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Modelling the Topography of the Ancient Laurion:
Epigraphical Sources, Mental Maps and GIS

Introduction

In this contribution, we present a research plan to explore what could be perceived as an “ancient landscape”¹ by analysing a specific epigraphic corpus. The 4th C BCE *poletai* records inscriptions present a set of systematized spatial references that produce a verbal map for the ancient Laurion mining district, which could be read and comprehended by an Athenian Citizen of the time; in this manner, an inscribed set of collectively shared spatial concepts allows a glimpse of the mental map(s) of those who composed, inscribed and read the inscription texts.

It is our intention that the decoding of the structural principles of the epigraphic sets of spatial concepts will provide the key to translating the ancient map

¹ When it comes to terminology of spatial concepts, there is always a need to clarify their content; we thus define here the terms we employ hereafter: *Space* signifies the abstract entity defined by the measures of its dimensions (coordinates within a system of reference). *Tópos* signifies the totality of the spatial entity with all constituent elements (usually distinguished in anthropogenic and physical) and all their relationships as lived by humans (individuals and collectivities) in time. *Landscape* stands for both the perception and the narration of *tópos*. *Tópos* corresponds to the ontology of the socio-spatial entity and *Landscape* to its phenomenology. *Place* is situated between and partially overlapping the two, as it is employed to denote a discrete portion of a *Tópos* and/or a *Landscape*. As we all communicate via *narratives* of *tópos*, it is the term *landscape* that dominates writing on humans in space. These definitions have evolved on a substratum of extensive and winding debates building upon Merleau-Ponty 1945; Heidegger 2001(=1952), 141-160; Piaget 1952; Husserl 1962 (=1913); Bourdieu 1990; Ingold 1993, 152-174; Bailey 2007, 198-223.

(both verbal and mental) into a modern one (i.e. one that is comprehensible to modern people), employing a GIS platform; the ‘reconstruction’ of ancient people’s mental maps in a GIS environment has been a challenge since the late 1990s².

The next step is to establish links between the aforementioned maps and the present-day topography by obtaining a deeper understanding of the landscape palimpsest as the bearer of a diachronic thread of collectively shared spatial values. A first corollary of such an understanding will be the potential identification of certain material features of past “taskscape”³ (e.g. mining, metallurgical, agricultural, sacred), recorded in the inscriptions, with presently observable material remains. Laurion in Attica is the palimpsest of an ancient-to-modern mining district – it combines strong visibility regarding the remains of mines and metallurgical workshops with the presence of technology-laden materials, farms, roads, sanctuaries, burial enclosures, as well as all anthropogenic attributes of the Classical Athenian rural Deme spatial model⁴. A second consequence will be to apprehend the *tópos* we experience today as integrally linked to the socioeconomics of a past society, thus visualizing a past socioeconomic landscape (or taskscape[s]).

The reason for presenting this research attempt at such a preliminary stage is to stir up a discussion on the proposed methodology and develop a basis for potential collaboration, which would link cases analogous to the one presented here. In this way, we may ultimately arrive at a generally applicable tool.

Our methodological premises are built upon a consensus that has been developing since the time of Merleau-Ponty’s body-space phenomenology (1945) and Piaget’s schemas (1952), namely that the experience and the subsequent learning of the landscape, in its three-dimensional spatial reference, is both generated by bio-physiological conditions (e.g. sensory organs) and structured via socio-cultural factors⁵. The latter emerge at the intersection between the individual, groups and society, that is, their corresponding mentality, as circumscribed by the Annales School⁶. Within this frame of reference, *places* may be defined as such on the differential basis of – among other things – intentions, naming, and the recurrent use or peculiar characters. Placenames relate to human perception

² Llobera 1996, 612-622; Gillings - Hacıgüzeller - Lock 2018; Landeschi 2019, 17-32; see Farinetti - Cavallero 2019. In the related field of geography, Ciobanu 2008, 25-34, sets an example of mental geography, which is similar to the attempt we present here.

³ Ingold 1993, 152-174.

⁴ Kapetanios 2013, 185-187.

⁵ Merleau-Ponty 1945; Piaget 1952.

⁶ Bloch 1928, 15-50; 1949, *Introduction*, ix-xiv; Burguière 1982, 424-437; Burke 1986, 439-451; Guervich 2008, 141-150.

processes, as people construct places by giving them names⁷. Mental maps are the products of learning the landscape in the manner described above. These are continuously generated by individuals, who experience life within certain spatial coordinates (*tópos*). Collectivities share similarly structured mental maps, the structure of which is regulated by shared conventions which reside in the aforementioned mentality. Fundamental relational values linked to notions of orientation and vicinity may be widely shared by collectivities.

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The poletai records and the Laurion landscape

The inscriptions

The *poletai* fragmented inscriptions were found in the excavations in the Athenian Agora, or nearby; their chronologies fall in the period between 367 and 300-295 BC. They are official documents, once erected in the Agora, that record public property contracts; among them (the most prominent, in terms of the number of record-entries and the extent of inscribed text) are the leases of the Laurion mines⁸. There is standardization, by record-entry, in registering this practice of leasing mines to individuals by the Athenian polity (see Table 1): each entry is structured by the mine's name (Table 1, line A) and its class⁹, usually the territorial Deme, a typically repeated location description (Table 1, lines B, C, D1-4), which is our focus here, the lessee's name and demotic, and the fee payable (Table 1, line E). In this manner, catalogues of the mines named are produced, with their location described by a systematic mode of reference to geomorphological and anthropogenic features bordering them in all four directions (E, W, N, S). A series of place names, physical features and land-tenures or ownerships are mentioned, some of which are recurrent. A few of these match available archaeological data or modern landscape features (Fig. 1) and can be located in modern geographical space, with varying degrees of precision¹⁰.

⁷ The process of place-naming can be understood within “*nominalisme*” and in the same vein with other taxonomic and classificatory systems for the constituents of the world we live in (Lévi-Strauss, 1962, 48-99; 1991, 51-84; cf. Bowden - Lowenthal 1965; Tilley 1994; Johnston 1998, 54-68; Ingold 2000; Betts 2017, 23-38).

⁸ Crosby 1941, 14-30; 1950, 189-312; 1957, 1-26; Lalonde - Langdon *et al.* 1991.

⁹ Ανασάξιμον, εργάσιμον, συγκεχωρημένον, καινοτομία; for a discussion on the meaning of these terms, see Kakavogiannis 2005, 112-116.

¹⁰ Kapetanios 2013, 183-198.

Looking for an Ariadne's thread

When someone decides to start reading the book of the Laurion landscape palimpsest, the most appropriate sensory organ is his or her body moving into and within the landscape¹¹. The scale at which material remains (mainly of the mining and metallurgical activities in classical times and in the late 19th and 20th centuries) unfold is overwhelming, as is their density; the effect is multiplied once someone enters the underground world of mining galleries and shafts. In this labyrinth, extending on the surface and underground, you need an Ariadne's thread: a map and landmarks. Among the diachronic notional threads which permeate the Laurion palimpsest, stitching it to its integrity, the most prominent are geology, ore, metals, metallurgy and the need for guidance into these spaces.

In the late 19th and early 20th centuries, the mining and metallurgical companies involved in the exploitation of ancient *scoriae* (slugs) and other ore and metallurgical by-products (tailings and sand/mud residues), worked in this direction meticulously. As they moved towards implementing their production project, the need for large areas to be conceded by the Greek state generated maps, as well as landmarks that were erected on the ground (Fig. 2b).

Fig. 2a shows a map of the Laurion Peninsula that records the distribution of ancient *scoriae* and tailings. The map was employed during the agile discussions in the Greek Parliament, in the 1860s or 1880s, on the terms and conditions for the ancient mining and metallurgical by products (*scoriae* and tailings) to be conceded to Serpieri and Roux Co. The vertices of this polygon were materialized on the landscape by cylindrical features known as the "Serpieri Horoi" (Fig. 2b).

In an analogous manner, the leasing of the Laurion mines by the *poletai* demanded their spatial designation by landscape description and landmarking. Figs. 3a and b show respectively a stele bearing an inscription of the δηλωτικά class and an *in situ* stele base; such pairs were erected close to the mine entrances, recording the name of the mine, the lessee's name, and the class of the mine consisting the so-called *metalla horoi*¹². Reference to its presence is recorded as part of the typical leasing entry in the *poletai* records by the phrase «...στήλην έχον...».

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¹¹ Merleau-Ponty 1946, 112-132.

¹² For the δηλωτικά μεταλλείων class of inscriptions see Kakavogiannis 2005, 39-86. On the stele in Fig. 3a, see Kakavogiannis 2005, 48; it reads Ἀρτεμισ[ι]ακόν | Θυμοχ[ά]ρης κατέλαβ[ε] | καινοτόμη[σαν] | *vacat*. (Transl.: "Thymochares took over the Artemissiakon mine, which is a new venture").

Reading the poletai landscape

As Muir¹³ writes, “in the course of sensing, the mind simplifies complex environmental reality into an environmental image”. In a certain way, the Laurion inscriptions report a somewhat simplified image of the specific landscape perceived at that time, allowing us to open a window into the shared mental map of the community which produced them: the scribes, the *poletai*, the bureaucracy they belonged to, the lessees, and eventually the Athenian citizens who would read them in the Agora, all shared conventionalities residing in the mentality of the Athenian society.

The density and scale of the material culture in the area triggers in the reader of the Laurion landscape (who is simultaneously a reader of the *poletai* mine leasing records) a sense of familiarity. When you squeeze your body among the ruins of ancient mines and workshops, you get the impression that, as you grasp their materiality by merely stretching out your hand, you could just as easily identify them by the name of the owner or lessee, and thus identify the landscape you move within with that which emerges from within the *poletai* inscriptions.

Why is this? Because we share with the composers of the inscription texts certain mental map structuring principles: orientation and reference to geomorphological features.

ἡλίου ανιόντος	[to the side of the] rising sun
ἡλίου δυομένου	[to the side of the] setting sun
Βορράθεν	from the North
Νότοθεν	from the South

(four horizon-directions, Table 1, D1-4)

Λόφος	hill
Χαράδρα	cliff/gorge
Ποταμός	river/stream
Θάλασσα	sea
Οδός	road/route

(geomorphological features as landmarks)

¹³ Muir 1999, 126.

It cannot be argued, of course, that by sharing this terminology we also share the exact semasiological spectrum of the terms employed; but we do share that they are used heuristically to implement orientation and land marking. We do, also, share a minimum of the meaning founded in the experience of these geomorphological features, as well as relational terms such as proximity (ὄρι γεί) and motion to and from (ἐς, ἀπρό, -θεν, -ζέ) – see Table 1. An understanding is thus certainly achievable.

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The project's plan

So far, in the relevant literature, the processing of the epigraphical data of the *poletai* records has targeted issues such as price statistics, mine categorization nomenclature and prosopography¹⁴.

In this project, we attempt to visualize a flexible set of abstract mental maps, building upon the logical relationships generated by the substratum of shared concepts described previously, and beyond any defined geometric space. This “grasp” of the basic structure of the mental map(s) narrated in the inscriptions allows us to further explore the network of spatial relationships defined in the epigraphical record and trace the social and economic meanings involved. These meanings reside in how mental maps are structured in reference to the politics of descent, landownership, production, ritual and finance. In achieving this, we have planned and begun to follow a four-step process:

I) the construction and implementation of a database to investigate the “intermediate” logical network of relationships, which transforms the *poletai* records landscape into an intra-referential network (Fig. 4). With this step, we aim to reach a contingent apperception of the world contained in these maps, although at this stage we make no attempt to reach a charted map of the various objects (elements of the physical world – hills, gorges, and streams – and those of an anthropogenic nature – roads, paths, toponyms, properties, buildings, metal workshops, and cult places)¹⁵;

II) the discrete, discontinuous textual references analysed in their network links are transformed into a continuous virtual surface, with virtual spatial dimensions, in a virtual space defined by a matrix of cells;

III) we develop a methodology for transferring the intra-referential network into a spatially and geometrically correct “intermediate” virtual map. In other words, we should be able to mathematically form a coherent, geometrically correct idiosyncratic coordinate system of an intermediate virtual space (Fig. 5);

¹⁴ Aperghis 1998, 1-20; Shipton 2000; Bissa 2008, 263-273; Leonardos 2010, 47-52.

¹⁵ Götz - Holmén 2018, 157-161.

IV) we proceed to a representation (insofar as it is possible) of the landscape of the area as it was in the 4th cent. BCE, mapping mines, workshops and physical features such as streams, ridges, cliffs and hills. As this landscape constitutes an integral part of the modern palimpsest, the process involves linking the intermediate map to the modern three-dimensional geo-topographical space; such links can then be identified by comparing archaeological data such as rupestral inscriptions and *horoi*, the archaeological remains of workshops, and mine *stelae*¹⁶ to the *poletai* inscription texts.

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The work so far

As explained above, we first have to tackle the construction and implementation of a database to investigate the “intermediate” logical network of relationships, with the aim of converting the *poletai* records into an intra-referential network that will constitute our series of mental maps.

The implementation of the database (in SQL language within a Spatialite environment) is a worthy task on its own, as it enables the investigation of many queries on epigraphical issues and prosopography, landownership and the relationships between landowners, workshop owners and mine lessees (*onetai*), as well as the embodiment of the Athenian socio-economic structure (property management system). Of particular importance is a focus upon the logical relationship between prosopography and place names (involving mines, workshops, physical features such as ridges, streams and gorges) – *topothesies*, *geomorphology*, *metalla* and *toposima* in the ER model in Fig.4. In this context, relational terms of motion and proximity have to be analysed by studying the occurrence and use of particular prepositions in the indication of places (ἐν, ἐπί, εἰς) and of suffixes designating motion to and from (-θεν, -ζε) – *protheseis* in the ER model in Fig.3.

The database records indications of the relative location of place names mentioned in the ἐγγραφαί μεταλλῶν, the *poletai* records. These indications can be understood by several possible combinations of their relative spatial distribution, marked by variable degrees of complexity. To reduce the number of alternatives, we could introduce additional Proxy factors, on top of the factors of proximity registered in the inscriptions. We could, for example, employ the recurrence of landowners or their relatives in conjunction with other, non-relatives, as an indicator of land proximity: a convergence of ownership and affinal landscapes. Space thus reflects personal or family relationships and acquires a social dimension.

¹⁶ Kapetanios 2013, 185-187.

Concisely, in this first step of the process we explore a network of discrete elements with a 'relational' spatial character (Fig. 3).

In the second step, the discrete, discontinuous textual references, analysed in step 1 via their internal connections (intra-relationships by links of orientation, landmarks, etc.), are transformed into a continuous virtual surface, with a virtual spatial dimension, in a virtual space defined by a matrix of cells. Fig. 5 shows the mathematical transformation of each quartet of orientations (N, S, W, E) defined in each *poletai* record, in Cartesian space, each cell defined by four vectors (V1...V4) of the form $V1=(1,0,0,0)$, $V2=(0,1,0,0)$, $V3=(0,0,1,0)$, $V4=(0,0,0,1)$. Each digit of each quartet derives from the N-S-E-W set in the inscriptions; their values derive from the N4 group of IDs corresponding to unique places. Following this, the Database is queried in order to retrieve missing spatial information. For example:

If Ω is located East of Δ , then $V3(\Delta)=\Omega$ and $V4(\Omega)=\Delta$.

Given the quartets as in Fig. 6, if a Γ is located in 3rd place anywhere in the QUARTETS, the corresponding quartet would be the question mark and would fill a gap in the virtual map.

In step 2, the virtual representation of the records investigated is a matrix, which maps, in a symbolic abstract virtual space, the assignment of spatial attributes that cannot yet be defined. The construction of the matrix is based on an algorithm working in a Cartesian space where the transition between the cells is feasible only by moving step by step from one cell to another.

The transition between step 1 and step 2 is allowed through the dynamic interconnection PLACE NAMES – PROSOPOGRAPHY – SPATIAL ATTRIBUTES, due to the incorporation in the inscriptions of the Athenian socio-economic structure (in the form of the prosopographical record linked to spatial features and place names). From text strings representing discrete features, we move to cells that signify the link between the words and their spatial attributes.

In order to move on to step 3, we need to develop a methodology for transferring the intra-referential network into a spatially and geometrically correct "intermediate" virtual map. In other words, we should be able to mathematically create a coherent and geometrically correct coordinate system. To move on to the third stage, and then the fourth, we need to complete the first two stages and resolve the matrix in all its possible components, in order to build up a proper topology of the Laurion landscape.

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Perspectives

The research presented here is still in its very initial stage; yet, we have attempted to set out its framework and guidelines to progress further. The methodology we are trying to prescribe could produce a decoding of social dynamics linked to landscape properties during certain periods: *poletai* records refer to the second half of the 4th cent. BCE; other inscriptions from the same area, such as those of the *Salaminioi*, move forward to the 3rd cent. BCE¹⁷, while those of the sacrificial calendars expand the scope both earlier and later¹⁸.

It is time that generates a conjectural socioeconomic pattern of a certain past community, which is perceived by agents/members of the community and is implemented in the long-term dynamics of the landscape; in this manner, an active palimpsest is formed, experienced in (each) present. At this intersection of space and time, we may find the key concepts to unlock an understanding of further principles which structure ancient mental maps as intrinsic elements of the collective ideology of an ancient community – namely, its mentality.

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¹⁷ Ferguson 1938.

¹⁸ *SEG* 33:147; Daux 1980; 1984.

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Abstract

In questo contributo, presentiamo un tentativo di avvicinamento al paesaggio antico dell'area del Laurion, in Attica, prendendo in considerazione come mappe mentali alcune iscrizioni datate al IV secolo a.C., la lista dei *poletai*, che registravano gli affitti delle miniere da parte del sistema politico ateniese ad individui. Lo scopo della ricerca è triplice: in primo luogo, ricostruire un insieme flessibile di mappe mentali astratte, al di là di uno spazio geometrico definito, al fine di esplorare la rete di relazioni spaziali definita nella registrazione epigrafica e i significati sociali ed economici coinvolti; in secondo luogo, sviluppare una metodologia per la produzione di una mappa "intermedia", spazialmente e geometricamente corretta, che trasformi la mappa mentale in una mappa intra-referenziale; in terzo luogo, obiettivo finale è quello di procedere a una ricostruzione (per quanto possibile) del paesaggio e dell'assetto topografico dell'area come si presentava nel IV secolo a.C.

In this contribution, we present an attempt to approach the past landscape of the Laurion area, considering inscriptions dated to the 4th cent. BCE, recording the leases of mines by the Athenian polity to individuals (the *poletai* records) as mental maps. The research aim is threefold: first, to reconstruct a flexible set of abstract mental maps, beyond a defined geometric space, in order to explore the network of spatial relationships defined in the epigraphical record and the social and economic meanings involved; second, to develop a methodology for the production of an "intermediate" map that is spatially and geometrically correct, thus transforming the mental map into an intra-referential map; finally, we proceed to a reconstruction (insofar as is possible) of the landscape and the topographical layout of the area as it was in the 4th cent. BCE.

Inscription	SEG 12.100	Agora XIX, Poletai P 5	SEG 12.100	Agora XIX, Poletai P 5	Agora XIX, Poletai P 5	Agora XIX, Poletai P 5	Agora XIX, Poletai P 5	Agora XIX, Poletai P 29
Date	367/6	367/6	367/6	367/6	367/6	367/6	367/6	338/7 και 340/39
A				Προεδριωνικών	Δεξιακών	Δημητριακών		Αρραμισιακών
B	έν Νάπτου έν τοις χωρίοις τῆς Χαρμυλίου (ἐν Χαρμυλίου) γυναικός	ἐπι Συνήτοι έν Νάπτου έν τοις Χαρμυλίου παιδῶν	ἐπι Συνήτοι έν τοις Χαρμυλίου παιδῶν,	έν Νάπτου των ἐκ τῆς στήλης ἐν τοις Αλατήρειου	έν Νάπτου ἐπι Σκοπῆται,	έν Νάπτου, έν τοις Τυρρῆσιου		έν Νάπτου έν τοις ἐδορεῖ(ον τοις ...6...) ἐκ τῆς στήλης τῆς ἐπ' Ευβοῖου
Is bounded by	ἀγ γει :	ἀγ γει :	ἀγ γει :	ἀγ γει	ἀγ γει	ἀγ γει :	ἀγ γει :	ἀγ γει :
C	τὸ χωρίον τῆς γυναικός τῆς Αλατήρειου			Καλλιὰς Σφήτου καὶ Διοσκλέους Πιθεύς	πανταγόρων Νικίας Κουδαν			
D1 (N)	βορρά Τελέσσωνος Σο- Σωνι	βορρά : Παρρακος Αἰγι :	βορρά Κλειόκροτος Αἴγι,					βορρά : μέταλλ(ον Α)ραμισιακόν δ ἐῖπρέζεται . . 5 . .]ων
D2 (S)		νοτό : Αετίσκος Σωνι	νοτό : Αετίσκος Σωνι,			νοτό Διοσκλέους Πιθεύς		νοτό : ἢ χωράθου (ἢ ἀπό) Νάπτης πέσσα καὶ τὸ ἀρραμισίον τὸ Ἐσκριότους
D3 (E)	πρὸς ἡλίο ἀνών : Χορίον Τελέσσων Σωνι							πρὸς ἡλίου ἀνών : τὸ Τελέσσωνος ἐστὶ ἢ οὐκ
D4 (W)	δυομένο Ἐσκριότης Παύλη :							δυομένου ἐῖπρασιῖνον
E	ὄνη : Ἐσκριότης Σφήτ : ΔΑ :	ὄνη : Φεῖδαρος Πιθεύς : ΔΑ :	ὄνη : Φεῖδαρος Πιθεύς ΔΑ :	ὄνητῆς Φρασιόλογο- : Χ :	ὄνη Καλλιὰς Σφήτου ΔΑ	ὄνη Δημιον Ἄγρω : ΔΑ		ὄνη : Φουσιμῆδης Φουσιόσι/Σωνι : Η :

Table 1: An example of the spatial relationships recorded in mine-lease entries in the *poletai* record for the Laurion area and the 4th C BC metallurgical workshops.

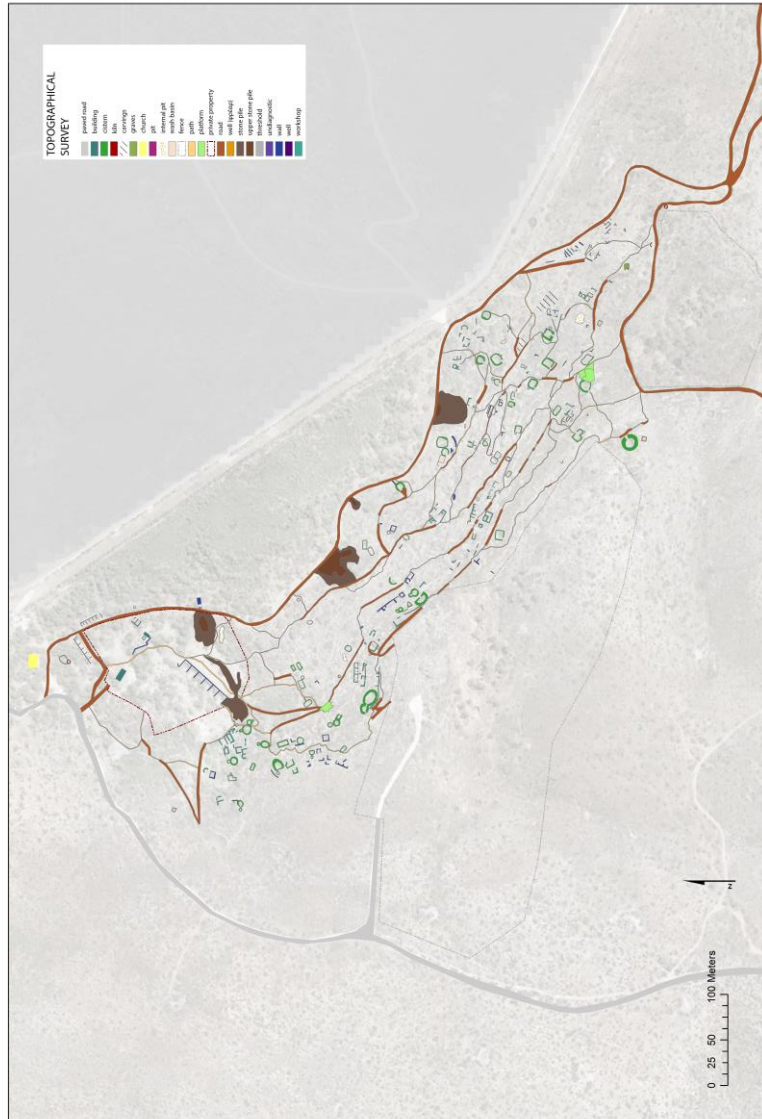


Fig. 1: GPS archaeological survey of the Souriza area (Laurion), a topographical base useful for the reconstruction of the past real map of the ancient Laurion.

Modelling the Topography of the Ancient Laurion

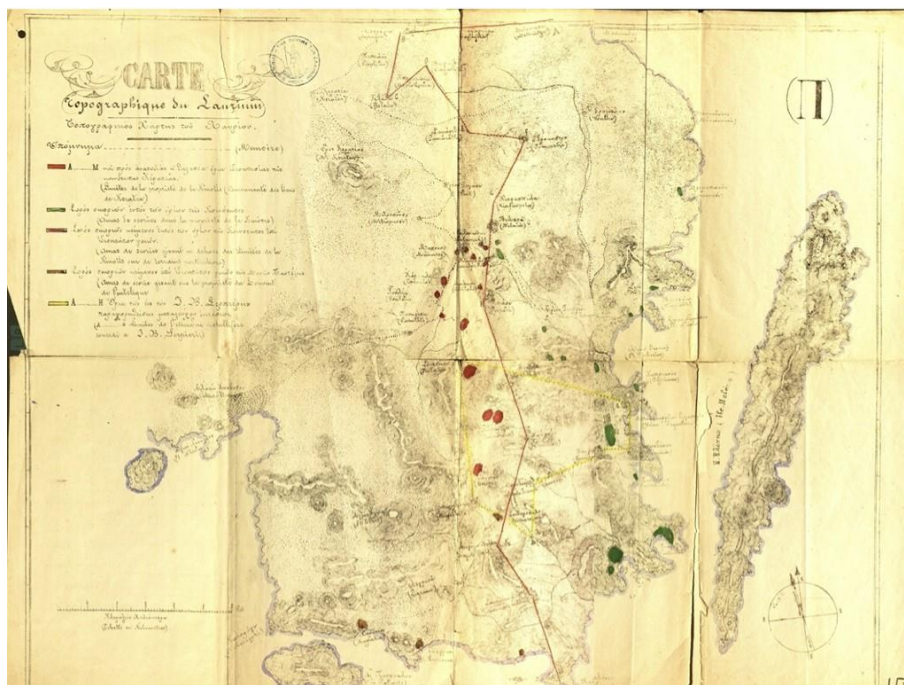


Fig. 2a: Map of the Laurion Peninsula (second half of the 19th century) recording the distribution of ancient scoriae and tailings. Red, green and brown areas signify large concentrations of these materials. The red polygon outlines the administrative border between two communities. The yellow polygon marks the area conceded to a private company to exploit ancient residues. (Source: The Hellenic Parliament Library, Map Collection).



Fig. 2b: One of the cylindrical features known as “Serpieri Horoi”.



Fig. 3a:
Α δηλωτική
μεταλλείων stele
inscription.
Photo after Kakavogi-
annis 2005, 48, fig. 7,
Inv. no. ML961.



Fig. 3b A stone base of a stele *in situ*, by the entrance of a mine.

Modelling the Topography of the Ancient Laurion

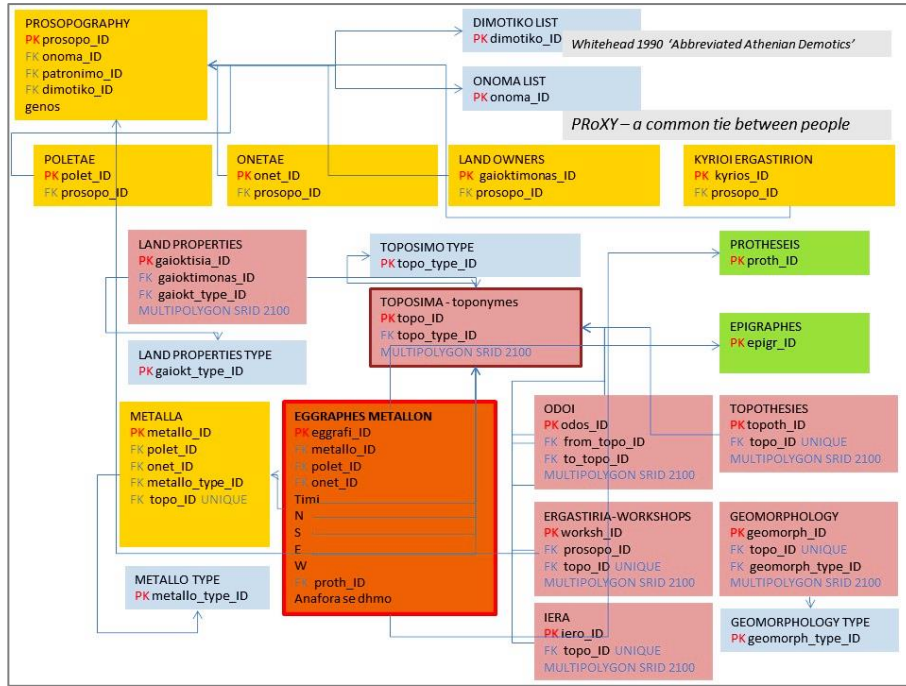


Fig. 4: The simplified ER model on which the Database implemented for the project is based.

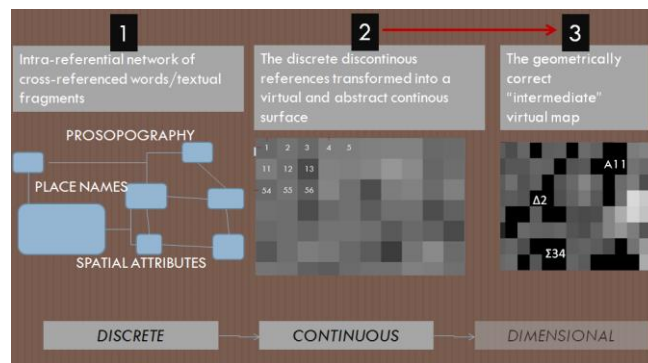


Fig. 5: The 4 steps of the process: from the *poletai* inscription to real landscape via the construction and the virtual representation of mental map

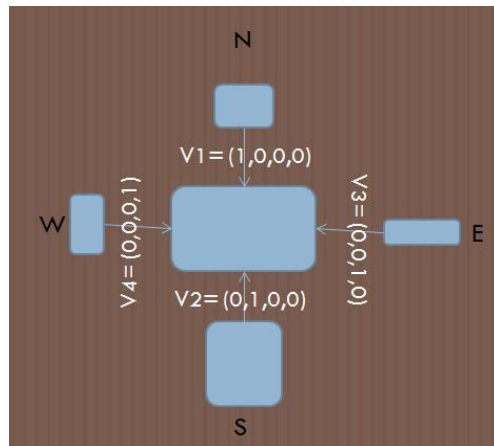


Fig. 6: The mathematical transformation in Cartesian space, each cell defined by four vectors ($V1...V4$) of the form $V1=(1,0,0,0)$, $V2=(0,1,0,0)$ $V3=(0,0,1,0)$, $V4=(0,0,0,1)$.