compared to the road network.

### 6.2.2 CHURCHES AND SETTLEMENTS

The major part of the churches in the Ager Valley are related to a village, to a castle or to an area of scattered settlement. This means that the original chronology that we can associate to many of these churches is related to the chronology of the respective site. Until now, the historical documents did not give information about churches in the Ager Valley before the 11<sup>th</sup> century and then useful information could

come only from Archaeology. Unfortunately, the excavations around the existing churches in the Ager Valley are scarce and the only data that we possess are the results of the excavation of Santa Coloma we carried out in 2014 and in 2015.

As seen above, the northern area of the valley is characterised by a series of fortifications that can be dated for their constructive techniques to the 10<sup>th</sup> century as Escumó and Mallabecs. In addition, the written sources tell us about the presence of Christians under the Islamic domain, especially the Exabel family of Pedra. We should consider the possibility that under this conditions a group of churches existed since the 10<sup>th</sup> centuries in the proximity of Pedra, Mallabecs and Escumó. While there are no traces of a church near Escumó, the architectonic remains of the churches of Pedra and Mallabecs do not have clear signs of a 10<sup>th</sup> century architecture but are more similar to the 11<sup>th</sup> and 12<sup>th</sup> century constructive techniques. In particular, for the church of Pedra, only a small portion of the building can be addressed to its original phase.

The major part of the churches in the valley has its origins in the 11<sup>th</sup> and the 12<sup>th</sup> century. Amongst these, we should separate the churches of the castles to the churches of the villages. In the first case the churches of Sant Pere d'Ager, Sant Llorenç d'Àres, Mare de Deu de La Pertusa, Santa Maria de Claramunt, Sant Miquel de Montaspre, Sant Julià de La Règola, Santa Maria de Oroners and Sant Jaume of Cas are strictly related to their castle and often included inside its walls. These churches may have been used especially by the élites living in the castle, especially for privileged burials even if the function of each church is not perfectly clear. Another interesting aspect is that some of these castles had multiple churches associated. For example in Sant Llorenç we find the church of Santa Maria located outside the walls at few hundred meters from the castle, in the castle of Claramunt we find the church of Sant Bartomeu located under the hill where was positioned the castle and probably near the village. Finally, the particular case of Ager where in the hilltop we know about the churches of Sant Pere, Santa Maria and Sant Nicolau. The second case is that of the churches directly related to a village like Sant Pere Màrtir of Agulló, Santa Maria of Colobor, the parish of Conill, Santa Maria of Montlleó, Sant Pere of Millà, Santa Maria of Corçá. In these cases, the churches were built

contemporaneously to the village but in many cases survived after their abandonment and changing their function. The churches of Sant Vicenç, Sant Salvador, Sant Martí and Sant Joan of Ager also belong to this category.

For the churches related to the scattered settlement, we can consider Sant Pere Martir of Agulló, La Trinitat of La Règola, Santa Coloma and Santa Maria del Pla that we know were still used in the 11<sup>th</sup> century. The location of these churches make sense only if we consider them in relation with the settlements of the agrarian areas where they are located. Is not casual that all these church are located near the plain area where the agricultural activity was more intense and that was characterised by a scattered settlement.

Finally, the organisation of the church network was a precise political plan of the Tost seigniorial family in order to give a shape of uniformity to the conquered area. The role of the Sant Pere abbey as head of the group is the natural consequence of this decision. To understand better the phenomenon we should look over the border of the Ager Valley because the Tost were interested in shaping a larger area of influence and in organising it under the control of Sant Pere of Ager. The spatial organisation of the churches shows a dense network of buildings related to every typology of settlement and disposed along the main axes of communication.

### 6.3 THE DEFENSIVE SYSTEM BETWEEN 10<sup>TH</sup> AND 12<sup>TH</sup> C.

An important task of the aristocracy was the control of the territory as well as the manifestation of their domain over the valley. Since the 10<sup>th</sup> century, the presence of the Islamic fortification in the hilltop of Ager faced the defensive towers of the southern side of the Montsec held by Christian communities. The towers of Mallabecs, Escumó and the castle of Pedra can be considered as the first nucleus of the Christian outpost in the valley.

Since the first half of the 11<sup>th</sup> century, the written sources inform us of a dense network of towers and castles in the hills that surround the valley and that filled



strategic positions in its centre. We can identify at least four defensive group a) two at the external sides of the valley, b) one in the middle area and c) one at south.

To understand the spatial positioning of these groups of towers we carried out an analysis of visibility and inter-visibility between the buildings. This typology of spatial analysis is a usual procedure in the study of the control of the territory. It was proposed since the nineties using the available tools developed with the Geographic Information Systems<sup>430</sup>. The analysis have been made using the toolbox available in the ArcGIS software Viewshed, Observation Points, Visibility and Intervisibility. It has been added a vertical offset attribute to each point in order to simulate the presence of a person in the top of the tower observing the area.

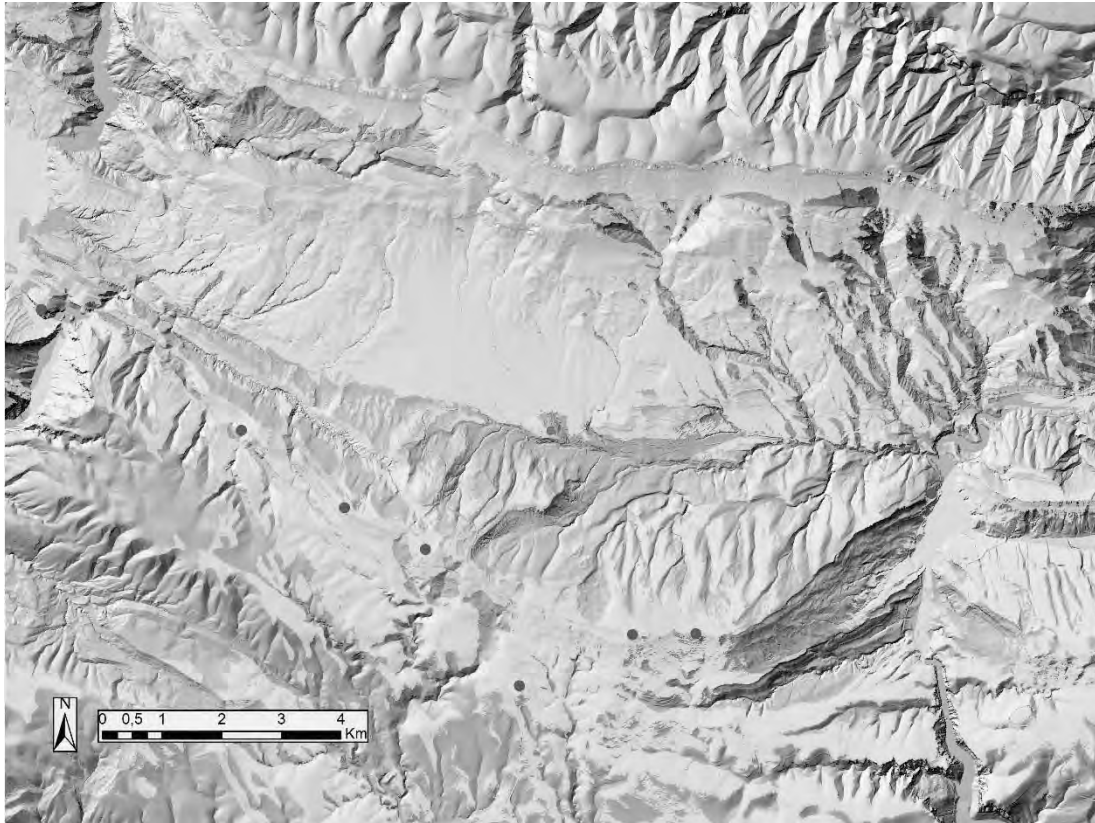
The southern group<sup>431</sup> of fortifications controls the point of access to the valley and the passage of the two rivers at its sides. The sites of Portaclusa, Millá, Cogul, Montlleó, Fontdepou, Montesquiu, Cas and Oroners form the line that closes the valley at south. These fortifications, as we saw, are often associated to a settlement and to a church and served as protection for the local inhabitants and for a complete observation of the access to the valley. They are located at an average distance of 2 km from each other even if the density is higher in the central area of the Montclús with 1 km separating the tower of Montesquiu and Cas and also 1 Km from the site of Montlleó and Cogul. The site of Portaclusa is approximately 3.5 Km far from Millá and the site of Oroners is about 3.8 Km from Cas. Nevertheless, this gap is filled at south by the settlement of Montclús already inside the area of Les Aspres but with a contemporary chronology to the other buildings.

The viewshed analysis and the intervisibility confirmed the defensive role of the towers. From this line, it is possible to control the southern extension of Les Aspres area into a radius of more than 5 kilometres. They also have a good visibility of the northern area of the valley, especially after the plain of Ager with a good intervisibility between the towers of the group 2 and 3.

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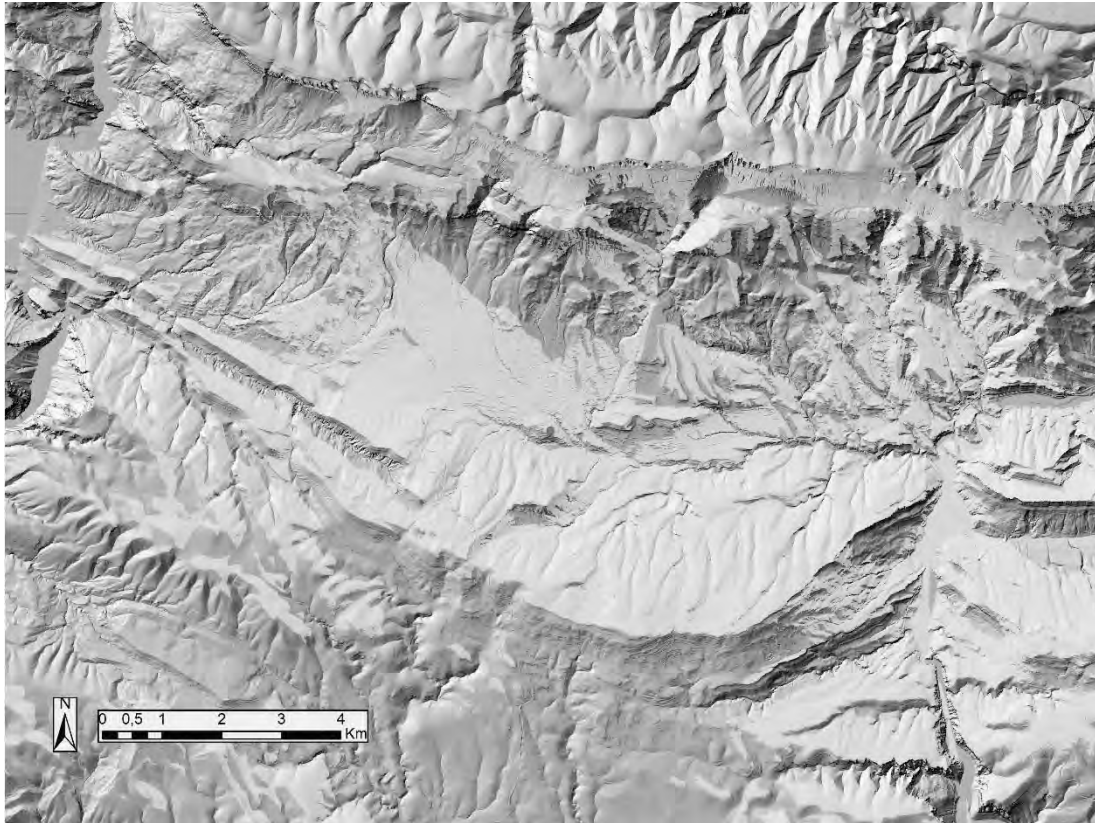
<sup>430</sup> David Wheatley. "Cumulative Viewshed Analysis: A Gis-Based Method for Investigating Intervisibility, and Its Archaeological Application." In *Archaeology and Geographical Information Systems: A European Perspective*, edited by Gary Lock and Zoran Stančić, 171-85. Boca Raton: CRC Press, 1995.

<sup>431</sup> We named it as "Group1" in the analysis shapefiles.



*Figure 115. Viewshed of the southern defensive system. From left to right: Conclues, Millá, Cogul, Montlleó, Fontedpou, Montesquiú, Cas.*

The northern-east group of tower follow the topography of the first geological terrace that precede the vertical side of the Montsec, in this group we put the tower of Mallabecs, Escumó, Colobor and Pedra that continued to be used also during the 11<sup>th</sup> and the 12<sup>th</sup> centuries. The average distance of these places is about 2.5 Km for each one and all are located around an altitude of 1000 meters above sea level. The analysis of visibility shows that these fortifications benefitted the altitude of their location, indeed the plain and the northern side of the Montclús are completely visible but what is really interesting is the huge visibility along the course of the river Noguera Pallaresa. Our explored area stops at approximately 7 kilometres south from the Montclús but the visibility could continue more inside the area of Les Aspres.



*Figure 116. Viewshed of the north-east defensive group. From right to left: Escumó, Mallabecs, Colabor, Pedra.*

The north-west group is a complex network of fortification that include Claramunt, Corçá, Pedra and Sant Llorenç. This group is particularly interesting because it controls the entire set of itineraries that pass through the Noguera Ribagorçana river and also the roads going to the hilltop of the Montsec. The fortifications of this group are very close, inside a range of 2 Km of length from each one and only the castle of Sant Llorenç results a bit farer with a distance of 3.5 Km from Pedra, due to the difficulty produced by the local geomorphology. If we consider the simple line of sight they are all inside a range that varies between 1.5 and 1.8 kilometres. The visibility analysis for this group shows as expected a predominant control of the west area of the valley. The course of the river Noguera Ribagorçana is visible until the point of Les Conclues, and this should explain the needing of a second point of observation in that place. In addition, a good visibility exists for the half of the Ager plain as well as for the northern side of the Montclús.

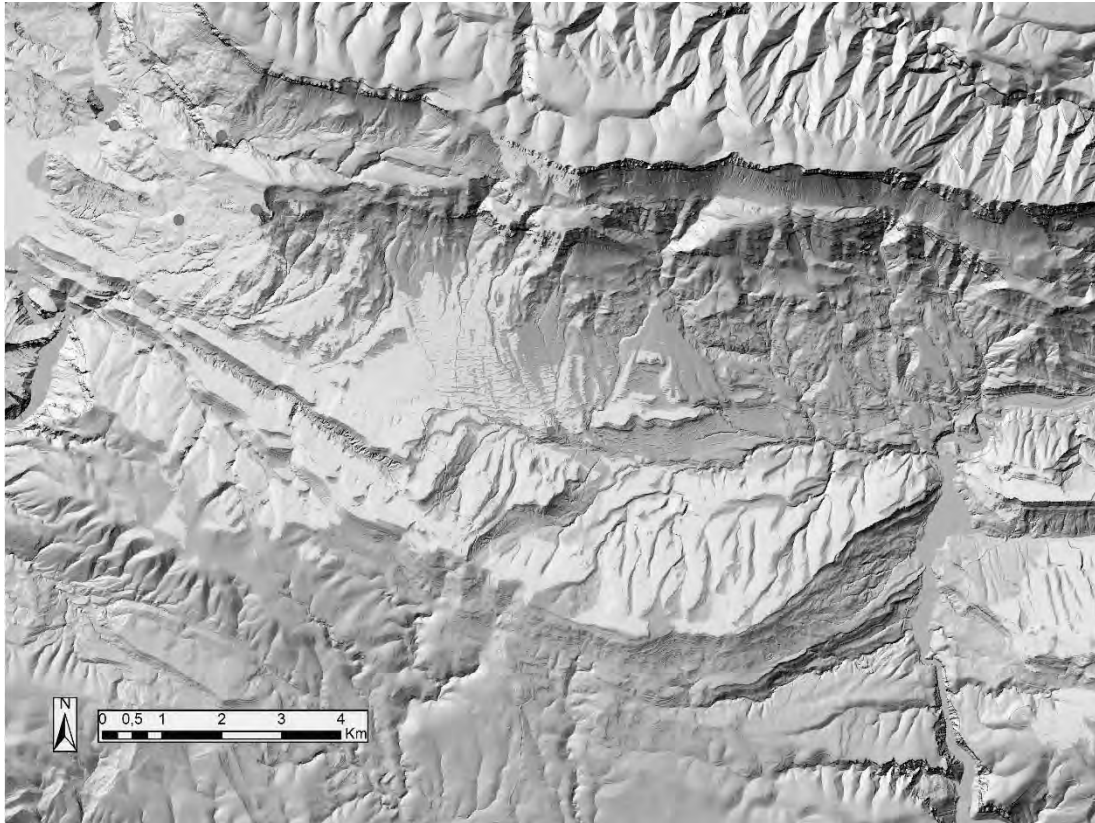


Figure 118. Viewshed of the North-west group of defense structures. From left to right: La Pertusa, Sant Llorenç, Corçà (below) and Claramunt (below).

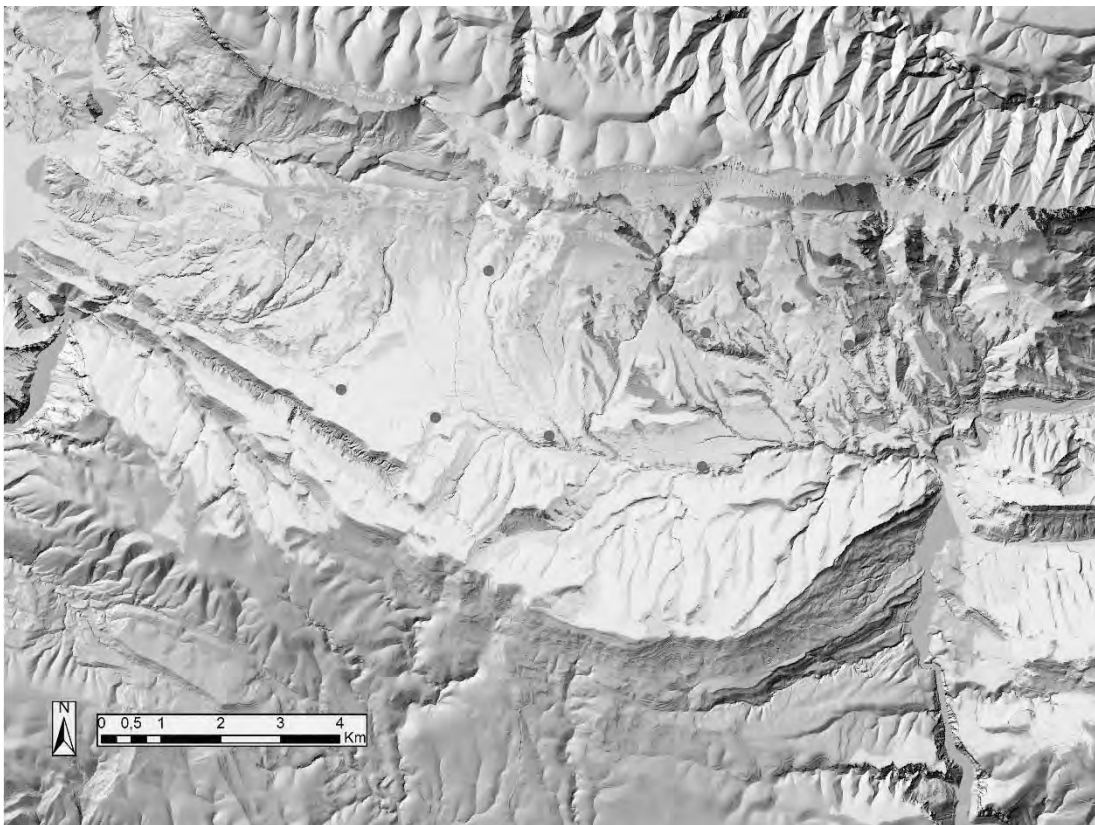


Figure 117. Viewshed of the central defensive system.

The central group of tower is formed by the castle of Agulló, Tower of Sanui, Ager, La Règola, L'Ametlla, Sant Miquel de Montaspre, Conill and the tower named *Torre del Negre* that closes the circle of the plain area. These fortifications follow the settlement of the plain area along the Riu Fred river and around the middle altitude hills in front of the plain. The visibility analysis shows that these fortification only controls the plain area and the north south of the Montclús without exiting the borders of the valley except at the east side.

A special mention should be made for the circular tower of Ager. It was discovered during the excavation of 2000 and 2003 made by Coberó and Vila in the hilltop of Ager. The tower is a circular building of which it remains only the foundation and few centimetres of high with a diameter of 16.5 meters and with a wall thickness between 3.5 a 4 meters. This very massive structure could have achieve a high of more than 30 meters. We do not know why it was demolished but from the archaeological records and for its position in the hilltop it is possible to fix a date of complete demolition between the 16<sup>th</sup> and the 18<sup>th</sup> century<sup>432</sup>. We make a viewshed analysis using this only point of observation and setting an offset of 31.5 meters considering the altitude of the tower as 30 meters and a person standing on its roof with an eight of 1.5 meters. The results show that this tower only could guarantee the visibility of the plain of Ager and the southeast side of the Montclús. It is interesting to notice that the calculus shows a reduced visibility in correspondence with the plain of Agulló, the data correspond very well to the change of orientation of the parcel system around this area that turns toward the centre of Agulló.

We think that the magnitude of the circular tower of Ager should have been a higher value as symbol of power considering that it was visible from the area most densely populated of the valley, the area of the plain. Indeed, its presence on the hilltop of Ager is redundant respect to the other towers scattered around the valley and along the Montclús and its size was not necessary from a functional point of view. We should see in this building the need of the new arrived aristocracy of Ager to

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<sup>432</sup> Josep Maria Vila Carabasa. *Memòria De La Intervenció Arqueològica...*, p. 105.

demonstrate its power in front of the other seigniorial family that populated the area, like the family of Exabel and the families of the county of Pallars that probably stopped their advance in this area after to the arrive of the Urgell county. This can explain the selling of the castle of Sant Llorenç d'Àres to Arnau Mir de Tost by the Pallars count as a further step to uniform the controlled area to the geographic borders.

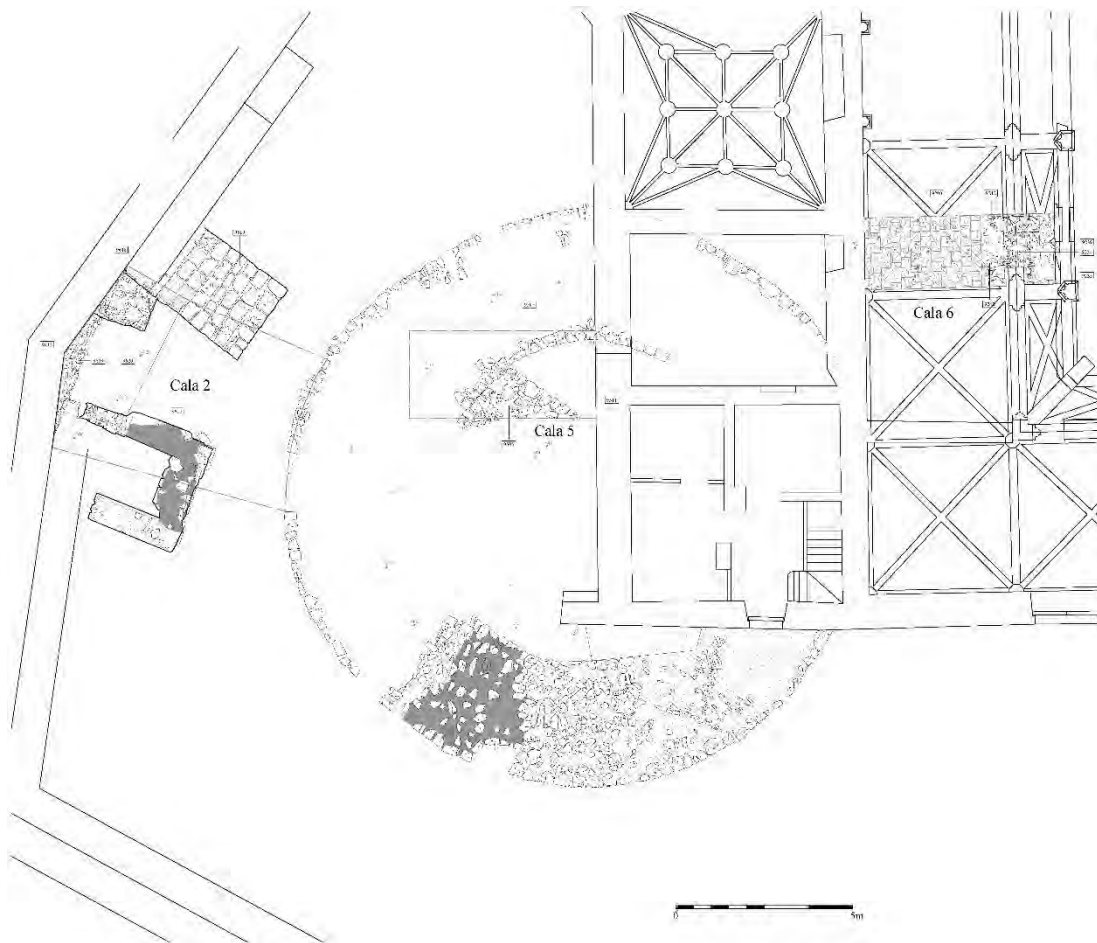


Figure 119. Plan of the circular tower discovered in the hilltop of Ager. (Source: Vila 2003)

### 6.3.1 DEFENSIVE SYSTEM AND ROAD NETWORK

The relation between the defensive system and the road network is very close. Analogously to the case of the church, we see that the presence of a fortification is justified by the passage of an important route of communication, but at the same time the fortification and the settlements strengthen the materialisation of the road.

In the Ager Valley we described two classes of itineraries, the local and the regional ones. As the local itineraries connects the settlements in pairs, every itinerary is controlled by the fortification associated to the settlement itself.

An interesting example comes from the area of Sant Llorenç d'Ares and La Pertusa. From the B-series aerial photograph of 1956 is clearly visible near the peak of La Pertusa the bridge that allowed the crossing of the Noguera Ribagorçana river. The itinerary that goes from Ager to Ribagorça must pass in every case from here with the two available variants of Sant Llorenç or La Pertusa. The figure show very clearly the domination of the sites over the road and in both cases the itinerary is controlled also by Corçá and Claramunt.

Another example comes from the central area of the valley. The disappeared tower of Sanui, where now stands a private house, was not associated to any settlement. Analysing its position we notice that it is located halfway between Ager and Agulló and almosts in front of the former church of Santa Maria del Pla. In addition from this point it was possible to control the access to the valley that came from a road descending from Montlleó.

Finally, the Torre del Negre tower was also located in an area that apparently has no utility for the defence of a place. Indeed, it is located in the plain of Ager at an approximate altitude of 800 meters that does not give an advantage for the observation of its surroundings considering that the relative difference with the plain of Ager is between 150 and 200 meters of altitude. Nevertheless, if we consider it in the context of the road network it appears clear that this location guarantees the control of two important ravines used as road to reach the church of Mare de Deu de Pedra and possibly also its castle, as well as to climb toward the central area of the Montsec mountain.

## 6.4 THE ECONOMIC ACTIVITY

For the Ager Valley, we do not dispose of paleo-environmental studies as pollen analysis and paleobotanic detection that could illustrate the natural situation of the area in the past centuries. Nevertheless, we receive a set of hints from the historical document that can be used to interpret the framework of the economic activity in the valley in the 11<sup>th</sup> and the 12<sup>th</sup> century. As in every medieval economy, the resources came not only from the agriculture but also from the wood and the livestock.

From the archaeological point of view, with the archaeogeographic analysis in the previous chapter it has been clear that the agrarian organisation is heavily constrained by natural factors especially by the geomorphology that reduces the availability of plain areas. To propose an interpretation of the agrarian organisation during the middle ages we must refer to the main generators of parcel systems: the settlements and the roads.

The agrarian morphology suggests that the main morphological generators in the valley are the settlements placed along the Riu Fred river. As we have seen, many of the itineraries that cross the valley start or end in the centre of Ager creating a typical star-shape pattern visible around the settlement. Analysing the itineraries it was shown that the tracks have a strict relation with the medieval settlements causing a stronger materialisation of the network occurred since the 11<sup>th</sup> century.

Nevertheless, we should consider the possibility that the Iberian settlement could have generated before some of the successive structure reused in the Late Antique and in the Middle Ages. As Jordi Diloli asserted studying the Iberian settlements of the Ebro Valley through spatial analysis, these settlements are characterised by a common ground criteria about their positioning<sup>433</sup>. In particular, the Iberian settlement were positioned in low altitude hills next to water presence and next to agriculture suitable areas. These characteristics, that may appear standard also for

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<sup>433</sup> See in general Jordi Diloli. "Anàlisis Del Poblament En Època Ibèrica Al Curs Inferior De L'ebre (Baix Ebre-Montsià)." *Revista d'Arqueologia de Ponent* 5 (1995): 99-124 and also Jordi Diloli, and David Bea Castañó. "L'urbanisme D'època Ibèrica Al Baix Ebre: L'assentament De L'assut De Tivenys." *Butlletí Arqueològic. Reial Societat Arqueològica Tarraconense* 27 (2005): 5-46.



the Middle Ages settlements, especially from the 11<sup>th</sup> century, are not constraining for the roman period. This is a known reason of why several protohistoric settlement are often excavated under medieval hill settlements with no roman phase and that we already mentioned for the case of Ager.

Since the first half of the 11<sup>th</sup> century, the written documents define a general organisation of the landscape around the settlements of the valley. In a document of 1042 where Arnau Mir de Tost and Arsenda granted an economic exemptions to the Exabel family of Pedra, when describing the list of the properties they wrote<sup>434</sup>

“Sunt ipsi alaudes suprascripti terris et vineis [...], ortis, arboribus, linares et cannamares [...] pratis, pascuis, silvis et garriiciis...”. Even if this expression is a sort of standard formula used also in many other documents, we can extract a set of objects of interest that describe the general land use of the period.

The vineyard is probably one of the main cultivated plant with the olive trees and the cereals, confirmed by several deeds of sale of vineyard and olive cultivated fields. The presence of the vineyard is confirmed in the plain area, for example around Santa Coloma, as well as in the elevated hills of Corçá, Claramunt and Sant Llorenç<sup>435</sup>. Also the wheat was a large cultivated cereal especially in the plain area. We found a reference of 1278 that attests the cultivation of saffron<sup>436</sup>.

Another interesting typology of cultivation is the gardens, we described many morphological units with regular parcels associated to gardens along the Riu Fred river. It is possible that these gardens already existed in the same locations since the 11<sup>th</sup> century and were used for the daily needing of the settlement inhabitants. It is also interesting the presence of the cultivation of flax-fields and sugar-canes, the cultivation of these plants, especially for the sugar-cane, is another usual practice during this period around the entire area of the Noguera, and its cultivation continued until the present day.

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<sup>434</sup> Chesé p. 217.

<sup>435</sup> Chesé 303-304.

<sup>436</sup> The original text has been published as appendix by Fité p 332. Trascritto da Serra Ràfols

In the second part of the sentence, we find the non-agricultural economic activity with lands used as pastures and the areas covered by woods. It is interesting to notice that the uncultivated areas are cited separately from the woods. In some recent studies was demonstrated that actually during the Middle Ages the woods could be considered as cultivated areas because their managing was a very relevant task in the economic activity and the wood cultivation was not a marginal activity but it had the same importance as the agriculture<sup>437</sup>. Considering that we are dealing with a pre-Pyrenees valley and considering the geomorphology of the area we should expect that between the 11<sup>th</sup> and the 14<sup>th</sup> century the Ager Valley had an important portion of its surface covered by woods and then the activity related to its exploitation was relevant in terms of its economy. Amongst the possibility of hunting and phishing, the uncultivated areas were also sources of many products as the wood, the charcoal, natural tar, mushrooms and other spontaneous plants as well as medicinal plants and aromatic herbs<sup>438</sup>.

Inside this economic context, we should situate the takeover of new agrarian spaces in order to respond to the plan of economic expansion of the valley intended by the Tost seigniorial family. In this sense, we consider that the aristocracy carried out two main actions to accomplish the economical growing objectives a) the reorganisation of the Ager plain and b) the creation of many terraced systems related to the new settlements.

Even if in the archaeogeographic analysis we could not identify a precise planned parcel system in the plain because of the lack of a metrological uniformity for the parcels we can propose an interpretation of a semi-planned agrarian system. We think that even if is not possible to confirm the presence of a measurement of the individual parcels, it is possible to determine the main axes along which it has been structured the agrarian landscape of the plain. As explained above, in this case we cannot have a certain chronology for each single parcel but, because the axes that

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<sup>437</sup> Sylvain Burri. "Reflections on the Concept of Marginal Landscape through a Study of Late Medieval Incultum in Provence (South-Eastern France)." *Post Classical Archaeology* 4 (2014): 7-38.

<sup>438</sup> Sylvain Burri. "Vivre De L'inculte, Vivre Dans L'inculte En Basse-Provence Centrale À La Fin Du Moyen Âge. Histoire, Archéologie Et Ethnoarchéologie D'un Mode De Vie." Aix Marseille Université, 2009.

we consider are mainly roads and that they develop through dated settlement, we can assign a starting chronology for the general structure.

As visible in the figure 120, there are at least three axes with a north-south orientation that cut the plain of Ager with a variation of few degrees from the natural slope of the alluvial fan. Along these three axes, a series of perpendicular parcels develop their shape again with a variation of few grades respect to the normal slope followed by the rivers. In our opinion, these can be the signs not of a planned system, because we do not have enough data to demonstrate it, but it could be a sort of guideline for the plain arrangement operated between the 11<sup>th</sup> and the 12<sup>th</sup> centuries for the agrarian development.

The second intervention was the organisation of the hills around the settlements with agrarian terraces. Considering that settlements like Corçá, Claramunt, La Pertusa, Conill or Sant Miquel de Montaspre were positioned in sloped areas the only agricultural field could have been only the agrarian terraces. In this case the archaeological survey supported this hypothesis because many evidence of pottery dated to the 11<sup>th</sup> and the 12<sup>th</sup> century were found in the terraces of La Pertusa, Corçá, Claramunt etc.



Figure 120. Axis of development of the parcel system related to the settlement of Ager.

## 6.5 CONCLUSION

All the data discussed in this chapter are difficult to separate and to analyse individually because there is a strict relation between the settlements, the defensive network, the agrarian system, the road network and the sacred places. As seen until here, one of the great challenges of Landscape Archaeology is to analyse separate data with fragmented chronology and spatiality and organise them in order to create a unitary framework. As expected the quantity of the sources and their quality forced us to retain more our discussion on the central centuries of the Middle Ages that in this case are the century in during which the Ager Valley had the major political importance of its history.

The unpublished archaeological data that we analysed here, helped to delineate a sequence of occupation of the central place of the valley and to associate to it the destiny of the entire area. We are able to confirm that before the occupation of the area by the Christian seigniorial family of Tost the area was used as an outpost of the Islamic defensive line, at least between the 9<sup>th</sup> and the 10<sup>th</sup> century. Nevertheless, we locate at the same time a line of Christian defensive outposts in the southern side of the Montsec. We should confirm the role of frontier of the Ager Valley but also confirm a role of marginality respect to both forces. This can explain the permanence of a Christian community and at least an autochthonous aristocratic family as the Exabel, the lack of Islamic placenames, pottery, architectures, or other typologies of evidence that remained deeply in the territory of Balaguer even if it was conquered by the Christians only 60 years later.

It was this marginality that encouraged the Tost family to foster a plan of economic and social improvement and that allowed Arnau Mir de Tost and his successors to create a uniform territorial domain that will become a viscounty at the end of the 13<sup>th</sup> century.

# 7

## GENERAL CONCLUSIONS

As every scholar knows, it is very difficult to talk about conclusion when dealing with a research work. Every research is concluded only when the researcher decide it is. We should talk about temporary conclusions, making a review of the work done and concentrating on the new perspective that this point opens for the following tasks.

We started this work shaping the panorama of an embedded historic tradition almost unchanged since the 18<sup>th</sup> century and mainly based on few written documents with all the annexed limits. The first change in the approach arrived with the works of the eighties and the excavations carried out by Francesc Fité and we have seen that only an Archaeological approach is able to give new light on the history of the Ager Valley. Nevertheless we did not reject systematically every former interpretation, our approach intended to produce an archaeological interpretive line about the evolution of the settlement in the Ager Valley without any prejudice on the former scheme. As it was demonstrated we also gleaned information from every available

source without any distinction and our attitude was dedicated to follow two main principles:

- a) use the evidence to delineate the general phase of evolution of the Ager Valley historic landscape
- b) abandon where possible the site-centred perspective in order to achieve a more holistic framework

We did not want to confirm or confute the hypothesis made by documentarist historians with the archaeological sources because this is not the aim of Archaeology. We tried to exploit every single source to answer to archaeological questions, which may differ from the historical ones, and to start a never tried research approach for the Ager Valley.

In this way, we were able to face different subjects related to the study area with an innovative methodology, from the agrarian organisation to the road network structure. From the visual defence of the territory to the organisation of the church network in the valley.

We are conscious that many research objectives are still unsolved but this approach paves the way for further researches. In particular there are some interesting themes that can be developed starting from our work.

- 1) The land use and the chronology of the agrarian system. We know that until now it is still impossible to define the exact moment of creation of the agrarian terraces and the parcel structure even if many details and comparisons bring to the 11<sup>th</sup> century. It would be very interesting to associate the parcel morphology to the land use. This target can be improved with specific analysis of paleoenvironmental nature, like pollen analysis and terraces system excavations.
- 2) A deeper understand of the settlement in the paleochristian and Early Middle Ages periods is a verisimilar target that has an interesting base for its development. In this sense, the lack of written evidences implicates that only Archaeology could bring new data through excavations and intensive prospections. Following the paths of the 5<sup>th</sup> century burials is a possibility to

obtain a clearer panorama of the Early Middle Ages organisation of the Ager Valley.

- 3) The knowledge about the relations between Christian and Islamic power in the Ager Valley is at its begin. We were able to confirm that Ager was an Islamic settlement but we need to extend the knowledge of the situation through the valley. There is a high possibility of a pacific cohabitation of the two cultures until the beginning of the 11<sup>th</sup> century. We are not able to locate an Islamic frequentation of other areas in the valley and producing some predictive models of site preferential location could help the researchers to narrow the research area.
- 4) The economic framework of the valley is very interesting and it should be deepen from the non-agrarian point of view. Especially for the Middle Ages the exploitation of the mountainous landscapes was very intense and it could be interesting to analyse deeper the consequences of this economy on the general activity of the valley. Often these activity generated temporary sites that should be explored with intensive survey of the mountains.

To conclude we think that the Ager Valley has been a marginal landscape for its environmental inadequacy during the roman period and this status continued for many centuries. During the Early Middle Ages, the major part of the settlements was positioned around the central plain area that was also the area mostly exploitable of the entire valley. From the cases of Santa Coloma and Santa Maria del Pla we think that the social groups were formed by small monastic communities. These followed the settlement model described along the courses of the rivers Noguera and Segre and that can be found at the other side of the Montsec with the sites of Els Altimiris and Sant Martí de les Tombetes. This typology of settlement can have survived in the Ager Valley also during the Islamic domination and as we see, it could be confirmed by the written document with the analysis of the onomastic characteristics.

The archaeological evidences show a clear difference between the 10<sup>th</sup> and the 12<sup>th</sup> century in the hilltop of Ager corresponding to an increased importance of this area. This could have generated changes also in the agrarian systems, in the road networks

and in the general organisation of the settlement in the entire valley with the creation of new settlement and the strengthening of the existing ones, with a creation of a new defensive system and a dense church network along the main communication axis.

Final it seems that in the following centuries, from the 13<sup>th</sup> onwards, the centrality of Ager disappears again and the valley become again a marginal territory due to the crisis of the Late Middle Ages and to the abandonment of many settlements.



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