QUARRYING EVIDENCE AT THE QUISPISISA OBSIDIAN SOURCE, AYACUCHO, PERU

Nicholas Tripcevich and Daniel A. Contreras

Artifacts made from Quispisisa obsidian are widely disseminated in the Peruvian Andes, but the geological source of the Quispisisa geochemical type was only recently located in southern Ayacucho. Following the positive identification of the source in 1999 by Richard Burger and colleagues, we found evidence of broad quarrying activities in unexplored portions of the source area. We describe 34 quarry pits, some as large as 80 m across, together with evidence of early-stage lithic reduction at the source. We encountered high concentrations of reduction debris associated with more extensive knapping in two localities, but our preliminary evaluation of surface evidence suggests that much of the material quarried was removed from the area as intact nodules or after minimal reduction at the source area.

Los estudios geoquímicos de la obsidiana en los Andes Centrales han demostrado que la gran mayoría de los artefactos prehispánicos hechos de obsidiana se produjeron utilizando materia prima de ocho fuentes, cada una de las cuales es distinta en términos de composición geoquímica. De las ocho fuentes, material de Alca, Chivay, y Quispisisa predomina en las colecciones de todas las épocas prehispánicas. El tipo geoquímico de obsidiana llamado Quispisisa ocupa una posición importante en la historia del Perú prehispánico, pues herramientas hechas de este material se han encontrado en muchos sitios de la costa y sierra de la parte norcentral del país. Esos sitios se caracterizan por encontrarse dispersos en un amplio marco espacial y temporal, pues algunos se ubican en lugares distantes de la fuente y corresponden a épocas diversas, inclusive, algunas de ellas tan antiguas como el Precerámico Temprano. A pesar de esa importancia evidente, hasta la fecha solo se había ubicado la fuente, y faltaba cualquier exploración y registro detallado de los afloramientos de obsidiana y de los rasgos de explotación humana de la zona. A partir del año 2007 Tripcevich y Contreras visitaron la fuente ubicada por Richard Burger y sus colegas en la zona de Huanca Sancos, Ayacucho; posteriormente en el año 2009 los autores, con el apoyo de unas colegas, ampliaban las investigaciones y como producto de ello han revelado que el área geográfica que abarca la fuente de obsidiana tipo Quispisisa es mucho más extensa de lo que se había pensado. Asimismo, han logrado documentar la existencia de varios rasgos de explotación de la fuente tales como: pozos de cantera, lascas de reducción inicial de material, y caminos, los mismos que evidencian la presencia de la actividad de la cantería de obsidiana a una escala única en los Andes.

Evidence of the procurement and processing of lithic material that circulates throughout large areas provides archaeologists with insights into technological change, social interaction on a regional scale, and the relationship among valued materials, technology, and sociopolitical developments. In the Central Andes of South America, the limited number of sources of fine-grained material for stone tools and the demand for relatively rare material like high-quality obsidian resulted in wide geographical distributions of obsidian during much of the prehispanic period. These distributions shed light on the nature of interaction between coastal and highland communities and patterns of regional interaction over time. In the Central Andes, geochemical studies (summarized in Glascock et al. 2007) have shown that material from three principal obsidian sources, Alca, Chivay, and Quispisisa (Figure 1), dominates obsidian assemblages in the region from all prehispanic time periods, even in areas far removed from the geological sources.

In this article we examine the procurement of one of the most widely distributed of these South

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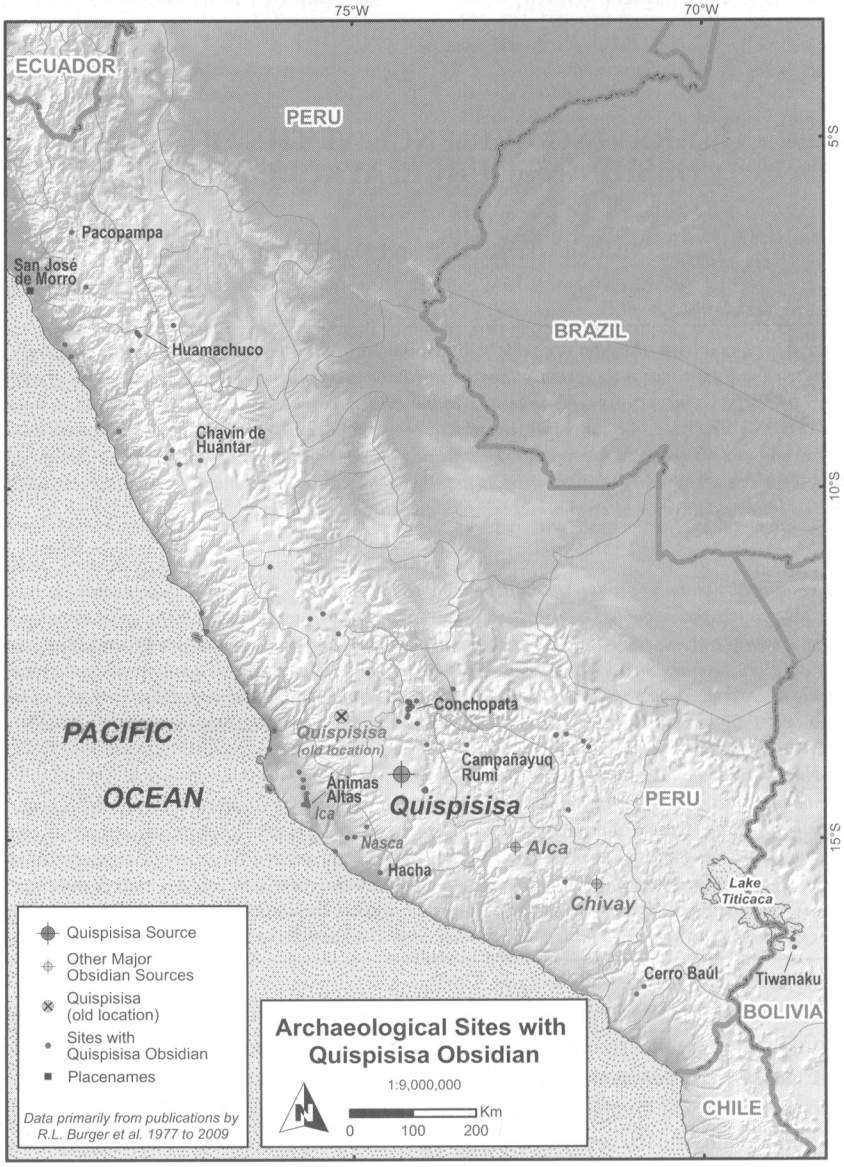


Figure 1. Map showing the geological source locations of the three obsidian types with the widest artifactual distributions in the Central Andes and sites that contain identified Quispisisa obsidian. Sites and regions mentioned in the text are labeled.

American obsidians, a geochemical type known as "Quispisisa," which was first identified in the late 1970s in a broad study by Richard Burger and Frank Asaro (1977). This initial research demonstrated that the Quispisisa type was prevalent in obsidian artifact assemblages from northern and central Peru. More recently, Richard Burger and Michael Glascock (2000, 2002) definitively identified the geological source area using samples collected from southern Ayacucho, Peru. However, in spite of its importance in Andean prehistory, the Quispisisa source area remains minimally explored. Here we report the results of recent reconnaissance trips during which we documented evidence of prehispanic obsidian quarrying at the Quispisisa source on a scale not previously described anywhere in South America.

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History of Research into the Quispisisa Obsidian Type

In the 1970s Andean archaeologists began to systematically examine the prehispanic distributions of portable artifacts made from nonperishable and geochemically distinct materials like obsidian (Burger and Asaro 1977; Burger et al. 2000; Glascock et al. 2007). Early research into the use of x-ray fluorescence and neutron activation analysis for geochemical sourcing of archaeological obsidian in the Central Andes by Burger and Asaro (1977) at Lawrence Berkeley Laboratory identified an obsidian source that contributed the majority of the obsidian in archaeological collections from northern and central Peru throughout the duration of the prehispanic period. This geochemical type was first recognized in artifactual samples and named "Quispisisa type" from the Quechua term for shattered glassy stone (Burger and Glascock 2002:342–343). The geological source of this obsidian was initially thought to be located in the San Genaro area of Huancavelica in south-central Peru, but in 1999 the correct location of the geological source of Quispisisa obsidian was identified by Burger and colleagues in Ayacucho (Burger and Glascock 2000, 2002), 130 km to the southeast of the originally assigned location (Figure 1).[1] Quispisisa obsidian is remarkable for its prevalence in sites throughout north and central Peru, as well as for the long distances that it was transported in prehistory. Artifacts made from Quispisisa obsidian are encountered in small but persistent quantities at sites many days' travel from the source beginning ca. 1800 cal B.C. For instance, at the second-millennium B.C. site of Hacha, 156 km distant from the source in the coastal valley of Acarí, two-thirds of the 53 obsidian samples tested came from the Quispisisa source, and by the first millennium B.C. Quispisisa obsidian is found consistently at Chavín de Huántar, 580 linear km to the north of the geological source (Burger and Asaro 1977; Burger and Glascock 2009; Burger et al. 1984:264; Burger et al. 2006:107; Nado 2007). Quispisisa obsidian was transported as far as the site of Pacopampa, nearly 1,000 km north of the source (see Figure 1; Burger 1984; Burger and Glascock 2009).

The actual location of the Quispisisa source was identified in 1999 during a brief reconnaissance trip (Burger and Glascock 2000, 2002) among lava flows south of the towns of Sacsamarca and Huanca Sancos, in the south-central Peruvian department of Ayacucho. Burger's team visited one major outcrop of obsidian in the area and collected samples that eventually confirmed the geological origin location of the Quispisisa obsidian type. However, due to time limitations they were unable to further explore the source area. A regional geological summary (Castillo M. and Barreda A. 1973; Castillo M. et al. 1993:12) describes the formation containing the obsidian as corresponding to the Plio-Pleistocene geological unit known as the Barroso Group (TQ-ba), where it contacts the underlying Lower Miocene Castrovirreyna Formation (Tm-c). The Barroso Group consists primarily of lavas with breccias and volcanic agglomerates, while the top layers of the underlying Castrovirreyna Formation are described as containing brown breccias in a tuffaceous matrix atop a sandy light tuff (Burger and Glascock 2002:355; Castillo M. et al. 1993:50–55).

In July 2007 and August 2009 we visited the Quispisisa source area in order to collect geological samples of obsidian and explore any associated archaeological features. The goal was to conduct further archaeological exploration in the area of the deposit encountered by Burger's team and to investigate outcrops in the region and better document the extent and variability of the Quispisisa type. The broad distribution of Quispisisa obsidian throughout the Central Andes is testament to its importance in prehistory, and we sought evidence related to prehispanic intensification of activities at the source and the type of labor involved in obsidian extraction and initial reduction.

The Cerro Jichja Parco Outcrops at the Quispisisa Source

The 1999 reconnaissance trip led by Burger identified a single exposure of Quispisisa-type obsidian, eroding from a bluff on the east side of the Urabamba River (Figure 2), referred to locally as "Queshqa" (Burger and Glascock 2002). During field visits in 2007 and 2009 we were able to confirm that this exposure is part of a larger rhyolite dome complex, and artifact-quality obsidian matching the Quispisisa geochemical signature is available in multiple locations. In addition, we have

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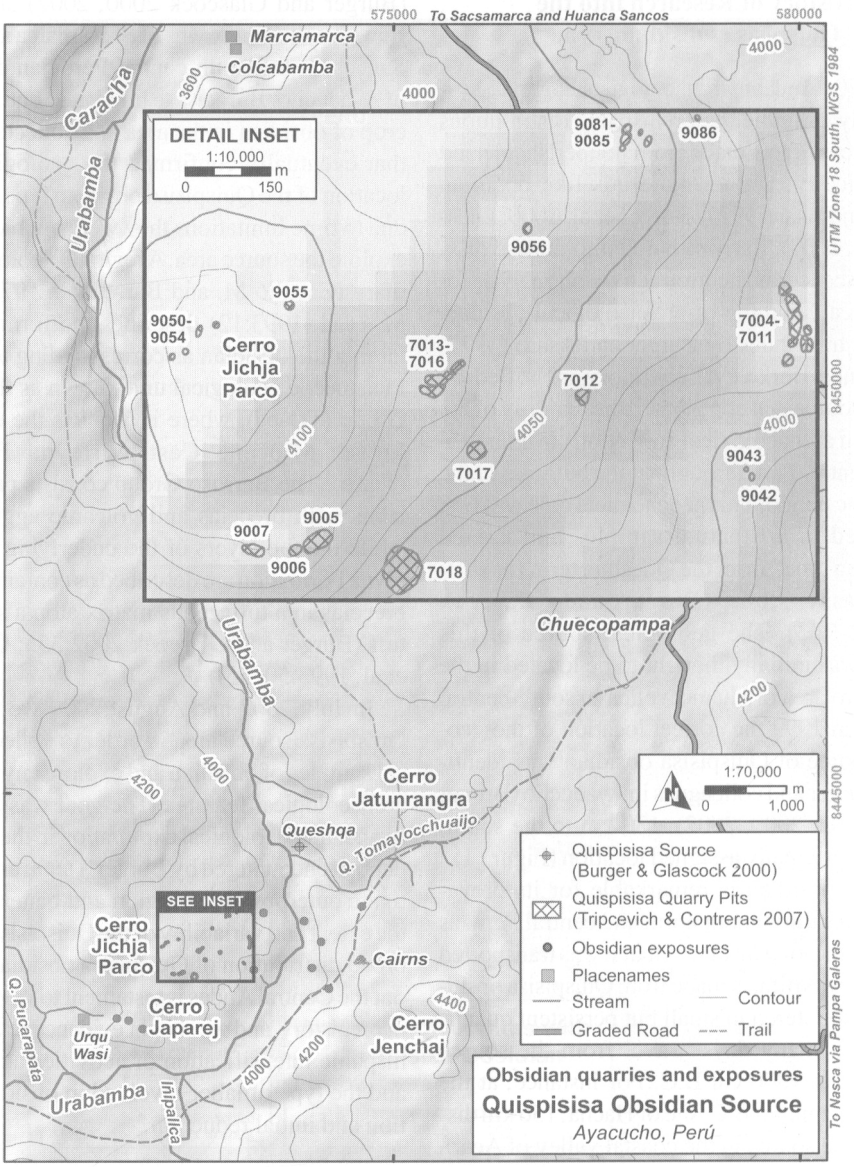


Figure 2. Map showing obsidian exposures and quarry pits (with ID numbers) at the Quispisisa source area together with locations mentioned in the text.

documented evidence of obsidian extraction on a scale not previously reported anywhere in South America.

In the Quispisisa source area the east bank of the Urabamba River contains multiple obsidian-bearing exposures. Accessing the source involves hiking for several hours along a prehispanic route from Chuecopampa, on the gravel highway that links the modern towns of Nasca and Huanca Sancos, to the Urabamba River (see Figure 2). Following this prehispanic route, one enters the Urabamba River valley from the east after climbing through a band of rhyolite and approaching the Urabamba River from the east. The first obsidian deposits we encountered along this path were thin (< 5 cm) bands of heavily fractured obsidian in a matrix of tephra and perlite; we collected samples here but did not encounter any nodules of sufficient size to be useful as toolmaking material. Continuing west, the path crosses a low ridge that forms a

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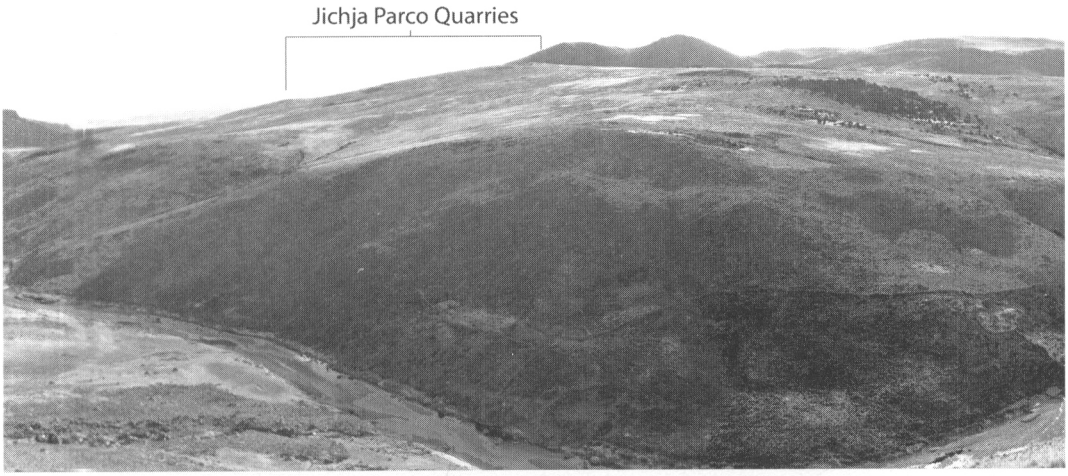


Figure 3. Photo of Cerro Jichja Parco from across the Urabamba River.

sloping apron of rhyolite where over 50 small stone cairns (known locally as *sayllua*) have been constructed, as well as an *apacheta* (a larger pile of stones) and at least two *huanca* (single stone slabs standing on end). *Apacheta* are features associated with Inca road systems, while *sayllua* are apparently both Inca and pre-Inca, and *huanca* are generally associated with much earlier construction, dating as far back as the Formative period. Such features are frequently encountered at ritual locations and major passes in the Andes. They are still constructed today, but the practice dates to the prehispanic period. While the examples here remain undated, the *apacheta* and *huancas* suggest that they have considerable antiquity, and the many single-column, unstable *saylluas* in this area appear to be maintained. It therefore seems that this route passing through the Quispisisa source area has remained a significant one for local peoples (Dean 2006; Jett 1994; Kuznar 2001:50–52). In addition to these features on the exposed shoulder of the hill, segments of slab paving and stone steps remain on the trail itself in this area. This road segment apparently forms part of the Qhapaq Ñan route that runs from the Palpa-Nasca zone on the coast inland and north, where it splits and has branches running to both Vilcashuaman and Huamanga (Yuri Cavero, personal communication 2009).

From this high point, the trail then descends to the east bank of the Urabamba River and crosses a tributary stream. It is along this slope that large nodules of obsidian are first encountered when approaching the obsidian source from the east. On the west side of the Urabamba River, across the river from the deposit encountered by Burger's team, lies Cerro Jichja Parco, a hill rising approximately 200 m from the river, dissected by a few small drainages (Figure 3). The alluvial deposits in these drainages are predominantly obsidian, and the exposed stratigraphy also includes a significant quantity of obsidian. Nodules in these contexts ranged in size up to approximately 30 x 20 x 10 cm (Figure 4). These secondary deposits reflect alluvial and colluvial processes rather than in situ flows, however, and the drainages appeared geomorphically active enough that visible surfaces in them are unlikely to be precolumbian in age. We collected samples from material available on the surface and in these small drainages. At the heads of several of these small dissected drainages, on both sides of the Urabamba River beginning approximately 100 m above river level, in situ obsidian flows are exposed by erosion, and these flows are clearly the donors for the material available in alluvial contexts farther downslope (Figure 2). Nodules in these areas range up to 35 cm in size but are predominantly less than 20 cm on their long axes.

Obsidian nodules large enough to be practical for knapping purposes and glassy enough to serve as high-quality raw material for toolmaking are thus available in multiple locations today. These locations are centered on Cerro Jichja Parco, but substantial nodules are also available above the east bank of the Urabamba River both east of Jichja Parco and to the north below Cerro Jatunrangra, where Burger and colleagues (2000)

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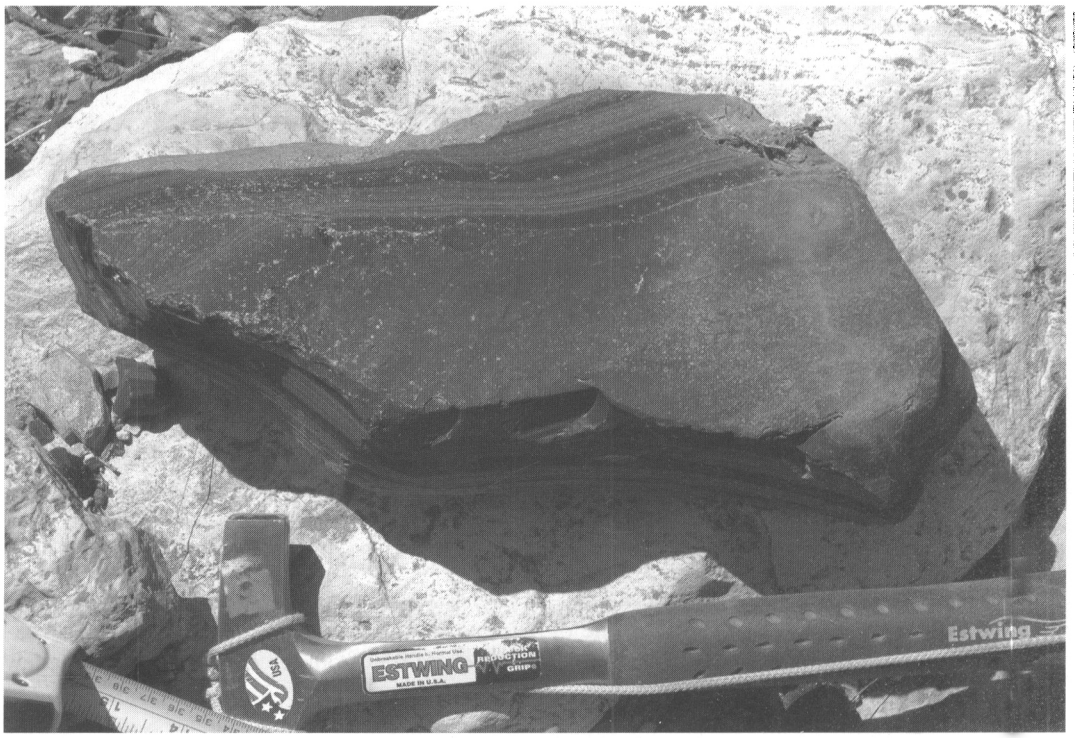


Figure 4. Photo of large obsidian nodule in one of the drainages descending the eastern slope of Cerro Jichja Parco.

encountered the Queshqa obsidian flow in 1999 (Figure 2). Survey of the alluvial gravels of the Urabamba River indicates the limits of the source material. Upriver of Jichja Parco to the south, where the Iñipallca River flows into the Urabamba, survey in the riverbed revealed only a few small obsidian cobbles. Farther upstream (west) along the Urabamba, above the confluence with the Quebrada Pucarapata, a riverbed survey revealed no obsidian nodules that did not show cultural modification. In contrast, these are abundant in the stretch of the river that flows at the foot of Cerro Jichja Parco. To the north at the confluence of the Urabamba and Caracha rivers, 12 km downstream of Jichja Parco, small obsidian cobbles are available in the Urabamba but nonexistent in the Caracha. These observations indicate that obsidian is not apparently available in the Caracha drainage and that upstream of the Río Iñipallca and the Quebrada Pucarapata it is likely either absent or available only in small quantities. Several local informants corroborated this impression, indicating that obsidian is available in large quantities (Figure 2) on Cerro Jichja Parco and on the east banks of the Urabamba and only in reduced quantities elsewhere.

Moreover, the obsidian cobbles available as alluvial material in the Urabamba River seem to rapidly diminish in size: survey at the confluence of the Urabamba and Caracha rivers, 12 km downstream of the source, did not recover any nodules larger than ~5 cm in diameter. Obtaining nodules large enough for knapping purposes, at least in any quantity, would thus seem necessarily to have involved a visit to the Jichja Parco area itself or at least to the Urabamba River immediately downstream of Jichja Parco.

The slopes of Cerro Jichja Parco are dissected by small drainages and extensively vegetated with ichu and other puna bunchgrasses, exposing concentrations of small obsidian fragments but without any visible rocky outcrops; nodules were generally smaller than those visible in drainage gullies. While it is likely that the alluvial deposits and surface nodules were exploited in prehistory, they do not appear to provide access to sufficient raw material to have served as the primary source of Quispisisa obsidian in the past. Indeed, as we

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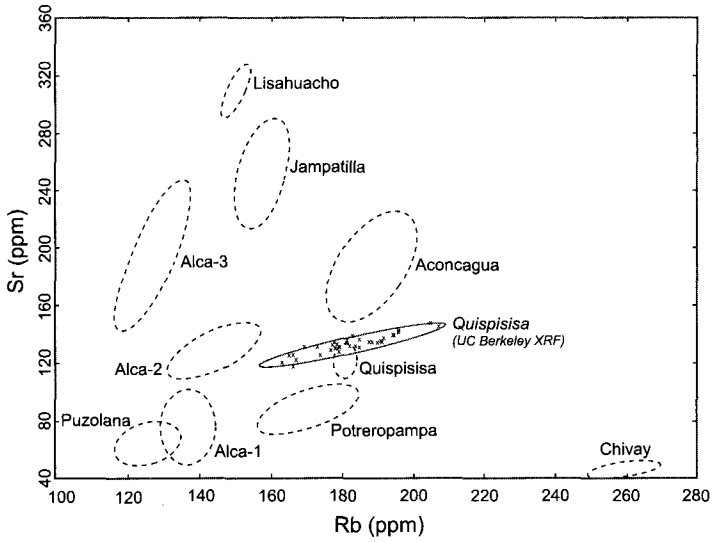


Figure 5. Plot of Sr vs. Rb from x-ray fluorescence (XRF) analysis of samples from Peruvian obsidian sources with confidence ellipses at the 95 percent level. Dotted ellipses are traced from Glascock et al. 2007:Figure 5. The dotted Quispisisa obsidian ellipse is based on 17 samples from one locality. Point values and the solid ellipse show the results of our XRF analysis (n = 34) on the Quan-X instrument at the Archaeological XRF Lab at the University of California, Berkeley.

discuss below, there is substantial evidence that subsurface flows on Cerro Jichja Parco were heavily exploited.

Geochemical Characterization of Obsidian from the Quispisisa Area

Unmodified nodules from each of the zones of the Quispisisa area visited in 2007 and 2009 were characterized by energy-dispersive x-ray fluorescence (ED-XRF) in the Berkeley Archaeological XRF Laboratory, and samples collected in 2007 were analyzed by neutron activation analysis and ED-XRF at the University of Missouri Research Reactor. The sampling strategy focused on (1) exploring the possibility of geographical variability within the Quispisisa source area, (2) determining whether the Queshqa area identified by Burger is an outcrop of the same flow as the Jichja Parco exposures we documented, (3) comparing obsidian from the Quispisisa source flows to other obsidian sources in the immediate region, and (4) comparing obsidian from the Quispisisa source flows to the corpus of artifactual obsidian assigned to the Quispisisa type.

The results from our analyses show that obsidian from the Queshqa flow on the east bank of the Urabamba River and from the Jichja Parco quarries on the west side of the river belong to the geochemical group known as Quispisisa (Burger and Glascock 2000, 2002; Glascock et al. 2007). Preliminary analyses indicate, however, that this larger group of samples from the source shows greater variability within the discriminant elements (e.g., Th, Rb, Mn) than did the samples collected by Burger and colleagues in 1999. The detailed results of these geochemical analyses will be presented elsewhere (Figure 5).

Additionally, we collected samples from "unconfirmed deposits" shown on the map by Burger and Glascock (2000:261, Figure 3). Our visits to these sources established that the flow to the northwest of Huanca Sancos is known locally as Intihuaytana and that it contains good-quality obsidian over an area of 200 m^2, with some evidence of knapping nearby. However, we observed that the unmodified nodules are never more than 5 cm across, limiting the source's utility in prehistory. The unconfirmed deposit shown on the map by Burger and Glascock (2000:261) lying approximately 4 km south of Sacsamarca is not a source area but actually a major obsidian knapping zone at the large prehispanic site of Marcamarca adjacent the modern town of Colcabamba (see the "Lithic Production in Colcabamba" section, below).

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Figure 6. Photo of a midsize quarry pit (9055), with downslope berm visible to the left and Yuri Cavero standing in the pit providing scale. Small, discarded nodules and flake debris are abundant on the ground.

Quarrying at Quispisisa

In 2007, local herder Jesus Vilchez, traversing his familiar grazing land, was able to lead us directly to an area of quarry pits. Fifteen pits were mapped using either a differential GPS polygon or a single GPS point from a recreational GPS together with estimated dimensions. Relatively few artifacts were encountered in association with these quarry pits during our cursory survey, but preliminary reduction flakes are evident along the margins of many of the quarry pits. Further investigation in 2009 expanded the roster of pits to a minimum of 34, distributed over much of the summit of Cerro Jichja Parco (Figure 2) and extending to the south and east. Additional shallow quarries and surface concentrations of obsidian were encountered on Cerro Japarej to the south.

In general, quarry pits were circular or ellipsoidal features in plan view, carpeted with obsidian nodules and surrounded by small discarded nodules and some flake debris (Figure 6). The majority of the pits ranged from 10 m across and 1 m deep to 45 m across and 3 m deep; one larger, irregular pit had a diameter ranging from 68 m to 82 m, and we estimate that it was over 7 m deep. Ellipsoidal pits had approximately 2:3 width-to-length ratios, often with a substantial berm of excavated material downslope of each pit. Areas of less intensive excavation were, in many cases, also visible. These were present as dense scatters of exposed small nodules but without marked changes in topography. In several cases, clusters of pits contoured along the topographic profile of the natural hill, with mounded berms creating a divide between adjacent pit features.

The 34 quarry pits documented thus far are spread over an area of 90 ha and comprise in total a mined surface of at least 13,000 m^2 and an estimated excavated volume of at least 32,000 m^3 (see Table 1). These are minimum estimates, as they represent only those pits roughly mapped in the field; due to limited field time we observed many pits that we were unable to document in detail. Figures are derived from field measurements and/or estimates of the major and minor axes and depth of each roughly ellipsoidal pit. Surface area thus refers to the area of original ground surface cut by the pit,

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Table 1. Measurements of Mapped Quarry Pits Using Either a Differential GPS or Estimated Dimensions and a Single Central GPS Point.

Location ID	Length (m)	Width (m)	Estimated Depth (m)	Estimated Surface Area (m^2)	Estimated Volume (m^3)
7003	20	19	1	298	199
7004	19	13.4	1	200	133
7005	46.2	19.9	2	722	963
7007	30.5	20.8	2.5	498	830
7008	16.2	12.2	1	155	103
7009	28.4	12.3	1	274	183
7010	23.2	10.3	1	188	125
7011	22.3	21.5	1	377	251
7012	13.5	10.6	3	112	225
7013	30.1	11.4	1.75	270	314
7014	13.5	10.6	1	112	75
7015	38.9	18.5	3	565	1,130
7016	43.1	18.6	2	630	839
7017	32.1	30.6	4	771	2,057
7018	82	68	7	4,379	20,437
9005	53	28	2	1,166	1554
9006	23	16	1	289	193
9007	39	18	1	551	368
9042	13	8	.25	82	14
9043	8	6	.25	38	6
9050	10	10	1	79	52
9051	10	12	2	94	126
9052	20	8	2	126	168
9053	10	10	2	79	105
9055	15	15	3.5	177	412
9056	15	20	.5	236	79
9058	15	18	1	212	141
9059	10	15	2	118	157
9081	10	8	1.5	63	63
9082	25	15	4	295	785
9083	20	12	3	188	377
9084	10	6	1	47	31
9085	20	10	2.5	157	262
9086	8	10	2	63	84
Total				13,610	32,842

calculated by π*a*b, where a and b are one-half of the major and minor axes. Volume estimates for each pit are derived by presuming that the pit volume represents one-half of the ellipsoid whose central axis is represented by the surface cut by the pit—thus calculated by 4/3*π*a*b*c, where a and b are half of the major and minor axes and c is the depth. See Darras (1999:93–105) for a more detailed implementation of this approach at the Zináparo-Prieto obsidian quarries in West Mexico.

As large and high-quality obsidian nodules are currently available in erosional exposures throughout the source area (Figure 2), the need for large-scale quarrying in antiquity suggests that these naturally occurring exposures were insufficient to meet momentary need or were temporarily exhausted in the past. We infer that through prehispanic quarrying obsidian nodules were made available that were larger or of higher quality than surface material or that the quantity of material available on the surface was—at least at times—not sufficient to meet demand. Both quarry pits and shallow excavations are characterized by the abundance of small (sub-10-cm) nodules that were apparently discarded during the excavation process (Figure 7).

These quarry areas are also characterized by the presence of primary reduction flakes that appear to

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Figure 7. Photo showing small nodules apparently discarded during the excavation process. Note that some flake debris is also visible.

result from assaying material and/or removing cortex. While quantitative technological analyses of flake debris will be required to reach firm conclusions, our preliminary assessment is that there is little reduction debris from later reduction stages. There was also very little other material culture: while we did note a few hammerstones (Figure 8), clearly cobbles transported from the river below, and one architectural fragment, we saw no other cultural material. Ceramics that might indicate cultural affiliation were conspicuously absent in the quarry area, but it is not uncommon for lithic source areas to be largely devoid of material from other artifact classes. No promising contexts for gaining chronological control for the quarry pits through excavated, dated materials were encountered, and relative dating through obsidian hydration offers promise (Eerkens et al. 2008).

These quarry pits are similar in form to those described by Healan (1997) as "dough-nut quarries" at the Ucareo-Zinapécuaro obsidian source in Michoacán, Mexico. Mexican obsidian sources provide some comparison with the scale of quarrying that occurred at Quispisisa (Cobean 2002; Darras 1999; Holmes 1919:214–227; Pastrana 1998), though these sources are often dominated by the remains of prismatic blade manufacture and sometimes include mine tunnels. It is important to note that no quarrying evidence comparable in scale to that reported here has been reported at any of the Peruvian sources, even following recent investigation at the two other major sources of Alca (Jennings and Glascock 2002; Rademaker 2006; Rademaker et al. 2004) and Chivay (Tripcevich 2007; Tripcevich and MacKay 2011). Evidence of quarrying is limited at both sources: in the Chumpullu Valley at the Alca source Rademaker (2006:154–155; Kurt Rademaker, personal communication 2009) reports a few modest quarry pits, while extensive survey at the Chivay source area revealed only one small ellipsoidal quarry pit measuring 4 x 5 m (Tripcevich 2007:687–692).

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Production Areas

Evidence of simple procurement of obsidian raw material is accompanied at Quispisisa by some remains of lithic production in the source area, although more extensive study will be required to understand the scale and organization of this activity. As is true at many sources of raw material for stone tools worldwide, lithic production zones adjacent to sources were reused over millennia, and identifying chronological variation becomes a complex task. While quarry areas may lack culturally diagnostic materials that provide clear evidence of cultural affiliation, excavation of stratified workshop deposits can shed light on changing reduction strategies and the condition of obsidian being procured (Clark 2003; Darras 1999; Ericson 1984; Torrence 1986). At the Quispisisa source such work remains to be done, but it is now clear that sites suited to such investigation are present.

The morphology of artifacts made from Quispisisa obsidian provides insight about production goals driving extraction strategies at the source. In the Central Andes the production of formal obsidian tools consisted primarily of biface manufacture, resulting mainly in projectile points up to 6 cm in length but typically much smaller (Burger 2007; MacNeish 1983; MacNeish et al. 1980:35–95; Stone 1983). Projectile point forms dating to the Preceramic are generally larger; these were largely replaced by small, triangular forms approximately 1,000 years before the Ceramic period, or by about 3000 cal B.C. (compare with a typology for the south-central Andes by Klink and Aldenderfer [2005] applicable as far north as the departments of Arequipa and Puno). A specific case of use of Quispisisa obsidian in subsequent periods is characterized by Burger (2007), who analyzed 51 complete or nearly complete and 170 partial obsidian bifacial artifacts—all sourced to Quispisisa—that were surface collected by L. Dawson in 1959 from a single-component Ocucaje 9 (late Early Horizon) portion of the Ánimas Altas site in the Ica Valley. The 51 complete and nearly complete bifaces are described as being 96 percent triangular in shape and measuring 2.2 to 5.7 cm in length with a modal length of 3.6 cm (Burger 2007:480). Obsidian has been found at a number of sites in the Nasca and Ica regions, and these materials are derived overwhelmingly from the Quispisisa source in samples from all various prehispanic periods (Burger and Asaro 1979:303–304, 307–308; Eerkens et al. 2010; Vaughn and Glascock 2005).

Some of the largest obsidian bifaces in the Andes, knives over 10 cm in length, have been found in Wari-affiliated sites far from the Quispisisa source. At Conchopata near the capital of Ayacucho a biface measuring 11.4 x 5.9 cm is documented (Bencic 2000:Figure 18), and in Moquegua at Cerro Baúl bifaces measuring 10.5 cm long x 6 cm wide and 9.5 cm long x 6.2 cm wide were encountered in a subfloor cache (Donna J. Nash, personal communication 2009; Vining 2005; Williams et al. 2011). Large points and knives have been found at Wari-affiliated sites elsewhere in Moquegua (Nash 2002; Owen and Goldstein 2001), and large "Wari-style" bifaces have been found far to the north in Peru at the sites of Huamachuco and San José de Moro (Burger and Glascock 2009; Castillo 2000). Of such bifaces, those geochemically analyzed thus far were most frequently made from Quispisisa obsidian (Burger and Glascock 2009; Burger et al. 2000; Eerkens et al. 2010; Williams et al. 2011).

To date we have encountered evidence of assay flakes and initial core preparation and some products of advanced stages of reduction in the vicinity of the Quispisisa source. Both hammerstones (Figure 8) and flaking evidence (principally cortical flakes and cores) were found in the material associated with the quarry pits. The prevalence of entirely cortical primary flakes suggests that nodules were being assayed at the quarries before being exported for further reduction elsewhere. Some advanced-stage reduction flakes were present, but relatively few advanced-stage reduction artifacts were observed.

Digging tools such as mauls, long bones, or sticks are conspicuous in their absence. While digging implements are found at some archaeological quarries, the need for digging tools, and their taphonomic preservation through to the modern era in an area that is today treeless grassland, is dependent on context. Digging for loose nodules in sandy soils may not have required tools with significant prying force. At the Alca obsidian source in Arequipa, Peru, a broken digging stick was encountered in a shallow quarry pit (Rademaker 2006:154), together with quartzite hammerstones that could have served as mauls for

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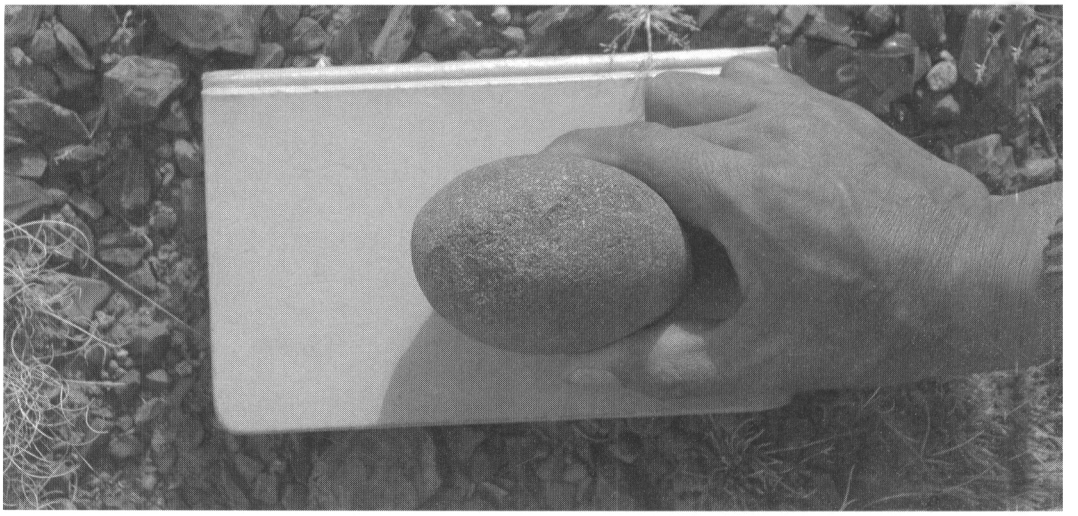


Figure 8. Photo of a river cobble carried up in antiquity for use as a hammerstone, from pit 9083.

excavating. Quarrying with wooden stakes and wedges has been observed ethnographically at the Tuman hornfels quarry in New Guinea (Burton 1984:241).

The limited evidence of lithic reduction associated with the quarry areas in the Quispisisa zone is somewhat surprising, given the scale of quarrying and the wide known distribution of artifacts produced with Quispisisa obsidian in the Andes. Evidence to date suggests that the large volume (at least 32,000 m^3) of excavated material produced a limited number of nodules of sufficient size to be appealing to those quarrying; hence the quantity of discarded small nodules and gangue or matrix material forming berms downslope of each quarry pit. Moreover, the limited amount of reduction debris suggests that those nodules selected were minimally worked at the quarry, likely having a flake or two removed for assay purposes but being exported mostly intact. This perspective is supported by evidence from the consumption zone, such as in the southern Nasca region, where a recent study of 426 samples found that evidence of obsidian reduction, including cortical flakes, is more common with Quispisisa obsidian samples than with other obsidian types found in the study (Eerkens et al. 2010). If a full reduction sequence had been regularly practiced around the Quispisisa quarries, the entire Jichja Parco area would be dense with flake debris. However, only limited production evidence is associated with the source area, and only two sites of intense reduction of obsidian have thus far been encountered in the region.

Lithic Production Near Bofedales *Adjacent to the Quarry Pits*

Closest to the source area, concentrations of obsidian flakes were encountered in pedestrian survey in areas associated with pastoral activities directly west of the quarry pits. In the Quebrada Pucarapata drainage (Figure 2), flakes of both initial and advanced-stage reduction were encountered, although flakes from advanced-stage reduction seem to be better represented numerically. These production areas are directly below modern pastoral residence areas such as Urqu Wasi, and flakes are found in large quantities eroding downslope from household middens and from below corral areas. Modern pastoralists reside in this area because it is adjacent to large, well-watered *bofedal* marshlands, the richest grazing in the region. By situating their homes on the crests of low ridges and on prominences herders are able to monitor their grazing flocks from the residence, the corrals and patio spaces around the homes are well drained, and they are positioned to receiving the warming rays of the sun both earlier and later in the day. These locations were likely prized for herder residences since the beginnings of pastoralism in the region, and the locations may also have been used by hunters observing wild camelids and deer grazing in the grasslands; it is thus likely that they have long use histories.

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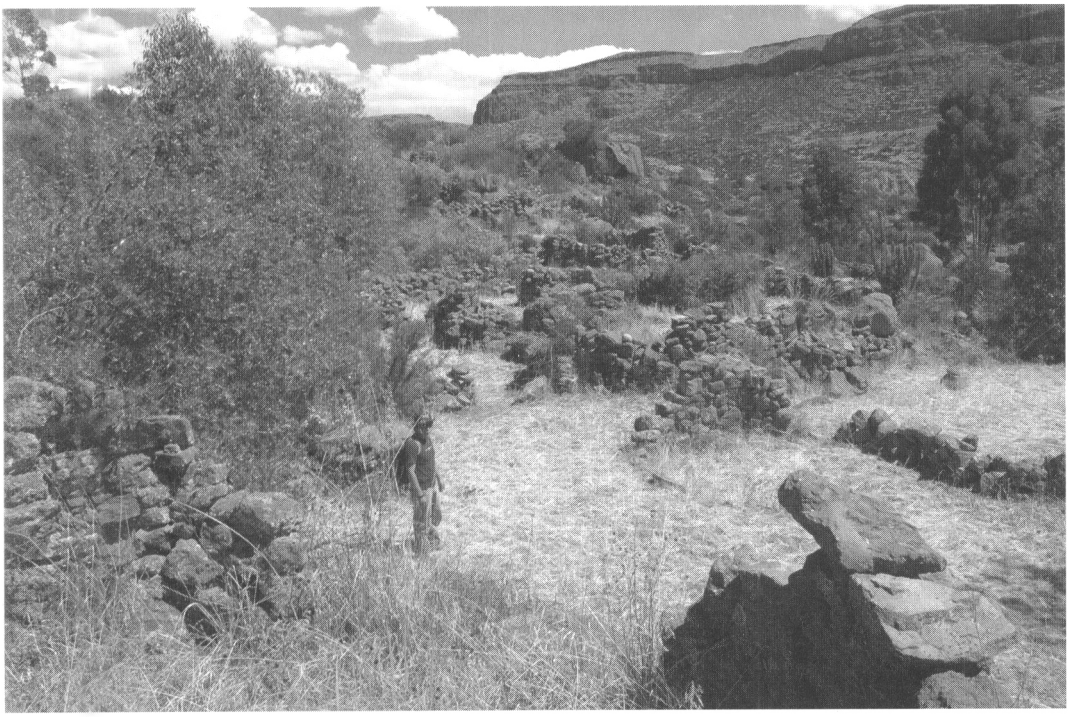


Figure 9. Architectural features at the large Late Intermediate Period site of Marcamarca, adjacent to the village of Colcabamba, contain high densities of obsidian flakes from all reduction stages.

Lithic Production in Colcabamba

Downstream of the Quispisisa quarries abundant evidence of obsidian reduction is found in and around the town of Colcabamba. At 3,550 masl, the area suffers less severe frosts as it is 400 m lower in elevation than the Jichja Parco area. Its elevation and relatively protected position just below the puna rim in the upper reaches of the Caracha River valley make it more amenable to permanent occupation, and it is well positioned for both herding and agricultural activities. Colcabamba is built adjacent to and partly over the large archaeological site of Marcamarca (Figures 2 and 9), whose architectural pattern of small, round hilltop structures appears to be Late Intermediate Period, though some of the architecture suggests construction from earlier periods as well. Dense concentrations of obsidian flakes spilling from the fill of a double-walled fortification surrounding the hilltop settlement suggest that intensive obsidian knapping preceded the Late Intermediate Period episode of construction.

Although no obsidian outcrops are available nearby, and the Jichja Parco area is 15 km upstream, the large quantities of flaked obsidian of various production stages strongly suggest that the area was a center of lithic production. While obsidian is found in modest quantities as small (sub-5-cm) alluvial cobbles in the Urabamba River nearby, a relatively direct trail from the Quispisisa source (reported to be four hours away on foot) and the quantity of debitage suggest that obsidian was transported here and knapped at this residential settlement.

Discussion

Initial research at the Quispisisa source (Burger and Glascock 2000, 2002) focused principally on matching the source flow to the type that had been defined on the basis of geochemical characterization of obsidian artifacts. While evidence of exploitation of the source was indicated—"preforms for points and scrapers are present, although workshop debris is not plentiful" (Burger and Glascock 2002:353)—such evidence was apparently encountered in limited quantity and was not explored in depth. The extent and scale of the quarrying evidence now apparent in the Jichja Parco area are more in keeping with the long history of

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exploitation, wide distribution, and prevalence of Quispisisa obsidian in north and central Peru. Analysis of Burger and Asaro's initial sample from 94 sites at Lawrence Berkeley National Laboratory found that 45 percent of the artifacts analyzed were Quispisisa type (the location of the source was then unknown), and in sites in north and central Peru that percentage doubled to 90 percent (Burger and Asaro 1977; Glascock et al. 2007).

While a conclusive discussion of quarrying activity at Quispisisa awaits thorough survey and excavation, the limited data we report here, in combination with Burger's published observations, provide a starting point. The prevalence of Quispisisa obsidian in the artifactual corpus had already suggested that the Quispisisa source was heavily exploited in prehistory; the number and large scale of the quarry pits that we report here apparently represent the manifestation of that exploitation at the source.

In spite of reports from local residents of occasional modern extraction of obsidian for lapidary use in Lima, the quarry pits we explored are, we are convinced, prehispanic. Most notably, the presence of knapping tools and debris — which we have impressionistically characterized as representing primarily the removal of cortex and nodule assay — indicates that obsidian was being mined for knapping purposes and thus presumably predates the introduction of metal tools into the region. Moreover, the presence of a substantial prehispanic road adjacent to the obsidian source is consistent with its prominence in regional exchange throughout the entire prehispanic period. While some use of obsidian certainly persisted into the colonial period, the large-scale mining visible in the Jichja Parco area appears to have been prehispanic.

Several questions remain, however. To what period does the mining activity date, and are the quarry pits generally contemporaneous? Given the limited amounts of reduction debris, are there associated sites where further reduction of quarried material was taking place? In what form was obsidian being exported from the local area? These are of course questions that may be addressed both at the source and at other sites in the region through which obsidian might have passed. Matsumoto and Cavero (2008, 2009) suggest that the site of Campañayuq Rumi may have played such a role during the Initial Period and Early Horizon. It is likely, given the extensive distribution of Quispisisa obsidian during the Middle Horizon, that a comparable Middle Horizon site exists in the region as well.

The apparent absence of any large-scale domestic and production sites in the Jichja Parco area suggests that obsidian was removed from the immediate area of the quarries in the form of selected and lightly modified nodules before being processed further off-site. Further fieldwork will be necessary to clarify the dating of specific quarry features and the procurement strategies employed over time.

Conclusions

The distribution of Quispisisa obsidian to both numerous and distant sites and its use in relatively large quantities at locales far removed from the source area have underscored the source's importance in the prehispanic Central Andes since Burger and Asaro (1977) initially identified the geochemical type. In the three decades since, as the catalog of identified Quispisisa obsidian from sites consuming obsidian has multiplied, it has become clear that further investigation of procurement and production at the Quispisisa source is necessary. The major Andean obsidian sources of Alca and Chivay have good-quality nodules over 30 cm in size exposed through erosion and available with minor excavation. At Quispisisa, the quarrying evidence presented here points to either a large-scale and probably coordinated extractive activity, or a persistent quarrying effort over protracted periods of time. The former seems more probable and perhaps better answers the question "Why expend the effort to dig quarry pits?" In the case of Quispisisa, nodules naturally exposed through erosion appear to have been insufficient to satisfy demand during particular periods of time, perhaps in the Middle Horizon at least, because the obsidian was being used to produce large bifaces. A shortage of nodules of significant size would then have motivated the excavation of numerous pits. The accessibility of high-quality large nodules on the surface and in erosion exposures argues that small-scale extraction, even over the long term, would not have exhausted the available obsidian. Only when collection outstripped the rate of exposure by erosion would excavation have become necessary. The presence of Quispisisa obsidian at distant sites

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throughout prehistory implies that such high demand was regionally derived, and thus illuminating the nature of ancient extraction at this source has consequences for regional as well as local archaeology.

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Note

1. The source area, in the districts of Huanca Sancos and Sacsamarca in southern Ayacucho, is known locally and on the Instituto Geográfico Nacional: Carta Nacional as Cerro Jichja Parco. Nevertheless, to avoid confusion, we here follow Burger and Glascock's (2002) decision to continue to use the name Quispisisa, assigned when the source was thought to be in Huancavelica to describe the geochemical type. We use local toponyms to describe distinct areas within the source.

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