



In the land of the *apu*: Cerro Llamocca as a sacred mountain and central place in the pre-Columbian Andes of southern Peru

Christian Mader^{a,*}, Markus Reindel^b, Johnny Isla^c, Martin Behl^d, Julia Meister^d, Stefan Hölzl^e

^a Bonn Center for Dependency and Slavery Studies, University of Bonn, Niebuhrstraße 5, 53113 Bonn, Germany

^b Commission for Archaeology of Non-European Cultures, German Archaeological Institute, Dörenstraße 35-37, 53173 Bonn, Germany

^c Nasca-Palpa Management Plan, Peruvian Ministry of Culture, Nasca, Peru

^d Institute of Geography and Geology, University of Würzburg, Am Hubland, 97074 Würzburg, Germany

^e Zentrum für Rieskrater- und Impaktforschung (ZERIN), RieskraterMuseum, Eugene-Shoemaker-Platz 1, 86720 Nördlingen, Germany

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ABSTRACT

Cerro Llamocca is a mountain with a summit elevation of 4,487 m asl in the southern Peruvian Andes. This paper presents a first overview of recent archaeological and paleoenvironmental research in its vicinity, and introduces new results from archaeological surveys and strontium isotope analyses. Our survey data show how the wider Cerro Llamocca area comprises an extensive complex of archaeological sites, composed of different sectors with public, domestic, and funerary architecture and rock shelters, occupied throughout the pre-Columbian period from the Early Archaic to the European invasion in 1532. Despite the extreme living conditions of this high-elevation environment, Cerro Llamocca includes the oldest archaeological site hitherto recorded in the larger region: a rock shelter (PAP-969) on its south-eastern slope with evidence of human occupation in the Early Archaic period ~ 8000 BCE. Human activity in the Cerro Llamocca area reached its zenith in the Middle Horizon (CE 600–1000), at a time of a dry climate and when an expansive Wari state incorporated the worship of mountain deities into an imperial strategy to dominate local people. Our strontium isotope analyses of archaeological human dental enamel from a funerary rock shelter (PAP-942), alongside modern plants as reference data, indicate that the people buried here originated in the adjacent highlands. At a broader level, we study the roles of Cerro Llamocca as a sacred mountain or *apu* and central place over a long-term perspective, and how these functions integrated and focused religious, ritual, social, political, and economic activities over this high-altitude complex. Its central place function was linked to its sacredness, but also to its topography, provision of shelter, and geographical proximity to a range of critical resources such as water, creating resource dependencies that shaped socio-economic cooperation and exploitation. Although Cerro Llamocca has progressively lost many of these roles since the beginning of the colonial period, local communities continue to revere it as a sacred mountain today.

1. Introduction

In the ancient Andes of South America, mountains were important places in many respects. They were not merely features in the landscape for native Andean peoples, but rather centers of natural and sacred environments (Reinhard, 1985; Castro and Aldunate, 2003; Williams and Nash, 2006; Staller, 2008; Besom, 2013). Through the worship of mountain peaks as powerful deities and their geographical proximity to a variety of resources, including mineral raw materials, water and pastureland, mountains in the pre-Columbian Andes should be regarded as intersections—or central places—of religious, ritual, social, political,

and economic practices on different scales.

An illustrative example of just such a prominent mountain is Cerro Llamocca (also known as Apu Llamota, María Llamocca, Cerro Yana Orqo, and Cerro Yana Moqo) in the western Andes (Fig. 1). The names in Quechua, an indigenous language family of the wider Andean region, all signify different expressions of “black mountain,” referring to the color of the Cerro Llamocca massif (Fig. 2). Situated approximately 340 km south-east of Lima, Cerro Llamocca lies in the high *puna* zone of the Ayacucho region, Lucanas province, in southern Peru. With a summit at 4,487 m above sea level (asl), Cerro Llamocca’s altitude is the highest in the area, likely the reason—along with its impressive appearance and

* Corresponding author.

E-mail address: christian.mader@uni-bonn.de (C. Mader).

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strategic location—for its veneration until today as one of the most significant sacred mountains or *apus* of the region. To its south-east lies a watershed from where headwaters supplying the western Andean flank arise.

In this paper, we present a first overview of recent archaeological and paleoecological research at Cerro Llamocca and the larger study area, thereby introducing new data from field surveys—including chronological insights from surface ceramics and architecture—and strontium isotope analyses ($^{87}\text{Sr}/^{86}\text{Sr}$) of archaeological human tooth enamel and modern plants. These human remains were found in a Middle Horizon (CE 600–1000) and Late Intermediate (CE 1000–1450) funerary rock shelter (PAP-942) at nearby Cerro Mollepunco, also a sacred mountain and considered the dual counterpart of Cerro Llamocca, while the modern plants were collected in the wider Cerro Mollepunco area to serve as references. The $^{87}\text{Sr}/^{86}\text{Sr}$ data suggest that the people buried in this funerary rock shelter were originally from these wider adjacent highlands. Although its high-altitude environment presents harsh living conditions, our survey data show that Cerro Llamocca and its immediate environs form an extensive complex of archaeological sites, composed of different sectors with architectural structures, public places, rock shelters, and caves. Moreover, this complex includes the oldest archaeological site (PAP-969) thus far documented in the region (for a comparison of the earliest sites on the coast, see Beresford-Jones et al., 2015).

At a more general level, we aim to explore the extent to which the Cerro Llamocca archaeological complex served as a sacred mountain and central place in the pre-Columbian era, and how these roles unfolded over the *longue durée* (sensu Braudel, 1973) through the last 10,000 years. Our research shows how Cerro Llamocca functioned as an important site for dwelling, economic, and ritual purposes throughout the entire pre-Columbian period, from the Early Archaic ~ 8000 BCE to the European invasion in 1532, and indeed still retains some of these functions to the present day (Reindel, 2010, 2012; Reindel and Isla, 2013). Regarding its economic and religious significance, the Cerro Llamocca area was central far beyond this local scale, not least during periods showing elevated levels of human activity, such as the Middle



Fig. 2. Cerro Llamocca seen from the south. In the foreground is a part of cushion-plant peatland (*bofedal*), a fundamental water reservoir of the region from where an important headwater stream arises which brings down water to lower altitudinal zones.

Horizon.

Its key features and long-term occupation and use make Cerro Llamocca perfectly suited to the study of topics such as human-environment interactions, perceptions of landscape, mountain veneration, strategies of adaption to extreme climatic conditions, mobility, and resource dependencies. By the latter we mean human dependencies on resources of every type and how their accessibility and control defined socio-economic inequalities and degrees of cooperation and exploitation (Mader et al., 2021, 2022a). These interwoven levels of dependency and inequality must be examined within their particular ecological and socio-political settings, for which the Cerro Llamocca sacred mountain complex provides an ideal case study.

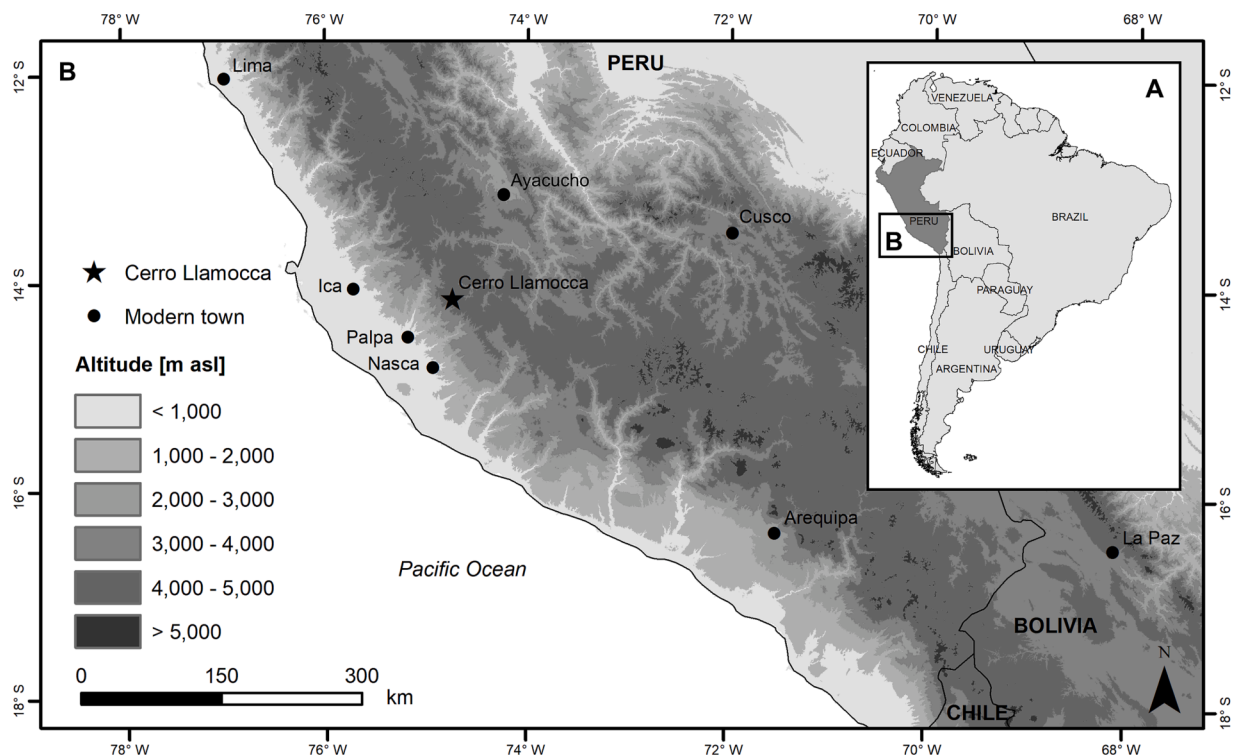


Fig. 1. Map showing the location of Cerro Llamocca in the Peruvian high Andes of South America.

2. Central places and sacred spaces

Broadly defined, a central place holds functions essential to surrounding communities, providing one or more services such as religious and spiritual care, legislation, healthcare, shelter, and access to a range of commodities (Nakoinz, 2012; Knitter et al., 2013; Ragkou, 2018; Vionis and Papantoniou, 2019). Importantly, a central place does not necessarily have to be an established settlement, but rather a location where these kinds of services and related institutions are made available. Central place theory goes back to the seminal work by geographer Christaller (1933), who studied the distribution and development of settlements in southern Germany. Central place research has been widely applied and further developed since then, not least in archaeology; yet the concept of central places and the criteria that define their centrality remain debated (Lösch, 1954; Nakoinz, 2010; Knitter, 2013; Knitter and Nakoinz, 2018).

In a recent study, Knitter and Nakoinz (2018) define centrality as the “relative concentration of interaction” greater than the average of other related locations (see also Nakoinz 2012). In addition, natural and politically controlled centrality may be differentiated (Knitter et al., 2013). Natural centrality is characterized by location, topography, and environment; whereas politically controlled centrality is characterized by social and cultural factors. In this article, we follow these broad definitions of central place and centrality because they usefully describe the significant roles of mountains in Andean contexts. A central place perspective may also be useful in network analysis, which has emerged in recent years as an effective research tool in archaeology to investigate past socio-economic relations (Collar et al., 2015; Kerig et al., 2019; Ragkou, 2020).

Staller (2008) highlights the relevance of centers as structuring and existential elements within Andean sacred landscapes. Such centers are locations that evoke particular meaning to local populations through environmental, temporal, socio-cultural, spiritual, cosmological, and ideological dimensions. The meaning and importance of these centers is inevitably linked to their sacred qualities. Sacred landscapes are constructed by human-environment interactions and collective human activities reflecting religious, cultural, and organizing notions of society (Reese-Taylor, 2012). A sacred landscape, then, consists of sacred places and centers within the natural, modified, and built environments. The ritual and ceremonial practices carried out in a sacred landscape are crucial, but not necessarily the degree of environmental alteration of that landscape by people, underlining the temporal significance of such sacred geographies (Ingold, 1993).

Archaeological, ethnohistorical, and ethnographic evidence all suggest that landscapes were part of the spiritual and animistic world of indigenous Andean belief systems, in which different types of sacred places were omnipresent but difficult to describe according to European notions (Bray, 2015a; Jennings and Swenson, 2018). This worldview still can be observed across the Andes today, albeit modified by European oppression and Christian influence since the arrival of the Spaniards. Two Andean concepts of sacred place are particularly relevant here: *wak'a* (also written as *huaca* or *guaca*) and *apu* (also known as *wamani*, *mallku*, *jach'arana*, and *achachila*).

Wak'a is a Quechua and Aymara word, referring generally to material manifestations of sacredness and power, including natural places, temples, platforms, shrines, sculptures, mummies and ancestors, people, idols, images, and things (Allen, 2015; Bray, 2015b; Chase, 2015; Mannheim and Salas, 2015). Such extraordinary places were hubs of religious, social, and political activity in pre-Columbian times, shaping cultural complexity and socio-economic inequalities (Staller, 2008). *Wak'as* were often connected to other *wak'as* and other places and settlements, constituting networks of powerful relationships. A striking example is the so-called *ceque* system made up of imagined lines which radiated from the sacred center of the Inka capital Cusco and which integrated numerous *wak'as* (Zuidema, 1964; Bauer, 2018).

Apus are a special form of *wak'as*. The Quechua term *apu* means

sacred mountain, mountain spirit, or mountain god, usually referring to summits and their sanctuaries where powerful divinities and ancestors reside (Castro and Aldunate, 2003; Williams and Nash, 2006; Gose, 2018). *Apus* belonged to the most important Andean sacred places, expressed by the widespread practice of mountain veneration with its associated rites, performances, offerings, and sacrifices (Reinhard, 1985; Ceruti, 2004; Besom, 2009, 2013; Reinhard and Ceruti, 2010). Castro and Aldunate (2003) identify five main features of *apus*: (1) relation to ancestors and the deceased, (2) ranking according to altitude, (3) local and regional attributes, (4) particular functions, and (5) guarding and maintaining life by distributing necessary resources. Through these substantial roles in the Andean universe, *apus* were connected, not only to local communities, elites, and intermediaries, but also to water, fertility, and agriculture (Reinhard, 1985; Staller, 2008).

3. Regional and paleoenvironmental context

The South American Andes are marked by extreme physical characteristics and an enormous variety of ecological zones and microenvironments, entailing a concomitant diversity of climate, vegetation, fauna, raw materials, and economic and agricultural opportunities. Several scholars have attempted to define the ecozonation of the tropical central Andes, extending over relatively short distances, from the arid desert on the Pacific coast in the west, across snow-capped mountain peaks of the highlands, to the lowland forests in the east (Tosi, 1960; Troll, 1968; Pulgar Vidal, 1981; Brush, 1982). Pulgar Vidal's (1981) classification scheme is particularly applicable to the ecological levels in our broader study area in southern Peru (see also Sandweiss and Richardson III, 2008). He defines Andean ecological tiers divided into coastal *chala* (<500 m asl), maritime *yunga* (500–2,300 m asl), *quechua* (2,300–3,500 m asl), *suní/jalca* (3,500–4,000 m asl), *puna* (4,000–4,800 m asl), *janca* (>4,800 m asl), fluvial *yunga* (1,000–2,300 m asl), *ruparupa* (400–1,000 m asl), and *omagua* (<400 m asl).

Cerro Llamocca is situated in the vast high-altitude *puna* zone. The eroded mountain is a magmatic dike of andesite, andesitic tuff, and volcanic conglomerate (Schitteck et al., 2015). Despite harsh environmental conditions due to low atmospheric pressure and reduced availability of oxygen in the air, a cold alpine climate, and high solar irradiation, the *puna* is the highest ecological zone in the world permanently habitable by humans, not least because the Andes here span tropical latitudes whereas other major mountain ranges do not (Thomas, 1977; Pulgar Vidal, 1981; Sandweiss and Richardson III, 2008).

The area of Cerro Llamocca lies in the transition zone between the humid and the dry *puna* (Troll, 1968; Custred, 1977). The estimated annual precipitation here is between 200 and 400 mm a⁻¹, mostly falling during the summer rainy season from November to March (Schitteck et al., 2012, 2015; Höfle et al., 2013). Average annual temperatures in the *puna* zone range from 0 to 7 °C, although there are substantial diurnal differences and slight seasonal variation with maximum temperatures as high as 28 °C and minimum temperatures as low as -25 °C.

The natural vegetation of the Cerro Llamocca area is characterized by different grasses, dwarf shrubs, and some herbs. South of Cerro Llamocca is a sector of cushion-plant peatland, or *bofedal*, typical of *puna* environments and functioning as substantial, but ecologically sensitive, water reservoirs while also providing fundamental pasturage for livestock grazing (Schitteck et al., 2012, 2015, 2018; Höfle et al., 2013). In this peatland rises the headwater stream of the Atocata river, a tributary of the Laramate river, known as Viscas further downstream, which then, on the coast, flows into the Río Grande.

The high grassland region of the *puna* represents the uppermost limits of agriculture but is essential for pastoralism (Flores Ochoa, 1977). In some *puna* localities a few crops can still be cultivated, most significantly potatoes (*Solanum tuberosum*) and kaniwa or cañihua (*Chenopodium pallidicaule*). The *puna* grassland and *bofedales* provide important pasturage for South American camelids, comprising wild

species of guanaco (*Lama guanicoe*) and vicuña (*Vicugna vicugna*) and domesticated species of llama (*Lama glama*) and alpaca (*Vicugna pacos*).

Camelids were highly valued by pre-Columbian Andean societies because of their importance to economic and social life (Browman, 1974; Bonavia, 2008; Mengoni, 2008; Capriles and Tripevich, 2016; Vilá and Arzamendia, 2022; Mader et al., 2022b). The animals were used in many ways, including as beasts of burden in caravans; as a source of wool, meat, and other raw materials such as bones, skin, tendons, and dung; and in ritual activities. The high *puna* also provides conditions in which storable food such as *ch'arki* or jerky (dried camelid meat) and *ch'uñu* or *chuño* (freeze-dried bitter potatoes) can be produced.

Located on the western margin of the *puna*, Cerro Llamocca is in a strategic position to access important resources, including camelids; diverse lithic raw materials such as obsidian, chert, and flint; water; and many agricultural products, from the *puna* itself, but also from the nearby *sumi*, *quechua*, and maritime *yunga* zones which are more suitable for the cultivation of crops. The abundance of ancient and present-day corrals in the immediate and wider surrounding area of Cerro Llamocca offers powerful impressions of the region's relevance for raising and keeping livestock. Today the Cerro Llamocca area is affected by overgrazing, largely caused by introduced Old World animals such as cattle and sheep (Schitteck et al., 2012).

Among the different lithic raw materials of the *puna* is obsidian, a key preferred resource for the production of stone tools and weapons through the entire pre-Columbian period (Glascock et al., 2007; Mader, 2019a). Intense pre-Columbian obsidian consumption has been revealed over the Cerro Llamocca archaeological complex (Reindel, 2012). One of the most significant pre-Columbian obsidian sources in the central Andes was that at Quispisisa/Jichja Parco at 4,100 m asl, as evidenced by the widespread distribution and use of its obsidian throughout the wider region and up to 1,000 km distant (Burger and Glascock, 2000; Tripevich and Contreras, 2011; Reindel et al., 2013; Stöllner et al., 2013; Matsumoto et al., 2018; Beresford-Jones et al., 2023). The Quispisisa/Jichja Parco source lies only 45 km to the east of Cerro Llamocca.

Paleoenvironmental research from 2009 and 2010 focused on the cushion-plant peatland lying to the south-west of Cerro Llamocca (Schitteck et al., 2012, 2015, 2018; Höfle et al., 2013). Several sediment cores were taken across this peatland in 2009, including one to 10.5 m deep (Pe852), and interrogated by methods such as radiocarbon dating and pollen analysis to provide a high-resolution paleoenvironmental record over the last 8,600 years. Other methods applied in this context included geophysical prospection, LiDAR (light detection and ranging), and the collection of plants for taxonomic identification, all providing detailed morphological, hydrological, and paleoecological information on the Cerro Llamocca peatland.

4. Archaeological context

4.1. State of the art and survey methods

Including an Early Archaic occupation ~ 8000 BCE, the archaeological complex of Cerro Llamocca includes, not only the highest, but also the oldest, archaeological site hitherto registered in the study area. Cerro Llamocca was recorded and explored by the Nasca-Palpa Archaeological Project as part of a larger interdisciplinary study of settlement patterns and environmental and climate changes during the pre-Columbian era in the northern Nasca drainage, southern Peru (Reindel and Wagner, 2009; Mächtle and Eitel, 2013; Isla and Reindel, 2017). This research area spans from the Pacific coastal desert to high-altitude regions, encompassing all ecological tiers of the western Andean flank and the valleys of the Viscas (Laramate and Ocaña in the highlands), Palpa (Llauta in the highlands), Grande, and Santa Cruz rivers. More than 1,500 pre-Columbian sites have been cataloged by the surveys of the Nasca-Palpa Archaeological Project (Reindel, 2009; Reindel and Isla, 2013; Soñna, 2015). Archaeological excavations of various scales were

conducted at many of these sites (Isla and Reindel, 2014; Reindel and Isla, 2018; Mader, 2019a; Gorbahn, 2020).

The Cerro Llamocca complex was cataloged in regional, large-scale archaeological surveys in 2008 (Reindel, 2010). To identify sites in this high-elevation region, our survey methodology entailed three stages: (1) gaining an overview of archaeological complexes with the possible determination of sites through satellite imagery (QuickBird and Google Earth); (2) systematically groundchecking and identifying sites by pedestrian survey, including the collection of surface artifacts; and (3) test-pitting certain sites to obtain stratigraphic information and chronological control of finds (Banning, 2002). Several sites and sectors were surveyed intensively following this methodology between 2008 and 2010, collecting and analyzing surface finds including lithic artifacts, ceramics, and human and animal remains (Reindel, 2012). This included excavation of a 1 × 1 m test pit in the center of rock shelter PAP-969 on Cerro Llamocca's south-eastern slopes in 2010 (Reindel, 2012; Reindel and Isla, 2013). Cerro Llamocca was visited again by team members of the Nasca-Palpa Archaeological Project in 2021, to plan for new archaeological surveys and excavations initiated in 2022.

4.2. Chronology

Our archaeological research at Cerro Llamocca shows that the complex was occupied, used, and frequented throughout the Holocene, but particularly during the pre-Columbian period up until 1532. More than 180 radiocarbon dates from various archaeological sites and stratigraphies provide a solid chronological framework for the entire northern Nasca drainage (Unkel et al., 2012). At the PAP-969 rock shelter test excavations yielded charcoal radiocarbon dated to 8863 ± 32 (8199–7955 cal. BC, 1-sigma, Hd-28896) in the Early Archaic period (Reindel, 2012). Other evidence, in particular characteristic lithic artifacts such as unifaces and projectile points, support the dating of its occupation to this time and may hint at even earlier occupations during the Paleoindian period (11000–8000 BCE). Many areas at Cerro Llamocca evince an abundance of stone artifacts on the surface, in all stages of reduction, pointing to the consumption of lithics, especially during the course of the Archaic (8000–3500 BCE) and subsequent Formative (3500–200 BCE) periods. Paleoindian and Archaic occupations in high-elevation environments are well-documented elsewhere in the Andes, including at Telarmachay rock shelter at 4,420 m asl (Lavallée, 1995), Cuncaicha rock shelter at 4,480 m asl (Rademaker et al., 2014), and Cueva Bautista rock shelter at 3,933 m asl (Capriles et al., 2016).

Surface ceramics and architectural remains also show copious evidence for later pre-Columbian occupations throughout the Cerro Llamocca archaeological complex. Ceramic sherds from the Paracas Late Formative (800–200 BCE) were, for instance, identified in the upper layers of the test pit at the PAP-969 rock shelter. These contribute to our significant recent finding that Paracas settlement extended far beyond the Pacific coast, high into the *puna* above 4,000 m asl (Mader, 2013; Reindel and Isla, 2017, 2018): a dense settlement pattern enabling direct access to important highland resources such as camelids, camelid products, obsidian, certain crops, and water, for which we invoke the term “economic directness” (Mader, 2019a, 2019b; Mader et al., 2022a).

Pottery from all the subsequent Nasca Early Intermediate (200 BCE–CE 600), Wari Middle Horizon (CE 600–1000), Late Intermediate (CE 1000–1450), and Inka Late Horizon (CE 1450–1532) are recorded in surface collections across the Cerro Llamocca complex. Many architectural remains, not least a D-shaped structure at the summit, suggest that during the Middle Horizon in particular, when a dry climate prevailed across the wider region (Eitel and Mächtle, 2009; Schitteck et al., 2015, 2018), the Cerro Llamocca area was used the most intensely. Such distinctive D-shaped buildings are typical of Wari architecture and are known throughout the central Andes, for instance at other sites in southern Peru such as Tres Palos (Strong, 1957; Matsumoto et al., 2022), Huaca del Loro (Strong, 1957; Conlee, 2021), Lambrasniyoq and Mauka Llaqta (Isla and Reindel, 2014), Pakaytambo (Reid, 2023), Conchopata

(Ochatoma, 2007), Huari itself (Isbell and McEwan, 1991), and Cerro Baúl (Williams, 2001). An expansive Wari state seems to have incorporated the worship of local mountain deities into its own ideology as part of an imperial strategy to exert control over subject peoples (Williams and Nash, 2006): a strategy later adopted also by the Inka (Besom, 2013).

Ethnohistorical sources from the colonial period mention mountains with the name Llamocca, although it is not always clear precisely which mountain is being referred to, since there are several with the same name in the central Andes. The Cerro Llamocca we deal with here was certainly mentioned by Cristóbal de Albornoz, an ecclesiastical inspector who visited the region in the sixteenth century, describing the mountain as one of the most revered *wak'as*, or sacred places, in the context of his campaigns against idolatry (Guillén, 1984). The summit of Cerro Llamocca is still venerated today, as can be seen in the contemporary offerings to its mountain shrine and the many stone piles (*apachetas*) still maintained on its mountaintop.

4.3. Topography, sites, and architectural remains

Notwithstanding its extreme high-altitude environment, Cerro Llamocca's wider landscape was significantly transformed by humans. Distinct areas of use and types of architectural remains through different sites and sectors offer insight into these cultural transformations over millennia (Fig. 3).

4.3.1. Summit (PAP-851)

The 4,487 m asl summit of Cerro Llamocca can be reached after a 150 m ascent from the surrounding high plateau (Fig. 4). Here, at the highest elevation in the region, is the aforementioned D-shaped building along with a modern circular wall, *apachetas*, and contemporary offerings to the mountain shrine. The D-shaped structure, likely dating to the Middle Horizon, is built of stone and covers an area of 13×13 m. Its remaining wall is approximately 1 m high and 0.8 m wide, while its

north-eastern part is defined by a straight wall with a 1 m wide entrance in its center.

Excavations at the Wari site of Conchopata in Ayacucho show that such D-shaped structures had ceremonial functions, indicated by their large amounts of intentionally broken votive pottery vessels often depicting deities and leaders (Ochatoma, 2007). Given its location on the summit of Cerro Llamocca, this D-shaped building is also likely to have staged such ritual activities, which might be clarified in future excavations.

The interior of the D-shaped structure houses a small shrine of 0.7×0.8 m on which, in recent times, offerings of alcohol, cigarettes, coca leaves, fruit, and sweets have been placed, probably during rituals called *ch'alla* (Fig. 5). There are also shards of glass in the immediate area. In times of prolonged drought, we were told by multiple informants from the Palpa district, it is still a custom of people living in the coastal region to bring seawater, preferably from the open sea, to the summit of Cerro Llamocca, to ask the *apu* for rain.

Apachetas cover almost the entire summit of Cerro Llamocca, but particularly its southern and eastern parts (Fig. 6). These stone piles were important landmarks in the past. The custom of incrementally building *apachetas*, stone by stone, by visitors and travelers along mountain passes, trails, pilgrim routes, or at sacred places is still practiced in the Andes today, for which Cerro Llamocca offers a prime example.

4.3.2. Stone walls and corrals (PAP-985-A)

The whole area around Cerro Llamocca contains many stone walls and corrals, particularly around its northern base at around 4,283 m asl (Fig. 7). Between these large enclosures is other domestic and funerary architecture of varying dimensions. Corrals have both circular and rectangular shapes, some forming long parallel walls. The largest measures 85×100 m.

This wider zone is obviously ideal for pastoralism, offering plenty of grazing opportunities for camelids. There are few diagnostic artifacts on

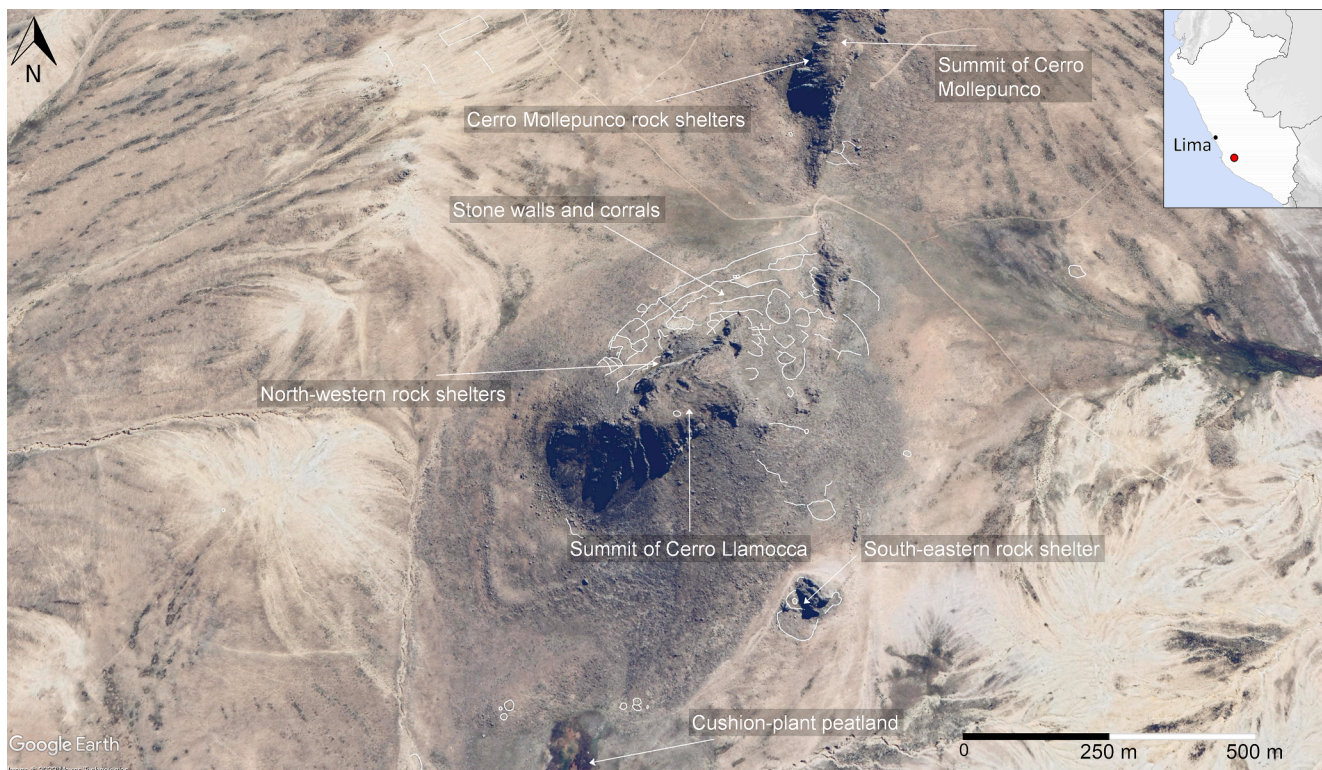


Fig. 3. Satellite image of Cerro Llamocca in its high-altitude *puna* environment, showing the topographic features, various sites, and mapped architectural remains at the complex.

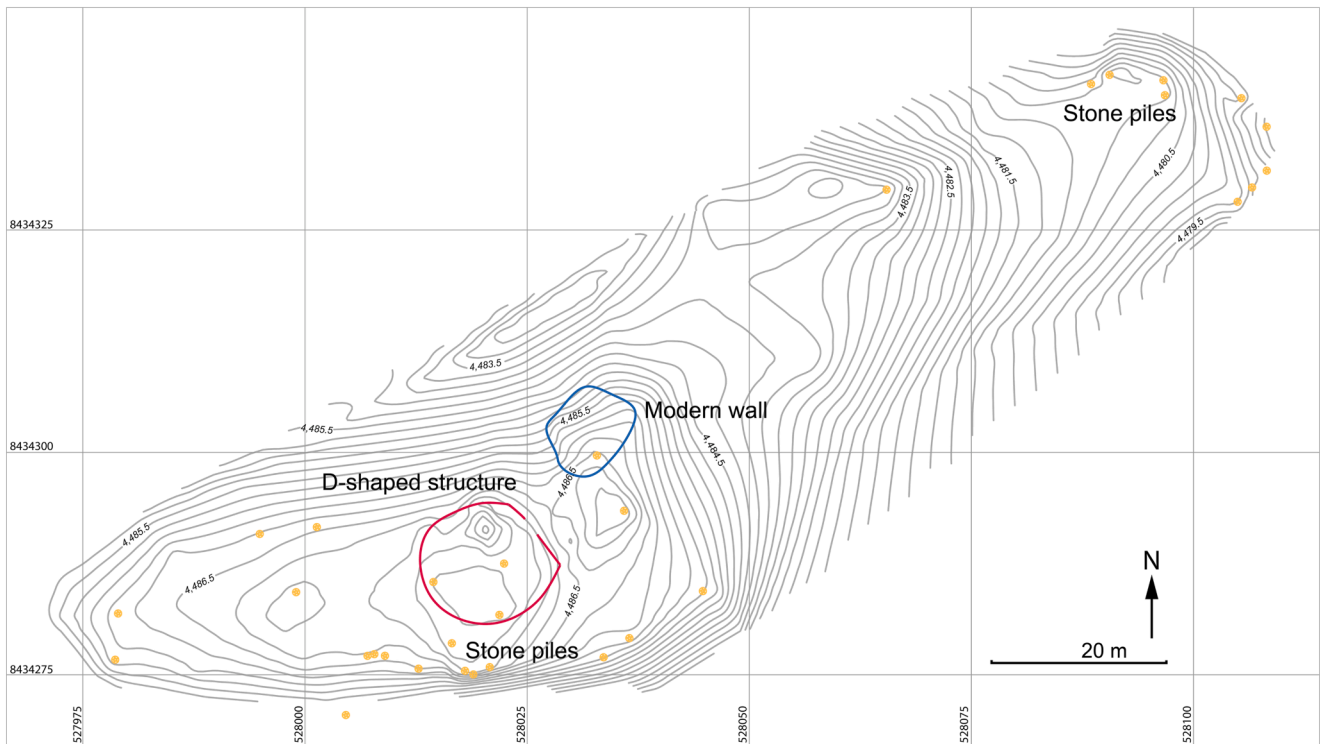


Fig. 4. Topographic map of Cerro Llamocca's mountaintop including its architectural structures and stone piles (*apachetas*).



Fig. 5. The inner arrangement of a mountain shrine on the peak of Cerro Llamocca, which includes a cross made from grass, flowers, candles, and offerings of liquor, cigarettes, coca leaves, and fruit.



Fig. 6. Stone piles (*apachetas*) in the south-western part of Cerro Llamocca's mountaintop.

the surface of this sector, so that it is hard to date these walls and corrals. The rectangular corrals are, however, rather unusual and only known in the region from the Middle Horizon. There are also two rectangular Middle Horizon funerary structures or *kunti* in the north-east area of PAP-985-A.

4.3.3. North-western rock shelters (PAP-844)

The PAP-844 rock shelters are situated on the north-western slope of Cerro Llamocca at 4,423 m asl (Fig. 8). The site comprises a large rock shelter and three smaller ones used for burials. The large rock shelter faces north-west and is 30 m wide, protecting an interior up to 12 m in depth. Its front section is enclosed with a stone wall.

In front of the rock shelter lies the area of PAP-985-A with its walls

and corrals. Within the rock shelter are the remains of further stone walls along with obsidian artifacts, ceramics, and animal bones on the surface. Other modern structures and fireplaces show that the rock shelter is still occasionally used nowadays.

The smaller rock shelters lie all further south-west, also enclosed to some extent with a stone wall across their fronts. In our initial 2008 survey these were shown to be funerary rock shelters containing the disturbed skeletal remains of at least five human burials. Unfortunately few human bones were still left here in 2021, when the site was visited again. Archaeological materials associated with the PAP-844 rock shelters suggest a long-term occupation or use through the pre-Columbian period, possibly from as far back as the Archaic period all the way through to the Late Horizon.



Fig. 7. Stone walls and corrals around the north-western base of Cerro Llamocca.



Fig. 8. Ascent to the north-western rock shelter of Cerro Llamocca.



Fig. 9. South-eastern rock shelter with its stone walls seen from the summit of Cerro Llamocca.

4.3.4. South-eastern rock shelter (PAP-969)

On the opposite south-eastern flank of the mountain is an outcrop with another rock shelter, located at 4,317 m asl (Fig. 9). There are *apachetas* on top of this rock formation. The rock shelter faces south-west and is 16 m wide with a depth of 9 m.

As with the PAP-844 rock shelters, the entrance is enclosed with a stone wall. Within this protective wall, but beyond the shelter itself, is a central circular structure, partly formed by large stones and perhaps used for gatherings. There are further stone walls and corrals around the rocky outcrop.

Inside the rock shelter on its wall are paintings covering an area of around 0.5×0.7 m, comprising at least six red circles with diameters between 5 and 7 cm, and a vertical line with a dot. The floor of the interior is mostly even, interrupted by some large rocks which may have served as windbreaks. Over its entire surface are artifacts such as ceramics and lithics (Reindel, 2012; Reindel and Isla, 2013). The test pit excavated in the central part of this rock shelter provided a stratigraphy of 61 cm, the aforementioned Early Archaic radiocarbon date, potsherds, and lithics of obsidian and silex (Fig. 10). These all document the long-term intermittent occupation of this rock shelter, beginning in the Early Archaic through into recent times.

4.3.5. Cushion-plant peatland

To the south of Cerro Llamocca extends a sector of cushion-plant peatland (*bofedal*), the so-called Cerro Llamocca peatland, investigated particularly through geoarchaeological methods to provide important information on past environmental and climatic conditions in the region (Schittek et al., 2012, 2015, 2018; Höfle et al., 2013). The Cerro Llamocca peatland—a significant regional water reservoir—has also been used, or rather engineered (*sensu* Lane, 2009, 2021) by people, evidenced by associated stone architectural remains, including corrals, walls, small artificial ponds, silt dams, and other structures. Such architectural structures and hydrological features are typical of pre-Columbian wetland management in the highlands, relevant for regional water storage, water supply, and pastoralism (Lane, 2009, 2014, 2021; Lane and Mader, 2021; Lane et al., 2022).

4.3.6. Cerro Mollepunco (PAP-943)

Cerro Mollepunco (also known as Joséchontamarca) is another mountain just north-east of Cerro Llamocca (Fig. 11). Its summit in the southern part of this elongated rock formation lies at 4,451 m asl and has various buildings and *apachetas*, including an oval structure and two smaller architectural units all made of stone. The extant wall of the oval structure is 0.5 to 1.2 m high and 0.6 to 0.8 m wide. On the south-western side of this building is an entrance and one of the smaller architectural units built into large natural rocks. The other similar unit lies to the north-east of the oval building.

The oval building resembles the D-shaped structure on the summit of Cerro Llamocca, thereby also suggesting a ceremonial function of these buildings and the veneration of the Cerro Mollepunco mountain peak: an impression supported by the *apachetas* and recent offerings in this sector. The remaining architecture and surface ceramics suggest that Cerro Mollepunco was in use particularly during the Middle Horizon, and maintained importance in later centuries.

4.3.7. Cerro Mollepunco rock shelters (PAP-942)

Within the Cerro Mollepunco complex of distinct areas and architectural remains are two rock shelters named as sectors, each apparently serving different purposes on its western lower slopes at 4,388 m asl. Sector A is a shelter beneath a large rock showing evidence of intermittent occupation and use. It has western and northern entrances, separated by the remains of a stone wall, and has an interior area of 2×3.5 m whose surface contains ceramic fragments and obsidian artifacts.

Sector B is a funerary rock shelter, also beneath a large rock, with an interior of around 2×3 m, although its access—demarcated by a stone wall—measures some 5 m in width. This rock shelter contains human

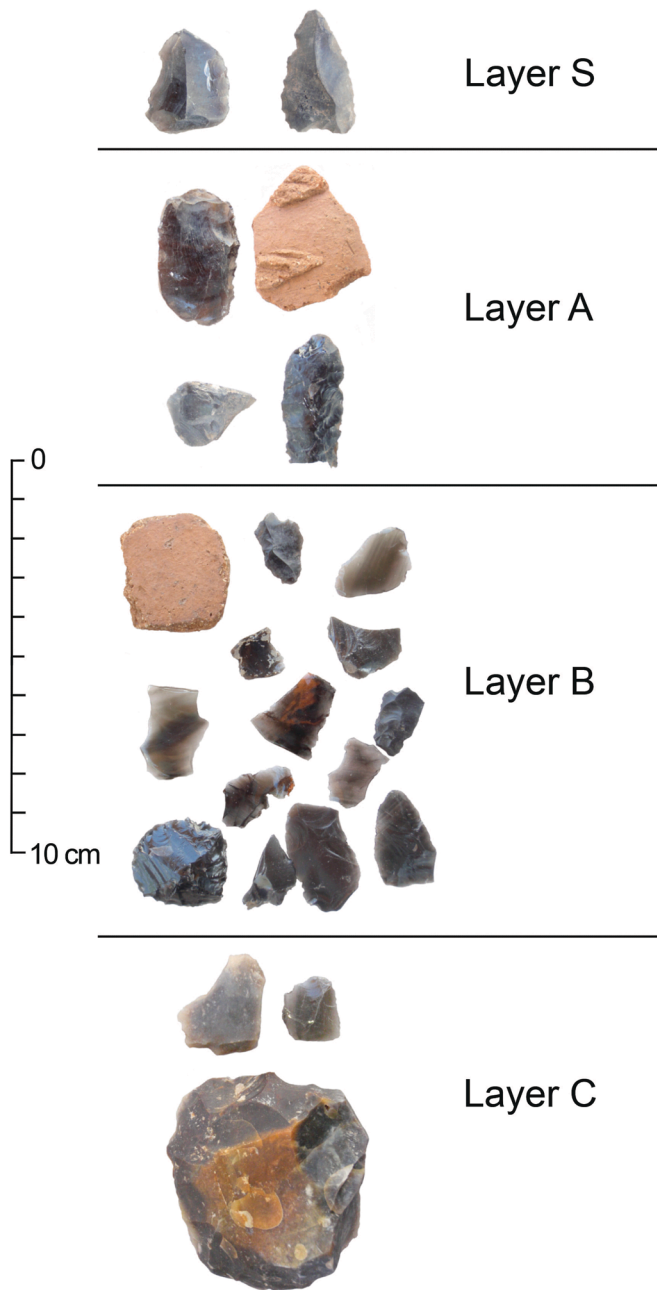


Fig. 10. Ceramics and obsidian and silex artifacts excavated in the different layers of a test pit in the south-eastern rock shelter at Cerro Llamocca.

bones dispersed across its surface, but no associated archaeological materials. The few diagnostic finds in the wider PAP-942 context suggest that these rock shelters were in use during the Middle Horizon and the Late Intermediate period.

5. Strontium isotope data

5.1. Material and methods

Strontium isotope analysis ($^{87}\text{Sr}/^{86}\text{Sr}$) has, over recent decades, developed into a common and reliable method with which to explore provenance, mobility, landscape use, and life histories of past societies (Hözl et al., 2007; Slovak and Paytan, 2011; Britton et al., 2021; Sillen, 2021). Strontium (Sr) is an element with four stable natural isotopes: ^{84}Sr , ^{86}Sr , ^{87}Sr , and ^{88}Sr . The strontium isotope with the mass 87 (^{87}Sr) is radiogenic and partly results from the beta decay (β -decay) of the



Fig. 11. Cerro Mollepunco seen from the summit of Cerro Llamocca.

rubidium (Rb) isotope with the mass 87 (^{87}Rb). Strontium occurs abundantly in the environment and can be traced in rocks; soil; ground, river, and sea water; plants; animals; and humans. $^{87}\text{Sr}/^{86}\text{Sr}$ ratios are integrated parameters reflecting the geological history of bedrock and the local environment.

Forming part of a larger multi-element isotope study (H, C, N, O, S, and Sr), $^{87}\text{Sr}/^{86}\text{Sr}$ analyses have been carried out by the Nasca-Palpa Archaeological Project and our regional $^{87}\text{Sr}/^{86}\text{Sr}$ database now comprises more than 340 records from archaeological human, animal, and plant remains, alongside modern animals, plants, water, and rocks (Horn et al., 2009; Mader et al., 2018; Mader, 2019a; Gorbahn, 2020). In the broader study area, these data show reduced $^{87}\text{Sr}/^{86}\text{Sr}$ ratios of ~ 0.706 for samples from the highlands, compared with the higher ratios of ~ 0.707 for those from the coast. As a part of these large-scale isotope studies, dental enamel from seven human individuals found in the PAP-942 funerary rock shelter at Cerro Mollepunco to the north-east of Cerro Llamocca, and woody parts of four modern plants as references from the Cerro Mollepunco area, were analyzed to assess their $^{87}\text{Sr}/^{86}\text{Sr}$ ratios, and are presented here for the first time. Sampling focused on human remains found on the surface (Fig. 12) because this funerary shelter has yet to be excavated. Remaining architectural features and surface ceramics in the wider Cerro Mollepunco area (PAP-942 and PAP-943) suggest that these sampled human remains date between the Middle Horizon and Late Intermediate period.



Fig. 12. Sampling of human bones in a funerary rock shelter (PAP-942) at Cerro Mollepunco.

The emphasis was on human tooth enamel and local plants because this study is interested in aspects of mobility and centrality and, therefore, in the strontium isotopic compositions of the environment of these persons around their birth and juvenile development (Tütken et al., 2008; Slovak and Paytan, 2011). This kind of information can be revealed in the enamel of humans (and other mammals), which is formed during the early years of an individual's life and does not alter thereafter. In these respects, $^{87}\text{Sr}/^{86}\text{Sr}$ signatures of enamel reflect nutrition and the environment during tooth formation. Because of its very high inorganic and mineral components, dental enamel also has the advantage of being one of the best-preserved biological tissues in archaeological contexts (Hillson, 2005). Modern plants grown in the immediate area provide mean $^{87}\text{Sr}/^{86}\text{Sr}$ reference values of the local environment. Comparing $^{87}\text{Sr}/^{86}\text{Sr}$ ratios of archaeological human enamel and these reference values can thereby indicate whether the respective persons were born and raised locally, or not.

All relevant analytical steps of the strontium isotope analysis were performed in the laboratory under clean room conditions using ultra-clean reagents and equipment. Purification and accumulation of Sr was achieved using a Sr-specific crown-ether resin (Sr-Spec). Strontium isotope ratios were measured between November 2010 and January 2011 in static mode with a thermal ionization mass spectrometer (Thermo Finnigan MAT 261, Spectromat) using tungsten filaments. The measured isotope values were normalized for mass fractionation using the naturally invariant value for $^{87}\text{Sr}/^{86}\text{Sr}$ of 8.37521 and the exponential fractionation law.

Significant extant Rb was evaporated by controlled preheating before the isotopic composition of Sr was measured. The contribution of any remaining lowest amounts of isobaric ^{87}Rb was corrected during the measurement by reference to the co-measured ^{85}Rb and the invariant $^{85}\text{Rb}/^{87}\text{Rb}$ of 2.59265. The accuracy and precision of the mass spectrometer runs were controlled by analyzing the reference material SrCO₃ NIST SRM 987. Based on replicate analyses of natural samples, the accuracy of the total laboratory procedure is assumed to be better than ± 0.000035 for $^{87}\text{Sr}/^{86}\text{Sr}$ (1 SD; for further details of analytical techniques, see Horn et al., 2009; Mader et al., 2018; Mader, 2019a).

5.2. Results

$^{87}\text{Sr}/^{86}\text{Sr}$ data for the individuals from the PAP-942 funerary rock shelter range from 0.7051 to 0.7058, with one outlier of 0.7088, and from 0.7062 to 0.7064 for the modern plants (Table 1; Fig. 13). Since these $^{87}\text{Sr}/^{86}\text{Sr}$ ratios all lie within a fairly tight range (except for the outlier), we infer that the people buried in the rock shelter originated in the wider adjacent highland region, although probably not from the immediate Cerro Mollepunco and Cerro Llamocca locality because of the slightly higher $^{87}\text{Sr}/^{86}\text{Sr}$ signatures for the modern reference plants from this area. This deduction is also in line with our broader database, showing $^{87}\text{Sr}/^{86}\text{Sr}$ values of ~ 0.706 for samples from the highlands in the research area.

The outlying isotopic signature of one individual from Cerro

Mollepunco suggests that this person originated from some more distant region, perhaps at lower altitude, in line with certain $^{87}\text{Sr}/^{86}\text{Sr}$ ratios from coastal parts of our broader study area. This individual may, however, also have come from a distant highland region as suggested by Scaffidi and Knudson's (2020) $^{87}\text{Sr}/^{86}\text{Sr}$ isoscape model for the central Andes. Wherever they came from, this outlying isotopic data hints at long-distance interactions and the religious and socio-economic centrality of the Cerro Llamocca sacred mountain complex far beyond its immediate hinterlands.

6. Discussion

The evidence we present, in particular data from archaeological surveys and strontium isotope analyses, suggests that Cerro Llamocca fulfilled important functions both as a sacred mountain and as a central place through long millennia of occupation and use through the pre-Columbian period. Worship of Cerro Llamocca as a principal sacred mountain is evident in its ceremonial architecture and *apachetas*, associated funerary architecture with implications of ancestor reverence, sixteenth century ethnohistorical accounts of it as an important *wak'a* by Cristóbal de Albornoz, and indeed recent offerings on its summit. Many of these features are also evident for the nearby Cerro Mollepunco so that it too should be considered a sacred mountain: the dual counterpart of Cerro Llamocca within the context of this extensive archaeological complex and sacred landscape.

Ritual activities at Cerro Llamocca were probably connected with water and fertility, not least because the water supply of the larger region, including its lower altitudinal zones, arises in this area. Water management in these highlands was critical for people and agriculture—in short, for life—down all the western Andean slopes and onto the coastal desert. Evidence for ceremonies and offerings associated with water and fertility were also identified in excavations near Nasca geoglyphs on the coast, in particular at stone platforms lying at the ends of certain trapezoidal geoglyphs (Isla and Reindel, 2005; Lambers, 2006; Reindel et al., 2006). In these respects, then, there seems to be a relationship between Cerro Llamocca as the main *apu* of the greater region, and such similar ritual phenomena on the coast.

During the pre-Columbian era, Cerro Llamocca gained centrality—as a hub of interaction—because of its veneration as a sacred mountain, the associated funerary practices, its topography with its options for shelter, and its geographical proximity to diverse crucial resources, including water, camelids, camelid pasture, and lithic raw materials. Such functions and services were of fundamental importance to the regional populations who made Cerro Llamocca a central place as defined above. That role does not indubitably imply that Cerro Llamocca was occupied continuously throughout the pre-Columbian period. Rather most of its sectors suggest temporary occupations. What is significant in this context are the cycles of availability and supply of functions and services that concentrated interactions here (*sensu* Knitter and Nakoinz, 2018), over those of surrounding sites and settlements.

Our archaeological survey and $^{87}\text{Sr}/^{86}\text{Sr}$ data serve as lines of

Table 1

Results of strontium isotope analyses ($^{87}\text{Sr}/^{86}\text{Sr}$) of archaeological human dental enamel and modern plants from Cerro Mollepunco.

Sample ID	Lab ID	Site	Sample type	Date of $^{87}\text{Sr}/^{86}\text{Sr}$ measurement	$^{87}\text{Sr}/^{86}\text{Sr}$ ratio	2-sigma error [%]
P1008002a	nk96	PAP-942 funerary rock shelter	Human dental enamel	18 November 2010	0.705433	0.005
P1008002b	nk97	PAP-942 funerary rock shelter	Human dental enamel	18 November 2010	0.70579	0.0055
P1008002c	nk98	PAP-942 funerary rock shelter	Human dental enamel	18 November 2010	0.705167	0.0048
P1008002d	nk99	PAP-942 funerary rock shelter	Human dental enamel	18 November 2010	0.708768	0.0075
P1008002e	nk100	PAP-942 funerary rock shelter	Human dental enamel	18 November 2010	0.705572	0.0031
P1008002f	nk101	PAP-942 funerary rock shelter	Human dental enamel	18 November 2010	0.7058	0.0076
P1008002g	nk102	PAP-942 funerary rock shelter	Human dental enamel	18 November 2010	0.705068	0.0023
P1008001-a	nl66	Cerro Mollepunco	Woody part of modern plant	10 January 2011	0.70615	0.0036
P1008001-b	nl67	Cerro Mollepunco	Woody part of modern plant	10 January 2011	0.706242	0.0083
P1008001-c	nl68	Cerro Mollepunco	Woody part of modern plant	10 January 2011	0.706388	0.0074
P1008001-d	nl69	Cerro Mollepunco	Woody part of modern plant	10 January 2011	0.706236	0.0097

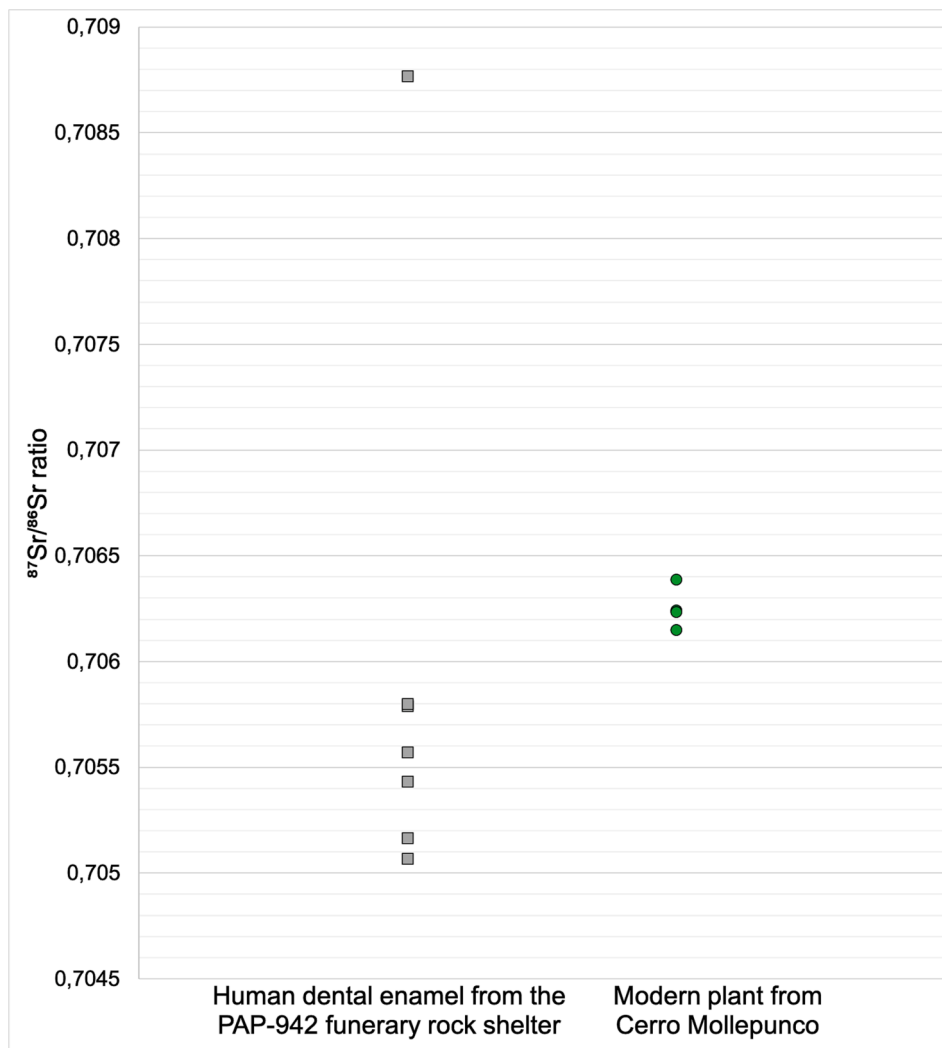


Fig. 13. Plot showing the strontium isotope compositions ($^{87}\text{Sr}/^{86}\text{Sr}$) of archaeological human dental enamel and modern plants from Cerro Mollepunco.

evidence for the centrality and regional significance of the Cerro Llamocca sacred mountain complex, particularly during the Middle Horizon and Late Intermediate period. That the deceased from the adjacent highlands were buried here, as indicated by their strontium isotope data, suggests the relevance of these sacred mountains to their local communities, while the outlying data of one individual suggests the religious centrality of this complex beyond its core area. More isotope data from various sites at Cerro Llamocca will provide clearer patterns of the range of interaction, especially for other time periods.

We emphasize how Cerro Llamocca combined the characteristics of a sacred mountain and a central place, thereby providing a compelling case study for how notions of sacredness and economy complement, rather than exclude, each other. This union likely had different focal points through the course of the pre-Columbian period. The proximity of critical resources and its several rock shelters are doubtless reasons why Cerro Llamocca exhibits the earliest evidence of human presence in our broader study area dating back at least to the Early Archaic period. In time these natural features became the basis for regarding Cerro Llamocca as sacred and the primary *apu* of the region.

The availability of critical resources such as camelids and lithic raw materials created not only dependencies on them by those who used them, but also between people as they obtained those resources through cooperation and exploitation, doubtless exacerbated by Cerro Llamocca's environmental extremes. Because of its location and *longue durée* use, Cerro Llamocca provides a key location in which to study the

formation and development of such resource dependencies evidenced by inter alia its varied architectural remnants, the investments in their construction and maintenance, and their associated purposes and practices. While Cerro Llamocca was occupied through the entire pre-Columbian period, many of its architectural remains and surface finds suggest that the zenith of its human activities took place during the Middle Horizon. Explanations for this significance could be the dry climate and related water and fertility rituals during that period, and that the Cerro Llamocca *apu* was integrated by the Wari into their pantheon of deities as part of an expansive imperial strategy to subject local communities.

Recent offerings at Cerro Llamocca show that the site still retains its significance as a sacred mountain, albeit on a different scale to pre-Columbian times. Compared to the extension and complexity of its pre-Columbian architectural remains, today's worship of Cerro Llamocca must be seen as merely a mooncast shadow of its former reverence and use. The mountain also appears to have steadily lost its functions as a central place after the beginning of the colonial era. While the sacred character of mountains is a well-studied Andean phenomenon, far less attention has hitherto been paid to their roles as places of critical socio-economic interaction. As we have elaborated in this paper, Cerro Llamocca was, simultaneously, a sacred mountain and a central place in the pre-Columbian past, bringing together ritual, religious, social, political, and economic aspects. Indeed, contrary to European categorizations, it is likely that its ancient native occupants recognized

little distinction between these aspects so that the new integrated perspective we propose here for mountains should be helpful far beyond the case of Cerro Llamocca.

7. Conclusions

Cerro Llamocca, a significant sacred mountain or *apu* and central place in the southern Peruvian Andes, was considered by indigenous communities as an essential part of the broader sacred landscape and natural environment. The mountain was the center of an extensive archaeological complex which retained significance throughout the pre-Columbian period, beginning as early as the Early Archaic and having its apogee during the Wari Middle Horizon. While Cerro Llamocca's socio-economic role as a central place was not retained into the colonial period, the mountain is still revered as an *apu* today. Ritual activities were likely related to water and fertility, with relationships to similar ceremonial phenomena on the Pacific coast. Cerro Llamocca's more quotidian functions and services as a central place were directly related to the sacredness and worship of its mountain peak, as well as to its topography of natural rock shelters and logistical access to a wide spectrum of fundamental resources.

This paper integrates data derived from recent archaeological surveys and excavations, analyses of archaeological materials, and strontium isotope analyses of archaeological human remains and modern plants. As we continue and expand these investigations in future years, more information will become available to shed further light on the past importance and centrality of Cerro Llamocca. Showing evidence both of the earliest human occupation hitherto known in the region, and continuous use through succeeding millennia, future research should refine the chronology of Cerro Llamocca and the central Andes.

CRedit authorship contribution statement

Christian Mader: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing, Visualization, Supervision, Project administration, Funding acquisition. **Markus Reindel:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Writing – review & editing, Visualization, Supervision, Project administration, Funding acquisition. **Johnny Isla:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Writing – review & editing, Visualization, Supervision, Project administration. **Martin Behl:** Validation, Formal analysis, Data curation, Visualization. **Julia Meister:** Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Writing – review & editing, Visualization, Supervision, Project administration, Funding acquisition. **Stefan Hölzl:** Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Writing – review & editing, Visualization, Supervision, Project administration, Funding acquisition.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jasrep.2023.104045>.

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