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Abstract

Machu Picchu contains the highest concentration of *huacas* of any of the royal estates and, in addition serving as a part-time residence of the Inca, may have one of several state-supported pilgrimage centers. The large rock surrounded by the walls of the Torreon and illuminated by the light of June solstice sunrise appears to have been one of its greatest huacas. Other huacas that have astronomical associations are the Temple of the Condor, Temple of the Mortars, and the cave of Intimachay. The precision with which the Torreon and the Intimachay mark solstice sunrise sets them apart from the other astronomical sites of the Inca and may indicate a later interest in ritual calendrics at Machu Picchu.

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Introduction

Machu Picchu, dramatically located on the narrow granite spine between Salcantay and Huayna Picchu, surrounded on three sides by the Urubamba River, set in a landscape of sacred mountains, contains the highest concentration of huacas of any of the royal estates. It may have also been one of several state-supported pilgrimage centers, such as Pachacamac and Isla del Sol (Bauer and Stanish 2001; Magli 2010; Malville 2010). Pilgrims to Machu Picchu who followed the Inca Trail, leaving the Urubamba River at Patallacta, would have encountered settlements on the route that were increasingly ceremonial with unusually large numbers of ritual baths. They would have had to pass through check points on the Inca trail as they approached Machu Picchu, similar to the pilgrimage experience at Isla del Sol (see ► Chap. 69, “Island of the Sun: Elite and Non-Elite Observations of the June Solstice”). Entry to Machu Picchu itself was limited by the main gate. Non-elite pilgrims could have viewed ceremonies at the Sacred Plaza or the Intiwatana pyramid from the terrace of the Sacred Rock. The arduous journey to Machu Picchu and the first views of Machu Picchu from the gate at Intipunki would have been liminal experiences, as described by Turner (1969). Two other spectacular entrances to Machu Picchu would have been over the top of Huayna Picchu after following a path upward from the Urubamba River and from the Llactapata ridge.

Astronomy at Machu Picchu is manifest in its huacas, living beings possessing great power and wisdom (Bray 2009; Malville 2009; see ► Chap. 67, “Inca Royal Estates in The Sacred Valley”; ► Chap. 61, “Pre-Inca Astronomy in Peru”). The many huacas of Machu Picchu would have been protectors and advisors to the Inca when he was in residence. There is a close association between huacas and the transformative powers of water and the sun (Salomon and Urioste 1991, p. 45). Van de Guchte (1990) has noted that almost all of the carved huacas of the Inca are associated with water.

Machu Picchu and Llactapata

Llactapata, rediscovered in 2003 (Malville et al. 2004, 2006), lies some 5 km to the southwest of Machu Picchu and appears to have been part of an extended, interconnected ceremonial center. Llactapata contains an elaborate water temple, an elevated platform, and a collection of seven halls with a double-jamb doorway facing the sunrise on June solstice. The passageway behind the double-jamb doorway at Llactapata dead-ends at a hillside, suggesting that the doorway may have been primarily a portal for the sun to enter. The seven halls and double-jamb doorway are remarkably similar to the design of the Coricancha. A sunken corridor, 33 m in length, opens to 63.5° based upon 11 measurements along its length and sunsights with a theodolite. The corridor has no side passages or doorways, suggesting that it may have functioned as a sighting device for locating the heliacal rising of the Pleiades. A stone-lined channel leads from the double-jamb doorway

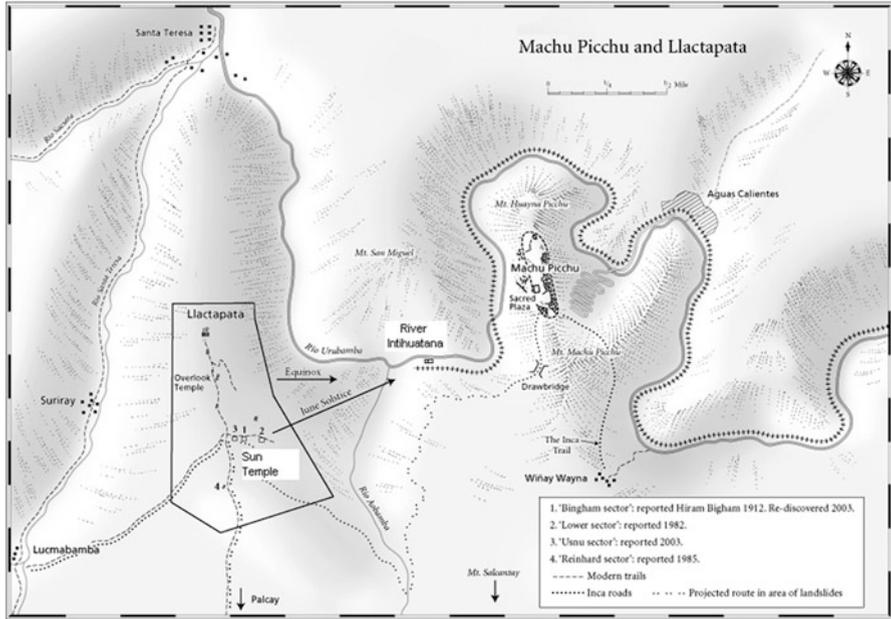


Fig. 68.1 Machu Picchu and Llactapata

of Llactapata toward the Sacred Plaza of Machu Picchu, making explicit the close connection between these places. Because there is no source of water behind the double-jamb doorway, water would have been obtained from the nearby spring and poured into the channel to flow toward Machu Picchu. A similar ritual is suggested in the Coricancha by reports of a basin or fountain in its eastern plaza and the three drainage holes in its eastern wall on Avenida Ahuacpinla.

The east-facing wall of the Coricancha was covered with plates of high quality gold (Bauer 2004). If the east-facing wall of Llactapata had adornments similar to those of the Coricancha, reflections of June solstice sunrise from its gold plates would have been a spectacular sight at Machu Picchu (Figs. 68.1–68.4, Table 68.1).

The Sacred Plaza

The Sacred Plaza of Machu Picchu opens to June solstice sunrise to the northeast and December solstice sunset to the southwest. The Plaza contains the Temple of Three Windows over which June solstice sunrise occurs. The December solstice sun sets in the direction of Llactapata and the sacred mountain of Pumasillo. The western edge of the Plaza contains a semicircular balustrade that faces Llactapata

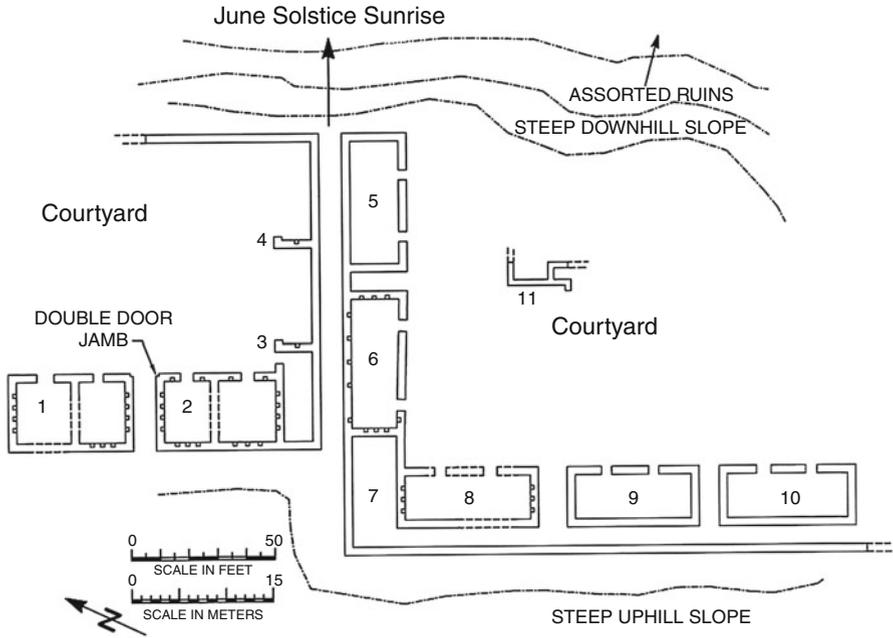


Fig. 68.2 The sun temple of Llactapata

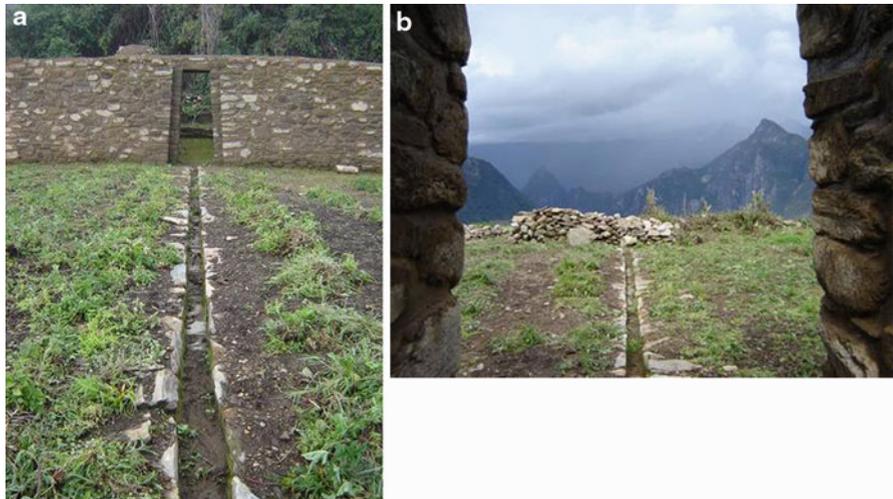


Fig. 68.3 The double-jamb doorway of Llactapata. The stone-lined channel aligns with the Sacred Plaza of Machu Picchu

Fig. 68.4 June solstice sun entering the double-jamb door of Llactapata (Steven Gullberg)



Table 68.1 Comparison of Llactapata and the Coricancha

Feature	Llactapata	Coricancha
Passageway behind double-jamb doorway	8.5 m × 2.4 m	10 m × 1.5 m
Rooms on either side of passageway	11 m × 7.3 m	13 m × 8 m
Orientation of passageway	63.5°	66.7°
Elevation of horizon	6°	5.6°
Courtyard to northwest	27 m × 26.7 m	36 m × 34 m
Features of courtyard	Stone-lined channel toward Sacred Plaza of Machu Picchu	Stone basin, drainage holes in northeast wall
Number of buildings	7	7

and is similar to but smaller than the Torreón. Adjacent to the Plaza is the Sacristry, one of the most beautifully crafted rooms of Machu Picchu. A bench at the rear of the room faces December solstice sunset and possible reflections of June solstice sunrise from the walls of Llactapata (Figs. 68.5 and 68.6).



Fig. 68.5 June solstice sunrise over the Temple of Three Windows, as viewed from the Sacred Plaza. Note the peak of Putucusi in the foreground (Steven Gullberg)



Fig. 68.6 Reflection of the June solstice sun from the double-jamb doorway of Lactapata (Carlos Aranibar)

Double-Jamb Doorways

Double-jamb doorways, i.e., doors within doors, had a special importance in the Inca world. They established sacred and restricted areas into which only certain elites could enter. Machu Picchu contains 11 such doorways: four are associated with elite residential areas and six provide entry to restricted sacred areas.

Fig. 68.7 View outward from the double-jamb doorway of Conjunto 1 toward Putucusi and June solstice sunrise (Carlos Aranibar)



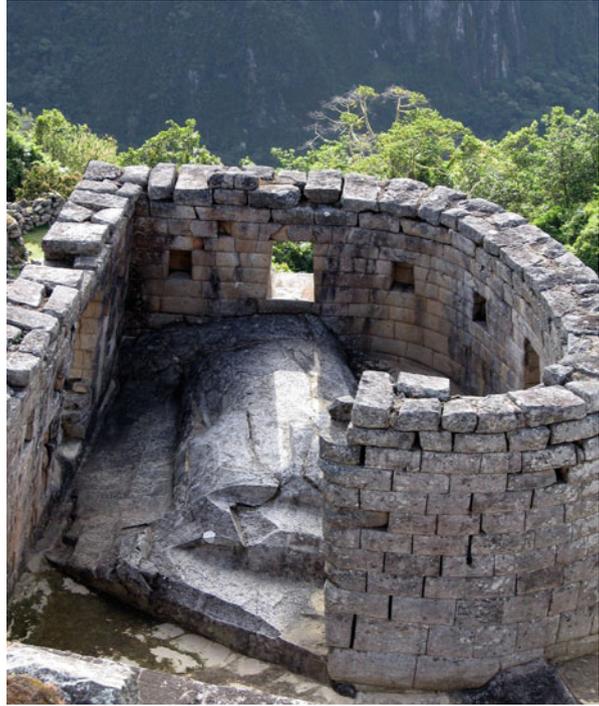
A double-jamb doorway in Conjunto 1, some 80 m north of the principal entrance, provides an intriguing puzzle. Instead of controlling entry into a restricted space, it faces June solstice sunrise, toward an azimuth of approximately 63.5° , similar to the orientation of the double-jamb doorway of Llactapata. The doorway appears to be another portal for the sun to enter at solstice (Fig. 68.7).

The Torreón and the Royal Mausoleum

The first investigations of astronomy at Machu Picchu were performed in 1980 by Earthwatch teams led by David Dearborn and Ray White (1982, 1983, 1989). They discovered that the northeast window of the Torreón opens to an azimuth of 63° , within 1° of the rising position of the Pleiades and a little more than 2° from the rising position of the sun at June solstice. The Torreón encloses the top of a large boulder, which contains a cut edge, which Dearborn and White determined lies within $2'$ of the rising position of the sun on June solstice. However, the edge of the rock cannot be used for direct observation of the rising sun. Dearborn and White speculated that the shadow of plumb bob suspended in the window would have provided a device for determining the date of June solstice. The possibility that the edge cut in the top of the rock establishes a level of precision by which to judge other astronomical alignments of the Inca has generated lively debate (Dearborn and Schreiber 1986). Aveni (1988) has criticized the interpretation of the Torreón as an observatory for making highly precise measurements. Hyslop (1988) and Zuidema (1988) have expressed similar concerns.

The base of the rock enclosed by the Torreón contains the Royal Tomb, which combines a cave, symbolic stairs, niches for ancestors, illumination at June solstice, and proximity to transformative water. It is one of the most symbolically potent huacas of Machu Picchu. Because of the similarity of its beautifully curving wall,

Fig. 68.8 The stone enclosed by the Torreon illuminated at June Solstice (Carlos Aranibar)



the Torreon has been likened to the Coricancha of Cusco and identified as a sun temple. Other than the curved wall, there are few similarities with the Coricancha.

The cut edge is strangely tentative, apparently not part of the original design of the huaca. Given the masonry skills of the Inca, a more effective sun-watching station could have been built. The cut edge could have been carved with sharper edges and a northeastern window could have been larger to allow direct observation of the horizon sun. Furthermore, it would have been redundant, because the rising position of the sun on the irregular horizon could have been used to establish June solstice without shadow casting. It appears to have been more important for the sun to enter the northeast window and touch the huaca, than for an “astronomer-priest” to look outward. An interest in ritual calendrics incorporating precision light and shadow effects may have been a later development at Machu Picchu (Figs. 68.8 and 68.9).

Intimachay

In 1984, Dearborn et al. (1987) described this unusual cave with a light tube pointing approximately toward sunrise on December solstice and named it Intimachay. The end of the light tube is a very constricted space so that only one

Fig. 68.9 Torreón above and Royal Tomb below. Both the window of the Torreón, the rock behind it, and the cave receive light of the sun on the morning of June solstice (Clive Ruggles)



person can view the horizon in the vicinity of the December solstice sunrise. Dearborn et al. indicate that the window covers $7^{\circ}40'$ of the horizon. They suggest that the rock overhanging behind the window was modified to allow an observer deeper in the cave to observe a $10'$ section of the horizon centered on the first gleam of December solstice sunrise. The precision of this alignment appeared strong evidence for intentionality.

In 2012, a Peruvian-Polish team completed a 3D laser scan of Intimachay and was not able to confirm the high-precision sighting device proposed by Dearborn et al. lying deep in the cave (Ziółkowski et al. 2013). They concluded that the light tube reveals a window 1° along the horizon in which the December solstice sun rises above a notch. Anyone, once aware of the horizon notch, could identify the date of December solstice, simply by viewing the position of sunrise on the horizon. Similar to the Torreón, a precise sighting device would have been redundant and unnecessary for calendrical purposes.

Ziółkowski and his team measured the northern port of the light tube and found that light from the June solstice sun and the moon at the major northern lunar standstill would enter it and illuminate the southern wall of the light tube. They suggest that the Intimachay served as an observatory for important calendrical events of both sun and moon. An alternative interpretation of the northern port is that it was a place for inserting objects to be illuminated and empowered by the light

Fig. 68.10 Intimachay. Note the northern portal on the right



of the December solstice sun. The cave of Intimachay is large enough for a resident. The huacas of Pachacamac, Puellana, Chavin, and many others had resident oracles. Nick Campion and Tore Lomsdalen have suggested that the light tube of Intimachay may have been an oracle hole, similar to those elsewhere in the world, such as at the temple of Mnajdra in Malta (Lomsdalen 2013; see ► [Chap. 125, “Temples of Malta”](#)) (Fig. 68.10).

The Temple of the Condor

The Temple of the Condor contains the stylized head of a condor carved into bedrock in front of a small cave. This is the only huaca of Machu Picchu in which access is entirely limited by double-jamb doorways. Westerman (2005) photographed the light of rising sun on August 19, 1995, and April 21, 1994, when it touched the head of the condor. The sun could enter the cave beyond the head, where there is a set of nonfunctional stairs descending into the earth and Pachamama. Zuidema (1981) has noted that August 18 was a major festival during which reportedly 1,000 guinea pigs were brought into Cusco to be sacrificed. It is also the day of the anti-zenith sun. Just to the south of the Condor is a building containing a collection of guinea pig hutches, the only hutches identified in Machu Picchu. Flowing water is nearby in the last of the 16 fountains. Bauer and Dearborn (1995) express doubt that the Inca celebrated the anti-zenith sun.

The Temple of the Mortars

The floor of the Temple of the Mortars contains two elevated basins carved out of bedrock. The building was apparently not roofed, suggesting the importance of rituals involving the light of the sun and/or moon throughout the day and, for that

matter, throughout the year. Not all archaeoastronomical events need to be calendrically specific. The mortars may have been the location for the re-enactment by Pachacuti of the major mytho-historic event in the founding of the Inca Empire (Zuidema 1982) in which the sun appeared to him out of the spring of Susurpuquio on the eve of his victorious battle with the Chancas. According to mythic tradition, stones were turned into warriors for that battle. The powerful combination of stone, water, and sunlight touching the mortars may have been understood to bring these huacas to life. An alternate interpretation of their meaning involves sunlight illuminating the northern basin on the morning of equinox and illuminating of southern basin on the morning of June solstice (Cabada Hilderbrandt 2008).

Concluding Remarks

Multiple interpretations of astronomy at Machu Picchu pivot on the issue of *emic* versus *etic*. An *etic* view, an outsider's view of astronomy, could be described as a search for observatories, precise alignments, and evidence of astronomer-priests. An *emic* approach would include the so-called ontological turn in anthropology (Henare et al. 2007; Bray 2009), and the Andean concept of *camaquen* (Salomon and Urioste 1991). The sun at Machu Picchu does appear to have been more than a remote object on the horizon, but rather a deity who played active roles by entering doorways and windows, touching and energizing huacas. The sun entered the double-jamb doorways of Llactapata and Conjuncto 1, the NE window of the Torreón, the cave of the Temple of the Condor, and the light tube of Intimachay. The unroofed Temple of the Mortars suggests a ceremonial viewing of sunlight reflected from the water-filled mortars, as a re-enactment of a decisive event in Inca history.

It seems unlikely that any of the stone huacas of Machu Picchu were initially and exclusively designed to function as observatories. Precise observation of the solstices such as are suggested at the Torreón and Intimachay may indicate an interest, not initially present, in ceremonial calendrics in which perfection and precision were elements of ritual. The continuing challenge for the archaeoastronomer, seeking to understand Inca culture from the inside, is to decipher the complex relationship between the sun, water, and huacas.

Cross-References

- ▶ [Analyzing Light-and-Shadow Interactions](#)
- ▶ [Inca Astronomy and Calendrics](#)
- ▶ [Inca Calendar](#)
- ▶ [Inca Royal Estates in the Sacred Valley](#)
- ▶ [Island of the Sun: Elite and Non-Elite Observations of the June Solstice](#)
- ▶ [Pre-Inca Astronomy in Peru](#)

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