Title:ED-XRF analysis of obsidian artifacts from the probable labor colony (mitmaqkuna) settlement of Yanawilka and implications for Inca imperialism in Vilcashuamán province, Peru

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Abstract: Perhaps the most ambitious social policy carried out by the Incas, the mitmaq program resettled one third to one quarter of subject populations for the purposes of control and producing for the state. Ethnohistoric sources suggest that the relocated people, called mitmaqkuna, were given access to fertile lands and enjoyed elevated social status and freedoms bestowed to them by the Incas. Until now, these claims have not been tested with archaeological evidence. This paper evaluates the ethnohistoric claims through the geochemical analysis of 84 obsidian artifacts from a probable mitmaqkuna agricultural labor colony called Yanawilka, located in Vilcashuamán province, Peru. There is evidence that the ability of laborers at Yanawilka to independently participate in regional trade was severely limited. The obsidian was mostly from the Quispisissa source, but the relative scarcity and evidence for conservation of raw material suggests that access to this high-quality source was limited and not due to direct procurement.

1. Introduction and research questions

The Incas may have socially elevated *mitmaqkuna* groups by granting them economic advantages such as access to fertile land (Alconini 2013: 278). According to Sarmiento de Gamboa (2010: 146), the Inca emperor Topa Inca expanded the *mitmaq* system and gave *mitmaqkuna* “more privileges and freedom.” Ethnohistoric evidence shows that the area surrounding Yanawilka was settled by mitmaqkuna identified as the Condes (Carabajal 1965 [1586]; Piel 1995; Salas 1998, 2002; Santillana 2012). They spoke Quechua (Carabajal 1965 [1586]: 217; Salas 2002: 64). In the early Spanish colonial period, before the 1570s, Yanawilka belonged to the Condes community of Vischongo (Hu 2016: 47). In the land titles of Pomacocha, “Yanavilca” is listed as one of the boundary markers of the former “patrimonio de los Incas,” and the Condes of Vischongo had claimed it as their own (Hu 2016: 488-490, 495-497). Yanawilka was most likely inhabited by Condes *mitmaqkuna*, who were probably originally from the Arequipa region to the south (Hu 2016).

The Condes were considered allies of the Inca, and they were transplanted to the Inca Vilcashuamán province to secure this strategic area (Salas 2002). The Condes were one of the groups who formed part of the Inka armies’ campaigns in the Vilcashuamán area (Cieza de León 1984 [1553]: second part, chapters 34, 36, 47, 48). Therefore, the Inca may have socially elevated the Condes while at the same time isolating antagonistic groups like the Cañaris, who were also transplanted to the Vilcashuamán area (Salas 2002: 66, 73). Did the social elevation mean the Condes *mitmaqkuna* had freedom? Did the *mitmaqkuna* of Yanawilka maintain ties to their homeland and other regions? Or did obsidian circulation reflect a more Inca-dependent economic network? The answer to these questions may shed light on whether the Inca severed regional social and economic ties of *mitmaqkuna* such as the Condes of Yanawilka. To answer this question, we must consider the following research questions:

1) Were the variety of obsidian sources exploited at Yanawilka more, or less, geographically extensive and diverse than at comparable sites prior to Inca conquest? If the variety of obsidian sources exploited were more geographically extensive and diverse than at comparable

settlements from shortly before Inca conquest, then Inca hegemony expanded the obsidian networks of the Condes *mitmaqkuna* of Yanawilka. This implies that *mitmaqkuna* considered political allies of the Inca were given special economic privileges and access to obsidian resources. If, however, the obsidian sources utilized at Yanawilka were less geographically extensive and diverse, then the implication is that the Condes at Yanawilka had restricted exchange networks. The relationship between geographic distances to the sources and the relative proportions of the sources used can be used to infer the political aspects of exchange (Shackley 2005: 154-155). For example, if the Condes *mitmaqkuna* used obsidian sources in proportion to distance, then political restriction of exchange is less likely. If, however, the Condes *mitmaqkuna* primarily used obsidian sources from farther afield than expected, then there probably were political influences on obsidian exchange networks. The ideal test for this question would be to compare obsidian networks of the Late Intermediate Period (CE 1100-1400) (thereafter LIP) sites in the Condes' homeland to that of Yanawilka. Unfortunately, because no research on obsidian circulation of LIP sites in the Condes' homeland exist, we will use the LIP Chanka sites of Achanchi and Luisinayoc as proxies for LIP and we will use the Late Intermediate Period (CE 1100-1400) Chanka sites of Achanchi and Luisinayoc as proxies for Late Intermediate Period social landscapes (Kellett *et al.* 2013). Fortunately, the Andahuaylas area is geographically close to both Yanawilka and to the Condes' homeland, so one would expect the same range of sources to be potentially exploited in both areas. Another line of evidence that can be used to judge vibrancy of Inca period obsidian circulation is to compare the densities of obsidian artifacts at Yanawilka to those of Inca-period Pulapuco and pre-Inca Achanchi and Luisinayoc. If Yanawilka has high obsidian density compared to the other sites, then access to obsidian was not restricted and exchange was vibrant. If, however, Yanawilka has lower than expected obsidian density, then restriction of access to obsidian was likely.

2. Instrumentation and methodology

A Thermo Electron Quant'X Energy Dispersive X-Ray Fluorescence (ED-XRF) machine was used to the analyze mid-Zb condition elements of Ti-Nb, Pb, and Th. The X-ray tube operated at 30 kV with the current set automatically and used a 0.05mm (medium) Palladium (Pd) filter. Each sample was analyzed at 200 seconds 'livetime' and in an air path atmosphere. Trace element data are reported in parts per million (ppm) for titanium (Ti), manganese (Mn), iron (Fe_2O_3), zinc (Zn), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), niobium (Nb), (Shackley 2011: 203). Shackley calibrated the Quant'X machine using international rock standards certified by the National Institute of Standards and Technology (NIST), the U.S. Geological Survey (USGS), the Canadian Centre for Mineral and Energy Technology, and the French Centre de Recherches Pétrographiques et Géochemiques (Shackley 2011: 204). Energy calibration was checked each analysis day using USGS standard RGM-2 was used to check accuracy with each analysis batch. The instrumentation and calibration has shown good accuracy over numerous analyses and results are comparable to both XRF and NAA analyses among laboratories for most elements (Shackley 2011: 33). Most recently, the re-characterization of the Quispisisa source obsidian was carried out using the same instrument (Tripcevich and Contreras 2011).

The optimum sample size is a minimum of 10mm in diameter and 1.2-2.5mm in thickness, at which "no statistically measurable element distortions are observed" (Davis *et al.* 2011: 61). This level of precision, however, is not necessary for accurate source assignment because relative element proportions are not affected, and samples with minimum dimensions of 8mm in diameter and 0.5mm in thickness should yield results appropriate for source assignment (Davis *et al.* 2011: 62). My sampling strategy was to analyze all available obsidian artifacts above the 8mm diameter and close to the 0.5mm thickness threshold; as a result, 84 obsidian artifacts from all excavation units were analyzed. The 84 obsidian artifacts constitute 66% (84/128) by count and 94% (128g/136g) by mass of the total obsidian artifacts excavated from four excavation units (Y1, Y2, Y3, Y4) from Yanawilka. Detailed descriptions of the excavation units and the obsidian artifacts recovered from them is described in Hu (2016). A bivariate plot of Sr versus Rb distinguishes most major South-central Andean obsidian sources (Figure 1); when identification is not clear, other elements such as Fe (%), Y (ppm), Zn (ppm), Zr (ppm), and Nb (ppm) were considered (Table 1) (Shackley 2005; Glascock *et al.* 2007). The obsidian artifacts were manually washed to remove excess dirt before analysis.

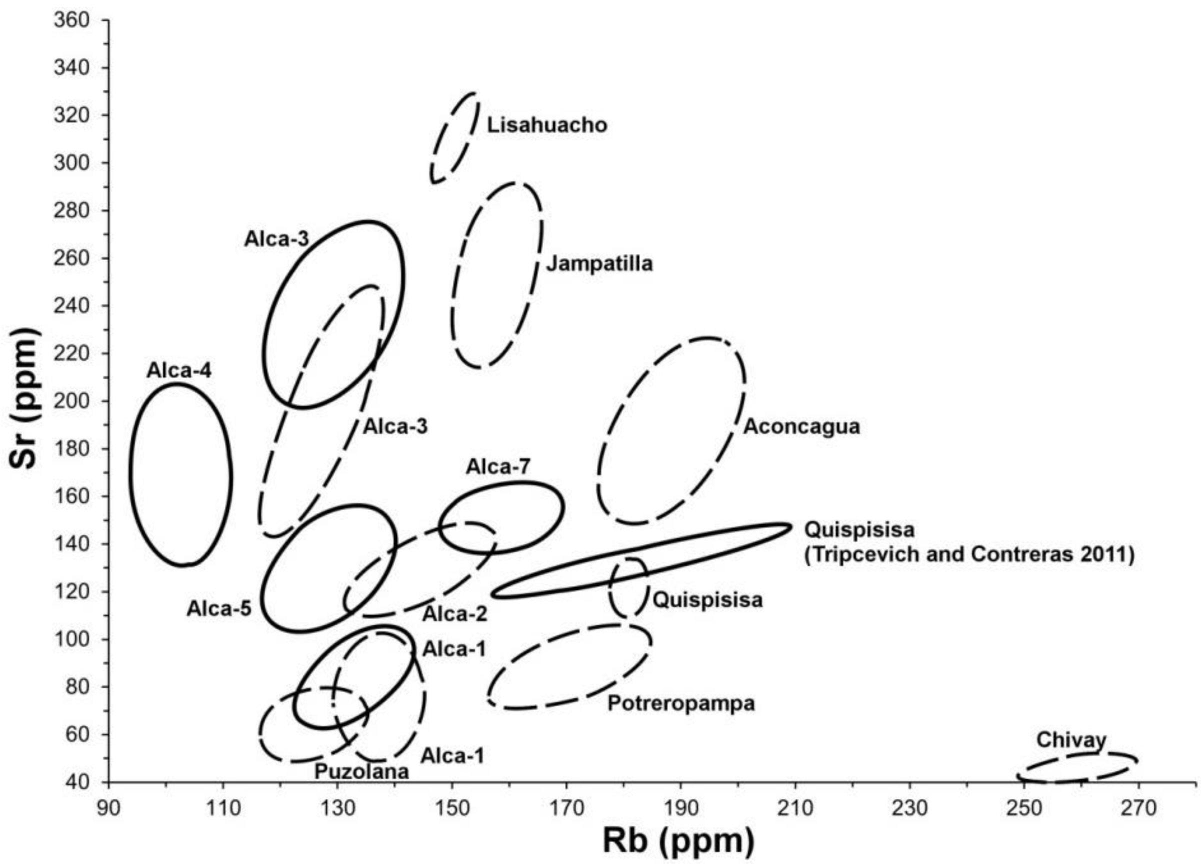

Figure 1: Bivariate plot of ED-XRF Sr (ppm) and Rb (ppm) concentrations of obsidian sources in Peru with 95% confidence interval ellipses. Dashed lines are 95% confidence interval ellipses from Glascock *et al.* 2007: figure 5. Solid lines are more recent chemical characterizations of Alca type obsidian (Rademaker *et al.* 2013) and Quispisisa obsidian (Tripcevich and Contreras 2011).

Attribute	Alca-1	Alca-2	Alca-3	Jampatilla	Lisahuacho	Potrero-pampa	Quispisisa
N	169	5	32	6	6	6	16
K (%)	3.70±0.20	3.57±0.34	3.60±0.21	3.68±0.10	4.03±0.08	3.96±0.26	3.73±0.03
Ti (ppm)	831±161	1142±96	1378±96	1164±63	1389±59	534±63	836±17
Mn (ppm)	439±52	428±83	398±71	610±43	472±17	547±43	332±12
Fe (ppm)	5371±271	6961±178	8118±324	8692±301	8547±135	4593±167	5623±39
Zn (ppm)	40±4	46±5	49±7	110±7	85±8	42±3	35±1
Ga (ppm)	17±2	15±2	15±2	11±1	18±1	21±3	16±1
Rb (ppm)	134±4	141±5	129±5	158±3	150±2	170±6	181±1

Sr (ppm)	82±10	142±13	233±19	252±16	310±8	88±7	121±5
Y (ppm)	13±2	16±2	15±2	27±2	14±3	16±3	19±2
Zr (ppm)	101±9	141±10	159±12	169±10	198±6	91±9	104±3
Nb (ppm)	13±2	11±3	12±1	27±3	15±4	13±3	11±1

Table 1: Obsidian sources and their elemental compositions (ED-XRF) (Glascock *et al.* 2007: table II; Rademaker *et al.* 2013: supplement). Alca-1, Alca-2, and Alca 3 have combined means and standard deviations from Glascock *et al.* 2007 and Rademaker *et al.* 2013. Tripcevich and Contreras (2011) have analyzed 34 samples from the Quispisisa source, but elemental compositions have not yet been published (±= 1 standard deviation)

3. Migration, social networks, and identity

The geochemical analysis of obsidian artifacts can illuminate past migrations, social networks, and identities (Braswell 2003; Shackley 2002, 2005; Golitko and Feinman 2015). The most compelling studies combine multiple lines of evidence to understand different facets of social interaction. Nowhere is the marriage of ceramic and obsidian source analysis stronger than in Southwest North American archaeology (e.g., Golitko and Feinman 2015; Mills *et al.* 2013; Neuzil 2008; Shackley 2005). The vibrant research is enabled by the large databases of obsidian and ceramic artifacts from numerous sites and active collaboration among Southwest ceramicists and lithicists. In the Andes, unfortunately, obsidian source analyses of artifacts are still few and far between, although the last ten years have seen an upsurge (Bigazzi *et al.* 1992; Burger and Asaro 1977, 1978; Burger *et al.* 2000, 2016; Burger and Glascock 2000; Craig *et al.* 2010; Eerkens *et al.* 2010; Glascock *et al.* 2007; Glascock and Giesso 2012; Giesso *et al.* 2011; Jennings and Glascock 2002; Kellett *et al.* 2013; Lazarri *et al.* 2009; Ogburn *et al.* 2009; Stanish *et al.* 2002; Tripcevich and Contreras 2011, 2013; Williams *et al.* 2012; Yacobaccio *et al.* 2002, 2004).

Because there are currently no geochemical analyses of obsidian artifacts from contemporary sites near Yanawilka/Pomacocha, we must rely on methods appropriate to the analysis of a single site in order to address questions of migration, identity, and social networks. For understanding the nature of migration, we can use ethnohistoric sources, and studies from the Southwest United States showed that migrants sometimes kept their former obsidian source preferences even at great distances (e.g., Mills *et al.* 2013; Shackley 2005). Therefore, if there is continued reliance on major obsidian sources near the Condes' homeland (i.e., the Alca sources), then kinship ties to their homeland probably continued (Figure 2).

Figure 2: Map of the approximate area of the Condes' heartland in relation to obsidian sources, the Inca capital of Cuzco, and Yanawilka. Condes' heartland extent based on Julien 1991: 107-108 and Trawick 2003: 47-48. Newly discovered minor source of Pomacocha described in Hu (2016: 94-96).

The relative importance of direct procurement versus exchange mechanisms can shed light on the nature of economic networks across the landscape. Appropriate methods include analyzing any significant variations from the standard distance decay model, also known as the "Law of Monotonic Decrement" (Molyneaux 2002: 144; Renfrew 1984: 136; Shackley 2005: 154-155; Torrence 1986: 15-16). Significant deviations from the baseline distance decay model may be a result of political tensions and/or different kin affiliation (Levine *et al.* 2011; Shackley 2005: 137). The shape of the distance decay curve can help determine whether obsidian was acquired by a small number of short moves, implying "direct access to mode of procurement" (Hodder and Orton 1976: 142-145; Torrence 1986: 131). A large number of obsidian sources used often signals diverse exchange partners, implying some degree of regional integration and interaction (Mills et al. 2013; Shackley 2005: 143-144). Analysis of the artifacts themselves can also shed light on direct procurement versus exchange. If there is reliance on nearby sources, then direct procurement is more likely (Neuzil 2008: 72-73). Flakes and shatter from distant sources imply direct procurement or direct access to far-flung networks (Bayman and Shackley 1999: 843). The size of debitage in relation to distance to the source can also be used to assess the nature of the obsidian networks (Torrence 1986: 128). The presence of bipolar technology (conservation) can imply limited access to large nodule sources and, thus, general restriction from regional obsidian networks (Bayman and Shackley 1999: 843).

The presence of expansionist polities can cause significant changes in obsidian exchange patterns (e.g., Levine *et al.* 2011). This was also true for the Andes. In the Middle Horizon (CE 600-1000), the Wari polity seemed to have expanded the use of the high quality

Quispisisa obsidian in Peru, although local sources still dominated at most sites (Burger *et al.* 2000; Kellett *et al.* 2013; Williams *et al.* 2012). The Inca seemed to have dramatically affected obsidian exchange patterns. In the case of Late Horizon (thereafter LH) (CE 1450-1532) northwestern Argentina, the Inca's strict control over economic traffic manifested in significant shifts in obsidian exchange patterns from the previous period (Yacobaccio *et al.* 2002, 2004). Before the Inca, there were two long-lived distribution spheres centered on two separate major sources, respectively. With the arrival of Inca hegemony, all major sources appeared together at certain archaeological sites (Yacobaccio *et al.* 2002: 190; Yacobaccio *et al.* 2004: 202).

At the northern frontier of the Inca Empire in Ecuador, the Inca practice of drawing soldiers from disparate parts of their empire was reflected in the diversity of obsidian sources of the soldiers' tools (Ogburn *et al.* 2009). Possible interpretations are that the soldiers carried their tools from their places of origin or that the Incas drew tribute from various parts of the empire and then redistributed the goods. Ogburn *et al.* (2009) suggested that political boundaries, as in the case of the Inca frontier, may have prevented certain sources from being exploited despite proximity. This article contributes a significant advance in our understanding of obsidian networks of the LH in Peru, especially of a core imperial area like Vilcashuamán. The data from this chapter can be used in future social network analyses of multiple sites in the area once more provenance studies are done.

4. Results

4.1 Geochemical characterization of obsidian artifacts at Yanawilka

In this section, we argue that obsidian circulation at Yanawilka was politically mediated and consistent with what other scholars have noted about the highly controlled nature of interregional traffic under the Inca (Murra 1980; Yacobaccio *et al.* 2002). A bivariate plot of strontium and rubidium aided in assigning the vast majority of obsidian artifacts to obsidian sources (Figure 3). Quispisisa obsidian is predominant at Yanawilka, comprising at least 83% of the obsidian artifacts analyzed (Table 2). The next most frequent obsidian source utilized at Yanawilka was Jampatilla (10.7%). Because the Jampatilla and Lisahuacho sources were only characterized by six samples each, we expect that their true 95% confidence ellipses differ significantly from the present chemical characterization (Glascock *et al.* 2007). For four of the samples that fell outside of the Jampatilla confidence ellipse (#63, 73, 84, 104), high yttrium concentrations were used to assign them to Jampatilla rather than to Lisahuacho (Glascock *et al.* 2007: 541). One sample (#78) is most likely from an unknown source due to its high rubidium concentration; nevertheless, #78's other elemental concentrations are largely consistent with Jampatilla. There are three unassigned samples (#81, 132, 139) that could either be Alca-2 or Quispisisa, judging from manganese (Mn) concentrations (Appendix 1).

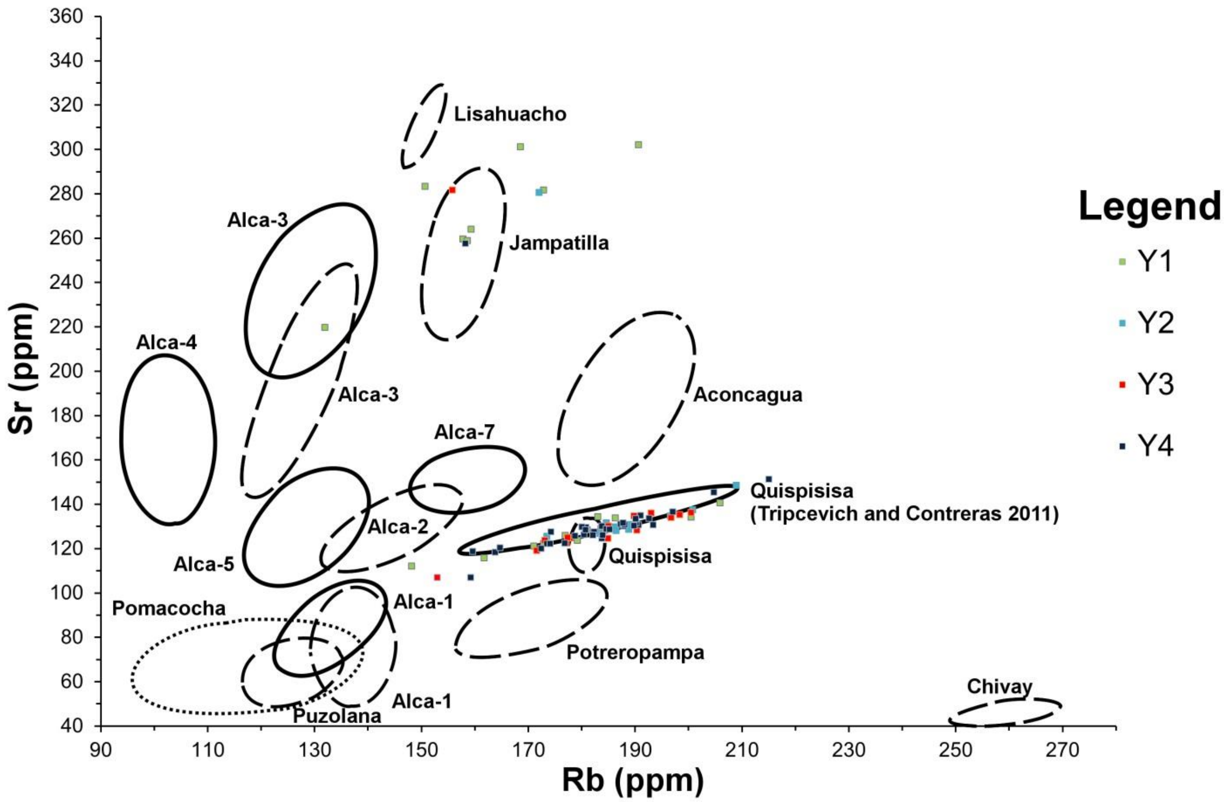

Figure 3: Bivariate plot of strontium (Sr) and rubidium (Rb) concentrations of 84 obsidian artifacts from Yanawilka superimposed on 95% confidence ellipses of obsidian sources.

Unit	Alca-3	Jampatilla	Quispisisa	Unassigned	Unknown	Total
Y1	1 (4.5%)	6 (27.3%)	13 (59.1%)	1 (4.5%)	1 (4.5%)	22 (100%)
Y2		1 (9.1%)	10 (90.9%)			11 (100%)
Y3		1 (6.7%)	13 (86.7%)	1 (6.7%)		15 (100%)
Y4		1 (2.8%)	34 (94.4%)	1 (2.8%)		36 (100%)
Total	1 (1.2%)	9 (10.7%)	70 (83.3%)	3 (3.6%)	1 (1.2%)	84 (100%)

Table 2: Source provenance of obsidian artifacts at Yanawilka.

To contextualize the geographic extensiveness and diversity of obsidian sources used at Yanawilka, I compare Yanawilka (ca. 1450-1532 CE) to the Chanka sites of Achanchi (1227-1315 CE 1σ) and Luisinayoc (1045-1221 CE 1σ) (Kellett *et al.* 2013). There are three reasons for comparing Yanawilka to these two sites. First, no other major obsidian provenance study has been carried out in the area for either the LIP Period (1000-1450 CE) or the LH (1450-1532 CE). Second, Achanchi and Luisinayoc are not far from Yanawilka: 62km and 69km away, respectively. Third, they are about the same average distances to the obsidian sources, and the differences in travel times to any obsidian source are less than two days (Table 3). Therefore, geographic distance alone should not prevent any one source from being potentially exploited. Therefore, the Chanka sites of Achanchi and Luisinayoc make acceptable proxies for obsidian exploitation in the area before the arrival of the Inca. Ideally, one should compare Yanawilka obsidian provenance proportions to those of LIP sites in the Vilcashuamán area as well as in the Condes homeland, but such research has not been conducted yet.

Source	Yanawilka	Achanchi	Luisinayoc

Quispisisa	81.8 (2.6 days)	133.1 (4.2 days)	137.8 (4.3 days)
Jampatilla	69.2 (2.2 days)	112.1 (3.5 days)	116.0 (3.6 days)
Alca	216.7 (6.8 days)	188.7 (5.9 days)	182.8 (5.7 days)
Lisahuacho	106.7 (3.3 days)	88.9 (2.8 days)	85.4 (2.7 days)
Porteropampa	108.7 (3.4 days)	88.2 (2.8 days)	84.4 (2.6 days)
Mean distance (all)	116.6 (3.6 days)	122.2 (3.8 days)	121.3 (3.8 days)

Table 3**:** Euclidean distances on an isotropic (flat) surface from obsidian sources to archaeological sites in kilometers. Travel times in parentheses are minimum estimates, assuming 4km/h velocity and 8h travel a day (Kellett *et al.* 2013: 1893).

Although the absolute number of obsidian sources exploited does not differ significantly among Yanawilka and the Chanka sites, there are substantial differences in emphasis (Table 4; Figure 4). At Yanawilka, Quispisisa is the overwhelming preference, and at the Chanka sites of Achanchi and Luisinayoc, the vast majority of the obsidian used comes from the Lisahuacho and Potreropampa obsidian sources, which are less than 5-10km away from each other. Because the occupations at Achanchi and Luisinayoc together span most of the LIP, it is clear that the area of Lisahuacho and Potreropampa was always part of the LIP Chanka obsidian circulation network, even if conflicts may have changed which source was emphasized (Kellett *et al.* 2013: 1899). Because of the diversity of obsidian sources present at Achanchi and Luisinayoc all came from either south or west of Andahuaylas as opposed to the east toward Cusco and Arequipa, Kellet *et al.* (2013: 1898) suggest that the Chanka obsidian patterns reflected stronger cultural ties to the Apurimac and Ayacucho regions. This is consistent with ethnohistorical sources that say the Chanka were a confederate of allied groups of the Apurimac and Ayacucho regions who opposed Inca expansion (Bauer *et al.* 2010). The Quispisisa and Jampatilla sources are located in the LIP territories of the Lucanas and Soras peoples, respectively. The Andahuaylas Chanka area, therefore, did have access to exchange relationships or even directly procured in these areas. While there was certainly inter-group violence (Bauer and Kellett 2010; Kellet 2010, 2013; Kellet *et al.* 2013; Kurin 2012, 2014) the political landscape was fluid, and cultural similarities may have facilitated possibilities for the anti-Inca political alliances described in the ethnohistorical sources.

Site	Jampatilla	Lisahuacho	Potreropampa	Quispisisa	Unknown	Total
Achanchi		1 (6.3%)	15 (93.8%)			16 (100%
Luisinayoc	1 (2.8%)	18 (50%)	8 (22.2%)	5 (13.9%)	4 (11.1%)	36 (100%)
Total	**1 (1.9%)**	**19 (36.5%)**	**23 (44.2%)**	**5 (9.6%)**	**4 (7.7%)**	**52 (100%)**

Table 4: Source provenance of obsidian artifacts at Achanchi and Luisinayoc.

Figure 4: Obsidian sources utilized by Yanawilka (LH), Achanchi and Luisinayoc (LIP). Line thickness is proportional to the square root of the percentage of obsidian artifacts at the site from the source.

There was no Lisahuacho and Potreropampa obsidian among the artifacts analyzed from Yanawilka, which is surprising given that those sources comprised 80.8% of the total assemblage of Achanchi and Luisinayoc. Potreropampa had been a major source of archaeological obsidian in the area from 2500 BCE-1400CE (Kellett *et al.* 2013: 1899), and it is roughly equidistant from the Andahuaylas area as it is from the Vilcashuamán area. The dominance of Quispisisa at Yanawilka (83.3%) and of Lisahuacho/Potreropampa at Achanchi and Luisinayoc (80.8%) show a stark difference in obsidian source preference. A possible explanation is that since Lisahuacho and Potreropampa were located in the Chanka territories, the Inca may have discouraged the Condes at Yanawilka from having direct economic relations with the Inca-unfriendly Chanka groups. Alternatively, the Condes themselves may not have traditionally pursued obsidian exchange with the groups in the Apurimac Chanka area.

At Yanawilka, distant Alca obsidian is present at very low quantities, with only 1 out of 84 analyzed being Alca obsidian. The Alca obsidian source is located in the Condes homeland, and its presence at Yanawilka could be a result of weak or infrequent exchange with groups from their homeland. Another possibility is that the Alca obsidian (specifically Alca-3, found around Cerro Aycano) was carried from the homeland as part of the initial migration. Direct procurement after initial migration is less likely given the low quantities, small size of the debitage, and distance of the Alca obsidian source. The presence of Alca obsidian at Yanawilka marks a qualitative difference in obsidian exchange from the earlier Chanka sites where no Alca obsidian was used (even though Alca is closer to the Chanka area than to Yanawilka), presumably due to political considerations (Kellett *et al.* 2013: 1898). Just as the Wari Empire had spread and intensified the use of Quispisisa obsidian (Burger *et al.* 2000a: 343-344, 351;

Kellett *et al.* 2013: 1899), the dominance of Quispisisa obsidian at Yanawilka may be a result of similar Inca imperial interventions in interregional exchange. Further obsidian source provenance research at other LH and LIP sites is needed to further test this hypothesis.

Another line of evidence used to judge the effect of imperial intervention on obsidian circulation is how well the correlation between source proportion and linear distance conforms to the distance decay model (Shackley 2005: 154-155). The correlation at Yanawilka is very weak (r^2=0.274, p=0.649), implying that political influences on obsidian exchange existed (Table 5). Even though Jampatilla is closer to Yanawilka, there was an overwhelming preference for Quispisisa obsidian even though the quality of obsidian at both sources is good. Although not prohibitively distant, the Lisahuacho and Potreropampa sources were not exploited, at least to any appreciable degree, at Yanawilka. The combined source proportions at Achanchi and Luisinayoc conform better to the distance decay model (r^2=0.727, p=0.147) (Table 6). The pattern at Yanawilka is more consistent with controlled traffic than at Achanchi/Luisinayoc.

Source	Frequency	Percent	Distance to source (linear km)
Jampatilla	9	10.7	69.2
Quispisisa	70	83.3	81.8
Alca-3	1	1.2	213.7
Total	80	95.2	

Table 5: Frequency distribution of obsidian source provenance at Yanawilka (1460-1532 CE) and linear distance to source. r^2=0.274, p=0.649.

Source	Frequency	Percent	Distance to source (linear km)
Potreropampa	23	44.2	86.3
Lisahuacho	19	36.5	87.2
Jampatilla	1	1.9	114.1
Quispisisa	5	9.6	135.5

Table 6: Frequency distribution of obsidian source provenance at Achanchi (1227-1315 CE 1σ) and Luisinayoc (1045-1221 CE 1σ), and linear distance to source (averaged distances from Achanchi and Luisinayoc). r^2=0.727, p=0.147.

4.2 Scarcity of obsidian and bipolar reduction at Yanawilka

Obsidian was relatively scarce at Yanawilka and production methods reflected economizing scarce resources. The lines of evidence I use are the importance of bipolar reduction, analysis of debitage, and density of obsidian. Bipolar reduction is evident when flakes are sheared, diffuse or multiple bulb of percussion/point of impact or ripple direction on the same surface, and when their inner and outer surfaces are not distinct (Ahler 1989: 210; Kooyman 2000: 56; Kuhn 1995: 97-98; Odell 2004: 61). Orange-slice shaped flakes (with cortex as the 'rind') or splintered flakes are also generally indicative of bipolar reduction (Shott 1999). Bipolar reduction can produce flakes of various sizes and shapes (Shott 1989). Debitage consist of angular debris, flakes, and blades. For the analytical purposes of this chapter, the "blades" category was lumped with debitage: the single blade found at Yanawilka is incidental in that it happened to be a complete flake with the formal properties of a blade. Flakes are defined by having an identifiable interior surface, and angular debris have uncertain dorsal to ventral orientation (the interior surface is not identifiable) (Shott 1994: 70).

Production certainly occurred on site due to the predominance of debitage (flakes and angular debris) in the assemblage (Table 7). Furthermore, the small size of the debitage, with

83% (83/99) weighing a gram or less, shows that production did occur within the structures. Half of the obsidian artifacts (64/128) have cortex on the dorsal side or platform. The high proportion of obsidian artifacts with cortex also supports production occurring on site. Evidence of bipolar reduction is present at all of the structures and occurs on 13% (17/128) of obsidian artifacts. The bipolar classification is conservative, as we only included flakes that exhibited clear signs of bipolar reduction (at least two identifying attributes). The actual proportion of debitage that was created through bipolar reduction is undoubtedly higher, since a lot of bipolar reduction shatter does not leave clear evidence (Barham 1987: 48). Furthermore, there is no significant difference in dimensions and mass of debitage with and without evidence of bipolar reduction, making it possible that some of the debitage classified as non-bipolar nevertheless were a result of bipolar reduction (Table 8). Surprisingly, bipolar reduction is evident on obsidian from sources with large nodule sizes, such as Quispisisa (Tripcevich and Contreras 2011) (Table 9). I have personally seen some Quispisisa nodules at the primary source measuring 40 to 50cm in the largest dimension. The prevalence of bipolar reduction on obsidian from a source with large nodules is a classic indicator of resource scarcity and minimal direct procurement, if any. Even a smaller-sized nodule from Quispisisa could more than account for all the mass of Quispisisa obsidian excavated at Yanawilka. Large debitage were rare, and the vast majority clustered around 1.4cm in length and 1.0cm in width, implying that the original cores, preforms, or source material started out small (Table 10).

Unit	Angular debris	Blade	Core	Flake	Flake tool	Projectile Point	Total
Y1	22		1	19	2	1	45
Y2	4			4	3		11
Y3	7	1		2	6	3	19
Y4	15			25	12	1	53
Total	**48**	**1**	**1**	**50**	**23**	**5**	**128**

Table 7: Distribution of obsidian lithic classes among Yanawilka units.

Bipolar evidence?	N	Mean of mass (g)	Mean of length (cm)	Mean of width (cm)	Mean of thickness (cm)
Yes	17	0.9	1.6	1.1	0.4
No	111	1.1	1.6	1.1	0.4
Total	**128**	**1.1**	**1.6**	**1.1**	**0.4**

Table 8: Attributes of all obsidian artifacts with and without evidence of bipolar reduction.

Bipolar evidence?	Jampatilla	Quispisisa	Total
Yes	1	13	14
No	8	57	65
Total	**9**	**70**	**79**

Table 9: Evidence of bipolar reduction on Jampatilla and Quispisisa obsidian.

Lithic class	N	Mean and SD of mass (g)	Mean and SD of length (cm)	Mean and SD of width (cm)	Mean and SD of thickness (cm)
Angular debris	26	1.1±0.9	1.3±0.5	0.9±0.4	0.4±0.2
Blade	1	0.3	1.6	0.8	0.2
Flake	32	1.1±1.8	1.6±0.9	1.0±0.4	0.3±0.2
Total	59	1.1±1.4	1.4±0.7	1.0±0.4	0.4±0.2

Table 10: Attributes of debitage (Angular debris, blade, and flakes).

Although the inhabitants of Yanawilka had access to the Jampatilla and Quispisisa sources, they did not have great quantities of obsidian from those sources. Nevertheless, the Jampatilla and Quispisisa obsidian were in quantities too large to have solely originated from being carried on site during the initial migration.

Although some obsidian reduction undoubtedly occurred outside of the structures, I do not expect it to be significantly different than inside the structures because we excavated a small area outside of Y1 and did not find any debitage, only one intact obsidian point. Survey of Yanawilka also confirmed the low densities of obsidian on site (Hu 2016: 74). Likewise, at Pulapuco, another LH site under Inca hegemony, obsidian debitage densities were evenly also low (1-3 flakes per unit) throughout the site (Abraham 2010: 246-247). The very small debitage recovered inside the Yanawilka structures confirm that the inhabitants did carry out obsidian reduction inside the structures. The inhabitants of Yanawilka may not have regularly swept the interior of their structures, because they left behind significant small cultural material behind. They may have knapped indoors due to inclement weather or as occasional tool-making for pressing food preparation needs.

The low densities of obsidian artifacts at the LH sites of Yanawilka and Pulapuco may be a characteristic of many settlements under Inca hegemony. Comparing obsidian densities at the LH sites of Pulapuco and Yanawilka to the LIP sites of Achanchi and Luisinayoc shows that the LH sites have significantly lower obsidian densities than the LIP sites (Table 11). I suspect that the low obsidian densities at Pulapuco and Yanawilka are common, if not the norm, among sites in areas of firm Inca hegemony. I interpret the low density of obsidian at Yanawilka as a result of restriction of interregional traffic of obsidian. Such control of traffic is likely a result of Inca imperial policies, as other scholars have noted.

Site	No. of obsidian	Volume excavated (m^3)	Density (No. of obsidian/m^3)
Yanawilka (Condes, LH)	128	25.93	4.94
Pulapuco (Lucanas, LH)	120	33.54	3.58
Achanchi (Chanka, LIP)	228	9.06	25.17
Luisinayoc (Chanka, LIP)	156	8.63	18.08

Table 11: Obsidian artifact densities at four sites (Abraham 2010; Kellett 2010). They are ordered chronologically from youngest to oldest sites.

Yanawilka and Pulapuco are more similar to each other than either is to the Chanka LIP sites in terms of obsidian artifact density. The Chanka LIP sites have much higher obsidian artifact densities than Pulapuco and Yanawilka. Overall, it seems that access to obsidian was restricted to some degree at Pulapuco and Yanawilka, and that this may be part of a larger pattern of obsidian scarcity at domestic settlements under Inca hegemony. Unfortunately, other than the sites of Pulapuco, Achanchi, and Luisinayoc, there is a lack of published information on obsidian densities. The general dearth of research in general about the LIP and the LH sites of the south-central Peruvian Andes precludes more systematic comparisons.

5. Discussion

Were the Condes of Yanawilka able to maintain direct regional ties to other groups, especially from their homeland, or were economic ties mediated through Inca-controlled regional traffic? From the standpoint of obsidian exchange, at least, it seems that there was some restriction of interregional traffic. Because obsidian was considered a “bulk” luxury, much like salt (Tripcevich 2007), other goods that traveled on the same economic circuits may also have been regulated. Given the small size of the debitage and the very low numbers of medium to large size flakes, as well as the low density of obsidian on site, direct procurement of the obsidian was less likely than some form of exchange. Obsidian likely arrived at Yanawilka in the form of preforms, large flakes, or finished products. The expansion of the use of Quispisisa obsidian is similar to other time periods with regional hegemonies like the Wari and is consistent with regulated traffic (Burger *et al.* 2000; Kellett *et al.* 2013).

Yanawilka is positioned only 700 meters from a major royal Inca road and is geographically close to both the royal palace at Intihuatana (3km) and the Inca provincial capital of Vilcashuamán (6km). The proximity of Yanawilka to this major artery of the Inca Empire would have meant that there was constant traffic passing by. Therefore, it would have been easy to acquire obsidian from traders on the royal Inca road. Despite being in an area of great economic connectivity, the inhabitants of Yanawilka seemed to be economically marginalized. They did not seem to have high status goods such as fancy ceramics or metal objects, and their domestic structures were expediently constructed, further reinforcing the idea that traffic was regulated and controlled (Hu 2016). The royal Inca road had regular wayside posts (*tampu*) every few kilometers (about 7km) for relay of goods and messages by runners, and thus, the royal Inca roads were easily controllable (Hyslop 1984; Polo de Ondegardo 1873: 169). Cieza de León (1959: 127) mentioned that troops patrolled these roads, and that the storehouses of Vilcashuamán supplied maize and other provisions for these troops.

The Inca are renowned for their divide-and-control policies such as the *mitmaq* system and encouraging distinction, especially through dress, among groups (D'Altroy 1992; Rowe 1982). The obsidian provenance data at Yanawilka does not contradict the Incas regulating or dividing the larger political landscape to their advantage, even if they did not exercise direct control of Yanawilka. The obsidian at Yanawilka only came from one direction: south and southwest. Notably, obsidian did not come from obsidian sources in Chanka territory, even though those sources are not much further away. Before the Inca, the Ayacucho area, which included Inca Vilcashuamán province, had ties to the Andahuaylas area (Kellett *et al.* 2013). By controlling major traffic on the royal Inca roads, the Inca presumably were also the mediators of a significant, if not majority, portion of interregional interaction. An important implication of the obsidian provenance study at Yanawilka is that even the *mitmaqkuna* afforded special status and considered friendly by the Inca may have been restricted in interethnic interactions, both locally and to other regions. The Inca strategy was to minimize political alliances among large groups that would pose a threat.

6. Conclusion

This article represents the largest obsidian provenance study of any Andean archaeological site from a single time period. It is also the first major obsidian provenance study in the core of the Inca Empire and yielded intriguing preliminary patterns. The patterns are consistent with other literature that emphasizes the divide-and-conquer strategies of Inca control that minimize the need for costly direct control. The surprising part is that even though the Condes were considered friendly to the Inca, the Condes *mitmaqkuna* of Yanawilka had relatively economically marginalized status, and frequent direct interaction with other ethnic groups was unlikely. The scarcity and provenance of obsidian at Yanawilka are consistent with some form of control of interregional traffic. Another non-mutually exclusive possibility is that the scarcity of obsidian at Yanawilka is a result of the Inca fragmenting the larger political landscape, which would have disrupted the previous obsidian exchange networks. The literature that states that certain *mitmaqkuna* groups were socially and economically elevated by the Inca may not apply to the Condes at Yanawilka. The agricultural focus of Yanawilka might be a factor in their economic marginalization, because at other sites, like Milliraya, the *mitmaqkuna* were craft specialists and may have been elevated by the Inca (Alconini 2013; Spurling 1992). There was no metal found at Yanawilka, which is unusual for LH domestic settlements and may also reflect their economically marginal status.

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