

**FAMSI © 2008: Travis Doering and Lori Collins**

**The Kaminaljuyú Sculpture Project: An Expandable  
Three-Dimensional Database**



**Research Year:** 2007

**Culture:** Maya

**Chronology:** Late Pre-Classic, Early Classic

**Location:** Guatemala

**Site:** Kaminaljuyú

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Submitted 02/14/2008 by:

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*"Every later Mesoamerican society developed within a framework that was laid in the Pre-Classic. The material features that we see archaeologically as typical of Mesoamerica took their essential form during this period." (Joyce and Grove 1999:2)*

## **Introduction**

Recent epigraphic and iconographic work in Mesoamerica (e.g., Guernsey 2006; Houston 2004; Rodríguez-Martínez et al. 2006; Saturno et al. 2006) lends further support to the statement made by Joyce and Grove above. These and other investigations demonstrate that the Formative period (c. 1250 BCE to 250 CE) was a pivotal time in the evolution from symbolic or iconographic depictions to writing systems as well as in the materialization of the Mesoamerican calendrical system (Rice 2007). To better analyze and determine the sequence of stages in these changes, it is advantageous to have a substantial body of comparative material with which to work. Furthermore, the assemblage of material should span the chronological period that is inclusive of the actions deemed significant in the maturation of these systems. For these and other reasons that are discussed below, the corpus of stone and ceramic sculpture from the site of Kaminaljuyú has been selected for documentation.

The purpose of the Kaminaljuyú Sculpture Project, which was wholly sponsored by the Foundation for the Advancement of Mesoamerica Studies, Inc., (FAMSI), is to provide a foundation for an expandable three-dimensional database of sculpted ceramic and stone monuments from the Formative and Classic period site of Kaminaljuyú in present-day Guatemala City. The three-dimensional images in this database allow Mesoamerican scholars, iconographers, epigraphers, or other interested parties to study the sculptures at a level of detail and in a virtual reality not previously possible. The complete data sets for each piece permit the researcher to examine the artifact on their office, lab, or home computer as thoroughly and meticulously as if the object were physically present. Besides being viewable in three-dimensions, the images are manipulable a full 360°, they can be enlarged for closer scrutiny, the light source can be maneuvered to any angle to bring out or enhance desired detail, and extremely accurate on-screen measurements can be made anywhere on the object. This database allows researchers anywhere in the world to conduct visual analysis and investigation without having to visit the actual artifact.

The objectives of this project were multifaceted. We wanted to remove several of the obstacles that had previously hindered a systematic, coordinated, and broad-based study of Kaminaljuyú's stone sculpture. Kaplan (1995b:1) has identified the critical research problem relative to the monuments at Kaminaljuyú, the "sculptures and sculptural fragments in the ancient city's monumental corpus have not been studied with the aim of integrating iconography, ideology, and history." The causes of this problem are three-fold. First, the corpus is disunited

and dispersed. Second, only a few of the pieces that are known have been documented sufficiently for critical iconographic and epigraphic analysis. The third problem is a result of the first two, the availability of the pieces for study and research has been severely restricted. The three-dimensional database of Kaminaljuyú sculpture alleviates these obstacles.

The dispersed sculpted pieces were first located and then permissions acquired to document them at the site and in various museums, storage facilities, parks, and national and international private collections where they were found. The majority of pieces identified as originating from Kaminaljuyú were at the three major museums in Guatemala City: the Popol Vuh, Miraflores, and the Guatemala National Museum of Archaeology and Ethnology. The National Museum had more than 100 documented carved pieces from the site, some of which were on display while others were located in various parts of the bodega and other off-display storage areas.

Kaplan (1995b:1) also called attention to the difficulty in accessing the data that had been collected. We wanted these new data to be available in a format that could be readily used by researchers and that images could be freely obtained by those with an interest in the sculptures. Another consideration was the ability to compare the corpus of work from Kaminaljuyú to a growing body of contemporaneous sculpture from other Mesoamerican Formative period sites (e.g., La Venta, Izapa, or Takalik Abaj). This element of comparability along with the ability to add new materials meant that the database had to be expandable. This feature would allow the addition of data collected by other investigators and as more sculptures came to light or became available they could be added to the corpus. Finally, we were concerned with the long-term preservation of the data. The method of storage and format was designed to allow these data to be used, augmented, and improved as new technologies are developed in the future. With support from and collaboration with FAMSI, we believe that these project objectives have been achieved.

### **The Significance of the Site of Kaminaljuyú**

Kaminaljuyú was selected for this initial project for several reasons. The sculpted material from the site is a primary nexus in the transformative process from conceptual communication to its physical demonstration. Admittedly, these processes of materialization occurred in other locations and times throughout Mesoamerica (e.g., San Lorenzo, La Venta, the Valley of Oaxaca, Izapa, Ulua River Valley, Chalchuapa, and Abaj Takalik). As we will demonstrate, however, Kaminaljuyú offers a more inclusive socioeconomic composition and broader spatial scope than most other sites.

Another factor in the decision was the longevity of Kaminaljuyú's occupation, which spans the Early Formative period (c. 1200 BCE) through the Classic period (c. 900 CE). This is precisely the time when the archaeological record indicates

the incipient materialization in stone of symbols and icons occurred across Mesoamerica (Flannery 1968; Miller 1996; Pool 2007). This phase was followed by the appearance of emergent writing systems and their subsequent florescence (Guernsey 2006; Parsons 1988). Covering some five square kilometers, Kaminaljuyú was the largest settlement in the Guatemala Highlands during this dynamic period (Hatch 2001:387), and it was also the site of the region's most powerful chiefdom (Demarest 2004; Michels 1979).

To some, the relationship of the settlement's inhabitants with those of the major central Mexican city of Teotihuacán in the Early Classic period is of primary importance (Rice 2007:129). Nevertheless, multiple and earlier sociopolitical transitions occurred among and between elites across Mesoamerica during the Formative period. While the Teotihuacán connection is significant, Kaminaljuyú's relationships with numerous other contemporaneous regional sociopolitical centers may be more important to understanding the occupants' iconographic actualizing of their ideology.

### ***The Beginning***

The initial documented occupation of Kaminaljuyú began in the Arévalo phase (c. 1200-1000 BCE). This sedentary presence is based upon ceramic evidence, which, "seem to have no antecedents in the valley, nor any close relationships to those of Las Charcas" (Hatch 2001:388), the subsequent temporal phase (c. 1000-700 BCE). The timing of this occupation is interesting in that obsidian from nearby El Chayal begins, for the first time, to appear at sites distant from Kaminaljuyú and the Guatemala Highlands (Clark and Lee 1984; Hoopes 1993; Sheets 1975).

It is possible that early societal occupation and development at Kaminaljuyú was instigated by the desire for formal organizational control of the exportation of this major raw material. Some of the most notable Early Formative period appearances of El Chayal obsidian were in Southern Gulf lowland sites. The early rise of Kaminaljuyú may have been, in part, stimulated by contact with the major Olmec site of San Lorenzo (c. 1250-900 BCE). The source of some of the earliest obsidian material including prismatic blades recovered at San Lorenzo was El Chayal (Cobean et al. 1971; Cobean et al. 1991; Coe and Diehl 1980). As well, at El Macayal, a contemporaneous settlement approximately 12 km east of San Lorenzo (Ortíz and Rodríguez 1990; Ortíz et al. 1988; Ortíz et al. 1989), El Chayal obsidian was also present (Doering n.d.). This hypothesis is strengthened by the continually emerging evidence of San Lorenzo's presence along the Soconusco Coast, nearby to Kaminaljuyú (Cheetham 2005; Clark and Hodgson 2004; Clark and Pye 2000; Lesure 2004; Pool 2007; Rosenswig 2006, 2007).

As Hatch (2001:388) pointed out, the succeeding Las Charcas phase (c. 1000-700 BCE) at Kaminaljuyú shows little relationship to its predecessor. Again, the timing corresponds to major events occurring on the Southern Gulf Coast,

primarily the decline of San Lorenzo and the rise of La Venta and the substantial differences in their material record (see Clark 2005). Also, coeval changes occurred on the Soconusco Coast (i.e., the decline of centers in the Mazatan region, significant regional population movements, and the rise of La Blanca) (Love 2002; Rosenswig 2000, 2006). These types of socioeconomic changes may be reflected at Kaminaljuyú in the seeming lack of ceramic continuity between its first and second phase.

### ***An Economic, Linguistic, and Social Interface***

Early long distance contacts appear to signal Kaminaljuyú's role as a center in a growing socioeconomic interaction sphere that literally spanned the entire eastern half of Mesoamerica. Contacts were eventually established with La Venta, Tres Zapotes, Chiapa de Corzo, Teotihuacán, Izapa, Chalchuapa, and in the Maya Lowlands. To understand the reasons that Kaminaljuyú enjoyed its position as a key point of socioeconomic interaction between such diverse and distant centers, one needs to examine its physical geography and geology.

The settlement is located in the western portion of the Valley of Guatemala, a broad relatively flat intermontane plateau. The valley is in the Southern Sierra Madre Mountains, a volcanic range of the Antillean Chain. The well-watered plateau is actually "a transverse north-south graben or rift structure. As such, it represents the only major pass connecting the Pacific coastal plain and the Motagua Valley" (Michels 1979:39). Thus, the site's propitious position was on the only significant natural pass that connected the Pacific Coast to the northern interior of Guatemala and the Caribbean. Routes along the Pacific Coast extended from the Isthmus of Tehuantepec in the west (Zeitlin 1982) to El Salvador in the east (Sharer 1978) and possibly to Costa Rica in the southeast (Graham 1998; Jones 1998; Taube 2004).

Add to this geographic advantage the close proximity of two major obsidian sources, El Chayal and San Martín Jilotepeque; direct access to the Motagua River Valley, location of the only documented Mesoamerican jade source (Seitz et al. 2001); and an active expansive acquisition and redistribution system that also included salt, cacao, fruits, and ceramics (Hatch 1997; Parsons 1986; Sanders 1969; Stanislawski 1996). Thus, Kaminaljuyú was at the center of an extensive socioeconomic interaction sphere of exchange and acquisition that extended to the Caribbean Coast, Honduras, El Salvador, Teotihuacán, Chiapas, the Maya Lowlands (El Petén), the Isthmus of Tehuantepec, and the Southern Gulf Coast. Another minor, but possibly warranted, consideration is the constant temperate climate that makes the Valley a welcome location at any time of the year (Hatch et al. 2002). This condition may have been an inviting respite to agents from the sweltering coasts and tropical regions, frigid elevations, or arid plains and dry savannahs.

The Valley was also a key point of interaction among a remarkable variety of linguistic groups. Mora-Marín (2001) has determined that Kaminaljuyú was an interface between Mixe-Zoquean and Mayan linguistic traditions. Rice (2007:129) states that there was an amalgamation of emerging regional proto-linguistic traditions that included “Mixean, Xincan, Lencan, Zoquean, Ch’olan-Tzeltalan, and Poqom.” The valley was considered a “cosmopolitan meeting ground for various ethnolinguistic groups, presumably with competing politico-economic goals, interethnic or factional rivalries” (Rice 2007:138). If this presumption is true, Kaminaljuyú may have been a type site for Polyani’s (1963) port of trade, a neutral locality where agents of disparate polities could assemble and safely conduct mercantile transactions. At Kaminaljuyú, however, the interaction may have extended beyond purely economic contact to include ideological and social aspects.

Based on the varied linguistic-cultural groups and the diversity of products and materials associated with Kaminaljuyú, there was a convergence and transmission of mutual and dynamic ideas and technologies from widespread regions of Mesoamerica. The site’s occupants acted as conduits for the communication of sociopolitical, ideological, and technological activities that were occurring throughout southeastern Mesoamerica. For these reasons, Kaminaljuyú’s sculptural corpus is a record that involves multiple cultural groups who shared a common creation myth, cosmology, and political structure (Coggins 1996:33) and, therefore, is an invaluable assemblage to anyone investigating the emergence and development of ancient pan-Mesoamerican communication systems.

### ***The Kaminaljuyú Sculptural Corpus***

Multiple sociopolitical transitions occurred among and between discrete societies across Mesoamerica during the Formative period. It appears that there existed, “a dynamic, multiethnic interaction sphere that included not only the dissemination of tangible goods, but the communication of symbolic ideas as well” (Guernsey 2006:6). Many of the changes that occurred in the evolving political and economic landscape of the Mesoamerican Formative period were expressed and preserved in an active sculptural record (see Clark 2005; Parsons 1986). Visual vocabularies emanated from these sites, images carved in stone that exemplified the diversity and transmutation in the form and display of power and authority.

Kaminaljuyú was a nexus in this evolving sociopolitical landscape and was a preeminent repository for early pan-Mesoamerican sculptural canons and conventions. Therefore, the significance and primacy of the sculptural corpus at Kaminaljuyú for the study of the evolution of Mesoamerican inscriptions lies in the fact that various symbolic conventions, emblematic of distant and diverse centers, were present at the site (Hatch 1997; Parsons 1986). As Guernsey (2006:6) notes, these presentations were not unsophisticated efforts but were,

instead, part of a well-devised program that the later Classic period elite in Mesoamerica would imitate.

More so than other sites, the Kaminaljuyú sculptures demonstrate a more eclectic assemblage that suggests a more broadly shared style (Rice 2007:138). Notable similarities between Kaminaljuyú carved monuments and those of other contemporaneous sites have been noted. For example, Guernsey-Kappler (2002:77-80) discusses the relationships between Kaminaljuyú Stelae 4, 10, 11, and 19 and stone sculptures from Izapa. Rice (2007:137) states that, “the similarities and continuities between Olmec, Epi-Olmec, Izapan, Kaminaljuyú, and lowland Maya styles of art and epigraphy cannot be denied.” She goes on to add that, “they clearly indicate both distinct ethno-linguistico-epigraphic traditions and considerable interaction—social, economic, and linguistic—[occurred] over a wide area in the Late and Terminal Preclassic periods.”

Guernsey (2006:5) maintains that carved stone monuments and their collective cache of incised symbols, “must be understood as protagonists—albeit stone ones—that structured sacred space and delivered powerful messages to a diverse Late Preclassic audience.” Cyphers (1993:156-158) stresses that interpretation and meaning of symbolic accounts cannot be conceived of in isolation. She contends that, to be effectively considered, the evidence must be placed within an “archaeological and sociological” context. “Ideally, a context implies not only the single object, but those objects found together with it, including constructed architecture and/or modified landscapes, immediate or more remote” (Cyphers 1993:158). In turn, the specific contexts must be situated within a setting broad enough to define the circumstances that, “reminds occupants of the appropriate rules and hence of the ongoing behaviors appropriate to the situation” (Rapoport 1990:12). Thus, the context of the site of Kaminaljuyú must be understood, and the conceptual constructions evaluated, relative to the setting of Formative period Southeastern Mesoamerica. As an example, the simple presence of monumental stone, carved or uncarved, at Kaminaljuyú requires investigators to consider the social interactions, organizational and rulership structure, as well as the technologies necessary to transport, erect, and carve these memorials. For best results, these new data generated by this project should be integrated with other multidisciplinary data and documentation that has been assembled over the past century (including but not limited to Gamio 1926 ; Hatch 1997; Houston et al. 2005; Houston et al. 2003 ; Kaplan 1995a; Kidder et al. 1946; Michaels 1979; Monterroso and Galindo 2004 ; Ohi 1994; Parsons 1988; Parsons 1986; Sanders and Michaels 1977; Shook and Smith 1942 ; Valdés and Wright 2004; White et al. 2000).

There are other considerations that should be made when examining the dynamic but still poorly understood Late Formative period and its sculptural record at Kaminaljuyú. Like many stone artifacts from Mesoamerica, the monumental carvings have been subjected to millennium of natural and anthropogenic factors that have negatively impacted many of the pieces. Some

pieces from Kaminaljuyú, prior to being in museum and private collections, have suffered from weathering, while others have been intentionally defaced or broken, both in ancient and modern times. Results of these conditions have, in some cases, limited their archaeological visibility. Post-processing techniques applied to three-dimensional laser scan data can often extract greater detail than other methods of recordation to assist in the interpretation of the sculptural record, and to tease out details that can be imperceptible to the human eye.

### **Three-Dimensional Laser Scanning and Mesoamerican Sculpture**

Three-dimensional laser scanning is a non-contact, non-intrusive, and non-destructive method for the highly accurate documentation of Mesoamerican stone and sculpted artifacts. The technique is a new tool that can be used by archaeological researchers in conjunction with other documentation techniques to produce the most complete and accurate data for their investigations. High definition, close range scanning significantly reduces the subjectivity associated with more conventional sculpture recording processes. At the same time, however, it can be combined with previous documentation methods to produce a more accurate and objective record. Processed scan data sets can be used to generate an exceptional archival record for research, restoration, reconstruction, replication, and monitoring of deterioration (Collins and Doering 2006; Price 1996: 30).

In a report from the Getty Conservation Institute regarding stone monuments, Price (1996:30) states that, “[d]rawing and photography still have a place in recording, but attention is turning increasingly to techniques of three-dimensional recording.” He cites the fact that laser scanning does not require any physical contact with the object while offering optimal results in almost every instance as justification for the use of three-dimensional techniques. Furthermore, the observation of minute detail afforded by three-dimensional scanning is superior to stereophotography and photogrammetry, methods that portray only an illusion of depth from a single perspective and does not provide a quantitative record. Tracing, rubbing, molding, and casting are not feasible on fragile, damaged, or deteriorated surfaces. Thus, laser scanning is an appropriate method for the majority of applications.

In this current project, we used a Konica-Minolta VIVID 9i Laser Digitizer, a close-range scanner that excels at high-precision three-dimensional measurement that, when combined with three dimensional software, is capable of rapid processing that facilitates the straightforward merging and editing of large amounts of measurement data. The choice of the VIVID 9i was also due to its proven ability to produce excellent results in a variety of locales (e.g., labs, bodegas, museums, and archaeological sites) and under a range of physical and climatic conditions. Equipment, computer hardware and software, and expertise were provided by the Alliance for Integrated Spatial Technologies in the Office of Research and Scholarship at the University of South Florida in Tampa.



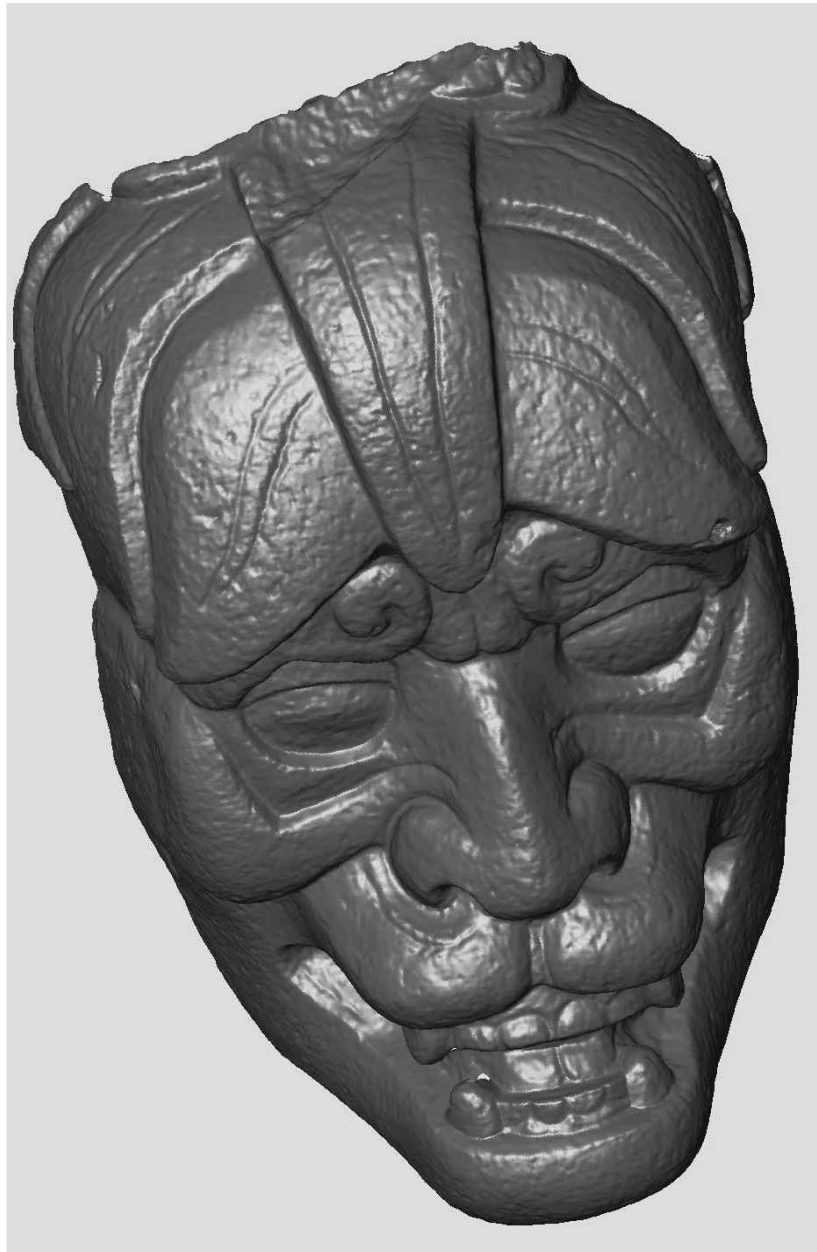
Data generated by close-range three-dimensional scanning have proven to be exceptionally advantageous for the documentation, visualization, and analysis of sculpted objects (Doering and Collins n.d.; Doering et al. 2006). The VIVID 9i scanner operates on the principle of triangulation or sine law (Boehler and Marbs 2002; Boehler et al. 2003), and surface images are captured at an accuracy level approaching .05 mm (Konica-Minolta 2007), approximately the diameter of a human hair. The visualization of the object is further enhanced by three dimensional software techniques that provide the viewer the ability to change the angle of light and shadow across the surface. Each piece can be freely maneuvered 360° to obtain optimal detail and perspective, and disarticulated pieces can be virtually reassembled. Dimensional and volumetric measurements can be produced as well. Thus, computerized visualization of the resultant data permits researchers to study sculpted objects in a virtual reality and at a level of detail and accessibility not previously possible.

### **The Kaminaljuyú Sculpture Project: Data Collection and Processing**

The best extant presentation of a collection of Kaminaljuyú sculpture was conducted by Parsons over 20 years ago (Parsons 1986), but it was not designed for intimate study and analysis. Since then, new pieces have been located and advancing technologies have recently been developed that permit the collection and dissemination of highly accurate and detailed visualizations of the objects (Collins and Doering 2006). We have decided to use the descriptive nomenclature put forward by Parsons (1986). Although these 20-year-old terms may not be as accurate as may be desired, we have decided to follow Parson's lead instead of trying to rewrite and redefine each term. Therefore, monumental stone artifacts recorded in the current project were classified as monuments, stelae, altars, silhouetted reliefs, and pedestal sculptures. Each piece is identified according to the museum accession number, if known, and the FAMSI Mesoamerican Three-Dimensional Imaging Project number (M3D), which is discussed in the following section. Also, please note that the gray-scale figures produced for this report are two-dimensional images of three-dimensional data. Significantly better clarity and detail can be observed in the true three-dimensional realm that allows the viewer to move, manipulate, and highlight the object as desired.

A total of 141 Mesoamerican artifacts were scanned and documented during the project's June and July, 2007 field season. Of these, 118 pieces were stone or ceramic sculptures from the site of Kaminaljuyú. The three-dimensional scanning of Kaminaljuyú sculpture commenced at the Francisco Marroquín University's Popol Vuh Museum in Guatemala City. Here, eight iconographic stone sculptures were scanned with the cooperation and assistance of Dr. Oswaldo Chinchilla, the museum's curator, and his staff. These pieces included the often illustrated grotesque mask (Museum #0322-Popol Vuh, FAMSI Imaging Project # M3D0024 ([Figure 1](#))); a carved and incised stone frog (Museum #0601-Popol Vuh, FAMSI Imaging Project # M3D0023); a small potbellied sculpture designated Monument

57 (Museum #0584-Popol Vuh, FAMSI Imaging Project # M3D0019) ([Figure 2](#)); two silhouetted relief carvings (Museum #0330-Popol Vuh and #0326-Popol Vuh, FAMSI Imaging Project # M3D0020 and M3D0021); an altar fragment from the four-legged Altar 14 (Museum #0332-Popol Vuh, FAMSI Imaging Project # M3D0022) ([Figure 3](#)); an ovoid stone disc with carving (Museum #1.1.2.2712-Popol Vuh, FAMSI Imaging Project # M3D0016); and a stela fragment (Stela 28) (Museum #Unknown-Popol Vuh, FAMSI Imaging Project # M3D0017).



**Figure 1. Screen capture of scan image of Grotesque mask from Kaminaljuyú, curated at the Popol Vuh Museum in Guatemala City.**



**Figure 2. Front and reverse side view screen captures of Monument 57 from Kaminaljuyú, curated at the Popol Vuh Museum in Guatemala City.**

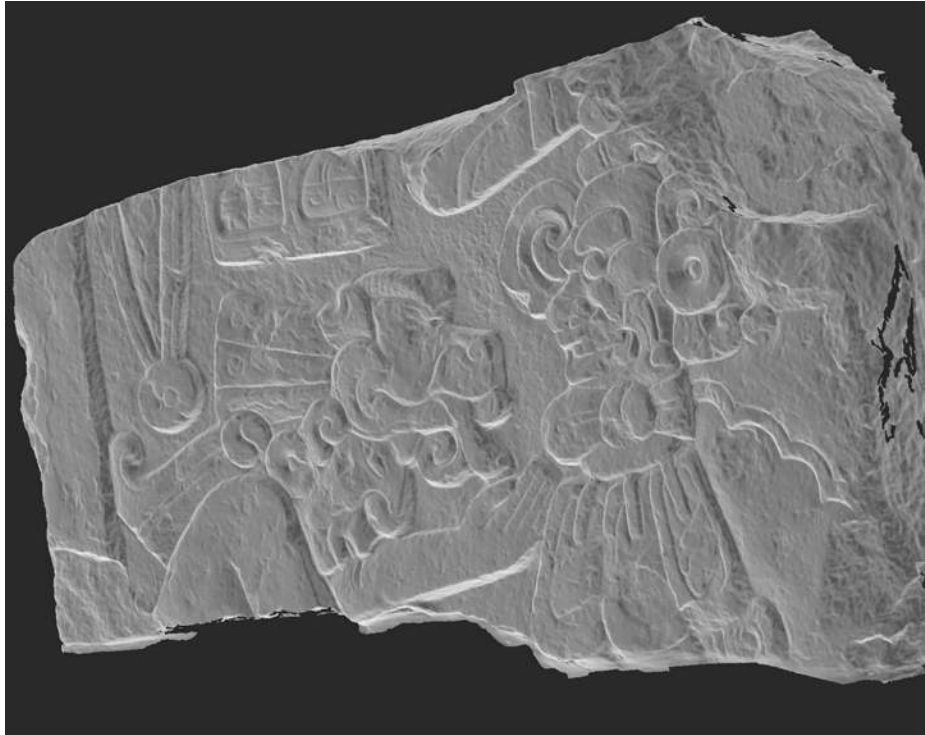
Next, documentation of four stone and three ceramic objects from Kaminaljuyú was conducted at the Miraflores Museum. Here, the authors worked under the direction of Dr. Juan Antonio Valdés. The stone sculpture included a four-faced carved pedestal sculpture (Museum #Unknown-Miraflores, FAMSI Imaging Project #not yet assigned); a zoomorphic toad sculpture (Museum # Unknown-Miraflores, FAMSI Imaging Project # not yet assigned; Altar 1 (Museum #2072-Miraflores, FAMSI Imaging Project # not yet assigned) ([Figure 4](#)); and the Stela 21 fragment (Museum #8135, FAMSI Imaging Project # not yet assigned) ([Figure 5](#)).



**Figure 3. Screen capture views of scan images of Altar 14 fragment from Kaminaljuyú, curated at the Popol Vuh Museum in Guatemala City.**



**Figure 4. Screen capture of scan image of Altar 1 from Kaminaljuyú, curated at the Miraflores Museum in Guatemala City.**



**Figure 5. Screen capture of scan image of Stela 21 from Kaminaljuyú, curated at the Miraflores Museum in Guatemala City.**

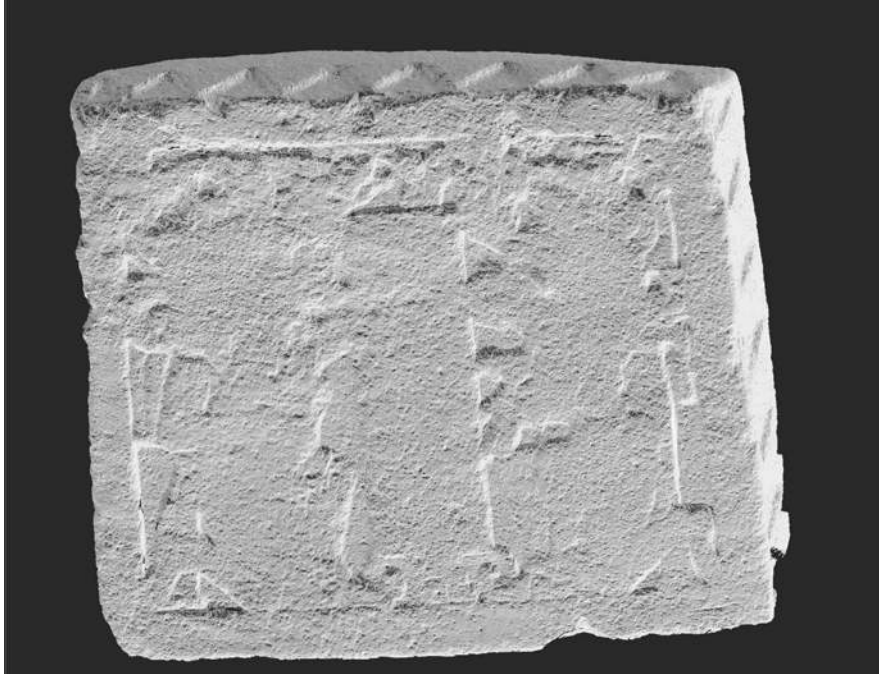
In Antigua, Guatemala pieces were documented and scanned at the VIGUA Museum of Pre-Columbian Art and Modern Glass, a private collection of VICAL, Central American Glass Company with permission and assistance from Susana Campins, director of the museum. Pieces were also documented at the private MAYAP Collection in the Archaeology Museum in the Paseo de los Museos, Casa Santo Domingo with the permission of the director Ana Claudia de Suasnavar and the assistance of Tessa de Alarcón. Some of these pieces included carved objects from sites other than Kaminaljuyú, but with similar temporal range and iconographic elements, such as the low-relief “Shook Panel” (Museum #Unknown-Casa Santo Domingo, FAMS I Imaging Project # not yet assigned) ([Figure 6](#)).



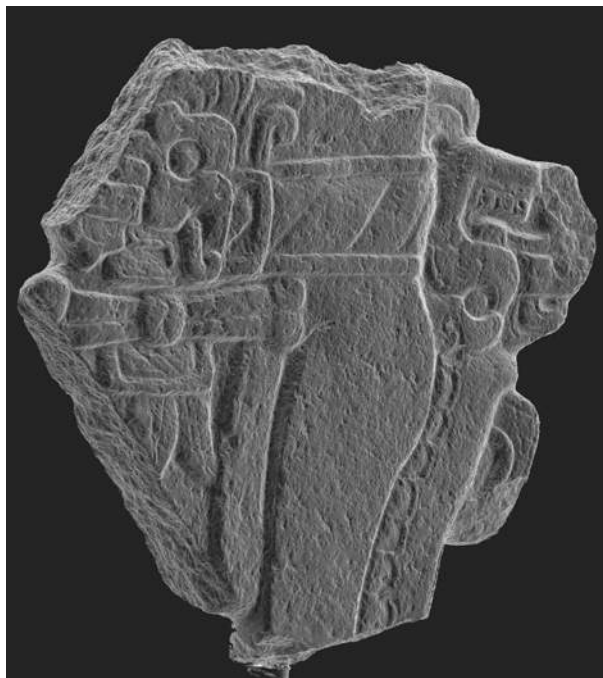
**Figure 6. Screen capture of scan image of Stela 21 from Kaminaljuyú, curated at the private MAYAP Collection in the Archaeology Museum in the Paseo de los Museos, Casa Santo Domingo, Antigua.**

The remainder of the project focused on the Kaminaljuyú pieces curated at the National Museum of Archaeology and Ethnology in Guatemala City. Here, a total of 100 sculptures were recorded under the direction of Curator Claudia Monzón Sosa de Jiménez, whose graciousness and patience was greatly appreciated. We also received critical assistance from Rodolfo Yakian, Director of Artifacts at the National Museum, who helped us locate pieces from Kaminaljuyú. Three weeks were spent at the museum scanning objects from Kaminaljuyú that were on exhibit, in the bodega, and in special storage areas. James “Bart” McLeod and William Klinger, graduate students from the University of South Florida, assisted the authors in all phases of the project.

An example of a Kaminaljuyú altar from the National Museum is illustrated in [Figure 7](#) (Museum # M-3092-A, FAMSI Imaging Project # M3D0044); a silhouetted relief in [Figure 8](#) (Museum # MNAE 3232, FAMSI Imaging Project # M3D0088); fragments of multiple classifications in [Figure 9](#) (Museum #MN1923, FAMSI Imaging Project # M3D0102) and a stela (Stela 8) in [Figure 10](#) (Museum #Unknown, FAMSI Imaging Project # M3D 0044). Kaminaljuyú Monument 65 is shown in [Figure 11](#) (Museum #MN-Unknown, FAMSI Imaging Project # M3D004), a pedestal sculpture in [Figure 12](#) (Museum # MNAE 3094, FAMSI Imaging Project # M3D069) and an anthropomorphic ceramic vessel is depicted in Museum # MNAE 7512, FAMSI Imaging Project # M3D 0066 (not shown).



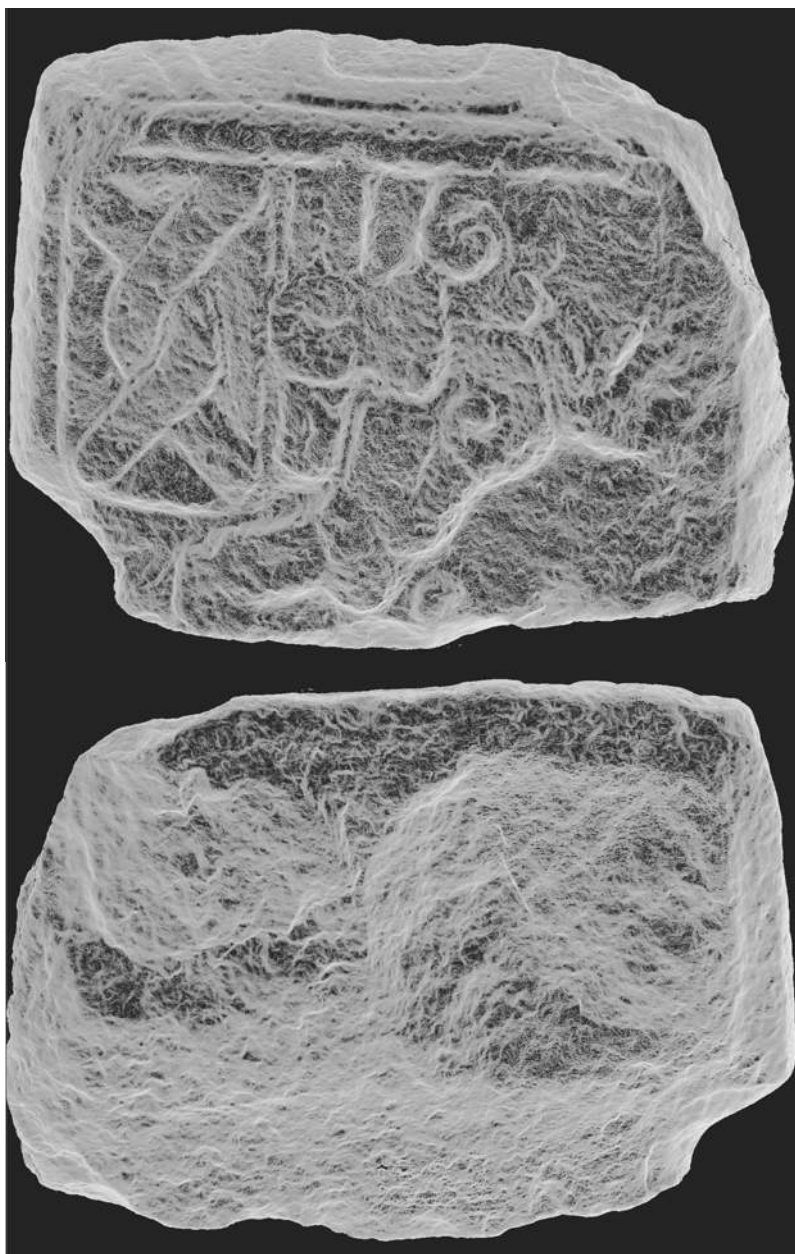
**Figure 7. Screen capture of scan image of Altar 2, MN#2043, from Kaminaljuyú, curated at the National Museum of Archaeology and Ethnology in Guatemala City.**



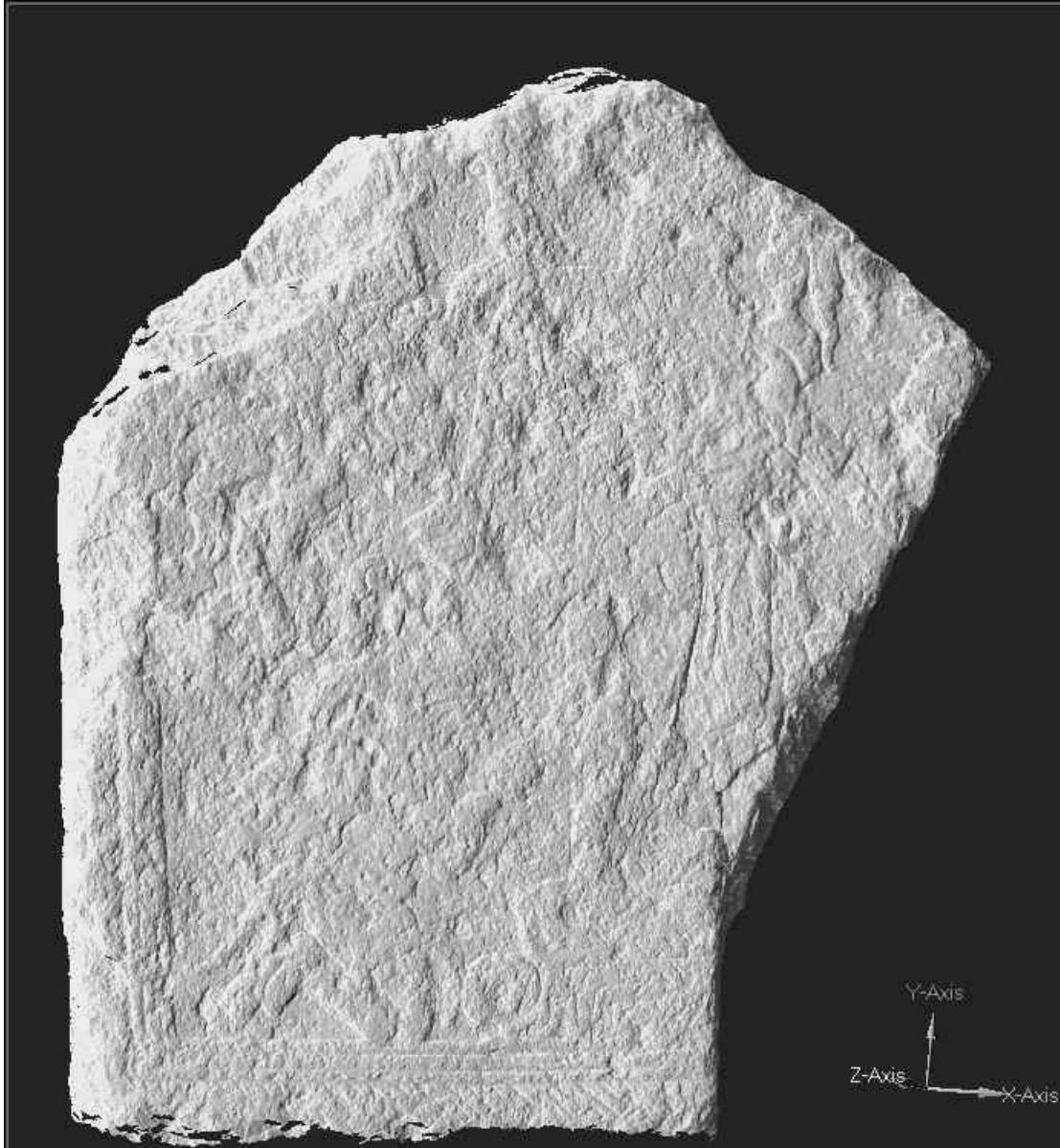
**Figure 8. Screen capture of scan image of Silhouette Relief 1, MN#2235, from Kaminaljuyú, curated at the National Museum of Archaeology and Ethnology in Guatemala City.**

As opportunity presented itself during our field season, we used laser scanning and digital photography to document artifacts and sculptures from other Formative period sites and when access was made available to these types of pieces in private collections. We also received requests from international researchers to scan other Formative and Classic period incised and sculpted objects that were considered significant to iconographic and epigraphic research. These pieces included Naranjo Altar 1 (Museum #Unknown-Popol Vuh, FAMSI Imaging Project # M3D0029) and four ceramic vessels curated at the Popol Vuh Museum; a monument from the Petén site of El Mirador (Museum #MNAE 14118-IDM1, FAMSI Imaging Project # M3D0068); a panel from Piedras Negras (Museum #PN Lintel 12-National Museum, FAMSI Imaging Project # not yet assigned), and several sculpted ceramic vessels in the National Museum. Also, a ceramic vessel from the MAYAP Collection in the Casa Santo Domingo and three stone masks, a ceramic carved vessel, and the “Shook panel” from the VICAL private collection were recorded. Additionally, the authors supported researchers in the Guatemala by performing scans on items of iconographic significance including Stela 27 from El Naranjo, in the Valley of Guatemala, for Dr. Barbara Arroyo and an Olmec stone figurine and ceramic vessel from the site of El Peru-Waka for Dr. David Freidel.

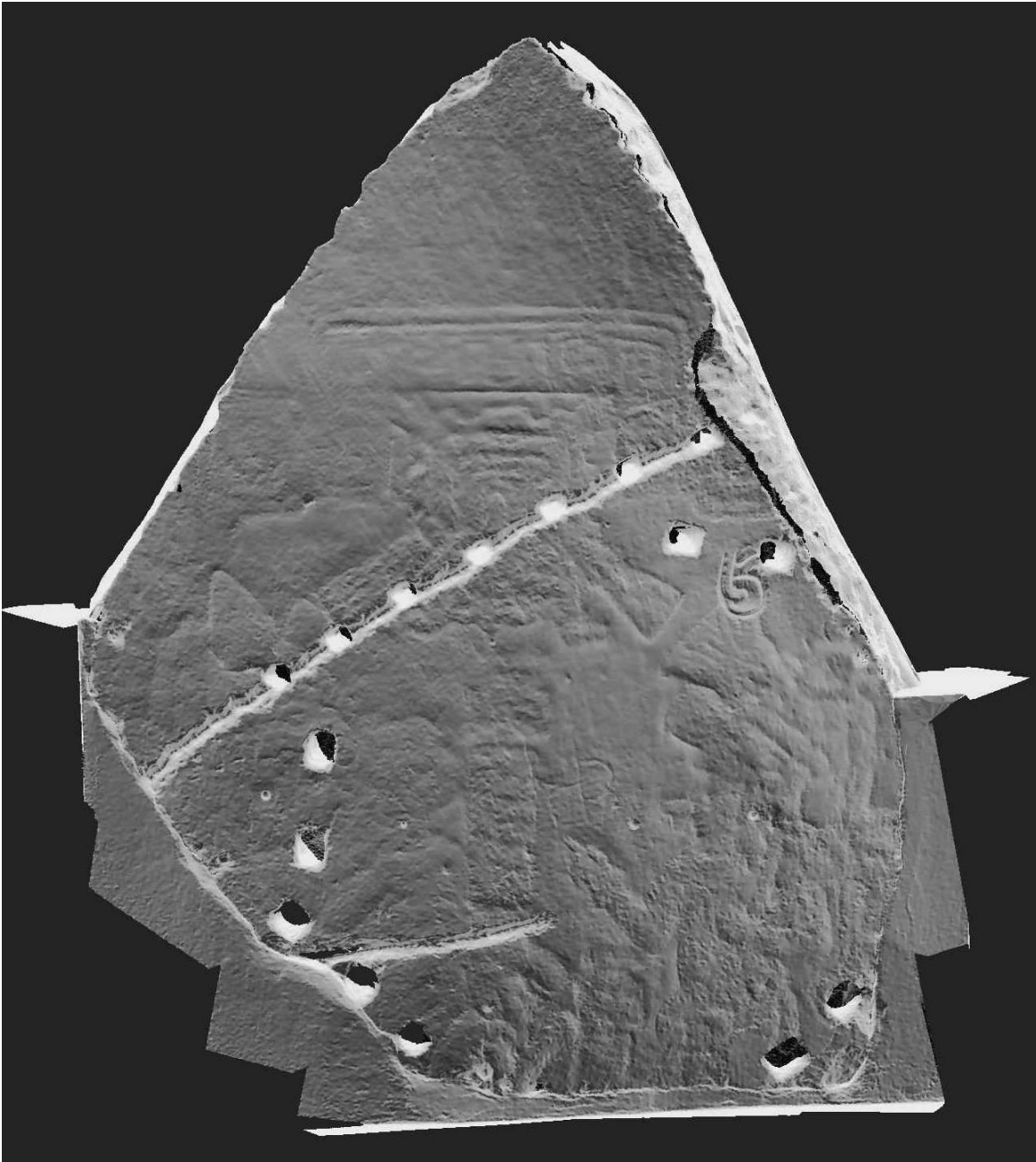




**Figure 9. Screen captures of scan image of the front and reverse side of fragment from Kaminaljuyú, Museum #MN1923, FAMSI Imaging Project #M3D0102, curated at the National Museum of Archaeology and Ethnology in Guatemala City. This fragment is from a table altar not discussed in Parsons (1986), but shown in (Kaplan 1995a:188). It is approximately 27 x 30 cm, with a 5 cm wide beveled edge. It once had legs as shown by the cavities measuring 12 x 12 cm on its basal portion.**



**Figure 10. Screen capture of scan image of the abraded Stela 8, MN#2052, from Kaminaljuyú, curated at the National Museum of Archaeology and Ethnology in Guatemala City.**



**Figure 11. Screen capture of scan image of Monument 65, from Kaminaljuyú, curated at the National Museum of Archaeology and Ethnology in Guatemala City.**



**Figure 12. Screen capture of scan images of the front and reverse sides of Pedestal Monument 4, MN#2053, from Kaminaljuyú, curated at the National Museum of Archaeology and Ethnology in Guatemala City.**

Our project workflow consisted of high-resolution digital photography using a Nikon D200, to photo document each piece prior to scanning from a variety of angles. Next, objects were scanned using the Konica-Minolta 9i and GeoMagic Studio 9 three-dimensional software with the Minolta plug-in tool. A typical scanning setup included an adjustable Manfrotto 3258 tripod, and depending on the size and configuration of the object being scanned, we may have also utilized a Minolta rotary-stage turntable.

In the field, registration of all data was conducted as scans were completed to ensure proper coverage and detail capture. These data were immediately backed-up to an external hard drive on site. Later, off-site post-processing of the registered data from each day's scanning activities were checked, merged into three-dimensional models using GeoMagic Studio<sup>®</sup> software, and backed-up to another external hard drive. This procedure ensured that each piece documented was satisfactorily completed and significantly reduced the amount of standard post-processing required after project completion.

Processing and testing continued with a variety of software enhancements and analysis tools, such as Adobe Photoshop<sup>®</sup>, Intuos3<sup>®</sup> drawing tablet, Corel Draw<sup>®</sup>, and GeoMagic Studio 9<sup>®</sup> at the computer lab of the Alliance for Integrated Spatial technologies at the University of South Florida. Each day during field collection, all raw and processed data from the project were backed-up and stored on external hard drives as well as the internal drive on the laptop processor. Additionally, all raw and processed data are stored on University of South Florida computer network drive with back up capacity. Additional innovative processing techniques have substantially improved the visibility and delineation of indistinct and previously indistinguishable detail, and efforts to further improve data extraction and increase visualization are ongoing.

### **The Mesoamerican Three-Dimensional Imaging Project**

In 2006, the Foundation for the Advancement of Mesoamerican Studies, Inc., (FAMSI) and the University of South Florida's *Alliance for Integrated Spatial Technologies* began a collaborative effort entitled the Mesoamerican Three-Dimensional Imaging Project. The result is a freely accessible resource database housed on the FAMSI website ([http://research.famsi.org/3D\\_imaging/index.php](http://research.famsi.org/3D_imaging/index.php)). The project is a continuing effort that makes high definition, three-dimensional laser scans of Mesoamerican objects viewable to researchers online. The objects documented by the Kaminaljuyú Sculpture Project are being made available on the web site. To analyze scanned objects in full three-dimensional detail, Geomagic<sup>®</sup> Review 9.0, a 3D data viewer software program is available on [www.geomagic.com](http://www.geomagic.com). The Geomagic<sup>®</sup> Review program will allow manipulation of viewing angles, rotation of the object, and changing the intensity and direction of the grazing light across scanned pieces to provide optimal viewing of detail. The program has a complete tutorial available as a help file that details these procedures. Sample data sets are available on the FAMSI Imaging Project website, and complete data sets of individual artifacts can be requested by researchers.

On the Mesoamerican Three-Dimensional Imaging Project web pages each documented piece has been assigned a unique database identification number, and is also referenced in terms of existing museum accession numbers or other designated nomenclature such as Parsons (1986). The present location of the item is noted along with other available information such as bibliographic citations of published data relevant to the object (e.g., journal articles, books, chapters, conference proceedings). When possible, photographs, line drawings, rubbings, or other types of images from historical documentation are provided, along with new documentation including photographs and static screen captures of three dimensional models. Chronological, contextual, and other supportable information pertinent to the artifact's interpretation and discovery are also provided.

The database is intended to accommodate continued use and development. It is hoped that as epigraphers, iconographers, and other scholars use these scan data sets to improve depictions and line drawings they will contribute to the informational package. As computer and other analytical techniques progress and enhanced visualizations become available they too will be added to the site. As previously stated, the Mesoamerican Three-Dimensional Imaging Project is designed to be a living document. On-going and future recordation of other Mesoamerican artifacts, features, architecture, sites, and landscapes are being conducted by the authors, and will be made available to the research community. We would like to encourage other researchers using these and other forms of documentation and visualization in their work to contact us about adding and enhancing the web portal.

### **Closing Comments**

Results from the application of close-range laser scanning to the Mesoamerican sculptural corpus have demonstrated the effectiveness of this technique. In some cases, previously indistinguishable features can now be perceived, and the life history of the stone (e.g., tool marks, abrading, re-use, recycling, and other production techniques) can be identified. The visualization of the object in three-dimensions allows the sculpted piece to be observed as the original artist meant it to be viewed.

Three-dimensional laser scanning is a new tool that offers significant potential for interpretation and insight into Mesoamerica's past. Nevertheless, it will take considerable time, effort, and dedication to realize the full capabilities of this technique. Therefore, we encourage cooperative efforts to begin routinely using these data and incorporating them into research designs. We are interested in opportunities to work collaboratively with archaeologists, epigraphers, iconographers, and researchers to develop and maximize the implementation of these exceedingly robust and metrologically accurate data sets. The future development of the FAMSI Mesoamerican Three-Dimensional Imaging Project is designed to be inclusive of multiple partners using these types of data to conserve, preserve, document, and analyze Mesoamerican sculpture.

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[Figure 9](#). Screen captures of scan image of the front and reverse side of fragment from Kaminaljuyú, Museum #MN1923, FAMSI Imaging Project #M3D0102, curated at the National Museum of Archaeology and Ethnology in Guatemala City. This fragment is from a table altar not discussed in Parsons (1986), but shown in (Kaplan 1995a:188). It is approximately 27 x 30 cm, with a 5 cm wide beveled edge. It once had legs as shown by the cavities measuring 12 x 12 cm on its basal portion.

[Figure 10](#). Screen capture of scan image of the abraded Stela 8, MN#2052, from Kaminaljuyú, curated at the National Museum of Archaeology and Ethnology in Guatemala City.

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## Sources Cited

- Boehler, Wolfgang and Andreas Marbs  
2002 3D Scanning Instruments Paper presented at the CIPA, Heritage Documentation - International Workshop on Scanning for Cultural Heritage Recording, Corfu, Greece.
- Boehler, Wolfgang, M. Bordas Vicent and Andreas Marbs  
2003 Investigating Laser Scanner Accuracy. In *The XIXth CIPA Symposium*, Antalya, Turkey.
- Cheetham, David  
2005 *Recent Investigation at Cantón Corralito: A Possible Olmec Enclave on the Pacific Coast of Chiapas, México*. Arizona State University and the New World Archaeological Foundation, Brigham Young University.
- Clark, J. E. and T. A. Lee  
1984 Formative Obsidian Exchange and the Emergence of Public Economies in Chiapas, México. In *Trade and Exchange in Early Mesoamerica*, edited by Hirth, pp. 235-274. University of New Mexico Press, Albuquerque.
- Clark, John E.  
2005 The Birth of Mesoamerican Metaphysics: Sedentism, Engagement, and Moral Superiority. In *Rethinking Materiality: The Engagement of Mind with the Material World*, edited by DeMarrais, Gosden and Renfrew, pp. 205-224. McDonald Institute Monograph Series. McDonald Institute Cambridge.
- Clark, John E. and John G. Hodgson  
2004 A Millennium of Wonders in Coastal Mesoamerica. In *The Annual Meetings of the American Anthropological Association*, Atlanta, Georgia.
- Clark, John E. and Mary E. Pye  
2000 The Pacific Coast and the Olmec Question. In *Olmec Art and Archaeology in Mesoamerica*, edited by Clark and Pye, pp. 217-252. National Gallery of Art, Washington, D.C.
- Cobean, R. H., M. D. Coe, J. Edward, A. Perry, K. K. Turekian and D. P. Kharkar  
1971 Obsidian Trade at San Lorenzo Tenochtitlán, México. *Science* 174:666-671.
- Cobean, R. H., J. R. Vogt, M. D. Glascock and T. R. Stocker  
1991 High Precision Trace Element Characterization of Major Mesoamerican Obsidian Sources and Further Analysis of Artifacts from San Lorenzo Tenochtitlán, México. *Latin American Antiquity* 2(1):69-91.



- Coe, Michael D. and Richard A. Diehl  
 1980 *In the Land of the Olmec: The Archaeology of San Lorenzo Tenochtitlán*  
 1. University of Texas Press, Austin.
- Coggins, Clemency C.  
 1996 Creation Religion and the Numbers at Teotihuacán and Izapa. *Res, Anthropology and Aesthetics* 29-30:17-38.
- Collins, Lori D. and Travis F. Doering  
 2006 Integrated Spatial Technologies: High Definition Documentation of the Miami and Royal Palm Circles. *The Florida Anthropologist* 59 (Special Issue: The Miami Circle: Fieldwork, Research and Analysis II with additional commentary by Robert Carr):161-177.
- Cyphers, Ann  
 1993 From Stone to Symbols: Olmec Art in Social Context at San Lorenzo Tenochtitlán. In *Social Patterns in Pre-Classic Mesoamerica*, edited by Grove and Joyce, pp. 155-180. Dumbarton Oaks Research Library and Collection, Washington, DC.
- Demarest, Arthur A.  
 2004 *Ancient Maya: The Rise and Fall of a Rainforest Civilization*. Cambridge University Press, Cambridge.
- Doering, Travis F.  
 n.d. Early Formative Obsidian Artifacts from El Macayal, Veracruz, México. Working paper, Alliance for Integrated Spatial Technologies, College of Arts and Sciences, University of South Florida, Tampa, Florida.
- Doering, Travis F. and Lori D. Collins  
 n.d. High Definition Archaeological Documentation and Survey: Applications to Mesoamerica's Formative Period Sculpture. In *The Place of Sculpture in Mesoamerica's Preclassic Transition: Context, Use, and Meaning*, edited by Clark, Guernsey and Arroyo. vol. The 2007 Dumbarton Oaks Pre-Columbian Symposium, Antigua, Guatemala, 5-6 October 2007. Dumbarton Oaks, Washington, D.C.
- Doering, Travis F., Lori D. Collins and Dan Perreault  
 2006 *Guatemala Three-Dimensional Laser Scanning Project*. Report submitted to the New World Archaeological Foundation, Brigham Young University, Provo, Utah.

- Flannery, Kent V.  
 1968 The Olmec and the Valley of Oaxaca: A Model for Inter-Regional Interaction in Formative Times. In *Dumbarton Oaks Conference on the Olmec*, edited by Benson, pp. 79-118. Dumbarton Oaks Research Library and Collections, Washington, D.C.
- Gamio, Manuel  
 1926 Cultural Evolution in Guatemala and Its Geographic and Historic Handicaps. *Art and Archaeology* 22(6):203-222.
- Graham, M. M.  
 1998 Mesoamerican Jade and Costa Rica. In *Jade in Ancient Costa Rica*, edited by Jones, pp. 39-57. Metropolitan Museum of Art, New York.
- Guernsey-Kappleman, Julia  
 2002 Carved in Stone: The Cosmological Narratives of Late Preclassic Izapan-Style Monuments from the Pacific Slope. In *Heart of Creation: The Mesoamerican World and the Legacy of Linda Schele*, edited by Stone, pp. 66-82. University of Alabama Press, Tuscaloosa.
- Guernsey, Julia  
 2006 *Ritual and Power in Stone: The Performance of Rulership in Mesoamerican Izapan Style Art*. University of Texas Press, Austin.
- Hatch, Marion Popenoe de  
 1997 *Kaminaljuyú / San Jorge: Evidencia Arqueológica de la Actividad Económica en el Valle de Guatemala. 300 a.C. a 300 d.C* Fundación para la Cultura y el Desarrollo, Guatemala City.
- 2001 Kaminaljuyú, Guatemala. In *Archaeology of Ancient México and Central America: An Encyclopedia*, edited by Evans and Webster, pp. 387-390. Garland, New York.
- Hatch, Marion Popenoe de, Erick Ponciano, Tomás Barriento, Mark Brenner and Charles Ortloff  
 2002 Climate and Technological Innovation at Kaminaljuyú, Guatemala. *Ancient Mesoamerica* 13(1):103-114
- Hoopes, John W.  
 1993 A View from the South: Prehistoric Exchange in Central America. In *The American Southwest and Mesoamerica: Systems of Prehistoric Exchange*, edited by Ericson and Baugh, pp. 247-274 Springer, New York.

- Houston, Stephen D.  
 2004 Writing in Early Mesoamerica. In *The First Writing: Script Invention as History and Process*, edited by Houston, pp. 274-312. Cambridge University Press, Cambridge.
- Houston, Stephen D., Zachary Nelson, Carlos Chiriboga, Carlos Alvarado, Héctor Escobedo and Karl Taube  
 2005 Nuevas Perspectivas sobre la Acrópolis de Kaminaljuyú, Guatemala. In *XVIII Simposio de Investigaciones Arqueológicas en Guatemala, 2004*, edited by Laporte, Arroyo and Mejía, pp. 505-510. Ministerio de Cultura y Deportes, IDAEH, Asociación Tikal, FAMSI., Guatemala City: .
- Houston, Stephen D., Zachary Nelson, Carlos Chiriboga and Ellen Spensley  
 2003 The Acropolis of Kaminaljuyú, Guatemala: Recovering a Lost Excavation. *Mayab* 16:49-64.
- Jones, Julie  
 1998 *Jade in Ancient Costa Rica*. The Metropolitan Museum of Art, New York.
- Joyce, Rosemary A. and David C. Grove  
 1999 Asking New Questions about the Mesoamerican Pre-Classic In *Social Patterns in Pre-Classic Mesoamerica*, edited by Grove and Joyce, pp. 1-14. Dumbarton Oaks Research Library and Collection, Washington, D.C.
- Kaplan, Jonathan  
 1995a The Incienso Throne and other Thrones from Kaminaljuyú, Guatemala. *Ancient Mesoamerica* 6:185-196.
- 1995b [The Kaminaljuyú Miraflores II Ground-Penetrating Radar Subproject](#). Report submitted to the Foundation for the Advancement of Mesoamerican Studies, Inc.
- Kidder, Alfred, Jesse Jennings and Edwin Shook  
 1946 *Excavations at Kaminaljuyú*. Publication 561. Carnegie Institution, Washington, D.C.
- Konica-Minolta  
 2007 *VIVID 9i Three Dimensional Digitizer Technical Specifications*. Non-contact 3D laser scanner. <http://www.minolta3d.com/products/vi9i-en.asp#specs>.
- Lesure, Richard G.  
 2004 Shared Art Styles and Long-Distance Contact in Early Mesoamerica. In *Mesoamerican Archaeology*, edited by Hendon and Joyce, pp. 73-96. Blackwell Studies in Global Archaeology. Blackwell, Malden, MA.

- Love, Michael W.  
 2002 *Early Complex Society in Pacific Guatemala: Settlements and Chronology of the Río Naranjo, Guatemala*. Papers of the New World Archaeological Foundation 67. Brigham Young University, Provo, UT.
- Michaels, Joseph  
 1979 *Settlement Patterns Excavations at Kaminaljuyú, Guatemala*. Monograph Series of Kaminaljuyú. Pennsylvania State University Press, University Park, PA.
- Michels, Joseph W.  
 1979 *The Kaminaljuyú Chiefdom*. The Pennsylvania State University Press Monograph Series on Kaminaljuyú. Pennsylvania State University Press, University Park, PA.
- Miller, M. E.  
 1996 *The Art of Mesoamerica: From Olmec to Aztec*. Revised ed. Thames and Hudson, New York.
- Monterroso, Matilde Ivic de and Carlos Alvarado Galindo  
 2004 Kaminaljuyú: Informe de las Excavaciones Realizados en el Parque Kaminaljuyú, Guatemala, pp. 335-339. Universidad Del Valle, Guatemala.
- Mora-Marín, David  
 2001 *The Grammar, Orthography, Content, and Social Context of Late Preclassic Mayan Portable Texts*. Unpublished Ph.D. Thesis. University at Albany, State University of New York.
- Ohi, Kuniaki  
 1994 *Kaminaljuyú (1991-1994)*. 2 volumes. Museum of Tobacco and Salt, Tokyo.
- Ortíz, Pociano and Maria Carmen Rodríguez  
 1990 *Proyecto Manatí 1990: Informe Final de Campo*. Instituto Nacional de Antropología e Historia, Veracruz, México.
- Ortíz, Ponciano, Maria Carmen Rodríguez, Paul Schmidt, Alfredo Delgado, Luis Heredia and Lourdes Hernández  
 1988 *Proyecto Manatí 1988*. Instituto Nacional de Antropología e Historia.
- Ortíz, Ponciano, Maria Carmen Rodríguez, Paul Schmidt, Alfredo Delgado, Luis Heredia, Daniel Nahmad, Ignacio Montes, Jesús Ramirez, Cesar Correa, Julio Chan, Lourdes Hernández, Eric Juarez, Jorge Bautista, Ricardo Herrera, J. Manuel Hernandez, and Stephan A. Nelson  
 1989 *Proyecto Manatí 1989*. Instituto de Antropología e Historia. México City

Parsons, Lee A.

1986 *The Origins of Maya Art: Monumental Stone Sculpture of Kaminaljuyú , Guatemala, and the Southern Pacific Coast*. Studies in Pre-Columbian Art and Archaeology, Number 28. Dumbarton Oaks Research Library and Collection, Washington, D.C.

1988 Proto-Maya Aspects of Miraflores-Arenal Monumental Stone Sculpture from Kaminaljuyú and the Southern Pacific Coast. In *Maya Iconography*, edited by Benson and Griffin, pp. 6-43. Princeton University Press, Princeton, NJ.

Polanyi, Karl

1963 Ports of Trade in Early Societies. *Journal of Economic History* 23(1):30-45.

Pool, Christopher A.

2007 *Olmec Archaeology and Early Mesoamerica*. Cambridge World Archaeology. Cambridge University Press, New York.

Price, Clifford A.

1996 *Stone Conservation: An Overview of Current Research*. Research in Conservation. The Getty Conservation Institute, J. Paul Getty Trust., Santa Monica, CA.

Rapoport, Amos

1990 *History and Precedent in Environmental Design*. Springer-Verlag, New York.

Rice, Prudence M.

2007 *Maya Calendar Origins: Monuments, Mythistory, and the Materialization of Time*. University of Texas Press, Austin.

Rodríguez-Martínez, Maria del Carmen, Ponciano Ortiz Ceballos, Michael D. Coe, Richard A. Diehl, Stephen D. Houston, Karl A. Taube and Alfredo Delgado Calderón

2006 Oldest Writing in the New World. *Science* 313(5793):1610-1614.

Rosenswig, Robert M.

2000 Some Political Processes of Ranked Societies. *Journal of Anthropological Archaeology* 19:413–460.

2006 Sedentism and Food Production in Early Complex Societies of the Soconusco, México. *World Archaeology* 38(2):330-355

- 2007 Beyond Identifying Elites: Feasting as a Means to Understand Early Middle Formative Society on the Pacific Coast of México. *Journal of Anthropological Archaeology* 26(1):in press.
- Sanders, William T.  
1969 *The Pennsylvania State University Kaminaljuyú Project, 1968 season, Part 1* Occasional Papers in Anthropology 2. Department of Anthropology, Pennsylvania State University, University Park.
- Sanders, William T. and Joseph W. Michaels  
1977 *Teotihuacán and Kaminaljuyú*. Pennsylvania State University Press, College Park.
- Saturno, William A., David Stuart and Boris Beltrán  
2006 Early Maya Writing at San Bartolo, Guatemala. *Science* 311(5765):1281-1283.
- Seitz, R., G. E. Harlow, V. B. Sisson and K. A. Taube  
2001 Olmec Blue and Formative Jade Sources: New Discoveries in Guatemala. *Antiquity* 75:687-688.
- Sharer, Robert J.  
1978 *Prehistory of Chalchuapa, El Salvador*. University of Pennsylvania Press Philadelphia.
- Sheets, Payson D.  
1975 A Reassessment of the Precolumbian Obsidian Industry of El Chayal, Guatemala. *American Antiquity* 40(1):98-103.
- Shook, Edwin M. and A. Ledyard Smith  
1942 Guatemala: Kaminaljuyú. In *Carnegie Institution of Washington Yearbook 1941*, pp. 263-267. Carnegie Institution of Washington, Washington, DC.
- Stanislowski, Dan  
1996 The Spanish Province of San Salvador in the Mid-Sixteenth Century. *Geographical Review, Latin American Geography* 86(3):408-413.
- Taube, Karl A.  
2004 *Olmec Art at Dumbarton Oaks*. Dumbarton Oaks Research Library and Collection, Washington, D.C.

- Valdés, Juan Antonio and Lori E. Wright  
2004 The Early Classic and its Antecedents at Kaminaljuyú: A Complex Society with Complex Problems. In *Understanding Early Classic Copan*, edited by Bell, Canuto and Sharer, pp. 337-355. University of Pennsylvania Museum of Archaeology and Anthropology, Philadelphia.
- White, Christine D., Michael W. Spence, Fred J. Longstaffe and Kimberley R. Law  
2000 Testing the Nature of Teotihuacán Imperialism at Kaminaljuyú Using Phosphate Oxygen-Isotope Ratios *Journal of Anthropological Research* 56(4):535-558.
- Zeitlin, Robert N.  
1982 Toward a More Comprehensive Model of Interregional Commodity Distribution: Political Variables and Prehistoric Obsidian Procurement in Mesoamerica. *American Antiquity* 47:2760-275.