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Provisioning of the Inka army in wartime: obsidian procurement in Pambamarca, Ecuador

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ABSTRACT

Ninety-nine obsidian artifacts from fortified and non-fortified sites in the Pambamarca region of northern Ecuador were analyzed with XRF to examine patterns of procurement of obsidian by soldiers in the Inka army and by the local Cayambes who were resisting Inka conquest. The results show that the Inkas acquired material from several different sources, a pattern consistent with provisioning by subject peoples in partial fulfillment of labor obligations. The Cayambes also acquired material from multiple sources, although they may not have directly procured material from all of the sources because the external boundary of Inka territory bisected the region of obsidian sources. That frontier may have prevented the Inkas from accessing one source, Callejones, from which the Cayambes acquired some of their obsidian. In addition, the Inkas were acquiring some obsidian from the Yanaurco-Quiscatola source, which had been previously abandoned around AD 1000.

1. Introduction

While armies of early empires were stationed in fortified positions, they could have been provided with material support in a number of ways. Options for obtaining food supplies and other resources included self-support, provisioning by the state from local or distant facilities, and provisioning of goods by local subjugated populations. The particular strategies followed can give us insights into such issues as imperial policies that sustained expansion, levels of resources maintained by the state, and the tempo of integration of subjugated populations into imperial political economies.

For the Inka Empire of Andean South America (ca. AD 1430–1532), major chronicles indicate that the state provided its soldiers with what they needed (Betanzos, 1987; Cobo, 1979) from supplies produced by subject populations and kept in state storehouses. Armies on the move would draw from the closest supplies; typically, local Inka administrative sites served as the supply points, where food and other goods collected from local groups were stored and distributed. The situation may have differed on the imperial frontiers where the army was actively engaged in territorial expansion. For example, in conquering provinces in what is now Ecuador, the Inkas would force local, recently subjugated groups to build forts for the empire, and then require them to supply the soldiers with everything they needed (Cabello Balboa, 1945). Such arrangements imply a direct interface with the local groups supplying matériel to the military, which bypassed the use of intermediate storage and administrative centers.

This conception of the provisioning of the Inka army is informed primarily through ethnohistorical rather than archaeological research. Although the historical accounts are not necessarily untrustworthy in this matter, the claims that local populations were subjugated and immediately obligated to supply local Inka garrisons can be open to question. For example, were the Inkas using a propaganda ploy in which they falsely claimed to have forced locals to supply the army, while actually employing other methods? Were the Inkas able to establish firm control over these populations quickly enough for the latter to be building and supplying forts immediately after being conquered? Moreover, were the Inkas perhaps using a combination of strategies in addition to local provisioning?

The Pambamarca Archaeological Project in the northern Ecuadorian highlands has provided a unique opportunity to address these questions via archaeological data. The project's work includes the investigation of Inka forts and local Cayambe forts and settlements occupied during Inka campaigns of conquest in the Pambamarca region to the north and east of Quito (Figs. 1 and 2). Significantly, this area is just to the north of the major obsidian sources of Ecuador. This desirable raw material was found to be used extensively in both Inka and Cayambe sites in Pambamarca,

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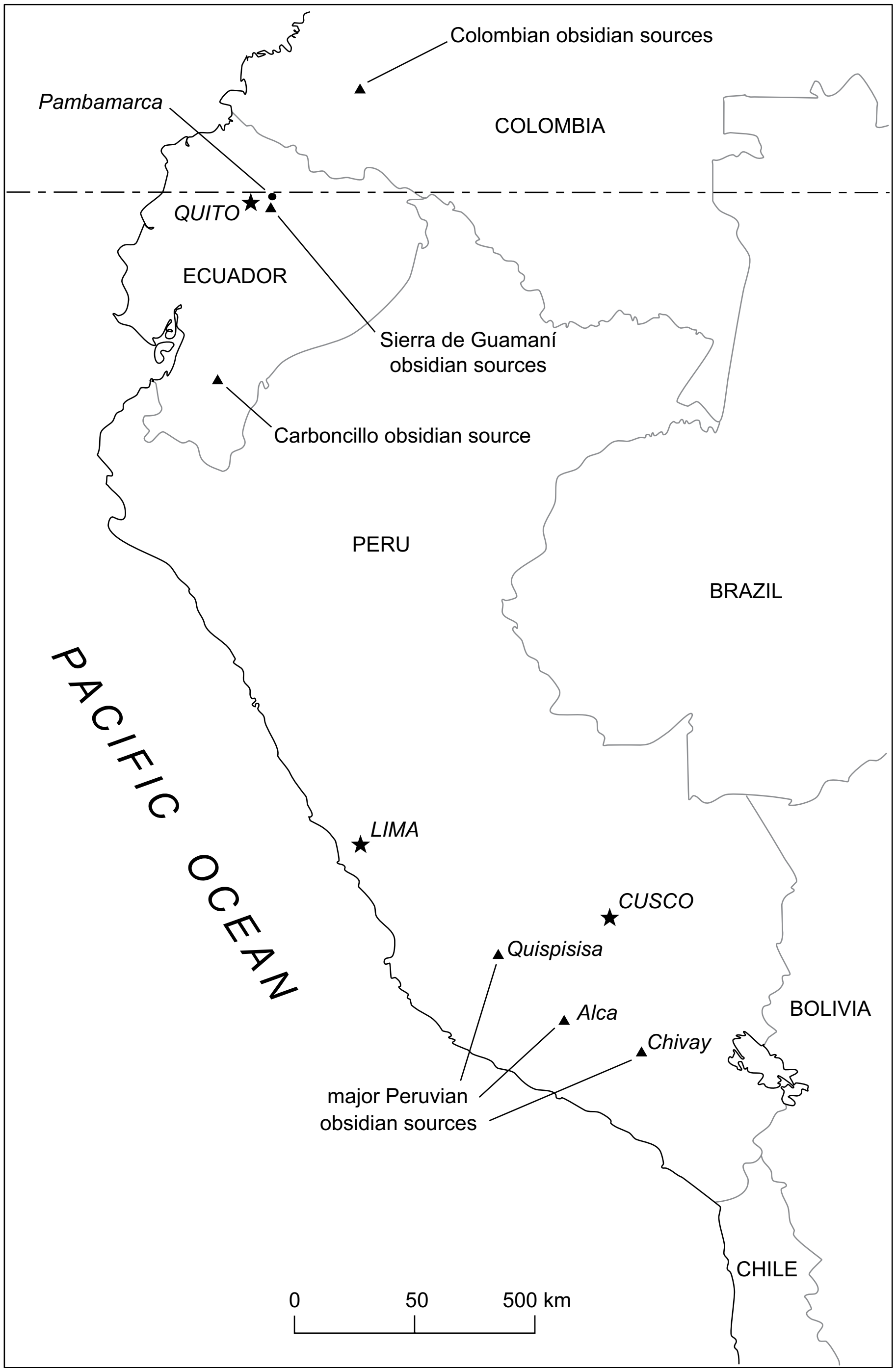

Fig. 1. Location of the Pambamarca region in relation to obsidian sources of Ecuador, Colombia, and Peru.

mainly for the expedient production of flakes for cutting, scraping and other tasks necessary to support daily operations at the sites, although no finished weapons such as spear points or knives were found to be made from obsidian. The spatial distribution of high-quality outcrops of obsidian in relation to the Inka forts and territory under Inka control is such that the main sources would have fallen under Inka control just as they began undertaking the conquests of the Cayambes, with the exception of one source, located in a spot that may have been just outside the imperial frontier. The obsidian sources were also sufficiently separated in space such that no single village would have had primary access to all sources, i.e., people in several different villages would have been in close proximity to at least one of the sources, and could have been required by the Inka state to collect obsidian as part of their labor tribute obligation.

Obsidian provenance analysis offers the ability to study the procurement of a valuable lithic material in past societies. Research typically examines circumstances of procurement involving members of egalitarian to state-level societies, who obtained obsidian through mechanisms ranging from direct access to elaborate long-distance exchange systems. This research expands the scope of obsidian provenance studies to the analysis of the procurement of obsidian for imperial states at military settlements.

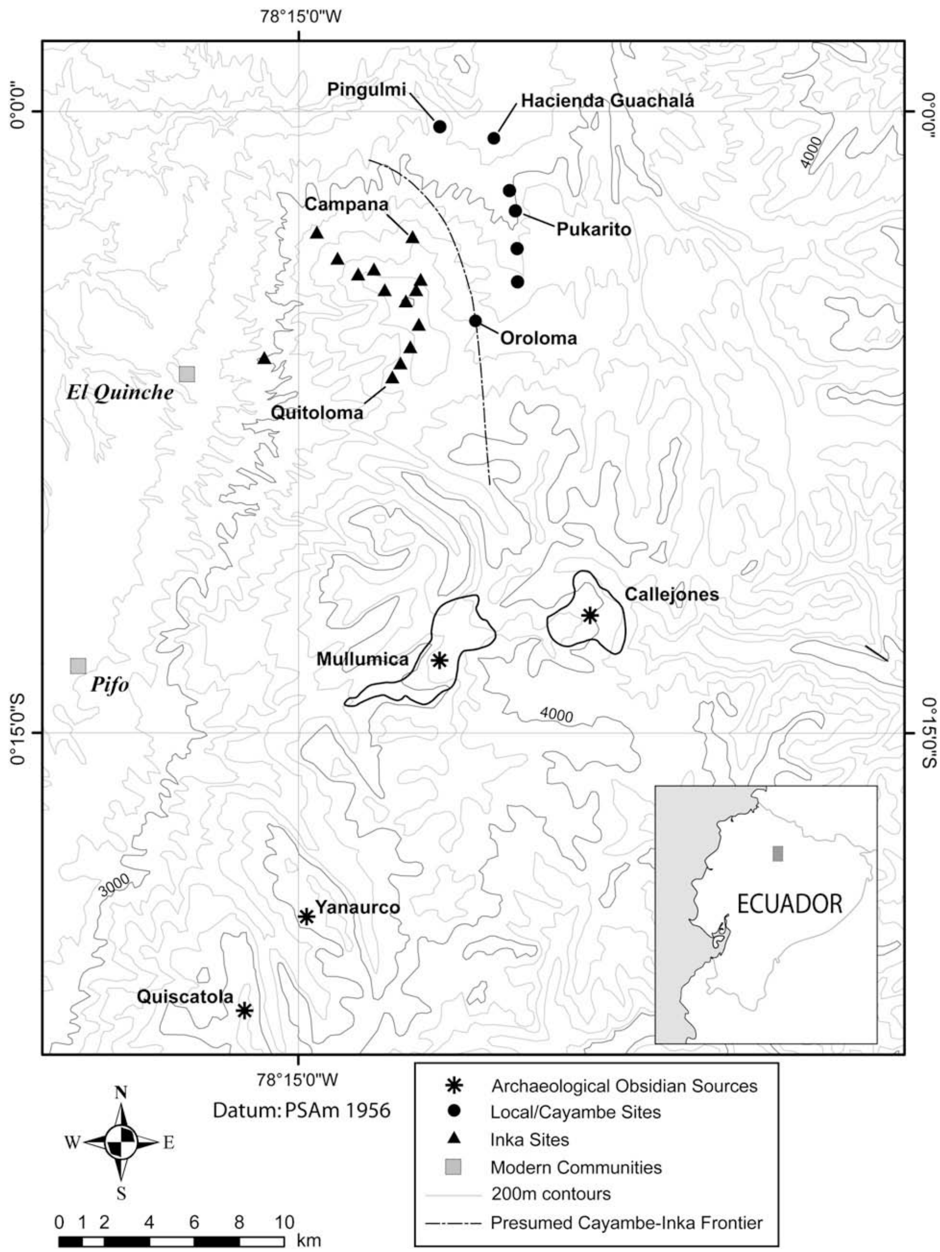

Fig. 2. Location of Inka and Cayambe sites in the Pambamarca region in relation to the major archaeological obsidian sources of northern Ecuador; outlines of Mullumica and Callejones flows are derived from Bellot-Gurlet et al. (2008).

2. Obsidian sources

Obsidian occurs in a number of locales within Ecuador (Bellot-Gurlet et al., 2008; Bigazzi et al., 1992), although only a few of those deposits contain material suitable for manufacturing stone tools. To date, four of the known deposits have been identified as sources of archaeological obsidian. Of those, three lay within the Sierra de Guamaní, 35 km east of Quito: Mullumica, Callejones, and Yanaurco-Quiscatola (Fig. 2). These were first identified by Salazar (1980, 1992), and first characterized chemically by Asaro et al. (1994) and Burger et al. (1994). A number of secondary deposits from those main sources are found in the Sierra de Guamaní along with several deposits of low quality obsidian. As these flows are all part of the same volcanic complex, the Chacana caldera, their obsidians are related chemically. However, through magmatic evolution and mixing, differences in the time and place of eruption have resulted in variations in composition that allow us to distinguish the materials in some of the major deposits from one another.

The Mullumica flow comprises the largest obsidian deposit in Ecuador, spreading more than 5 km in a thick volcanic stratum (Burger et al., 1994). The Callejones source is located about 6 km to the east of the center of Mullumica; fewer data are available from Callejones source samples, but it is apparent that the two sources are closely related chemically. Located about 10 km west-south-west of Mullumica, the Yanaurco-Quiscatola source encompasses erosional remnants of obsidian flows on two separate mountains, Yanaurco Chico and Quiscatola (Bigazzi et al., 1992). Those flows were likely produced by the same volcanic event, and because the obsidians from the two loci are chemically indistinguishable, researchers have treated them as a single source. Up to the present, research has indicated that Mullumica and Yanaurco-Quiscatola have been the main sources for most Ecuadorian artifacts analyzed; a smaller portion of artifacts have been sourced to Callejones.

The fourth Ecuadorian source of archaeological obsidian is Carboncillo, located in the southern highlands near Saraguro, as recently identified by the lead author. Carboncillo obsidian occurs in small nodules and its archaeological distribution is more limited than the northern sources, which offer much larger chunks.

Analysis of archaeological materials indicates that there are at least three additional sources of obsidian yet to be located in Ecuador. Of particular importance, five artifacts from the site of La Chimba to the NE of Quito were found to represent two unknown sources (Asaro et al., 1994). One of those sources appears to have been pinpointed, as recent research by Bellot-Gurlet et al. (2008) reports a sub-type of Callejones obsidian with low Fe content, which we note matches the composition of four of the La Chimba artifacts. The fifth artifact from La Chimba was noted as a "deviant" type of material that is chemically distinct from the Sierra de Guamaní obsidians (Asaro et al., 1994); here we refer to it as the La Chimba type. Two other sources of chemically distinct archaeological obsidian are indicated by the analyses of Bellot-Gurlet et al. (1999) and Bigazzi et al. (1992). Bellot-Gurlet et al. (1999) posit the existence of additional sources, based on fission-track analysis of a number of artifacts, though it remains to be shown whether those distinctions are meaningful in terms of defining obsidian quarries.

Elsewhere in the Andes are found a number of other obsidian sources. Those closest to the Pambamarca region (Fig. 1) include the deposits in southern Colombia linked to the Paletará caldera (Bellot-Gurlet et al., 2008) and the more distant deposits of southern Peru, which include the major sources of Quispisisa, Alca, and Chivay along with a number of minor sources (Burger et al., 2000). These are potentially relevant to this study as alternate sources of material for people living in the Pambamarca region. The Colombian sources could have served as an alternate source for the Cayambes if they had no access to Ecuadorian sources during the Inca invasion, but because those deposits were significantly outside the limits of the maximum extension of their Empire, it is unlikely that they would have been accessed by the Incas. The Peruvian sources were too distant for the Cayambes to have access to those obsidians through exchange and were firmly within Inca-controlled territory, so they would not be expected to appear in Cayambe contexts, but material from those sources could have been brought north by the Incas to supply their troops involved in fighting the Cayambes (see below).

3. Late prehispanic period in Pambamarca

In the early 16th century, the emperor Huayna Capac extended the Inka domain in northern Ecuador via the conquests of the Cayambes, Pastos, and other peoples. But unlike many groups that were conquered swiftly by the Inkas, the Cayambes offered strong resistance. Notably, they managed to repel Inka attacks and hold their ground for about ten years (Cobo, 1979; Espinoza Soriano, 1980); the most detailed report noted that the war lasted eight or nine years (Espinoza Soriano, 1980).

To conduct their extended campaign, the Inkas constructed a series of forts in the Pambamarca region. The Cayambes, in turn, fortified themselves in their own series of sites to the north and east of the Inka frontier (Fig. 2), including newly constructed forts plus pre-existing forts that had been utilized in regional conflicts (Plaza Schuller, 1976). As the Inkas advanced north to their standoff with the Cayambes, they conquered the outlying areas around the settlement of Quito. This territory included at least part of the Sierra de Guamaní, where the major obsidian sources are found 13–24 km south of the Pambamarca forts. The border separating the Inka and Cayambe forts in part runs north-south along the eastern flank of Pambamarca; if we extend this line southward to the Sierra de Guamaní, then Yanaurco-Quiscatola and most of the Mullumica source would fall on the Inka side, and Callejones on the Cayambe side. If that line approximated the actual border between territories, the Inkas would have had control over and access to the major deposits of quality obsidian in Ecuador. Excavations in Pambamarca have confirmed that while ensconced in their forts in the Pambamarca region, the Inkas indeed made heavy use of obsidian.

According to historical accounts, the Inka fortresses in Pambamarca were built specifically for the period of active warfare against the Cayambes (Espinoza Soriano, 1980). This was a key battle in successive waves of expansion undertaken by Huayna Capac in his push to conquer peoples north of Quito. The Inkas had first established a perimeter on the north side of Quito, as evidenced by the remains of a number of forts (Plaza Schuller, 1976) including the well-known fort Rumicucho. The string of military installations subsequently established in Pambamarca could be considered an "offensive perimeter," comprising sites built for temporary use while undertaking campaigns of conquest; a similar temporary perimeter was established by the Inkas in the Cañete Valley of Peru (Hyslop, 1985). In contrast, defensive perimeters encompassed more permanent outposts established to defend external borders, as was the case with the Inka frontier with the Chiriguanos of lowland Bolivia (Alconini, 2004). Defensive perimeters are characterized by longer occupations of military installations, infrequent engagement in warfare, and somewhat different relations with exterior groups – these have different archaeological implications than sites along an offensive perimeter.

Thus, Inka strategy in Pambamarca focused on the establishment of temporary military installations in the push for conquest, rather than long-term occupation of forts for maintaining imperial boundaries. In all, this wave of expansion from Quito to the northeast, encompassing the construction of forts, the establishment of control over people in the intervening territory such as the zones of El Quinche and Pifo (Bray, 1992), and abandonment of the forts after defeat of the Cayambes, appears to have taken about eight to ten years.

4. Different strategies for procurement of obsidian by the Inka military

We know of no historical references that detail how soldiers in the Inka military acquired lithic materials. However, there are references to local populations being made to construct forts for the empire and give general support to garrisons stationed within them (Cabello Balboa, 1945). This scenario matches the general picture provided by the major chronicles, which hold that the Inka army was supported by the products of local populations, tendered as part of their labor obligation to the state.

In general, this fits within the accepted view of the economic policies of Inka Empire, as implemented in provinces incorporated into the empire for several decades or more. However, the question remains as to how quickly the Inkas were able to successfully consolidate their control over conquered territories and begin extracting goods via imposition of labor tribute; i.e., did the process require a decade or more, or could it have required as few as one or two years? Was this consistent across time and space, or did the time necessary to consolidate control fluctuate according to local conditions such as the nature of the local population, or change as the empire developed? It is almost certain that there was variability, but a key issue is how much effort the Inkas put into establishing their control immediately vs. following a strategy of gradually implementing imperial policies to eventually gain control via efforts at legitimating rule and negotiating power relations with local leaders.

Pambamarca presents us with a situation at the margin of imperial expansion, practically a snapshot in time where the Inkas had arrived and set up forts soon after beginning the push for expansion out from Quito. The inhabitants of the newly conquered lands between Quito and Pambamarca, including the regions of El Quinche and Pifo, comprised the local population that could have been made to supply the imperial military installations. By analyzing the acquisition of obsidian for Pambamarca, we can explore whether the Inkas quickly established their control over those recently conquered peoples and began requiring them to provide goods immediately, or whether, because the process was more drawn out, they had to pursue alternative methods to supply soldiers stationed at the forts.

In light of this, we can posit four different strategies through which the soldiers in the forts of Pambamarca could have acquired obsidian; the test implications for source provenance resulting from those strategies are as follows:

1. Procurement by soldiers in home territories – the Inkas conscripted soldiers from various provinces of the empire; some could have been required to bring their own supplies of obsidian on their tour of duty. In such a case, we should see a number of obsidian pieces from sources from elsewhere in the Andes, such as Quispisisa, Chivay, and Alca in southern Peru. Given the distance such material would have been carried, it is most likely that soldiers would have brought with them finished tools or high quality material with cortex removed, and quantities would have been small.
2. Direct procurement – soldiers or others stationed at the forts could have been required to directly procure obsidian from local sources via excursions away from the forts by groups or individuals. Given Inka restrictions on subjects traveling through the Empire and the injunctions against soldiers interfering with the lives of local people (Cobo, 1979), in this scenario the soldiers should have procured obsidian from the closest source, Mullumica, procuring their materials from the same limited set of outcrops. Thus only one or at most two sources should show up in the archaeological materials.
3. State procurement – the Inkas could have established a state-run quarry to extract obsidian to be transported to the forts. Such an operation would most likely have been limited to a single locale with an abundance of high-quality obsidian, and if the Inkas were emphasizing efficiency of procurement, they would have chosen a quarry as close as possible to the forts to minimize transport costs; this implies exclusive exploitation of Mullumica. Implications for sourcing are similar to the second strategy. However, we would expect more substantial archaeological remains at the source itself, such as Inka-style structures to house workers or a roadway leading to the extraction site.
4. Procurement through tribute obligation of local subjects – in line with the tribute obligations imposed throughout the empire, the Inkas could have required subjects living in the region surrounding the obsidian sources to procure material and transport it to state facilities. People living in the different villages should have fulfilled their obligation by collecting obsidian from the sources within their jurisdictions (i.e., those closest to their homes). As a result, obsidian provided to the Pambamarca forts would have come from several different sources, and even from several different outcrops within each source.

Another possible strategy was for the Inkas to obtain obsidian by reclaiming pieces found in the sites or making use of material curated by previous occupants. However, this would only be applicable if the Inkas had commandeered existing fortified sites; excavations in Pambamarca indicate that the Inka forts were primarily single component sites.

5. Sites and obsidian samples

To examine Inka obsidian procurement strategies and compare them to local practices through time, provenance of 99 obsidian samples was analyzed by X-ray Fluorescence (XRF): 37 samples from two Inka sites and 62 from five local sites. Samples were collected from the following sites (Fig. 2):

Quitoloma – A large Inka fortress located at 3800 m on the southern tip of the Pambamarca complex, Quitoloma has received the most archaeological attention (Connell et al., 2003; Fresco et al., 1990; Gifford et al., 2008; Oberem et al., 1969). It is comprised of successive rings of high fortification walls that encompass more than 100 structures divided into what may be elite and non-elite areas. The obsidian samples come from excavated living surfaces located both inside and outside of stone buildings within what appear to be both elite and commoner sections of the site.

Campana Pucara – an Inka fort with well-preserved architectural features, situated on the northern edge of Pambamarca at 3600 m. Excavations suggest that the site had been sacked and later modified and reoccupied. Obsidian samples were recovered during the 2003 and 2005 excavations of the main plaza and buildings on the east side.

Oroloma – a local settlement located at 3200 m and occupied ca. AD 700–1180. The people occupying this earlier site were not engaged in warfare with the Inkas, but were focused on exploiting the resources of the páramo ecozone. Obsidian samples were obtained in 2005 and include 21 artifacts from excavated units and 8 from surface collection.

Pingulmi – a large open fortified Cayambe settlement. Dating to the end of the Cayambe period, ca. AD 1250–1520, it was occupied prior to and during the Inka incursion. As a lower elevation (3000 m) fortress in the temperate zone, it differs in construction from higher elevation fortresses on the páramo. Pingulmi is characterized by three concentric walls constructed of *cangahua*, compact volcanic loess. Samples were collected in 2006, and were primarily surface finds plus one excavated piece.

Pukarito – a local Cayambe fortress located near 3000 m, which was constructed before the Inka arrival and used during the invasion, ca. AD 1250–1520. Likely key to early resistance to the Inkas, Pukarito is distinguished by three phases of outer wall construction, each of *cangahua* blocks. Obsidian samples come from units excavated in 2005 plus one surface sample.

Hacienda Guachalá – a Spanish hacienda established in AD 1580, which controlled most of the area east of the Pisque River, including Pambamarca. Obsidian samples came from limited excavations conducted from 2003 to 2006 within a suspected dye-production workshop located behind extant hacienda architecture. Local indigenous people would have supplied the labor for the productive activities at the hacienda, thus the flaked stone artifacts represent a continuation of native practices.

Oyacachi-1 – a settlement comprising a terraced hillside with a number of platform features and some low lying architecture, located 15 km SE of Pambamarca on the other side of the continental divide. Occupied ca. AD 700–1534, its location along a major access route to the Amazon may have been strategically important. The site was probably occupied by the Quijos rather than Cayambes, with whom they may have had exchange relationships. Obsidian samples were collected from a surface concentration near the modern road in 2006.

The obsidian artifacts primarily include flakes, flake fragments, debitage, and small cores or fragments of cores (Table 1). Some of the flakes and cores show utilization scars, and a few flakes have been retouched. The samples also included a single biface fragment from the early Cayambe site of Pingulmi. The lack of other extensively worked tools is not surprising given that the use of flaked stone tools such as projectile points declined notably in late prehispanic times compared to earlier periods, likely as a result of the increasing use of metal tools (Burger et al., 2000). Moreover, the primary weapons, such as slings, clubs, axes and maces, were made from fibers, wood, metal, and ground stone. It is conceivable that materials such as obsidian or chert were chipped to produce blades or flakes for insertion into wooden war clubs, similar to the

Table 1
Context and form of obsidian artifacts analyzed by XRF.

Sample	Site name	Cultural affiliation	Date (AD)	Context	Lithic type
PM-1	Pukarito	Cayambe	1250–1520	Surface	Core
PM-2	Pukarito	Cayambe	1250–1520	Excavation	Debitage
PM-3	Pukarito	Cayambe	1250–1520	Excavation	Flake
PM-4	Pukarito	Cayambe	1250–1520	Excavation	Debit age
PM-5	Pukarito	Cayambe	1250–1520	Excavation	Flake, utilized
PM-6	Pukarito	Cayambe	1250–1520	Excavation	Flake
PM-7	Pukarito	Cayambe	1250–1520	Excavation	Debitage
PM-8	Campana	Inka	1500–1520	Excavation	Debitage
PM-9	Campana	Inka	1500–1520	Excavation	Debitage
PM-10	Campana	Inka	1500–1520	Excavation	Debitage
PM-11	Campana	Inka	1500–1520	Excavation	Flake fragment, retouched
PM-12	Campana	Inka	1500–1520	Excavation	Debitage
PM-13	Campana	Inka	1500–1520	Excavation	Debitage
PM-14	Campana	Inka	1500–1520	Excavation	Core
PM-15	Campana	Inka	1500–1520	Excavation	Flake
PM-16	Campana	Inka	1500–1520	Excavation	Flake, retouched
PM-17	Pingulmi	Cayambe	1250–1520	Surface	Bipolar flake, retouched, utilized
PM-18	Pingulmi	Cayambe	1250–1520	Surface	Flake, utilized
PM-19	Pingulmi	Cayambe	1250–1520	Surface	Debitage
PM-20	Pingulmi	Cayambe	1250–1520	Surface	Flake, retouched
PM-21	Pingulmi	Cayambe	1250–1520	Surface	Flake
PM-22	Pingulmi	Cayambe	1250–1520	Surface	Flake fragment, utilized
PM-23	Pingulmi	Cayambe	1250–1520	Surface	Debitage
PM-24	Pingulmi	Cayambe	1250–1520	Surface	Debitage
PM-25	Pingulmi	Cayambe	1250–1520	Surface	Debitage
PM-26	Pingulmi	Cayambe	1250–1520	Surface	Flake, utilized
PM-27	Pingulmi	Cayambe	1250–1520	Surface	Biface fragment
PM-28	Pingulmi	Cayambe	1250–1520	Surface	Debitage
PM-29	Pingulmi	Cayambe	1250–1520	Surface	Flake, retouched
PM-30	Pingulmi	Cayambe	1250–1520	Surface	Core
PM-31	Pingulmi	Cayambe	1250–1520	Excavation	Debitage
PM-32	Oroloma	Pre-Cayambe	700–1180	Surface	Core
PM-33	Oroloma	Pre-Cayambe	700–1180	Excavation	Core
PM-34	Oroloma	Pre-Cayambe	700–1180	Excavation	Core
PM-35	Oroloma	Pre-Cayambe	700–1180	Excavation	Core
PM-36	Oroloma	Pre-Cayambe	700–1180	Excavation	Debitage
PM-37	Oroloma	Pre-Cayambe	700–1180	Excavation	Flake
PM-38	Oroloma	Pre-Cayambe	700–1180	Excavation	Flake
PM-39	Oroloma	Pre-Cayambe	700–1180	Excavation	Flake
PM-40	Oroloma	Pre-Cayambe	700–1180	Excavation	Flake
PM-41	Oroloma	Pre-Cayambe	700–1180	Excavation	Flake, utilized
PM-42	Oroloma	Pre-Cayambe	700–1180	Excavation	Flake, utilized
PM-43	Oroloma	Pre-Cayambe	700–1180	Excavation	Core
PM-44	Oroloma	Pre-Cayambe	700–1180	Excavation	Core
PM-45	Oroloma	Pre-Cayambe	700–1180	Excavation	Core
PM-46	Oroloma	Pre-Cayambe	700–1180	Excavation	Core
PM-47	Oroloma	Pre-Cayambe	700–1180	Excavation	Debitage
PM-48	Oroloma	Pre-Cayambe	700–1180	Excavation	Debitage
PM-49	Oroloma	Pre-Cayambe	700–1180	Excavation	Flake
PM-50	Oroloma	Pre-Cayambe	700–1180	Excavation	Flake, retouched, utilized
PM-51	Oroloma	Pre-Cayambe	700–1180	Excavation	Debitage
PM-52	Oroloma	Pre-Cayambe	700–1180	Excavation	Flake fragment, retouched
PM-53	Oroloma	Pre-Cayambe	700–1180	Excavation	Flake fragment
PM-54	Oroloma	Pre-Cayambe	700–1180	Excavation	Debitage, utilized
PM-55	Oroloma	Pre-Cayambe	700–1180	Excavation	Flake, utilized
PM-56	Oroloma	Pre-Cayambe	700–1180	Excavation	Flake, utilized
PM-57	Oroloma	Pre-Cayambe	700–1180	Excavation	Flake
PM-58	Oroloma	Pre-Cayambe	700–1180	Excavation	Core
PM-59	Oroloma	Pre-Cayambe	700–1180	Excavation	Debitage
PM-60	Oroloma	Pre-Cayambe	700–1180	Excavation	Debitage
PM-61	Quitoloma	Inka	1500–1520	Excavation	Debitage
PM-62	Quitoloma	Inka	1500–1520	Excavation	Flake
PM-63	Quitoloma	Inka	1500–1520	Excavation	Flake
PM-64	Quitoloma	Inka	1500–1520	Excavation	Flake
PM-65	Quitoloma	Inka	1500–1520	Excavation	Core
PM-66	Quitoloma	Inka	1500–1520	Excavation	Flake, utilized
PM-67	Quitoloma	Inka	1500–1520	Excavation	Core
PM-68	Quitoloma	Inka	1500–1520	Excavation	Debitage, utilized
PM-69	Quitoloma	Inka	1500–1520	Excavation	Flake fragment
PM-70	Oyacachi-1	Quijos	700–1534	Surface	Flake
PM-71	Oyacachi-1	Quijos	700–1534	Surface	Flake
PM-72	Quitoloma	Inka	1500–1520	Excavation	Flake
PM-73	Quitoloma	Inka	1500–1520	Excavation	Flake, utilized
PM-74	Quitoloma	Inka	1500–1520	Excavation	Core
PM-75	Quitoloma	Inka	1500–1520	Excavation	Core

(*continued on next page*)

Table 1 (*continued*)

Sample	Site name	Cultural affiliation	Date (AD)	Context	Lithic type
PM-76	Quitoloma	Inka	1500–1520	Excavation	Flake fragment
PM-77	Quitoloma	Inka	1500–1520	Excavation	Flake
PM-78	Quitoloma	Inka	1500–1520	Excavation	Flake, utilized
PM-79	Quitoloma	Inka	1500–1520	Excavation	Flake, utilized
PM-80	Quitoloma	Inka	1500–1520	Excavation	Flake fragment
PM-81	Quitoloma	Inka	1500–1520	Excavation	Flake
PM-82	Quitoloma	Inka	1500–1520	Excavation	Flake
PM-83	Quitoloma	Inka	1500–1520	Excavation	Flake
PM-85	Quitoloma	Inka	1500–1520	Excavation	Core
PM-86	Guachalá	Indigenous colonial	1580+	Excavation	Flake fragment, retouched
PM-87	Guachalá	Indigenous colonial	1580+	Excavation	Flake
PM-88	Guachalá	Indigenous colonial	1580+	Excavation	Flake, utilized
PM-89	Guachalá	Indigenous colonial	1580+	Excavation	Flake, utilized
Z3-B2-001-4-177	Quitoloma	Inka	1500–1520	Excavation	Not available
Z3-B2-001-4-24	Quitoloma	Inka	1500–1520	Excavation	Not available
Z3-B2-001-4-24b	Quitoloma	Inka	1500–1520	Excavation	Not available
Z3-B2-001-4-39	Quitoloma	Inka	1500–1520	Excavation	Not available
Z3-B2-001-5-4	Quitoloma	Inka	1500–1520	Excavation	Not available
Z3-B2-001-7-1	Quitoloma	Inka	1500–1520	Excavation	Not available
Z3-B2-007-9-96	Oroloma	Pre-Cayambe	700–1180	Excavation	Not available
Z3-B2-007-9-96b	Oroloma	Pre-Cayambe	700–1180	Excavation	Not available
Z3-B2-007-9-96c	Oroloma	Pre-Cayambe	700–1180	Excavation	Not available
Z3-B2-007-9-144	Oroloma	Pre-Cayambe	700–1180	Excavation	Not available
Z3-B2-007-9-144b	Oroloma	Pre-Cayambe	700–1180	Excavation	Not available

construction of the Aztec *macuahuitl*, but we currently lack archaeological or ethnohistorical confirmation of the use of flaked stone for these or other non-projectile weapons in this era.

6. XRF data and source assignments

Eighty-eight samples were analyzed using a Spectrace Quanx Energy-Dispersive XRF instrument at the Archaeological Research Facility at the University of California, Berkeley, following the procedures as described in Negash and Shackley (2006). The concentrations of 11 elements were determined: Ti, Mn, Fe, Zn, Ga, Rb, Sr, Y, Zr, and Nb. An additional 11 samples were analyzed by Richard E. Hughes at the Geochemical Research Laboratory, using a Thermo-Electron Quanx-EC EDXRF instrument; Rb, Sr, Y, Zr, Nb, and Ba were measured, and the ratio of Fe/Mn was reported. In both analyses, the geostandard RGM-1 was analyzed with each run of samples as a check on calibration (Tables 2 and 3). Because both instruments are similar models and were calibrated using similar procedures, the data for trace element concentrations are considered comparable. However, data for Fe, Ti, and Mn may be less comparable because calibration for those elements is more challenging on these instruments.

The work of geochemical characterization and mapping of obsidian deposits in northern Ecuador is in its early stages, but the data available are sufficient for making source assignments in most cases. In this analysis, bi-variate plots of Sr vs. Zr and Fe (Figs. 3 and 4) are the most useful in differentiating sources. The task presents some challenges because the main sources are part of the same Chacana caldera volcanic complex and thus show some close relationships in composition. The obsidian from Mullumica shows the greatest variability, falling into two broad groups of high and low Fe content. Asaro et al. (1994) further divided samples from Mullumica into four chemical sub-types, grouped according to distinct levels of Fe content, and noted that there could be as many as nine. Obsidian from Callejones is closely related to Mullumica material, and also falls into high and low Fe sub-types (Bellot-Gurlet et al., 2008). The high Fe obsidian from Callejones is distinguished from that of Mullumica by higher concentrations of Fe, Sr, and Zr. The low Fe variants from the two sources overlap significantly in chemical composition, but can be distinguished primarily by the ratio of Sr/Zr, which is higher in Callejones material. It is possible that an overlap in the Sr/Zr ratio could lead to mistaken assignment of some Callejones samples to Mullumica, but in this project, the low Fe Callejones samples stood out in the plot of Sr vs. Zr (Fig. 3).

La Chimba type material is significantly different from the other sources, and is easily distinguished by very low concentrations of Sr and Ti. Y is elevated compared to the other sources, which may indicate that the La Chimba source is significantly older than the other obsidians of northern Ecuador, as there is a tendency in the Ecuadorian Andes for Y to be depleted in younger volcanic rocks (Andrade et al., 2005).

The results (Tables 2 and 3) show that all samples came from the obsidian sources in the northern highlands of Ecuador. No Peruvian or Colombian obsidian was among the samples, nor was the southern Ecuadorian Carboncillo source represented. The great majority of the samples came from Mullumica, including both high and low Fe varieties, which formed two distinct clusters (Figs. 3 and 4). The Mullumica obsidian did not exhibit smaller sub-groups, forming instead a continuous distribution within the two main varieties. This variation in the samples suggests that multiple extraction areas were being accessed within the Mullumica flow throughout time. Of the remaining samples, three came from Yanaurco-Quiscatola, five were of the low Fe variety of Callejones obsidian, and seven artifacts were found to be of the La Chimba type. One artifact, sample PM-6 from Pukarito, is noted as indeterminate; it closely resembles low Fe Mullumica, but stands apart in some ways (Fig. 4). The deviation may be due to the artifact's significant weathering, or because it derived from one of the minor obsidian occurrences in the Sierra de Guamaní.

The results also indicate that while the sources exploited in the Sierra de Guamaní all contained high quality obsidian well-suited to flaking, they had a great range of variation in visual characteristics. Material included black, gray, reddish-brown, and clear coloration, with notable variations in transparency. Numerous pieces were multi-colored, combining colors and levels of opacity through banding, layering, and mottling. Furthermore, none of the visual types appeared exclusive to any single source, and each source contained more than one variant. Thus attempts at visual sourcing are precluded, and no conclusions can be drawn from this data as to the use of sources based on visual qualities of material.

6.1. Implications: provisioning of the Inka army

The provenance of the Inka samples indicates that obsidian was obtained from multiple sources (Table 4), including Mullumica

Table 2
XRF data and source assignments for artifacts analyzed at the UC Berkeley Archaeological Research Facility, plus concentrations for geostandard RGM-1 as measured with archaeological samples and recommended values for the geostandard (RGM-1 rec) from Govindaraju (1994); concentrations are in ppm, except for Fe, which is in weight percent.

Site	Sample	Ti	Mn	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Th	Source assignment
Pukarito	PM-1	1351	479	1.03	48	17	122	285	16	167	14	12	Mullumica (high Fe)
Pukarito	PM-2	489	518	0.74	42	12	185	12	22	61	16	25	La Chimba type
Pukarito	PM-3	1202	491	0.99	58	19	124	259	14	162	16	18	Mullumica (high Fe)
Pukarito	PM-4	1236	499	1.03	62	18	130	276	11	171	5	14	Mullumica (high Fe)
Pukarito	PM-5	1350	497	1.07	60	17	130	282	12	170	14	9	Mullumica (high Fe)
Pukarito	PM-6	881	377	0.73	39	16	133	104	12	72	7	29	Indeterminate
Pukarito	PM-7	792	376	0.70	37	19	133	176	12	94	20	31	Callejones (low Fe)
Campana	PM-8	1298	464	1.07	50	17	121	292	13	168	18	11	Mullumica (high Fe)
Campana	PM-9	1345	467	0.99	57	20	107	239	4	131	12	34	Mullumica (high Fe)
Campana	PM-10	1119	394	0.73	40	18	101	174	15	118	0	21	Mullumica (low Fe)
Campana	PM-11	1027	449	0.96	50	19	118	239	8	155	8	21	Mullumica (high Fe)
Campana	PM-12	769	398	0.71	32	16	136	132	17	85	12	26	Mullumica (low Fe)
Campana	PM-13	910	417	0.74	45	17	123	173	13	117	14	20	Mullumica (low Fe)
Campana	PM-14	1121	494	0.95	52	17	117	253	14	158	17	26	Mullumica (high Fe)
Campana	PM-15	1295	472	1.02	51	19	123	278	14	167	17	23	Mullumica (high Fe)
Campana	PM-16	669	400	0.54	34	16	175	76	12	65	16	35	Yanaurco-Quiscatola
Pingulmi	PM-17	1058	453	0.90	45	18	124	222	15	140	5	20	Mullumica (high Fe)
Pingulmi	PM-18	1308	463	1.05	58	17	133	286	12	176	22	37	Mullumica (high Fe)
Pingulmi	PM-19	1038	382	0.91	45	14	104	236	8	151	12	12	Mullumica (high Fe)
Pingulmi	PM-20	810	403	0.73	38	18	115	159	14	100	11	22	Mullumica (low Fe)
Pingulmi	PM-21	708	315	0.52	32	15	106	130	5	70	5	11	Callejones (low Fe)
Pingulmi	PM-22	1266	453	1.00	46	17	114	257	11	160	10	12	Mullumica (high Fe)
Pingulmi	PM-23	702	419	0.69	47	21	141	132	12	90	19	17	Mullumica (low Fe)
Pingulmi	PM-24	1151	397	0.92	40	20	109	244	12	149	1	28	Mullumica (high Fe)
Pingulmi	PM-25	428	441	0.71	37	17	171	15	28	67	9	19	La Chimba type
Pingulmi	PM-26	736	428	0.69	53	18	134	145	13	93	9	21	Mullumica (low Fe)
Pingulmi	PM-27	1304	468	1.02	49	20	125	263	16	168	1	18	Mullumica (high Fe)
Pingulmi	PM-28	1301	419	0.97	47	15	104	223	5	135	16	27	Mullumica (high Fe)
Pingulmi	PM-29	695	391	0.62	34	18	143	104	14	77	14	27	Mullumica (low Fe)
Pingulmi	PM-30	1162	483	0.98	58	20	121	259	15	163	12	19	Mullumica (high Fe)
Pingulmi	PM-31	706	349	0.66	37	15	130	151	11	73	8	31	Callejones (low Fe)
Oroloma	PM-32	950	414	0.83	45	17	133	199	14	127	9	23	Mullumica (high Fe)
Oroloma	PM-33	1355	411	0.87	43	15	119	248	14	160	14	23	Mullumica (high Fe)
Oroloma	PM-34	652	372	0.64	43	16	131	159	4	81	16	15	Callejones (low Fe)
Oroloma	PM-35	376	525	0.77	53	18	188	23	25	72	18	27	La Chimba type
Oroloma	PM-36	1210	468	1.00	56	20	122	275	14	169	10	11	Mullumica (high Fe)
Oroloma	PM-37	1344	519	0.95	53	21	124	271	12	166	10	19	Mullumica (high Fe)
Oroloma	PM-38	887	450	0.80	39	19	139	174	19	112	21	28	Mullumica (low Fe)
Oroloma	PM-39	1200	480	0.91	39	15	116	239	13	143	14	17	Mullumica (high Fe)
Oroloma	PM-40	1003	446	0.91	47	18	100	237	10	140	11	6	Mullumica (high Fe)
Oroloma	PM-41	931	429	0.77	44	17	136	165	13	106	6	13	Mullumica (low Fe)
Oroloma	PM-42	1360	517	1.06	58	20	125	294	14	179	14	17	Mullumica (high Fe)
Oroloma	PM-43	1190	483	0.99	48	20	133	262	12	162	13	25	Mullumica (high Fe)
Oroloma	PM-44	451	556	0.78	58	18	209	10	26	70	12	31	La Chimba type
Oroloma	PM-45	1188	450	0.93	56	20	124	247	13	160	9	20	Mullumica (high Fe)
Oroloma	PM-46	1351	526	1.04	64	19	126	265	16	164	13	6	Mullumica (high Fe)
Oroloma	PM-47	652	428	0.68	46	20	135	147	16	97	18	29	Mullumica (low Fe)
Oroloma	PM-48	605	358	0.58	36	16	128	146	14	72	4	26	Callejones (low Fe)
Oroloma	PM-49	852	402	0.74	39	20	133	154	17	98	5	21	Mullumica (low Fe)
Oroloma	PM-50	796	426	0.77	38	19	137	181	10	121	15	11	Mullumica (low Fe)
Oroloma	PM-51	1409	456	0.98	45	18	125	242	13	154	13	25	Mullumica (high Fe)
Oroloma	PM-52	830	453	0.69	37	19	144	150	10	99	6	20	Mullumica (low Fe)
Oroloma	PM-53	1279	516	1.02	52	20	125	288	13	174	1	6	Mullumica (high Fe)
Oroloma	PM-54	948	435	0.86	54	18	121	224	14	140	6	22	Mullumica (high Fe)
Oroloma	PM-55	1238	453	0.94	51	18	122	259	12	164	7	20	Mullumica (high Fe)
Oroloma	PM-56	1248	412	0.97	45	18	121	274	17	162	13	17	Mullumica (high Fe)
Oroloma	PM-57	1424	481	1.07	53	19	128	307	10	176	11	28	Mullumica (high Fe)
Oroloma	PM-58	820	427	0.76	29	21	137	169	9	108	7	21	Mullumica (low Fe)
Oroloma	PM-59	818	393	0.80	42	19	119	211	13	129	7	20	Mullumica (high Fe)
Oroloma	PM-60	730	367	0.68	33	14	135	152	10	98	13	15	Mullumica (low Fe)
Quitoloma	PM-61	1179	476	0.87	52	16	135	221	14	140	14	18	Mullumica (high Fe)
Quitoloma	PM-62	630	426	0.62	35	17	150	113	11	78	2	18	Mullumica (low Fe)
Quitoloma	PM-63	717	422	0.72	41	15	134	159	14	101	16	22	Mullumica (low Fe)
Quitoloma	PM-64	745	410	0.62	32	15	136	105	19	72	13	15	Mullumica (low Fe)
Quitoloma	PM-65	795	393	0.70	45	18	128	164	12	108	19	17	Mullumica (low Fe)
Quitoloma	PM-66	720	398	0.65	64	21	123	134	11	90	13	12	Mullumica (low Fe)
Quitoloma	PM-67	745	400	0.71	46	16	127	140	19	87	6	16	Mullumica (low Fe)
Quitoloma	PM-68	1076	412	0.86	46	17	115	235	15	149	14	25	Mullumica (high Fe)
Quitoloma	PM-69	687	361	0.67	41	16	127	146	13	98	12	19	Mullumica (low Fe)
Oyacachi-1	PM-70	299	500	0.68	45	15	191	4	27	66	11	21	La Chimba type
Oyacachi-1	PM-71	1240	413	0.97	51	15	123	277	11	161	10	14	Mullumica (high Fe)
Quitoloma	PM-72	473	365	0.60	32	17	125	108	13	75	12	22	Mullumica (low Fe)
Quitoloma	PM-73	824	384	0.67	46	19	145	129	11	94	13	24	Mullumica (low Fe)

(*continued on next page*)

Table 2 (*continued*)

Site	Sample	Ti	Mn	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Th	Source assignment
Quitoloma	PM-74	998	392	0.82	64	19	121	213	7	142	12	23	Mullumica (high Fe)
Quitoloma	PM-75	630	428	0.68	44	21	139	131	12	88	7	16	Mullumica (low Fe)
Quitoloma	PM-76	516	384	0.56	28	16	129	100	9	72	10	24	Mullumica (low Fe)
Quitoloma	PM-77	1063	441	0.97	51	17	115	265	14	164	8	11	Mullumica (high Fe)
Quitoloma	PM-78	804	397	0.64	43	17	147	119	17	83	3	19	Mullumica (low Fe)
Quitoloma	PM-79	963	393	0.79	45	16	123	219	13	138	13	13	Mullumica (high Fe)
Quitoloma	PM-80	715	396	0.67	40	16	134	135	11	89	13	12	Mullumica (low Fe)
Quitoloma	PM-81	1093	408	0.89	51	20	119	256	16	156	9	21	Mullumica (high Fe)
Quitoloma	PM-82	726	387	0.67	36	18	135	135	11	85	9	29	Mullumica (low Fe)
Quitoloma	PM-83	1184	478	0.88	43	19	125	214	14	133	12	24	Mullumica (high Fe)
Quitoloma	PM-85	536	566	0.77	58	20	197	16	31	71	16	36	La Chimba type
Guachalá	PM-86	1163	437	0.97	42	18	115	257	13	158	12	20	Mullumica (high Fe)
Guachalá	PM-87	1131	453	1.00	49	20	122	268	12	177	9	14	Mullumica (high Fe)
Guachalá	PM-88	1095	424	0.90	48	16	126	217	14	141	8	14	Mullumica (high Fe)
Guachalá	PM-89	436	499	0.74	42	17	187	14	27	70	14	12	La Chimba type
	RGM-1	1573	305	1.28	5	21	149	100	27	218	10	19	Geostandard
	RGM-1	1309	348	1.30	5	21	151	99	25	210	13	31	Geostandard
	RGM-1	1323	334	1.25	5	18	142	98	23	211	13	12	Geostandard
	RGM-1	1348	300	1.29	5	21	145	108	27	211	5	16	Geostandard
	RGM-1	1401	321	1.27	5	23	150	102	26	211	9	26	Geostandard
	RGM-1	1472	330	1.27	5	21	151	99	22	214	5	22	Geostandard
	RGM-1	1223	313	1.28	5	20	150	104	24	219	10	6	Geostandard
	RGM-1	1441	313	1.28	5	21	148	105	24	218	16	22	Geostandard
	RGM-1	1426	331	1.28	5	21	147	105	27	209	11	19	Geostandard
	RGM-1 rec	1601	279	1.30	32	15	149	108	25	219	9	15	Recommended values

(a range of both high and low Fe variants, suggesting multiple extraction locales), La Chimba type, and Yanaurco-Quiscatola. These results are most consistent with the procurement of material by local subjects in partial fulfillment of their tribute obligations. Because obsidian in the Inka installations derived from three separate sources, it is unlikely that obsidian was primarily procured by individual soldiers or via a state obsidian extraction operation. However, we cannot entirely rule out the possibility that such strategies served as supplemental means of procurement at some point in time. In contrast, there is no evidence that the Inkas required soldiers to bring their own lithic materials from their home territories, as none of the obsidian analyzed came from distant sources.

The lack of Callejones obsidian in Inka contexts is notable, and suggests that people were not crossing the frontier (Fig. 2) into territory that may have been controlled by another group to acquire resources, instead concentrating entirely on materials within the Inka zone of control.

6.2. Cayambe procurement

Samples from the local sites showed that a range of obsidian sources was exploited before, during, and after the time of the Inka incursion (Table 4).

Inhabitants of the early site, Oroloma (ca. AD 700–1180), were able to procure obsidian from the widest variety of sources, including Mullumica (both low and high Fe varieties), Yanaurco-Quiscatola, Callejones, and the La Chimba type. Because the sources were not distant, obsidian could have been obtained via direct procurement or exchange.

The inhabitants of sites occupied just prior to and during the Inka invasion also obtained obsidian from multiple sources. Pingulmi contained obsidian from Mullumica (both low and high Fe types), Callejones and the La Chimba type, and Pukarito had material from Mullumica (high Fe only), Callejones, and La Chimba type, plus one indeterminate artifact, which resembles low Fe Mullumica. However, no Yanaurco-Quiscatola material was present in the late sites; this could be an effect of the lower number of samples analyzed for these sites, or the result of the cessation of obsidian quarrying at the source during late pre-Inka times.

At the Colonial period Hacienda Guachalá, indigenous workers obtained obsidian of Mullumica and La Chimba types, showing that they continued to access multiple sources, even after the major societal changes ushered in with Spanish colonization.

The presence of Mullumica material in the two late sites raises the question of if and how the Cayambes were able to obtain obsidian from within Inka territory during wartime. The large area around the sources has not been systematically surveyed, so it is unknown if the Inkas had established any sort of defensive sites to control access to the obsidian along the eastern frontier or whether that frontier was left unprotected. If the Inkas had closely guarded

Table 3
XRF data and source assignments for artifacts analyzed at Geochemical Research Laboratory, plus measured concentrations for geostandard RGM-1 and recommended values (RGM-1 rec) from Govindaraju (1994); concentrations are in ppm.

Site	Sample	Fe/Mn	Rb	Sr	Y	Zr	Nb	Ba	Source assignment
Quitoloma	Z3-B2-001-4-177	26	122	216	12	149	10	1076	Mullumica (high Fe)
Quitoloma	Z3-B2-001-4-24	20	139	123	10	80	9	1012	Mullumica (low Fe)
Quitoloma	Z3-B2-001-4-24b	19	145	121	12	81	9	1029	Mullumica (low Fe)
Quitoloma	Z3-B2-001-4-39	26	123	199	11	145	10	1025	Mullumica (high Fe)
Quitoloma	Z3-B2-001-5-4	27	113	213	11	142	11	1161	Mullumica (high Fe)
Quitoloma	Z3-B2-001-7-1	15	177	84	10	65	10	1009	Yanaurco-Quiscatola
Oroloma	Z3-B2-007-9-96	27	122	258	12	163	12	1113	Mullumica (high Fe)
Oroloma	Z3-B2-007-9-96b	22	130	144	11	94	11	1085	Mullumica (low Fe)
Oroloma	Z3-B2-007-9-96c	16	179	81	9	64	12	966	Yanaurco-Quiscatola
Oroloma	Z3-B2-007-9-144	22	132	164	13	105	9	1067	Mullumica (low Fe)
Oroloma	Z3-B2-007-9-144b	23	137	169	12	108	10	1045	Mullumica (low Fe)
	RGM-1	n/a	145	104	24	219	7	809	Geostandard
	RGM-1 rec	n/a	149	108	25	219	9	807	Recommended values

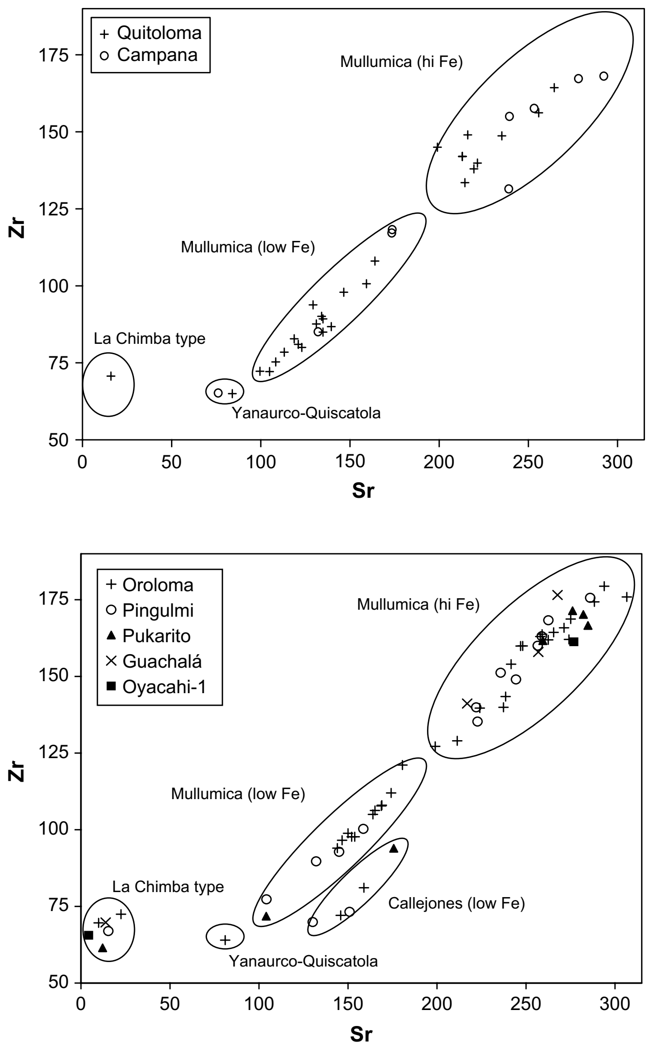

Fig. 3. Bi-variate plots of Sr vs. Zr for obsidian artifacts from Inka sites (above) and local sites (below); values in ppm.

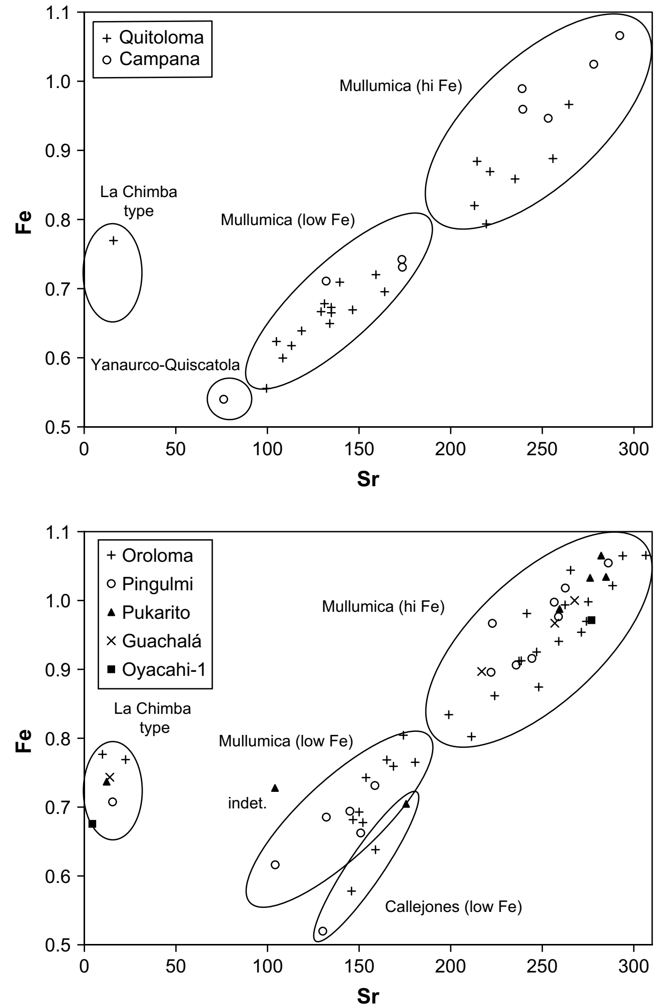

Fig. 4. Bi-variate plots of Sr vs. Fe for obsidian artifacts from Inka sites (above) and local sites (below); values for Sr in ppm, in weight percent for Fe.

the border, the Cayambes would have been prevented from directly procuring material from Mullumica, and able to acquire fresh obsidian only from a source within territory under their control, i.e., Callejones. The Mullumica obsidian found in the Cayambe sites could have been acquired prior to the Inka incursion, and possibly cached or reclaimed from archaeological contexts for use during wartime.

Alternatively, if the frontier was more permeable, some Cayambes could have traveled to the sources to directly procure material, or they may have been able to obtain obsidian through exchange with intermediary groups. The area around Oyacachi and elsewhere to the east and southeast of the obsidian sources was occupied by the Quijos, who are known to have established trade networks with highland groups (Uzendoski, 2004). Ethnohistoric data indicate the existence of traders known as mindalaes traveling between some groups in northern Ecuador in late prehispanic times (Salomon, 1986), suggesting a possible mechanism for supplying the Cayambes with obsidian. However, it is unknown whether they traded in obsidian or if the Inkas allowed them to operate freely across the frontier during times of active warfare.

Finally, the Cayambes may have been able to access sources via direct military raids, or when they succeeded in briefly chasing Inka forces from positions in Pambamarca. Further analysis is needed to assess these possibilities, but it seems most likely that the Inkas would have tried to maintain a rigid border to the east in addition to their perimeter of forts to the north, given the circumstances of fierce resistance by the Cayambes and the fact that the Inkas frequently established forts along the eastern border of the empire to prevent incursions from Amazonian groups.

6.3. *Use of the Yanaurco-Quiscatola source*

The appearance of Yanaurco-Quiscatola material in Inka contexts is notable given that exploitation of that source seems to have ceased around AD 1000 (Bigazzi et al., 1992). The impetus for abandonment is unknown, but it is intriguing that the source was once again exploited in Inka times. Perhaps native political or social restrictions on use of the obsidian were obviated by the Inka conquest, a likely scenario if the Inkas had implemented their common imperial practice of forcefully removing the local population to replace them with outsiders. Likewise, religious injunctions against use of the obsidian may have been irrelevant to a transplanted population. Alternatively, if such proscriptions existed and the local population was left in place, they may have chosen to provide the Inkas with “taboo” obsidian as a subversive action. In a sense, this could have worked as a “weapon of the weak,” (Scott, 1985) a strategy through which people that are subjected to domination by another group show their resistance to the power structure by small or indirect actions in opposition to the dominant society rather than by direct disobedience.

Table 4
Obsidian artifact source provenance, summarized by site.

Site	Affiliation	Obsidian samples from source						Total
		Mullumica (low Fe)	Mullumica (high Fe)	Yanaurco-Quiscatola	Callejones (low Fe)	La Chimba type	Indet.	
Quitoloma	Inka	16	10	1		1		28
Campana	Inka	3	5	1				9
Oroloma	Early Cayambe	11	18	1	2	2		34
Pingulmi	Cayambe	4	8		2	1		15
Pukarito	Cayambe		4		1	1	1	7
Guachalá	Colonial		3			1		4
Oyacachi-1	Quijo		1			1		2
Total		34	49	3	5	7	1	

It is also conceivable that Yanaurco-Quiscatola material was still being exploited in late pre-Inka times, and that we lack sufficient data from that time period to reveal the duration of quarrying activities. It is notable that one sample of Yanaurco-Quiscatola obsidian showed up in the earlier site of Oroloma. Oroloma dates to ca. AD 700–1180, so the use of Yanaurco-Quiscatola obsidian in this site is consistent with the scenario of abandonment of the source in late pre-Inka times.

6.4. Unidentified source: La Chimba type obsidian

This analysis may have provided some clues regarding the location of the source of La Chimba type obsidian. Given that the material is markedly different in composition from the major deposits in the Sierra de Gaumaní, the source may be located outside the Chacana caldera. Because the Inkas were obtaining La Chimba type obsidian for use in Pambamarca, it is likely that the source was at least partly within the territory they controlled. But because La Chimba type obsidian also appeared in Cayambe sites in Pambamarca, the source could be somewhere accessible by both groups, perhaps via outcrops located on each side of the frontier. Also, considering that this type was first noted in the site of La Chimba, which lies to the north of Pambamarca, the source is unlikely to be located very far to the south of the Inka and Cayambe forts.

7. Conclusions

This provenance analysis indicates that obsidian was provided to the Inka military installations of Pambamarca as part of the tribute obligations of the people residing in the recently conquered region just to the south and west of the Inka forts. This is consistent with the general picture of provisioning of food and other materials to the Inka military and other operations as described in major chronicles of the Inka Empire. A significant implication of these results is that the Inkas had quickly consolidated their control over the people residing in the region of the obsidian deposits within just a few years of conquering the area, such that tribute obligations were established and being fulfilled while the Inkas were concentrating on conquering the people to the north and east.

The time lag between conquering provinces and consolidating control over them is somewhat of an open question, as most chronicles of Inka conquests do not provide details on the duration of this process in different areas. Scholars have tended to assume the process was a lengthy one, and that provinces conquered late in Inka expansion were not fully under state control at the time of the Spanish conquest of the Andes. In contrast, these results present a case wherein the Inkas appear to have quickly established control over an area and implemented imperial political and economic practices. This process took fewer than ten years after initial conquest, possibly as few as a year or two.

The analysis is also consistent with the hypothesis that the frontier between the expanding Inka state and the native Cayambes crossed through the obsidian deposits. It appears that the Inkas acquired obsidian only from sources within what would have been their territory behind that border, while the Cayambes were able to directly access the Callejones source in land outside Inka control and still manage through some mechanism to obtain material originating from a source within Inka territory. In certain ways, the frontier of the Inka Empire seems to have been guarded and closed in times of active warfare. Subjugated people within the Inka domain were not allowed to cross the border to access resources, but on the other side, it is possible that the Cayambes penetrated into Inka territory to obtain obsidian from Mullumica. Such a strict control of economic activities is similar to limitations on exchange imposed by the Inkas in their occupation of nearby regions in northern Ecuador (Bray, 1992); these indicate an imperial approach of strict control of the local political economy through the successive stages of invasion, conquest, consolidation of control, and long-term occupation of provinces in the northern sector of the empire.

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