Spatial Humanities 3.0: QSR and Semantic Triples as means of exploration of complex indigenous spatial representations in 16th century Early Colonial Mexican maps

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Abstract

For some time now, the field of Spatial Humanities has acknowledged the need for a system capable of the spatial exploration of historical and archaeological phenomena beyond Geographic Information Systems (GIS). This idea comes from the need to analyse holistically spatial information, including that which is not geographic (i.e. vague, symbolic and imaginary space). In addition, this need becomes more apparent when dealing with traditions that do not conform to the European/Cartesian conception of space in which GIS is rooted. This article, explores the use of Qualitative Spatial Representation (QSR) and Semantic Triples as possible alternative means to model complex and diverse expressions of spatial information, including social and symbolic conceptions in 16th century Mexican maps. Using as case study the map from the region of Atengo-Misquiahuala (Hidalgo) which combine the Mesoamerican and European traditions, we explore how these approaches might open new venues of research, potentially shedding light to long discussed and problematic Mesoamerican spatial categories. Focusing on a contained and partial example, we examine from a theoretical perspective and as a starting point, the possible future implementation of these approaches for historical and archaeological research.

Introduction

The use of Geographic Information Systems (GIS) has transformed modern Humanities scholarship, and along with the theoretical explorations of the spatial turn, it has matured resulting in a varied and exciting field now called the Spatial Humanities. This field which includes practitioners from Archaeology, History and Literature, has gone through steady development in the last 10 years, going from traditional spatial analysis in Landscape Archaeology to analysing geographies mentioned in texts through Geographical Text Analysis with GIS in the Digital Humanities[1]. While these advances are certainly welcome, and both, training and accessibility of the software have made GIS an increasingly used tool of exploration in the Humanities, its shortcomings have been also pointed out by multiple scholars[2]. One of the advantages of GIS is that coming from the environmental sciences, it enables the spatial exploration in complex ways and at large scale of precise geographic information represented numerically through coordinates. This capacity, however, can be also seen as a shortcoming in the Humanities, since much of the spatial information we deal with does not necessarily conforms to this precision.

In previous work[3], we have argued that although there are many ways in which we can classify spatial information in historical and literary corpora, we can at least roughly identify three broad types of spatial references for its analysis: 1) precise geographic information where coordinates can be assigned such as toponyms (e.g. Mexico City); 2) spatial information that although might correspond to a 'real' place we cannot necessarily locate geographically with precision and can be therefore defined as 'vague' (e.g. the reference in a narrative to 'the forest'); and 3) spatial information that does not correspond to what can be called the 'real or tangible world' (e.g. imaginary places such as Mordor in Lord of the Rings; or ritual spaces such as the Mesoamerican underworld). This classification is useful simply to demonstrate that while the first type is the one that we can usually analyse and visualise with GIS, there is many other spatial information and attributes of interest in the Humanities that cannot be analysed with it. While its limitations to handle some of these types of information but also its value is recognised, we also argue somewhere else[4] that given GIS increasing popularity in Humanities research worldwide, and specially its emergence in the Global South, there is also the need for critical reflexion regarding its use, due to the fact that the technology is rooted in a western and Cartesian conception of space. This is a discussion long held[5], but for scholars working in the Humanities is important to sustain, as it is expressly relevant when dealing with traditions different to those of Europe, such as the Mesoamerican.

The case study presented here, the 'map' of *Atengo-Misquiahuala,* was created or handed to the colonial authorities in 1579 and interweaves complex social, geographic, perceptual and ideological information (Fig. 1). Analysing this early colonial map of mainly Mesoamerican tradition, the purpose of this paper is to explore along with the rest of this collection, how other computational means such as Qualitative Spatial Representation (QSR) and concepts taken from the Semantic Web such as Semantic Triples, can be used in the Spatial Humanities possibly as a complement to GIS, in some cases as substitute of this technology, or as a mode of theoretical reflexion about complex ideas and representations of space.
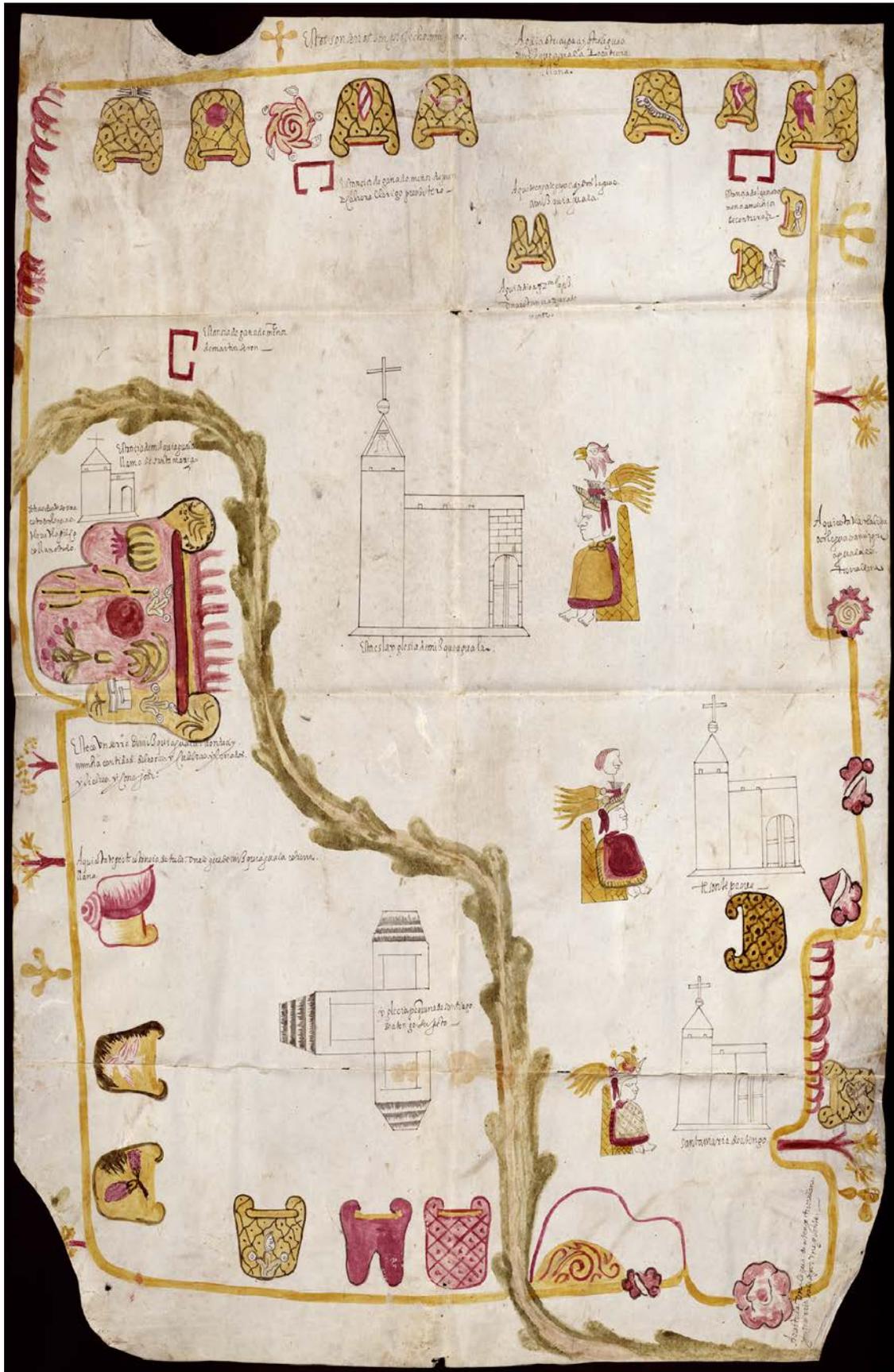
Fig. 1 Map of Atengo-Misquiahuala, with permission of the Benson Latin American Collection, LLILAS Benson Latin American Studies and Collections, The University of Texas at Austin.

Early Colonial Mexican Maps and the 16th century *Relaciones Geográficas de la Nueva España*

Early colonial Mexican maps or better said, *pinturas* (paintings), are complex representations of space that were born as the result of the process of contact between Americans and Europeans in the early 16th century. While some of them are still drawn in the tradition of the Mesoamerican codices, others display a combination of both, indigenous spatial understandings and representations with newly introduced European forms. All of them, however, showcase the profound transformations that not only territorial, political and social organisation, but also ideology underwent after the fall of the Aztec Empire and the subsequent conquest of America. As the interpretation of these documents is a complex subject and their study has been carried out for a long time by multiple specialists[6], is not the purpose of this paper to delve into this topic. However, some aspects of the historical context in which they were created is necessary to understand the general background of this material.

The map analysed here is part of a massive endeavour carried out under the orders of the king of Spain, Philip II, in which a large collection of information was gathered through an ordinance mandating every town in New Spain to answer a set of 50 questions. This collection called the 'Geographic Reports of New Spain' is subject of our T-AP project '[Digging into Early Colonial Mexico](#)' and it was compiled between 1577 and 1585 in the modern territories of Mexico and Guatemala. This questionnaire enabled the collection of a massive wealth of information related to the life, resources and geographies of this territory. The corpus is comprised of texts and maps, and it is considered one of the most important sources of information about geography, culture and economy, as well as social interactions between indigenous groups, colonial Spanish towns and officials.

The map of Atengo-Misquiahuala

The map of *Atengo-Misquiahuala* was created, or at least incorporated to the *Relación* text in 1579, and it demonstrates how Mesoamerican logographic writing was still very much alive at the time. In fact, Juan Padilla, the *corregidor* of Atengo and author of the manuscript said that the map was handed to him, implying that this map possibly existed before, or could be the copy of another one already in existence in the community[7].

The full map represents a large territory located in the modern state of Hidalgo, and it aimed to accompany the *Relación Geográfica of Atengo and Misquiahuala*. These two towns are depicted in the map along with many other places and communities in the region including *Tezontepec*. The original map is represented west-east, so if we turn a north-south aerial view 90 degrees, we can match the image where the Tula River can be recognised and several of the towns and places from the original map can be also identified (Fig. 2).

We can see in a schematic version of this map that there is plenty information (Fig. 3). Although we will not delve on the reasoning behind this here, one of the challenges for GIS presented by these maps, is that meaning in the Mesoamerican case can be derived not only from the elements that make the composition of the *pintura*. Other things like colour, or the clothes a person wears can give or indicate specific meanings to it. For example, in this case, warm colours dominate the map, especially ochre and red. These two colours highlight the dry qualities of the mountains and this landscape, an idea that is complemented by the presence of cactus, palms, and organs painted on the sides of the roads (Fig. 3: 3 and 17). The dry qualities of the mountains contrast with the fertility of the valley represented by the 'emptier' spaces of this map, and which is benefited by the drainage

of the hills, creating tributaries such as the Tula River (Fig.2 and 3: 16) that allowed cultivation in the area.
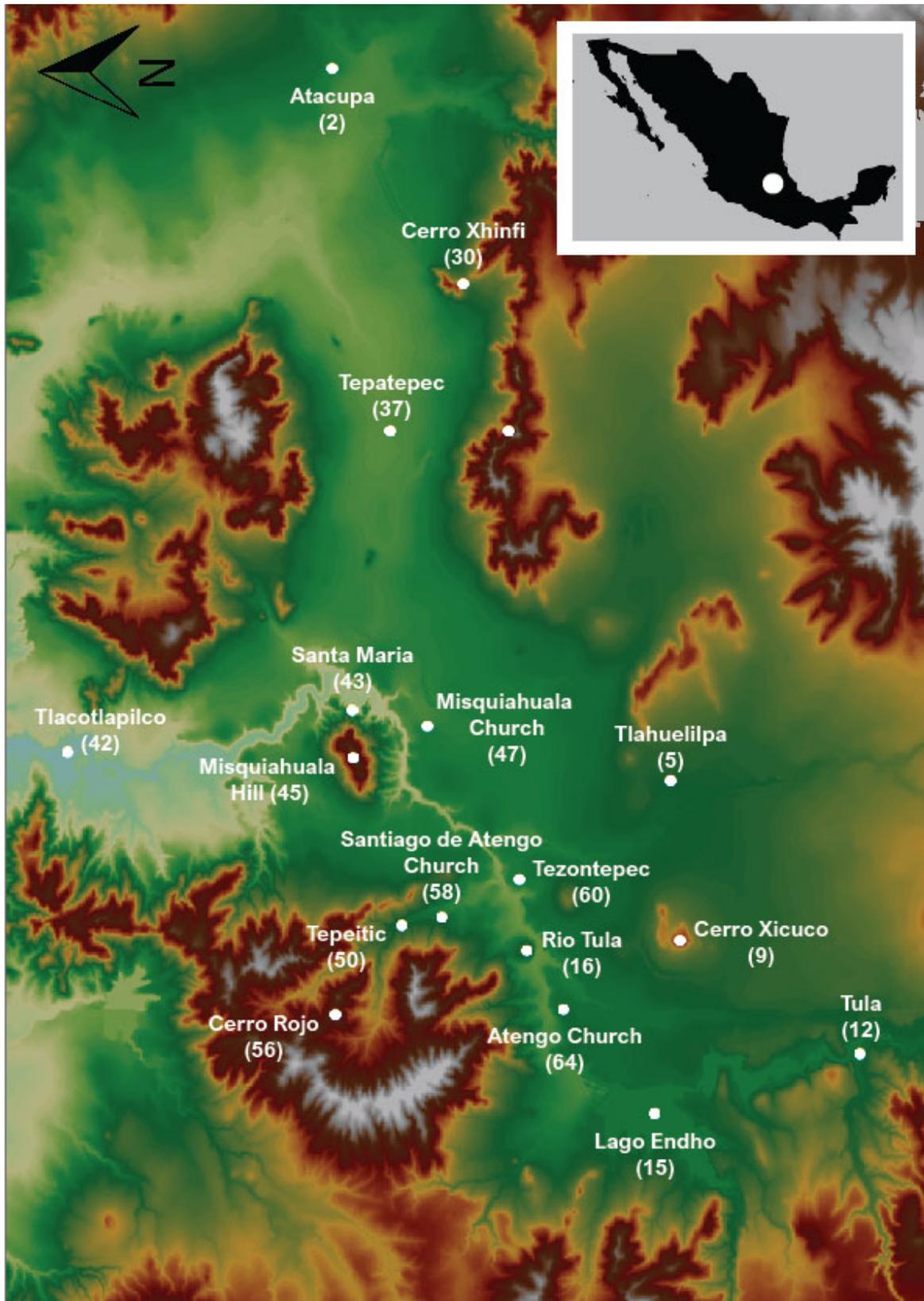

Fig. 2 Map of the area of Misquiahuala with the locations we could identify also shown in the *Relaciones* map.
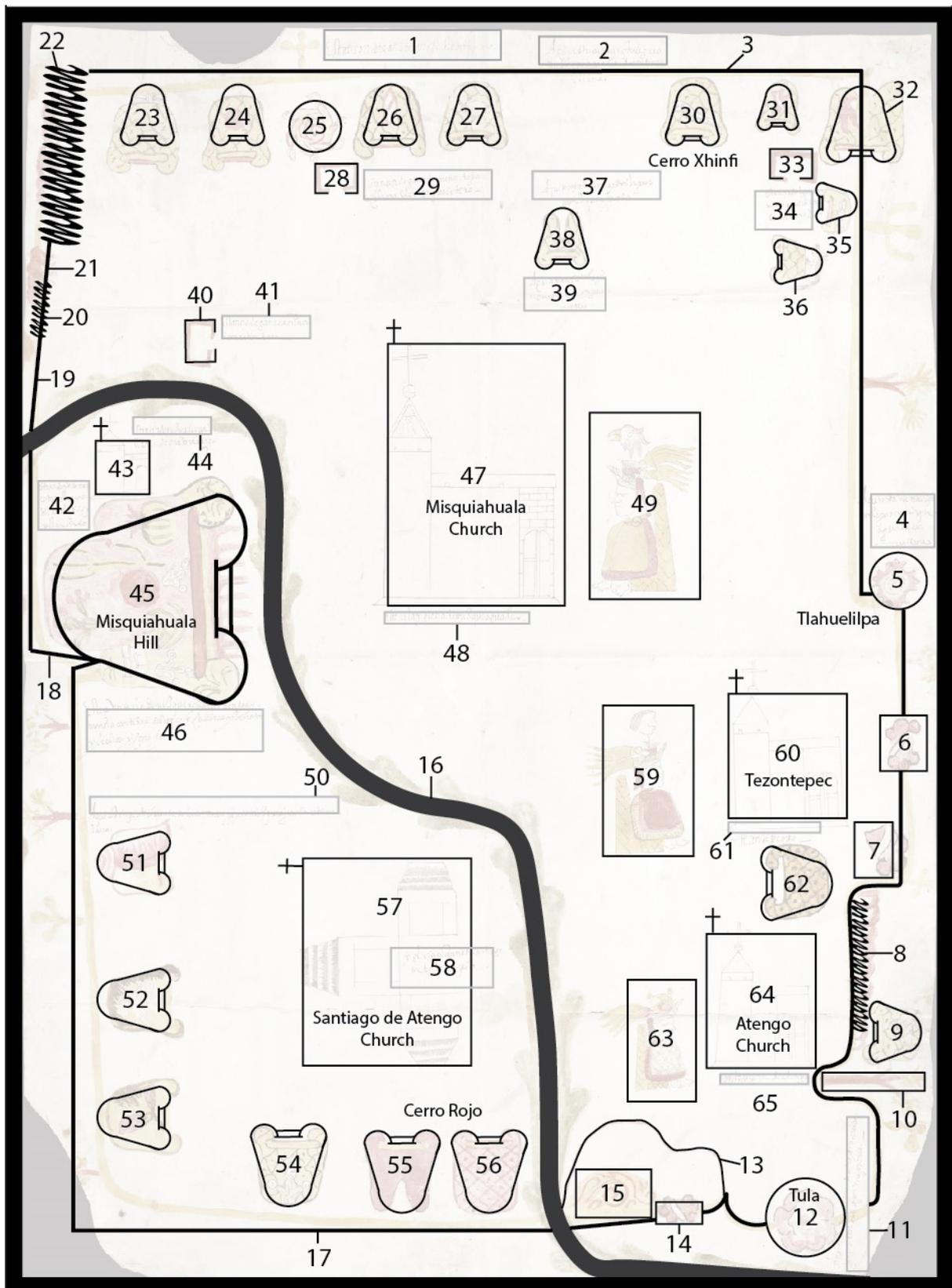
Fig. 3 The cabecera de Misquiahuala (A) represented in a schematic version portraying the elements of the Atengo-Misquiahuala map for their analysis with QSR and semantic triples.

Other complex information is provided by the *tecuhtli* or rulers of Misquiahuala, Tezontepec and Atengo (Fig. 3: 49, 59 and 63) which are represented with several symbols of power: they are sitting on an *icpalli* and have a *xiuhuitzolli* or turquoise diadem that shows their high rank. They also have their hair tied at the top with a hairdo hat called *temillotl* that could only be used by warriors. Also, the prominent ribbon wore as a headdress was only used by the *quauhyacatl*, who were the bravest warriors. This ribbon was so important, that usually the main rulers represented themselves using it. Moctezuma II, for example, is depicted as a *quauhyacatl* in the Vatican Codex A[8], and Nezahualpilli (son of Nezahualcóyotl), was painted with this same ribbon in the Codex Ixtlilxóchitl[9].

Other main elements in this *pintura* are places, landscape features, vegetation, roads, written components, and architectural elements. The depiction of places here can be quite complex as this can be done in different ways. There is the depiction of indigenous *glifos* or logographic toponyms (Fig.3: e.g. 23-27 or 51-56), European and American style architecture such as churches (Fig. 3: 47, 60, 64 and 57) and bridges (Fig.3: 6, 7 and 14), and toponyms written in the form of Spanish glosses.

Spanish glosses are another example of complex representation of information. Some of the glosses here are used not only to indicate the name of a place (Fig.3: 61: "Tezontepeque"), these can also describe views or perceptions about places (Fig.3: 1: "These hills are of no use"), spatial and hierarchical relationships between these (Fig.3: 44: "Estancia de Misquiahuala called Santa María"), provide descriptions of the landscapes (Fig.3: 4: "Here is Tlahualilpa. It lies two leagues from Misquiahuala, is all flat ground"), as well information about people that owned or occupied the land (Fig.3: 39 "Here, Jeronimo Lopez was given a sheep ranch"). Furthermore, they can also be used to describe measures of distance between places (Fig.3: 2 "From here to Atacupa, it is four leagues from Misquiahuala"). Therefore, the glosses can act as both, descriptive but also important spatial references.

The native artist which name we ignore, draws the map, but he is not the one adding the alphabetic writing on it. It is the Spanish scribe that does so. The fact that the native artist is not the one determining what the alphabetic text should say, has been pointed out by Barbara Mundy[10] as one of the ways in which Mesoamerican people lost control of the means of representation of their own communities and lands. This has important implications as the means of spatial communication and thinking change during the colonial period, giving way to European forms. While the Spanish glossas added some information, it is also apparent that the scribe was only interested in some elements that he might have deem as useful or necessary to add some additional data; or perhaps he had in fact only limited knowledge of native spatial representations. He only adds textual place names to the churches, and explains where sheep ranches have been granted or established, but none of the at least 22 glyphic toponyms are mentioned or attempted to be identified. He only refers to some of them in the gloss where he writes: "these hills are of no use" (Fig.3: 1). In one hand, it seems like the author of the *Relación* and the scribe that inserted the glosses, did not see much value in many of the elements in this map and these hills (or possibly nothing of interest to the Spanish crown); but in the other hand, the indigenous author of the map creates an ordered and interesting composition of these hills and places, demonstrating their importance in his/her world. This *pintura*, therefore, offers two views of the world. Views, that should not be flattened through an equal representation in GIS. As already pointed out, although many of these places can be 'plotted' in GIS as seen in figure 2, there is plenty important information that cannot be translated to this format. Take for instance, just some elements of this *pintura*:

While we can identify in GIS several towns including Atengo, Tezontepec and Misquiahuala itself, and is clear that the hill of Misquiahuala (Fig. 2 and Fig.3: 45) lies to the north of the Tula River (Fig.3: 16), as shown in the *pintura*, the glossa next to it (Fig.3: 42) declares: "Behind this hill, two leagues

from here lies Tlacutlapilco. It is all flat". Tlacutlapilco is not shown in the *pintura*. Nevertheless, the information about it is there, and it is also describing what the landscape is like. Furthermore, two roads (Fig.3:17 and 18) go out from the left-hand side of Misquiahuala hill. We do not know the precise location of these roads, but we do know they run south-east and south-west from it. The importance of Misquiahuala hill is given not only by the prominence of its glyph and the many resources and elements depicted within it including water, different types of cactus, and a temple or a palace in the Mesoamerican style, but also by the fact that the pathways that seem to create a frame of reference to the whole territory, end or start there. Immediately to the west, a gloss (Fig. 3: 50) gives the reference to the town of *Tepeitic* which is not represented through a glyph. After and also to the west of Misquiahuala hill we find another three logographic toponyms (Fig.2 and Fig. 3: 51, 52 and 53), which we haven't been able to identify, so there is also uncertain information. These logographic toponyms may be representing the mountainous area that flank the northwest of *Misquiahuala*, but the precise identification of each of the hills is complicated because the name of many of these have changed to Spanish. Despite this, some inferences can be made. In the north-western range, possibly the *Cerro Colorado* (*Tlatlauquitepec*?) is represented in glyphs 55 or 56 and this can be located in the map (Fig. 2 and Fig.3: 55/56). Likewise, in the lower-right corner of the map, some hills of the range to the south-east of Misquiahuala can be identified. Glyph 36 is composed by the traditional form of *tepetl* -hill- and a quadruped animal. This has been previously interpreted as a coyote, but we think is probably the hill called "Cerro del Caballo" (Fig. 2 and Fig. 3: 36). Similarly, *Cerro Xhinfi* may correspond to the glyph previously identified as Coatepec[11] (Fig. 2 and Fig. 3: 30). We can also observe that *Cerro del Caballo* and *Cerro Xhinfi* form a 90 degrees angle, as in the map, and if it is related to the town of *Tepaltepec*, it can be assumed that the lands in the middle were those granted to Melchor de Contreras to establish a cattle ranch (Fig. 3: 33, 34).

In addition, there are two hills that constitute important landscape references in this area. The first of these is the *Cerro Huitel*, which is located west of *Tezontepec* and, in the case of the map, was found just below the church of this site (Fig. 2 and Fig. 3: 62). *Cerro Xicuco* (Fig. 2 and Fig. 3: 9), which lies between *Tula* and *Misquiahuala*, has been for centuries of historical and symbolic importance in the area. The second name of *Tula* (one of the most important archaeological sites in the region) - *Xicotitlan*-, makes in fact reference to this hill in its own name which means "next to the Xicuco", highlighting its importance. In the mythology, it is even mentioned that Quetzalcoatl (one of the most important Mesoamerican gods and symbolic figures), performed fasting and penance on this hill. By representing it on the map, the painter was probably seeking to connect the region of *Misquiahuala* with spatial references charged with mythical contents.

QSR and semantic triples to describe the Atengo-Misquiahuala 'world'

In comparison with GIS which is capable of handling only explicit geographic information, Qualitative Spatial Representation (QSR) is a computational method which can deal with qualitative spatial relationships. As Stell (in this collection) puts it: "QSR allows computation, not with numbers representing points but with logical statements representing qualitative relationships". This gives the advantage then, that when is not possible to locate an entity in a geographic setting, there is still the possibility of describing the spatial relationships between this and any other. This is done computationally through Region-Connection Calculus (RCC). In simple terms, instead of focusing on the Euclidean conception of points, lines, etc., it concentrates in regions, whether these are connected or not, and the properties of such connections. Starting from this, RCC can be used as a language to state the spatial relations between entities (see Stell's essay in this same volume for an extended explanation on this).

Taking this into account and the observations described in the section above, geographical and not, we can then attempt to describe the spatial relationships between elements through QSR statements. In here, we focus only on some examples corresponding to few elements of the map. We attempt first to describe some of the spatial relationships between elements in the way explained above, and then make a reflexion about the inclusion through semantic triples, of elements that although can be thought of as spatial in principle, they may also have many other connotations and attributes.

Examples 1 and 2

All elements in the map belong to the cabecera of Misquiahuala. This can be translated to statements such as:

Element	Relation	Element
The church of Misquiahuala (47)	is part of	Cabecera de Misquiahuala (A)
Tezontepec (61)	is part of	Cabecera de Misquiahuala (A)
Santa Maria de Atengo (65)	is part of	Cabecera de Misquiahuala (A)
The River Tula (16)	overlaps with	Cabecera de Misquiahuala (A)

Example 2

We can explore the spatial relationships of one specific place, describing among many others, some that can be directly observed:

Element	Relation	Element
The hill of Misquiahuala (45)	connects with	Pathway (17)
The hill of Misquiahuala (45)	connects with	Pathway (18)
The hill of Misquiahuala (45)	externally connects with	Tepeitic (Gloss-50)
The hill of Misquiahuala (45)	externally connects with	Tlacotlapilco (Gloss-43)
The hill of Misquiahuala (45)	externally connects with	Estancia Santa Maria (Gloss-44)
The hill of Misquiahuala (45)	is discrete from	Tula (12)

Example 3

We can also provide a spatial description of elements for which there is no geographic reference:

Element	Relation	Element
Glyph (51)	is part of	Cabecera de Misquiahuala (A)
Glyph (51)	is externally connected with	The hill of Misquiahuala (45)
Glyph (51)	is externally connected with	the River Tula (16)
Tepeitic (50-gloss)	is non tangential proper part of	Tula (12)

Example 4 integrating other attributes through triples

As there are some elements in the map that might be related to space and places but have other important attributes that are not spatial, we attempt here to use semantic triples to describe these:

Element	Relation	Element
The landscape of the cabecera de Misquiahuala (A)	is represented in	red
The landscape of the cabecera de Misquiahuala (A)	is represented in	ochre
Tezontepec (61)	has an	indigenous ruler (59)
The indigenous ruler of Tezontepec (59)	is represented as a	quauhyacatl
Quetzalcoatl	carried out fasting in	Cerro Xicuco (9)

Although for space reasons we cannot provide a full interpretation and description of the map in this way, with the complete example what could potentially emerge, is a fuller picture of the diverse spatial relationships depicted in the map geographic or not. Furthermore, adding other attributes describing these as triples like in the Semantic Web, we could achieve an ontological model of this region or territory (Fig.4).
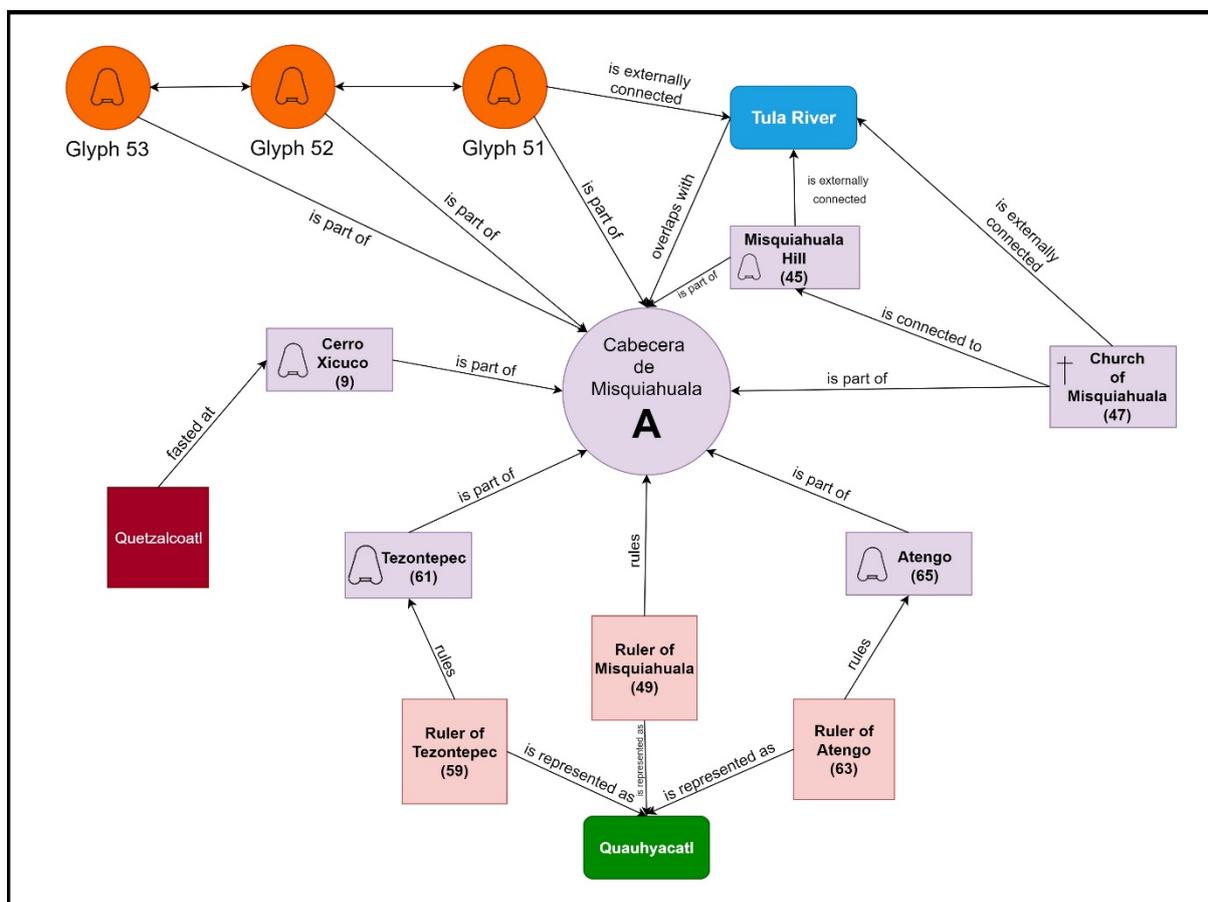

Fig. 4 Semantic Network showing only few components combining QSR and other attributes associated through semantic triples

Achieving a model of the territory of *Misquiahuala* would allow us to define with precision "all things known" of it and places within, and therefore possibly achieve a 'signature' or description of it. With the creation of similar ontological models for all maps of the *Relaciones Gegráficas,* there is the potential to possibly reach a knowledge base of early colonial maps (and therefore each cabecera). This would allow us to compare the 'signatures' of, for instance, neighbouring communities or far way kingdoms while exploring their connections and places within an extended network, while identifying patterns of particular sites or full regions that exhibit similar or dissimilar descriptions. While the ideas of Deep Mapping and using semantic technologies to connect and extract historical

information (or at least records) in archaeology, history, and cultural heritage is not new[12], the technological implementation in the Humanities of a system integrating various approaches from digital media and geospatial semantic web is still being explored. However, the use of semantic descriptions in combination with QSR aiming to understand colonial information has not been attempted. What this research shows from our point of view, is that even as a theoretical exercise, the creation of these descriptions is already aiding us to think in radically different ways about indigenous spatiality.

Conclusion

The mere geolocation of *cabeceras* and *estancias* is just some of the information that the maps of the *Relaciones Geográficas* can provide us with. As we have seen in the map of Atengo-Misquiahuala, there are also other elements such as people, toponymic glyphs of orographic features and localities; paths, colours associated with certain types of landscapes, glosses describing these and distances, among other elements. While we chose this map due to its relative simplicity in terms of fewer elements in order to illustrate the possible use of QSR and semantic triples as a framework to explore spatial and other relationships in the elements of the *Relaciones Geográficas* maps, there are other examples which complexity is astonishing. This is the case for instance of the maps of *Cempoala* and *Teozacalco* among many others, where the information is vast and as in the Mesoamerican codices, there is a palimpsest of meanings embedded into them. This complex information can go from the genealogical (and therefore temporal) representation of the community ruler's lineage, to implicit social and symbolic knowledge codified into the graphic elements.

While we are still far of fully implementing possible semi or automated means of identification and analysis of spatial data in images such as these maps, the approach presented here seems to offer an interesting way into perhaps integrating not only spatial, but also other important information included in these maps, and analyse it computationally through alternative or additional means to GIS. The example offered here is a simple reflection of its potential, however, this approach might help unravelling or getting at least a better understanding of complex spatial Mesoamerican concepts.

One of the most problematic cases of spatial categories in Mesoamerica derives from the political unit known as *altepetl*.[13] The Spaniards described this geopolitical unit as a centre of population and its associated territorial segments in the sixteenth century[14]. In the earliest dictionaries created after the Spanish conquest, *altepetl* was translated as "pueblo, o rey"[15]. Lockhart further reported that in early colonial documents the word *altepetl* was used in the sense of "city" separated from "rural field," even though the indigenous concept included both urban and rural area[16].

Since the indigenous concept began to be taken into account by the historical and archaeological disciplines, its association with mainly urban spaces continued, which has confused the interpretation of the indigenous spatial conceptions before the arrival of the Spaniards, attributing them an artificial dichotomy between the rural and the urban. Likewise, Gutiérrez says that the description of the altepetl as a cabecera and its estancias in the sixteenth century gave rise to the interpretation that its territory was discontinuous, but without explaining the nature behind this peculiarity[17]. This same author proposes a model that takes into account the "functional territory" and the "structural territory" of the *altepetl*[18]. The functional territory explains the relationships between settlements and people (for example, X and Y are governed by A, but tributed by B); while the structural territory refers to the segmentation of the land by land use, land tenure, etc. With the

approach presented here we should be able to integrate the complexity of the spatial conception of the *altepetl*, allowing us even to create models where we can compare two distinct territories, but connecting them and/or particular spaces, communities, people, and other non-explicit information when necessary (for example, Torquemada in his work *Monarquía Indiana*[19], refers to large paintings where the lands were represented with different colours depending on the ruler who owned them, or if they were communal properties).

A combination of QSR and semantic triples then, might allow us to generate a picture of these larger networks, with the nuances that the complex and layered variety of information these maps and reports offer. In carrying out this contained research, we have aimed to reflect and experiment applying RCC and a descriptive approach through semantic triples, using statements that connect subject, object and predicate. We believe that this combination might allow us to create models of the elements in these maps, as well as models of full territories, facilitating to describe with precision "all that is known" about a place. As said already, this could include complex social, symbolic, politic, and economic relationships among many other things.

Acknowledgments

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[11] R. Acuña, ed., *Relaciones Geográficas del siglo XVI: México*, vol. 1 (México, 1985), 37.

[12] K. Byrne and E. Klein, 'Automatic extraction of archaeological events from text', in *CAA2009, Making history interactive. Computer applications and quantitative methods in archaeology (CAA). Proceedings of the 37th International Conference* (Virginia, USA, 2009), 22-26; H. Wright, 'Seeing triple: Archaeology, field drawing and the semantic web' (unpublished Ph.D. thesis, University of York, 2011); L. Isaksen, 'Archaeology and the semantic web'(unpublished Ph.D. thesis, University of Southampton, 2011); D. J. Bodenhamer, J. Corrigan, and T. M. Harris, *Deep Maps and Spatial Narratives* (Indiana, 2015); M. P. di Buono, 'Information Extraction for Ontology Population Tasks. An Application to the Italian Archaeological Domain', *International Journal of Computer Science: Theory and Application*, (2015), 12; J. Pereda, 'A TUI to explore cultural heritage repositories on the web', in *Proceedings of the Thirteenth International Conference on Tangible, Embedded, and Embodied Interaction - TEI '19* (Tempe, Arizona, USA, 2019), 259–67.

[13] *Altepetl* is a word formed by the union of two independent concepts; in this case, *atl*-water and *tepetl*-hill. According to Navarrete (these two "essential elements of any Mesoamerican political entity" were the sacred hill (*tepetl*) and the body of water or spring (*atl*) that provided sustenance to the human population. See F. Navarrete Linares, *Los orígenes de los pueblos indígenas del Valle de México. Los Altépetl y sus historias*, (México, 2011), 24.

[14] Navarrete Linares, *Los orígenes de los pueblos indígenas del Valle de México*; G. Gutiérrez Mendoza, 'Hacia un modelo general para entender la estructura político-territorial del estado nativo mesoamericano (*Altepetl*)',

in Annick Daneels and Gerardo Gutiérrez, eds., *El poder compartido ensayos sobre la arqueología de organizaciones políticas segmentarias y oligárquicas*, (México, 2012), 27–68.

[15] A. de Molina, *Vocabulario en lengua castellana y mexicana y mexicana y castellana.* (México, 2008).

[16] J. Lockhart, *The Nahuas after the conquest* (Stanford, 1992); Navarrete Linares, *Los orígenes de los pueblos indígenas del Valle de México*.

[17] Gutiérrez Mendoza, 'Hacia un modelo general para entender la estructura político-territorial del estado nativo mesoamericano (Altepetl)', 31.

[18] Gutiérrez Mendoza, 37.
[19] J. de Torquemada, *Monarquía Indiana* (México, 1995).