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Research Article

Integrated studies in the N2E1 quadrant, north of San Juan River, Teotihuacan, Mexico.

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Abstract

An international and interdisciplinary archaeological survey was carried out in the centre of Teotihuacan, the great city of the Mesoamerican Classic period in Central Mexico. The area covers the N2E1 quadrant of Millon's map and is located among the Sun pyramid, the Street of the Dead and the San Juan River. The project has the aim of identifying buried buildings and open spaces present in the area and to better assess the distribution of buildings in time and space as well as the relationship between the studied area and the Rio San Juan. A combination of drone photogrammetry, magnetic and electric survey, georadar and recording of surface materials was carried out.

Our integrated study allowed the detection of walls and floor surfaces, suggesting an articulated space that includes at least two construction phases. Although it is not yet possible to define the function of the buildings, nor date them exactly, it is possible to start to investigate the role of this part of the city and its relationship with the river.

Keywords: Mesoamerica; Teotihuacan; Neighborhood; San Juan; Archaeological prospection; Geophysics; Georadar

Introduction

The ancient city of Teotihuacan (0-550 AD) is located fifty kilometres northeast of Mexico City. The city stands out for its monumental architecture, its character as a sacred city and for the complexity of its urban system of 22 km^2 [1]. Over more than 500 years Teotihuacan was a multi-ethnic city linked inside and outside by a complex network of neighborhoods that were responsible for supplying local and non-local goods to the city.

Teotihuacan has been studied for over a century. Interdisciplinary studies such as ours, involving archaeological prospection, has been performed before by Linda Manzanilla in Oztoyahualco [2], Teopancazco [3], Xalla and recently by David Carballo at Tlajinga [4,5].

Our joint research, performed by the Universitat de Barcelona (UB) and the Universidad Nacional Autónoma de México (UNAM), has investigated the area located in the N2E1, N2E2 quadrants of Millon's (1973) map of Teotihuacan, delimited by the Streat of the Dead to the West, the San Juan River to the South and the Sun pyramid to the North (Figure 1). In this paper we concentrate on the N2E1 quadrant.

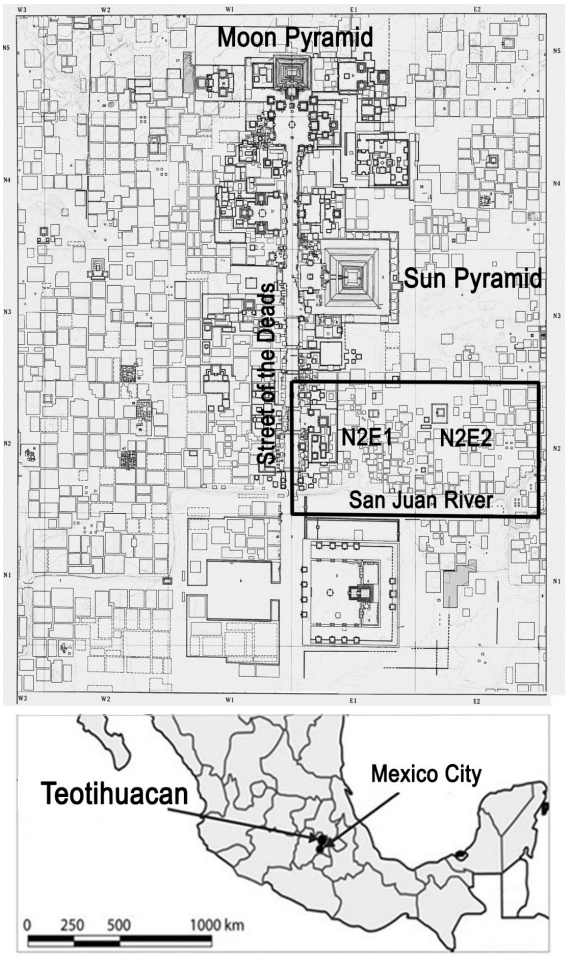

Figure 1: Bottom: location of Teotihuacan; top: Millon's map of the center of the city with N2E1 quadrant (modified after Millon 1973).

In 2015 Agustin Ortiz suggested that perhaps one of the main neighborhood centers of the city of Teotihuacan could be located in this area [6]. This is why we started the research in the selected quadrants. However, we realized that before being able to establish if there was neighborhood center there, we needed to know better the area, define the buildings that could be present under the surface and the limits of the neighborhood itself. We aimed at better understanding the organization of this area of Teotihuacan, and its relationship with the San Juan River, that crosses the south of the quadrant and was modified by the inhabitants so it could flow perpendicular to the Deads. In particular, we aimed at clarifying the spatial distribution of buried buildings and understand if there are different construction phases. Although located in the center of the city, this area has been little investigated compared to other areas of the Streat of the Deads. Millon and his team, mapped and studied through ground survey and pits the area occupied by the ancient city (1). After this research, only the western part of the quadrant was studied by the Teotihuacan 80-82 Archaeological Project, exploring the architecture in an area of about 30 meters on the axis of the Street of the Deads [7]. In the framework of this project the area called "Calle de los Muertos Complex (CMC)" [8], that corresponds to the western part of the N2E1 quadrant, was explored. Noel Morelos defined the CMC as a Conjunto urbano tipo plaza [9] and suggested that it was organized into the Conjunto Plaza NE, characterized by four structures around a plaza and the Conjunto Plaza SE, characterized by five structures around two plazas. The results of this project suggest that the Conjunto Plaza Oeste had continuous occupation during the Miccaotli phase, indicating that perhaps this was the moment in which changes in the flow of the river were carried out [10].

During the years 1980-82, Jesús Sánchez investigated the area that had to be destroyed to build the modern road that connects the Street of the Deads and the current Museum of Teotihuacan. In the framework of this project, Sánchez studied buildings 2D, 88 and its surroundings, and suggested that both buildings had stairs looking towards the river [9]. Finally, during the years 1992-94, Tomás Villa carried out an excavation in the southwest corner of quadrant N2E1 to understand the relationship between the river and the buildings closest to it. Several rooms were excavated, but the results of that investigation are still unpublished (Rubén Cabrera, personal communication).

In 2019 our project started to carry out archaeological prospection in the area, using drone aerial photography, geophysical survey with electrical resistivity, gradiometer and georadar. Also, a preliminary archaeological survey (registration of surface material concentrations) was carried out. The integrated study in the area allowed the detection of remains of walls of buildings and terraces, suggesting an articulated space with at least two construction phases.

Materials and Methods

The research methodology follows the one established by the Laboratorio de Prospección Arqueológica of the Instituto de Investigaciones Antropológicas, UNAM [12] [4] and performed an extensive magnetic gradient survey with the verification of specific areas with ground penetrating radar and electric resistivity [4,6,11]. The archaeological project also included the collection of aerial photos at 50 m height with a drone Phantom 4 pro y Phantom, 3 equipped respectively with sensors RGB and infrared to produce a Digital Elevation Model (DTM) of quadrant N2E1, in collaboration with the Laboratorio de Análisis Espacial y Digital of the IIA, UNAM.

A total area of almost 30 000 m^2 was surveyed with magnetic gradient using grids of 20x20 m (Figure 2). The study was carried out with a Geoscan FM36, a distance between readings of 25 cm and one meter between parallel lines. To interpret the results of the study, it is important to remember that Teotihuacan is located in a volcanic environment and that building materials used are mostly from igneous extrusive materials (basalt and volcanic scoria locally called tezontle), which bear strong magnetic properties. In Figure 2 it is possible to see the grid surveyed.

Figure 2: 20x20 grid units used for magnetic gradient survey in N2E1 quadrant. The recording of surface materials was carried out following the same grid, although not all the squares of the grid west the Street of the Deads, to the south the San Juan river.

After the magnetic gradient survey was carried out, we used georadar to verify specific areas to confirm the data obtained with the magnetic survey. The georadar survey was carried out in parallel S-N lines every 1 m, using a GSSI SIR System 3000 with 400-MHz antenna with survey wheel, penetrating barely 3 m. It is important to mention that, as cactuses and other spiny plants are protected species at Teotihuacan, they cannot be cut. As these plants tend to grow where stones are stacked, and such accumulation of stones can be related to the presence of structures, it is likely that during our survey we missed some of the structures, as it is impossible to walk in the middle of this vegetation.

As mentioned, part of the area that was surveyed with gradiometer, was also surveyed to record the spatial distribution of archaeological materials on the surface. A total of 49,5 grids of 20x20 m, were surveyed: (Figure 2).

The surface materials' recording was conducted on parallel lines S-N using 2 square meter units. No material collection was carried out: we only recorded the materials visible in the surface. In particular, the following archaeological materials were recorded: pottery sherds, obsidian, and polished stone. Building materials were also recorded, such as adobe, andesite, basalt, ixtapaltete (basalt slabs), lime plaster fragments. Among them tezontle (the local volcanic scoria) was an especially important building material, as it was widely used in the core of walls. The recorded materials were inserted in a QGIS database and distribution maps were obtained.

Results and Discussion

Aerial photography

The flights with the drone allowed to obtain a digital elevation model of the investigated area (Figure 3) In it, it is possible to identify the area excavated during the 80-82 project, which is located next to the Streat of the Deads, and of mounds that should correspond to the presence of structures and platforms already identified in Millon's map [1]. The line of the current course of the Rio San Juan is also recorded to the south. In general, this image allows to identify slightly elevated parts that could correspond to the presence of structures.

In the aerial image it is possible to recognize the linear patterns produced by the piling up of tezontle stones emphasized by the abundance of vegetation, that were used to mark the limits of private properties before 1960, when the area was declared an archaeological site. Besides those patterns, there are small reliefs that can barely be seen in the open areas of the image and that likely represent collapsed Teotihuacan structures.

Figure 3: Orthophotography overlapping the digital elevation model.

To better define these elevations, we processed the topographic data to show subtle differences and overlapped it to Millon's map of the quadrant, in which he interpreted the presence of structures based on survey data [1] (Figure 4). Figure 4 shows that some of the elevated areas actually correspond to rectangles used by Millon's team to represent Teotihuacan compounds, as we were expecting, but it is also evident that there are other features that are related to low and flat areas, here displayed in blue. To clarify this inconsistency geophysical techniques were used to provide information from the underground.

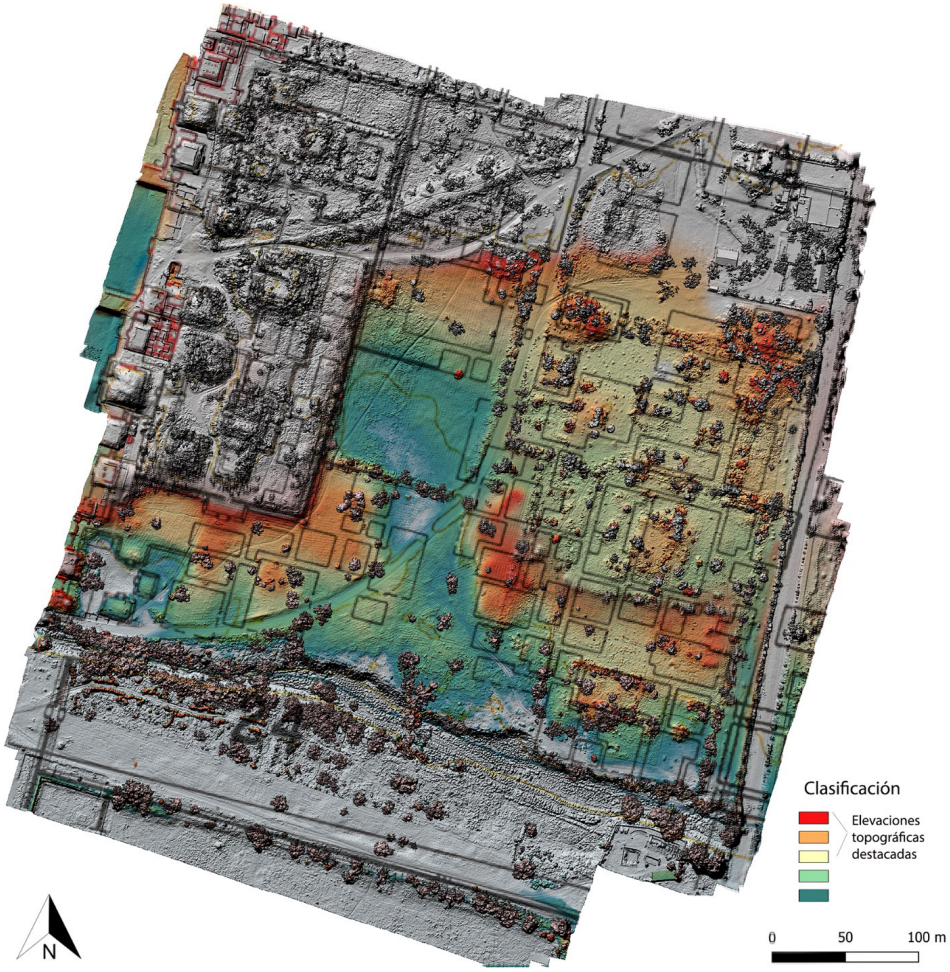

Figure 4: Millon's map of the quadrant N2E1 overlapping the micro topographic map. In red and orange the most elevated parts of the studied area. Blue: low and flat areas.

Geophysical survey: magnetic gradient survey and georadar verification

The next stage of the project was to get information from what is preserved below the surface, using geophysical techniques. Applying gradiometer survey, it is possible to observe the dipolar magnetization of the materials which is represented by small red and blue spots, which show respectively the positive and negative parts of magnetic dipoles produced by volcanic rocks present in the surface of the studied area (Figure 5).

It is important to mention that in the magnetic gradient map, the trajectory of a 3-inch iron pipe that runs diagonally across the studied area (Figure 5) is evident. In some parts the pipe was visible on the surface. On the other hand, it has to be remembered that volcanic stones were used as building materials for most structures, and they can be detected very well in the magnetic survey. In the investigated area, structures have collapsed, their dispersed stones making the interpretation of the limits of the structures quite difficult. However, it is possible to recognize linear patterns that correspond to buried features that can be interpreted as walls of buried buildings. We are presenting the results grouped into different areas.

To the north of the quadrant, there is a pyramidal building which was referred to by Millon [1] as a temple. The magnetic survey identified in this area the boundaries of a square (plaza) surrounding the building (number 1 in Figure 5). This building displays on top a looting pit, where stucco floors and walls of a previous building are visible. Moreover, scattered painted stucco fragments are also visible in the surroundings. Actually, it is the only place where plaster fragments with mural painting were identified until now, on the surface.

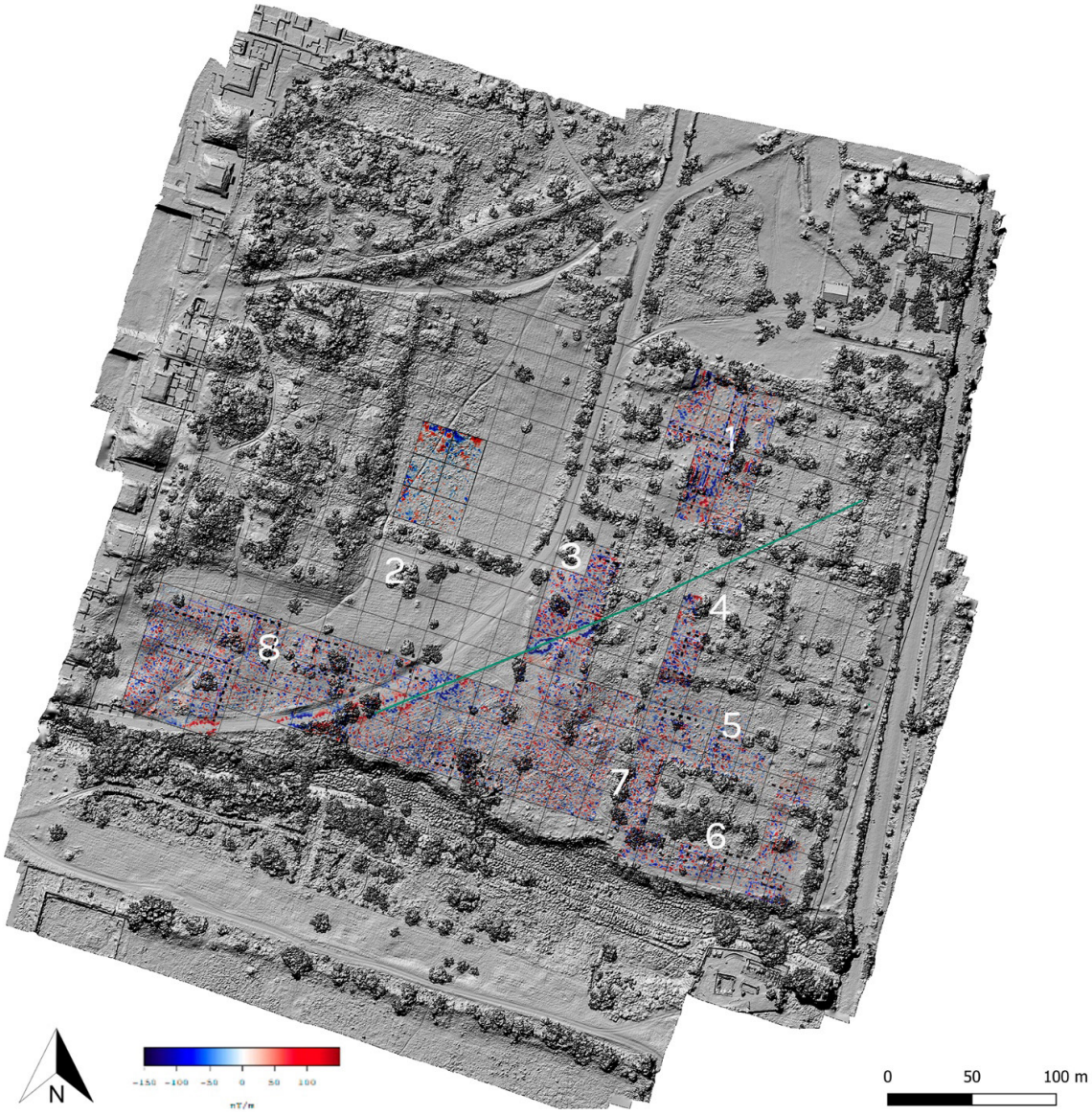

Figure 5: Magnetic gradient map overlapped to the elevation model. The numbers indicate the areas mentioned in the text. Black dotted lines indicate the interpretation of linear features.

In different parts of the areas marked as 3, 4 and 5 in Figure 5, the magnetic map allows to identify walls and corners. Here the black dotted lines indicate the existence of walls. In particular, it is interesting to point out that some of the walls could belong to terrace limits. In fact, all the area has a slope that goes down from the north of the quadrant to its southern part, where the San Juan River is located. Therefore, the area had to be terraced. Other walls could belong to parts of courtyards/squares.

In the central southern part of the quadrant, to the north of the river, a georadar grid in area 7 (Figure 5) was performed on the upper part of a wide but low mound, to verify the presence of a rectangular space identified in the magnetic gradient map. Overlapping the gradient map to the 50 cm georadar depth slice, we can observe a close relationship between the results of the two techniques, allowing to interpret the presence of a buried rectangular space about 8 by 12 m wide that can be interpreted as a central courtyard perhaps surrounded by rooms (Figure 6).

Figure 7 displays radargram F 9, to give an example of the reflection of walls and floors in the center of the grid that cross the southern and northern walls of the possible courtyard/room. From 3 to 6 m there are reflections, that correspond to the crossing of the south wall. The same happens between 12 and 14 m crossing the north wall, suggesting the existence of an inner space around 8 m long. Stronger reflections are observed between 15 to 17 m that seem to correspond to the presence of a perpendicular wall.

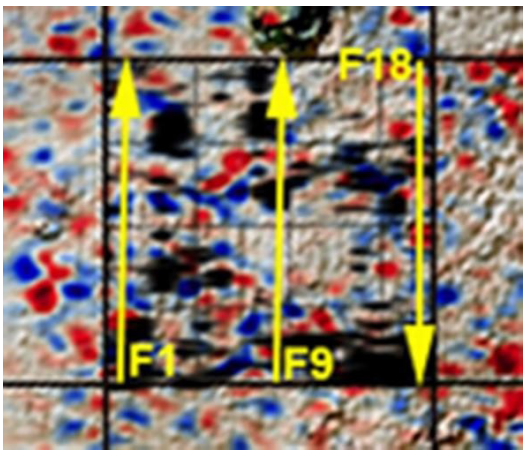

Figure 6: Overlapping of the magnetic map and georadar depth slice 0.5 m (area 7).

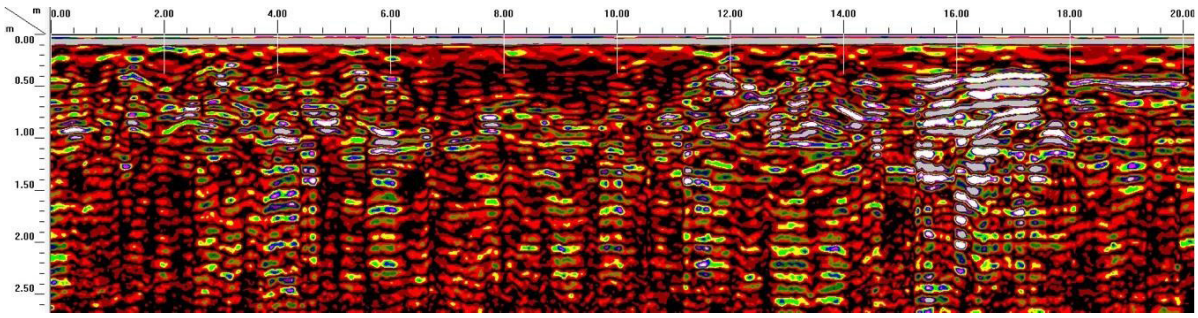

Figure 7: Radargram of line F9 in area 7.

In the southeastern part of the quadrant on the northern bank of the San Juan River, three sides of an open plaza surrounded by structures can be observed, as well as much dispersed stone (number 6, Figure 5). In the same area 6 (Figure 5), another example of the presence of rooms identified by the combination of magnetic survey and georadar is visible to the far east of the area in Figure 5, where the dotted black lines show a small room (Figure 8). Here a small elevation closely related to a rectangular structure evident in the magnetic gradient map can be identified. We show the radargram of line F 51, crossing the area (Figure 9). This line shows a package of reflections from 1 to 16 m which indicates the presence of a floor. From 16 to 36 m there is a homogeneous fill (the area without magnetic signals), while the horizontal reflections between 40 and 50 m suggest again the presence of a floor limited by walls.

These data indicate that in the southern part of the quadrant to the north of the San Juan River, the survey allows to identify the presence of walls and floors that could be related to the presence of rooms and courtyards. These rooms are apparently smaller than those identified by Millon. Beneath these rooms drainages conducting water to the river can be observed both in the geophysical survey and in the exposed northern profile of the San Juan River (Figure 10), likely due to seasonal floods of the river that lead to the erosion of this side of the riverbank.

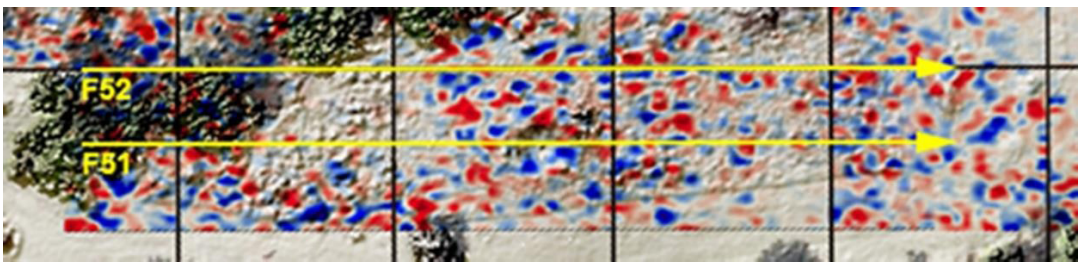

Figure 8: Overlapping of the magnetic map and two georadar lines (line 51 and 52).

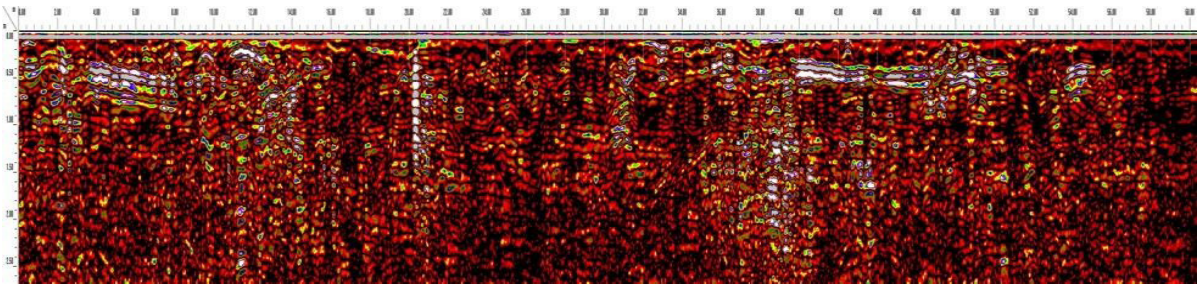

Figure 9: Radargram F51 in area 9.

Figure 10: Drainage visible in the cut of the northern bank of the San Juan River. Two floors (one on the top and the other one where the label is placed) are visible in the cut.

Area 8 (Figure 5) is the most complex part of the studied area and displays walls and corners that deserve a more detailed study involving topographic and georadar studies to better understand the shape and size of the structures present under the surface. What is extremely interesting it is that the georadar data as well as the stratigraphy visible in the cut of the river, confirm that at least two building phases were present in several parts of the investigated quadrant.

Apparently the first building phase included smaller rooms, that were partially destroyed and filled to build big open plazas in the last phase. This allows to propose changes in the city planning over time. In the near future we will go on with the investigation of this area and we will proceed to take samples to date these building phases.

Preliminary surface materials distribution

Surface materials distribution can help in trying to better interpret the presence of possible structures below the surface and in some cases their use and function (Figures 11-13). Tezontle (Figure 11), basalt, stone slabs and plaster, are present in almost all the investigated areas, confirming the presence of buildings under the surface. However, while tezontle and basalt are spread around the whole area, it is interesting that basalt slabs are almost absent in the south-east part of the quadrant, while they can be observed close to the Streat of the Deads and in the northern part of the quadrant. As stone slabs are indicators of the presence of Teotihuacan *talud-tablero*, a typical feature of the architecture of the city, this difference could possibly be associated with a difference in the type of architecture that characterizes the different studied areas. Actually, it is likely

that buildings related to a higher status/prestige (characterized by the talud-tablero) could be located closer to the Streat of the Dead and the Sun Pyramid.

Building materials are present in squares G42-45 and G50 (Figure 2), concentrated mainly in the northern part (G51), where the small structure identified by Millon as a temple is still visible (number 1 in Figure 5, see as an example the distribution map of tezontle in Figure 11). This is one of the areas where polished stone and pottery are more concentrated (Figure12). Also painted stucco has been identified here, confirming the importance of the building. Less materials are present in the surrounding plaza identified by the geophysical prospection, while they increase again in the southern part of the studied area, in squares G42 and 43.

In area 7 (Figure 5) tezontle and other building materials are also present (especially in G23 and 25). This confirms the presence of walls and rooms/courtyards here, identified by the geophysical study. Pottery is especially concentrated in G23 and G26, while obsidian is scattered around (Figure 12), and polished stone is absent. This suggests a different type of activities carried out compared with other areas of the quadrant.

Finally, in area 8 (Figure 5) building materials and tezontle are present confirming the collapsed buildings in the area, also identified by the geophysical survey. Here, the tezontle concentration follows a curve that could be due to the recent moving of stones to build the street that crosses the area.

Other building materials are also present. Polished stone, obsidian and pottery, suggesting a combination of different activities that were carried out in the area (Figures 18 & 19).

In the future, a better refinement of the materials recorded on the surface will allow to better indicate the function of the investigated areas. For instance, differentiating among obsidian production debris and finished products, would allow to differentiate obsidian production workshops, domestic spaces and/or the presence of workshops that used obsidian in other production processes (i.e. fibres production).

An interesting exercise can be done studying the distribution of surface materials Figure 2 (the area occupied by squares G97-G102, Figure 2). In fact, Millon [1] suggests the presence of a "plaza", which indicates the existence of an open area. However, the distribution of surface materials indicates that in the northern part, there are concentrations of tezontle and in some cases stone slabs (associated with "talud tablero"), plaster and basalt. Geophysical prospection only indicates the existence of a wall in the northern part, so that building materials could derive from the collapse of surrounding buildings. In addition, pottery and obsidian were identified suggesting that in this open plaza some kind of activities were carried out.

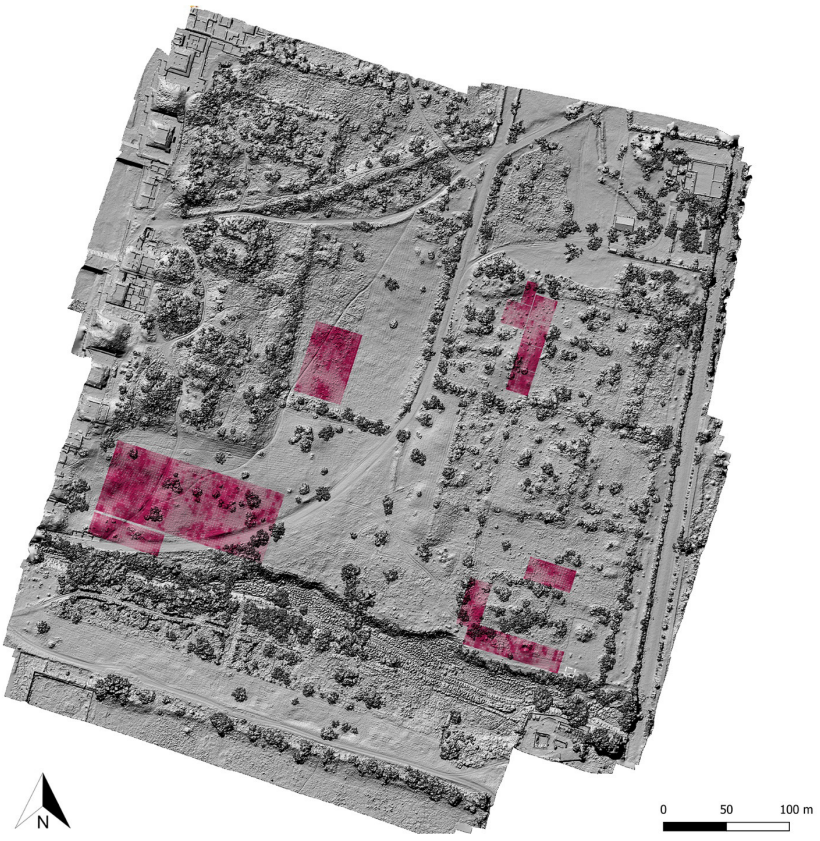

Figure 11: Distribution map of tezontle fragments in the surface.

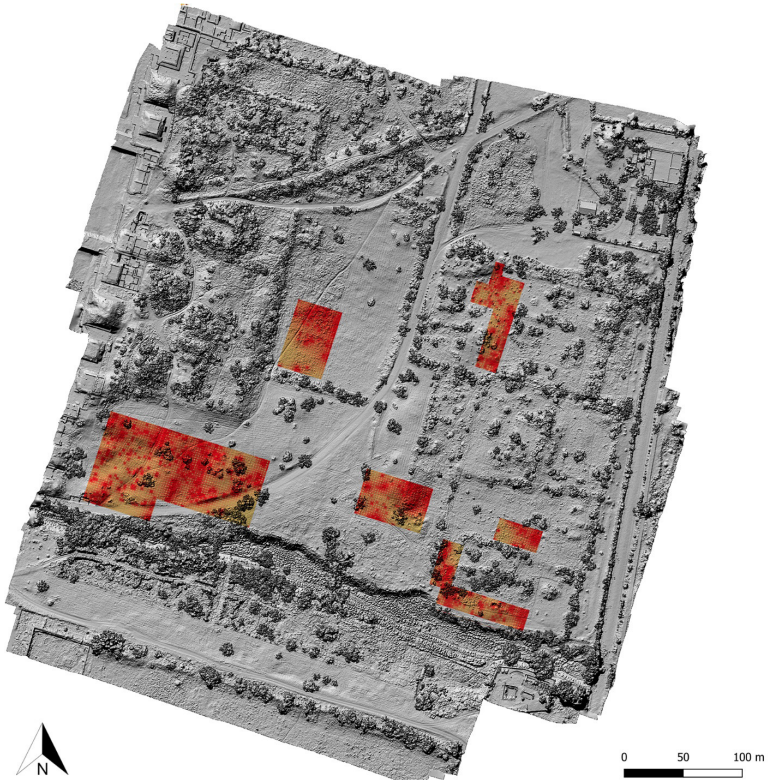

Figure 12: Distribution map of pottery in the surface.

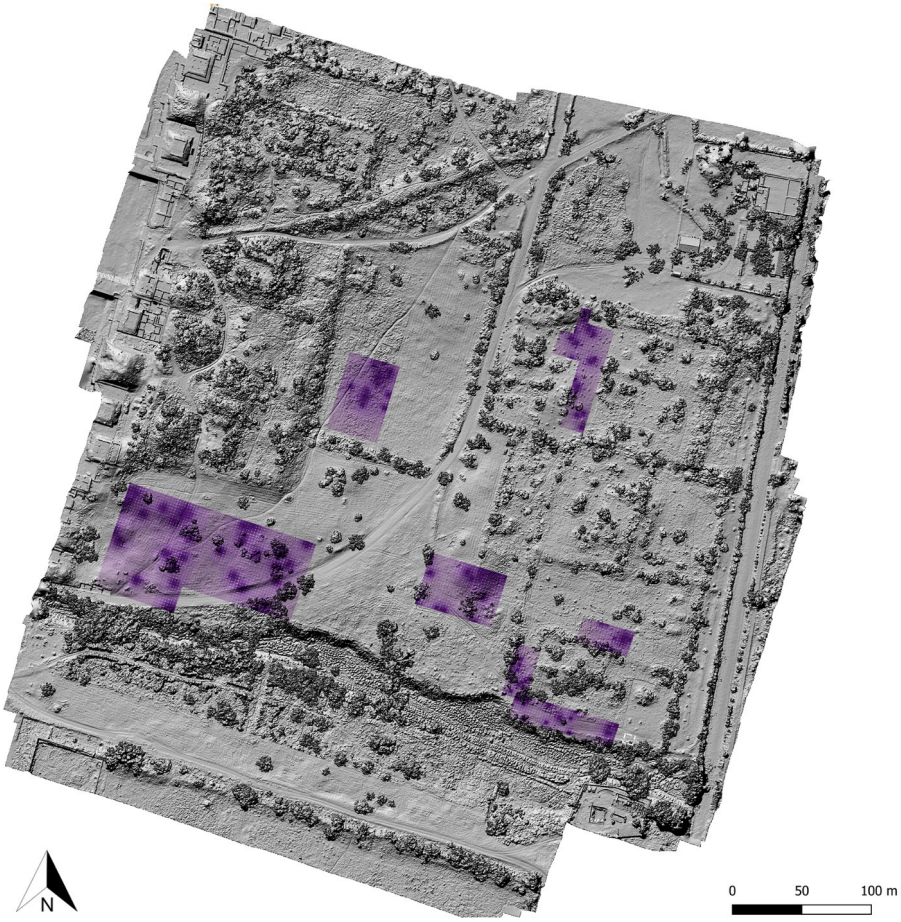

Figure 13: Distribution map of obsidian fragments in the surface.

Discussion

The integrated study of the area allowed the detection of wall remains of buildings and some terrace limits, suggesting an articulated space. Until now, the results obtained identify the presence of large plazas in the last occupation phase and confirms the existence of important structures, some of them already identified by Millon. Moreover, it is possible to suggest that at least in part of the area (mainly in the open plazas) there were at least two construction phases that must be investigated. To explain this phenomenon, we can suggest that there was a change in the planning of the area, that needed bigger open spaces. In the future, it will be very interesting to carry out small excavations to verify interpretations and take reliable samples to date the identified phases. The dimensions of the buildings that we could identify, mainly in the southern part of the quadrant N2E1, are smaller and more numerous than those marked by Millon in his map.

Figure 14: Overlapping of aereal photo, Millon's map and gradient survey.

Finally, we identified walls that could be related to the presence of rooms located to the north side bank of Río San Juan. This is extremely interesting because they could be interpreted as possible storerooms, or other types of buildings which could have a function related to the use of the river to transport goods or people. In fact, although nowadays it seems to be a very small creek, Rio San Juan was likely navigable in ancient times, at least in some periods of the year, using small canoes that could be pulled upstream from the sides. Until now the relationship between the inhabitants of Teotihuacan and the use of the river has not been investigated, and the main fact that researchers have pointed out, was that the river was modified by Teotihuacans, to run perpendicular to the Street of the Deads, as it shows square angles in the western part of Teotihuacan (in quadrant N2W1). Moreover, it is still uncertain if there was a bridge over the river, and if its location was the current one (along the Streat of the Deads) and how it looked like, in order to let canoes, pass under it.

Although the erosion destroyed some parts of structures of the northern part of the river edge, it is still possible to identify some of the walls and floors of the rooms cut by the river. For this reason, we want to clean the exposed profile to try to understand the articulation of buildings and river in this part of the city.

Moreover, there likely was a part of the river inside the city where it could have been possible to stop and load and unload goods, that could for instance be located in the central part of the south of the N2E1 quadrant.

To provide an example of the enormous need of goods in the city, it is interesting to think that only to build the typical flat roofs buildings of Teotihuacan, a huge quantity of wood was needed, and in particular thousands of 5m long main beams used to support the flat roofs, that were possibly brought floating along the river [13]. Moreover a huge quantity of food was also needed to feed the inhabitants of Teotihuacan. Some of it was likely coming from

the lakeshore located around 15km to the south of Teotihuacan, close to the colonial convent of Acolman. In fact, here goods from all around the huge lakes of the Basin of Mexico, could be collected and transported to Teotihuacan.

Conclusion

This project allowed to better understand an area in the center of the city of Teotihuacan that hasn't received enough attention until now. The integrated study of the area allowed the detection of remains of walls of buildings and terraces, suggesting an articulated space that includes at least two construction phases. Geophysical prospection data need to be complemented with test pits to date the identified phases, but with magnetic and georadar surveys it was possible to confirm the existence of structures below large plazas in the second phase. More and smaller structures than those marked by Millon [1], mainly in the southern part of the quadrant, were identified. Although erosion destroyed at least part of the structures of the northern part of the river bank, the relationship of the structures with the river can still be investigated. The San Juan River may have had a crucial role in the city, including the movement of goods. Therefore, possibly some of the identified structures could be related to the storage of materials.

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Conflict of Interest

The authors report there are no competing interests to declare.

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