STRONTIUM ISOTOPE EVIDENCE FOR PREHISTORIC MIGRATION AT CHOKEPUKIO, VALLEY OF CUZCO, PERU

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Although Spanish chroniclers referred frequently to coerced migration in the Inca Empire, these migrations have been difficult to document archaeologically. One approach to migration studies, strontium isotope ($^{87}Sr/^{86}Sr$) analysis, has emerged as an effective technique. Until now, however, this method has not been applied to the Inca heartland region of Cuzco, Peru. In this study, we use strontium isotope analysis to examine patterns of prehistoric migration in the Cuzco Valley. Human dental enamel samples from the Cuzco Valley site of Chokepukio are analyzed and compared to the local $^{87}Sr/^{86}Sr$ signature established through faunal specimens. Though tentative due to a small sample size, the isotope results do not provide evidence for migration at this site from the time periods preceding the rise of the Inca Empire (200 B.C. to A.D. 1400). In contrast, there is substantial evidence for migration during the time of Inca imperialism (A.D. 1400–1532). Among these migrants, variation in 87Sr/86Sr values suggests that individuals emigrated from geologically diverse locations, while sex differences in the migrant group include a higher percentage of females and a greater diversity in female $^{87}Sr/^{86}Sr$ values. These data, along with ethnohistoric evidence, reveal how Inca labor policies reconfigured the composition of populations in the imperial heartland.

Este artículo presenta evidencia de las migraciones prehistóricas en el valle de Cuzco basado en un análisis de los isótopos de estroncio en los restos humanos. Muestras del esmalte dental de individuos enterrados en el sitio de Chokepukio en el valle de Cuzco han sido analizadas para determinar si habían imigrantes viviendo entre la población local. Nuestros datos indican la presencia de varios individuos migratorios enterrados en Chokepukio en la muestra del Horizonte Tardío/período Inca (1400–1532 d.C.), pero los datos no confirman la presencia de imigrantes antes del período Inca. La variación en niveles de estroncio sugiere que individuos migraron a la capital incaica de lugares diversos. Un análisis de la demografía de la migración sugiere que el estado inca dirigió la migración para cumplir con obligaciones al imperio incaico.

The success of the Inca Empire—unparalleled in scope in the New World—depended largely on a system of innovative imperial policies (D'Altroy 1992; Rowe 1982; Schreiber 1992). Among these policies, coerced migration emerged as an important strategy. The Inca relocated groups—known as *mitima* colonies—to fulfill the economic demands of the growing empire, a strategy that also aided in suppressing rebellions by removing hostile groups from their homelands (Gyarmati and Varga 1999; La Lone and La Lone 1987; Rowe 1946, 1982; Stanish 1997; Wachtel 1982).

Though colonial documents contain numerous references to coerced migration (e.g., Cobo 1979 [1653]; Espinoza 1969, 1973, 1974; Pease 1982:176; Rowe 1946:269; Sarmiento de Gamboa 1942:124 [1572]), it has proved difficult for archaeologists to identify (D'Altroy 2002:248). Material culture is often used to detect group movements, yet this approach can be problematic (Anthony 1990:897; Van Buren 1996:342). Cultural indicators of group identity—such as clothing, hats, or textiles—may not preserve in the archaeological record (Brothwell and Pollard 2001; Cronyn 1990; Good 2001:217). Moreover, cultural artifacts, as

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bounded material categories, may not reflect the fluid and dynamic boundaries of ethnic groups (Emberling 1997; Jones and Graves-Brown 1996; Stanish 2003:222). Consequently, the archaeological identification of migration has remained a challenge.

One alternative approach, strontium isotope ($^{87}Sr/^{86}Sr$) analysis, has emerged as an important method to investigate migration (e.g., Ericson 1985; Montgomery et al. 2000; Montgomery et al. 2005; Price et al. 1994; Price et al. 2000; Price et al. 2002; Price et al. 2004; Price et al. 2006; Sealy et al. 1991). Strontium studies involve the analysis of teeth and/or bone to identify variations in $^{87}Sr/^{86}Sr$ values, which differ based on local geology (specifically, the age and composition of local rocks).[1] By comparing human isotope values to a region's local biogeochemical signature, strontium analysis can be used to identify migrants living in a new locale. This technique has been successfully applied in the Andes at sites in northern Chile, Bolivia, and Peru (Knudson 2004; Knudson and Price 2007; Knudson et al. 2004; Knudson et al. 2005; Tung 2003).

However, the Cuzco region of Peru has not been investigated for strontium data until now. Cuzco—the capital of the Inca Empire—hosted a variety of migrant groups, according to colonial documents (Betanzos 1996 [1557]; Cieza de León 1985 [1553]; Cobo 1979 [1653]; Garcilaso de la Vega 1986 [1609]; Helmer 1955–1956:40). Yet no isotopic analyses have been completed to verify these accounts or to document how these migrations restructured the composition of Cuzco populations. The present study was therefore developed with three goals: obtain preliminary local strontium values using faunal teeth, analyze human dental enamel to identify prehistoric migrations into the Cuzco Valley, and explore resulting social and political implications. The site chosen for study, Chokepukio, was occupied from the Early Intermediate period through the Late Horizon (200 B.C.–A.D. 1532), providing the opportunity to document migration before and after the rise of the Inca Empire.

The resulting data offer a diachronic view of migration into the Cuzco Valley. The results suggest that migrants were not present among individuals sampled from the time periods preceding the Inca Empire (200 B.C.–A.D. 1400). In contrast, there is clear evidence for migration during the Inca Imperial period/Late Horizon (A.D. 1476–1532), with individuals originating from diverse regions. These results allow us to examine what appear to be the consequences of state-directed migration, as well as to explore sex differences that may reflect migration for the purpose of marriage in the Cuzco region.

Identifying Past Migration in the Andes

Migration in the Andes

Migration has long played a key role in shaping the Andean social landscape. At times, highland Andean groups have exploited ecological niches at different altitudes, maintaining a base population in one location and sending off smaller groups to exploit other "vertical islands" (Murra 1968, 1972, 1985). While maize agriculture is most successful at lower elevations, higher elevations are better suited for potatoes. The highest grassland regions (puna), where plant cultivation is ill-suited, are primarily used for herding. By moving among ecozones, Andean groups, both past and present, have maximized their resource options and developed a system of reciprocal exchange (Brush 1976, 1977; Guillet 1981; Masuda et al. 1985).

One well-documented example of resource-based migration is found in the Middle Horizon state of Tiwanaku (A.D. 500–1000), where colonists migrated to the Moquegua Valley, Peru, from the capital near the Bolivian shore of Lake Titicaca (Blom et al. 1998; Goldstein 1993, 2000; Knudson et al. 2004; Kolata 1993; Owen 2005). Described as "diaspora communities" (Goldstein 2000), the colonists remained both biologically and culturally affiliated with the Tiwanaku core (Blom 1999; Blom et al. 1998; Goldstein 1989a, 1989b, 2005:266; Owen 2005:64; Stanish 2003:291). In Moquegua they cultivated and exported resources—such as maize, cotton, peppers, and coca—that were either unavailable or limited in the capital region (Goldstein 2005:237).

In the Late Horizon (A.D. 1400–1532), the Inca adopted this pattern of ecological migration as a tool of state control (Goldstein 2005:48; Wachtel 1982:200). This tactic proved invaluable for imperial success: as Stanish notes, "Forcible movement of populations for strategic and economic purposes is perhaps the most intrusive, nonlethal means of

control for a premodern empire" (2001:224). In one example of coerced migration, detailed in colonial documents, the Inca established mitima colonies in the fertile valleys of Cochabamba, Bolivia (Wachtel 1982). To exploit this agricultural opportunity, the Inca removed local ethnic groups and shifted all arable land to the state. Foreign groups were resettled to work the fields and build administrative centers, roads, and storehouses to support production (Gyarmati and Varga 1999). An estimated 14,000 individuals—originating as far away as Chile—worked the state fields in Cochabamba (Wachtel 1982:214).

Identifying Migrations

Despite the recognized importance of migration in the ancient Andes and elsewhere, its identification presents challenges (Burmeister 2000:540; Snow 1995:72). In the absence of written records, archaeologists often rely on stylistic differences in material culture to distinguish groups, based on the premise that groups retain unique symbols of their ethnic unity (Blom 2005:2). However, many variables complicate the differentiation of ethnic groups based on material culture (Jones 1997; Smith and Schreiber 2005:208). Ceramic style has been used to distinguish Andean ethnic groups, yet we know that differences in style may relate to regional, temporal, or status-based differences (Conkey and Hastorf 1990; Odess 1998; Plog 1983; Shennan 1994:13). In addition, critical symbols of ethnic identity such as apparel may be absent from the archaeological record; for example, only in rare circumstances do archaeologists recover the distinctive hats worn by various ethnic groups in prehistoric Andean times (Cock 2002).

Further complicating the matter, ethnic identity is not static but, rather, fluid and varied, such that material assemblages may not properly reflect its multidimensional nature (Bernardini 2005:32; Eriksen 1992; Jones and Graves-Brown 1996). Ethnic identity incorporates both self-ascription and ascription by others, influenced by external circumstances and internal agency (Barth 1998; Nagel 1994). Rapid shifts in ethnic identity can result from changes in the physical or social environment (Reycraft 2005:5), such as in Late Intermediate period Chile, where Atacameños created a unified identity in response to social encroachment following Tiwanaku collapse (Torres-Rouff 2003:142). Ethnic identity may also be manipulated for personal gain, as seen with Nubian individuals co-opting foreign Egyptian styles for status elevation (Buzon 2006:692; Smith 2003). Due to the active, responsive nature of ethnic identity, the use of bounded cultural assemblages to identify past groups and their movements can be problematic (Chapman and Dolukhanov 1993; Emberling 1997; Singleton 1998:174).

Bioarchaeological methods offer promising approaches to some of these problems. In particular, strontium isotope studies have been successful in distinguishing subgroups within a population (Ambrose and Krigbaum 2003; Katzenberg 2000). Although these studies do not specifically address issues of ethnic affiliation, strontium isotope analysis can document geographic origins and migration by establishing a local signature and identifying deviations representative of migrants (Burton et al. 2003). This technique is employed in the current study to identify migrants at the Cuzco Valley site of Chokepukio.

Principles of Strontium Isotope Analysis

Migration studies based on strontium isotopes rely on the principle that $^{87}Sr/^{86}Sr$ values in dental enamel reflect the local geological composition (Price et al. 1994). Geological $^{87}Sr/^{86}Sr$ values are a function of varying strontium (Sr) and rubidium (Rb) concentrations (i.e., Rb/Sr values) and the age of the bedrock within a given region. The only radiogenic isotope of Sr, ^{87}Sr, is produced by the slow radioactive decay of the rubidium isotope ^{87}Rb (Faure 1986). Because the ^{87}Rb decay rate remains constant, the relative amount of ^{87}Sr to ^{86}Sr will reflect the composition of subsurface bedrock (i.e., its Rb/Sr value) and the time elapsed since formation or deposition. Thus, regions containing older rocks with very high $^{87}Rb/^{87}Sr$ values (e.g., granite) are characterized by higher $^{87}Sr/^{86}Sr$ values than areas containing younger basaltic rocks with lower Rb/Sr values (Faure 1986). Consequently, the geological composition influences the ratios of strontium isotopes in groundwater and soil, which are taken up by local plants and animals.

Strontium is incorporated into the body's hard tissues through consumption of plant and animal products and water. Following consumption, strontium substitutes for calcium in the hydroxyapatite

of teeth and bone (Bentley 2006; Ericson 1985; Nelson et al. 1986; Schroeder et al. 1972:496; Sealy et al. 1991). During the processes of consumption and substitution, the ratio of strontium isotopes remains constant—a prerequisite for migration studies. In some elements this is not the case: isotope amounts may change when moving from plants to animals to humans. Changes in isotope abundance result from their differences in mass, a process known as isotopic fractionation. While this process can affect isotopic analyses, it does not apply to strontium. With regard to the four strontium isotopes (^{84}Sr, ^{86}Sr, ^{87}Sr, ^{88}Sr), the relative mass difference is small, so isotopic fractionation does not occur through the food chain (Faure and Powell 1972). Because strontium isotope ratios are not altered by isotopic fractionation, an individual's ^{87}Sr/^{86}Sr values will mirror the original ratios present in the soil and groundwater of his or her local area, assuming that local food was eaten.

Strontium isotopes become integrated in teeth during development in the first 12 years of life. After this phase of dental enamel formation, strontium isotope ratios do not change with additional intake. Minerals may be taken up by the surface of the tooth during life or after burial, yet these materials seldom penetrate deep into the enamel (Budd et al. 2000; Price et al. 2002; Wright 2005). As such, individuals' dental strontium isotope ratios reflect their childhood environment, given that they consumed local foods (Burton et al. 2003:91). Strontium isotope analysis can therefore be used to detect migration, as a migrant's strontium value may differ from that of the local populace (if he or she lived in a geologically different region in early life [Price et al. 1994:327; Price et al. 2004]). In comparing individual values to the local isotope signature, deviations may signify the presence of migrants.

Strontium Isotope Analysis in the Andes

The Andean region presents an ideal setting for strontium isotope analysis due to its varied geology. The Cuzco Valley and the adjacent Vilcanota Valley constitute an inter-Andean basin separating the Andean hills to the south and west and the higher-range slopes to the north and east. The valley floor, formed by the Quaternary Pleistocene–aged San Sebastián Formation, consists of sedimentary gravels, alluvial fan sands, mudflows, extended diatomite, loams, clays, and peats. Within the district of Cuzco, igneous intrusive plutonic bodies of Paleocene origin have been identified. One such complex located north of the city of Cuzco, the Stock of Sacsayhuaman, is characterized by medium-to-coarse fractured gray-green quartz diorite (Salvador and Davila 1994). Though no strontium isotope values have been published on geologic material from the Cuzco region, ^{87}Sr/^{86}Sr values for the Arequipa volcanics located just to the south range from .70714 to .70794 (James et al. 1976:Table 1; Lebti et al. 2006). In contrast to the Cuzco region, the southeastern Lake Titicaca area of Tiwanaku contains bedrock of primarily andesites and igneous basalts beneath a layer of Quaternary lacustrine and fluvial sediments (Argollo et al. 1996; Binford and Kolata 1996). A third area, the Moquegua Valley, features a late Cenozoic volcanic composition that differs from Tiwanaku, with a geologically defined ^{87}Sr/^{86}Sr range of .7055 to .7068 (Hawkesworth et al. 1982; James 1982; Rogers and Hawkesworth 1989).

Though geological sources may be used to determine the ^{87}Sr/^{86}Sr value of a region, faunal sources are preferred (Price et al. 2002; Sillen et al. 1995). Faunal sources more accurately measure biologically available ^{87}Sr/^{86}Sr values, while water and soil sample ^{87}Sr/^{86}Sr values do not always have a direct 1:1 relationship with animal tissue. Figure 1 shows the biologically available ^{87}Sr/^{86}Sr signatures of several locations in the Andes. The Tiwanaku ^{87}Sr/^{86}Sr signature, based on analysis of local *cuy* (guinea pig), shows a mean value of .7097 ($n = 3$; sd = .0006 [Knudson et al. 2004]). The Moquegua Valley exhibits a faunal ^{87}Sr/^{86}Sr mean value of .7063 ($n = 3$; sd = .0001 [Knudson et al. 2004]). In the San Pedro de Atacama region of northern Chile, faunal analysis produced a mean ^{87}Sr/^{86}Sr value of .7076, which does not overlap with either the Tiwanaku or Moquegua Valley regions ($n = 3$; sd = .0001 [Knudson 2004:165]).

Based on their unique geology, the strontium signatures of these areas can be used to explore ancient migrations between regions. However, two factors complicate this endeavor. First, strontium isotope ratios can differ within a region due to geological microvariation. Because zones are rarely

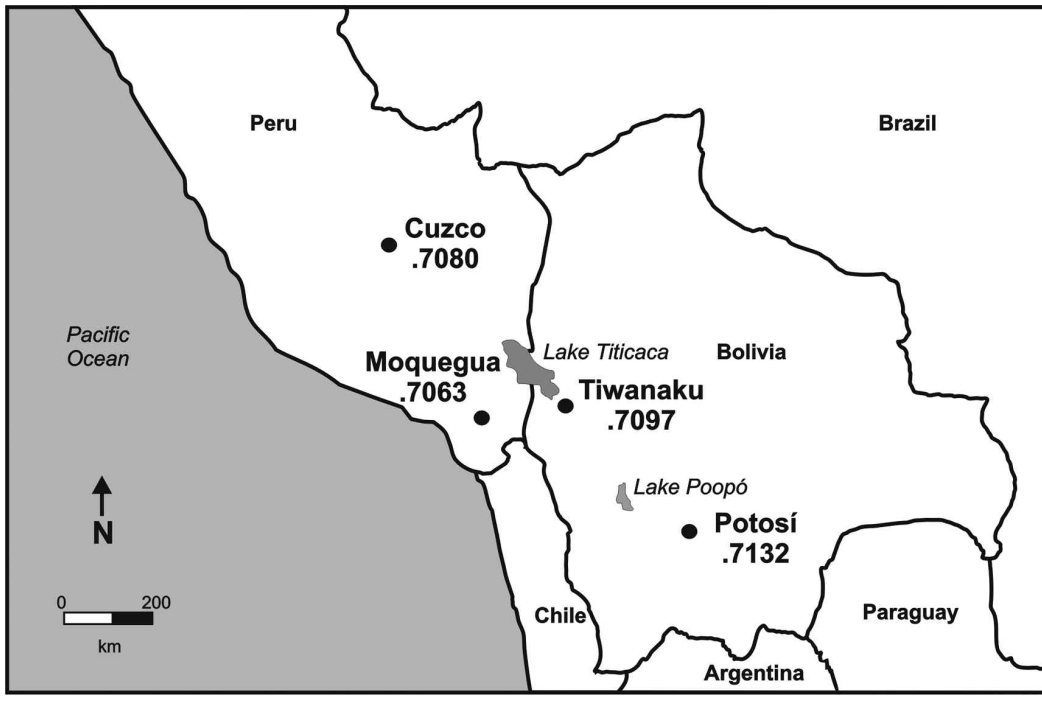

Figure 1. Regional distribution of biologically available $^{87}Sr/^{86}Sr$ values from archaeological sites in the Andes. The Chokepukio value (archaeological *cuy*) is from the present study. Modern *cuy* values for the Moquegua and Tiwanaku regions from Knudson et al. (2004), values for Potosí from Knudson et al. (2005).

homogeneous, single $^{87}Sr/^{86}Sr$ estimates cannot characterize an entire geological zone. Therefore, it is important to sample more than one location in an area. Second, several areas in the Andes may share the same $^{87}Sr/^{86}Sr$ signature, reflecting a similar geological composition. As a result, determining the original residence of an immigrant is a complex undertaking. Particular areas can be eliminated based on their $^{87}Sr/^{86}Sr$ signatures, but the specific location of an immigrant's homeland may be difficult to ascertain.

Materials and Methods

Strontium isotope ($^{87}Sr/^{86}Sr$) analyses were completed on dental enamel from 59 individuals buried at Chokepukio (Table 1), a stratified site located 30 km southeast of the city of Cuzco (McEwan et al. 1995). The site is situated in the Lucre Basin, the easternmost basin of the Cuzco Valley that includes the Cuzco and Oropesa basins. Excavations from 1994 to 2005 uncovered architectural, artifactual, and skeletal remains from the Early Intermediate period (EIP, 200 B.C.–A.D. 700) through the Inca Imperial period/Late Horizon (LH, A.D. 1400–1532).[2] Though the site lacks a distinct cemetery section, certain spaces around Late Intermediate period (LIP, A.D. 1000–1400) and Late Horizon buildings were preferentially used for interment; from these site sectors, 176 burials were recovered.

Of the 176 burials, 59 individuals were selected for strontium isotope analysis based on two criteria: age and the availability of teeth. Only adults were sampled for this initial study, and teeth (Table 2) were not available for several adults due to antemortem and postmortem loss. (Age and sex determination followed Buikstra and Ubelaker 1994; these methods are described in Andrushko 2007.) The individuals were classified by time period using radiocarbon dates, stratigraphy, architectural association, and material culture (when available). The burials contained few associated artifacts with little differentiation in mortuary treatment (Andrushko et al. 2006), such that group differences were rarely identifiable using material culture.

Faunal (cuy) teeth were collected from three loci within the Cuzco region to determine the local

Table 1. Analyzed Dental Enamel Samples in Ascending Order of $^{87}Sr/^{86}Sr$ Value.

Sample #	Sex	Cultural Affiliation	$^{87}Sr/86Sr$	2σ Error	Sr ppm
CHO-27	M	EIP	.70728	.00002	296
CHO-164	M	Inca/LH	.70728	.00002	291
CHO-124	F	EIP	.70735	.00002	175
CHO-147	I	LIP	.70738	.00002	297
CHO-70	M	EIP	.70774	.00002	309
CHO-38	F	EIP	.70775	.00002	276
CHO-133	M	Unknown	.70780	.00003	284
CHO-42	F	MH	.70780	.00003	240
CHO-71	M	EIP	.70799	.00002	318
CHO-76	M	LIP	.70803	.00001	257
CHO-176	M	Inca/LH	.70809	.00003	205
CHO-85	M	Inca/LH	.70809	.00002	213
CHO-45	F	EIP	.70811	.00001	350
CHO-19	F	EIP	.70817	.00002	362
CHO-166	M	Inca/LH	.70820	.00003	311
CHO-20	F	Inca/LH	.70824	.00004	156
CHO-118	M	Unknown	.70828	.00003	318
CHO-153	I	LIP	.70831	.00002	177
CHO-131	M	Inca/LH	.70832	.00001	302
CHO-63	I	LIP	.70835	.00002	325
CHO-87	M	Inca/LH	.70835	.00001	309
CHO-117	M	Unknown	.70842	.00003	356
CHO-169	I	Inca/LH	.70846	.00002	451
CHO-121	M	Unknown	.70850	.00005	365
CHO-31	F	Inca/LH	.70851	.00001	348
CHO-25	I	Inca/LH	.70852	.00002	245
CHO-165	M	Inca/LH	.70855	.00002	329
CHO-51	M	Inca/LH	.70864	.00004	183
CHO-68	M	Inca/LH	.70867	.00002	271
CHO-7	M	Inca/LH	.70868	.00002	184
CHO-159	M	Inca/LH	.70877	.00001	164
CHO-132	F	Unknown	.70888	.00002	334
CHO-126	M	LIP	.70895	.00002	306
CHO-16	F	EIP	.70897	.00002	229
CHO-69	M	Inca/LH	.70900	.00002	530
CHO-55	F	Inca/LH	.70906	.00003	111
CHO-136	M	Inca/LH	.70906	.00002	219

$^{87}Sr/^{86}Sr$ range. Four archaeological cuy teeth were taken from Chokepukio, while four modern cuy specimens were collected from the town adjacent to the site of Tipón, located 5 km northwest of Chokepukio and 25 km southeast of the city of Cuzco. In addition, two archaeological cuy teeth were sampled from the Inca site of Kanamarca (147 km southeast of Cuzco) for comparative purposes.

The 59 human tooth samples and 10 faunal samples were analyzed at the Radiogenic Isotope Facility at the University of Alberta, Edmonton, from September 2005 to September 2006. The majority of the human tooth samples were premolars, which contain enamel that forms between two and six years of age. If the premolars were missing, another tooth type was used. Laboratory methods for the strontium isotope analysis followed standardized protocol, with steps taken to ensure that contamination did not affect the results. These methods are detailed by Buzon and colleagues (2007). Accuracy and reproducibility of the analytical protocol were verified by the repeated analysis of a 100 ppb solution of the NIST SRM 987 Sr isotope standard during the course of this study; this yielded an average value of .710242 ± .000041 (2s standard deviation; $n = 13$ analyses) and is indistinguishable compared to the accepted standard value of .710245 (Faure and Mensing 2005:78). To verify that contamina-

Table 1 (continued). Analyzed Dental Enamel Samples in Ascending Order of $^{87}Sr/^{86}Sr$ Value.

Sample #	Sex	Cultural Affiliation	$^{87}Sr/86Sr$	2σ Error	Sr ppm
CHO-148	M	LIP	.70939	.00010	246
CHO-32	M	Inca/LH	.70950	.00002	432
CHO-171	M	Inca/LH	.70961	.00002	406
CHO-35	F	Inca/LH	.70970	.00024	91
CHO-8	M	Inca/LH	.71018	.00003	184
CHO-158	F	Inca/LH	.71045	.00002	196
CHO-145	M	Inca/LH	.71046	.00006	204
CHO-84	M	Inca/LH	.71060	.00004	247
CHO-90	M	Inca/LH	.71098	.00003	154
CHO-106	F	Inca/LH	.71130	.00002	252
CHO-119	M	Unknown	.71132	.00002	215
CHO-21	I	Inca/LH	.71275	.00003	387
CHO-120	M	Unknown	.71306	.00014	352
CHO-18	F	Inca/LH	.71323	.00002	121
CHO-28	F	Inca/LH	.71454	.00003	323
CHO-82	F	Inca/LH	.71559	.00005	408
CHO-79	F	Inca/LH	.71716	.00002	267
CHO-11	M	Inca/LH	.72003	.00003	378
CHO-101	F	Inca/LH	.72022	.00007	194
CHO-162	F	Inca/LH	.72062	.00003	212
CHO-22	M	Inca/LH	.72068	.00001	159
CHO-109	M	Inca/LH	.72136	.00002	236
Chokepukio Archaeological *Cuy*-1			.70782	.00001	850
Chokepukio Archaeological *Cuy*-2			.70789	.00003	1197
Chokepukio Archaeological *Cuy*-3			.70797	.00002	869
Chokepukio Archaeological *Cuy*-4			.70812	.00002	920
Kanamarca Archaeological *Cuy*-1			.70653	.00002	571
Kanamarca Archaeological *Cuy*-2			.70665	.00002	432
Tipón Modern *Cuy*-1			.70821	.00003	447
Tipón Modern *Cuy*-2			.70824	.00002	573
Tipón Modern *Cuy*-3			.70831	.00002	530
Tipón Modern *Cuy*-4			.70840	.00002	614

Note: M = male; F = female; I = indeterminate sex; EIP = Early Intermediate period; MH = Middle Horizon; LIP = Late Intermediate period; Inca/LH = Inca Imperial period/Late Horizon.

tion had not occurred from postdepositional strontium sources, we examined the correlation between $^{87}Sr/^{86}Sr$ values and strontium concentration (Budd et al. 2000; Horn and Müller-Sohnius 1999).

Results

Four archaeological cuy teeth from Chokepukio provide a local baseline with an average $^{87}Sr/^{86}Sr$ value of .70795 and a standard deviation of .00013 (Table 1). Four additional modern cuy specimens from the town adjacent to the site of Tipón yielded an average $^{87}Sr/^{86}Sr$ value of .70826 with a standard deviation of .00027, indicating some microvariation of strontium values in this region of the Cuzco Valley. For comparison, two cuy specimens from Kanamarca, 147 km southeast of Cuzco, produced values lower than the Chokepukio faunal average (.70653 and .70665), revealing a different signature for the Espinar region.

The Chokepukio human $^{87}Sr/^{86}Sr$ values exhibit a substantial amount of variability evident in a large standard deviation and range (Figure 2, Table 3). These values range from .70728 to .72136 with a mean of .71033. Descriptive statistics of the human $^{87}Sr/^{86}Sr$ values illustrate that the skewness (measure of asymmetry) is highly positive, as is the measure of kurtosis, the "heaviness" of the tails of a distribution. These measurements indicate that the human $^{87}Sr/^{86}Sr$ values deviate from a normal distribution, with many more values above the mean than below. The asymmetrical distribution is not

Table 2. Chokepukio Dental Enamel Samples by Time Period.

	Number of Samples Analyzed			
Time Period	Males	Females	Indeterminate Sex	Total
Early Intermediate Period (200 B.C.–A.D. 700)	5	3	0	8
Middle Horizon (A.D. 700–1000)	0	1	0	1
Late Intermediate Period (A.D. 1000–1400)	3	0	3	6
Late Horizon (A.D. 1400–1532)	22	12	3	37
Unknown Temporal Affiliation	6	1	0	7
Total Number of Individuals	36	17	6	59

likely a result of diagenesis, as the $^{87}Sr/^{86}Sr$ values display no covariance with the Sr concentration in each sample (Figure 3; Budd et al. 2000; Horn and Müller-Sohnius 1999).

The traditional method for identifying migrants uses the faunal average ±2 standard deviations as the local range, with values outside of the range considered migrants (Price et al. 1994; Price et al. 2002). However, this method may not be appropriate for the Chokepukio sample. Given the minute standard deviation of the Chokepukio faunal values (sd = .00013), the resulting local range comprises only 19 percent of the sampled individuals (11/59), leaving 81 percent of the sample as "nonlocal." This local range does not accord with the faunal data from Tipón—though Tipón is located only 5 km from Chokepukio, its $^{87}Sr/^{86}Sr$ mean value (.70826) would be considered nonlocal. Because the traditional method does not account for the variation in $^{87}Sr/^{86}Sr$ values between Chokepukio and Tipón, alternative techniques merit consideration. Accordingly, we have taken a more conservative approach to the identification of migrants, to account for the apparent local variability of $^{87}Sr/^{86}Sr$ values in this region of the Cuzco Valley.

A different technique—using descriptive statistical analysis of the human data (Wright 2005)—appears better suited for the Chokepukio material. In this method, the data are analyzed for outliers (migrants), which are then separated from the main ("trimmed") body of data (locals). The trimmed data, when observed spatially, should conform to a normal distribution (Wright 2005:560). For

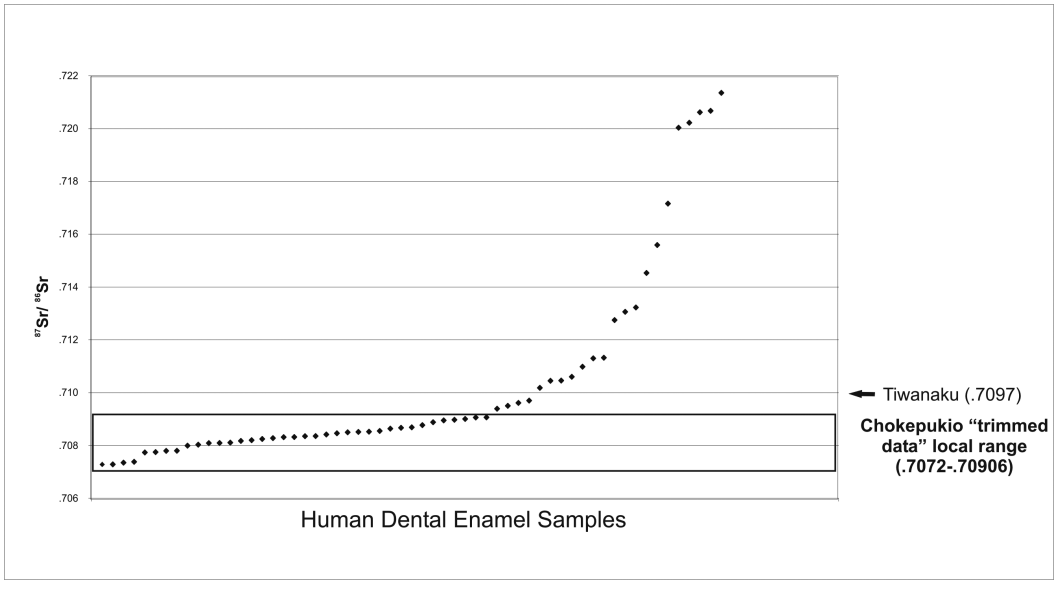

Figure 2. Scatterplot of Chokepukio human enamel $^{87}Sr/^{86}Sr$ values showing the presence of possible migrant individuals outside of the dotted-line box. Value for Tiwanaku region is from Knudson et al. (2004).

Table 3. Summary Statistics of Complete Versus Trimmed Chokepukio Data Set.

	$^{87}Sr/^{86}Sr$ Value	
Statistic	Complete Data Set	Trimmed Data Set (Outliers Removed)
Count	59	37
Mean	.71033	.70829
Standard Deviation	.00374	.00050
Range	.01408	.00179
Skewness	1.936	–.409
(Standard Error)	(.311)	(.388)
Kurtosis	2.764	–.404
(Standard Error)	(.613)	(.759)
Minimum	.70728	.70728
Maximum	.72136	.70906

Chokepukio, outliers are not apparent below the faunal average, where the $^{87}Sr/^{86}Sr$ values appear consistently and successively distributed (Figure 2). The sequential distribution continues above the faunal average up to the value of .70906, followed by a series of outliers. Since all the outliers are above the faunal average, the lowest $^{87}Sr/^{86}Sr$ values (.70728–.70738) likely reflect local variation in strontium sources. When the outliers are removed, the human mean more closely matches the faunal mean (Table 3). Moreover, in the trimmed data set the skewness and kurtosis resemble a normal distribution.

Employing these outlier calculations, we separated the Chokepukio sample into 37 locals and 22 nonlocal individuals. The $^{87}Sr/^{86}Sr$ average for locals is .70829, with a range of .70728 to .70906, while the $^{87}Sr/^{86}Sr$ average for nonlocals is .71376, with a range of .70939 to .72136. The local group is composed of individuals from four temporal periods at Chokepukio: EIP, MH, LIP, and LH. In contrast, the nonlocal group is composed entirely of LH individuals, with the exception of one LIP individual. However, the LIP individual represents the lowest value for the nonlocal group ($^{87}Sr/^{86}Sr$ = .70938). This value falls into local range when the standard deviation is considered, thus classifying the LIP individual as a local.

For the EIP and LIP groups, there is relatively little variation among the $^{87}Sr/^{86}Sr$ values (Table 4).

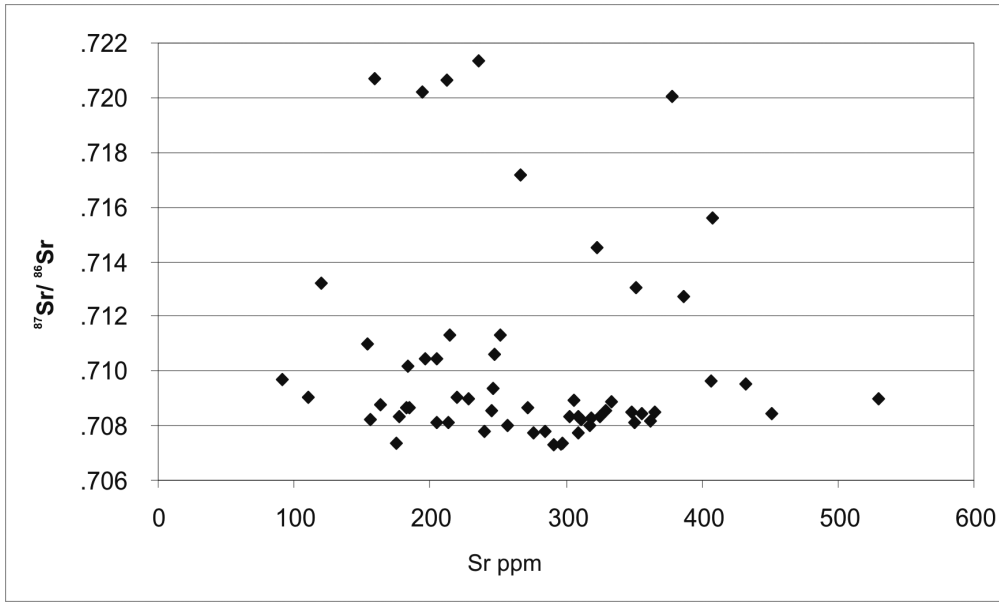

Figure 3. Distribution of Chokepukio strontium concentration (ppm) and $^{87}Sr/^{86}Sr$ values.

Table 4. Chokepukio $^{87}Sr/^{86}Sr$ Values by Temporal Phase.

Temporal Group	Average	Standard Deviation
Early Intermediate Period (n = 8)	.70792	.00054
Middle Horizon (n = 1)	.70780	N/A
Late Intermediate Period (n = 6)	.70840	.00070
Inca Imperial Period/Late Horizon (n = 37)	.71139	.00428
Males (n = 22)	.71061	.00421
Females (n = 12)	.71322	.00442

The EIP group $^{87}Sr/^{86}Sr$ values range from .70728 to .70897, while the LIP group ranges from .70738 to .70939. The within-group variation is minimal, with standard deviations of .00054 and .00070, respectively. The values indicate continuity between the earlier EIP group and the later LIP group.

The results change markedly in the LH group, with a broad range of $^{87}Sr/^{86}Sr$ values and several outliers ($^{87}Sr/^{86}Sr$ average = .71139; range .70728 to .72136). Eighteen individuals display local $^{87}Sr/^{86}Sr$ values similar to the EIP/LIP groups, between .70728 and .70906. In contrast, 19 individuals exhibit higher $^{87}Sr/^{86}Sr$ values between .70950 and .72136. The difference in $^{87}Sr/^{86}Sr$ mean between the combined earlier groups and the LH group is statistically significant at a greater than 99 percent confidence level.

Sex differences exist within the LH group, where females show more variation in $^{87}Sr/^{86}Sr$ values than males (Figure 4). The males have relatively similar $^{87}Sr/^{86}Sr$ values, except for three extreme outliers above .720. Females, on the other hand, show a wider range of values, with a greater mean $^{87}Sr/^{86}Sr$ value and a slightly higher standard deviation. Seventy-five percent of LH females identify as migrants, while only 41 percent of males in the LH sample are classified as migrants.

Possible Influence of Food Importation and Preparation

While $^{87}Sr/^{86}Sr$ values can fluctuate due to food importation and processing (Knudson 2004; Wright 2005), these influences likely did not affect the Chokepukio strontium results. Individuals at Chokepukio may have consumed nonlocally grown imported maize, yet maize consumption does not influence human $^{87}Sr/^{86}Sr$ values, as the crop contains little calcium and strontium (Aufderheide and Allison 1995). While certain marine resources can affect strontium values (Burton 1996), these resources did not constitute a substantial portion of the local Cuzco diet (Rowe 1946:220). Additionally, Inca maize processing did not incorporate lime in the manner of the Maya "nixtamalization," a process that can influence strontium values (Davidson 1999:534; Wright 2005). Finally, though the consumption of sea salt can alter $^{87}Sr/^{86}Sr$ values (Wright 2005:556), sea salt was not consumed by most Cuzco populations; instead, salt came primarily from the montane salt springs of Cachimayu outside of the village of San Sebastián (Bauer 2004:7). Because the Cuzco-region dietary salt was derived from montane rather than marine sources, salt is not expected to have influenced strontium values.

While the Chokepukio $^{87}Sr/^{86}Sr$ values were not significantly affected by food importation or processing, individuals did ingest some strontium through their diet. Diets rich in plant sources such as seeds, nuts, and legumes—as opposed to meat or maize—contribute to $^{87}Sr/^{86}Sr$ levels in humans (Price et al. 1994:323). The native Andean diet included maize, potatoes and other tubers, quinoa, camelid and cuy meat, peppers, and beans (Rowe 1946:210). Of these foods, beans constitute the most important source for strontium, because legumes have a high calcium and strontium content (Burton and Wright 1995:278). These foods likely account for the $^{87}Sr/^{86}Sr$ values seen in all sampled individuals at Chokepukio. The slight increase in $^{87}Sr/^{86}Sr$ values between the Chokepukio EIP and LIP groups may reflect a wider range of food-procurement zones due to exchange networks established in the Late Intermediate period (Bauer and Covey 2002). In the Late Horizon, however, those $^{87}Sr/^{86}Sr$ values above the local range likely indicate migration into the Cuzco Valley.

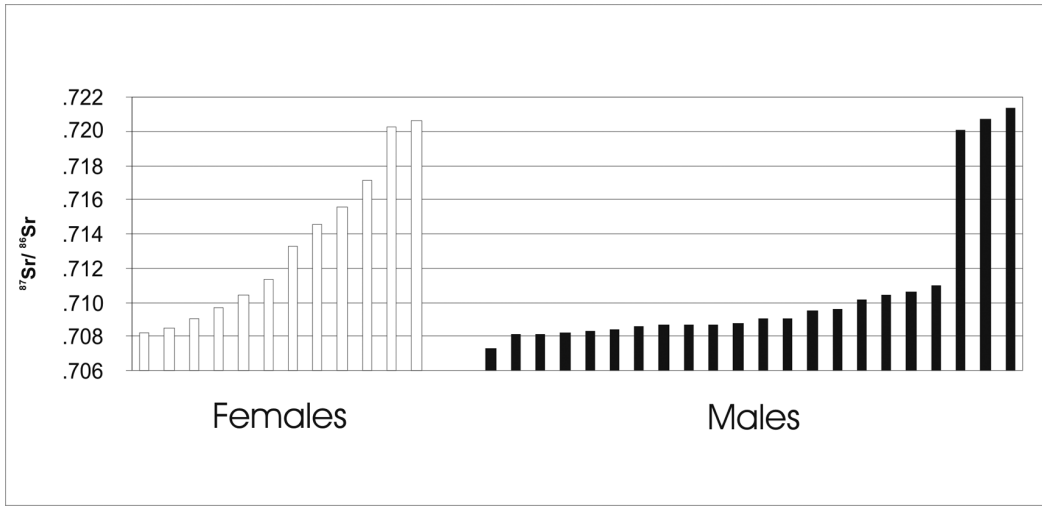

Figure 4. Distribution of Chokepukio Late Horizon human enamel $^{87}Sr/^{86}Sr$ values by sex revealing the wider distribution of female values in comparison to male values.

Discussion

Implications of Pre–Late Horizon Results

Though tentative due to a small sample size, the pre–Late Horizon $^{87}Sr/^{86}Sr$ values do not reveal evidence of migrants among individuals sampled at Chokepukio. Strontium isotope values from the EIP, MH, and LIP fall into the local range (with the exception of one LIP individual, whose value straddles the local/migrant division). These $^{87}Sr/^{86}Sr$ values are relatively continuous and show little within-group variation, demonstrated by small standard deviations. Outliers that unquestionably represent migrants are not apparent in these groups.

Interpretation of these results is complicated by the slight overlap of the Tiwanaku and Chokepukio local signatures. Knudson (2004) has determined the Tiwanaku $^{87}Sr/^{86}Sr$ range to span .7087 to .7105, while the present study places the Chokepukio $^{87}Sr/^{86}Sr$ range at .70728 to .70906. The overlap at the high end of the Cuzco spectrum and the low end of the Tiwanaku range complicates interpretation: Do these individuals represent locals or migrants? As such, it becomes challenging to categorize the seven individuals within the intersecting values. Despite this overlap, the pre-LH individuals appear local, based on the continuity of their values and similarity to the faunal values from Chokepukio.

State-Directed Migration in the Late Horizon

At Chokepukio, migration during the Late Horizon is confirmed by several $^{87}Sr/^{86}Sr$ values above the local range. The timing of these migrations coincides with the development of the Inca tribute system featuring state-directed migration. The system involved temporary and permanent relocation and comprised several different labor categories, including *mitimas* (resettled colonies), *mita* laborers (rotational workers), *yanaconas* (hereditary servants), *mamaconas* (female ritual specialists), and *acllas* ("Chosen Women" [Rowe 1982; Wachtel 1982]).

Through the mitima policy, the Inca permanently resettled groups in colonies outside of their ethnic homelands. This policy affected a significant portion of the population: In total, an estimated 25–30 percent was uprooted (D'Altroy 2005:269). Mitima status did not specify a particular type of occupation (Rowe 1982:96); while many mitima laborers farmed state lands, others built state works, served in the military, or produced state crafts (Espinoza 1969:140). According to colonial documents, mitima colonies were prevalent in the Cuzco area (Rowe 1946:270). These colonies included the Cañari and Chachapoya from the northern region, as well as individuals from the central and southeastern regions (Betanzos 1996:125 [1557]; Bauer 2004; Cieza de León 1985:67 [1553, cap.

XXII]; Covey 2006:215; D'Altroy 2005:281; Julien 1988; La Lone and La Lone 1987; Rowe 1982:103).

Complementing the mitima colonists were the yanaconas, *camayos* (craft specialists), and mita laborers (Murra 1982; Rowe 1982). In contrast to mitima labor, mita laborers were not permanently resettled but, rather, spent a portion of each year working for the empire. Often mita laborers were called up at seasonal times such as harvests, returning home after completing their rotations (Gyarmati and Varga 1999:35). As a group with distinct civil status, the yanaconas were typically male servants who served as personal retainers to the Inca or other nobles (Julien 2000:265; Rowe 1982:97). The yanaconas identified with a particular ruler, often severing ties to their original ethnic groups (Rostworowski 1999:43). Similar to yanaconas, camayos served under a single ruler or governor. Camayos worked either in their homelands or in areas suited to their specific craft (Rowe 1982:103). Combined, these labor obligation programs made up the greatest portion of the Inca tribute system, in which tribute was exacted in labor rather than commodities (Julien 1982:120).

An additional Inca policy focused on acllas (Chosen Women), some of whom were brought to Cuzco for schooling in state religion and craftwork (Costin 1998; Guaman Poma 1936:300 [1615]; Rowe 1982:107). The acllas brewed *chicha* (maize beer), wove *cumpi* (fine cloth), and performed religious rituals. They residing in segregated communities within regional capitals, and their presence aided in the maintenance of Inca ideology in the provinces (Silverblatt 1987). After adolescence, acllas served as mamaconas, secondary wives of the Inca ruler or wives of royal subjects (Cobo 1990:172 [1653]; Rowe 1946:269).

Colonial documents suggest that several of these policies may have contributed to the presence of migrants at Chokepukio. According to accounts from "El Habitat de la Etnia Pinagua, Siglos XV y XVI" (Espinoza 1974), during the 1520s the Pinagua were moved out of the area around Chokepukio and resettled in two places, Paucartambo and Urco-Urco, while other groups were brought in to work the vacated lands. Some workers came from Muyna, a nearby site where the Inca ruler Huascar had established a mitima colony. A yanacona group also resided in the area and was later reduced to the town of Lucre ca. 1570 (Espinoza 1974:175–176). These yanaconas, referred to as Yanamanche Guascar, may have been associated with the Muyna mitima colony. There are also brief mentions of mamaconas and an *acllahuasi* (House of the Chosen Women), though few details are provided (Espinoza 1974:162, 169, 177, 186, 200). Three years after the Pinagua were relocated, Atahuallpa allowed them to return from Paucartambo, yet many refused to leave their new community (Espinoza 1974:201).

Though historical evidence must be cautiously applied to archaeological interpretations, these testimonies do illustrate the coerced movement of people based on a system of interconnecting labor policies. The continual reshuffling of groups across the landscape resulted in a "melting pot" of people that fluctuated in response to imperial demands (Rowe 1946:270). This melting pot is apparent in the Chokepukio $^{87}Sr/^{86}Sr$ values, with migrants from several geologically distinct regions residing at the site. Migrations such as these likely contributed to the massive increase in population levels during the period of Inca imperialism, an increase that has been documented through extensive survey of the Cuzco region (Bauer 2004). Combining the survey and strontium results, we can infer that at least some of this population increase was the result of migration and resettlement.

Sex Differences Among Chokepukio Migrants

Sex differences among the Chokepukio migrants include a higher percentage of LH female migrants (75 percent of females vs. 41 percent of males) and more $^{87}Sr/^{86}Sr$ variation within LH females than males. While most males appear to have originated from geologically similar areas, the females apparently emigrated from geological regions throughout the empire. The surplus of migrant females was not due to an overall excess of females, as males outnumber females 22 to 12 among individuals analyzed from the Late Horizon. Explanations focusing on a dearth of males, such as warfare-related deaths or relocation (e.g., D'Altroy 2005:289), are therefore not applicable; rather, reasons for the excess of nonlocal females must be explored.

While the presence of mamaconas could explain the migrant female surplus, the supporting evidence is ambiguous. To elucidate the status and possible

occupations of individuals at Chokepukio, analyses of mortuary practices and demography were conducted (Andrushko et al. 2006). The mortuary analysis revealed that Chokepukio individuals were rarely buried in tombs or recovered with grave goods, and the demographic distribution indicates a population of both sexes and all ages represented. In comparison, analysis at Sacsahuaman in Cuzco revealed a cemetery of primarily females in elaborate tombs with high-status artifacts. While the Sacsahuaman cemetery displays characteristics expected of a mamacona community—women fulfilling highly valued duties to the state—the Chokepukio individuals resemble a domestic community engaging in subsistence activities and craftwork (Andrushko et al. 2006:78). However, the Chosen Women who became mamaconas were ranked hierarchically (Rowe 1946:269; Silverblatt 1978:48), so those with lower social status may not have received elaborate mortuary treatment.

The presence of nonlocal females at Chokepukio may reflect migration for the purpose of marriage. The Inca were known to use exogamous marriage practices as a means of political control (Rowe 1982). To reward workers loyal to the empire, the Inca gifted some of the Chosen Women to males in the army or other administrative posts (Rowe 1946:252, 269). This gifting of wives—females as "commodities" (Kolata 1992:234) or "alienable goods" (Silverblatt 1978:48)—would have resulted in greater numbers of female migrants and communities with "a particularly cosmopolitan character" (Rowe 1982:108), an apt description of the Chokepukio results.

Exogamy-dictated migration can be detected through skeletal data that identify postmarital residence patterns (e.g., Corruccini 1972; Corruccini and Shimada 2002; Konigsberg 1988; Lane and Sublett 1972; Schillaci and Stojanowski 2003; Spence 1974a, 1974b; Stefan 1999; Tomczak and Powell 2003; see Stojanowski and Schillaci 2006 for an overview). In these studies, the more "mobile" sex (i.e., the sex category most likely to marry into a different group) is expected to exhibit higher within-group variation. In studies documenting more female variation, the variation is usually attributed to a patrilocal residence pattern in which unrelated females are brought into a community (Tomczak and Powell 2003:104).

Though these studies use dental and skeletal morphological data, the same principle is relevant in stable oxygen isotope analyses (Spence 2005:189; White and Spence 1998; White et al. 2004) and can be applied to strontium isotope analyses as well. Strontium analysis at the Tiwanaku colony of Chen Chen found a high number of female migrants, a pattern that suggests exogamy-dictated migration (Knudson 2004:136). At Chokepukio, the $^{87}Sr/^{86}Sr$ variation indicates that many LH females originated from geologically different regions and were possibly brought in as marriage partners. These sex differences may reflect the Inca use of marriage as a political tool, a possibility that will benefit from additional consideration in future studies.

Conclusions and Future Research

This study underscores the value of strontium isotope analysis for identifying migrations, using a case study from the Cuzco Valley site of Chokepukio. The results show definitive evidence for migration during the time of Inca imperialism, with individuals emigrating from diverse locations. The Late Horizon data reveal a higher percentage of female immigrants with greater intrasex variation; it is suggested that females were relocated either for marital purposes or to fulfill imperial obligations. Colonial documents confirm the occurrence of state-directed migrations into the Chokepukio region as a result of Inca imperial labor policies.

In confirming one research question—the presence of Late Horizon migrants at Chokepukio—this initial study introduces many new questions. Who were these migrants, and where did they come from? Are the observed sex differences related to state-directed exogamy, or are there additional explanations? How do other regions of the Cuzco Valley compare to the Chokepukio results? Given the complexity of the situation revealed by this study, further research is warranted.

One important data source for future research is cranial vault modification, the intentional reshaping of the head (Allison et al. 1981; Blom 2005; Gerszten 1993; Hoshower et al. 1995; Lozada 1998; Torres-Rouff 2002). Because cranial modification is initiated during infancy—while the cranial bones are malleable—the practice reflects the local customs of an individual's childhood resi-

dence. If that individual migrates to a new region, his or her head shape may differ from that of the local population. Furthermore, migrants may continue to modify their children's heads in the manner of their homeland, particularly in diaspora communities that retain their native ethnic affiliation (Goldstein 2005:43; Owen 2005:49). As a result, nonlocal modification forms may be perpetuated at sites where migrants are residing. Cranial vault modification therefore represents a productive area for future research on population movements (Blom 1999; Torres-Rouff 2003). To address this issue, cranial modification data have been collected at Chokepukio and 10 other Cuzco region sites (Andrushko 2007).

An additional line of evidence, biological distance analysis, has been successfully applied toward identifying migration (Blom et al. 1998; Rothhammer and Silva 1990; Sutter 2000; Verano 2003). Verano (2003) has used craniometric data along with cranial modification to show differing geographic origins of Machu Picchu inhabitants, with migrants originating from the Peruvian coast and highlands. These individuals were likely relocated through Inca labor policies to provide the royal estate with servants and caretakers (Verano 2003:90). Following Verano's standards, craniometric data have been collected for 11 Cuzco-region sites. These future analyses will help to clarify the complex relationship of group affiliation, postmarital residence patterns, and population movement in the Inca heartland.

At this point, it is impossible to identify the original homelands of the Chokepukio migrants, as biologically available strontium signatures are known for only a few sites in the Andes. Though this study adds Chokepukio, Tipón, and Kanamarca to the list of locations with known $^{87}Sr/^{86}Sr$ values, the majority of the Inca Empire remains undocumented. Additional strontium isotope analyses are therefore needed to supplement the results from the present study. Nonetheless, this analysis underscores the importance of strontium isotope analysis as a means to investigate ancient Andean migrations.

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References Cited

Allison, Marvin J., Enrique Gerszten, and Juan Munizaga
1981 La Práctica de la Deformación Craneana entre los Pueblos Andinos Precolumbianos. *Chungará* 7:238–260.

Ambrose, Stanley H., and John Krigbaum
2003 Bone Chemistry and Bioarchaeology. *Journal of Anthropological Archaeology* 22:193–199.

Andrushko, Valerie A.
2007 The Bioarchaeology of Inca Imperialism in the Heartland: A Regional Analysis of Prehistoric Burials from Cuzco, Peru. Unpublished Ph.D. dissertation, Department of Anthropology, University of California, Santa Barbara.

Andrushko, Valerie A., Elva C. Torres Pino, and Viviana Bellifemine
2006 The Burials at Sacsahuaman and Chokepukio: A Bioarchaeological Case Study of Imperialism from the Capital of the Inca Empire. *Ñawpa Pacha* 28:63–92.

Anthony, David W.
1990 Migration in Archaeology: The Baby and the Bathwater. *American Anthropologist* 92:895–914.

Argollo, Jaime, Leocadio Ticcla, Alan L. Kolata, and Oswaldo Rivera
1996 Geology, Geomorphology, and Soils of the Tiwanaku and Catari River Basins. In *Tiwanaku and Its Hinterland: Archaeology and Paleoecology of an Andean Civilization*, edited by Alan L. Kolata, pp. 57–88. Smithsonian Institution, Washington, D.C.

Aufderheide, Arthur C., and Marvin J. Allison
1995 Chemical Dietary Reconstruction of North Chile Prehistoric Populations by Trace Mineral Analysis. In *Proceedings of the First World Congress on Mummy Studies*, Vol. 1, pp. 451–461. Museo Arqueológico y Etnográfico de Tenerife, Organismo Autónomo de Museos y Centros, Cabildo de Tenerife, Santa Cruz de Tenerife.

Barth, Fredrik
1998 Introduction: Ethnic Groups and Boundaries: The Social Organization of Culture Difference. In *Ethnic Groups and Boundaries: The Social Organization of Culture Difference*, edited by Fredrik Barth, pp. 9–38. Waveland Press, Prospect Heights, Illinois.

Bauer, Brian S.
2004 *Ancient Cuzco: Heartland of the Inca*. University of Texas Press, Austin.

Bauer, Brian S., and R. Alan Covey
2002 Processes of State Formation in the Inca Heartland (Cuzco, Peru). *American Anthropologist* 104:846–864.

Bentley, R. Alexander
2006 Strontium Isotopes from the Earth to the Archaeological Skeleton: A Review. *Journal of Archaeological Method and Theory* 13:135–187.
Bernardini, Wesley
2005 Spatial and Temporal Aspects of Prehistoric Cultural Identity. *American Antiquity* 70:31–54.
Betanzos, Juan de
1996 [1557] *Narrative of the Incas*. University of Texas Press, Austin.
Binford, Michael W., and Alan L. Kolata
1996 The Natural and Human Setting. In *Tiwanaku and Its Hinterland: Archaeology and Paleoecology of an Andean Civilization*, edited by Alan L. Kolata, pp. 23–56. Smithsonian Institution, Washington, D.C.
Blom, Deborah E.
1999 Tiwanaku Regional Interaction and Social Identity: A Bioarchaeological Approach. Unpublished Ph.D. dissertation, Department of Anthropology, University of Chicago.
2005 Embodying Borders: Human Body Modification and Diversity in Tiwanaku Society. *Journal of Anthropological Archaeology* 24:1–24.
Blom, Deborah E., Benedikt Hallgrimsson, Linda Keng, Maria C. Lozada, and Jane E. Buikstra
1998 Tiwanaku "Colonization": Bioarchaeological Implications for Migration in the Moquegua Valley, Peru. *World Archaeology* 30:238–261.
Brothwell, Don R., and A. Mark Pollard (editors)
2001 *Handbook of Archaeological Sciences*. John Wiley and Sons, Chichester, England.
Brush, Stephen B.
1976 Man's Use of an Andean Ecosystem. *Human Ecology* 4:147–166.
1977 *Mountain, Field, and Family: The Economy and Human Ecology of an Andean Valley*. University of Pennsylvania Press, Philadelphia.
Budd, Paul, Janet Montgomery, Barbara Barreiro, and Richard G. Thomas
2000 Differential Diagenesis of Strontium in Archaeological Human Tissues. *Applied Geochemistry* 15:687–694.
Buikstra, Jane E., and Douglas H. Ubelaker (editors)
1994 *Standards for Data Collection from Human Skeletal Remains*. Arkansas Archeological Survey Research Series No. 44. Fayetteville.
Burmeister, Stefan
2000 Archaeology and Migration: Approaches to an Archaeological Proof of Migration. *Current Anthropology* 41:539–567.
Burton, James H.
1996 Trace-Elements in Bone as Paleodietary Indicators. In *Archaeological Chemistry VI*, edited by Mary V. Orna, pp. 327–333. American Chemical Society, Washington, D.C.
Burton, James H., T. Douglas Price, Laura Cahue, and Lori E. Wright
2003 The Use of Barium and Strontium in Human Skeletal Tissues to Determine Their Geographic Origin. *International Journal of Osteoarchaeology* 13:88–95.
Burton, James H., and Lori E. Wright
1995 Nonlinearity in the Relationship Between Bone Sr/Ca Ratios and Dietary Ratios: Paleodietary Implications. *American Journal of Physical Anthropology* 96:273–282.
Buzon, Michele R.
2007 Biological and Ethnic Identity in New Kingdom Nubia. *Current Anthropology* 47:683–695.
Buzon, Michele R., Antonio Simonetti, and Robert A. Creaser
2006 Migration in the Nile Valley During the New Kingdom Period: A Preliminary Strontium Isotope Study. *Journal of Archaeological Science* 34:1391–1401.
Chapman, John, and Pavel M. Dolukhanov
1993 Cultural Transformations and Interactions in Eastern Europe: Theory and Terminology. In *Cultural Transformations and Interactions in Eastern Europe*, edited by John Chapman and Pavel M. Dolukhanov, pp. 1–36. Avebury, Aldershot, England.
Cieza de León, Pedro
1985 [1553] *Crónica del Perú, Segunda Parte*. Pontificia Universidad Católica del Perú, Lima.
Cobo, Bernabe
1979 [1653] *History of the Inca Empire*. University of Texas Press, Austin.
1990 [1653] *Inca Religion and Customs*. University of Texas Press, Austin.
Cock, Guillermo
2002 Inca Rescue. *National Geographic Magazine* 201(5):78.
Conkey, Margaret W., and Christine A. Hastorf (editors)
1990 *The Uses of Style in Archaeology*. Cambridge University Press, Cambridge.
Corruccini, Robert S.
1972 The Biological Relationships of Some Prehistoric and Historic Pueblo Populations. *American Journal of Physical Anthropology* 37:373–388.
Corruccini, Robert S., and Izumi Shimada
2002 Dental Relatedness Corresponding to Mortuary Pattering at Huaca Loro, Peru. *American Journal of Physical Anthropology* 117:118–121.
Costin, Cathy L.
1998 Housewives, Chosen Women, Skilled Men: Cloth Production and Social Identity in the Late Prehispanic Andes. In *Craft and Social Identity*, edited by Cathy L. Costin and Rita P. Wright, pp. 123–141. Archaeological Papers of the American Anthropological Association, No. 8. American Anthropological Association, Washington, D.C.
Covey, R. Alan
2006 *How the Incas Built Their Heartland: State Formation and the Innovation of Imperial Strategies in the Sacred Valley, Peru*. University of Michigan Press, Ann Arbor.
Cronyn, Janet M.
1990 *The Elements of Archaeological Conservation*. Routledge, London.
D'Altroy, Terence N.
1992 *Provincial Power in the Inka Empire*. Smithsonian Institution, Washington, D.C.
2002 *The Incas*. Blackwell Publishers, Malden, Massachusetts.
2005 Remaking the Social Landscape: Colonization in the Inka Empire. In *The Archaeology of Colonial Encounters*, edited by Gil J. Stein, pp. 263–296. School of American Research Press, Santa Fe.
Davidson, Alan
1999 *Oxford Companion to Food*. Oxford University Press, Oxford.
Emberling, Geoff
1997 Ethnicity in Complex Societies: Archaeological Perspectives. *Journal of Archaeological Research* 5:295–344.
Ericson, Jonathan
1985 Strontium Isotope Characterization in the Study of Prehistoric Human Ecology. *Journal of Human Evolution* 14:503–514.
Eriksen, Thomas H.
1992 *Us and Them in Modern Societies: Ethnicity and Nationalism in Mauritius, Trinidad and Beyond*. Scandi-

navian University Press, London.
Espinoza Soriano, Waldemar
1969 El Memorial de Charcas: "Crónica" Inédita de 1582. *Cantuta, Revista de la Universidad Nacional de Educación* 4:117–152.
1973 Colonias de Mitmas Múltiples en Abancay, Siglos XV y XVI: Una Información Inédita de 1575 para la Etnohistoria Andina. *Revista del Museo Nacional* 39:225–299.
1974 El Habitat de la Etnia Pinagua, Siglos XV y XVI. *Revista del Museo Nacional* 40:157–220.
Faure, Gunter
1986 *Principles of Isotope Geology*. John Wiley, New York.
Faure, Gunter, and Teresa M. Mensing
2005 *Isotopes: Principles and Applications*. 3rd ed. John Wiley and Sons, Hoboken.
Faure, Gunter, and James L. Powell
1972 *Strontium Isotope Geology*. Springer-Verlag, New York.
Garcilaso de la Vega, Inca
1986 [1609] *Comentarios Reales de los Incas*. Colección Autores Peruanos. Editorial Universo S.A., Lima.
Gerszten, Peter C.
1993 Investigation into the Practice of Cranial Deformation Among the Pre-Columbian Peoples of Northern Chile. *International Journal of Osteoarchaeology* 3:87–98.
Goldstein, Paul S.
1989a Omo, a Tiwanaku Provincial Center in Moquegua, Peru. Unpublished Ph.D. dissertation, Department of Anthropology, University of Chicago.
1989b The Tiwanaku Occupation of Moquegua. In *Ecology, Settlement and History in the Osmore Drainage, Peru*, edited by Donald S. Rice, Charles Stanish, and Phillip R. Scarr, pp. 219–256. International Series 545(2). British Archaeological Reports, Oxford.
1993 Tiwanaku Temples and State Expansion: A Tiwanaku Sunken-Court Temple in Moquegua, Peru. *Latin American Antiquity* 4:22–47.
2000 Communities Without Borders: The Vertical Archipelago and Diaspora Communities in the Southern Andes. In *The Archaeology of Communities: A New World Perspective*, edited by Marcello A. Canuto and Jason Yaeger, pp. 182–209. Routledge, New York.
2005 *Andean Diaspora: The Tiwanaku Colonies and the Origins of South American Empire*. University of Florida Press, Gainesville.
Good, Irene
2001 Archaeological Textiles: A Review of Current Research. *Annual Review of Anthropology* 30:209–226.
Guaman Poma de Ayala, Felipe
1936 [1615] *Nueva Corónica y Buen Gobierno*. Travaux et Memoires de l'Institut d'Ethnologie, Universite de Paris, 23. Paris.
Guillet, David
1981 Land Tenure, Ecological Zone, and Agricultural Regime in the Central Andes. *American Ethnologist* 8:139–156.
Gyarmati, János, and András Varga
1999 *The Chacaras of War: An Inka State Estate in the Cochabamba Valley, Bolivia*. Museum of Ethnography, Budapest.
Hawkesworth, Christopher J., Michael Hammill, Andrew R. Gledhill, Peter van Calsteren, and Graeme Rogers
1982 Isotope and Trace Element Evidence for Late Stage Intra-Crustal Melting in the High Andes. *Earth and Planetary Science Letters* 58:240–254.
Helmer, Marie
1955–1956 "La Visitación de los Yndios Chupachos" Inka et Encomendero 1549. *Travaux de l'Institut Français d'Etudes Andines* 5:3–50.
Horn, Peter, and Dieter Müller-Sohnius
1999 Comment on "Mobility of Bell Beaker People Revealed by Strontium Isotope Ratios of Tooth and Bone: A Study of Southern Bavarian Skeletal Remains" by Gisela Grupe, T. Douglas Price, Peter Schröter, Frank Söllner, Clark M. Johnson, and Brian L. Beard. *Applied Geochemistry* 14:263–269.
Hoshower, Lisa, Jane E. Buikstra, Paul Goldstein, and Ann D. Webster
1995 Artificial Cranial Deformation at the Omo M10 Site: A Tiwanaku Complex from the Moquegua Valley, Peru. *Latin American Antiquity* 6:145–164.
James, David E.
1982 A Combined O, Sr, Nd, and Pb Isotopic and Trace Element Study of Crustal Contamination in Central Andean Lavas, I. Local Geochemical Variations. *Earth and Planetary Science Letters* 57:47–62.
James, David E., Christopher Brooks, and Arturo Cuyubamba
1976 Andean Cenozoic Volcanism: Magma Genesis in the Light of Strontium Isotopic Composition and Trace-Element Geochemistry. *Geological Society of America Bulletin* 87:592–600.
Jones, Siân
1997 *The Archaeology of Ethnicity: Constructing Identities in the Past and Present*. Routledge, London.
Jones, Siân, and Paul Graves-Brown
1996 Introduction: Archaeology and Cultural Identity in Europe. In *Cultural Identity and Archaeology: The Construction of European Communities*, edited by Siân Jones and Paul Graves-Brown, pp. 1–24. Routledge, London.
Julien, Catherine J.
1982 Inca Decimal Administration in the Lake Titicaca Region. In *The Inca and Aztec States, 1400–1800: Anthropology and History*, edited by George A. Collier, Renato I. Rosaldo, and John D. Wirth, pp. 119–151. Academic Press, New York.
1988 How the Inca Decimal Administration Worked. *Ethnohistory* 35:257–279.
2000 *Reading Inca History*. University of Iowa Press, Iowa City.
Katzenberg, M. Anne
2000 Stable Isotope Analysis: A Tool for Studying Past Diet, Demography, and Life History. In *Biological Anthropology of the Human Skeleton*, edited by M. Anne Katzenberg and Shelley R. Saunders, pp. 305–327. Wiley-Liss, New York.
Knudson, Kelly J.
2004 Tiwanaku Residential Mobility in the South Central Andes: Identifying Archaeological Human Migration Through Strontium Isotope Analysis. Unpublished Ph.D. dissertation, Department of Anthropology, University of Wisconsin, Madison.
Knudson, Kelly J., and T. Douglas Price
2007 Utility of Multiple Chemical Techniques in Archaeological Residential Mobility Studies: Case Studies from Tiwanaku- and Chiribaya-Affiliated Sites in the Andes. *American Journal of Physical Anthropology* 132:25–39.
Knudson, Kelly J., T. Douglas Price, Jane E. Buikstra, and Deborah E. Blom
2004 The Use of Strontium Isotope Analysis to Investigate Tiwanaku Migration and Mortuary Ritual in Bolivia and Peru. *Archaeometry* 46:5–18.
Knudson, Kelly J., Tiffiny A. Tung, Kenneth C. Nystrom, T. Douglas Price, and Paul D. Fullagar
2005 The Origin of the Juch'uypampa Cave Mummies:

Strontium Isotope Analysis of Archaeological Human Remains from Bolivia. *Journal of Archaeological Science* 32:903–913.

Kolata, Alan
1992 In the Realm of the Four Quarters. In *America in 1492*, edited by Alvin M. Josephy, pp. 215–250. Alfred A. Knopf, New York.
1993 *Tiwanaku: Portrait of an Andean Civilization*. Blackwell Publishers, Cambridge, Massachusetts.

Konigsberg, Lyle W.
1988 Migration Models of Prehistoric Postmarital Residence. *American Journal of Physical Anthropology* 77:471–482.

La Lone, Mary B., and Darrell E. La Lone
1987 The Inka State in the Southern Highlands: State Administrative and Production Enclaves. *Ethnohistory* 34:47–62.

Lane, Rebecca A., and Audrey J. Sublett
1972 Osteology of Social Organization: Residence Pattern. *American Antiquity* 37:186–201.

Lebti, Perrine P., Jean-Claude Thouret, Gerhard Wörner, and Michel Fornari
2006 Neogene and Quaternary Ignimbrites in the Area of Arequipa, Southern Peru: Stratigraphical and Petrological Correlations. *Journal of Volcanology and Geothermal Research* 154:251–275.

Lozada, Maria C.
1998 The *Señorio* of Chiribaya: A Bioarchaeological Study in the Osmore Drainage of Southern Peru. Unpublished Ph.D. dissertation, Department of Anthropology, University of Chicago.

Masuda, Shozo, Izumi Shimada, and Craig Morris (editors)
1985 *Andean Ecology and Civilization: An Interdisciplinary Perspective on Andean Ecological Complementarity*. University of Tokyo Press, Tokyo.

McEwan, Gordon F., Arminda Gibaja, and Melissa Chatfield
1995 Archaeology of the Chokepukio Site: An Investigation of the Origin of the Inca Civilization in the Valley of Cuzco, Peru: A Report on the 1994 Field Season. *Tawantinsuyu: International Journal of Inka Studies* 1(1):11–17.

Montgomery, Janet, Paul Budd, and Jane A. Evans
2000 Reconstructing the Lifetime Movements of Ancient People: A Neolithic Case Study from Southern England. *European Journal of Archaeology* 3:370–386.

Montgomery, Janet, Jane A. Evans, Dominic Powlesland, and Charlotte A. Roberts
2005 Continuity or Colonization in Anglo-Saxon England? Isotope Evidence for Mobility, Subsistence Practice, and Status at West Heslerton. *American Journal of Physical Anthropology* 126:123–138.

Murra, John V.
1968 An Aymara Kingdom in 1567. *Ethnohistory* 15:115–151.
1972 El "Control Vertical" de un Máximo de Pisos Ecológicos en la Economía de las Sociedades Andinas. In *Visita de la Provincia de León de Huánuco en 1562 por Iñigo Ortiz de Zuñiga*, edited by John V. Murra, pp. 427–476. Documentos para la Historia y Etnología de Huánuco y la Selva Central, Vol. 2. Universidad Nacional Hermilio Valdizan, Huánuco, Peru.
1982 The *Mit'a* Obligations of Ethnic Groups to the Inka State. In *The Inca and Aztec States 1400–1800: Anthropology and History*, edited by George A. Collier, Renato I. Rosaldo, and John D. Wirth, pp. 237–262. Academic Press, New York.
1985 The Limits and Limitations of the "Vertical Archipelago" in the Andes. In *Andean Ecology and Civilization: An Interdisciplinary Perspective on Andean Ecological Complementarity*, edited by Shozo Masuda, Izumi Shimada, and Craig Morris, pp. 15–20. University of Tokyo Press, Tokyo.

Nagel, Joane
1994 Constructing Ethnicity: Creating and Re-Creating Ethnic Identity and Culture. *Social Problems* 41:152–176.

Nelson, Bruce K., Michael J. DeNiro, Margaret J. Schoeninger, Donald J. DePaolo, and P. Edgar Hare
1986 Effects of Diagenesis on Strontium, Carbon, Nitrogen, and Oxygen Concentration and Isotopic Composition of Bone. *Geochimica et Cosmochimica Acta* 50:1941–1949.

Odess, Daniel
1998 The Archaeology of Interaction: Views from Artifact Style and Material Exchange in Dorset Society. *American Antiquity* 63:417–435.

Owen, Bruce D.
2005 Distant Colonies and Explosive Collapse: The Two Stages of the Tiwanaku Diaspora in the Osmore Drainage. *Latin American Antiquity* 16:45–80.

Pease G. Y., Franklin
1982 The Formation of Tawantinsuyu: Mechanisms of Colonization and Relationship with Ethnic Groups. In *The Inca and Aztec States, 1400–1800: Anthropology and History*, edited by George A. Collier, Renato I. Rosaldo, and John D. Wirth, pp. 173–198. Academic Press, New York.

Plog, Stephen
1983 Analysis of Style in Artifacts. *Annual Review of Anthropology* 12:125–142.

Price, T. Douglas, James H. Burton, and R. Alexander Bentley
2002 The Characterization of Biologically Available Strontium Isotope Ratios for the Study of Prehistoric Migration. *Archaeometry* 44:117–136.

Price, T. Douglas, Clark M. Johnson, Joseph A. Ezzo, Jonathan Erickson, and James H. Burton
1994 Residential Mobility in the Prehistoric Southwest United States: A Preliminary Study Using Strontium Isotope Analysis. *Journal of Archaeological Science* 21:315–330.

Price, T. Douglas, Corina Knipper, Gisela Grupe, and Vaclav Smrcka
2004 Strontium Isotopes and Prehistoric Human Migration: The Bell Beaker Period in Central Europe. *European Journal of Archaeology* 7:9–40.

Price, T. Douglas, Linda Manzanilla, and William D. Middleton
2000 Immigration and the Ancient City of Teotihuacan in Mexico: A Study Using Strontium Isotope Ratios in Human Bone and Teeth. *Journal of Archaeological Science* 27:903–913.

Price, T. Douglas, Vera Tiesler, and James H. Burton
2006 Early African Diaspora in Colonial Campeche, Mexico: Strontium Isotopic Evidence. *American Journal of Physical Anthropology* 130:485–490.

Reycraft, Richard M.
2005 Us and Them: Archaeology and Ethnicity in the Andes. In *Us and Them: Archaeology and Ethnicity in the Andes*, Vol. 53, edited by Richard M. Reycraft, pp. 1–11. Cotsen Institute of Archaeology, Los Angeles.

Rogers, Graeme, and Christopher J. Hawkesworth
1989 A Geochemical Traverse Across the North Chilean Andes: Evidence for Crust Generation from the Mantle Wedge. *Earth and Planetary Science Letters* 91:271–285.

Rostworowski de Diez Canseco, María
1999 *History of the Inca Realm*. Translated by Harry B. Iceland. Cambridge University Press, Cambridge.

Rothhammer, Francisco, and Claudio Silva
1990 Craniometrical Variation Among South American Prehistoric Populations: Climatic, Altitudinal, Chronological, and Geographic Contributions. *American Journal of Physical Anthropology* 82:9–17.

Rowe, John H.
1946 Inca Culture at the Time of the Spanish Conquest. In *The Andean Civilizations*, edited by Julian H. Steward, pp. 183–330. Handbook of South American Indians, Vol. 2, Julian H. Steward, general editor, Smithsonian Institution, Washington, D.C.
1962 Stages and Periods in Archaeological Interpretation. *Southwest Journal of Anthropology* 18:40–54.
1982 Inca Policies and Institutions Relating to the Cultural Unification of the Empire. In *The Inca and Aztec States, 1400–1800: Anthropology and History*, edited by George A. Collier, Renato I. Rosaldo, and John D. Wirth, pp. 93–118. Academic Press, New York.

Rowe, John H., and Dorothy Menzel
1967 *Peruvian Archaeology: Selected Readings*. Peek Publications, Palo Alto.

Salvador, Mendivil, and David Davila
1994 *Geología de los Cuadrángulos de Cuzco y Levitaca. Hojas 28-s y 29-s*. Boletín Numero 52, Serie A: Carta Geológica Nacional. Instituto Geológico Minero y Metalúrgico, Lima.

Sarmiento de Gamboa, Pedro
1942 [1572] *Historia de los Incas*. Emecé Editores, Buenos Aires.

Schillaci, Michael A., and Christopher M. Stojanowski
2003 Postmarital Residence and Biological Variation at Pueblo Bonito. *American Journal of Physical Anthropology* 120:1–15.

Schreiber, Katharina J.
1992 *Wari Imperialism in Middle Horizon Peru*. Anthropological Papers 87, Museum of Anthropology. University of Michigan, Ann Arbor.

Schroeder, Henry A., Isabel H. Tipton, and Alexis P. Nason
1972 Trace Metals in Man: Strontium and Barium. *Journal of Chronic Diseases* 25:491–517.

Sealy, Judith C., Nikolaas J. van der Merwe, Andrew Sillen, F. Johan Kruger, and Harold W. Krueger
1991 $^{87}Sr/^{86}Sr$ as a Dietary Indicator in Modern and Archaeological Bone. *Journal of Archaeological Science* 18:399–416.

Shennan, Stephen
1994 Introduction: Archaeological Approaches to Cultural Identity. In *Archaeological Approaches to Cultural Identity*, edited by Stephen Shennan, pp. 1–32. Routledge, New York.

Sillen, Andrew, Grant Hall, and Richard Armstrong
1995 Strontium–Calcium Ratios (Sr/Ca) and Strontium Isotope Ratios ($^{87}Sr/^{86}Sr$) of *Australopithecus robustus* and *Homo* sp. from Swartkrans. *Journal of Human Evolution* 28:277–285.

Silverblatt, Irene
1978 Andean Women in the Inca Empire. *Feminist Studies* 4:36–61.
1987 *Moon, Sun, and Witches: Gender Ideologies and Class in Inca and Colonial Peru*. Princeton University Press, Princeton.

Singleton, Theresa A.
1998 Cultural Interaction and African American Identity in Plantation Archaeology. In *Studies in Culture Contact: Interaction, Culture Change, and Archaeology*, edited by James G. Cusick, pp. 172–188. Center for Archaeological Investigations Occasional Paper No. 25. Southern Illinois University, Carbondale.

Smith, Michael E., and Katharina Schreiber
2005 New World States and Empires: Economic and Social Organization. *Journal of Archaeological Research* 13:189–229.

Smith, Stuart T.
2003 *Wretched Kush: Ethnic Identities and Boundaries in Egypt's Nubian Empire*. Routledge, London.

Snow, Dean R.
1995 Migration in Prehistory: The Northern Iroquoian Case. *American Antiquity* 60:59–79.

Spence, Michael W.
1974a Residential Practices and the Distribution of Skeletal Traits in Teotihuacan, Mexico. *Man* 9:262–273.
1974b The Study of Residential Practices Among Prehistoric Hunters and Gatherers. *World Archaeology* 5:346–357.
2005 A Zapotec Diaspora Network in Classic-Period Central Mexico. In *The Archaeology of Colonial Encounters*, edited by Gil J. Stein, pp. 173–205. School of American Research Press, Santa Fe.

Stanish, Charles
1997 Nonmarket Imperialism in the Prehispanic Americas: The Inka Occupation of the Titicaca Basin. *Latin American Antiquity* 8:195–216.
2001 Regional Research on the Inca. *Journal of Anthropological Archaeology* 9:213–241.
2003 *Ancient Titicaca: The Evolution of Complex Society in Southern Peru and Northern Bolivia*. University of California Press, Los Angeles.

Stefan, Vincent H.
1999 Craniometric Variation and Homogeneity in Prehistoric/Protohistoric Rapa Nui (Easter Island) Regional Populations. *American Journal of Physical Anthropology* 110:407–419.

Stojanowski, Christopher M., and Michael A. Schillaci
2006 Phenotypic Approaches for Understanding Patterns of Intracemetery Biological Variation. *Yearbook of Physical Anthropology* 49:49–88.

Sutter, Richard C.
2000 Prehistoric Genetic and Culture Change: A Bioarchaeological Search for Pre-Inka Altiplano Colonies in the Coastal Valleys of Moquegua, Peru, and Azapa, Chile. *Latin American Antiquity* 11:43–70.

Tomczak, Paula D., and Joseph F. Powell
2003 Postmarital Residence Practices in the Windover Population: Sex-Based Dental Variation as an Indicator of Patrilocality. *American Antiquity* 68:93–108.

Torres-Rouff, Christina
2002 Cranial Vault Modification and Ethnicity in Middle Horizon San Pedro de Atacama, Chile. *Current Anthropology* 43:163–171.
2003 Shaping Identity: Cranial Vault Modification in the Pre-Columbian Andes. Unpublished Ph.D. dissertation, Department of Anthropology, University of California, Santa Barbara.

Tung, Tiffiny
2003 A Bioarchaeological Perspective on Wari Imperialism in the Andes of Peru: A View from Heartland and Hinterland Skeletal Populations. Unpublished Ph.D. dissertation, Department of Anthropology, University of North Carolina, Chapel Hill.

Van Buren, Mary
1996 Rethinking the Vertical Archipelago: Ethnicity, Exchange, and History in the South Central Andes. *American Anthropologist* 98:338–351.

Verano, John W.

2003 Human Skeletal Remains from Machu Picchu. In *The 1912 Yale Peruvian Scientific Expedition Collections from Machu Picchu: Human and Animal Remains*, edited by Richard L. Burger and Lucy C. Salazar, pp. 65–117. Yale University Publications in Anthropology. New Haven.

Wachtel, Nathan
1982 The *Mitimas* of the Cochabamba Valley: The Colonization Policy of Huayna Capac. In *The Inca and Aztec States, 1400–1800: Anthropology and History*, edited by George A. Collier, Renato I. Rosaldo, and John D. Wirth, pp. 199–235. Academic Press, New York.

White, Christine D., and Michael W. Spence
1998 Oxygen Isotopes and the Identification of Geographical Origins: The Valley of Oaxaca Versus the Valley of Mexico. *Journal of Archaeological Science* 25:643–655.

White, Christine D., Michael W. Spence, Fred J. Longstaffe, and Kimberley R. Law
2004 Demography and Ethnic Continuity in the Tlailotlacan Enclave at Teotihuacan: The Evidence from Stable Oxygen Isotopes. *Journal of Anthropological Archaeology* 23:385–403.

Wright, Lori E.
2005 Identifying Immigrants to Tikal, Guatemala: Defining Local Variability in Strontium Isotope Ratios of Human Tooth Enamel. *Journal of Archaeological Science* 32:555–566.

Notes

1. The use of dental tissue is preferred over the use of human bone for strontium analyses, as bone is more susceptible to diagenesis and postdepositional contamination (Budd et al. 2000; Horn and Müller-Sohnius 1999).

2. The date of A.D. 1476 is traditionally cited for the inception of the Late Horizon, based on the appearance of imperial Inca ceramics in the Inca region of southern coastal Peru (Rowe 1962; Rowe and Menzel 1967). However, accruing archaeological data suggest an earlier date for the expansion of Inca imperialism in the heartland (Bauer 2004:12; Covey 2006:234). Therefore, an initial date of A.D. 1400 is used here to mark the beginning of the Inca imperial period in Cuzco, acknowledging that Andean chronology remains a topic of scholarly examination. The acronym LH is used throughout this article to denote the imperial Inca/Late Horizon occupation at Chokepukio (A.D. 1400–1532).

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