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A 3d model of Complex A, La Venta, Mexico

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ABSTRACT

La Venta was a large regional center located near the Gulf coast in Tabasco, Mexico. From ca. 800–400 BC it was the major Olmec capital in Mesoamerica. Despite its significance La Venta has received little archeological attention. The clay structures of its ritual precinct, Complex A, excavated in the 1940s–50s, were subsequently destroyed. Unfortunately, the published reports on those excavations are inadequate, with misleading archeological drawings. In order to obtain a more precise and comprehensive understanding of La Venta the original excavation records were consulted, and field drawings and maps were digitized to create more accurate 2d images as well as a 3d model of Complex A. This article summarizes the process of digitizing the archival records and the interpretive benefits from utilizing 3d visualizations of the site. Recounting the process may inform similar projects dependent on archival records when field mapping or excavation are no longer possible.

1. Introduction

1.1. The importance of La Venta

La Venta was a major regional center of the Olmec culture in Mesoamerica. Its apogee is dated to approximately 800–400 BC (uncalibrated), roughly coincident with the Middle Formative period (Pool, 2007: 160). The site is located in the state of Tabasco in southern Mexico 15 km inland from the Gulf coast (González Lauck, 1996: 73). First excavated in the 1940s La Venta became the "type site," the basis for defining Olmec culture (Grove, 1997), especially its stone-working tradition and distinctive art style. Despite the absence of native stone on the coastal plain La Venta's artisans crafted colossal sculptures out of boulders brought from the Tuxtla Mountains some 100 km to the west, and finely made small objects of serpentine and jadeite, the latter material originating nearly 500 km to the east (Diehl, 2004).

Although subsequent research in the Gulf coast area has provided more details on Olmec culture and chronology (Diehl, 2004; Grove, 1997; Pool, 2007), as the regional capital La Venta remains essential for understanding the Middle Formative Olmecs. Furthermore, the complex political and religious institutions evident at La Venta have long been thought to have influenced societal developments in many other parts of Mesoamerica, including neighboring Maya peoples to the east (Coe, 1968; Drucker et al., 1959; González Lauck, 1996).

Once shrouded in tropical vegetation, the 1.5 km long civic-ceremonial core of La Venta has now been mapped, revealing over 30 mounds and platforms. The site is dominated by a massive earthen pyramid over 30 m high, perhaps the largest single structure at its time in Mesoamerica (González Lauck, 1988, 1996; Pool, 2007: 157). Just north of the pyramid is a group of clay platforms and small plazas designated Complex A. Excavations in Complex A first brought world attention to Olmec culture, revealing richly stocked stone "tombs" and numerous purposely buried clusters of jade and other artifacts ("dedicatory offerings") (Stirling and Stirling, 1942). The most enigmatic finds at La Venta were three huge mosaic "pavements" all of the same design, crafted out of hundreds of polished rectangular blocks made from imported serpentine. The mosaics, as well as two large deposits of serpentine blocks not forming a design, were laid in great pits and then immediately covered with clay fill. Nothing comparable to these five "massive offerings" is known elsewhere in Mesoamerica (González Lauck, 1996: 78).

1.2. Excavations at La Venta Complex A

Although Complex A was small relative to the entire site, it remains the most thoroughly excavated and documented portion of La Venta's civic-ceremonial center. Three major excavation projects were carried out in Complex A: in 1942 directed by Matthew Stirling and Philip Drucker (Drucker, 1952; Stirling and Stirling, 1942); in 1943 directed by Stirling and Waldo Wedel (Drucker, 1952); and in 1955 directed by Drucker and Robert Heizer (Drucker et al., 1959; Drucker and Heizer, 1965, 1975). This last project was the most extensive and was dedicated to

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investigating the construction history of the earthen platforms into which the dedicatory and massive offerings were buried (Drucker et al., 1959: 1). Built out of specially prepared clays, the platform surfaces and the floor of the principal court were regularly painted in colorful thin layers of clay and sand, much of it brought to the site. At several intervals, great pits were dug to house the blocks of serpentine, after which the platforms were enlarged and repainted.

While the architectural biographies of the individual structures vary considerably, four construction phases (I–IV) were determined for Complex A as a whole based on the sequence of structural modifications initiated by the massive serpentine deposits (Drucker et al., 1959: 121–127; Drucker and Heizer, 1965; González Lauck, 2007). In the absence of chronological information elsewhere from the site, these four construction phases became the basis for the four "archeological" phases of La Venta's occupation (Grove, 1997; Pool, 2007). The phases were tentatively dated by radiocarbon, but samples were not obtained from every identified phase, leading to continuing questions about La Venta's chronology (Grove, 1997: 72).

Soon after the 1955 project ended, the site was badly damaged by looting and development, especially Complex A (Drucker and Heizer, 1965), although some stratigraphic data were retrieved there during a brief expedition in 1967 (Heizer et al., 1968a). Interpretations of La Venta's history and function, and by extension of Olmec cultural practices, are thus dependent on the Complex A excavations published over a half-century ago. Especially important is the 1955 instrument-made map of Complex A. As Heizer later observed, Complex A was "so torn up by bulldozers that no surface feature whatsoever exists that can be identified as being present in 1955. The 1955 map of Complex A, therefore, is the best we will ever have" (Heizer et al., 1968b: 139).

1.3. Shortcomings of the published excavation data

Unfortunately, the scant published excavation data are incomplete and inadequate. The maps and profile drawings in particular are inaccurate and misrepresent the field data (Coe and Stuckenrath, 1964). In the single major report of the 1955 field season (Drucker et al., 1959) it is impossible to correlate the textual descriptions of the excavations with the two-dimensional profile and plan views, many of which are schematic, leading archeologists to neglect the descriptive information in the text (Gillespie, 2011). Furthermore, the goal of the 1955 project was to reveal the four-phase history of construction of Complex A (Drucker and Heizer, 1965: 63) (Section 1.2). However, the various architectural strata that were assigned to those phases "float" in the published profile drawings because no datum was provided to anchor them in vertical space. Thus, the construction phases of one clay platform cannot be correlated with the phases of an adjacent platform (Coe and Stuckenrath, 1964).

Heizer's reference (Section 1.2) to the "1955 map" is a single plan map showing the structure footprints, excavation units, and locations of offerings (Drucker et al., 1959, Fig. 4). This map compress all phases of the history of Complex A into one flattened image. Later maps of La Venta derived from the 1959 report omit important information or misrepresent the size or configuration of structures (Gillespie, 2011). Interpretations of Complex A have tended to emphasize its structural design, especially its notable bilateral symmetry (e.g., González Lauck, 1996: 76), although that design is best evident only in the final phase of construction shown in the single plan map. In sum, despite the site's importance in Mesoamerican prehistory, archeologists, being so dependent on maps and drawings, cannot make much sense of the La Venta excavations.

1.4. Reconstructing the architectural history of Complex A

The lack of adequate publication, especially by today's standards, does not mean that archeologists can never know more about Complex A; neither does it imply that the excavation projects themselves were poorly done or inadequately recorded. Although there are shortcomings in the published maps, the original field maps and supporting data recorded during the 1955 project still exist and provide the opportunity to create more accurate, computer-assisted images of Complex A.

In 2007 Gillespie began a project, "Reconstructing the Architectural History of La Venta Complex A," to create new profiles and plans primarily from the field records of the 1955 excavations. The project's research objective is to determine the sequence and technology of the ritual practices – the building and elaboration of the clay structures and placement of artifact caches – that created and modified Complex A over time, similar to the intentions of Drucker and Heizer (1956) (Section 1.2). Volk was added to the project for his expertise with digitization and visualization software and knowledge of landscape formations.

Because the surface architecture of Complex A is destroyed, it is not possible to correlate the field records with the physical remains at the site today. We therefore had to rely entirely on the available archived field notes and drawings, made when mapping instrumentation and recording standards were quite different. All of the images had to be digitized to create 2d profiles and plans at a single scale that could then be developed into a 3d model of Complex A, to visualize how it looked at different periods of its construction history.

1.5. Objectives for this article

The first objective is to summarize the digitization and modeling processes, detailing some of the problems, missteps, and successes (Sections 2 and 4). A second important goal is to briefly explain the great benefits of the 3d digital model (Section 3), which has transformed our understanding of the site and its history of use (Section 4). We now have very different interpretations than those of the 1955 archeologists, who lacked the technology and means to utilize all their mapping data to evaluate the chronology and function of the Complex A ceremonial precinct.

2. Materials and methods

2.1. Major Complex A features

Complex A was a small group of low platform mounds and plazas approximately 13,520 m^2 in extent located immediately north of the 30 m tall pyramidal mound (Complex C) (Fig. 1). Its finished design plan is marked by bilateral symmetry – the arrangement of structures on either side of a virtual north–south centerline 8° W of N (Drucker et al., 1959: 15). Bisecting the centerline, from north to south, are the largest mound (A-2); a rectangular plaza (Feature A-1, the Ceremonial Court) measuring 2396 m^2 and partially walled with adobe bricks and columnar basalt pieces set vertically; the South-Central Platform within the Ceremonial Court; and a platform (Mound A-3) just south of the court. The other structures form pairs positioned equidistant east and west of the centerline: the Northeast and Northwest Platforms within the Ceremonial Court, the Southeast and Southwest Platforms on the court's southern boundary, and Mounds A-4 and A-5 flanking Mound A-3.

A trench excavated along the centerline from Mound A-2 to south of Mound A-3, begun in 1942 and extended in 1943, revealed a number of buried caches – the "dedicatory offerings" – including several presumed tombs and deposits of finely made

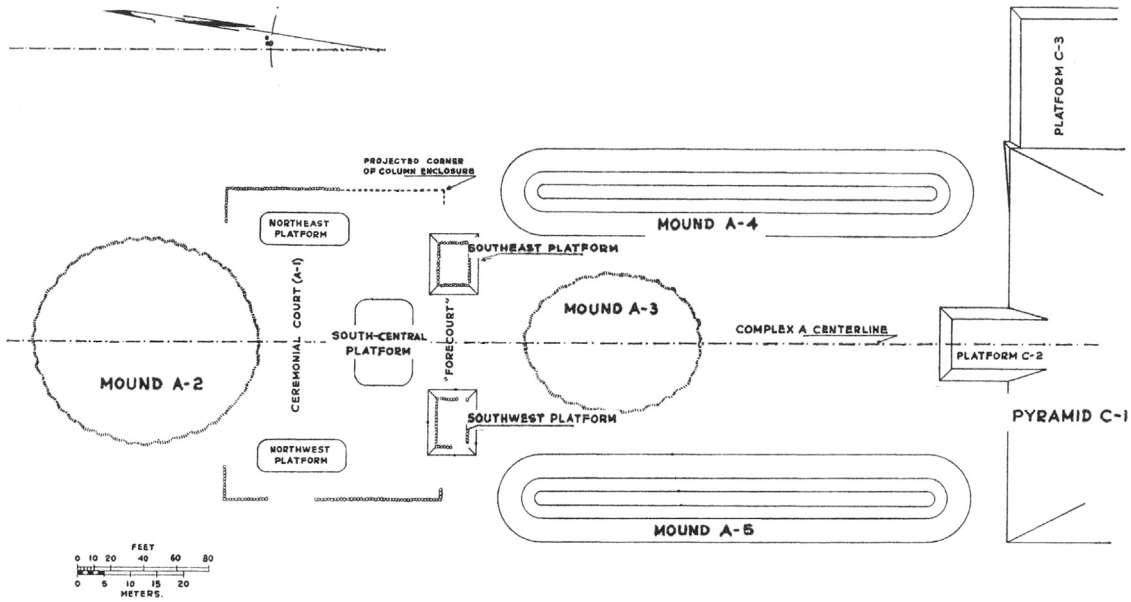


Fig. 1. Map of Complex A architecture with the Pyramid (C-1) to the right (south) (based on Drucker et al., 1959, Fig. 3).

jade objects (Drucker, 1952). These finds further manifested the significance of the centerline in the complex's design plan. The five "massive offerings" placed in well-constructed pits were excavated in 1943 and 1955, revealing that much of La Venta's architecture is subterranean. Three were composed of hundreds of worked serpentine slabs arranged in a mosaic pattern. Two mosaics were buried in pits preceding the construction of the Southeast and Southwest Platforms, with a third deposited just south of Mound A-3. Under the mosaic "pavement" in the Southwest Platform the 1955 project discovered 28 stacked layers of serpentine blocks laid in a deep square pit; presumably a complementary massive stack exists under the Southeast Platform but it was not excavated. Two other massive offerings discovered in 1955 were rectangular pits whose bottoms were lined with one or more layers of serpentine blocks: Massive Offering 3 under the Ceremonial Court floor just south of Mound A-2 and Massive Offering 2 dug into Mound A-2 itself. The massive offerings were believed to have initiated construction phases II–IV.

2.2. Archived field records

For this project three archives were consulted: the Robert Fleming Heizer Papers in the National Anthropological Archives (NAA) of the Smithsonian Institution in Suitland, Maryland; the Robert Fleming Heizer Papers in the Bancroft Library at the University of California, Berkeley; and the Richard H. Stewart photographs of the 1942 and 1943 La Venta projects at the National Geographic Society's Image Collection in Washington, DC. Many of the photographs and slides from Stirling's and Heizer's La Venta projects are now accessible online at the Smithsonian's "Olmec Legacy" website http://anthropology.si.edu/olmec/english/imagesDB/index.htm (accessed 12.04.14).

The most important field records were from the 1955 project. They include nine instrument-made (alidade and plane table) maps, eight of them on oversize graph paper. These were the work of Robert Squier, a University of California, Berkeley graduate student who had principal responsibility for mapping the site and excavations (Drucker et al., 1959: 4). Squier's "Drawing 2" provided our crucial base map, locating all the structures and some of the major finds of 1942–43 still in situ. His "Map 3" located the 1955 excavation pits and trenches at the same scale. Both maps pinpointed the same mapping station (Datum 2) as a singular reference point (Maps Folder, R.F. Heizer Papers, NAA). Squier's maps formed the basis for the published plan view of Complex A (Drucker et al., 1959, Fig. 4), which depicts most of the clay structures in terms of their footprints or maximal horizontal extent. The field maps include Heizer's additions and corrections to Squier's original maps, and not all of Squier's observations were included in the published map.

Other records consulted were the 1955 field journals of Heizer, Drucker, Squier, and Eduardo Contreras, a Mexican archeologist on the project (Box 2, R.F. Heizer Papers, NAA). Additional resources were the color slides and some miscellaneous papers, including loose drawings (Boxes 4, 19, 23, 24, R.F. Heizer Papers, NAA). Unfortunately, most of the slides were not labeled as to provenience, or were given a code designation we have not yet deciphered. We were able to identify the locations in virtually all of them by comparison with the field drawings, although some slides had been labeled upside-down.

Most of the profile and plan views were in the field journals, on graph or lined paper pages. With the exception of Contreras's journal, they were not drawn to scale but were rough-sketched with notated measurements of features and strata. To create the images for the 1959 publication, in 1956 Contreras was given the daunting task of converting the sketched profiles to scale drawings (Drucker et al., 1959: 3). We used the color excavation slides to help correct the shape and configuration of strata and features in the original sketched drawings. However, slides of strata in the trenches were not reliable for actual redrawing due to the angle of the photograph and potential distortion.

The most important new data in the field records were the over 600 spot elevations recorded by Squier. Significantly, these elevations were not used in the 1955 archeological interpretations or to create the published profiles, which therefore "float" in space. The elevations were critical to our project for aligning the trench profiles in vertical space, filling in unexcavated areas where no profile information was available, and comprehending the sequence of structural changes to the complex as a whole.

2.3. Digitizing the field maps and profile drawings

The challenge was to compile, organize, and digitize the various pieces of archival information for each architectural feature and then compile them into a single rendering of the entire complex. The first step was to scan notes, drawings, and slides and convert

them to jpeg, tiff, or Adobe® Acrobat® PDF files. For comparison, the published drawings from the 1942, 1943, 1955, and 1967 projects were also scanned. The initial scans were not always to scale or in proportion, and were corrected in either Adobe® Photoshop® 6.0 or AutoCAD® 2010. All of this information was then organized according to the individual structure or feature, such as the Southwest Platform or the Northeast Entryway. The next step was to coordinate plan and profile drawings of the same structures and features to check for any gaps or glitches indicating a problem to be resolved (Section 4.2). The resulting drawings were also compared with the color slides.

The 1955 project uniquely recorded relative elevations in Complex A from three instrument stations, recorded in Squier's field journal, maps, and trench profiles. Conveniently, he standardized them all in reference to a single instrument station (Datum 2) to make the readings consistent. However, he did not convert the stadia rod readings (mostly negative) into absolute elevations above sea level. The stadia rod was marked with English measurement units (feet and tenths of feet), and English measurements were also used in all the 1955 field records. For convenience our project maintained the English system. Following common practice, we assigned an arbitrary elevation of 100' to Datum 2 to convert the rod readings to relative elevations. Because none of the features mapped in 1955 still existed unmodified by the 1960s (Section 1.2), we cannot accurately convert our arbitrary elevations to actual elevations from the contour map made in the 1980s (González Lauck, 1988).

2.4. Making the 2d model: ArcGIS® and AutoCAD®

As these data were being digitized and organized by individual structure, the next task was to assess the best way to convert the original archival data into updated 2d profiles and plans, and compile them into a single rendering of the entire complex. We began by entering base point and line information for the site plan into ArcGIS® (ESRI ArcMap 9.3®) using the Editor toolbar and defining elevations for each feature. ArcGIS® is a readily available software package typically used for mapping and data analyses. Line and point entry was based on Squier's Maps 2 and 3 (Section 2.2), underlain and georeferenced in ArcMap®.

As a preliminary step, we then experimented with exporting these data to ArcScene® to produce 3d visualizations, using TINS (triangular irregular networks) to define surfaces based on the points, lines, and elevations (Fig. 2). However, while ArcGIS® is well suited to processing and analyzing large amounts of complex data, it is not as appropriate for entering detailed line and point data of the type we were using. It also produced what initially seemed to be an error that we could not trace, in that the base of Mound A-2 was considerably lower than the bases of the other structures dated to construction Phase I (Section 1.2); this "error" is further discussed in Section 4.4. Due to the difficult and cumbersome nature of the process, we transitioned to a different type of software to continue our work.

Our solution was to export the GIS data into AutoCAD® 2010 to complete our final updated 2d plans and profiles. Similar to the process used in GIS, we began by inserting and scaling raster versions of the archival plans and profiles into CAD. Where possible, portions or all of the archival drawings were traced, while also referencing dimensions and notes from various sources. Because most archival renderings were not drawn to scale or proportion, tracing was not an option except for isolated portions. In these situations, we relied on the dimensions and descriptions in various sources to create the drawing. We now have most of Complex A in a single multilayered AutoCAD® file; namely, Mound A-2 and the Ceremonial Court and its structures. This is the area of the complex with the best stratigraphic data for the different construction phases (Figs. 3 and 4).

2.5. Converting the 2d Files into a 3d model

Our final step was to export the 2d AutoCAD® data (and any 3d data that were created) into Google® Sketchup® 6 to create a diagrammatic but still accurate 3d model. Sketchup® is a free program, extremely useful for fast and simple 3d modeling work. It presents disadvantages for complex models, both in terms of the capabilities of the native tools and the actual ability of the software to run and regenerate smoothly when working with a data-intensive model. It is less capable than AutoCAD® when dealing with precise dimensions and forms. However, the lack of precision in the 3d model was less of an issue for our 3d visualization and general interpretation requirements; precision is maintained in the 2d renderings.

3. Results: 3d model of Complex A

3.1. Enhancing the 3d model

The resulting 3d model is based on a highly precise digital "skeleton" of strata, features, and embedded artifacts for visualizing the complex strata of Mound A-2 and the Ceremonial Court structures. Textures and colors were added in Sketchup® that, where feasible, are meant to resemble the original colorful sands and clays that painted the structures, such as the brilliant yellow and purple coatings, and the adobe brickwork of the Southwest and Southeast Platforms and the court wall (Fig. 5). We also imported

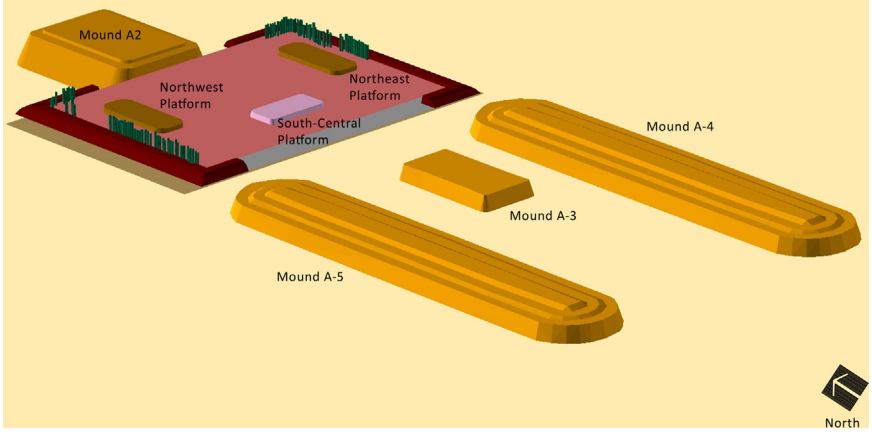


Fig. 2. Preliminary 3d image of Mound A-2 and the Ceremonial Court made in ArcScene® lacking the Southeast and Southwest Platforms.

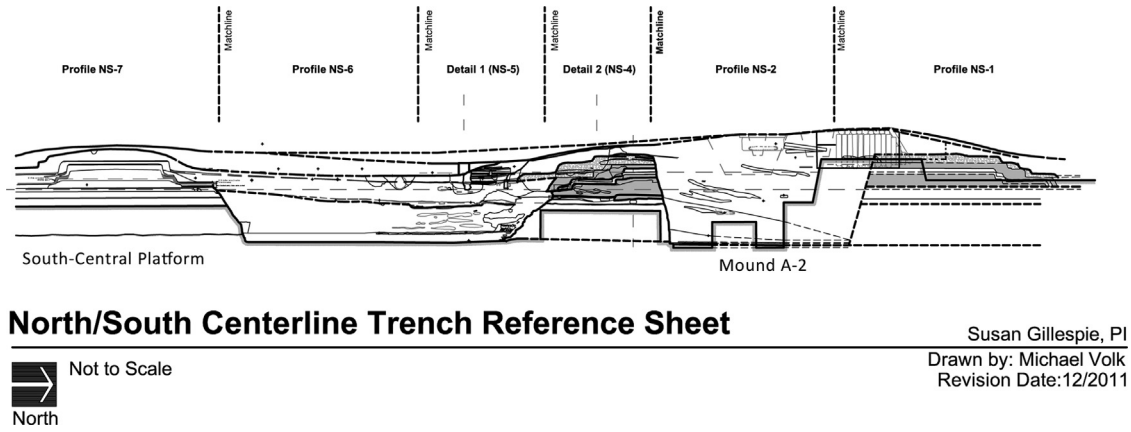


Fig. 3. AutoCAD® profile drawing of the north-south centerline trench running from Mound A-2 (right) through the South-Central Platform (left). This drawing is the key to the individual trench profile details.

jpegs of photographs of the major buried caches, in their appropriate scales and positions, and manipulated images in Photoshop® to add background and shadow figures.

Quick Sketchup® renderings of the southern structures (A-3, A-4, and A-5), which were less intensively excavated, were used to complete the 3d model of Complex A. For visual effect we also added the pyramid (Mound C-1) immediately south of Complex A. That structure was digitized from a topographic map made in 1968 (Heizer et al., 1968); its basal elevation was tentatively matched with that of Complex A. Like all other maps and drawings of Complex A, our 3d model is anachronistic – the structures are shown at different periods of construction, in part because we cannot be sure of the appearance of every mound at the same point in time.

3.2. A virtual journey through Complex A

The 3d model allows us to virtually experience the solid forms of the structures and their relationships to one another, enhanced by a "fly-through" ⟨insert Complex A fly-over video clip⟩. We can recreate the visual experience of approaching the elevated Ceremonial Court from the south, the likely principal entrance. The view of the court between the Southeast and Southwest "bastion-like" platforms was blocked by the expansive South-Central Platform. The view from the other direction, north to south, puts the impressive great pyramid in the view shed (Fig. 6) (Video 1).

The fly-through also gives a sense of the relative elevations of the Complex A mounds. Importantly, the interior court platforms were only about knee-high, an experiential factor not appreciable from the 2d base map. We can also visualize the deep pits that held the massive offerings, marvel at how they could have been stabilized in the sandy subsoil, and observe how this "inverse" architecture truly dwarfs the above-ground clay structures. Furthermore, the ca. 4 m thick adobe brick court wall, which has been almost completely ignored in published maps and drawings of Complex A (Gillespie, 2011), is revealed as an impressive boundary sheltering ritual activities inside the court.

4. Discussion

This section details some of the missteps experienced in making the 3d model and the solutions we selected to resolve the problems as they emerged from the process. Future researchers will, and probably should, use a different procedure depending on their circumstances. We also discuss the interpretive benefits of the 3d model in comprehending the construction history and ritual use of Complex A.

4.1. Weighing software options

With regard to the three-step process (Section 2.4), we found ArcGIS® too cumbersome and slow for our digitization goals. Its capabilities to georeference and analyze multiple sets of complex data were not necessary, and other software options are better for 2d and 3d digitization. Thus, the initial GIS data were exported into AutoCAD®. Although it is not as user-friendly as other programs, AutoCAD® was readily available, supported by the university, and familiar to the junior author. Importantly, we constantly had to remind ourselves that AutoCAD® permits more precision than was realistic or necessary for imaging earthen mounds originally recorded by imprecise hand measurements or alidade-based maps. In addition, because we were modeling earthen architecture, we found a strange void in the software's capability: the solids modeling capabilities were too precise and cumbersome, and the terrain modeling capabilities were not feasible due to the lack of adequate terrain-related information (i.e., contours).

All of our information was directly entered by hand. We briefly considered raster-to-vector conversion software for automated digitization, but the materials being digitized posed several constraints. Not all the information was provided in a given scan, and manual labor was required to delete unnecessary portions of the scan, add information that was incorrectly digitized, update lineweights for printing, assign layers, and cross-reference data derived from different sources. Furthermore, most of the scanned line and point information was not drawn to scale or in proportion (Section 2.2). There was no alternative than to enter that information manually, rectifying the various dimensions and spot elevations and correcting the line drawings.

If archival drawings were available on plain paper with clear and accurate point and line information, software to automatically digitize that information would be worth exploring. The same is true for text. All of the text was manually entered into our drawings, based on hand-written text in the drawing itself or in field journals, which in some cases was very difficult to read, utilized abandoned terminology, or required interpretation. In contrast, clear and accurate text in archival records might be scanned and automatically entered via OCR scanning or similar software.

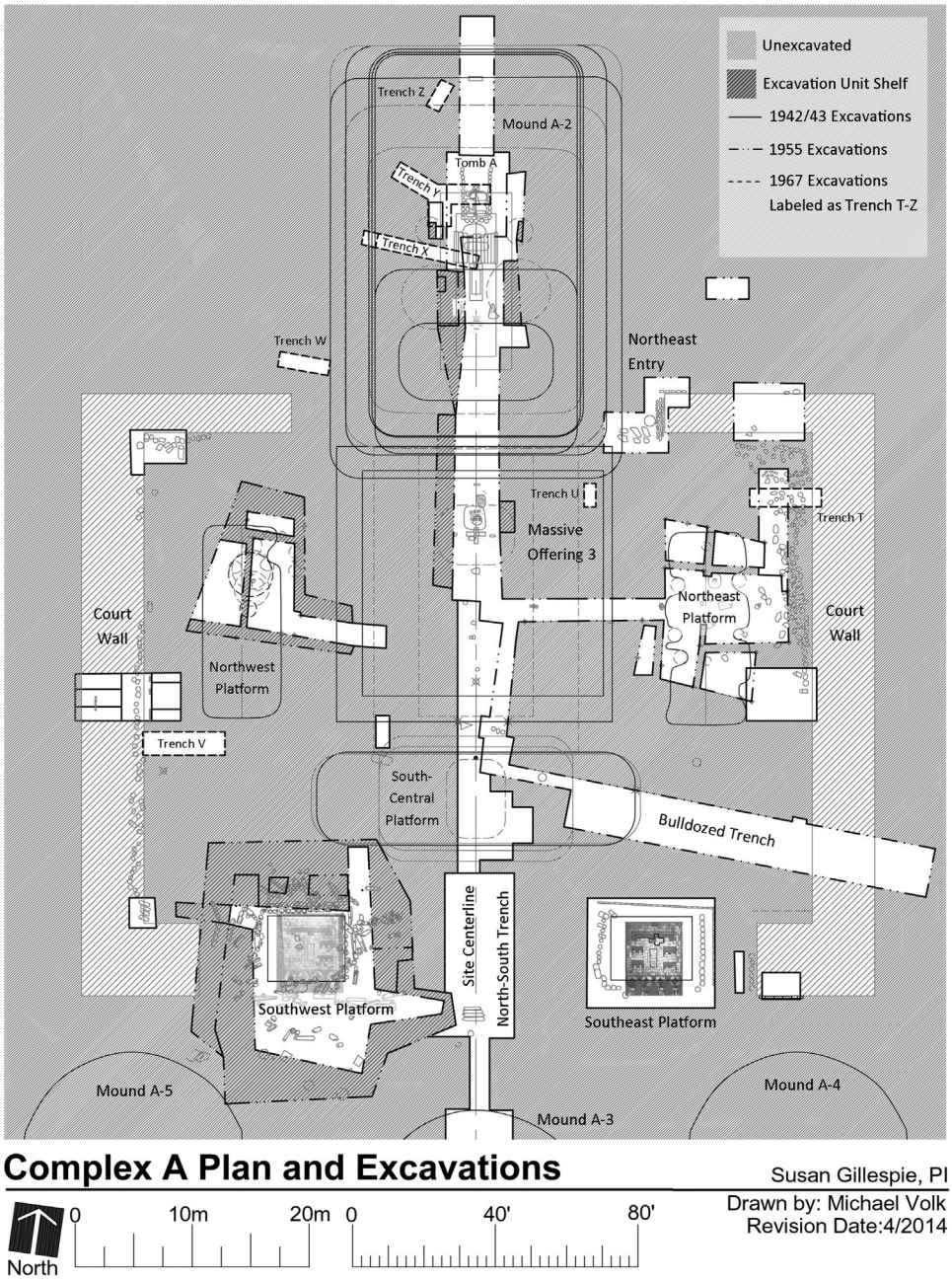


Fig. 4. AutoCAD® plan view of Complex A from Mound A-2 to the Southwest and Southeast Platforms. Excavated areas (1942/43, 1955, and 1967) are in white.

4.2. *Resolving other problems of digitizing archival records*

File organization is always key and must be considered early in the process. After a few missteps, we settled on a nomenclature for the individual structural features and the complex-wide stratigraphy. A well-labeled and separated system of layers within AutoCAD® was critical for us to isolate and view various features through time. Basic best practices for drafting, such as drawing at 1:1 scale and judicious use of blocks and external references in AutoCAD®, were also important and helpful.

Our first attempts to rectify the plan and profile views for the individual structures (Fig. 7) sometimes revealed mistakes that required correction – something had been either misrecorded in the field or misinterpreted by us in attempting to fill in the gaps between trench profiles. We always searched for the origins of the errors first in our own work, rather than in that of the field archeologists. When it became clear that a mistake had been made in the field (which was rare), we narrowed down the suspicious readings to the one that would cause the least repercussions for changes in the relevant and adjacent drawings. The slides and the 1940s photographs proved invaluable when deciding whether or where a mistake had been made.

It was also challenging to line up the various structures and features horizontally with one another according to their relative positions on the base map (Section 2.2). Errors were revealed in this process that otherwise would have remained hidden. Fortunately, we had the advantage of being able to align strata vertically across the complex. The spot elevations were sufficient to create a standard *z*-axis for the area from Mound A-2 south to Mound A-3 and including Mound A-5. Our profiles were finally anchored in space.

Furthermore, we were able for the first time to situate the 1967 excavation trenches (Heizer et al., 1968a) within the 1955 map, and to line up the stratigraphic information from the 1955 and

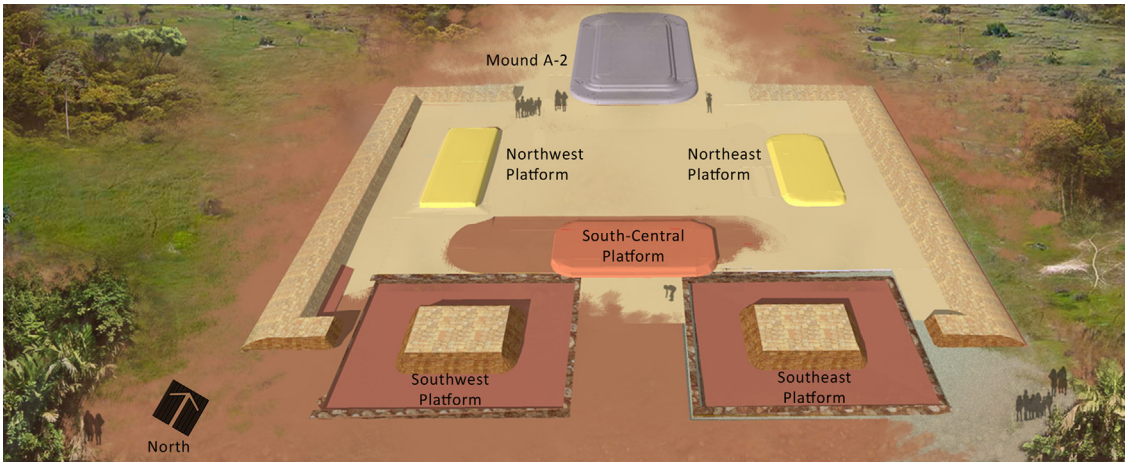


Fig. 5. 3d View of the northern half of Complex A from the south, with added vegetation and shadow figures for scale.

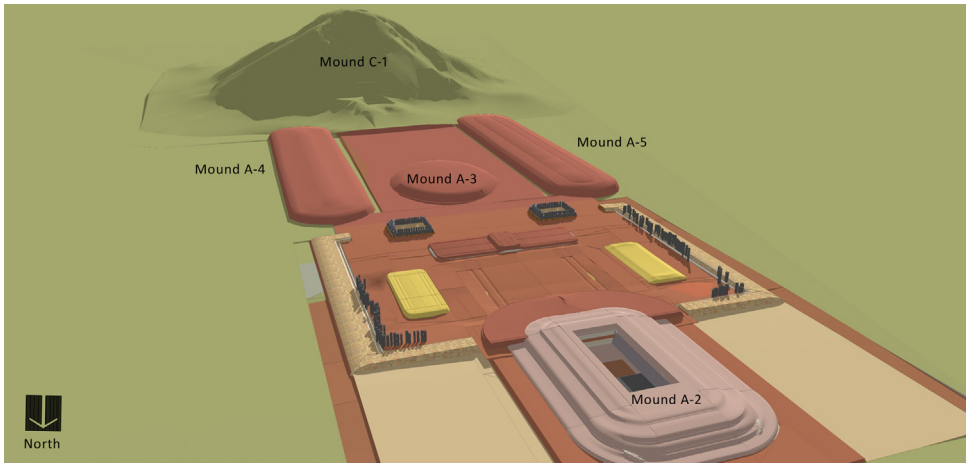
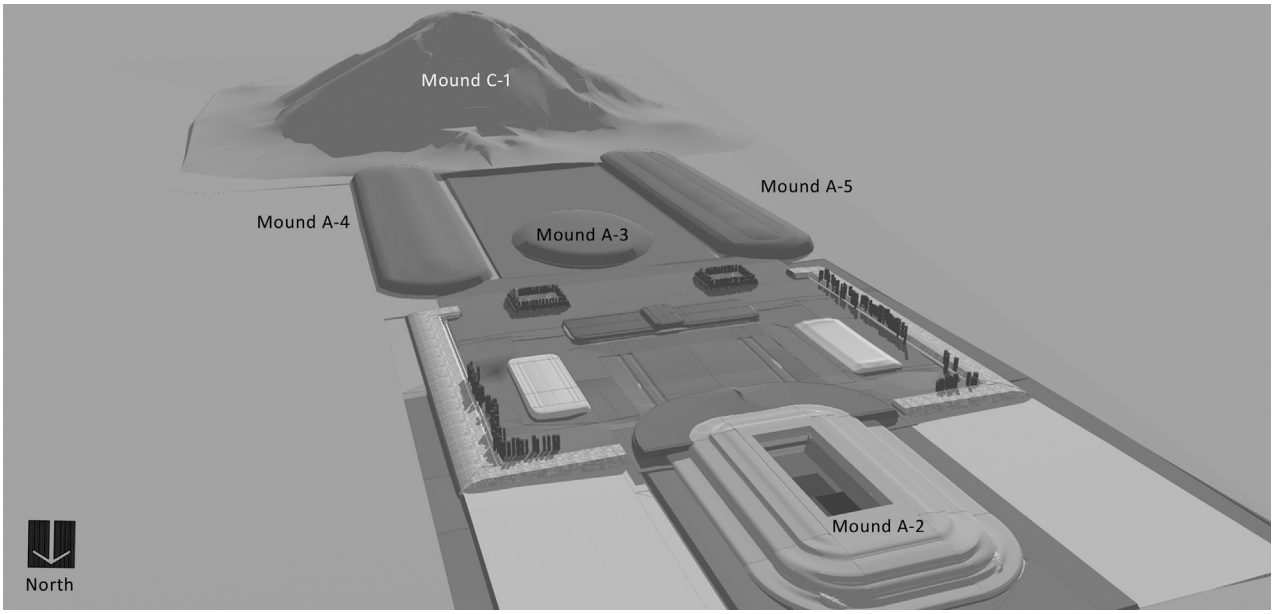


Fig. 6. A video still shows the great pyramid (Mound C-1) looming behind the Complex A structures; view from the north looking south. The pit for Massive Offering 2 in Mound A-2 is shown in the foreground.



Video 1. Complex A fly-over video clip: 3d flyover of Complex A, with the Complex C pyramid in the background. A video clip is available online. Supplementary material related to this article can be found online at http://dx.doi.org/10.1016/j.daach.2014.06.001.

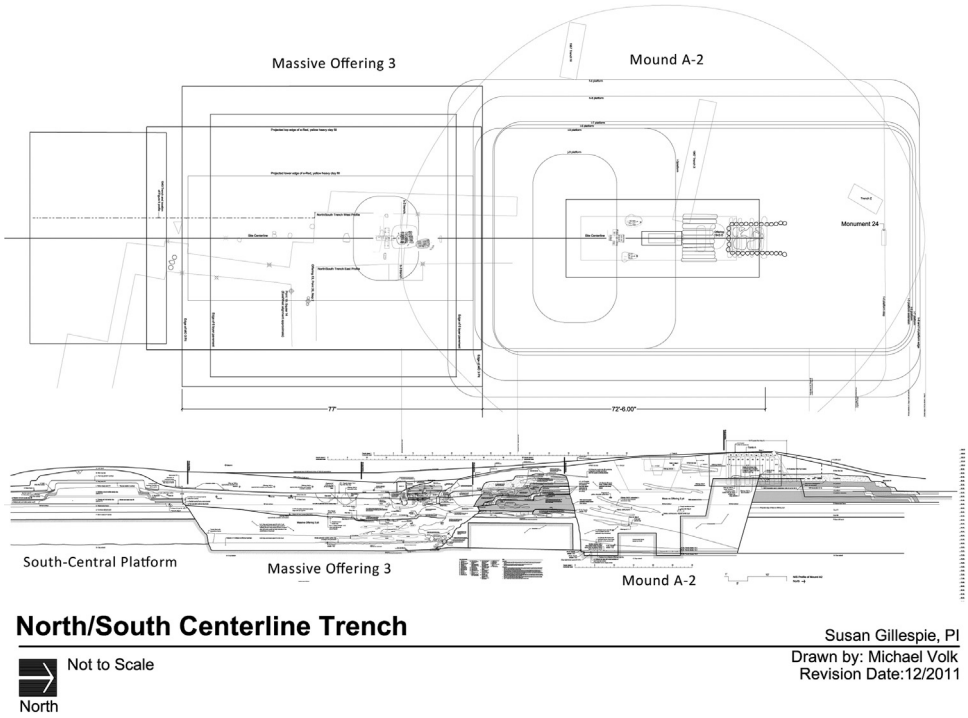


Fig. 7. Aligning profile and plan views of Mound A-2 (right) and Massive Offering 3 (left) in the Ceremonial Court.

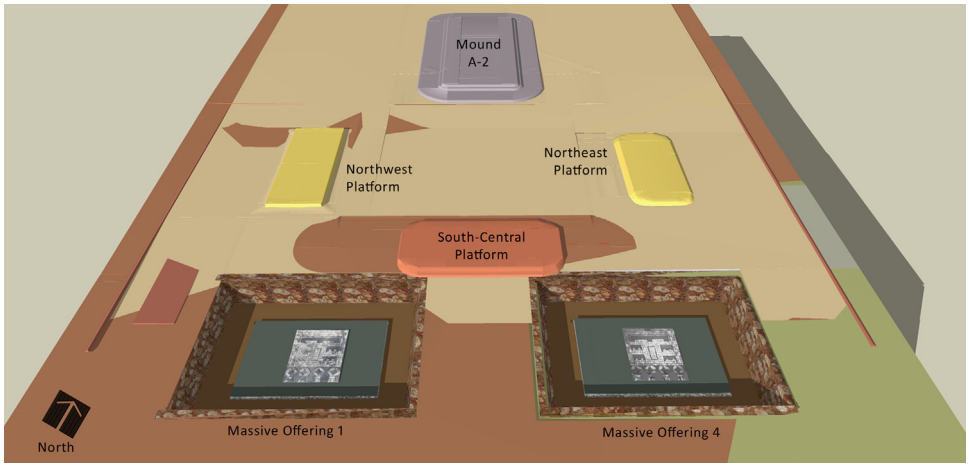


Fig. 8. A video still shows the Phase II massive offerings and mosaic "pavements" in the Southwest and Southeast Platforms. View looking north.

1967 projects in three-dimensional space (see Fig. 4, Section 2.4). Those latter excavations provided crucial information on the fluctuating northern extent of Mound A-2, something not recorded in 1943 or 1955.

4.3. *Rethinking the history and design plan of Complex A*

A major goal of the 1955 excavators was to re-create the construction history of Complex A and its individual structures. Unfortunately they did not integrate the vertical positioning of the structures and features in their interpretations, although those data were available. They were thus limited to demonstrating four major construction phases for the Ceremonial Court based on a sequential series of court-wide floors (Section 1.2). One of their principal conclusions was that a formal design plan of bilateral symmetry was maintained from Phase I to Phase IV, indicative of an uninterrupted Olmec or "La Venta" occupation (Drucker and Heizer, 1965: 64; Drucker et al., 1959: 14). However, their excavations also revealed portions of several painted low clay platforms beneath the Phase I floor layers, which they concluded dated to a "pre-La Venta" occupation (Drucker et al., 1959: 124).

Nevertheless the 1955 trench profiles published in 1959 did not support the interpretation of a single design plan maintained since the origin of the building group. For example, the Northeast Platform seemed to predate the Northwest Platform by an entire construction phase, in that the Phase I floor layers abutted the base of the Northeast Platform, while the Northwest Platform was built atop that floor (Coe and Stuckenrath, 1964: 6; Gillespie, 2008). Furthermore, although bilateral symmetry is readily apparent in the footprints of structures on the 1955 base map (Fig. 1), our reconstructed plan views based on the profile drawings (Fig. 4) reveal that even the twinned Northeast and Northwest Platforms were subjected to quite different ritual purposes and were not identical in appearance or use (Gillespie, 2011: 25–26).

With the 3d model we can now show change through time for individual structures and the complex as a whole. The different layers of the AutoCAD® file (Section 2.4) reference major and minor construction phases. They can be turned on and off,

rendering images of the complex at various times in its history. A video animation ⟨insert link to Complex A construction history animation⟩ demonstrates the changes to the northern half of Complex A through the major construction phases, including the excavation of large pits to hold the massive offerings of the Southwest and Southeast Platforms (Fig. 8). Our modeling also incorporates the buildup of the court floors and additions to the heights of the mounds in vertical space, resulting in a very different interpretation of the construction history and design plan than is evident in the published maps (Video 2).

4.4. The importance of Mound A-2

Drucker and Heizer (1965: 39–40) insisted that the Ceremonial Court (designated A-1) was always the "principal structural feature" of Complex A, even as they noted that "particular attention was given throughout the entire span of time" to Mound A-2 (Drucker et al., 1959: 34). Mound A-2 was the tallest structure in Complex A and had the most complicated stratigraphic history. Our 2d and 3d models also indicate that it was the oldest and most important from the very beginning of its existence.

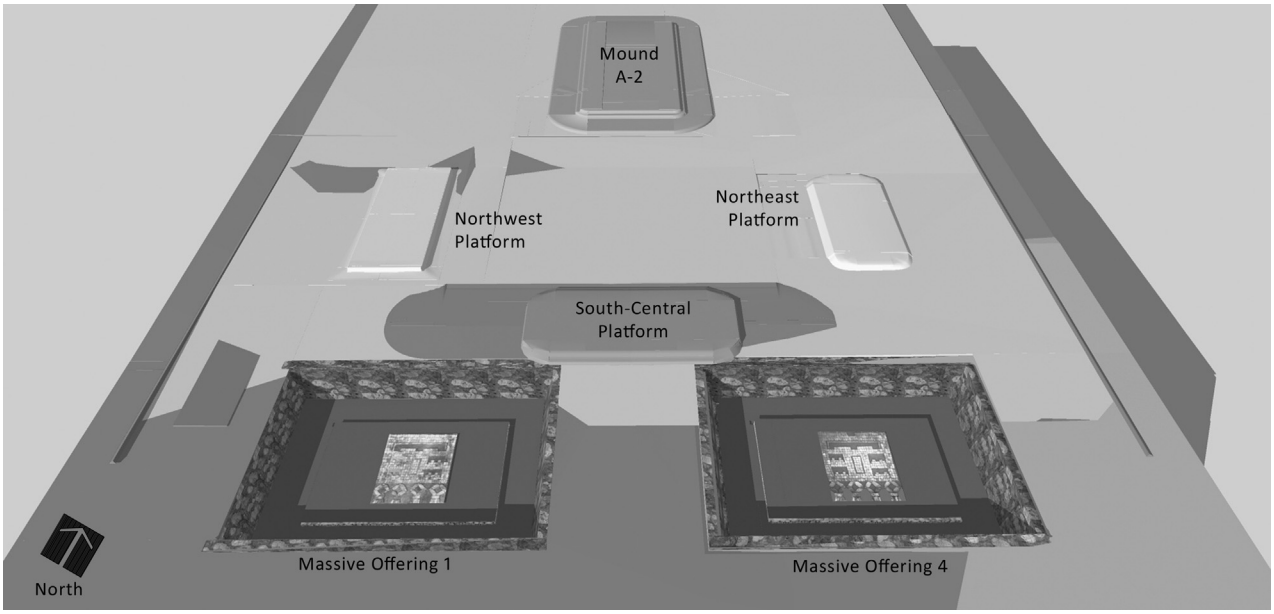
The making of what would become Mound A-2 started with sequential deposits of thin layers of sand upon undisturbed ground. Mound A-2 became a more proper flat-topped platform, about 0.3 m tall, with a deposit of prepared clay atop the earlier sand layers (stratum j-3 in Drucker et al., 1959: Fig. 10). Dedicatory deposits of vari-colored sands were gradually laid abutting the south edge of Mound A-2, eventually reaching its summit. Then a second, much larger stepped platform of prepared red and white sandy clays, over 1 m thick, was erected over the first phase (stratum i-1 in Drucker et al., 1959: Fig. 10). Drucker and Heizer considered the i-1 clay platform to date to Phase II of the Ceremonial Court (Drucker et al. 1959: 46), but our *z*-axis indicates that at this stage Mound A-2 still pre-existed all other structures and the Phase I floors. This is why our initial GIS model showed the base of A-2 was lower than the bases of the other platforms, something we thought at the time was an error (Section 2.4).

After or in concert with this major rebuilding of A-2, brown sand was brought in to begin to level the area immediately south of the platform, which would become the Ceremonial Court. On top of that fill at least three small low clay platforms were erected in the general vicinity of the later Northeast, Northwest, and South-Central Platforms (Fig. 9). Additional fill to further raise the lower, western portion of the court area buried the nascent Northwest and South-Central Platforms, which is why the 1955 excavators found remnants of "pre-Phase I" structures under them. This also explains why the Northeast Platform stratigraphically seemed to predate the Northwest Platform (Section 4.3), whose earlier construction phase had been covered by the sandy fill.

4.5. A new interpretation of Complex A

Taking into account the 3d model of the construction changes to the structures and the complex as a whole at a more refined temporal scale, the ability to locate precisely the various dedicatory and massive offerings, the incorporation of otherwise invisible ritual acts such as digging pits into the platforms, and the attention to building materials, we offer a different interpretation of the function and meaning of Complex A. From the beginning, this ritual precinct was devoted to the sacred locale of Mound A-2, a focus of ritual deposition and extraction of materials for generations. The smaller platforms, eventually enclosed in a walled court, separated off the southern edge of Mound A-2 in particular as a place for intense and continuous devotional activities. The adobe brick Southeast and Southwest Platforms were actually part of the adobe brick walled enclosure, erected at the same time, and are better considered "bastions," as they were labeled in the 1955 field notes.

The largest Massive Offering in areal extent was dug through the court floor just south of Mound A-2, initiating construction Phase III. Massive Offering 3 was the locus for several dedicatory offerings positioned above the six layers of serpentine blocks placed at the bottom of the great pit. This massive deposit, abutting Mound A-2, was a sacred place within the already sacred locale of the Ceremonial Court. Phase III also witnessed the shift towards placing offerings along the north-south centerline, especially above Massive Offering 3. The centerline per se seems not to have been important until Phases III and IV, indicating a change in the plan and use of the complex that nevertheless kept the focus of ritual attention on Mound A-2.



Video 2. Complex A construction history animation: video animation of changes to the Complex A architecture over the history of its active use. A video clip is available online. Supplementary material related to this article can be found online at http://dx.doi.org/10.1016/j.daach.2014.06.001.

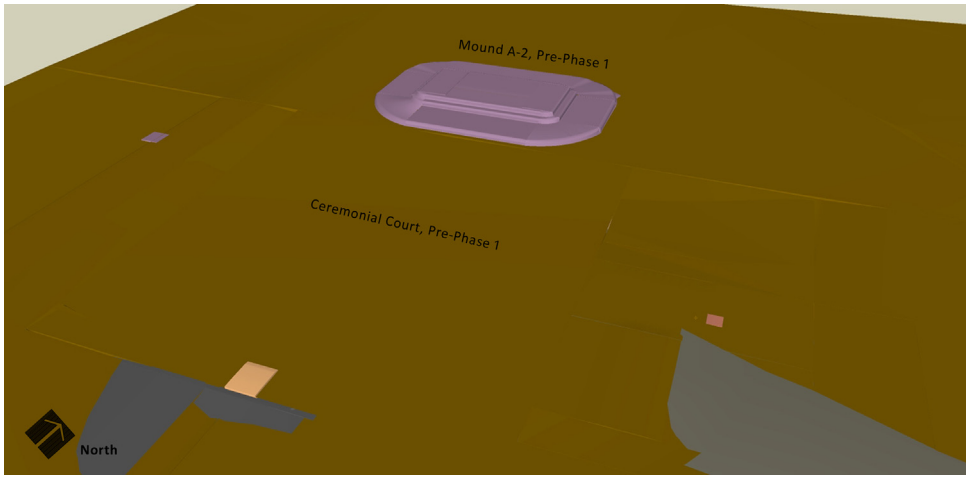


Fig. 9. A "pre-Phase I" image shows Mound A-2 as a large stepped clay platform, along with the mapped fragments of early versions of the Northwest, Northeast, and South-Central Platforms. The dimensions of the latter three small platforms are not known.

Finally, in Phase IV a massive offering pit was dug into the center of Mound A-2 itself (Fig. 6), at the bottom of which a single layer of serpentine blocks was laid. "Tombs" were located at the mound's summit directly over that serpentine deposit. The centerline orientation is most evident in Phase IV in terms of the locations of buried offerings, but for the first time they were placed only outside of the Ceremonial Court, which was a major shift in the ritual use of this precinct (Gillespie, 2008). Also in Phase IV the parallel structures A-4 and A-5 were erected, further marking and blocking access to the southern portion of Complex A between the Ceremonial Court and the pyramid.

5. Conclusion

Aside from the specific new interpretations regarding Complex A derived from the 3d model (Sections 4.4 and 4.5), more general conclusions can be reached regarding the significance and replicable utility of this project. The first is the potential for digitizing archival archeological records to create a data-base for 2d and 3d visualizations. Although it can be difficult and time-consuming to retroactively craft maps and drawings in this way, this possibility should be considered for the numerous sites at which archeological research was conducted in the past but where on-site digital mapping using new technologies is no longer possible due to the subsequent destruction of features or the inability to obtain permission from land-owners or authorities for such research.

Secondly, this project highlights the importance of archiving field records in repositories where they can be made available to researchers. Gillespie's one-day exploratory trip to the National Anthropological Archives in 2005, to discover whether the original La Venta field records deposited there by Heizer held any unutilized data to improve on the published maps, turned up a surprising amount of information. Finally, the authors' collaboration, combining different expertises (archeology and landscape architecture), has proven very productive, yielding more complex and useful results than a single disciplinary focus might have achieved.

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