Obsidian Utilization in the Moquegua Valley through the Millennia

By: Patrick Ryan Williams, David A. Reid, Donna Nash, Sofia Chacaltana, Kirk Costion, Paul Goldstein, Nichola Sharratt

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Keywords: obsidian | Moquegua Valley, Peru

Article:

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Chapter 10

Obsidian Utilization in the Moquegua Valley through the Millennia

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Abstract

We review obsidian acquisition and utilization at sites in the Moquegua Valley, Peru from the Formative Period through the Late Horizon (*c.* 0–1500 CE). We examine sources represented through time, as well as quantities of obsidian recovered from excavation contexts at a variety of sites excavated by the authors (MAS survey, Cerro Baúl, Cerro Mejía, Yahuay Alta, Tumilaca la Chimba, Capanto, Las Peñas, Sabaya, Torata Alta, Camata, and Tacahuay). Our results indicate that the Middle Horizon (600–1000 CE) was the principal period of obsidian use in the region, and that fall-off models indicate that Cerro Baúl served as a centralized distribution center for obsidian from the major sources during this time. Despite the importance of obsidian in other Andean regions during periods outside the Middle Horizon, our data indicate that the Moquegua region participated only tangentially in obsidian procurement in the absence of the Wari state, and that even the Inca Empire did not make obsidian a principal product of exchange during its apogee.

Introduction

The Moquegua valley in southern Peru is one of the more prevalent small valleys on the western watersheds of the Andes. It has been the subject of intensive archaeological investigation for four decades and as a result, provides a unique case study for obsidian utilization through time. In recent decades, dozens of archaeological sites have been surveyed or excavated by the authors. In the case of excavations, we have employed a similar high precision methodology for recovery of micro-artifacts and debitage at archaeological sites. The sites we have investigated span two millennia of principally farming communities under differing political hegemonies. The differential use of obsidian in these settlements provides perspective on the role obsidian played in the political economy of different societies through time.

In the South-Central Andes, archaeologists note that farming and irrigation agriculture began as early as the second millennium BCE (Formative Period). It was not until the first millennium CE, however, that early state societies began colonizing the Western valleys of southern Peru. Among these were the Middle Horizon states of Wari and Tiwanaku. These rival entities expanded along the spine of the Andes' mountains from Cajamarca to Moquegua in the case of Wari, and from the eastern valleys of Bolivia to the western valleys of Moquegua and south in the case of Tiwanaku. The Moquegua valley is the primary locale of dual colonization by both entities over the course of four centuries.

After the collapse of the Middle Horizon states, balkanized polities emerged, including the archaeological cultures of Tumilaca, Chiribaya, and Estuquiña in the Moquegua Valley. Elsewhere, the Colla, Lupaca, and Pacajes cultures held sway, and in the Cusco region, the Inca arose. This was the Late Intermediate Period landscape of competition and scarce water resources that heralded periods of rivalry and warfare, with the Inca arriving as victors and beginning the conquest of much of the Andean mountains from Ecuador to Chile. The Inca consolidated power across the Andes in the

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Late Horizon, establishing the New World's largest indigenous empire.

The dataset we employ to address the role of obsidian in sociocultural development is the result of forty years of fieldwork in the valley by the authors and by early colleagues in the Contisuyo research program. We sample sites from time periods ranging from the Formative Period (2000 BCE – 600 CE), Middle Horizon (600 – 1000 CE), Late Intermediate Period (1000 – 1400 CE) and Late Horizon (1400 – 1532 CE), and our sample includes both surface survey as well as excavated contexts. We have incorporated sites excavated from each time period using a similar excavation recovery methodology to ensure comparability. The excavated sample does not rely only on sites from which obsidian was recovered, since the absence of obsidian use is an important data point for our analysis as well.

We begin by examining the sources of obsidian through time, noting relative abundance at different settlements and comparing the distribution of source material at contemporary sites with the most material to that with the least material. Methods of analysis and instrumentation are the same as those detailed in Reid *et al.* (this volume). Our analysis illustrates that obsidian was scarce in settlements prior to 600 CE and was represented by sources relatively close to the valley (within *c.* 200 kilometers distance). Between 600 and 1000 CE, obsidian procurement exploded in the valley, and is strongly correlated with the expansion of the Wari state. Wari state sites have the most obsidian, and it predominantly is associated with sources closer to the Wari capital and affiliated with Wari state distribution networks. Obsidian use drops off precipitously in the Late Intermediate Period, with only a few pieces recovered in extensive excavations and none of them have been sourced. The Late Horizon is also only represented by four obsidian fragments across five excavated sites.

In order to model obsidian use, we turn to an analysis of excavated obsidian, including debitage too small for sourcing via pXRF. We examine the average weight per implement, density of obsidian objects and debitage, and ubiquity of obsidian across settlements to assess the relative importance of obsidian in each community. This analysis is most illuminating for the Middle Horizon period when obsidian was an important commodity. We collect the same data for the earlier Formative period and the Late Intermediate and Inca periods, though the data principally illustrate the paucity of obsidian use during these times. For the Middle Horizon, measures of obsidian density, average implement weight, and ubiquity demonstrate that the Wari state settlement on the summit of Cerro Baúl had the largest obsidian objects with the highest density of material and the greatest ubiquity of obsidian across the settlement among all sites sampled. The smallest pieces of obsidian, regardless of source, with the lowest densities and ubiquities on site for the time period were the Tiwanaku related settlements around Cerro Baúl. Even these Middle Horizon settlements, though, eclipsed the statistics for obsidian presence in the Formative, LIP, and Late Horizon sites in the sample. That is, even the most challenged obsidian users of the Middle Horizon had greater access than their predecessors or successors.

Our assessment of obsidian prevalence provides new data on how obsidian distribution and consumption can be modeled across a region (see Ortega *et al.* 2013; Renfrew 1975; Torrence 1986 for a Neolithic perspective). It is dependent on the rich and extensive excavated dataset that has been developed over four decades in the study region, and so will not be applicable in regions without this level of research fieldwork. Nonetheless, the nuanced data it provides illustrates how states can set up hierarchical distribution networks that dominate an economic assemblage, but also co-exist with more dispersed economic networks that supply sites not participating in the state system. This shadow economy or secondary network provides goods that have become important under the economic forces driven by the politics of the primary state to those operating on the margins of that network, or outside of it entirely. The prevalence of diverse obsidian sources in the Tiwanaku settlements follows this model. In order to assess the assertions here, we now turn to a description of the sites represented in our analysis.

Sites Represented in the study

We compile data from dozens of archaeological sites in the study that have been part of systematic archaeological investigation by the authors. Some were only investigated superficially through pedestrian survey, while fourteen were systematically excavated, often through extensive area excavations of activity areas measuring hundreds of square meters (Figure 10.1; Tables 10.1, 10.2). These fourteen excavated sites range from the Formative Period through the Late Horizon and are dispersed throughout the temporal sequence with a slight bias to Middle Horizon settlements (note that only sites with sourced obsidian recovered are listed in Table 10.1 and some sites in Table 10.1 are split into distinct sectors). This is supplemented by sites more representative of other time periods in the middle valley Moquegua Archaeological Survey directed by Goldstein.

Table 10.1. Obsidian sources by site (excavated sites without sourced obsidian: Capanto, Las Peñas, Colorado Mogoté, Sabaya, Torata Alta, Camata, Tacahuay, and Punta Picata); FM: Formative Period, MH: Middle Horizon, LIP: Late Intermediate Period, LH: Late Horizon[1]

Site	Alca-1	Alca-4	Alca-5	Alca-7	Anillo	Chivay	Quispisisa	Potreropampa	Unknown	Total
Recovered in Excavations (pXRF)										
Yahuay Alta FM	0	0	0	0	0	0	0	0		0
Yahuay Alta MH	19	0	0	0	0	2	3	0		24
Cerro Baul MH	205	0	0	0	1	10	33	2		251
Baul Slopes MH	8	0	0	0	0	5	7	0		20
Cerro Mejia MH	22	0	0	0	0	0	14	5		41
Mejia Slopes MH	42	6	2	2	0	4	29	0		85
El Paso MH	1	0	0	0	0	0	1	0		2
Tumilaca la Chimba MH	19	0	0	0	1	11	8	7		46
Chen Chen MH	0	0	0	0	0	1	0	0		1
Omo MH	8	1	10	0	3	2	6	0	1	31
										501
Collected in Archaeological Survey (pXRF)										
Calaluna Montalvo FM						2				2
Huaracane FM						1				1
Perro Muerto FM	1					1				2
Que Calor FM	1					1				2
Tres Quebradas FM						2				2
Yanahuara FM	1									1
Cerro Echenique MH	2					1				3
Cerro Trapiche MH	5									5
										18
Collected in Archaeological Survey (INAA) - Burger et al. 2000										
Cerro Baul MH	70	0	0	0	0	3	7	8		88
Omo MH	2	0	0	0	0	2	1	3		8
										96
									TOTAL	615

[1] While a new classification for the Alca sources has recently been proposed (see Burger *et al.* 2021), results here are based on traditional source classifications for the region.

Table 10.2. Obsidian Average weight, Density and Ubiquity in several of the collections excavated by the authors (not represented: Omo and Chen Chen)

Collection	Sector	Ct	Wt (g)	Avg Wt (g)	m2 excavated	count/m2	g/m2	ubiquity
Yaway FM		0	0.00	0.00	237	0.00	0.00	0.00
Yaway MH		77	60.82	0.79	320	0.24	0.19	0.10
MH Sites								
Baul02	A	308	347.00	1.13	297	1.04	1.17	0.47
Baul02	C	49	108.70	2.22	44	1.11	2.47	0.55
Baul02	K	74	39.80	0.54	61	1.21	0.65	0.62
Baul02	L	7	18.10	2.59	86	0.08	0.21	0.05
Baul02	N	8	1.30	0.16	86	0.09	0.02	0.07
Baul02	FGHI	6	1.20	0.20	222	0.03	0.01	0.04
Mejia 2000, 8–9	Slopes	1505	148.98	0.10	702	2.14	0.21	0.36
Mejia 2000, 2011	Summit	779	141.64	0.18	591	1.32	0.24	0.26
Tumilaca la Chimba (sourced only)		46	57.90	1.26				
Tumilaca Phase (all material)		96	67.70	0.71	292	0.33	0.23	0.21
Estuquiña Phase		1	0.10	0.10	245	0.00	0.00	0.004
LIP Sites								
Colorado Mogote/Las Peñas/Capanto		0	0.00	0.00	>1000	0	0	0
LH (Inca) Sites								
Sabaya & Torata Alta		3	12.50	4.17	>200	<.02	<.03	<.015
Camata		0	0.00	0.00	>200	0	0	0
Tacahuay & Punta Picata		1	0.80	0.80	>200	<.005	<.005	<.005

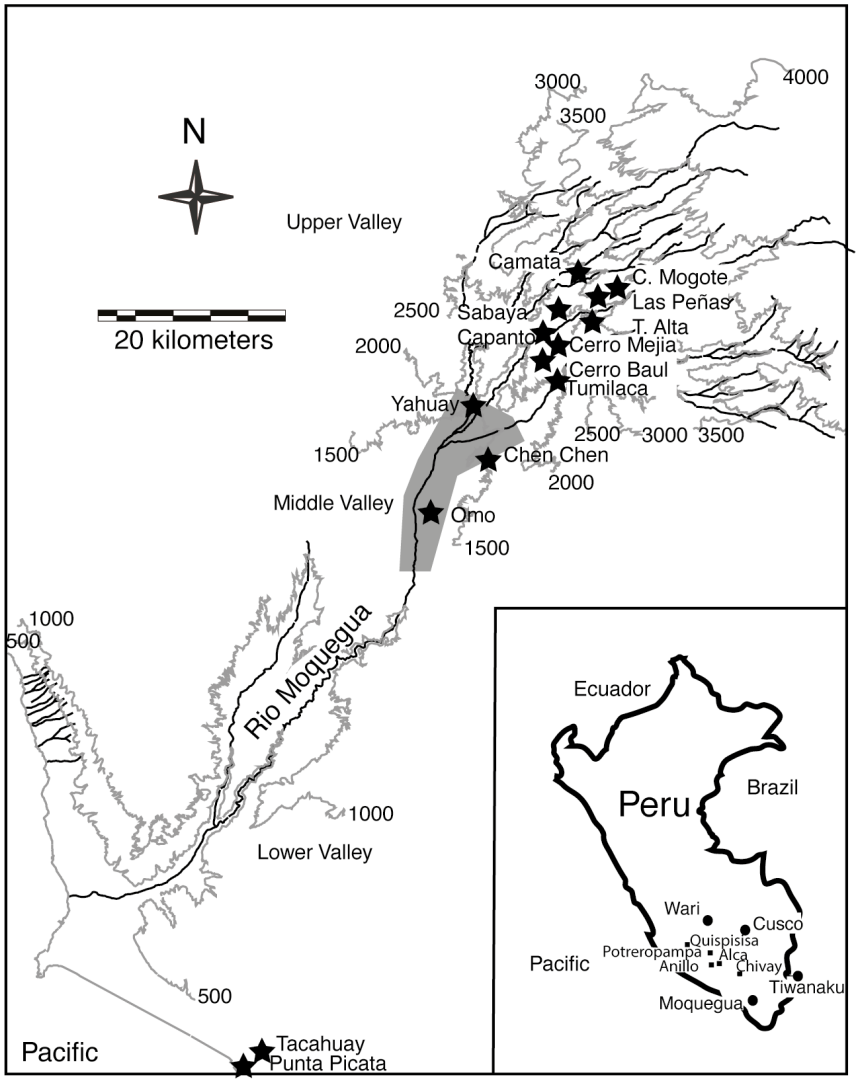

Figure 10.1. Map showing excavated sites and the MAS survey region (in gray) represented in this study. Location map shows study region in reference to principal obsidian sources and the ancient capital cities of Wari, Tiwanaku, and Cuzco.

The Middle Valley settlements (Omo, MAS survey and Contisuyo Collections)

The Middle Valley obsidian assemblage is represented by both excavated and surface collected archaeological materials (Reid *et al.* i.p.), including Goldstein's excavations at the Tiwanaku site of Omo (Goldstein 1989, 1993, 2013, 2015; Goldstein and Sitek 2018) and the residential sectors at Chen Chen (Goldstein and Owen 2001, Goldstein 2005). The dataset also includes obsidian collected during surface survey of the Moquegua Archaeological Survey (MAS), directed by Paul Goldstein, and by other surveys and excavations conducted by the Programa Contisuyo. These include the Formative Period sites of Perro Muerto, Que Calor, Tres Quebradas, Yanahuara, and Calaluna Montalvo from the MAS survey and Huaracane from Contisuyo collections. The Contisuyo collections from Cerro Echenique and MAS collections from Cerro Trapiche are complemented by Goldstein's excavations at Omo for the Middle Horizon data set. The largest group of obsidian recovered in this data set comes from the Tiwanaku site of Omo M16, with 28 obsidian objects sourced (Reid *et al.*, i.p.).

Yahuay Alta

Yahuay Alta is situated high upon the southwestern flanks of Cerro Estuquiña, one of the mountains that demarcates the boundary between the upper and middle valley sections of the Moquegua valley. The site was excavated by Costion in 2006 (2009, 2013) and had both Formative Period and early Middle Horizon occupations. Yahuay Alta was an atypical Huaracane settlement in that it is located at a significantly higher elevation above the riverbed in comparison to typical Huaracane settlements in the middle valley. Yahuay Alta is also the only Huaracane settlement with large-scale public architecture in the form of a monumental platform mound-plaza complex (see Costion 2013:

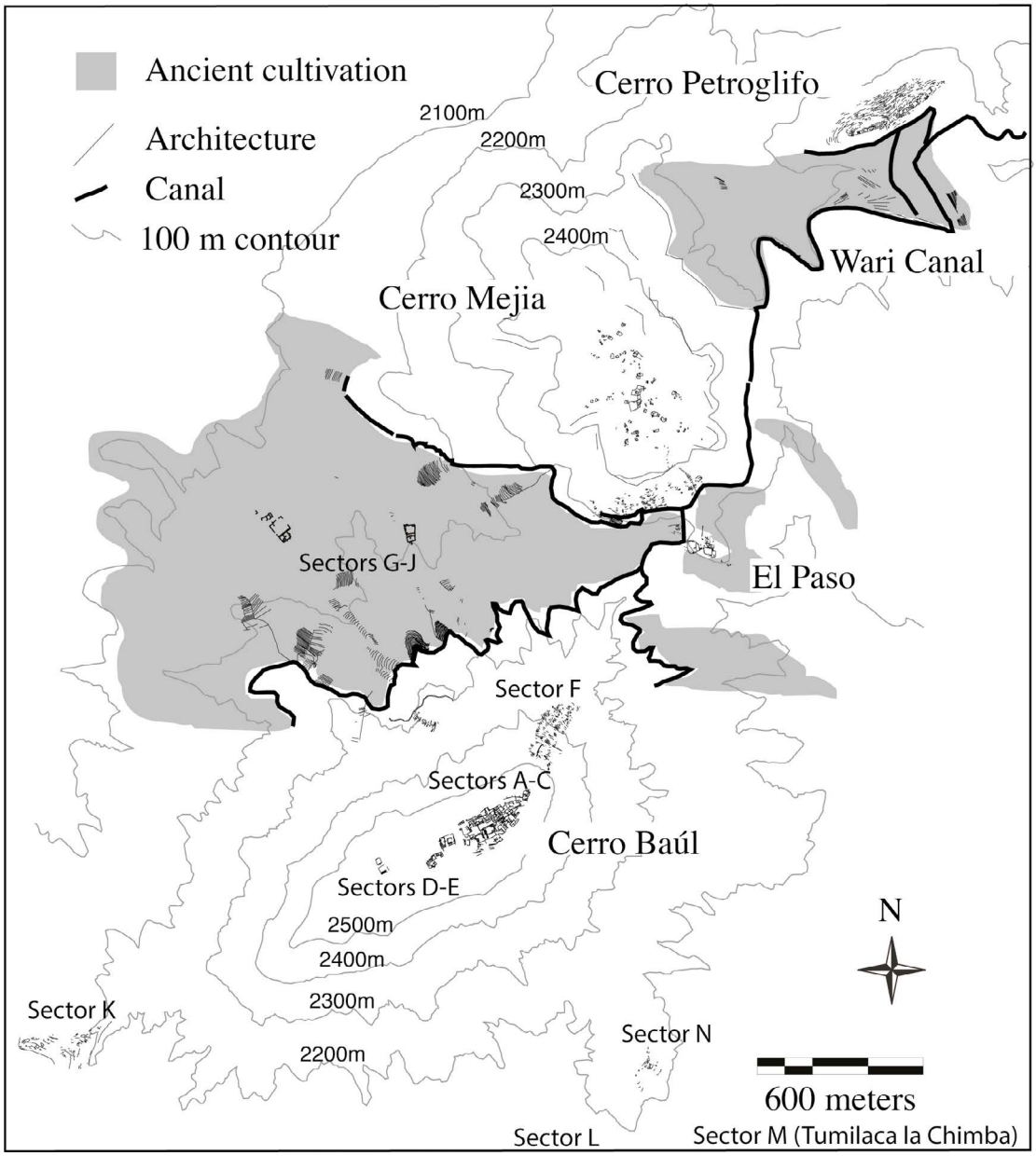

Figure 10.2. Map of the Cerro Baúl colony and environs, highlighting the distinct sectors with differential obsidian presence.

Figure 3, Sector B). Obsidian at Yahuay Alta was found only in the five excavated contexts that dated to the Middle Horizon, four of which are located in the eastern half of the site in relatively close proximity to the platform mound-plaza complex (Costion 2009).

Cerro Baúl and Cerro Mejía

These two sites represent the primary Wari occupations in the Moquegua Valley. Cerro Baúl is located on the summit of a kilometer long mesa that towers in the upper Moquegua valley. Its slopes contain settlements of both Wari and Tiwanaku affiliation. While most obsidian is concentrated in the summit contexts representing elite residence, administrative and religious architecture, and artisan production facilities that are overwhelmingly affiliated with Wari occupation, obsidian does also appear in limited quantities in the surrounding villages and are included in this assemblage. Cerro Mejia is located adjacent to Cerro Baúl and contains intermediate elite architecture on its summit, and smaller households in neighborhoods on its slopes. The obsidian assemblage used here draws on excavations conducted on Cerro Baúl in 1989 by Robert Feldman and excavations by Williams and Nash from 1997–2016 (Williams 2001; Nash 2012, 2017; Nash and Williams 2009, 2021). We also include an assemblage of material sourced by Richard Burger from surface collections at the site (Burger *et al.* 2001).

Cerro Mejia was excavated by Donna Nash between 1999 and 2011, and the dataset here represents sourced material from those excavations on both the summit and slopes of the mountain. The summit of Cerro Mejía is approximately 100 meters below that of Baúl.

Mejía's summit was demarcated by a thick boundary wall, where sheer cliffs were not present, and surmounted via a wide staircase on the southern slope facing Cerro Baúl. The summit has more than fifty large residential compounds, which are spread out rather than agglutinated like those on Baúl. Three of these have been excavated to some degree and contribute to this sample. The slopes were dotted with terraced dwellings that were divided by walls and canyons into several neighborhoods. The sample comes from the excavation of eleven Wari-affiliated houses of different size and construction style (Nash 2017). One house may have been occupied by a specialist who shaped points and other tools because a high concentration of obsidian reduction waste was found in a single small room. All houses at the site had very small obsidian debitage of the type generated by sharpening or edge maintenance (Nash 2012).

Tumilaca la Chimba

Tumilaca la Chimba is a settlement on the slopes of Cerro Baúl that spans the terminal Middle Horizon to the Late Intermediate Period. It is the type site for the Tumilaca archaeological culture, a late Tiwanaku cultural component. First excavated by Romulo Pari (1980) and then the Programa Contisuyo, the dataset analyzed here was excavated by Nicola Sharratt between 2006 and 2016 (Sharratt 2019). The Tumilaca phase (*c.* 950–1250 CE) occupation includes residential structures, four cemeteries, and a non-domestic community structure (Sharratt 2016; Sharratt *et al.* 2012). This occupation is partially covered by a second Estuquiña phase (*c.* 1250–1450 CE) occupation. However, no obsidian was recovered from contexts securely associated with the Estuquiña occupation, with one fragment recovered from a mixed context (Sharratt 2020). Obsidian included in the present study were excavated from five Tumilaca phase residential structures, which varied in size, architectural complexity, and construction quality, as well as from Tumilaca style burials located in two of the cemeteries, and from the community structure.

Capanto, Las Peñas, and Colorado Mogoté

These are small later Late Intermediate Period (1200–1450 CE) sites circumscribed by defensive walls. Capanto and Las Peñas may have been occupied into the Inca Era, whereas the sample from Colorado Mogoté is small and inconclusive in this regard. These three sites were sampled by Nash and Chacaltana in 2012 and extensive excavations at Las Peñas were directed by Nash in 2015 and 2016. Capanto is located near the modern town of Torata, a low hill near the floodplain. The ceramic assemblage from Capanto includes Tumilaca, Estuquiña, Gentilar, San Miguel, and local variations of Inca style wares (see also Bürgi 1993:156). Materials from the other two sites are more modest with few to no decorated vessels and domestic assemblages overlapping with other Estuquiña settlements. They are both located on narrow ridges oriented perpendicular to the Torata river and have small to moderately sized terrace dwellings along the top and west face of the ridge. Las Peñas has a *capilla* with a cross that is celebrated in May every year, although no prehistoric ceremonial feature has been identified at the chapel.

Sabaya, Torata Alta, and Camata

These three sites date to the Late Horizon and Torata Alta was occupied into the early Colonial Period. Sabaya was the Inca provincial capital of the upper Moquegua valley, while Camata was an important local settlement and *tambo* along the Inca road connecting Torata to the Inca centers of the altiplano (Dayton 2008; Chacaltana 2014, 2015). Torata Alta is an early colonial *reducción* in the upper valley, which may also have been occupied during the Inca period. The sites of Sabaya and Camata were excavated by Peter Burgi in the late 1980's (1993), and Torata Alta was likewise excavated by Programa Contisuyo archaeologists at that time (Van Buren 1993; deFrance 1993). The datasets discussed here from Sabaya and Torata Alta were excavated by Sofia Chacaltana in 2013 and from Camata in 2006 (Chacaltana *et al.* 2010).

Tacahuay and Punta Picata

Tacahuay is a Late Intermediate site occupied during the Inca period. It has been suggested it was a coastal enclave from the altiplano settled in order to extract coastal resources via building socio-economic alliances between elites (Chacaltana 2017). During the Inca period this site was part of a complex network of exchange of a variety of materials (ceramics, metal objects, Inca wood vessels or keros, etc); however, according to the excavations it did not include obsidian.

Punta Picata is a Late Intermediate site of a specialized fishing community occupied during the Inca period. It was excavated in 2010 by members of the Program of Investigations Tacahuay Tambo and Punta Picata directed by Alfredo Bar (Bar 2010) (Chacaltana 2015; deFrance and Olson 2013). Excavations at this site did not recover obsidian materials or fragments; nonetheless, it used and was a local quarrying source of *coquina* (maritime grain-stone) (deFrance and Olson 2013).

The Sources of Moquegua Valley Obsidian Through Time

While human settlement in the Moquegua valley dates back over 12,000 years (deFrance *et al.* 2001), our focus is on the permanent, settled agricultural populations that emerged at the beginning of the second millennium BCE, where we have permanent settled villages with long term occupations. Archaic period settlers used obsidian and inhabited temporary settlements throughout the valley, including at Asana, where a dozen obsidian flakes dating to 9000 years ago with at least some from the Chivay source were recovered (Aldenderfer 1998:157, 163). This early use of obsidian in the valley demonstrates that regional networks of obsidian exchange flourished once humans colonized the continent and the region. Our sample begins with Formative settlements dating to several thousand years later, and in concert with the introduction of pottery and settled agricultural villages in the region.

The Late Formative Period (400 BCE–600 CE)

During the Formative Period, small villages thrived along the middle Valley floodplain, farming the immediately adjacent low terraces along the Moquegua River. The upper valley was sparsely populated with few documented settlements at this time. Formative villages may have been organized into irrigation communities along a short irrigation canal that provided a level of supra-village integration (Williams 2020). They maintained sporadic connections with distant societies including Pukara and Nasca (Goldstein 2000), and a few exotic goods arrived into these communities through these connections. Even so, it appears that obsidian was not generally counted among the most valued of these exotic goods during this time.

In fact, obsidian was relatively scarce in Moquegua during the Late Formative period. A total of 10 fragments of obsidian were recovered from Formative sites in the MAS survey from six distinct sites (Table 10.1). No more than two obsidian objects came from any one site (Reid *et al.*, i.p.). The assemblage is dominated by the Chivay source, with 70 % of obsidian, with Alca-1 representing the other 30 %. Chivay is the closest high-quality source to Moquegua. Quispisisa, which becomes important in the following Middle Horizon, is absent from the Formative Period assemblage, and unlikely a sampling issue. As the furthest source from Moquegua and in the vicinity of Wari's heartland, it apparently only appears with later Wari expansion. Even so, given that these are surface finds, it is possible that these obsidian objects were deposited on the sites after their abandonment, perhaps by Middle Horizon folks who utilized obsidian much more extensively. The excavations in the Formative contexts at Yahuay Alta are telling in this regard. No obsidian was recovered from the Formative components at Yahuay Alta, despite employing the same excavation methodology as in the Middle Horizon contexts at the site where a substantial assemblage was recovered (Costion 2009; Green and Costion 2017).

Across the continental divide and in the high plains beyond the Moquegua Valley, the cave site of Quillqatani indicated that Formative period pastoralists in the high plains utilized a higher percentage of obsidian in the lithic assemblage than prior and subsequent occupants of the small rock shelter (Aldenderfer 1999). The pattern of obsidian paucity that we document was not necessarily a generalized pattern, but one that characterized the agrarian communities of the Pacific watershed valleys in the South-Central Andes. It is significant that obsidian was present among these agriculturists, but in low levels that indicate it was not a primary commodity for these communities.

The Middle Horizon (600–1000 CE)

The Middle Horizon saw the most widespread use of obsidian in the history of Moquegua. Driven principally by obsidian consumption at Cerro Baúl and the sites with which it interacted, obsidian use was pronounced at sites affiliated with Wari influence. In terms of raw numbers, Cerro Baúl, and to a lesser extent Cerro Mejia, dominate the assemblage of sourced obsidian in the valley. Of the 615 obsidian objects in this analysis, over half come from Cerro Baúl and nearly one quarter from Cerro Mejia. At these two sites, Alca-1 obsidian predominates the assemblage, representing nearly 80% of the sourced assemblage at Baúl and over 50% at Cerro Mejia. Quispisisa obsidian represents 14% of the sourced assemblage at Baúl and 34% at Mejia.

In the Middle Valley Middle Horizon sites, associated with Tiwanaku contexts, obsidian was relatively rare, as Tiwanaku settlers used other materials for most lithics. A total of only 48 obsidian objects were found in Tiwanaku contexts and all were sourced (Reid *et al.* i.p.). Here, only 35% of the obsidian is Alca-1, with Quispisisa only competing with many other sources for second place, including Alca-5/Charaña, Anillo, Chivay, and Potreropampa. This pattern is replicated at the terminal Tiwanaku site of Tumilaca la Chimba on the slopes of Cerro Baúl, where 46 sourced objects were composed of 41% Alca-1, with Chivay, Quispisisa, and Potreropampa each accounting for 15–24% of the assemblage.

The site of Yahuay Alta provides an interesting contrast to the Tiwanaku source assemblage, despite being in the Middle Valley. Here, nearly 80% of the assemblage of 24 sourced obsidian objects is Alca-1, while Chivay and Quispisisa represent around 10% of the assemblage each. This assemblage makeup strongly parallels the

assemblage at Cerro Baúl and suggests that Yahuay residents likely obtained most of their obsidian through the Cerro Baúl obsidian network, rather than through the more diverse and meager obsidian network that supplied Tiwanaku settlements.

One explanation for Yahuay's dependence on Baúl obsidian is that it is located along the likely road between Cerro Baúl and the Wari realms further north (Williams, i.p.). This same road likely passed through the nearby settlement of Cerro Trapiche, which also contained a Wari style brewery (Green and Goldstein 2009). The small sample of obsidian (n=5) sourced from the Trapiche site as part of the Mid Valley Middle Horizon assemblage was 100% Alca-1.

Thus, there appear to be two distinct obsidian exchange networks in place in Moquegua during the Middle Horizon. The most prolific of these was the Wari obsidian network, focused on Alca-1 and to a lesser extent Quispisisa. Quispisisa may have been more important earlier in the Wari expansion and was outpaced by Alca-1 obsidian later in time (Williams *et al.* 2012: 84). This exchange system supplied the site of Cerro Baúl with an overwhelming proportion of the sourced assemblage in this network. We hypothesize that from Baúl, obsidian was distributed to clients and allies at sites like Cerro Mejia and Yahuay Alta, and perhaps Cerro Trapiche. Some of this obsidian may also have found its way to Tumilaca la Chimba through secondary exchange or scavenging after Wari actors left. And some of it inevitably made its way into the Tiwanaku sites of the Middle Valley.

The second network was a more diffuse, less centralized network of obsidian exchange that brought some obsidian to the Tiwanaku settlements in the valley. Alca-1 was still a part of this network, but it did not supply the majority of obsidian to these settlements. Alca-1 still represents a plurality of obsidian used by the Tiwanaku groups, and it was likely obtained through informal exchange with the Wari network. Other smaller sources, often closer to Moquegua, are also well represented. The Charaña source, located in the highlands of nearby Tarapaca, is one of the lower quality sources represented in the assemblage (Burger *et al.* 2021). It can be easily confused chemically with Alca-5 when measured with p-XRF, which is why we list it here as Alca-5/ Charaña. Chivay, the closest high-quality source of obsidian and a favored source for the Tiwanaku heartland, is also represented, but in relatively small numbers compared to its prevalence in the Formative.

Chivay is also represented in small quantities at Cerro Baúl and Cerro Mejia, and it is instructive to observe where Chivay obsidian is found in those settlements. At Baúl, for example, nearly half of the excavated Chivay objects come from one room of the Tiwanaku temple on the summit of the great mesa (Williams and Nash 2016). Excavations conducted after the 2016 publication recovered nine obsidian points, six of which were sourced to the Chivay source and three to Alca-1, from that context. Meanwhile, one-third of Cerro Baúl's excavated assemblage of Chivay obsidian is from the settlements on the slopes of Cerro Baúl that were primarily populated by Tiwanaku villages dedicated to farming Wari fields in the latter half of the Middle Horizon. Fewer than five Chivay objects come from actual Wari excavated contexts of the more than 250 sourced objects from excavations in this analysis.

Late Intermediate Period (1000–1400 CE)

After the fall of Wari and Tiwanaku, the Moquegua valley obsidian networks collapsed. The site of Tumilaca la Chimba represents the last persistent use of obsidian in a prehispanic settlement in the Moquegua valley, and even this material is relatively scarce, perhaps having been scavenged from Wari settlements after abandonment. The Tumilaca component of this settlement persisted until at least 1250 CE (Sharratt 2019), and it is this component that represents the sourced obsidian assemblage for the site. After 1250 CE, the settlement largely shifted to the northern edge of the site and upslope to the summit of the hill on which it was situated. These contexts are bereft of obsidian and even lacked scavenged objects from the older settlement.

The MAS survey recovered only one object sourced to Alca-1 from the Mid valley associated with the LIP. The middle valley was populated by dozens of archaeological sites during this period, but obsidian use was virtually absent from surface collections (Goldstein 2005). Furthermore, excavations of settlements in the upper valley also reveal a complete absence of obsidian from excavated contexts of late LIP settlements. The sites of Colorado Mogoté, Capanto, and Las Peñas excavated by Nash yielded no obsidian in extensive excavations. They all date to the latter half of the Late Intermediate period.

Late Horizon (1400–1532 CE)

Despite the conquest by the Inca empire in the 15th century CE, the valley did not experience a new boom in obsidian exchange. Excavations by Chacaltana at the Inca administrative capital of Sabaya and the Inka/ early Colonial reduccíon of Torata Alta recovered only three obsidian objects (they have not been sourced). Excavations at Camata Pueblo (LIP) and Camata Tambo (Inca) by Barrionuevo, Chacaltana, and Dayton recovered no obsidian material in the assemblage. Excavations at the site of Tacahuay Tambo and Punta Picata on the Pacific coast south of the Moquegua valley by Chacaltana and deFrance recovered only one

obsidian object in the entire lithic assemblage. While obsidian tools were more ubiquitous in Inca contexts elsewhere in the empire, the Moquegua valley did not experience an "age of obsidian" as it did during the Middle Horizon when the Wari held sway.

The sourced obsidian material provides a perspective on the use of different source material through time. In order to assess the dynamics of obsidian movement between settlements in the different time periods, we now turn to an analysis of the prevalence of obsidian in the sites where is it most pronounced: several of the Middle Horizon settlements on and around Cerro Baúl and the middle valley where comparable data is available. We examine average weight of obsidian implements, density of obsidian material, and ubiquity of obsidian within several large collections of lithic material from different sectors at Cerros Baúl and Mejia, Yahuay Alta, and Tumilaca la Chimba.

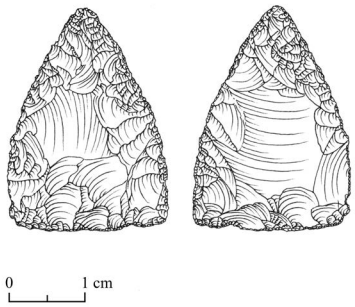

Figure 10.3. Reworked laurel leaf obsidian point CB01-3682 sourced to Alca-1 and recovered from the Sector A Palace complex 9B-B on Cerro Baúl (drawing by J. Seagard).

Modeling Obsidian Use: Average weight, Density, and Ubiquity

Obsidian average weight is probably not a metric of great utility in assessing obsidian prevalence at a site. Unprocessed large nodules would tend to have higher average obsidian weights, while small pressure flakes in the absence of their cores would tend to have lower average weights. Thus, some major differences in obsidian scarcity or stages of production may be reflected in average weights. However, any obsidian use context where implements are accompanied by sharpening by flaking would tend to result in bimodal distributions of obsidian weight and be of little utility.

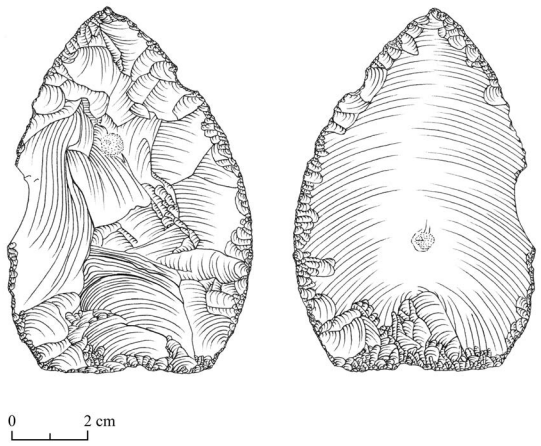

Figure 10.4. Obsidian pre-form CB07-41-0384 sourced to Alca-1 and recovered from the Sector A Palace Complex 41A-D2 on Cerro Baúl (drawing by J. Seagard).

There are some interesting patterns in the average obsidian piece weight in the data from the 2002 excavations at Cerro Baúl (Figure 10.2). In sectors A, C, and K, obsidian average weights range from 0.5g to 2.2g per fragment (Table 10.2). If we remove pressure flakes under 0.2g in weight from the equation, implement average weights vary from 1.5g to 2.7g in these assemblages (Figures 10.3–5). Compared to the average obsidian weights from the Tiwanaku related contexts in sector excavations (F, G, H, I, and N), these average weights are substantially greater than those from Tiwanaku houses on the slopes of the mesa. In these sectors, average weights are around 0.2g per fragment regardless of whether we remove the smaller pressure flakes from the sample.

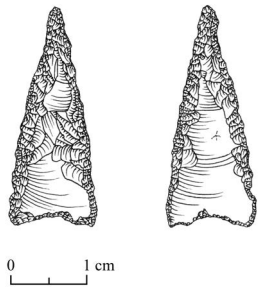

Figure 10.5. Obsidian drill CB02-09-1149 sourced to Alca-1 and recovered from the Sector A Palace Complex 9G-B on Cerro Baúl (drawing by J. Seagard).

For Cerro Mejia's excavated context based on Nash's excavations in 2000, 2008, 2009, and 2011, average weights of obsidian objects were 0.10g in houses on the slopes of the mountain while summit residences and workshops of the intermediate elite had an average obsidian piece weight of 0.18g. This means that obsidian

pieces on Mejia were 5 to 10 times smaller than on Cerro Baúl by weight. And Mejia summit obsidian was on average twice the size of obsidian from houses on the slopes. The smaller size in slope houses may reflect that these less wealthy households practiced more reduction and worked with smaller and smaller fragments than their wealthier counterparts. They may also have produced more retouch flakes and sharpened obsidian more than their more prosperous neighbors.

Meanwhile at the Middle Horizon contexts at Yahuay Alta, average weight of an obsidian implement was 0.79g, approaching the range of average weight for the Cerro Baúl pieces. It is possible that this site has retouch flakes and small fragments under-represented, but it nevertheless falls within the range of average implement weight. Thus, we can say that in Wari contexts at Cerro Baúl and Mejia, and perhaps at Yahuay Alta, there is a mixed set of implements and flakes from sharpening and working the material. Meanwhile, the Tiwanaku contexts around Baúl are characterized by smaller fragments of obsidian and are generally lacking larger implements weighing upwards of 1g. This systematic collection of obsidian, which is not reliant on minimum obsidian size that is present in the sourcing study materials, provides some insight into the differential use of obsidian in the distinct contexts.

We do note that the average weight of obsidian from Tumilaca la Chimba is 0.71g per implement. This includes the obsidian that was too small for sourcing from the Tumilaca phase contexts. These contexts date to the end of Wari influence in the Middle Horizon and a couple centuries after the departure of Wari state officials. Tumilaca la Chimba residents continued occupying their area until approximately 1250 CE, and their use of obsidian includes periods when Wari exchange networks were active as well as after the presumed collapse of those networks. Tumilaca residents would likely have had access to material scavenged from Wari sites after the departure of the Wari dwellers and the abandonment of their settlements on Cerro Baúl and Cerro Mejia.

Obsidian density per excavated site area may be a more indicative measure of obsidian presence. At Cerro Baúl, obsidian weight per square meter excavated ranged from 1.17g to 2.47g in contexts on the summit of the mesa (Table 10.2). Sector K, the site with elite Wari pottery on the western slope, was close behind with 0.65g per square meter. Moving further downstream, Yahuay Alta's Middle Horizon contexts had 0.19g of obsidian recovered per square meter excavated. At Cerro Mejia, just upstream from Baúl, weights per square meter excavated ranged from 0.21g on the slopes to 0.24g on the summit. Meanwhile, obsidian densities for Tiwanaku related contexts on the slopes of Cerro Baúl ranged from .01g in sectors F, G, H, and I to 0.02g in sector N and 0.2 g in sector L. These latter examples fall clearly on the lower end of obsidian densities despite their proximity to the Cerro Baúl summit. They are decidedly residential contexts with a non-Wari, Tiwanaku identity based on ceramics present. At Tumilaca la Chimba, weights per meter square are 0.23g, closer to the Mejia and Yahuay Alta numbers, though radiocarbon dates for Tumilaca Phase La Chimba are later than those sites and may represent increased access from scavenging after Wari abandonment.

Obsidian counts per square meter, another measure of density, can be highly influenced by reduction strategies and use, as well as the type of material (retouch flakes, large implements) present at the site. Still, we note that counts per square meter on Cerro Baúl range from 1 to 1.2 implements and counts per square meter on Cerro Mejia range from 1.3 to 2.1 pieces per square meter. Meanwhile, Yahuay Alta had 0.24 obsidian objects per square meter, and the Tiwanaku contexts on the slopes of Cerro Baúl ranged from 0.03 to 0.09 obsidian fragments per meter square excavated. At Tumilaca la Chimba, counts were closer to Yahuay Alta with 0.33 fragments per square meter.

Both these measures of obsidian density, weight per square meter and count per square meter, indicate that the summit contexts on Cerro Baúl had the highest measures of obsidian presence in the contemporary settlements examined. And the lowest measures of obsidian density were in the Tiwanaku related residential contexts on the slopes of the mountain. Comparative data from Tiwanaku settlements downstream should be similar to those from the slopes of Cerro Baúl.

Ubiquity measures for obsidian vary substantially by site as well and are perhaps more indicative of the commonality of use of obsidian at a site. Ubiquity controls for the size of excavation as well as diminishes the importance of singular large caches or pieces of material, and thus is more reflective of the spatial spread of obsidian use in any particular context. At Cerro Baúl during the 2002 excavation season, obsidian was present in 47% of the square meter excavation units in sector A, the palace and artisan residence area (Table 10.2). It was present in 55% of the meter squares in sector C, the D-shaped temple annex. At the Wari residential site of Pampa del Arrastrado (sector K), it was present in 62% of the excavation square meter units. At Cerro Mejia, obsidian was present in 36% of the meter squares in houses on the slopes of the mountain. Elite residences and workshops on the summit of the mountain had obsidian present in 26% of the meter squares excavated. Mejia summit residences were much more ample in their spacing and had the

capacity to dedicate certain areas for obsidian use, whereas slope residences were much smaller, as they were at Pampa de Arrastrado, and thus floor areas were more often multi-craft spaces.

Meanwhile, in the excavations in the primarily Tiwanaku related sectors N and L (El Tenedor and Santa Rita in the Tumilaca valley side of Cerro Baúl), it was present in only 7% and 4% of the excavation square meter units, respectively. Yahuay Alta had a ubiquity of 10% based on Costion's excavations at the site (Table 10.2). At Tumilaca la Chimba, Sharratt documented a ubiquity measure of 21% in the Tumilaca Phase contexts, while it was only 0.4% in the later Estuquiña phase contexts.

The obsidian average weight, density, and ubiquity data indicate that the summit of Cerro Baúl was the locale with the largest obsidian objects, with the highest density by count and weight of obsidian material and the greatest ubiquity of obsidian in all the sites sampled. The smallest pieces of obsidian, with lowest density and lowest ubiquity were located in the Tiwanaku related sectors on the slopes of Cerro Baúl, with the exception of Tumilaca la Chimba, which may partially reflect increased access in the waning days of Wari influence. Other Wari influenced settlements fell between these measures. Cerro Mejia had low average implement weights, but higher average counts per square meter. Ubiquity, however, was lower overall, though not as low as the Tiwanaku cases. At Yahuay Alta, average implement weight was higher than at Mejia, but obsidian density by count and weight was lower. This might suggest obsidian reduction was more pronounced at Mejia than elsewhere, reflecting intensive use of the material. Pampa del Arrastrado (Sector K), meanwhile, had the highest ubiquity for obsidian, and high density by count of the sites sampled. Density by weight and average weight of obsidian objects were somewhat lower than the summit contexts on Cerro Baúl. It is closest to Cerro Baúl in terms of the obsidian assemblage present, though the objects are roughly half the size as those on the summit.

Given these patterns, Cerro Baúl appears to be the locale where obsidian accumulated through Wari import networks to the valley. The largest objects and the density and ubiquity are highest at this site and its sector K outpost. We hypothesize that closely affiliated settlers at sites like Cerro Mejia and Yahuay Alta likely received obsidian directly from Cerro Baúl in a down the line exchange from their close political ally. Meanwhile settlements further removed from the Cerro Baúl interaction sphere likely obtained obsidian from low-level exchange with Wari allies or from scavenging abandoned Wari settlements for small pieces of obsidian. It is possible that some Tiwanaku settlements like Tumilaca la Chimba may have obtained obsidian directly from Cerro Baúl as close political allies despite their use of Tiwanaku pottery and domestic practice.

Obsidian weight, ubiquity, and average weight and counts per meter excavated are all virtually nil for the Late Intermediate Period and the Late Horizon, despite extensive excavations at sites from these periods. Nash, for example, found no obsidian in excavations at Colorado Mogote, Las Peñas, or Capanto, despite excavations exceeding 1000 square meters in house structures. Sharratt's excavations at Tumilaca la Chimba were roughly split between Tumilaca phase contexts (950–1250 CE) and Estuquiña phase contexts (1250–1450 CE). Yet the latter context only had one small piece of obsidian recorded in surface levels. The pattern is similar for Late Horizon sites excavated by Chacaltana, where hundreds of square meters of excavation at Tambo Tacahuay and Punta Picata on the Pacific coast recovered only one obsidian implement. Excavations in the highland sites of Camata, Sabaya, and Torata Alta in the immediate environs of Cerro Baúl recovered 3 obsidian implements. These pale in comparison to the prevalence of obsidian in the Middle Horizon Wari sphere.

Discussion and Conclusions

Obsidian represents a material commodity that relied on state networks for distribution during the Middle Horizon. Unlike ceramics, which were not widely imported (Williams *et al*. 2019) by the Wari or Tiwanaku states, obsidian played a significant role in Wari distribution networks, although it remained a rarity in Tiwanaku sites. Archaeologists often rely heavily on ceramic distributions in assessing political hegemony, but in this case, obsidian from the Alca-1 and Quispisisa sources is one of the best proxies for participation in Wari exchange networks of the Middle Horizon in Moquegua. Interestingly, obsidian is not an effective proxy for assessment of participation in state exchange networks during the Inca period.

One interesting note is that obsidian, which became such an important commodity during the Middle Horizon, was more accessible to Wari allies than to Tiwanaku peoples. Tiwanaku tended to have access to far less obsidian material, but obsidian from more diverse sources. Much of the more diverse source material came from smaller sources closer to the use context, as opposed to the more distant sources like Quispisisa or Alca-1. There also may be more continuity in small scale obsidian use between the Formative period, when it was used at low levels, and the non-Wari networks of the Middle Horizon, where white chert and other lower quality materials, such as dacite and rhyolite, dominate the lithic assemblage.

After the end of the Wari and Tiwanaku states, obsidian use drops out of the regional exchange systems almost entirely, perhaps due to a breakdown in long distance procurement networks. This mirrors a general decrease in the complexity and intensity of regional cross-cultural interactions during this time period (Costion and Green 2018). Even so, regional sources like Charaña or Chivay are no longer in use in the LIP either. Perhaps with the drop in the use of obsidian overall with the loss of the Wari and Tiwanaku state networks, demand for obsidian as a commodity in general fell off entirely. Even the relatively poor quality local and regional sources were no longer worth pursuing. Obsidian was a ritually charged and symbolic item in Middle Horizon networks and used in cache offerings for ritual payments to mountain deities, linked to ensure continued supplies of water resources in addition to other benefits (Glowacki and Malpass 2003). Perhaps a collapse of the association of obsidian with ritual offerings as well as a collapse of high quality obsidian networks accounted for the complete drop-off in the use of obsidian.

The Late Horizon did not replicate the demand for obsidian that was seen during the Middle Horizon. While access increased slightly since the Late Intermediate Period, obsidian was neither ubiquitous nor extensively used as it had been during the second half of the first millennium CE. This is certainly not the case across the Andes; the Inca occupations of highland Ecuador extensively exploited regional obsidian sources for implements on an actively contested frontier (Ogburn *et al.* 2009). However, the extent of obsidian use varied greatly across the Inca empire. Anecdotally, it does appear that Wari obsidian was much more accessible and ubiquitous in use at Wari and Wari influenced settlements across the Andes, and especially in other regions in the southern highlands (see Reid *et al.*, this volume).

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