Late Prehistoric High-Altitude Hunter-Gatherer Residential Occupations in the Argentine Southern Andes

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**ABSTRACT**
Test excavations were conducted at Risco de los Indios (RDLI), a site at 2480 masl with 29 residential features and a well-developed midden containing abundant floral, faunal, lithic, and ceramic materials. Analyses indicate the site was intensively used CA. 500 CAL. B.P. as a residential base for groups focused on hunting guanaco, supplemented by locally-available wild flora and fauna as well as domestic beans transported from the lowlands. Ceramic and obsidian artifacts indicate these groups were highly mobile and in contact with groups on the eastern and western margins of the Andes. These patterns compare favorably to those seen in the region’s other high altitude villages. It appears that the development of these patterns began with population increase and economic intensification in the lowlands CA. 2000 CAL. B.P. and that the move to slightly lower elevation settings like RDLI may have been conditioned by the onset of the Little Ice Age.

**KEYWORDS**
High altitude; hunter gatherer; Andes; residential; Late Prehistoric

**Introduction**
The subject of human use and occupation of high altitudes in general is critical to our conception of the economic, social, and even ideological pressures and incentives that led lowland populations to move into, intensively exploit, and eventually permanently reside in marginal alpine and subalpine environments (Aldenderfer 2006; Bettinger 1996; Brantingham 2006). This topic also plays an important role in our understanding of human adaptations to high latitude, altitude’s ecological analog (Innes 1991; Mäkinen 2007; Zhu et al. 2004). Understanding high altitude adaptations plays a significant role in how we perceive worldwide human dispersals and distributions across most of the planet (Dennell 2004; Klein 2008; Lahr and Foley 1994). The subject is important because high altitudes, due to the fact that they are often remote and difficult to access, are often left out of our reconstructions of past settlement systems and consequently many regional culture-historical explanatory packages (Bender and Wright 1988; Morgan et al. 2014a; Wright et al. 1980).

Here, we report on test excavations at a site situated at 2480 masl in the southeastern Argentine Andes known to local herders (Puesteros) as “Risco de los Indios” (RDLI), which translates as “Crag of the Indians,” no doubt in reference to the site’s setting at the base of a very distinctive, nearly bone-white dacite cliff. The site is a large residential locus with at least 29 stacked rock structures and a deep, well developed midden indicative of intensive, multi-family (and/or repeated) occupations. Though the site is not at a very high elevation for the Andes, it is at the elevation where hypoxia has its first effects (Beall 2001; Simonson 2015), biotic productivity is diminished, and seasonal changes are more pronounced than in lowland settings (Benedict 2007; Hevly 1983; Neme 2016), and there is considerable variability in weather and environmental productivity. This results in markedly more risk and uncertainty than in the lowlands with regard to foraging, hunting, and other decision-making processes associated with the success or failure of different behavioral strategies (Bordley and LiCalzi 2000; Morgan 2009). The site is also one of only three other known high altitude settlements in the region, all of which have been previously excavated. Comparison of the data from these sites to RDLI allows us to identify general trends in southern Andean high altitude residential occupations in regional cultural-historical and ecological contexts. From these comparisons, we develop a hypothesis regarding the cause of intensified high altitude occupations that relies more on demographic and economic explanations than on climatic or environmental ones.

**Archaeological Background**
The trajectory of human occupation of the high Andes mirrors that seen in many of the world’s mountain ranges in that the earliest occupations appear to be mainly transhumant while later occupations appear larger, more settled, and more intensive (Aldenderfer 1998, 1999, 2006; Moore 1998; Rick 1980, 1988). The earliest evidence for human occupation of the Andes in the southern Mendoza region of Argentina is at CA. 9000 B.P. at sites like Arroyo Malo 3 and Gruta el Mallín (Dieguez and Neme 2003; Neme 2007), but these occupations appear to have been mainly sporadic and constrained to elevations below about 2500 masl (Cornejo and Sanhueza 2003; Gambier 1979, 1985; Neme and Gil 2008). It appears the high southern Andes were nearly abandoned in the middle Holocene, likely due to deteriorating environmental conditions (Zárate et al. 2005, 2010). But in the 1970s, Humberto Lagiglia initiated the first high altitude work in the region by recording and test excavating El
Indigeno, a village containing 136 structures at 3400 masl on a mountain pass only ca. 14 km southwest of RDLI (Lagiglia 1997; Lagiglia et al. 1994). More recent work at the site indicates that between 1600 and 700 cal. B.P. it was geared mainly towards cameldid hunting by extremely mobile hunter-gatherer groups who interacted with other foragers and farmers on both the Argentine and Chilean sides of the Andes (Neme 2016).

Since Lagiglia’s pioneering work, two additional village site complexes have been identified: Los Pequenes and Laguna el Diamante. Los Pequenes is the smaller and lower of the two, with nine structures at 3100 masl. The Laguna el Diamante locality contains 60 structures and is situated at 3300 masl; it also has produced the oldest radiocarbon date (2100 ± 70 B.P.) for a high altitude village in the southern Andes (Durán et al. 2006). Material recovered from each of these sites indicates patterns similar to those identified at El Indigeno: high elevation; proximity to mountain passes; multiple domiciles; a focus on cameldid hunting; a subsidiary subsistence focus on transporting and processing wild and domestic plants, including the common bean (Phaselus vulgaris); and use and curation of extralocal obsidian and ceramics from both the eastern and western sides of the Andes, suggesting interactions with foraging and farming groups in these areas (Durán et al. 2006; Neme 2002; Neme et al. 2013; Otaola et al. 2015). It is consequently thought that the groups occupying the high elevations of the southern Andean interior were mobile hunter-gatherers who nonetheless were articulated within the larger regional economy by supplying farmers in the lowlands with resources available only in the mountains (e.g., guanaco meat and obsidian), exchanged for items produced by agriculture-based societies, especially domesticates like Phaseolus and maize (Cornejo and Sanhueza 2003, 2011). Importantly, farming societies like those represented by the Llolleo, Bato, and Aconcagua complexes (characterized as wide-ranging, mostly horticultural groups living in small hamlets that are marked by distinctive ceramic traditions, pipe smoking, little or no status differentiation, and in some cases use of domesticated llamas), do not appear until between 1500 and 900 B.P. to the west, in Chile (Falabella et al. 2007; Falabella and Stehberg 1989; Lagiglia 1968). To the east, in Argentina, domestic crops like maize, beans, quinoa, and squash also appear in the record at this time, but it seems their overall contribution to subsistence, at least as measured by stable isotope studies and archaeobotanical data, was minimal (Gil et al. 2011; Llano et al. 2011).

Worldwide, though there is considerable variability in high altitude lifeways, contemporaneity between permanent or semipermanent high altitude residential use, and both foraging and farming intensification in adjacent lowland settings is not uncommon. On the Ethiopian Plateau (Phillipson 2000), the Tibetan Plateau (Brantingham 2006), the Caucasus (Adler et al. 2006), the Alps (Leveau and Walsh 2005) and the northern Andes (Aldenderfer 1998; Moore 1998; Reinhard 2002; Rick 1980), low intensity, highly-mobile, high-altitude hunting and foraging was established early in each region’s prehistory. But settlements containing domiciles and extensive middens indicative of permanent or semipermanent occupation in mid-altitude settings were often (though not always) established after some sort of shift in basic economic pursuits, usually either to herding or agriculture, but also towards more intensive, broad-spectrum hunter-gatherer economies (Aldenderfer and Zhang 2004; Chen et al. 2015; d’Alpoim Guedes et al. 2014; Phillipson 1977; Walsh et al. 2006; Williams 2006). In North America, somewhat similar patterns pertain, with the establishment of albeit seasonally-occupied high altitude villages in California’s White Mountains (Bettinger 1991), central Nevada’s Toquima Range (Thomas 1982, 1994), and Wyoming’s Wind River Range (Morgan et al. 2012; Stirn 2014) mainly in the last 2000 years or less. More intensive use of high altitudes is also seen in California’s Sierra Nevada mountains (Morgan 2006; Stevens 2005) and Utah’s Uinta Range (Nash 2012; Watkins 2000) during this time, which is marked in general by regional population increases (Bettinger 1999) as well as the fluorescence of maize agriculture in the valleys south of the Uinta Range.

Explaining these shifts is a vexing problem. Some have linked population expansion and economic intensification to more intensive use of the highlands (Basgall 1987; Bettinger 1991; Stevens 2005) while others note that high altitude intensification in many cases is contemporaneous with climatic shifts which may have increased the biotic productivity and/or predictability of alpine and subalpine ecoczones (Losey 2013; Morgan et al. 2014b). The problem with the latter perspective, especially in Wyoming, is that such climatic shifts and intensified, residential alpine land use are also contemporaneous with evidence for economic intensification in the lowlands, in particular shifts to eating more low-return resources like geophytes and increased investments in constructing residential facilities (Smith and McNees 1999, 2011; Trout 2015). This explanatory conundrum makes new data from rare high altitude village sites like RDLI all the more intriguing because of the possibility of linking highland patterns with lowland ones and the opportunity to explore temporal correlations for climate change derived from paleoenvironmental proxy records and high altitude village occupational histories. Here we use data from test excavations at RDLI to do exactly that: to explore potential linkages between climate, lowland adaptive patterns, and high altitude village dynamics in the Mendoza region of Argentina as a means of developing hypotheses that might explain not only southern Andean mountain-adapted patterns, but global ones as well.

Environmental Setting

The study area is in the upper Diamante River watershed on the eastern slope of the southern Andes, in Mendoza Province, Argentina (Figure 1). The upper Diamante watershed is capped by peaks as high as 5000 masl. Much of the area above 3700 masl is currently glaciated or harbors permanent snowfields; glacial landforms characterize much of the landscape above 2800 masl (Volkheimer 1978). Upper ridgelines drop sharply into steeply-incised and often narrow canyons draining the high country. Large rivers like the Diamante and its major tributary, the Barroso, are difficult to ford even during relatively low water in the summer.

Precipitation, temperature, flora, and fauna are strongly conditioned by elevation (Capitanelli 1972; Solbrig et al. 1984). At 1400 masl, annual precipitation is only 300 mm but near 3000 masl, precipitation falls mainly as snow, averaging 800 mm per annum. At 2000 masl elevation, mean annual temperature is 9° C; at 3000 masl this number drops to 0° C, bracketed by maxima and minima of 25° C and –30° C, respectively. Elevations between the foothills (ca. 215

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1500 masl) and 3000 masl (above which is an alpine floristic province marked by sparse cushion plants, bare rock, and ice) fall within the Altoandean phytogeographic province, which is dominated by low shrub (Asteraceae) and grass (Poaceae) steppes (Cabrera 1976). On brushy hillside leña amarilla (Adesmia pinifolia—which grows to 3400 masl and is often used for firewood), patagulla–colimamul (Anarthrophyllum sp.), and molle (Shinus odonelli) are common. Small seeded species and greens exploited by humans like calafate (Berberis empetrifolia), molle (Shinus poligamus and johnstonnii), ali de las sierras (Rhododendron tuberosum), and porotera (Senna arnottiana) are also found on Altoandean hillslopes. Grasses encountered in mountain valleys are pasto hilo (Poa holciformis), tussock grass (Deschampsia venustula), and coiron duro (Pappostipa chrysophilla). Various cacti (e.g., yerba del guanaco [Mathuenia patagonica]) are found throughout the Altoandean province (Cabrera 1976; Muñio et al. 2012; Roig 1960). Faunal diversity is low and characterized by only two large mammals: guanaco (Lama guanicoe) and mountain lion (Puma concolor). Small rodents (e.g., Akodon sp. and Philotis sp.), reptiles, and armadillo (Dasypodidae) round out the indigenous faunal community. Migratory waterfowl frequent high elevation lakes and waterways on a seasonal basis (Roig 1972).

**Risco de Los Indios**

RDLI measures 25 by 110 m and is distinctive for its 29 stacked rock features (**Figure 2**). All but five of the features are circular or ovoid in plan and between 3 and 4 m in diameter; the remainder are linear arrangements and “U” or “C” shaped structures. The structures, which vary from two to seven courses high, resemble the rock-ringed house pits found at similar altitudes in North America; it is unclear if or what kind of superstructures topped the features (Bettinger 1991; Thomas 1982). Some of the features are contiguous, forming “blocks” of circular structures, in particular Structures 12, 13, 14A and 14B (**Figure 3**). The site also contains a surface scatter of mainly fine-grained volcanic (FGV), cryocrystalline silicate (CCS), and obsidian flaked stone knapping debris, burned and unburned animal bone, a small quantity of ceramic sherds, and an approximately meter-thick deposit of anthropogenic midden soils containing lithics, ceramics, animal bone, and macrofloral remains. The site is situated at 2480 masl in a low, gentle swale atop a ridge and below a distinctive, 40 m-high dacite cliff face ringed by a steep talus slope, the latter forming the northern site boundary. The top of the cliff is capped by a cairn of dacite slabs ca. 3 m in diameter and believed to also be of aboriginal origin. A perennial stream is 80 m west of the site and down a steep embankment. This stream flows into the Barroso River some 1.1 km south of the site.

**Excavations**

A single 1×1 m unit was excavated in the center of Structure 22, one of the more intact circular features at the site, situated in an area with a particularly well-developed midden. The **Figure 1.** Map showing the location of Risco de los Indios and other important archaeological sites and paleoclimatic proxy studies in the greater southern Mendoza region.
unit was excavated in 5 cm arbitrary levels save for the last level, which was excavated in a single 15 cm level. In total, 16 levels were excavated, to a maximum depth of 90 cm below the surface (weather and time constraints prevented us from reaching truly sterile basal levels). All sediments were passed through a 2 mm mesh, with all cultural material bagged separately by level. Sediment samples (in 16 liter [5 gal.] buckets) were taken from each level for flotation, recovery, and identification of macrofloral remains. Recovered cultural materials consist of 2807 items, the majority of which (75%) are faunal bone; the remainder consists of ceramics (14%), lithics (10%), and pigments like hematite (1%). Most of the cultural material is between Levels 3 and 14, 10–70 cm below the surface.

**Stratigraphy**

The profile of the north wall of Unit 1 in Feature 22 indicates three main strata: an upper 10–12 cm of recently-developed surface soils; 50 cm of well-developed midden soils; and 30 cm or more (the sterile base of the deposit was not reached) of slightly less-well developed midden that, while containing abundant cultural materials, contains less charcoal and organic materials than the overlying midden (**Figure 4**). The top 12 cm (Stratum I) consists of an 8–10 cm thick, organic “A” horizon overlying a 2–4 cm thick, leached “E” horizon. These recent and developing soils overlie the main site deposit (Stratum II), a sandy midden containing abundant cultural materials as well as lenses of charcoal and ash.
Both of the above strata contain large, angular dacite slabs indicative of colluvial deposition from the nearby talus slope, or perhaps rockfall from Structure 22’s sidewalls. The basal stratum (Stratum III) is a fine sandy subsoil and a more weakly-developed midden than Stratum II; Stratum III also contains angular colluvial dacite clasts, ash, and an oxidized area of soil underlying an ash lens.

Analytical Results

Radiocarbon

Carbon samples were recovered from both an ash and a charcoal lens on the north wall of Unit 1 as well as from the matrix of the deepest level, 75–90 cm below the surface (Figure 4). The samples from the sidewall were run by the University of Georgia Center for Isotopic Studies (UGAMS 13578 and 13579) and the sample from the deepest level was run by the Arizona Accelerator Mass Spectrometry Laboratory at the University of Arizona (AA 102653) (Table 1). Radiocarbon dates range from 478 to 500 B.P. Though mean radiocarbon dates technically result in a minor stratigraphic reversal, the errors associated with these dates overlap substantially, meaning that the strata these dates are associated with must at this point be considered as representing a suite of undifferentiated occupations between approximately 477 and 553 CAL B.P. (at two sigmas).

Ceramics

A total of 284 ceramic sherds was analyzed, the majority of which were recovered between Levels 2 through 6 (5–30 cm below the surface). The sherds were cleaned, cut to produce fresh surfaces by which to identify paste and temper, and subjected to macroscopic and microscopic analyses (with a Nikon SMZ 800 stereoscopic microscope). Recorded variables include thickness, temper, surface treatment, vessel shape, surface residues, and pottery type.

Sherd thickness ranges from 3.58 to 13.77 mm, with a mean of 6.91 mm, but most sherds are between 5.5 and 7.5 mm thick. Temper comprises between 10% and 20% of sherds matrices and ranges from fine to medium to large-sized clasts, mostly sand. Plainwares comprise 91.2% of the sample, with the majority (91.1%) showing smoothed surfaces. Some sherds (28.6%) also show evidence of polishing and only 1.5% show evidence of brushing. Only 25 sherds (8.8%) are painted with either red, white, black on white, red on white, and red and black pigments (Figure 5); all painted sherds represent nonlocal types (e.g., Aconcagua). Vessel forms, where discernable, consist of restricted necked pots with rounded bases. Combined with the soot and organic residues on interiors (32.4% of the sample) and exterior walls (53% of the sample), these forms suggest use as cooking and perhaps as storage vessels. Identified pottery types consist of Overo, Nihuil, Aconcagua, Atuel, and Rojo (Table 2). These types have been found in other, similar high altitude settings nearby (Lagiglia 1997). Aconcagua and other nonlocal, mostly decorated sherds show either interaction with or transport from other regions like northern Chile (Falabella et al. 2001; Lagiglia 1977).

Lithics

The lithic assemblage is composed of 283 artifacts, 261 of which are debitage, 21 of which are formed tools and one is a silicified sandstone core. Basalt is the most common material type, followed by cryptocrystalline silicates (CCS), obsidian, silicified sandstone, rhyolite, and trace amounts of dacite, andesite, slate, and granite (Figure 6). The remaining tools consist of a rhyolite hammerstone fragment, a basalt mano fragment, a spindle whorl made of sedimentary...
material, a small, drilled steatite bead, five CCS and silicified sandstone bifaces (one of which is a large chopper), and 13 obsidian and CCS bifaces. Eight of the bifaces are small, triangular, concave-based arrow points, seven made of obsidian, one of CCS (FIGURE 7).

As exhibited by the data presented in Table 3, following the typology developed by Aschero (1983), most of the debitage consists of angular shatter, flake fragments, and core reduction debris made on basalt, CCS, and obsidian; there is very little evidence for manufacture, maintenance, or repair of formal flaked stone tools. Evidence of differential curation of different material types, however, is exhibited by a comparison of the frequency of dorsal flake scars per mm² on flakes, a proxy for the intensity of raw material reduction and, by inference, curation (Ingbar 1994; Ingbar et al. 1989). As Figure 8 illustrates, obsidian debitage has on average three times more dorsal flake scars than basalt or silicified sandstone debitage and nearly double that of CCS flakes, suggesting more intensive curation of obsidian. This is not surprising given that basalt, silicified sandstone, CCS, and other lithic raw materials are found nearby, as clasts in Barroso River sediments and as outcrops throughout the region. The exception to this is obsidian. XRF trace element analysis of five obsidian artifacts from RDLI indicates provenance from the Las Cargas (n = 4) and Coche Quemado (n = 1) quarries, 100 km and 200 km away respectively from RDLI. Though the XRF sample size is small, it is interesting that no obsidian was sourced to the Laguna del Diamante quarry, which is only 30 km from the site.

Macrobotanical Remains

A total of 39 seeds, seed husks (endocarps), leaves, and seed leaves (cotyledons) were recovered by flotation (TABLE 4). Taxon identification was conducted via macro and microscopic visual comparison to reference collections and published reference materials (Babot et al. 2007; Martin and

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**Figure 5.** Sherds recovered from Risco de los Indios.

**Table 2.** Frequency and percentages of pottery types identified at RDLI.

<table>
<thead>
<tr>
<th>Type</th>
<th>Overo</th>
<th>Nihuil</th>
<th>Aconcagua</th>
<th>Atuel (brushed)</th>
<th>Rojo (polished)</th>
<th>Nonlocal</th>
<th>Indet.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td>86</td>
<td>91</td>
<td>3</td>
<td>4</td>
<td>9</td>
<td>17</td>
<td>74</td>
<td>284</td>
</tr>
<tr>
<td>Percentage</td>
<td>30%</td>
<td>32%</td>
<td>1%</td>
<td>1%</td>
<td>3%</td>
<td>6%</td>
<td>26%</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Figure 6.** Flaked stone raw material percentages. CCS = cryptocrystalline silicates.
Barkley 1973; Muiño et al. 2012; Singh et al. 1991). Wild taxa identified in Levels 1 and 2 included charred endocarps of Schinus johnstonii, a low-lying woody shrub that produces small, fleshy fruits (Barkley 1944); Maihuenia patagonica, a small cactus (Hunt et al. 2006); Maihueniopsis glomerata, a common, widely distributed cactus (Hoffmann and Walter 1989); and the leaf of a wild legume found in mountain steppes (Contu 2012). Charred remains of Phaseolus vulgaris were found in Levels 10–13 and 16. All these plants, wild or domestic, were eaten or otherwise used by the region’s aboriginal inhabitants. Though the literature is somewhat unclear on the subject (few vegetation studies have been conducted in the southern Andes), all these taxa save Phaseolus (which grows best between 500 and 1500 masl) grow in the Altoandean biotic province containing RDLI, suggesting they were locally available to the site’s inhabitants (Wortmann 2006).

Faunal Material
A total of 1430 pieces of animal bone was recovered, of which 347 were taxonomically identified. Taxa determinations were made following Lyman (1994) using comparative collections housed at the San Rafael Natural History Museum, Argentina and published reference material (Giardina 2010; Pacheco Torres et al. 1986). Herbivorous, large, and indeterminate mammal remains dominate the assemblage, comprising 97% of the identified specimens. We argue it is safe to say that a majority of these specimens (i.e., 63–97%) represent guanaco bone (especially the large mammal, Camelidae and L. guanaco) taxon identifications, given the fact that the only other large mammal in the Altoandean province is puma (FIGURE 9). Crania are the most common elements identified in the assemblage, though other elements (mandible, vertebrae, ribs, portions of the pelvis, femur, humerus, and smaller bones of the distal appendicular skeleton) were also identified, suggesting animals were brought back to the site whole, or nearly whole, and processed on-site. Smaller mammals including canids (Pseudalopex culpaeus) and armadillo (Dasipodidae) are present in trace amounts. Cut marks, bone chipping, and perimeter marking indicative of anthropogenic processing were identified on only 7% of the sample, though 62% of the sample is either burnt, charred, or calcined, indicating cooking over open fires and/or burning after discard.

Discussion
The abundance of rock ring features at the site is consistent with descriptions of high altitude domiciles both in the Andes (Aldenderfer 1998; Lagiglia 1997; Neme 2016) and beyond (Bettinger 1991; Morgan et al. 2012; Thomas 1982),
strongly suggesting that the structures at RDLI are indeed residential features. The presence of cooking refuse (charcoal, burned animal bone, and macrofloral remains) and domestic items (especially sherds and groundstone artifacts) supports this assertion, as does the diversity of the site's artifact assemblage according to the Clarke Effect (Schiffer 1987: 54–55). Assuming some degree of contemporaneity (which, however, has yet to be shown), the number of residential structures at the site suggests multi-family aggregations, though it is conceivable at this early stage in the site's research history that they might represent a palimpsest of repeated occupations. Radiocarbon dates and diagnostic artifacts indicate late Holocene occupation. The concordance of radiocarbon dates between 45 and 72 cm below the surface indicates rapid accumulation of thick midden deposits, suggesting intensive use of the site over a relatively brief period of time, perhaps as few as 76 years (the span of the radiocarbon dates at 2 sigmas), though clearly more dates are needed to substantiate this claim.

The fact that the midden is dominated by large animal bone, most of it guanaco or likely guanaco, suggests the site was a residential base (sensu Binford 1980) geared mainly towards accessing this type of prey. The fact that both low and high utility elements comprise the faunal assemblage suggests either that RDLI inhabitants faced considerable resource stress and were processing even low utility items (unlikely given the density, thickness, and diversity of the site's midden and the lack of evidence for intensive bone processing or greasing) or, much more likely, that animals were captured near enough to the site to reduce transport costs to the point that it was more efficient to bring entire carcasses back to the site where they were processed, cooked, and consumed (Binford 1977; Burger et al. 2005; Metcalfe and Jones 1988). Though it is possible that both situations may have been at play, the fact that we regularly saw guanaco on the ridge adjacent to the site during our work there lends some credence to the latter assertion.

Though the majority of the faunal, macrofloral, and lithic material may be procured at or near the site, nonlocal obsidian, exotic Chilean ceramics and domestic beans, which likely were grown in the lowlands, and perhaps as far away as central Chile (Durán 2000; Falabella et al. 2007; Hernández 2002; Llanos et al. 2011) indicate considerable mobility across and within the south-central Andes. They also likely indicate contact with Chilean groups to the north and west and with Argentine groups living along the eastern Andean front. Importantly, the presence of nonlocal, domestic beans suggests guanaco hunting at the site was subsidized (to an extent as-yet unclear) in part by transporting plant foods from lower elevations, a pattern also seen in several of North America's high ranges, in particular in California's Sierra Nevada mountains and White Mountains and Utah's Uinta Mountains (Nash 2012; Rhode in press; Scharf 2009; Watkins 2000).

The patterns identified at RDLI are mostly consistent with those seen at other southern Andean high altitude residential sites. In terms of subsistence, it appears camelid hunting drove the occupation of both RDLI and the three other known residential sites in the Atuel and Diamante watersheds; camelids comprise between 88% and 98% of their faunal assemblages (Durán et al. 2006; Giardina et al. 2014; Neme 2016). In a similar vein, though local plants (e.g., *Schinus* sp., *Anarthrophyllum* sp., and various cacti) were also exploited at these other sites, it also appears *Phaseolus* was brought to each (Gil et al. 2014; Lagiglia 2001; Planella and Planella 2004). Extralocal ceramics and obsidian artifacts were also identified at these other sites, suggesting considerable mobility within and across the Andes, in an area encompassing modern day Chile, the Andean crest, and the foothills of the Andes in western Argentina (Falabella et al. 2001; Lagiglia 1997; Lagiglia et al. 1994; Sanhueza et al. 2004).

The main differences between RDLI and the three other known high altitude villages in the southeastern Andes are their respective radiocarbon dates, numbers of structures, and elevations. RDLI is the second youngest of the bunch and also the lowest in elevation. When radiocarbon summed
probability distributions (c.f. Steele 2010; Williams 2012), elevations, and number of structures at each village site in the region are graphed, it appears higher, larger sites (El Indígeno and the Laguna el Diamante sites) were occupied earlier and lower, generally smaller sites (Los Pequenes and RDLI) were occupied later (FIGURE 10). This suggests that intensive high elevation village use in the region began approximately 2100 years ago, was most intensive between about 1500 and 600 years ago, and that high elevation residential use may have declined or at least shifted to somewhat lower elevations in the very Late Holocene.

Given the marginality of high altitude settings (Beall 2001; Lozny 2013; Simonson 2015) and their sensitivity to climatic fluctuations (Innes 1991; Morgan et al. 2014b; Smith et al. 2009), a candidate for explaining both the intensification (sensu lato, Morgan 2015) of high altitude residential use and variation in such use through time is climate. But as proxy records from both the eastern and western slopes of the southern Andes (of which there are admittedly relatively few) show, making such causal connections is problematic. On the eastern side of the southern Andes, these records indicate mainly wet and cold conditions between 2500 and 2000 cal B.P., during the establishment of the first high altitude village in the region (Durán et al. 2006; Navarro and Whitlock 2010) (FIGURE 10). On the western slope of the southern Andes, drier conditions pertained between 2150 and 1750 cal B.P., a period overlapping with the first occupations at Laguna el Diamante (Jenny et al. 2002). This results in a situation where it is unclear as to whether or not the earliest high altitude village occupation was during a wet or a dry period, though it is possible this conflict results from the paucity of proxy records and differences in paleoenvironments and atmospheric circulation on either side of the Andes.

More clear is that mesic conditions returned between 1750 and 1000 cal B.P., with markedly wetter conditions and flooding characterizing regional climate CA. 1400 cal B.P., when both Laguna el Diamante and the region’s largest high altitude village, El Indígeno, were occupied (Jenny et al. 2002; Neme 2016). Though the nature and expression of the Medieval Warm Period (MWP) in South America is contentious, it appears generally warmer, drier conditions pertained in Argentina between approximately 1000 and 600 cal B.P. (Gioccale 1999; Haberzettl et al. 2005; Mauquoy et al. 2004), the period of time representing the latter half of the occupations at both Laguna el Diamante and El Indígeno. This results in a situation where occupations of the region’s largest high altitude villages transgress a fundamental change in climate from mesic to xeric conditions, suggesting that climate had little effect on the occupational history of these sites.

By 600 cal B.P., increasingly cold conditions pertained, these associated with the Little Ice Age (LIA) (Espizua 2005; Stingle and Garleff 1985). LIA conditions intensified after 400 cal B.P., a period also characterized by an increase in the frequency and amplitude of the El Niño Southern Oscillation (ENSO) (de Jong et al. 2013; Jenny et al. 2002; Lamy et al. 2002). This is when Laguna el Diamante and El Indígeno appear to have been abandoned and when lower elevation sites like Los Pequenes and RDLI were occupied. In sum, proxy records provide conflicting information regarding the first occupations of the region’s earliest high altitude village locality, Laguna el Diamante. That site and El Indígeno, the region’s largest and highest village, were both occupied over a span of time marked both by pronounced mesic conditions but also the dry-warm MWP, a confounding situation that calls into question the idea of a causal connection between climate and high altitude intensification. Slightly more plausible is that colder and more variable LIA environmental conditions drove the region’s inhabitants to lower settings like Los Pequenes and especially RDLI (Gioccale 1999; Losey 2013; Morgan 2009).

![Figure 10. Summed probability distributions of radiocarbon dates from the four known high altitude village localities in the southern Mendoza region of the southern Andes superimposed on a regional paleoclimatic synthesis based on the literature reviewed herein (see FIGURE 1 for study locations). Distributions generated at 2 sigmas with CalPal 2015 (Weninger et al. 2015) and the Intcal 13 radiocarbon calibration curve (Reimer et al. 2013). ENSO = El Niño Southern Oscillation.](image-url)
More telling than the problematic and rough temporal correlations between some climatic and cultural changes are trends in the region’s archaeology that point to resource stress, intensified foraging and agricultural production, and increasing population density, all of which may have caused more intensive use of high altitudes. Beginning approximately 2000 CAL B.P. and continuing until approximately 1000 CAL B.P., regional artiodactyl indexes (sensu Broughton 1994) decrease; this is related to an increase in the frequencies of smaller animals in the region’s archaeofaunal assemblages (Neme 2007; Otaola 2014). There is also an increase in evidence for reliance on small-seeded, costly-to-process wild and domesticated plants including beans, maize, Chenopods, and squash (Falabella et al. 2007; Gil et al. 2011; Gil et al. 2014; Hernández 2002). Both lines of evidence indicate widening diet breadth and likely declining hunting, foraging, and farming efficiency (Llano 2010, 2014; Llano et al. 2011), both often seen as markers of population pressure (Morgan 2015). The most direct measure of increasing population density and arguably population pressure (see Keeley 1988), however, is an increase in the number of sites and more radiocarbon dates during this same period of time (Neme and Gil 2009; Neme and Gil 2012). Taken together, these data suggest that increasing population density in lowland valleys may have resulted in an imbalance between population and resources, forcing more intensive occupation and exploitation of high altitude settings and resources (Neme 2007; Neme and Gil 2008).

Given this, we think demographic and economic factors likely hold the most predictive power for explaining the inception of intensive high altitude residential occupations. The weakness of the climatic correlation to high altitude intensification in the southern Andes and the inability of climate to account for high altitude intensification on the global stage and in terms of general theory lead to the conclusion that the connections between demographic expansion, economic intensification, and intensified alpine land use is clearer (Aldefenderer 2006; Bettinger 1991). In light of this, we argue that high altitude intensification in the southern Andes (and likely elsewhere) resulted from demographic pressures forcing more intensive use of both low and high elevation resources and locales.

Expectations derived from these hypotheses consequentl consist of the following: contemporaneity of lowland and highland economic intensification (sensu stricto, Morgan 2015); evidence for increasing population density (e.g., diachronic and time corrected site frequencies and radiocarbon summed probability distributions) in lower elevations immediately before and during periods of high altitude village occupations; evidence for exchange, contact, or transhumance between lower and higher elevations (e.g., obsidian, ceramics, shell beads); and higher or at least equal returns from foraging and hunting in the highlands relative to the lowlands when high altitude residential sites are occupied. This last point is critical in that if economic concerns drove high altitude intensification in the region, then high altitudes would have to be at least equal in terms of economic potential as the lowlands; such an analysis would of course have to take into account population density and its effects on resource encounter rates in addition to gross comparison of resource return rates in both elevational settings. At this point, however, the connections between population dynamics, high altitude intensification, and less convincingly so, climate, remain hypothetical. What is clear is that considerably more work is required to elucidate the connections between these phenomena through the development of explicit hypotheses and expectations, modeling, and substantially more fieldwork in the region, both in terms of generating more paleoenvironmental proxy data and in reconstructing both highland and lowland population densities, economies, and other behavioral patterns.

Conclusions
Our test excavations at RD1 resulted in a rich dataset showing that occupation of this high-altitude village site occurred for a brief but intensive time CA. 500 CAL B.P. Flora, faunal, and lithic assemblages indicate mainly a hunting economy (mainly of guanaco), supplemented by small quantities of smaller fauna like armadillo, locally available small-seeded plants, and small quantities of domestic beans transported from lowland settings, likely in Chile. Lithic and ceramic assemblages suggest RD1’s inhabitants were quite mobile, with a seasonal round encompassing most of the interior portion of the Andes and forays into both the western and eastern slopes of the range, in modern day Chile and Argentina. When compared to the three other known high elevation residential sites in the region, these behavioral patterns appear to be more-or-less the norm for the southern high Andes after about 2000 CAL B.P., save for the fact that such patterns appear to move to slightly lower elevations around 500 or 600 years ago, at the onset of the LIA and increasingly uncertain environmental conditions affiliated with the ENSO. Rather than being climatically mediated, however, it appears the initial push to develop these intensive high altitude behavioral patterns may be found in the valleys surrounding the Andes, where increasing population densities and intensified economies may have driven people to more intensively exploit the high Andes. As we hope we have shown, these hypothetical connections are based on some intriguing temporal correlations between the onset, florescence, and demise of high altitude village life in the southern Andes and on fundamental changes in demography and economy in the region. It thus indeed seems plausible that population pressure drove people to more intensively exploit and occupy the region’s high altitude settings and that colder and more variable environmental conditions may have forced some sort of retreat from these settings. Evaluating these hypotheses will hopefully entail new and more comprehensive research in the region.

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