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An Analysis of Inequality During the Origins of States and Societies in the Oaxaca Valley of Mexico

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I. Abstract

During the Middle to Late Formative period, communities around the Oaxaca Valley of Mexico experienced the formation of the primary state, which fundamentally changed the way leaders and subjects interacted with each other (Carpenter. 2019). Many large polities arose between 300 and 100 BC in Mesoamerica, and Oaxaca was not the exception. This sudden and quick growth of state, however, had many effects on the lives of the people living in these communities. The Zapotec, an indigenous people of Mexico (and most commonly residing in the Oaxaca Valley), lived in sites near the modern day town of San Martin Tilcajete. They, too, experienced the formation of state and the large shift in daily life it brought. Understanding what these people experienced during this time is essential when considering the relationship between rule and individual experience. Therefore, the purpose of this project is to assess the effect of state formation on wealth inequality among the Zapotec people. This project seeks to address two questions: (1) How are the levels of wealth inequality in the Tilcajete sites affected with the emergence of state? and (2) What variables are better suited to accurately measure wealth inequality in ancient cities? To answer these questions, we used a variety of methods that all conclude with the quantitative representation of inequality, the Gini coefficient. Due to the differential preservation and inconsistency of information in the archaeological sites analyzed, variables like household surface area, obsidian count, obsidian weight, and ceramics were used to calculate this coefficient. The results from my calculations demonstrate that there is a mild increase in the levels of inequality throughout time (and as states form) and that obsidian weight is a more promising variable to consider when computing wealth inequality. The data found in this project is consistent with the Dual Processual Theory developed by archaeologist Richard Blanton.

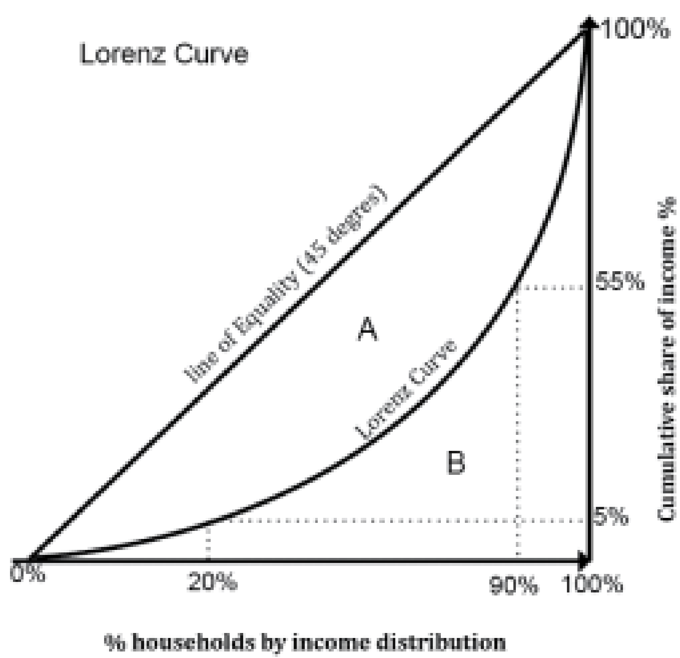
II. Introduction: Oaxacan History and the Tilcajete Sites

The Oaxaca Valley, found in the modern day state of Oaxaca, was home to one of the most ancient complex societies in Mesoamerica (Carpenter. 2019). Many renowned archaeological sites are found here, including San Jose Mogote and Monte Alban. The valley contains rich histories and is home to one of the most culturally diverse populations in the world. However, it goes without saying that poverty and more generally, wealth inequality runs rampant through Oaxacan streets. As a matter of fact, Oaxaca is one of the poorest states in all of Mexico. However, when attempting to address these existing issues it is important to understand the past. During the Middle to Late Formative period, communities in the Oaxaca Valley experienced one of the most radical shifts in ways of life in history. During this time, small scale communities underwent state formation and the increase of political hierarchy. The Tilcajete sites were no different. During the Early Monte Alban I phase, El Mogote was attacked by Monte Alban and was abandoned (Carpenter. 2019). According to Carpenter, El Palenque was founded almost immediately after and doubled in population and continued to thrive. With new government came new ways of interacting with political leaders as well as subjects. Furthermore, the levels of inequality at Tilcajete changed. Although there are multiple kinds of inequality (namely social and political), our research specifically focuses on economic (wealth) inequality by detecting inconsistencies in material signatures found in the archaeological record. Although this project seeks to measure wealth inequality, data from other sites like Joya de Ceren in El Salvador and Llano Perdido in Oaxaca is also considered in order to serves as reference points. Inequality is relative throughout space and time, and we seek to analyze it within the context of the Zapotec who lived in the Tilcajete sites. Furthermore, the purpose of this project is to further comprehend what modern day Oaxacans' ancestors experienced during their time at Tilcajete sites. I am in no way looking to co-opt Oaxacan or Zapotec culture but instead am seeking to appreciate and recognize the rich histories that lie within San Martin Tilcajete and the Oaxaca Valley as a whole.

IV. Gini coefficient in Economics:

Economists have used and considered many factors when attempting to measure the "health" and "success" of societies. Although Gross Domestic Product (GDP) has been widely used, it can only provide us with so much information about a country's wealth and not much else. Therefore, different measurements that describe a nation more holistically have become more popular. In addition to a country's unemployment rate, the Gini coefficient has become a popular measure to consider when gaging the health of a society, as it quantifies income inequality between the members of the population. The Gini coefficient (also referred to as an index or ratio), developed by Corrado Gini in the early 20th century, is a "measure of the distribution of income across a population," and is "often used as a gauge of economic inequality, measuring income distribution, or less commonly, wealth distribution among a population (Hayes 2021)." The scale for the Gini, which is independent from the units (income in dollars) it is describing, runs from the minimum of 0 to the maximum of 1. The value of 1 describes a society in which all the income is owned by a singular person, while the value of 0 describes an economy in which the income is equally spread throughout the whole population. Therefore, a higher Gini coefficient usually indicates inequality within a society. However, it is important to note that a low Gini coefficient does not necessarily mean that a population is doing well (in terms of overall wealth). For example, countries like Sudan, Nigeria, Iraq and Afghanistan have Gini coefficients lower than .40, while the United States usually falls at about .41. Furthermore, although the United States is one of the world's most powerful countries, it still fosters wealth and income inequality among its population.

Finally, it is important to consider that the calculation of the Gini relies on population and therefore sample size. Therefore, societies with small populations and the presence of outliers will produce a more extreme Gini, while societies with larger populations can leverage the presence of outliers with their size. The Gini coefficient, although a singular statistic, operates alongside the Lorenz Curve, which is a graphical representation of income inequality. The Curve is graphed alongside the "perfect equality line" on an X and Y plane. The X axis measures the cumulative percentage of a society's population (with a minimum of 0 and a maximum of 100) sorted by wealth, while the Y axis is the cumulative percentage of the total wealth owned (with a minimum of 0 and a maximum of 100). On the other hand, the "perfect equality line" is simply a line placed at the intersection of the X and Y axis and at a 45-degree angle from both (Sitthiyot. 2020). The equality line represents how a society with a Gini of 0 would be represented and therefore serves as a reference point. The Lorenz Curve itself is graphed by cumulatively plotting the individual incomes. Therefore, the Lorenz is seen to curve outwards (away from the line of perfect equality) when there is inequality. To find the Gini coefficient from a Lorenz curve, you would have to first calculate both the area between the perfect equality line and the Lorenz Curve itself and the total area under the perfect



equality line (Sitthiyot. 2020).

V. Gini Coefficient in Archaeology:

Due to the Gini Coefficient's versatility and ease of use, many archaeologists have adapted it to gauge inequality within ancient societies. When using the Gini, most archaeologists calculate it by measuring the wealth within each household of an archaeological site. However, due to differential preservation and the nature of the archaeological record, it is very difficult to standardize the calculation of this coefficient. The two pioneers of these estimations, archaeologists Timothy Kohler and Michael Smith, have used multiple variables to quantify inequality, especially in Mesoamerica. Because archaeologists do not have access to wealth information like economists today, they must take "many steps of fieldwork, analysis, and data to transformation before [they] can calculate the Gini coefficient, and each step in this process raises methodological considerations (Kohler. 2019)." Kohler states that the most common way to calculate the Gini coefficients in Archaeology is to look at household artifact assemblage data. Therefore, we have decided to use obsidian counts and weights as ways to calculate the Gini across our chosen sites. More specifically, the most important part of the assemblage data is the inconsistency within the distribution of these items among households, as it is what would be used to indicate inequality. The key to this, however, is to compare Gini scores from multiple kinds of archaeological remains in order to reach a more substantial conclusion. In addition to artifact availability in sites (like Obsidian and Crema sherds), we also consider household areas to determine which ancient communities fostered the greatest amount of inequality.

III. Joya De Ceren and Llano Perdido:

Throughout the past, present, and future, communities have formed, thrived, and ceased to exist in the presence and under the influence of surrounding communities. When attempting to gauge the big picture of a community or a group of people, we inspect not only internal affairs but also the interactions they had with the people in surrounding areas. These interactions whether beneficial or detrimental, are essential to consider when studying these ancient communities. Due to different natural and cultural limitations, it was difficult to find archaeological sites that are similar to the Tilcajete sites culturally or chronologically. Therefore, we had to expand the scope we were using. Throughout the project, we used multiple sites that either existed around the same time or shared similar household archaeology as the Tilcajete sites. We used these sites as reference points in order to increase the sample size of the data we examined.

Joya de Ceren, our first site of interest, is located within the Zapotitan Valley of El Salvador in the La Libertad Department. The Joya de Ceren site existed between 300 AD and 600 AD and is one of the best preserved Mayan archaeological sites in the world. The Loma Caldera eruption of 600 AD devasted the surrounding land, and completely covered Joya De Ceren with volcanic ash and debris. Although there was some minor destruction, the ash kept the artifacts within the site's structures as well as the structures themselves largely intact (Sheets. 2006). Due to the conditions of its burial and its immaculate preservation, it has since been named a UNESCO World Heritage Site and dubbed the Pompeii of the Americas. Moreover, the architecture of Joya de Ceren and its overall arrangement was very similar to what the Tilcajete sites looked like. Many times, especially when looking at architecture within Oaxacan sites, archaeologists like Carpenter tend to compare it to already studied architecture to better understand it. Furthermore, the arrangement of structures at both Tilcajete and Joya de Ceren were not similar to that of existing Aztec architecture (which is usually a main point of reference for archaeological sites within Mexico). Specifically, Joya de Ceren's architecture was characterized by the separation of structures. According to Dr. Payson Sheets, the lead archaeologist at Joya De Ceren, this was due to "specialization and practicality, a bigger roof would have been harder to make and been a danger because of winds. Chorti Maya who are 100 km north [of Joya de Ceren] do the same thing and say 'es costumbre' [meaning its tradition] (Sheets. 2006)." Although each of the structures (the eleven that have been excavated to date) were used for different household activities, Sheets separated them into two distinct households adjacent to a communal structure and a sweathouse. The final reason Joya de Ceren was used as a reference was because the Zapotitan Valley of El Salvador provided its inhabitants a similar climate and way of life (similar farming practices) as the inhabitants of the Tilcajete sites. Furthermore, Joya de Ceren's architecture and chronology made it a very useful site when completely our analysis of inequality.

Llano Perdido, on the other hand, existed in the Cañada de Cuicatlán of the Oaxaca Valley of Mexico during the Perdido phase (600 – 200 BC) and was abandoned around the Lomas Phase (200 BC – 200 AD) (Spencer et al. 1997). It is inferred that the Cañada de Cuicatlán was conquered by the Zapotec during the Late Formative Period. Llano Perdido itself shows evidence of being burned to the ground after its abandonment (Spencer et al. 1997). Similar to the Joya de Ceren site, Llano Perdido is a great site consider when analyzing the evolution of wealth inequality as it not only existed during the same time period as the Tilcajete sites, but it was also briefly occupied by the Zapotec, the inhabitants of the Tilcajete sites. Conversely, Los Mogotes was also a site that was included in our calculations as it existed in the San Martin Tilcajete area after El Palenque.

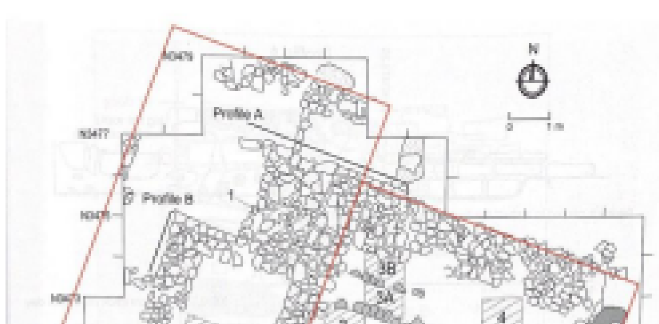
VI. Methods:

Using the Gini Coefficient in our research can tell us a lot about a site and the inequality that was found in it. However, doing this kind of analysis on multiple sites calls for a somewhat standardized way of looking at all the data collected. Due to opposing factors, different variables are cross-examined to assign a Gini value to each site. Consequently, across all methods, there is a common stage of dividing a site into different households. When analyzing collected data and measuring surface areas, the obsidian counts and weights, surface areas, and Crema ceramic counts must be grouped into households, as the Gini coefficient needs a wealth value for each "sample". However, some archaeologists (like Dr. Payson Sheets) have already separated their findings into distinct household units. For those whose research has not done this (like in the case of Llano Perdido), there must be some assumptions made about how structures were used and who lived in them based on the artifacts found within them and their architecture.

VII. Surface Area of Households:

In modern times, house size is a manifestation of the levels of wealth people have, and there usually seems to be a positive correlation between the two. As someone's wealth grows, their houses and properties seem to also grow in number and in size. Therefore, we decided that household surface area should be a way we estimated the Gini coefficient. However, before committing to this method, we looked at different ways that other archaeologists have done these kinds of measurements. We first considered doing a space syntax analysis at these sites. This would have been implemented by linking wealth with the access to more private rooms. To estimate this, we would have counted the doorways it would take to reach a certain room in the house and summing a grand total. However, many of the structures we looked at and worked with were either incomplete or were not suitable for this kind of analysis. Another method we considered was measuring and comparing the volumes of the building materials of the structures at the sites. Many archaeologists have done this when studying homes that are multiple stories high, as it would give a more accurate estimation of wealth than surface area. However, because all the sites we studied exist within single living floors, surface area was the more efficient and accurate method to use. Some archaeologists included the surface areas of their excavations (and more specifically, the structures excavated) in their publications, while others did not. If that was the case, I used the provided scale and used a ruler to measure structure lengths and widths to the best of my abilities to come up with a surface area estimation for each household. Thanks to the largely polygonal shapes of the households in these sites, I was able to use basic plane geometry in order to find the surface areas in meters squared (which would be directly used when measuring the Gini coefficient of these sites). The basic calculations were for rectangular and triangular area (base x height and (base x height) / 2. However, calculating the surface areas of incomplete houses (or houses with fragmentary walls) was tricky, as there are many ways through which the surface area of those specific structures can be calculated. Like in the picture below, there were some minor assumptions made about where rooms began and ended. Furthermore, some of the structures measured were measured strictly as polygonal shapes (if their architecture somewhat resembled an easily measurable polygon). The red rectangle and squares are what was measured. Consequently, the area calculations of these specific structures are approximations as wall widths, fragmented structures, and outliers cannot be completely accounted for. The sites whose

surface areas



were considered were El Mogote and El Palenque (which were largely excavated by Professor Lacey Carpenter and partially by archaeologists Charles S. Spencer and Elsa M. Redmond), Joya de Ceren (largely excavated by Payson Sheets), Llano Perdido (also excavated by archaeologists Charles S. Spencer and Elsa M. Redmond), and Los Mogotes (excavated by archaeologist Christina Elson).

Structure 1 (Mound A) of Los Mogotes (Elson. 2007)

VIII. Obsidian Count and Weights:

In addition to house sizes, another manifestation of wealth (in the past and certainly in the present) has been luxurious items, or items that are not easily obtainable. In today's world, these items take the form of designer handbags or trust funds. However, in the Middle to Late Formative period, evidence of items like this is a little more subtle. It has been deduced that items made of lithics like jade, mica, and most importantly, obsidian, have been considered to represent a household's access to uncommon resources. Due to the Tilcajete sites' locations in the Oaxaca Valley, there is very limited access to naturally occurring obsidian sources. Obsidian is an igneous rock created when lava from a volcano quickly cools and becomes a lustrous glass. Therefore, the presence of obsidian in homes indicates access to trade networks and a buying potential of a significant enough magnitude to obtain these rocks. More specifically, presence of obsidian in homes suggested interactions with Monte Alban, the most powerful polity in the area at the time (and one which the inhabitants of the Tilcajete sites usually had conflict with) (Carpenter. 2019). Furthermore, throughout this project, we assumed that the amount of obsidian found in homes was positively correlated with wealth. When it comes to the calculation of the Gini, the data used was collected from Lithics data from Professor Carpenter's excavations (when it comes to El Palenque and El Mogote) and Dr. Spencer and Dr. Redmond when it comes to Llano Perdido. Finally, it is important to note that Obsidian counts include flakes of obsidian as well as chunks of obsidian, while measured weights (in grams) of the resource can give a more accurate representation of how much obsidian a household truly consumed. Therefore, both of these variables are considered to obtain accurate Gini calculations.

IX. Ceramics:

Finally, ceramics were considered the least extensively out of all the other variables. Due to time constraints and the lack of information, ceramics were only studied for El Mogote (the earlier Tilcajete site). Although Ceramics data was recorded for El Palenque, which is one of the two Tilcajete sites, by Professor Carpenter, it was incomplete, and did not include data from Structures 9 and Structure 30, who were excavated by archaeologists Charles S. Spencer and Elsa M. Redmond. Although using the total diagnostic sherds was an option, we decided to use Crema counts under the same premise of using the Obsidian. Gray ceramics were abundant in every household and did show much inconsistency. Crema, unlike gray ceramics, is more rare and harder to access. Therefore, we can assume its presence is a manifestation of a household's wealth. When it comes to methods in which the data was used, the household sums of Crema ceramics were calculated from data lists compiled from

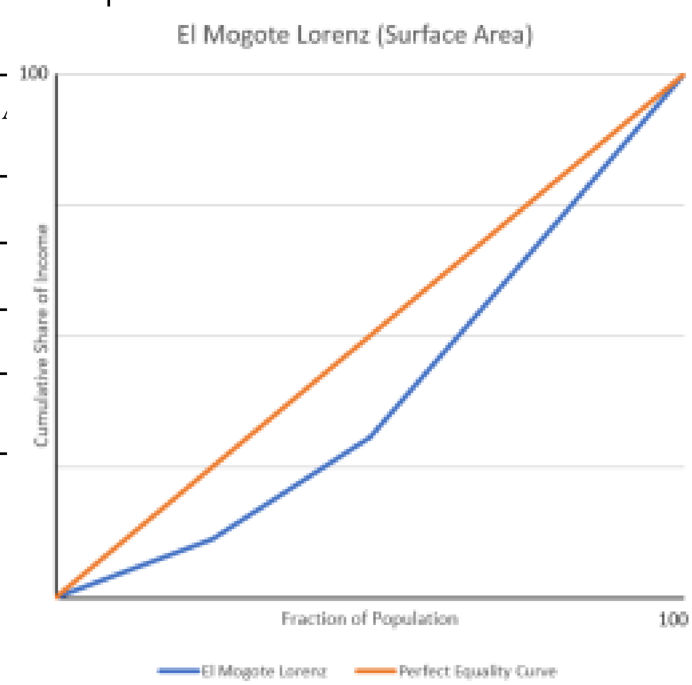
Professor Carpenter and using provenience lists that detailed which site, area, structure, and stratigraphic unit each excavated unit was found in. Finally, with the Crema sums of each household, the Gini coefficient was calculated.

X. Data (Results):

Using the different methods of Gini calculations, we were able to gauge a preliminary trend of what inequality looked like at the Tilcajete sites. In addition to the Tilcajete sites, I calculated Ginis for the other target sites that were either in or around the area or very similar to the Tilcajete sites in other ways. Below is a table of household data, Lorenz curve, and Gini coefficient for every distinctive site studied.

El Mogote

El Mogote Surface Areas	
Structure	**Total Surface A in m²**
Structure 33	195.4
Structure 34	108.7
Structure 36	63.06
Palace *	193.26

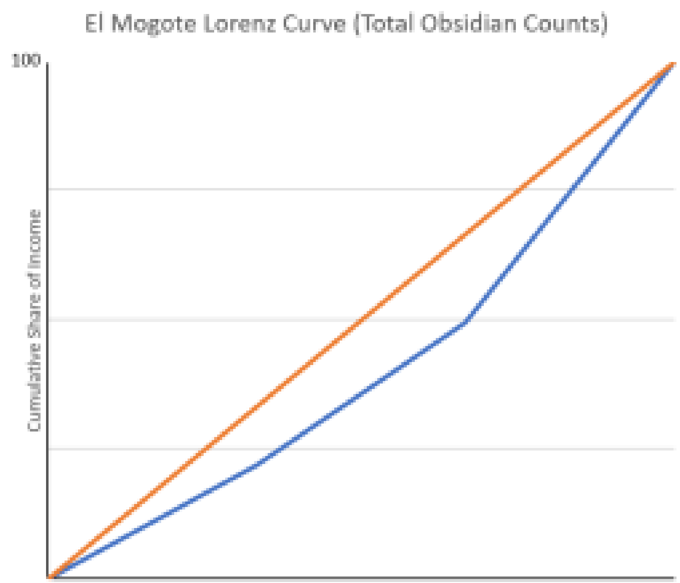


The calculated Gini for El Mogote's total surface

area is **.215**.

* It is important to note that the measurement for the Palace's surface area was calculated solely from the residential sector of the palace.

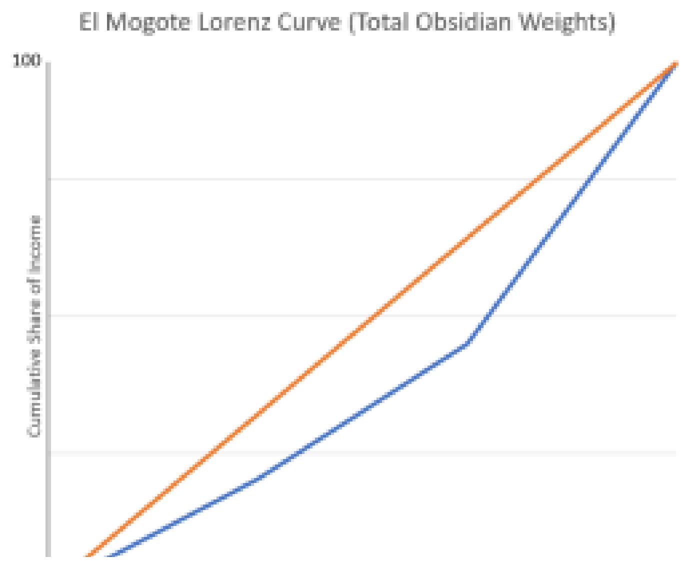
El Mogote Total Obsidian Counts	
Structure	**Obsidian Cou**
Structure 33	44
Structure 34	80
Structure 36	35



The calculated Gini for El Mogote's total obsidian

counts is **.189**.

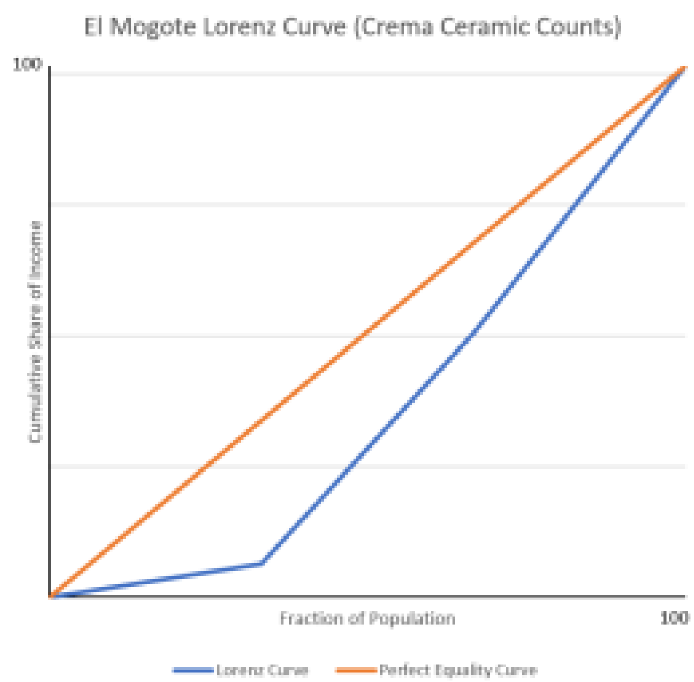
El Mogote Total Obsidian Weights	
Structure	**Obsidian Weight**
Structure 33	17.15
Structure 34	43.17
Structure 36	20.73



The calculated Gini for El Mogote's total obsidian

weights is **.214**.

El Mogote Total Crema Ceramic Counts	
Structure	**Obsidian Weight**
Structure 33	225
Structure 34	28
Structure 36	194



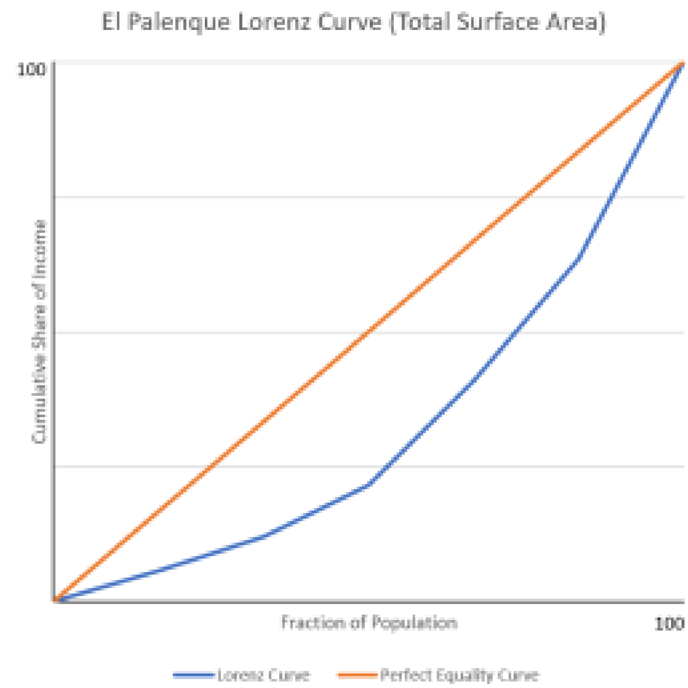
The calculated Gini for El Mogote's total crema

ceramic counts is **.294**.

As is shown in the multiple Lorenz Curves and Gini coefficients themselves, El Mogote shows some inequality (averaging out around .228 among all the calculated Ginis). However, this level of inequality is on the more equal side and is comparable to the country with the lowest Gini coefficient, Ukraine.

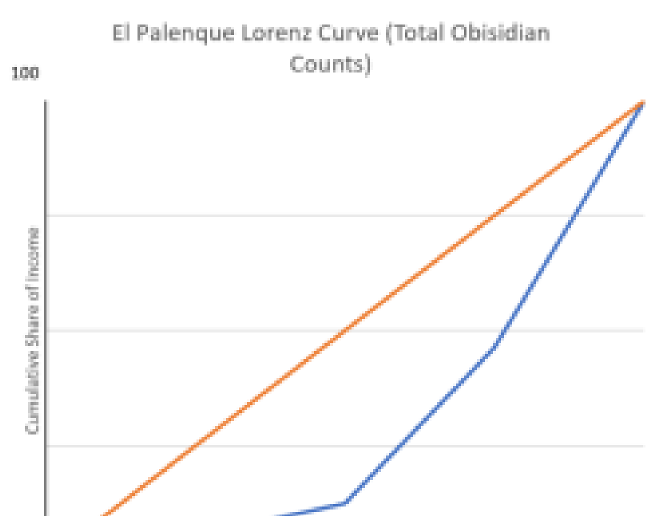
El Palenque

El Palenque Total Surface Areas		
Area	**Structure**	**Total Surface Area in m²**
Area P	Structure 9	83.3
Area X	Structure 30	75.2
Area X	Structure 31	299.5
Area P	Structure 50	482.5
Area X	Unexcavated Structure	126
Area I, H	Palace *	256



* Like El Mogote, it is important to note that out of the total 2790 m² the Palace occupied, only256 m² were strictly residential. This second value was used in the Gini calculations. The calculated Gini for El Palenque's total surface area is **.355**.

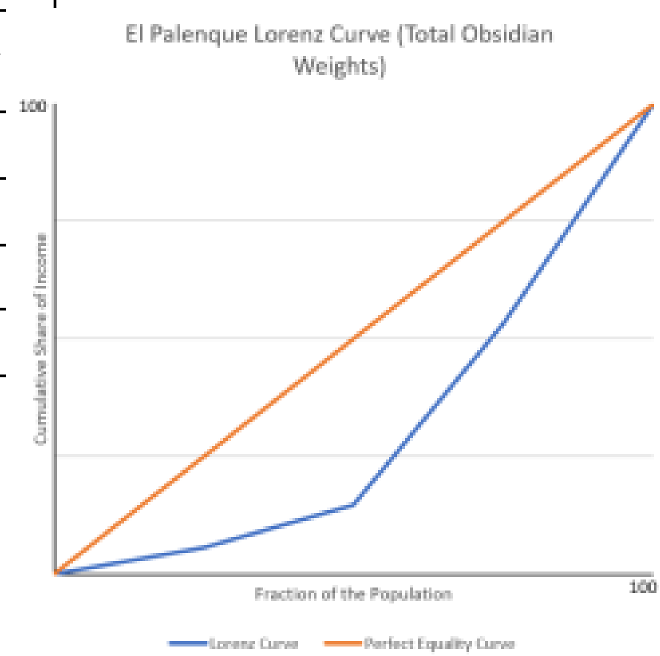
El Palenque Total Obsidian Counts		
Area	**Structure**	**Obsidian Counts**
Area P	Structure 9	12



Area X	Structure 30	16
Area X	Structure 31	76
Area P	Structure 50	121

The calculated Gini for El Palenque's total obsidian counts is **.43**.

El Palenque Total Obsidian Weights		
Area	**Structure**	**Obsidian Weights in**
Area P	Structure 9	7.3
Area X	Structure 30	4.5
Area X	Structure 31	30.81
Area P	Structure 50	37.29

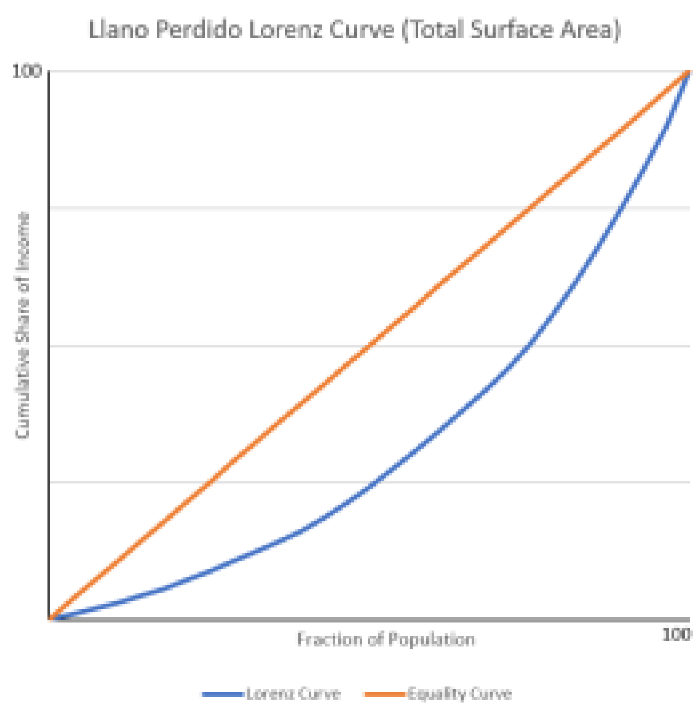


The calculated Gini for El Palenque's total obsidian weights is **.381**. Unlike El Mogote, El Palenque showed to have more prominent inequality throughout all the variables considered (with an average of .389).

Llano Perdido

Llano Perdido Surface Areas **		
Area	**Structure**	**Total Surface Area in m²**
Area A/B	House 1	15.4
Area A/B	House 2	13
Area A/B	House 3	24
Area A/B	House 7	56.2
Area A/B	House 8	9.36
Area A/B	House 9	15.6
Area A/B	House 9A	4.8
Area A/B	House 10	7.2

Area A/B	House 11	41.6
Area A/B	House 35	13.89
Area A/B	House 36	11.25
Area A/B	House 40	14.44
Area A/B	Structure 4	14
Area A/B	Structure 5	29.6
Area A/B	Structure 6	29.9
Area A/B	Structure 13	78.75
Area A/B	Structure 14	27.5
Area A/B	Structure 15	26.67
Area A/B	Structure 16	37.33
Area A/B	Structure 18	49.11
Area C	Structure 12	8.6
Area C	Structure 17	8.7
Area C	House 20	31.3
Area C	House 30	21
Area C	House 31	26.6
Area C	House 32	12
Area C	House 33 *	unknown



** (Spencer. 1997)

Llano Perdido Total Obsidian Count **

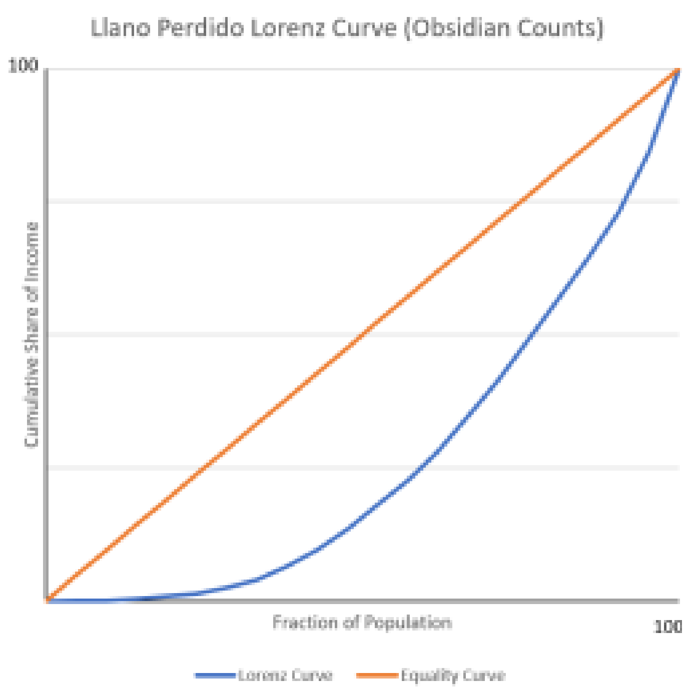
Area	Structure	Count
Area A/B	House 1	130
Area A/B	House 2	128
Area A/B	House 3	110
Area A/B	Structure 5	50
Area A/B	Structure 6	261
Area A/B	House 7	142
Area A/B	House 8	73
Area A/B	House 9/9A	91
Area A/B	House 10	45
Area A/B	House 11	129

Area A/B	Structure 13	8
Area A/B	Structure 14	23
Area A/B	Structure 15	66
Area A/B	Structure 16	9
Area A/B	Structure 18	112
Area A/B	House 35	5
Area A/B	House 36	18
Area C	House 20	77
Area C	House 31	188
Area C	House 32	2
Area C	House 33	1

* Unlike all the other structures at this site, there was insufficient information available about House 33, as it was partially or completely destroyed. The obsidian counts found in the area where it stood were not included in the

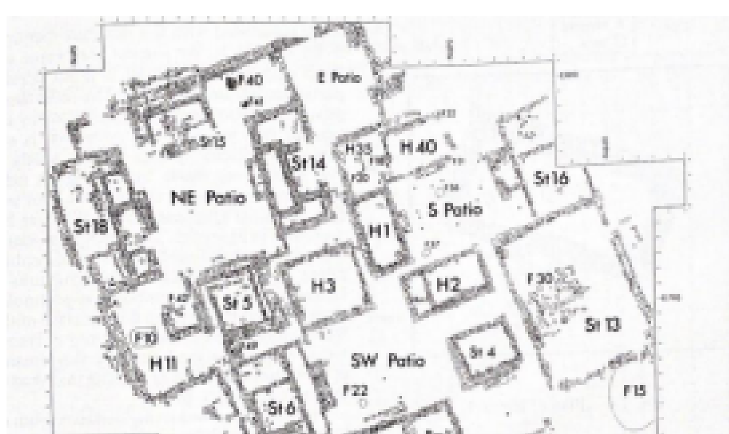
calculation of the Gini coefficient.

** (Spencer. 1997)



Due to the diversity among the structures at

Llano Perdido, it was very difficult to discern

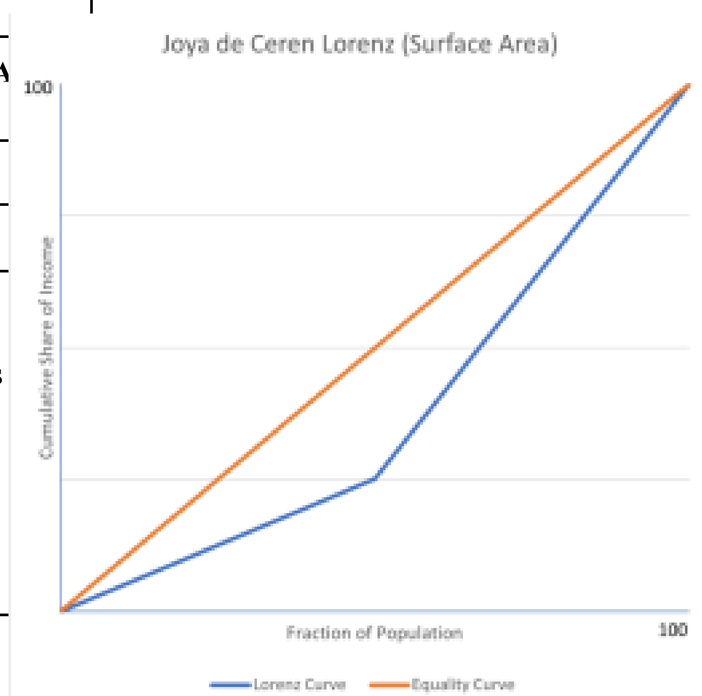


which ones were strictly used as dwellings and which structures were not. Furthermore, to account for this uncertainty, we assumed all buildings were residential and therefore included them in the calculation. The final Gini calculations for Surface Areas and Obsidian count were **.358** and **.465** respectively.

Like El Palenque, Llano Perdido presented much more inequality than El Mogote, with an average of .412. As shown in the Lorenz curves, there seems to be a greater area between the Lorenz curve and the perfect equality curve throughout all the curves made for Llano Perdido.

Joya de Ceren

Joya de Ceren Surface Areas	
Household *	**Total Surface A in m^2**
Household 1	73
Household 2	24.5



* Fortunately, Dr. Sheets, whose book was used to complete the Joya de Ceren analysis separated the structures into two different households.

Household 1 Surface Areas		
Structure	**Intended use**	**Total Surface Area in m^2**

Structure 1	Dwelling	12.8
Structure 5	Workshop	5
Structure 6	Storehouse	11.2
Structure 11	Kitchen and Kitchen Garden	44

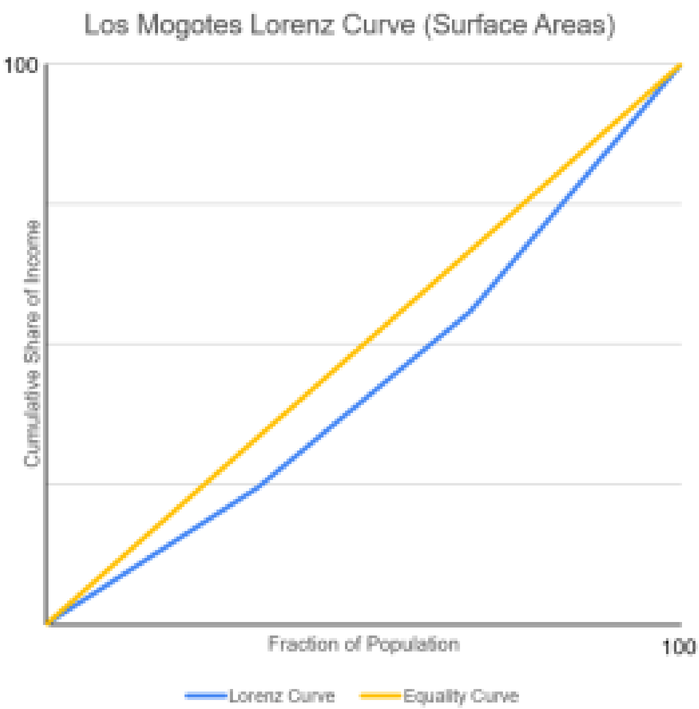
Household 2 Surface Areas		
Structure	**Intended use**	**Total Surface Area in m²**
Structure 2	Dwelling	14.8
Structure 7	Storehouse	9.7

An interesting consideration about Joya de Ceren is the assumption made about the correlation between wealth and household size. Although Household 2 had less total surface area than Household 1, Household 2 had more tangible evidence of wealth. For example, the sweathouse was closer in proximity to Household 2 than Household 1. In addition, Structure 2, the main dwelling associated with Household 2, contained decorative niches and shelves while Structure 1, the dwelling associated with Household 1, lacks them. Similarly, Household 1 includes two structures that are dedicated to physical labor, so it can be theorized that the inhabitants may have been of lower class. Therefore, household surface area seems to be a somewhat flawed method of calculating the Gini depending on the sites being studied. The Gini coefficient was measured to be **.249**. Obsidian count and weights were not used to calculate a Gini for Joya de Ceren.

Los Mogotes

Los Mogotes Surface Areas

Area/Mound #	Structure	[illegible]
Mound A	Structure 1	
Area C	Structure 3	
	Structure 4	



When it comes to the surface area calculation of Los Mogotes, we accessed data for only three structures. Therefore, the Gini coefficient measurement should be taken with a grain of salt. The Gini was measured to be **.132**. Due to the lack of information, we hope to study Los Mogotes more in order to see the progression of inequality at the Tilcajete sites (as it was a site that existed in the same area after El Palenque).

XI. Implications of Data:

With the Gini's calculated, we can now make comparisons with other sites that existed during the Formative Period (2500 BCE – 250 CE), the Classic Period (250 – 900 CE), the Late Postclassic Period (A: 1300 – 1430 CE, B: 1430 – 1521 CE), and the Colonial Period (1521 CE – 1821 CE). Like mentioned earlier, when making inferences about the changes in wealth inequality, it is important to not only the context of the sites but also the variable that was measured. Below are Gini measurements that have been published by both Smith and Thompson in the book 10,000 Years of Inequality. Looking at these statistics can tell us a lot about how wealth inequality changed within communities and as time progressed. However, there are two data points to note. First and foremost, Huitzillan and Quauhchichinollan showed a greater Gini than all other sites compared. This, however, can be inferred to have been caused by colonialism. On the other hand, the Gini measurements of the San Jose Mogote site are noteworthy. San Jose Mogote itself is found in the Northern Oaxaca Valley (in a different sub valley than the Tilcajete sites) and existed at the same time as El Mogote, one of its competitors. The reason why the San Jose Mogote Ginis were interesting is because the house area Ginis are very similar to those of El Mogote. San Jose Mogote was famous for its people's ostentatious displays of wealth, causing further manifestations of inequality and fueling state building (Carpenter. 2019).

Period	**Site**	**Agricultural Plot Area**	**House Volume**	**House Area**	**Amount of Obsidian**	**Amount of Mica**	**Amount of Jade**	**Amount of Shell**
Late Postclassic A/Aztec Period	Capilco (village) *		0.06	0.1				
Late Postclassic B/Aztec Period	Capilco (village) *		0.09	0.16				
Late Postclassic A/Aztec Period	Cuexcomate (town) *		0.46	0.48				
Late Postclassic B/Aztec Period	Cuexcomate (town) *		0.19	0.25				
Late Postclassic B/Aztec Period	Yuatepec (city) *		0.33	0.21				

Early Colonial	Huitzillan *	0.49						
Early Colonial	Quauhchichinollan *	0.45						
Classic Period	Teotihuacan *			0.12				
Formative (San Jose phase)	San Jose Mogote (16 houses) **			0.25	0.61	0.57	0.71	0.52

* (Smith, et al. 2014)

** (Thompson, et al. 2021)

Site	**Surface Area**	**Obsidian Counts**	**Obsidian Weights**	**Crema Sherd Counts**
El Mogote	0.215	0.189	0.214	0.294
Joya De Ceren	0.249			
El Palenque	0.355	0.43	0.381	
Llano Perdido	0.358	0.465		
Los Mogotes	0.132 *			

* Due to lack of data, there were only three households in the Los Mogotes site. Therefore, this result should be taken with a grain of salt.

When it comes to comparing the Gini coefficients calculated in this project and those published by previous archaeologists, there is a mild trend among the Gini coefficients across time. With the exception of cities like Teotihuacan (which is a famous case of surprisingly low inequality), there seems to be a slow but steady increase in the Gini coefficients as time passes on. The pattern among the Ginis is more evident in this project's results when comparing El Mogote and Joya de Ceren (the two earlier sites) and El Palenque and Llano Perdido (the two later sites). While El Mogote and Joya de Ceren's Ginis both center around the mid .20s, El Palenque and Llano Perdido are within three hundredths of a point, at around .35. Although surface area is the variable that is the most consistent throughout the five sites studied, there is also considerable change between the Gini coefficients of El Mogote (which is less than .2) and El Palenque, which is a whopping .43. Furthermore, with the data collected from the Tilcajete sites, we can conclude that the regional equality rose as state formation progressed in the area. This is consistent with the Dual Processual Theory, an anthropological theory that describes the actions of political leaders in the early processes of state formation and the effects these actions have on others living in the community. According to archaeologist Richard Blanton, the dual processual theory states that political leaders employ the strategy of "networking," which is defined by the leaders' action of using their ties to other societies, supernatural powers, or sources of knowledge or goods to build power (Blanton et al. 1996). Furthermore, this power was maintained by excluding others from accessing this power. Therefore, as states form, inequality seems to increase among members of a community, especially between political leaders and their subjects (Blanton et al. 1996).

XII. Limitations:

As mentioned in the methods section above, the archaeological record and its integrity is heavily reliant on the cultural and natural processes that happen around it. Many of the archaeological sites that are studied today are found when someone (most commonly farmers or agricultural workers in Central America), accidentally unearths an artifact or wall fragment. For example, the Joya de Ceren site was first discovered in 1976 when a bulldozer driver employed by El Instituto Regulador de Abastecimientos (IRA) accidentally destroyed structure 5 when leveling the ground for an agricultural project (Sheets YEAR). This is common for many sites, and archaeologists must work around damage done to sites post discovery. This is complicated even more when the site itself entered the archaeological record incomplete or damaged. Natural disasters, conflict, or inevitable wear narrow the view scholars can get of these communities as tangible evidence is destroyed. Therefore, the smaller the populations (in this case, the number of households) we study, the broader our assumptions must be. According to the Central Limit Theorem, the more numerous the population, the closer the descriptive statistic of the distribution will be to the real statistic. This is true not only for the mean and standard deviations of data, but also for Gini coefficients.

Finally, when scrutinizing the ability for archaeologists to "measure" the level of a household's wealth, the consistency between archaeology data is in question. A lot of information used in this paper was derived from the work multiple archaeologists who worked in the Oaxaca Valley in the past. As the sites themselves differ, so do the teams studying them. There is no one set way that these sites were dug and recorded, as Professor Lacey Carpenter's procedures were different compared to Dr. Payson Sheets' and Dr. Elsa Redmond's. Therefore, there was no monolithic standard by which I could cross examine these sites. However, there were usually overlapping data points that could be used to compare the levels of wealth inequality within these sites.

XIII. Conclusions:

Like it did hundreds of years ago, the Oaxaca Valley continues to change and thrive as a hub of cultural development. Studying ancient processes in the Valley can give current policy makers insight on what causes the problems that affect modern day populations. Political leaders and economists can study past trends in order to understand the benefits and consequences of policies they are considering. With all the data collected, it can be concluded that inequality in the Tilcajete sites increased as state formation progressed. Across all variables considered, El Mogote (and other sites that existed around the same time period) seems to have lower Gini coefficients than its successor, El Palenque (and other later sites). This conclusion was reached after using more than three different variables that represent access to wealth in these ancient societies. Furthermore, we have concluded that out of all variables considered, measuring obsidian weights is the most accurate way to assess the levels of household wealth during the Middle to Late Formative period. These results are consistent with the Dual Processual Theory, which describes the role of state building on the inequality within societies.

XIV. Further Actions:

Gaging inequality between the peoples of these societies has given us a view of how people interacted and lived during their time. We only studied some physically tangible manifestations of wealth, yet there are a lot more we can consider, especially when looking at the Zapotec. More specifically, we would like to consider burial data in our further research, as the Zapotec have complex and long lasting ritual traditions. In addition, we believe looking further into Los Mogotes data can help us analyze the overall trend of wealth inequality in the Tilcajete sites (as it existed after El Palenque).

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References

Blanton, Richard E., et al. "A Dual-Processual Theory for the Evolution of Mesoamerican Civilization." <i>Current Anthropology</i>, vol. 37, no. 1, 1996, pp. 1–14. <i>JSTOR</i>, www.jstor.org/stable/2744152. Accessed 26 Aug. 2021.

Carpenter, Lacey B. "Households and Political Transformation: Daily Life During State Formation at Tilcajete, Oaxaca, Mexico." *The University of Michigan*, 2019.

Elson, Christina M. *Excavations at Cerro Tilcajete: A Monte Albán II Administrative Center in the Valley of Oaxaca*. The University of Michigan: Memoirs of the Museum of Anthropology, 2007.

Hayes, Adam. "Gini Index." *Investopedia*, Investopedia, 23 Aug. 2021, www.investopedia.com/terms/g/gini index.asp#:~:text=The%20Gini%20index%2C%20or%20Gini,wealth%20distribution%20a mong%20a%20population.

Kievit, Karen A. “JEWELS OF CEREN: Form and Function Comparisons for the Earthen Structures of Joya De Cerén, El Salvador.” *Cambridge University Press*, Cambridge University Press, 1994, www.jstor.org/stable/pdf/26307295.pdf.

Kohler, Timothy A., and Michael Ernest Smith. *Ten Thousand Years of Inequality: The Archaeology of Wealth Differences*. The University of Arizona Press, 2019.

Sheets, Payson D. *The Ceren Site: An Ancient Village Buried by Volcanic Ash in Central America*. II, Thomson/Wadsworth, 2006.

Sitthiyot, Thitithep, and Kanyarat Holasut. “A Simple Method for Measuring Inequality.” *Nature News*, Nature Publishing Group, 4 June 2020, www.nature.com/articles/s41599-020-0484-6.

Smith, Michael & Dennehy, Timothy & Kamp-Whittaker, April & Colon, Emily & Harkness, Rebecca. (2014). Quantitative Measures of Wealth Inequality in Ancient Central Mexican Communities. Advances in Archaeological Practice. 2. 311-323. 10.7183/2326-3768.2.4.XX.

Spencer, Charles S., et al. *Archaeology of the CANÃDA De cuicatlán, Oaxaca*. No. 80 ed., American Museum of Natural History, 1997.

Thompson AE, Feinman GM, Prufer KM (2021) Assessing Classic Maya multi-scalar household inequality in southern Belize. PLoS ONE 16(3): e0248169. https://doi.org/10.1371/journal.pone.0248169