16 CHETUMAL'S DRAGONGLASS: POSTCLASSIC OBSIDIAN PRODUCTION AND EXCHANGE AT SANTA RITA COROZAL, BELIZE

Max Seidita, Diane Z. Chase, and Arlen F. Chase

The reconstruction of patterns of obsidian production and exchange has been vital to increasing our understanding of ancient Mesoamerican economies. During the Postclassic Period (ca. 950-1532 C.E.) inhabitants of the site of Santa Rita Corozal, Belize participated in multiple exchange networks to provision themselves with the materials to produce and distribute obsidian artifacts. Analyses of obsidian artifacts dating to the Postclassic Period recovered by the Corozal Postclassic Project from 1979-1985 has demonstrated that Santa Rita Corozal's population was engaged in the production of obsidian blades, likely from partially reduced polyhedral cores. Here we present information on 572 obsidian artifacts, including details relating to the tool production sequence and pXRF sourcing data. We further present the statistical distributions of objects in relation to hypothesized function or status of each structure. Procurement of these cores from at least six different obsidian sources likely occurred as a result of indirect trade carried out by non-specialist traders. The sources represented include Otumba, Mexico, a resource not previously identified in the region. Imported raw materials were transformed into finished artifacts and then distributed through a market system. These findings contrast with the patterns of procurement and production seen at neighboring sites thought to be members of the Chetumal polity, where prismatic blade production and number of sources being exploited were more limited. We conclude by discussing these findings in relation to neighboring sites and within our broader understandings the Postclassic Period regional economy.

Introduction

Obsidian is one of the most commonly recovered materials in the Maya region and some types of obsidian and obsidian artifacts, such as prismatic blades, were utilitarian goods used in everyday life and transported in bulk into sites across the lowlands (Braswell 2003; Edwards 1978; Smith 2003). A testimony to obsidian's popularity and perhaps its unique characteristics, the ancient Maya imported obsidian into regions where other sources of chipped stone, such as chert, were easily accessible and commonly available to the general population. Since the early 1900s, Maya archaeologists have viewed the presence of obsidian as an indicator of interregional exchange and consumption, as well as one avenue by which to explore production (Chase and Chase 1989; Kidder 1947; Sidrys 1976). The persistent emphasis on obsidian by Maya researchers may be attributed to its ubiquity in the archaeological record, the resilient nature of both finished artifacts and production debitage, and its elemental properties which allow for the attribution of an obsidian artifact to a specific geological source (Ferguson 2012; Shackley 2011). With the recent upswell in the study of Maya market exchange, obsidian has become a vital component in any discussion of the various mechanisms of distribution employed by the ancient Maya. Obsidian has been included in market studies at sites throughout the Maya region including Caracol (Chase and Chase 2015; Chase and Chase 2014) and Xunantunich (Cap 2015; Cap, et al. 2015) in Belize; Tikal, Guatemala (Masson and Freidel 2012); Mayapan, Mexico (Masson and Freidel 2012); and Ceren, El Salvador (Sheets 2000). Many of these studies, including the one presented here for Santa Rita Corozal, rely upon data derived primarily from the excavation of households (see Cap (2015); Cap, et al. (2015) for a recent and notable exception). Less often discussed than the broader mechanisms of distribution across sites are the means by which the market itself is provisioned.

With the above in mind, here we present an updated study of the Postclassic Period obsidian economy at the site of Santa Rita Corozal in northern Belize. Through a combination of lithic analysis, a sourcing study utilizing pXRF, and statistical analysis of obsidian locations, we seek to understand the importation, production, and distribution of obsidian at Santa Rita Corozal during the Postclassic Period (ca 950-1532 C.E.). We argue that the Postclassic Period population of Santa Rita Corozal was importing partially reduced polyhedral cores from a variety of Guatemalan and Mexican obsidian sources,

Research Reports in Belizean Archaeology, Vol. 15, 2018, pp. 169-178.

producing blades locally, and then distributing the obsidian through market exchange. Through this research we aim to contribute information from the Postclassic provincial capital of Santa Rita Corozal to discussions of other obsidian economies in northern Belize. More broadly, we seek to demonstrate the value of considering the provisioning of local economies with non-local goods in conjunction with local methods of distribution, the importance of large sample sizes in the elemental sourcing of obsidian, and the value of existing collections.

Santa Rita Corozal's Obsidian Economy

Located in northern Belize, Santa Rita Corozal was situated along the coast at the western end of Chetumal Bay; the site is now largely subsumed by the sprawl of Corozal town and rising sea levels. Santa Rita Corozal and its surrounding areas have been continuously occupied since at least the early Middle Preclassic Period (Chase 1981:26) with an Early Classic prominence in the region (Chase and Chase 2005). However, Maya occupation at the site reached its peak population during the Late Postclassic Period when the population of the city itself is believed to have been approximately 7,000 inhabitants (Chase 1990), not including people in the surrounding landscape. The site was situated near the mouths of three major river systems: The New River and Freshwater Creek (which both have their head waters in central Belize) and the Rio Hondo (which reaches into the Peten of Guatemala) (Figure 1). These river systems would have served as important transportation routes and would have fostered communication and exchange between the coast and inland settlements (Chase and Chase 1989). Additionally, Santa Rita Corozal's coastal location would have facilitated its participation in both circum-peninsular trade and exchange along the Belize coast (Chase 1986); seaborne trade has long been thought to be the primary means of long distance exchange amongst the Postclassic Period Maya (Sabloff and Rathje 1975).

Investigated by several projects since the early 1900s, Santa Rita Corozal was most intensively excavated by the Corozal Postclassic Project (CPP) from 1979-1985 under the direction of Diane and Arlen Chase (Chase

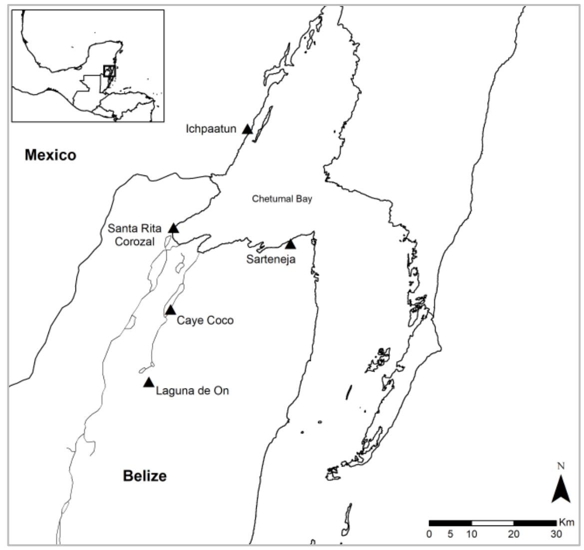

Figure 1. Map of Chetumal Bay showing sites mentioned in text.

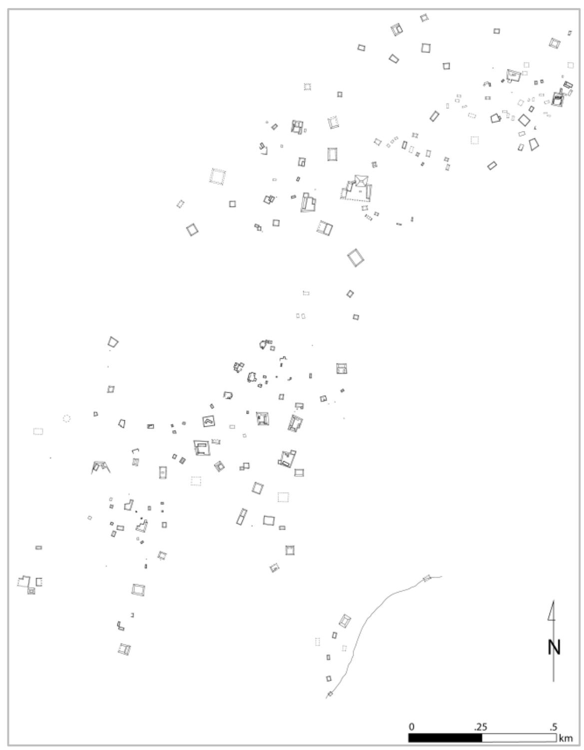

Figure 2. Map of Santa Rita Corozal From Seidita (2015), adapted from D. Chase and A. Chase 1988.

1982; Chase and Chase 1988). Excavations took place over the span of four years and consisted of the mapping of 200 features including structures, platforms, and chultuns, as well as the excavation of 46 of these features (Figure 2). The 572 Late Postclassic obsidian artifacts discussed here were recovered by the project (information on 27 obsidian points recovered during these investigations may be found in (Marino, et al. 2015)). The CPP established Santa Rita Corozal as the likely location of Chetumal, the Postclassic Period provincial capital and the namesake of the Chetumal province (Chase 1982, 1985; Chase and Chase 1988, 2004, 2008). Chetumal was described in Spanish accounts as an economic center which participated in extensive trade networks and was known for producing and exporting honey and cacao (Chase 1986). The Chetumal province itself is thought to have occupied the area of modern-day northern Belize and southern Quintana Roo. While the relationship between Santa Rita Corozal and smaller sites in the region has not been fully explored, work by Marilyn Masson (2000) suggested that, during the Postclassic Period, Santa Rita Corozal sat atop a hierarchy of sites, which may have included Caye Coco, Laguna de On, Ichpaatun, and Sarteneja. Following Masson (2000), the "primary site" of Santa Rita Corozal was likely supported by smaller "secondary sites" such as Caye Coco, which were in turn supported by "tertiary" communities such as Laguna de On.

Importation and Production

Seidita (2015), undertook an initial study of the Santa Rita Corozal obsidian, focusing on finished artifacts and debitage in an attempt to understand the type and extent of production that had occurred amongst the Postclassic Period population of Santa Rita Corozal. Additionally, this analysis was able to establish the likely form of the obsidian prepared for transport – for example nodules, cores, or finished artifacts – as various stages of reduction result in diagnostic and finished artifacts indicative of where in the reduction sequence local production began (e.g., Clark and Bryant 1997). Understanding the forms that were imported allows for partial modeling of the social and economic relationships which drove the provisioning of obsidian to non-obsidian producing regions, such as the Maya Lowlands (Hirth 2008).

Our analysis of the obsidian assemblage shows that, unsurprisingly, Santa Rita Corozal's primary industry was the production of final-series prismatic blades (Table 1). Of the 572 Postclassic Period obsidian artifacts, 498 are complete and segmented blades. Of these blades, over 95% are blade segments, most of which may be classified as purely or partially medial. The majority of these segments retain the "tongue" and "tongue facets" indicative of purposeful segmentation of blades (Hirth et al. 2006). De Leon (2009) has argued that selecting for medial segments, the flattest portion of the blade, makes blades easier to haft. This is supported by the presence of side notching on 15% of the blade assemblage. Most commonly blades were notched with a single unilateral side notch. While we do not discuss use-wear analysis here, this evidence suggests a preference for flatter blades that were more easily hafted, a claim supported by an earlier use wear study on Santa Rita Corozal materials by (Hartman 1980) that found that blade segments had been hafted for activities like those involving the repetitive cutting of a fibrous material. Additionally, two initial series blades, from early in the reduction sequence, were recovered; both have extensive edge damage that likely resulted from their use as tools.

Obsidian production debitage and refuse includes cores, blade errors, and error removals. Thirteen cores and core fragments dating to the Postclassic Period were recovered. Of these cores, only a single complete core was recovered. This exhausted core showed evidence of bipolar blade removal and is only 3.45 cm in length. If we consider the aforementioned complete final-series blades as indicative of the size of cores at Santa Rita Corozal, the average core would have been around 3.6 cm in length, with lengths ranging from 2.6 cm to 7.3 cm. The proximal section of the single complete core and the other proximal fragments indicate that cores were prepared by having their platforms ground. This method of preparation, while labor intensive, facilitates easier and more predictable blade removal (Crabtree 1968; Hirth et al. 2006). In addition to these cores, two platform preparation flakes were recovered. Other debitage and production errors include plunging blades, hinge fractures, and attempts at removing these errors through rejuvenation flakes.

Analysis of Santa Rita Corozal's obsidian assemblage demonstrates that during the Postclassic Period the population of Santa Rita

Table 1. Table of quantities and frequency of obsidian sources present in the sample.

Sources	El Chayal	Ixtepeque	San Martin Jilotepeque	Otumba	Pachuca	Pico de Orizaba
n	161	332	4	34	3	3
%	30%	62%	<1%	6%	<1%	<1%

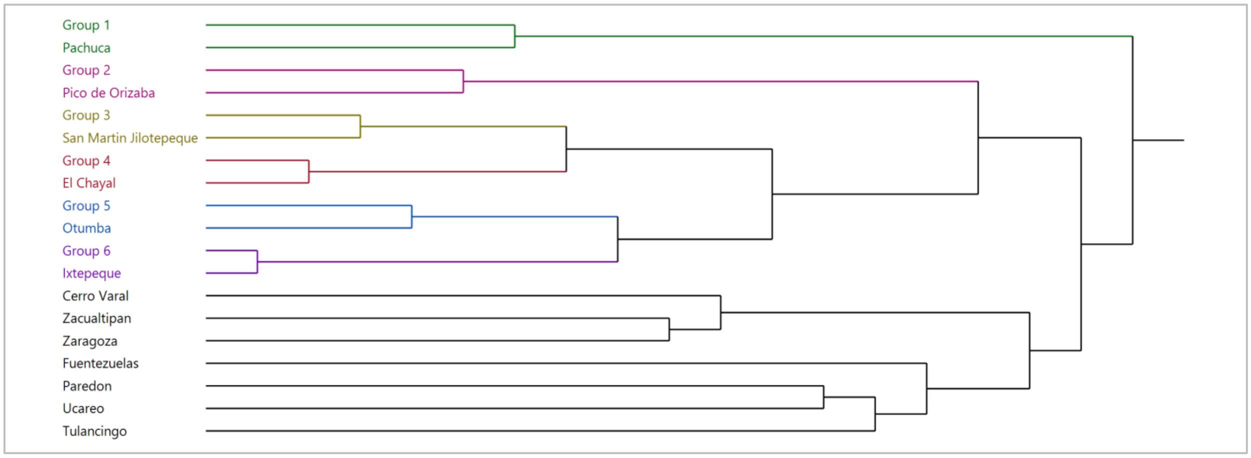

Figure 3. Hierarchical Cluster Analysis of the elements Mn, Fe, Zn, Rb, Sr, Y, Zr, Nb for chemical groups and known sources.

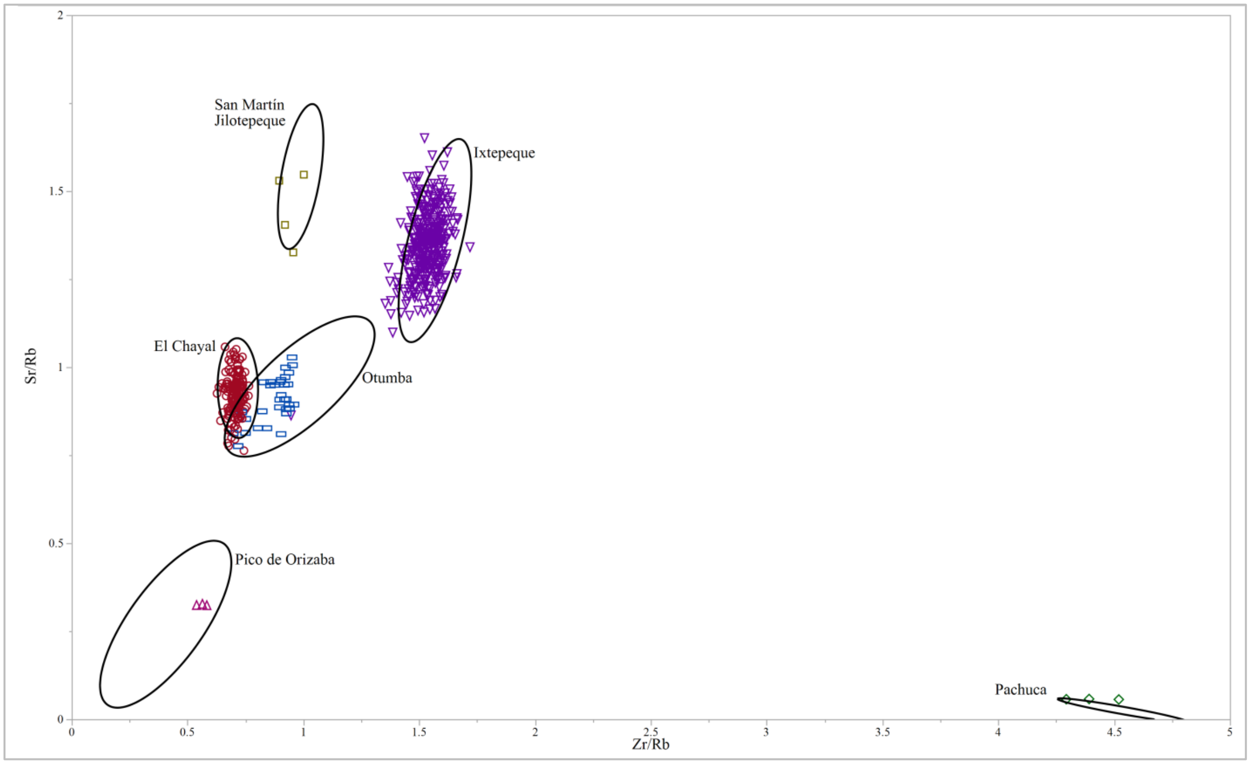

Figure 4. Bivariate plot of Sr/Rb by Zr/Rb PPM values, 90% confidence ellipses.

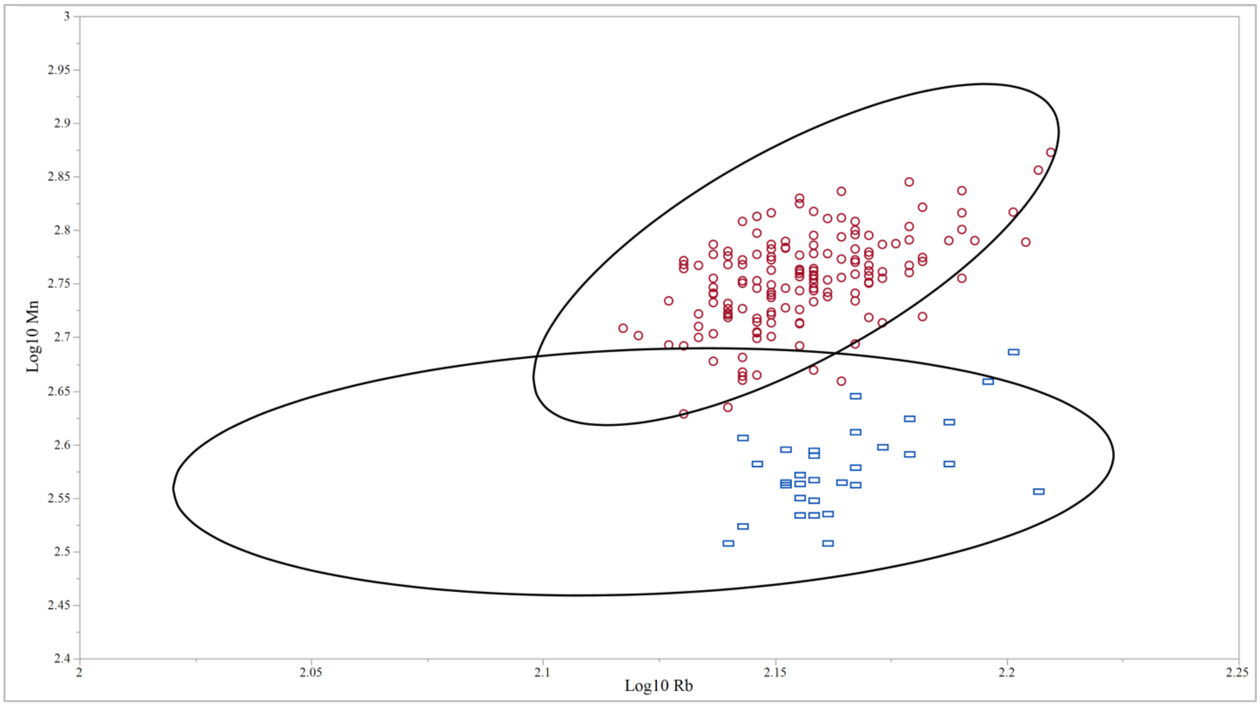

Figure 5. Bivariate plot of log10 Mn x Log10 Rb PPM values, 90% confidence ellipses.

Corozal was consuming blades produced locally. The assemblage does not represent any loci of production, such as workshops, which are characterized by significant amounts of debitage and refuse with little in the way of finished artifacts (Clark and Bryant 1997). The debitage and refuse which is present are indicative of the importation of prepared polyhedral cores or partially reduced polyhedral cores. The lack of percussion debitage, and the limited number of initial-series blades indicate that cores were likely prepared for the pressure flaking of final-series blades prior to importation (Anderson and Hirth 2008; Hirth, et al. 2006). Lastly, the small number of cores and core fragments recovered could easily account for the blades present in the assemblage. By treating core fragments as unique individual cores, the thirteen cores from Santa Rita Corozal that date to the Postclassic Period could potentially produce 2,600 blades (Clark 1988; Clark and Bryant 1997). This is 4.5 times the number of blades recovered; if we were to include the distal portion of three plunge blades, this climbs to 5.5 times the blades recovered. We do not suggest, however, that the full ancient sample of cores and blades has been recovered.

To identify the obsidian sources and source regions present in the Postclassic Period assemblage a sample of 536 pieces of obsidian dating to the Postclassic Period were assayed via pXRF. The data presented here derives from a more recent and detailed analysis than that presented previously by Seidita (2015). Using a Bruker Tracer III-SD pXRF samples were assayed for 90 seconds, at 40kV max voltage, without a vacuum, utilizing Bruker's 0.006" Cu, 0.001" Ti, 0.012" Al, "green filter." The pXRF data was normalized via a Log10 transformation to reduce the potential for analysis to favor elements with larger values by transforming all the elemental values into the same order of magnitude (Millhauser, et al. 2015; Popelka-Filcoff 2006). Following normalization, data was subjected to two rounds of hierarchical cluster analysis to establish the number of distinct chemical groups within the data set and to offer preliminary identification of group sources. These preliminary assignments were then substantiated via bivariate plots of PPM data and ratios of PPM data, specifically Sr/Rb by Zr/Rb. Frahm (2016) demonstrated that bivariate plotting of ratios helps control for size induced spread resulting from samples of less than ideal dimensions. This type of plotting has the additional benefit of adding a third or potentially fourth variable - in this case an element - to consider on a two-dimensional plot (Frahm 2016). Thus, through a combination of element ratios and standard bivariate plots it is possible to better characterize the sources present within the assemblage. To confirm the preliminary source assignments generated through the use of cluster analysis, confidence ellipses are generated at 90% confidence using reference material including source samples analyzed in an earlier pXRF analysis, published pXRF, and INAA data (Glascock and Cobean 2002; Millhauser, et al. 2015; Millhauser, et al. 2011).

The combination of hierarchical cluster analysis and bivariate plotting of ratios and ppm data was clearly able to distinguish between the sources present in the Postclassic Period assemblage (Figures 3, 4, 5). The initial round of cluster analysis identified six distinct chemical groups within the assemblage. The second round of cluster analysis preliminarily identified chemical clusters for all six groups within the Postclassic Period Santa Rita Corozal assemblage including: Pachuca (Group 1), Pico de Orizaba (Group 2), San Martin Jilotepeque (Group 3), El Chayal (Group 5), Otumba (Group 4), and Ixtepeque (Group 6) (see Figure 3). The bivariate plots of Sr/Rb by Zr/Rb confirm the preliminary assignments generated by the hierarchical cluster analysis (Figure 4). While Otumba and El Chayal have a slight overlap in this plot they may be separated by plotting Log10 Mn by Log10 Rb (Figure 5). These are the same sources, albeit with a substantially larger sample size, as documented in the earlier study. Significantly, the presence of Pico de Orizaba and Otumba were confirmed through this additional analysis; and, in the case of Otumba, the amount of obsidian attributed to that source increased in the second study. Along with green obsidian from Pachuca these sources represent the only Mexican obsidian sources documented at mainland settlements in northeastern Belize during this time.

Taken together these forms of analysis allow us to draw conclusions regarding the provisioning of the local obsidian economy. While the sample size of assayed materials dating to earlier periods at Santa Rita Corozal is too small to be conclusive, it appears that there is an explosion in the diversity of sources being exploited during the Postclassic Period. In particular, the presence, diversity, and quantity of Mexican obsidian were not expected, especially given the region's pattern of source exploitation, which favored Guatemalan sources (Braswell 2003; Golitko and Feinman 2015). We attribute the diversification of sources to increased interregional exchange during the Postclassic Period, something Mayanists have recognized since the 1970s (e.g., Sidrys 1976b). This type of exchange would have had the added benefit of aiding in the provisioning of the growing population. Given the distributions, it does not appear that the provisioning was a result of the elite investing in social ties to bring obsidian into the site. In his modeling of obsidian provisioning in Central Mexico, Kenneth Hirth (1998, 2009) has described this type of provisioning as "unspecialized," meaning that the obsidian is likely being exchanged along with other goods and not on commission or as part of a system of elite reciprocity. Furthermore, while it is possible that individuals were familiar with the regions from which the obsidian came, aside from skilled crafters it is unlikely that the average individual would have been able to distinguish between the various gray obsidian sources.

These assertions are supported by the production evidence which, while not from a formal workshop, are indicative of the local production of blades from polyhedral cores. Obsidian was being imported into Santa Rita Corozal in forms ready to produce blades. Given the length of the complete blades present in the assemblage and the general lack of initial series blades, it is likely that the population of Santa Rita Corozal was receiving cores that had already been reduced by having blades removed. If true, then it is highly unlikely that obsidian was being provisioned directly from the communities engaged in the extraction of obsidian. Directly procuring obsidian would result in obsidian artifactual remains that were earlier in the reduction sequence, such as nodules, percussion cores, or larger cores (see, for instance, Demarest et al. 2014: 202-203). Instead, the Santa Rita Corozal assemblage is

Table 2. Table displaying the t-test results for high and other status structures.

	High Status (n=13)	Other Status (n=12)	P
Obsidian Density	0.4896	0.2529	0.0926

Table 3. Table displaying the ANOVA results for high, middle, and low status structures.

	High Status (n=13)	Middle Status (n=4)	Low Status (n=8)	P
Obsidian Density	0.4896	0.2832	0.1924	0.2229

characterized by the presence of final-series blades and small exhausted cores. Therefore, we argue that, prior to entering local exchange systems, obsidian was being provisioned from a variety of sources and source regions as part of the general Postclassic Period interregional exchange and not directly from sources via the involvement of elite political networks.

Distribution

In addition to considering how the local obsidian economy was provisioned we sought to understand how obsidian was distributed and exchanged at the site level. This was accomplished through the application of Hirth's (1998) distributional approach to assess the presence of market exchange. This method is well suited for the Santa Rita Corozal data, especially as the obsidian assemblage represents the end users of obsidian and not necessarily the loci of production, such as a workshop or marketplace. The distributional approach infers the mechanisms of exchange based on the expected distribution of artifacts. Thus, by testing to see how homogeneous the distribution of a specific commodity is across a site's social statuses, it is possible to infer the method of exchange. Following this approach, a homogeneous distribution of non-local items is more indicative of a system where there is relatively equal access, whereas a heterogeneous distribution is indicative of a system where access is based on social status. Typically, these are conceived as market exchange and redistribution exchange, respectively.

In our study, we chose to employ surface area of excavations as the standard method of comparison between units. Due to the low lying "invisible" nature of architecture at Santa Rita Corozal and the complicated construction stratigraphy, we only consider structures and samples for which an unambiguous Postclassic date is available. In total, 25 domestic structures are included in our sample, and by using status designations generated within previous work (Chase 1992), we were able to consider two different scenarios. The first is a simple elite versus non-elite comparison of 13 high status structures against 12 non-high status structures; these were compared via a t-test (Table 2). The second was an ANOVA based on the classification of 13 structures as high status, 4 structures as middle status, and 8 structures as low status (Table 3). The results of these tests demonstrate that no statistically significant differences exist in terms of obsidian densities in either scenario. The average obsidian density of high status structures is 0.489 pieces per square meter while non-high status structures contained 0.242 pieces per square meter. A similar trend is seen in the second scenario where middle and low status structures contained 0.192 and 0.283 pieces per square meter, respectively.

While high status structures consumed slightly greater quantities of obsidian, they do not appear to have received privileged access to the method of distribution. We attribute these differences to either purchasing power or need. In particular, the elite residents of Platform 2 (Chase and Chase 1988:25-31), one of the most intensely investigated locations at the site, are believed to have participated in a variety of activities, both domestic and religious. On Platform 2, Structure 73 may have been the location of an activity that required greater quantities of obsidian as it's density is higher than that of nearby Structure 74, where use-wear analysis has suggested that the structure was likely the location for specialized tasks perhaps in support of Platform 2 (Hartman 1980). The lack of a statistically significant difference in obsidian densities among social statuses suggests that obsidian was not being distributed by elites along a social hierarchy. Instead, following Hirth's (1998) distributional approach, the relatively homogeneous distribution noted for Santa Rita Corozal Postclassic obsidian is more indicative of access to a market system where wealth and/or need impacted distribution.

Conclusion

Through this study we have been able to characterize the provisioning and distribution of obsidian at the Postclassic provincial capital of Santa Rita Corozal. The Santa Rita Corozal industry appears to be significantly different, in terms of both industry and source exploitation, from other Postclassic sites within the Chetumal province. Analysis of obsidian at Caye Coco and Laguna de On indicate that those populations were not primarily engaged in the production of blades; visual sourcing and limited chemical analysis at these sites suggests that their populations drew exclusively upon Guatemalan sources. We suggest that the local obsidian economy for northern Belize was provisioned through participation in the increased interregional exchange of the Postclassic Period. Access to locally produced obsidian blades was facilitated through a market system, possibly controlled by Santa Rita Corozal. However, because some obsidian production waste and debitage wound up in archaeological contexts with the consumers of the obsidian industry, potentially some individuals obtained prepared cores in the market and produced their own blades locally or purchased blades from itinerant crafters working in this economy. Santa Rita Corozal's trade networks were also broader than other sites in the area. The center received significant amounts of obsidian form Otumba, Mexico – and this occurrence constitutes the only known instance of obsidian from this source in the broader region. While this may be due to Santa Rita Corozal's advantageous geographic location on Chetumal Bay or to its political primacy as the Postclassic capital of Chetumal Province, it may also be the result of not a sufficiently large enough sample of obsidian being subjected to elemental analysis from other sites. It is clear that, with the increased availability of relatively inexpensive, rapid, portable, and archaeologically valid pXRF technology, large samples or entire assemblages of other sites should be assayed without assuming the sourcing of gray obsidian. Had the sample size for Santa Rita Corozal not been so large, it is entirely possible that we may have missed the presence of obsidian sources from Otumba, Pico de Orizaba, and San Martin Jilotepeque. This analysis provides not only greater refinement of obsidian analysis for Late Postclassic Santa Rita Corozal but also showcases the importance of sampling strategies and sampling sizes in obsidian analysis.

Acknowledgements The Corozal Postclassic Project, directed by Diane and Arlen Chase, carried out research at Santa Rita Corozal from 1979 through 1985. Funding for this research was provided by: the University Museum, the Department of Anthropology, and the College of Arts & Sciences of the University of Pennsylvania; a grant from Sigma Xi; grants from the Philadelphia and New York chapters of the Explorer's Club; and 2 grants from the National Science Foundation (BNS-8318531 and BNS-8509304); other support for the 1985 field season was provided by the University of Central Florida. Seidita also thanks Brigitte Kovacevich and Michael Callaghan at the University of Central Florida for the use of the pXRF to carry out the last round of analysis and Nicholas Tripcevich at the University of California Berkeley's Archaeological Research Facility for the use of the pXRF in the initial study. Publications relating to the research carried out by the Corozal Postclassic Project at Nohmul and Santa Rita Corozal are available at www.caracol.org.

References

Anderson, J. Heath and Kenneth Hirth
2008 Obsidian Blade Production for Craft Consumption at Kaminaljuyu. *Ancient Mesoamerica* 20(1):163-172.

Braswell, Geoffrey
2003 Obsidian Exchange Spheres. In *The Postclassic Mesoamerican World*, edited by M. Smith and F. Berdan, pp. 131-158. University of Utah Press, Salt Lake City.

Cap, Bernadette
2015 How to Know It When We See It: Marketplace identification at the Classic Maya Site of Buenavista del Cayo, Belize. In *The Ancient Maya Marketplace: The Archaeology of Transient Space*, edited by E. King, pp. 111-137. University of Arisona Press, Tucson, AZ.

Cap, Bernadette, Meaghan Peuramaki-Brown and Jason Yaeger
2015 Shopping for Household Goods at the Buenavista Del Cayo Marketplace. In *Research Reports in Belizean Archaeology*, edited by J. A. J. Morris, pp. 25-36. vol. 12. Institue of Archaeology, NICH, Belize, Belmopan, Belize.

Chase, Arlen and Diane Z. Chase
2015 The Domestic Economy of Caracol, Belize: Articulating with the Institutional Economy in an Ancient Maya Urban Setting. *Research Reports in Belizean Archaeology* 12:15-23.

Chase, Diane and Arlen Chase
2014 Ancient Maya Markets and Economic Integration at Caracol, Belize. *Ancient Mesoamerica* 25:239-250.

Chase, Diane Z.
1981 The Maya Postclassic at Santa Rita Corozal. *Archaeology* 34(1):25-33.

1982 Spatial and Temporal Variability in Postclassic Northern Belize. Dissertation, Department of Anthropology, University of Pennsylvania, Philadelphia, PA.

1985 Ganned But Not Forgotten: Late Postclassic Archaeology and Ritual at Santa Rita Corozal, Belize. In *The Lowland Maya Postclassic*, edited by A. F. Chase and P. M. Rice, pp. 104-125. University of Texas Press, Austin, TX.

1986 Social and Political Organization in the Land of Cacao and Honey: Correlating the Archaeology and Ethnohistory of the Postclassic Lowland Maya. In *Lat Lowland Maya Civilization: Classic to Postclassic*, edited by J. A. Sabloff and E. W. Andrews, pp. 347-377. University of New Mexico, Albuquerque, NM.

1990 The Invisible Maya: Population History and Archaeology at Santa Rita Corozal. In *Prehistoric Population History in the Maya Lowlands*, edited by T. P. C. a. D. S. Rice, pp. 199-213. University of New Mexico Press, Albuquerque.

1992 Postclassic Maya Elites: Ethnohistory and Archaeology. In *Mesoamerican Elites: An Archaeological Assessment*, edited by A. F. Chase and D. Z. Chase, pp. 124-135. University of Oklahoma Press, Nroman, OK.

Chase, Diane Z. and Arlen F. Chase
1988 *A Postclassic Perspective: Excavations at the Maya Site of Santa Rita Corozal*. PARI Monograph 4. Precolumbian Art Research Institute, San Francisco.

1989 Routes of Trade and Communication and the Integration of Maya Society: The Vista From Santa Rita Corozal, Belize. In *Coastal Maya Trade*, edited by H. McKillop and P. Healy, Peterborough, Ontario, Canada.

2004 Santa Rita Corozal: Twenty Years Later. *Research Reports in Belizean Archaeology* 1:243-255.

2008 Late Postclassic Ritual at Santa Rita Corozal, Belize: Understanding the Archaeology of a Maya Capital City. *Research Reports in Belizean Archaeology* 5:79-92.

Clark, John
1988 The Lithic Artifacts from La Libertad, Chiapas, Mexico: An Economic Perspective. In *Papers No. 52, New World Archaeological Foundation*. Brigham Young University Press, Provo, UT.

Clark, John and Douglas Bryant
1997 A Technological Typology of Prismatic Blades and Debitage from Ojo de Agua, Chiapas, Mexico. *Ancient Mesoamerica* 8(2):111-136.

Edwards, Clinton R.
1978 Pre-Columbian Maritime Trade in Mesoamerica. In *Mesoamerican Communication Routes and Cultural Contacts*, edited by C. Navarrete and T. Lee. New World Archaeological Foundation, Provo, UT.

Ferguson, Jeffrey
2012 X-Ray Fluorescence of Obsidian. In *Handheld XRF for Art and Archaeology*, edited by A. N. Shugar and J. L. Mass. Leuven University Press, KU Leuven, Belgium.

Frahm, Ellery
2016 Can I get chips with that? Sourcing small obsidian artifacts down to microdepitage scales with portable XRF. *Journal of Archaeological Science* 9:448-467.

Glascock, Michael D. and Robert H. Cobean
2002 Summary of Elemental Concentration Data for the Obsidian Source Groups in Mexico. In *A World of Obsidian: The mining and trade of Volcanic Glass in Ancient Mexico*, edited by R. H. Cobean, pp. 239-277. University of Pittsburgh, Pittsburgh.

Golitko, Mark and Gary Feinman
2015 Procurement and Distribution of Pre-Hispanic Mesoamerican Obsidian 900 BC - AD 1520: s Social Network Analysis. *Journal of Archaeological Method and Theory* 22:206-247.

Hartman, N
1980 A Preliminary Microwear Analysis of Obsidian from Santa Rita Corozal, Belize. *MSCA Research Papers in Science and Archaeology* 1(5):136-140.

Hirth, Kenneth
1998 The Distributional Approach: A New Way to Identify Market Place Exchange in the Archaeological Record. *Current Anthropology* 39(4):451 - 476.

2008 The Economy of Supply: Modeling Obsidian Procurement and Craft Provisioning at a Central Mexican Urban Center. *Latin American Antiquity* 19(4):435-457.

2009 Craft Production, Household Diversification, and Domestic Economy in Prehispanic Mesoamerica. *Archaeological Papers of the American Anthropological Association* 19(1):13-32.

Hirth, Kenneth, Bradford Andrews and J. Jeffrey Flenniken
2006 A Technological Analysis of Xochicalco Obsidian Prismatic Blade Production. In *Merchants, Markets, and Exchange in the Pre-Columbian World*, edited by K. Hirth and J. Pillsbury, pp. 63-95. Dumbarton Oaks Pre-Columbian Symposia and Colloquia, Washington D.C.

Kidder, Alfred V.
1947 *The Artifacts of Uaxactun, Guatemala*. Carnegie Institute of Washington, Washington D.C.

Marino, Marc, Lucas Martindale Johnson and Nathan Meissner
2015 Postclassic Tool Production at Santa Rita Corozal: Implications for Domestic Craft Production and Regional Exchange in Flaked Stone. In *Perspectives on the Ancient Maya of Chetumal Bay*, edited by D. Walker, pp. 251-263. University Press of Florida, Gainesville, FL.

Masson, Marilyn
2000 *In the Realm of Nachan Kan*. University of Colorado Press, Boulder, CO.

Masson, Marilyn and David Freidel
2012 An Argument for Classic-Era Maya Market Exchange. *Journal of Anthropological Archaeology* 31:455-484.

Millhauser, John K., Lane Fargher, Verenice Y. Heredia Espinoza and Richard Blanton
2015 The geopolitics of obsidian supply in Postclassic Tlaxcallan: A portable X-ray fluorescence study. *Journal of Archaeological Science* 58:133-146.

Millhauser, John K., Enrique Rodríguez-Alegría and Michael D. Glascock
2011 Testing the accuracy of portable X-ray fluorescence to study Aztec and Colonial obsidian supply at Xaltocan, Mexico. *Journal of Archaeological Science* 38:3141-3152.

Popelka-Filcoff, Rachel
2006 Applications of Elemental Analysis for Archaeometric Studies: Analytical and Statistical Methods for Understanding Geochemical Trends in Ceramics, Ochre, and Obsidian, Department of Chemistry, University of Missouri-Columbia, Columbia, Mo.

Sabloff, Jeremy and William Rathje
1975 The Rise of Maya Merchant Class. *Scientific American* 233(4):72-82.

Seidita, Max
2015 Chetumal's Dragonglass: Postclassic Obsidian Production and Exchange at Santa Rita Corozal, Belize, Department of Anthropology, University of Central Florida, Orlando, FL.

Shackley, M. Steven
2011 An Introduction to X-Ray Fluorescence (XRF) Analysis in Archaeology. In *X-Ray Fluorescence Spectrometry (XRF) in Geoarchaeology*, edited by M. S. Shackley, pp. 7-44. Springer, New York.

Sheets, Payson
2000 Provisioning the Ceren Households. *Ancient Mesoamerica* 11(2):217-230.

Sidrys, Raymond
1976 Classic Maya Obsidian Trade. *American Antiquity* 41:449-464.

Smith, Michael
2003 Key Commodities. In *The Postclassic Mesoamerican World*, edited by M. Smith and F. Berdan, pp. 117-125. The University of Utah Press, Salt Lake City, UT.