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The Cosmology of Inca Huacas

Thesis submitted by

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James Cook University

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Abstract

The Incas honored and venerated many features of both natural and man-made landscapes that they felt to be endowed with superhuman powers. In Quechua these shrines were known as *huacas*, and at the time of the Spanish conquest there were thousands of them. Soon after invading the Inca homeland the Spaniards began a campaign against the indigenous religion that included a systematic eradication of huacas. Shrines that were large carved stones and outcroppings survived, however, and form a part of this study. These are examined for astronomical orientations marking such events as solstices and equinoxes.

The Inca apparently believed rock could be empowered by elaborate carving as well as through the movement of water and, as such, astronomical huacas are evaluated for nearby sources of water. Ritual stairways are also common features, symbolizing shamanic movement between the three worlds of Inca cosmology. Certain shrines appear to be organized by lines or *ceques* connecting adjacent huacas which may be associated with sequential rituals as well as astronomical sightlines. These and other features are recorded for each of the huacas of this study.

The Incas built multiple towers on the horizons of Cusco to mark the positions of the rising or setting sun on significant dates of the year. All were destroyed. Beyond Cusco two solar pillars overlooking the modern village of Urubamba escaped the Spanish purge. This research establishes that when viewed from a large granite boulder in the center of the palace courtyard of Huayna Capac they mark the rising sun at June solstice. Additionally, from the boulder in the direction of the December solstice sunrise are located enigmatic stone structures on the summit of Cerro Unoraqui.

Below Machu Picchu, near the Urubamba River, lies a large and complex shrine initially identified by Bingham as the Urubamba Intihuatana. The massive granite stone lies approximately between the Sacred Plaza of Machu Picchu and the Sun Temple of Llactapata along the axis of the June solstice sunrise and December solstice sunset. The River Intihuatana is explored and catalogued in detail. There also appear to be more than 30 huacas in proximity to Machu Picchu itself. This array of huacas in the neighborhood of Machu Picchu is reminiscent of the concentration of huacas associated with the ceques of Cusco.

Many facets of Inca astronomy are explored, as well as the context within which it served Incan society. This thesis analyzes 29 sites near Cusco, in the Sacred Valley, and between Machu Picchu and Llactapata for evidence of astronomical orientation and inclusion of any of 25 motifs and iconic features. The approach is a holistic one in that it considers multiples levels of meaning including cultural motifs, topographic and astronomical contexts, sightlines, as well as light and shadow effects throughout the year, especially at times of the solstice, equinox, zenith and anti-zenith suns. Photographic evidence of light and shadow effects was recorded and is presented with the field data in Part IV. Various solar orientations were cataloged and the results are given in Chapter 12. Data was examined for trends regarding proximity to water sources and inclusion of the aforementioned motifs and iconic features. These trends are also presented in Chapter 12.

Acknowledgements

I am eternally grateful to Kim Malville, my advisor, mentor and friend. Kim's advice has always been indispensible, whether it be regarding my thesis or indoctrinating me in proper archaeoastronomical field research techniques in the Andes. Tom Zuidema was most helpful with the insight he shared at the beginning of my journey and as well with his excellent suggestions regarding this thesis near that journey's end. I would also like to thank Bernard Bell and Ken Wright for their valuable contributions to my work. Carlos Aranibar of Izcuchaca provided excellent support in the field time and again. He assisted me during each of my five research trips to Peru and I find it hard to imagine accomplishing what I have done without him. Carlos is a college educated professional guide trained and licensed by the Peruvian government. I am greatly indebted to Mike Zawaski for his assistance with regard to the T2 theodolite. I invited him to join my team in the spring of 2008 when he made sunsights and measured azimuths on my behalf. These measurements were instrumental for my research at Quespiwanka. Jesus Villafuerte of Cusco provided a special service at Llactapata by remaining behind with a tent and a mirror while I and the rest of my team proceeded on to Machu Picchu for the following day's June solstice demonstration. My wife, Jessica, and my sons, Steven and Gregory, individually accompanied me as assistants on separate research expeditions and each made notable contributions to my fieldwork. They have been incredibly supportive. I wish to extend special thanks to Wayne Orchiston for his advisement, support and encouragement throughout my entire project.

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Preface

Inca astronomy should never be taken by itself, as it was only an integral piece that played a much broader role in cultural activities. I have attempted wherever possible to establish some of the context within which these celestial orientations existed. The following pages will show that astronomical orientations not only can be found in the regions in and around Cusco, the Sacred Valley and Machu Picchu, but actually were quite commonplace. In many cases the orientations were more than just straight-forward alignments with the sun, as the Incas at times appeared to go to great lengths to create vivid visual effects of light and shadow.

This project has been most rewarding and I am pleased to be able to present catalogs of astronomical and iconic features found in the Inca huacas examined in my study. I greatly enjoyed exploring each of these sites and witnessing first-hand the solar orientations devised and incorporated by the Incas into their shrines. The caves of Lacco were especially fascinating in this regard and it pleases me as well to be able to share photographs of such events.

I am intrigued by the huaca near Lacco with the circles oriented for solar horizon events. Nowhere else did I find an example with so many astronomical orientations and I believe this site will emerge in the future as a major piece of Inca astronomical history.

I feel fortunate to have been able to add to the research involving the solar pillars above Urubamba and Quespiwanka. Focusing upon the white granite boulder and Niles' description of an ancient ceremonial platform adjacent to it, I not only verified the hypothesis that this was the correct location for viewing the June solstice sunrise, but then also observed that the platform and boulder may have been the position for observing other solar events such as the December solstice sunrise and the June solstice sunset. Since these pillars may share similarities with those formerly on the horizons of Cusco, it has been a privilege to be a part of establishing the validity of this aspect of Inca history. I've also enjoyed greatly pondering the meanings of the three pillars that I found on top of Cerro Unoraqui, as well as the wall remains on Cerro Pumahuachana.

Having been intrigued with Bauer's and Stanish's thoughts on elite and non-elite solar viewing areas at the Island of the Sun I am grateful to have played a part in expanding this concept to two other major sites and, having done so, I now feel that the practice was common and more examples will follow.

The dichotomy of orientations at Chinchero presented a fascinating area for study, especially with regard to these major contrasts in construction philosophy. It was intriguing to consider the astronomical concepts that the Incas may have employed when making such cardinal alignments.

It has been my pleasure to catalog and document the features and cosmological significance of the River Intihuatana. This site emerges as possible evidence in support of the existence of a ceque system surrounding Machu Picchu. Evidence for ceque systems outside of Cusco have been elusive and it is my hope that this research may provide an element that will help validate earlier writings such as those of Polo de Ondegardo. I was fortunate in that I had the opportunity to witness firsthand the June solstice sun rise over Machu Picchu as viewed from Llactapata's Sun Temple. A demonstration, performed with the aid of my assistants, flashing the dawn's light from Llactapata to Machu Picchu's Sacred Plaza was enlightening.

I have been privileged to have had the opportunity to share portions of my thesis and research in the following papers:

Malville, J. M., Zawaski, M. and Gullberg, S., 2008. Cosmological Motifs of Peruvian Huacas. In Vaiškūnas, J. (ed.), *Astronomy and Cosmology in Folk Traditions and Cultural Heritage, Archaeologia Baltica*, 10. Vilnius, Klaipėda University Press, 175-182.

Gullberg, S. and Malville, J.M., 2009a. The Astronomy of Peruvian Huacas. In Orchiston, W., Nakamura, T., and Strom, R. (eds.). *Highlighting the History of Astronomy in the Asia-Pacific Region*. New York, Springer (Proceedings of the ICOA-6 Conference). In press.

Gullberg, S. and Malville, J.M., 2009b. The River Intihuatana: Huaca Sanctuary on the Urubamba. *Archaeoastronomy*. In review.

My research has shown that it was common for the Incas to encode astronomy into their huacas and other ceremonial structures, but as well that not every shrine incorporated celestial orientations. Photographs presented in Chapters 9 through 11 graphically demonstrate the importance the Incas placed on the sun and how they were able to repeatedly harness its rays for graphic visual effect. Evidence also exists for Inca interest in the moon, the Pleiades, and certain constellations within the Milky Way Galaxy. Andean culture had accumulated a significant understanding of the heavens that was passed on to the Incas during their rise to prominence. The Peruvian countryside is replete with examples of the astronomy amassed by these worshippers of the sun.

Part I: Introduction

Chapter 1

1.1 Introduction

The Incas honored and venerated many features of their natural landscape such as mountains, snow peaks, caves, springs, lakes, and rocks, all felt to be endowed with meaning and sacred power. In Quechua these shrines were known as *huacas* and at the time of the Spanish conquest there were many hundreds of them. The most powerful huacas required care and maintenance that included gifts made to the powers of the shrines. Sacrifices were offered to these shrines and those of animals or produce were often used to support the huaca's attendants. The Incas organized the administration of huacas along lines called *ceques*, and the existence of such a system has been well explored for the area that surrounds Cusco.

Stone huacas are the principle focus of this study, most of which were elaborately carved and shaped. The Incas revered and venerated stones and the emperor, Pachacuti, apparently believed he could "improve" upon the work of his co-creator and father, the sun, by the sculpting of rocks. As a direct result these carved outcrops retain an immense amount of information about the sacred and ritual world of the Incas. Susan Niles (1987: 204-205) suggests that a fairly limited number of motifs were used in the shaping of huacas: "The pattern does not suggest a tolerance of innovation. It is unlikely that the Incas would encourage individual graffiti artists to practice their skills on sacred rocks. Certainly, the improvements on nature seen in Inca shrines...must have been officially controlled." An element of Pachacuti's architectural style was to incorporate carefully fitted stone masonry into natural outcrops such as at Machu Picchu where "building seemed to grow organically out of the bedrock….and the boundary between the work of the architect and the Creator is blurred" (Niles 2004: 62).

The huacas most central to Inca worship were dedicated to the sun and moon, sometimes designed with associated orientations. Certain shrines may have been constructed or carved so as to cast shadows at solstice, equinox, or with the zenith and anti-zenith sun. The concept of anti-zenith is discussed in section 8.6.1.4. Basins might have been crafted so their waters would make specific reflections of the light of the sun or moon. Standing stones could have been used as gnomons to cast shadows, or to mark solar horizon positions.

Zuidema (1977) described a ceque system for Cusco that comprises 328 huacas (shrines) on 41 ceques (lines) and discussed a complex ritual calendar system employing ceques and huacas, functioning with the worship of each huaca in turn on a specific day. Twelve sidereal months, each with 27 1/3 days, yield a total of 328 days (which corresponds to the number of days in a lunar sidereal year). He states that the missing 37 days are similar to the approximate period that the Pleiades are masked by the sun and when taken together this gives 365 days. The 41 ceques might also have functioned to denote 41 eight-day weeks (328/8 = 41). Certain huacas might have been used to identify the days of the year that the sun would be at either solstice, and perhaps others specified dates for crop management.

Descriptions by Bernabe Cobo (1990: 51-84) of the shrines that radiated from Cusco support Zuidema's count of 328. Additional huacas existed that were not part of the state system, instead of a more private nature associated with the dead of particular families and used for special sacrifices and ceremonies. It has not yet been shown comprehensively which of the carved limestone outcrops surrounding Cusco were designed with astronomical orientations. One of the purposes of this study is to explore light and shadow effects of these rocks, some of which may be associated with the dates of major solar horizon events.

1.2 Statement of Purpose

The goals of this research are to elucidate the characteristics of the astronomical aspects of the landscape of the Incas and to explore further the interrelations of architecture, religion, landscape, and astronomy. While many of the huacas described by Cobo were destroyed by Spanish priests in their efforts to eradicate all idol worship, some did survive - primarily those of geographical features and carved outcrops of rock. These rock huacas have not yet been systematically studied with regard to astronomical orientations. This investigation will examine existing carved rock huacas for potential astronomical significance. Light and shadow effects will be observed and orientations measured to determine whether or not these huacas yield evidence of Inca astronomy.

This research is an attempt to identify astronomical aspects of specific huacas and to place this information in context with other aspects of Inca culture.

1.3 Research Hypotheses

1. For millennia the people of Andean cultures preceding the Inca Empire believed the world to be filled with animate beings, some of which were ancestors, with powers to influence the living. The great snow mountains, rivers, springs, rocky outcrops, or other more subtle features of the landscape could be alive and powerful and, often, required offerings. People interacted with these animate beings, who could be supplicated, consulted with the help of an oracle, battled, abducted, and even destroyed. The Incas incorporated all of these features of the living and sacred landscape into their system of huacas, each of which they believed had power and wisdom. Since the sun was the primary deity of the Incas, it is reasonable that many of these huacas were associated with solar worship. In the early 16th Century there were over 400 huacas in the Cusco Valley. While originally in the minority, those that remain primarily were huacas that had been designed in rock. My first hypothesis is:

   > *The majority of the currently identified rock huacas in the Cusco Valley, the Sacred Valley, and surrounding Machu Picchu are associated with visual solar phenomena.*

2. Part of Inca claims for legitimacy were based upon the assertion that the Inca royalty were direct descendants of the sun. Demonstrations of that genealogical link with the sun could occur during public festivals when the sun would rise on the horizon at a location predicted by the Inca king and priests, the most likely times being identifiable elements of the solar cycle. The second hypothesis is:

   > *Those huacas found to be associated with visual solar phenomena (solar huacas) exhibit orientations related to the solstices, equinoxes, zenith suns and anti-zenith suns.*

3. A long-standing Andean tradition involved the concept of *camay* whereby inanimate objects were brought to life and made sacred and powerful, one means by which emanated from flowing water. The huacas that were energized by such waters were thought to be prominent living entities. During preliminary field work I observed that while all huacas were not associated with water, solar huacas were adjacent to water courses such as stone lined or carved channels. Based upon these preliminary observations I developed the third hypothesis:

   All solar huacas are associated with flowing water.

4. Part of the perceived power of carved huacas may have been derived from the inclusion of long standing Andean sacred symbols such as stairways for shamanic ascent and descent, caves, niches for sacred objects, seats for spirits, sacred animal carvings, channels for ceremonial fluids, fountains, and basins for viewing reflections in liquids of the sun, moon, and stars. The majority of huacas consisted of natural features, but those made of rock could be enhanced through carving. The fourth hypothesis is:

   Solar huacas in the form of carved rocks contain traditional Andean motifs.

This study presumes that the design and carving of rock huacas followed an established tradition that included cosmology, astronomy, and mythology. Meaning was encoded into ceremonial structures in the form of light and shadow effects, features framing or pointing to distant views or points on the horizon, and elements relating to origin myths such as caves, basins, and fountains. The carving and shaping of huacas was not spontaneous and was instead planned in accordance with a specific iconic repertory with shared meaning and purpose, as listed in Table 3-1.

This thesis investigates shrines, especially those carved from rock, as symbolic representations of astronomical knowledge and meaning. Through observation of the sun's light and shadow effects on significant days of the Inca calendar, field research tested the hypothesis that there is astronomical function encoded in the carving, orientation, and geographic context of certain shrines. Furthermore I examined dates for such orientations and established commonality of the features of water, stairs, seats and niches at huacas with astronomical orientations.

In this study I consider that many interpretations of huacas (astronomical, abstract sculpture, ritual, divination, worship, and ceremonial) are relevant, taking into account the multiple levels of meaning that people in traditional societies attach to significant landscape features. The approach of this study is holistic in that it considers cultural motifs carved into the stones, their topographic and astronomical contexts, sightlines to other huacas or prominent features of the landscape, and light and shadow effects throughout the year, especially on ceremonial or agriculturally important dates. Astronomical interpretations cannot be separated from the overall cultural significance of these objects.

This project is not looking for "observatories," but for evidence regarding the roles of astronomical phenomena and observations in Inca culture. The Spanish conquest abruptly curtailed much of Inca culture and resulted in a loss of much of its conceptual depth. Archaeoastronomy has an opportunity to recover some of the forgotten elements of their society.

1.4 Justification and Relevance

Although a number of the extant huacas outside of Cusco are well known and have been identified as members of a ceque system, the astronomical aspects and related orientations of these huacas have not yet been systematically studied. The approach of this research will be to investigate shrines including huaca-like carved rocks, their intricate carvings, caves and associated stones, the surrounding landscape, the light and shadow effects that develop on them, and any possible associations with sunrise/sunset on the horizon. By looking for light and shadow effects aligned with the sun on important days of the Inca calendar, this field work will test the hypothesis that there is naked-eye astronomical practice and knowledge encoded in the carving, orientation, and geographic context of the huacas. It will also show the motifs common to shrines found with astronomical orientations.

While certain aspects of astronomy in Inca civilization have been studied, there has not yet been a methodically thorough investigation of celestial utility in their huacas. This thesis searches for evidence that astronomy was an integral part of Inca culture and thereby helps fill an important void through examining the development and usage of astronomy by an American civilization that was contemporary with Nicolas Copernicus.

1.5 Thesis Structure

This paper will explore in subsequent chapters the astronomy found in shrines of the Inca Empire and will provide an overview of the cultural context of such. Current understanding of Inca astronomy will be surveyed, as will the ceque system of Cusco. A field investigation will be conducted. Ceremonial and astronomical features of selected huacas will be evaluated with regard to the results of the field work. Data collected will be examined and a determination will be made as to whether or not it supports the stated hypotheses. The process will be repeated at huacas throughout the regions of Cusco, the Sacred Valley and Machu Picchu in an effort to seek evidence of astronomical orientation.

Part II: Context of the thesis outlines aspects of the culture of the Incas and the context within which to better understand their astronomical designs. Chapter 4 explores the history of the Incas and their empire from the early beginnings through the completion of the Spanish conquest. Chapter 5 introduces the religion, mythology and culture of Inca civilization. Chapter 6 examines huacas and the system of ceques developed primarily around Cusco as defined by Zuidema and Bauer.

Part III: Astronomy describes certain technical concepts for my field research. Chapter 7 defines many aspects of archaeoastronomy that are applicable to the Incas and Chapter 8 examines the complex astronomy practiced in the Inca Empire.

Part IV: Field Research presents data accumulated in the field. Chapter 9 summarizes my field research of huacas in the region surrounding Cusco. Chapter 10 summarizes my field research of huacas in the Sacred Valley and Chapter 11 summarizes my field research of huacas located in and near Machu Picchu.

Part V: Results includes Chapter 12 with sections presenting findings, discussion, and potential work in the future.

1.6 Definitions of Terms

Quechua terms used throughout this thesis are defined in Appendix A1.

Chapter 2

Related Research

2.1 Prior Research Regarding Inca Astronomy and Huacas

The conquest of the Inca Empire began in 1532, ultimately ending in 1572. The Incas had no written language and therefore we rely upon the writings of Spanish chroniclers for much of what we know about Inca ceques and huacas. Cristóbal de Molina is sometimes mentioned as a possible author of the Cusco ceque system. Bernabé Cobo referred to the writings of Molina and used his *Relación de las fábulas i ritos de los Ingas* (ca. 1575) extensively in Cobo's *Historia del Nuevo Mundo.* Many of the chronicles were based on interviews with indigenous Incas. Juan Polo de Ondegardo interviewed Inca royals and their assistants for his *De los errors y supersticiones de los indios, sacados del tratado y averiguación que hizo el Licientiate Polo* (1585). Cobo likely used Polo de Ondegardo's work when writing about the Cusco ceque system. Zuidema (2008b) suggests that Polo de Ondegardo originally wrote of the ceque system of Cusco. Bernabé Cobo was a Jesuit scholar who chronicled Inca culture. His *Historia del Nuevo Mundo* (1653) listed 328 huacas on 41 ceques surrounding Cusco and went on to discuss huaca maintenance, worship and offerings. This and his *Relación de las gaucas del Cuzco* (1653) remain some of the most comprehensive sources on huaca worship in the Inca Empire.

The ground breaking research of R. Tom Zuidema has contributed greatly to contemporary understanding of the Cusco ceque system. Utilizing Spanish chronicles such as those of Cobo and Molina, Zuidema performed a systematic search for and study of huacas in the Cusco area during the 1950's and in 1964 published *The Ceque System of Cuzco: The Social Organization of the Capital of the Inca*, the first modern treatise of the Cusco's ceques. He explored Andean astronomy and proposed a calendar based upon these ceques and the Pleiades. Zuidema suggested that the 328 huacas described by Cobo were coincident with the 328 days found in 12 sidereal lunar months and that the "missing" 37 days of a tropical year were represented by those during the approximate period in which the Pleiades was not visible. Based on his reading of Spanish text, he concluded that celebrations were also established for two anti-zenith dates, which would be unique among world cultures. Anthony Aveni collaborated with Zuidema and has joined him in suggesting that a number of ceques had orientations with the sun on the horizon. They posit that the ceque system was a counting device for the Inca calendar, suggest each huaca represented one day of the year and found certain ceques to form straight lines oriented for horizon-related astronomical events. Zuidema and Aveni also documented orientations within the Coricancha of Cusco for June solstice sunrise and the rise of the Pleiades. Zuidema's work has been widely acknowledged and recognized by Peruvian archaeologists.

One of the early works comprehensively discussing the non-astronomical features of carved rock huacas and Inca architecture was *Monuments of the Incas* (1980), by John Hemming. César Paternosto also contributes through his discourse on Incan monumental sculpture and textiles, *The Stone and the Thread: Andean Roots of Abstract Art* (1989). He provides valuable information with regard to many monuments throughout the Inca Empire and describes techniques potentially utilized in their construction. Maarten Van de Guchte, a doctoral student of Zuidema, performed a significant study of the carved rocks of the Inca, but as well did not investigate astronomical issues. He published his dissertation, *Carving the World: Inca Monumental Sculpture and Landscape*, for the University of Illinois in 1990. Vincent Lee, an architect, lent his professional skills to more closely examine Inca design and construction. In *Forgotten Vilcabamba* (2000), the story of a search for Manco Inca's last jungle stronghold, he proposes an astronomical connection with Yurak Rumi, a great white boulder above a spring of water in Vitcos that he claims to be surrounded by ruins of a House of the Sun. The anthropologist Susan Niles has done significant research relating the physical order of archaeological remains with the social order of the Incas who first built them. Of great benefit to this study was her *The Shape of Inca History: Narrative and Architecture in an Andean Empire* (1999) that provided extensive information with regard to Huayna Capac's royal estate, Quespiwanka.

The understanding of Inca astronomy and cosmology took a great step forward in the late 1970's through the ethnoastronomical research of Gary Urton. His 1981 book *At the Crossroads of Earth and Sky: An Andean Cosmology* describes his 1976-1977 fieldwork while living in the Peruvian village of Misminay. It is thought that many of the Inca's astronomical traditions survive and Urton learned of much from the residents of this small local community including such as the structure of space and its relation to village design, cosmological crosses, and dark cloud constellations in the Milky Way.

David Dearborn as well has been a major contributor to research of Andean astronomy and much of his work is in regard to orientations found at Machu Picchu. In 1983 he and Raymond White described the Torreon as an observatory of the June solstice sunrise (Dearborn and White, 1983). Katharina Schreiber, Dearborn and White proposed that the Intimachay was designed to admit sunlight at the rise of the December solstice sun (Dearborn, Schreiber, and White, 1987). Dearborn, Brian Bauer and Charles Stanish found evidence of Inca astronomical orientations on the Isla del Sol in Lake Titicaca. In *Astronomy and Empire in the Ancient Andes* (1995) Bauer and Dearborn postulated that because stars rise in fixed horizon positions certain huacas were oriented to assist in visually locating the rising and setting of specific celestial bodies. These reference markers guided the observer's eyes at appropriate times of the year. During the early 1990's Brian Bauer conducted field research of the Cusco ceque system. In his book *The Sacred Landscape of the Inca: The Cusco Ceque System* (1998), Bauer outlined a model of the system and its huacas based, in part, on the writings of John Rowe (1980). Bauer's study added new hypotheses regarding huacas on the ceques of the four suyus of Cusco.

Bauer and Dearborn (1995) suggested that many ceques follow irregular courses between huaca locations that are not in straight lines. In 1995 Bauer and Dearborn published *Astronomy and Empire in the Ancient Andes: the Cultural Origins of Inca Sky Watching*, a work regarding Inca astronomy and cosmology.

Hiram Bingham briefly located a section of Llactapata in 1912, but following his departure the site once again was lost to the cloud forest. While portions of it were reported on at least two other occasions, in May 2003 Kim Malville, Hugh Thomson, and Gary Ziegler located Llactapata once again, this time in its entirety. Its expanse and significance had been previously unknown. The expedition found a prominent structure to be oriented to sunrise at the June solstice, with a design reminiscent of the Coricancha in Cusco. Both buildings were constructed with openings facing the horizon positions of the heliacal rising of the Pleiades and the June solstice sunrise. The heliacal rising of the Pleiades was important for crop management and corridors found both at the Coricancha and now Llactapata served to guide observers' eyes to the momentary first visibility of the Pleiades prior to the rising sun.

Mike Zawaski, a graduate student of Malville, performed field study during June and July 2005 that focused on potential astronomical orientations on the horizon from ten sites between

Cusco and Llactapata. He utilized a theodolite, a GPS receiver and a panoramic camera for his data collection. While Zawaski's study focused on certain points of horizon astronomy, it did not examine huaca astronomical features. His findings suggest evidence of horizon orientations to the June solstice and/or the Pleiades from the sites of Llactapata, Saihuite, Urubamba and Ollantaytambo. Zawaski wrote his thesis, *Archaeoastronomical Survey of Inca Sites in Peru,* for the University of Northern Colorado in 2007.

Accounts of the Spanish chroniclers vary as to how many pillars existed on the horizons of Cusco. They are discussed further in section 8.8.3. Cusco's pillars were all destroyed in the anti-idolatry campaign of post-conquest Catholic priests. In 2003 Bernard Bell and Vincent Lee discovered pillars they found to be aligned for the June solstice sunrise when viewed from what is referred to as the Incahuasi at Puncuyoc, 18 km north of Ollantaytambo. Two other pillars that survived away from Cusco are on a ridge above the village of Urubamba in the Sacred Valley. Bauer and Dearborn (1995: 69) state: "While the function of these markers is not known, aspects of their size, shape, and separation are similar to those of the solar pillars of Cuzco as described by Betanzos, Garcilaso de la Vega, and Cobo. We present them as useful examples of what solar pillars might have looked like." They did not, however, investigate the specific astronomical orientations of these pillars. Research involving potential solar alignments of the Urubamba pillars began in earnest in 2005 when Zawaski observed from outside the palace that the June solstice sun rose between them. In my field research during 2007 and 2008 I observed that the most likely viewing location for the June solstice sunrise was next to a white granite boulder located at the center of the courtyard of Huayna Capac's palace, Quespiwanka. Elements of Zawaski's research were combined with Malville's and my own for our 2008 paper *Cosmological Motifs of Peruvian Huacas*. Solar orientations involving Quespiwanka's white boulder form a prominent part of my research.

Chapter 3

Research Methodology

3.1 Introduction

This study mainly constitutes research in the field, following a prerequisite literature review. The field work conducted documents astronomical and other data with regard to Inca huacas in the Cusco, Sacred Valley and Machu Picchu regions of southern Peru. A sighting compass was utilized to measure solar horizon orientations that were also supplemented by T2 theodolite measurements in certain cases. GPS coordinates of latitude, longitude and altitude above sea level were recorded at all locations for subsequent trigonometric comparisons. Orientations of any features to sunrise or sunset at significant times of the year were documented. In general, for the purposes of this study “alignment” refers to a line defined by such as the wall of a building and “orientation” refers to a sightline from a point to the horizon. Light and shadow effects at the huacas were recorded by photographs. Huaca characteristics were noted including physical features, light and shadow effects, and relationships with the surrounding landscape and other huacas. In the Region Surrounding Cusco huacas come from those identified by Bauer (1998) formed the baseline for my research. Shrines in the Sacred Valley and Machu Picchu were evaluated as well. Mathematical and atmospheric considerations for observations are discussed in Chapter 7.

Huacas were examined in part based upon a catalogue of motifs and iconic features (Table 3-1). Multiple levels of meaning were considered including these cultural motifs, astronomical contexts and sightlines, as well as light and shadow effects throughout the year on the dates of key solar events.

3.2 Observations and Measurements

This project focused on key dates for solar horizon events. Horizon positions were calculated and measured on the dates of associated events. Particular attention was paid to the photo-documentation of light and shadow effects of solar horizon positions at solstice sunrises. The equinoxes were included in this research although there is no record of such Inca horizon observations in the chronicles.

3.3 Equipment and Calculations

Most of the orientations of this study are sightlines to the horizon that do not involve alignments with walls. Magnetic bearings and inclination angles were recorded with a Suunto Tandem Compass Clinometer Sight Survey Tool, a liquid-filled precision compass and clinometer. This instrument proved to be most valuable in the establishment of horizon related orientations. The recorded inclination angles were used with trigonometric formulas for establishing the position and time of sunrises on the actual local horizon.

Photo documentation was accomplished with an 8-megapixel digital camera and tripod.

Global positioning was made with a Garmin GPS. Latitude, longitude and elevation in meters above sea level were recorded at each of the sites in the study.

Certain measurements were validated with a Wild Heerbrugg T2 Theodolite.

GPS azimuths were calculated trigonometrically and are listed in Appendix A2.

Magnetic declinations were taken from the National Oceanic and Atmospheric Administration: National Environmental Satellite, Data and Information Service - National Geophysical Data Center and are listed in Appendix A3.

Solar horizon positions were calculated trigonometrically and are listed in Appendix A4.

3.4 Cultural Motifs and Huaca Features

Astronomy is only one of multiple levels of meaning in the designs of Inca huacas. Celestial orientations must be placed into context with other purpose and function in order to fully understand their significance. In that effort each huaca was examined for evidence of motifs and features common with others found throughout the area of study. These were derived from descriptions found in Hemming and Ranney (1982) and Paternosto (1989). They are listed in Table 3-1.

Motif/Feature	Potential meaning or function
1. Carved or sacred rock	Improvement upon nature
2. Light and shadow effects	Ceremony
3. June solstice sunrise	Horizon events
4. June solstice sunset	Horizon events
5. December solstice sunrise	Horizon events
6. December solstice sunset	Horizon events
7. Equinox sunrise events	Horizon events
8. Equinox sunset events	Horizon events
9. Zenith events	Horizon/zenith sun events
10. Anti-zenith events	Horizon events
11. Cardinal alignments	East-west and north-south
12. Stairs	Shamanic movement
13. Seats	Ceremony and sighting
14. Niches	Ceremony and mummies
15. Water source	Camay
16. Fountains	Ceremony and camay
17. Basins	Offerings or reflections
18. Caves	Origin myth/underworld
19. Light-tubes	Ceremonial illumination
20. Altars	Ceremony and sacrifice
21. Platforms	Ceremony and sacrifice
22. Gnomons, monoliths, pillars	Astronomical uses
23. Animal carvings	Cosmological spirits
24. Horizon replica stones	Sacred landscape
25. Channels - zigzag/straight	Offering and divination

Table 3-1: Motifs and Features of Huacas.

3.5 Protocol

Basic protocol followed for the collection of data at each of the field sites is listed in Table 3-2.

1. Record GPS position and elevation of shrine.
2. Examine and record azimuths to horizon for key solar events.
3. Visually inspect and photo-document shrine noting various motifs, record date and time, record pertinent orientations and dimensions.
4. Note sightlines to prominent landscape features and measure azimuths.
5. Photograph orientations and/or variations of light and shadow on features of the shrine.

Table 3-2: Protocol of Field Measurements.

3.6 Research Locations

This thesis focuses upon the huacas established during three generations of ruling Incas, Pachacuti, Topa Inca and Huayna Capac. The regions chosen for this study are three that were important to those rulers - Cusco, the Sacred Valley and Machu Picchu. The sites selected were primarily the principal huacas, mainly carved from rock, throughout each area as identified by Bauer (1998), Hemming and Ranney (1982), Gasparini and Margolies (1980), and suggested by Dr. Kim Malville. My research in the Region Surrounding Cusco included huacas at 19 locations beyond the city's center, seven of the sites were in the region of the Sacred Valley, and the remaining three sanctuaries were related to Machu Picchu. The focal points for my field research are as follows:

Region Surrounding Cusco

Kenko Grande
Kenko Chico
Mesa Redonda
Tetecaca

Patallacta
Kusilluchayoc
Lacco
Huaca for solar horizon events
Lanlakuyok
Puca Pucara
Tambomachay
Sacsahuaman
Mollaguanca
Sapantiana
Rumiwasi Bajo
Rumiwasi Alto
Kusicallanca
Tipon
Saihuite

Sacred Valley Region

Chinchero
Pisac
Quespiwanka
Cerro Pumahuachana
Cerro Unoraqui
Choquequilla
Ollantaytambo

Machu Picchu Region

Machu Picchu
River Intihuatana
Llactapata

Part II: Context

Chapter 4

History and Conquest

4.1 Introduction

The Inca Empire had grown to span the Andes and coastal regions from Chile to Columbia by the time of the 16th century invasion from Europe. While the Incas' reign was relatively short, they were preceded by many civilizations tracing back for thousands of years and the roots of Andean astronomy can largely be attributed to those ancient societies. Celestial myths, beliefs and knowledge developed through observations made century after century, passed on from one generation to the next, and one conquering tribe after another. The Incas inherited celestial knowledge and adapted it to their own needs. They created a strong state religion of the sun and assimilated astronomy obtained through their conquests. Temples and shrines were built that displayed publicly many of these astronomical concepts.

Systematic celestial development came to a halt in 1532 when fortune-seeking Spanish conquistadors first invaded Peru, and likely advanced little during the internal strife of the previous five years. The conquering Spaniards failed to appreciate local astronomical knowledge and instead persisted in framing their views according to those of European culture.

It took the Spanish 40 years to track down and execute the last ruling Inca and by that time Catholic priests from Spain had descended upon Peru and set out to locate and destroy everything related to the indigenous religion. This included all they could identify relating to worship of the sun, moon and stars.

The long history of the Andes and its many social pressures greatly affected the astronomy of the Incas. Some of those many influences are outlined in the sections of this chapter.

4.2 Before the Incas

The civilization of the Incas was built upon cultures that had preceded them such as the Huari, Nasca, and Chavin. Their period of dominance, lasting only a century, was far too short to independently develop such advanced forms of religion, social structure, construction and astronomy. The Incas were adept assimilators of knowledge, both what was available at the time of their empire's inception, as well as that of the many tribes conquered during their reign (D'Altroy, 2002; Gasparini and Margolies, 1980; Paternosto, 1996).

Silverman (2004), Isbell and Vranich (2004), Haas and Creamer (2004), Solis (2006), Kembel and Rick (2004), and Ghezzi (2006) have discussed periods of Andean chronology that update earlier delineations devised by Rowe. Table 4-1 is a compilation of such cultural periods. It must be stressed that exact dates remain uncertain and the ones I present were selected simply to serve as examples in my text. Representative cultures are provided for context, but this list is not comprehensive.

PERIOD	TIMEFRAME	REPRESENTATIVE CULTURES
Late Horizon	A.D. 1476 - A.D. 1532	Inca
Late Intermediate	A.D. 1000 - A.D. 1476	Chimú, Chincha
Middle Horizon	A.D. 550 - A.D. 1000	Huari, Tiwanaku
Middle Intermediate	A.D. 300 - A.D. 600	Huari, Nasca
Early Intermediate	A.D. 100 - A.D. 300	Moche, Nasca
Epiformative	200 B.C. - A.D. 100	
Final Formative	400 B.C. - 200 B.C.	
Late Formative	600 B.C. - 400 B.C.	Chavin
Middle Formative	1000 B.C. - 600 B.C.	Chavin
Early Formative	1500 B.C. - 1000 B.C.	
Final Archaic	2000 B.C. - 1500 B.C.	
Late Archaic	3000 B.C. - 1800 B.C.	Caral

Table 4-1: Andean Chronology

More than two millennia ago in the Middle Formative much of Peru was influenced by the Chavín; what we know of them comes from the art of their archaeological remains (Burger, 1992). In the Early Intermediate to the north lived the Moche, known for their pottery and textiles. The Huari followed in the Middle Intermediate and Middle Horizon, and later the Chimú in the Late Intermediate. In the region of southern Peru in both the Early and Middle Intermediate were the Nasca who produced pottery and textiles as well as enigmatic lines thought to be astronomically related – designs fully discernable only from great heights above. This southern area later saw the Chincha in the Late Intermediate (Hemming, 1970; Paternosto, 1996; Silverman, 2004; Zuidema, 1964).

In the Middle Horizon much of Peru was dominated by the Huari and the Tiwanaku. The Huari developed in Peru's Ayacucho region while the Tiwanaku stemmed from Lake Titicaca in Bolivia. The Tiwanaku occupied southern Peru, and its ruins include stone platforms, statues and a gateway of the sun. The Incas, also with cosmological beginnings at Lake Titicaca, likely learned much from the Tiwanaku with regard to their construction practices (Hemming, 1970).

During the Late Intermediate other cultures arose, such as the Canarí, Chanca, Colla, Lupaca, Huanca, Conchuco, Yarivilca, Chachapoya, and the Incas. These tribes flourished until they each were conquered during the consolidation period of the Incas. Prior to their conquest the Chimú developed a society especially sophisticated in art, construction, irrigation, defense, and politics. The Incas appear to have closely studied advancements in Chimú civilization (Hemming, 1970).

The Incas owed a great deal to their predecessors as much of their culture and technology came from knowledge assembled over many centuries. Technique and motivation for monumental sculpture seem likely to have taken root with the Tiwanaku and Huari. The Huari leave an intricate textile calendar. Construction with large blocks was taken from the Tiwanaku region at Lake Titicaca. The Tiwanaku shared a similar cosmology that provided the Incas with the ancestral roots they needed to establish the legitimacy of their empire (Zuidema, 1977; Hemming and Ranney, 1982).

4.3 The Early Incas

It is thought that the earliest Incas settled in the Cusco valley circa A.D. 1200. Their existence appears to have been relatively stable until the early 15th Century, a time at which many significant events in Inca history began to occur. Inca mythology proclaims Manco Capac to be their founding leader and that he began an unbroken dynastic succession that led to its 8th Emperor, Viracocha Inca, and his son who ultimately would be known as Pachacuti. Niles states that as no evidence of their mummies ever existed the first four Incas in the lineage were likely mythical (D'Altroy, 2002; Niles, 1987).

The Incas promulgated the belief that they were the chosen people of the sun and that they had been "created to be the rulers" (Sherbondy, 1992: 54). "They were the children of the sun and therefore first among all peoples" (Sherbondy, 1992: 55-56). The Incas developed their culture and religion around the sun and thrived as they grew over the next two centuries. Legend has it that a major change in fortune occurred c. 1438 when a powerful neighbor, the Chancas, attacked the Incas with the aim of conquest. Viracocha Inca, sensing defeat, fled Cusco with his designated heir leaving its defense to a younger son, Inca Yupanqui. In an epic battle he routed the Chancas and following his victory claimed rule from his father and brother (D'Altroy, 2002; Zuidema, 1964). He adopted the name Pachacuti Yupanqui Inca and empowered by his Chancan victory embarked on a campaign first to conquer the Chanca's allies, and then to expand Incan rule over all known tribes throughout the Andes. According to the legend Pachacuti's father would never to return to Cusco (Niles, 1987). Zuidema (1985) points out that no archaeological evidence has been found to support the occurrence of this battle.

The ensuing years were filled with conquest, but also construction and enlightenment. Pachacuti commanded a great building program that created a majority of the huacas, palaces, temples and Inca roads that we find today. Tribes, such as the Chimú, when defeated were often dispersed throughout the Empire as workers called *mitmaes* in an effort to diffuse threats to Inca security and gather specialists for service to the state (D'Altroy, 2002). The Incas assimilated much from many tribes as they conquered them, however, and further refined their civilization.

It is often mentioned that the Tiwanaku inspired the Incas' tradition of monumental sculpture (D'Altroy, 2002; Paternosto, 1989). There is a chronological gap between these two cultures, but distinct similarities exist between their architectural styles. Additionally, in-depth knowledge of astronomical cycles can only be observed over long periods of time, thus implying that the Incas acquired much of their celestial prowess through information gathered by other civilizations, either direct predecessors or conquered tribes holding ancient traditions.

Pachacuti, his son, and grandson successively built the largest empire ever known in the Americas, 4800 km from Chile to Columbia. They established armies in fortresses at distant stations with the infrastructure of roads and storehouses that was necessary to support them. Temples and shrines were constructed as a part of exerting state control over its subjects, as well as pilgrimage centers designed to reinforce the legitimacy of royal rule over the populace (Bauer and Stanish, 2001).

By the time Francisco Pizarro arrived in Peru in 1532 the Incas had not only built an impressive empire, but also a remarkable society. Their civilization had advanced to its sophisticated level without European influence or even knowledge that nations such as Spain existed (Hemming, 1970). As far as "the son of the sun" was concerned, he ruled the world.

4.4 Rulers of Imperial Expansion

The greatest period in Inca history began with Pachacuti's ascent and lasted until the c. 1527 death of his grandson, Huayna Capac. Pachacuti's son, Topa Inca, governed from 1471 to 1493 (Niles, 1987). Pachacuti's ambition and vision launched an empire of a magnitude never before seen in the Western Hemisphere. He initiated massive construction, created a complex society and bureaucracy, further developed a domineering religion and had very apparent interests in celestial alignments. His son and grandson continued to pursue his visions of imperial expansion and extensive construction, albeit building with interpretations of their own. It would take civil war and a European invasion to halt their progress.

4.4.1 Pachacuti Yupanqui Inca

Pachacuti, the name adopted by Inca Yupanqui, translates as "transformer of the world", which was exactly his intent. More specifically, from Quechua, *pacha* means "a moment or interval in time and a locus or extension in space" (Salomon, 1991: 14) and *cuti* "to turn around" (Hemming and Ranney, 1982). *The* 9th king of the Incas viewed himself both as the son of the sun and co-creator of the land. Salazar (2004: 41) suggests that Pachacuti felt a special association with "supernatural forces immanent in the landscape and the celestial sphere," and that his connection with these forces needed to be "actively reaffirmed through daily ritual."

The Incas sought first to control the Chancas. They later set out to subjugate the world, including the region surrounding Lake Titicaca – that of their mythical origins. Pachacuti aggressively expanded the Incas' sphere by conquering one tribe after another. He desired to spread Inca religion and culture across the Andes (Niles, 1987). Noteworthy is that while the Incas were known for their military prowess, Pachacuti actually sought first to assimilate tribes peacefully without bloodshed when at all possible. The Incas did this by sending scouts to assess the tribe, followed by communication with the chief informing him that he could keep his throne if he willingly joined the empire. The Incas often included bribes and most of all made it clear that they would take the land and its people by force if necessary. The tribe could be welcomed as new citizens of the empire, or be destroyed by the Incan army (Hemming, 1970).

The success of Pachacuti's initial efforts inspired him further as he added several large tribes to his empire, along with assets such as their gold and silver (Lee, 2000). He carried on a campaign across the Andes that would be continued by Topa Inca and Huayna Capac. Gasparini and Margolies (1980: 101) suggest that the goal for conquest "...was control of certain ecological zones and strong points rather than conversion of every last peasant to the solar cult...." Achievement of such would provide the Incas with security for their civilization as well as locations for fortresses and administrative centers to be used for control of these conquered regions and the imposition of Inca religion and culture upon those living there.

Conquest was not always peaceful, however. Subjugation of the Cañari, for instance, was protracted and quite bloody with great Inca brutality. Willing Canarí loyalty was never secured and thousands of them eagerly sided with the Spaniards against their Inca masters during the ensuing European conquest (Hemming, 1970). Others, such as the Wanka, would do so as well (Gasparini and Margolies, 1980).

The Incas often would displace new subjects after their conquest. Local gods were removed to Cusco along with their attendants and entire populations were conscripted and dispersed to service distant royal projects (D'Altroy, 2002; Hemming and Ranney, 1982). Still, Pachacuti and the elites of his administration sought to learn concepts of value from their new citizens while integrating them into their positions in Inca society.

In his legendary conflict with the Chanca Pachacuti reportedly wore the hide of a Puma into battle. Pachacuti is credited with being the designer of Cusco, a community whose city plan incorporating the confluence of two rivers has been said to resemble the body of a puma, a symbol of military valor that also represented the royal dynasty (Niles, 1987; Paternosto, 1989). Zuidema (1985: 183-186) counters that this concept is mistaken and that the real meaning of the puma is a metaphor meant to represent the emperor at the head of the Inca state. He asserts that there is no evidence in the chronicles to support the shape of Cusco as a feline. Betanzos (1996 [1576]: 71) writes of Pachacuti having decreed that the far end of Hurin Cusco would be referred to as "Pumachupa, which means the lion's tail," but this still was more figurative rather than part of an intentional design of the city.

The head of Cusco's puma was defined to the northwest by the jagged teeth of Sacsahuaman and its tail began where two streams met in the southeast. The streets of Cusco weaved throughout the body between (Hemming & Ranney, 1982).

As the architect of Inca civilization Pachacuti initiated such magnificent projects as Sacsahuaman, Ollantaytambo and Machu Picchu (Gasparini and Margolies, 1980). He felt he both could and was obliged to improve upon the handiwork of the creator. As the son of the sun and co-creator of the land Pachacuti promoted a style of masonry integrated with natural rock formations. Several sites give the appearance that the stone blocks of manmade construction are integral and simply grow from their natural rock foundations (Paternosto, 1989). Pachacuti also modified and enhanced stone outcroppings to improve them as huacas, some incorporating astronomical orientations. Celestial orientations found in the huacas and structures created during Pachacuti's reign suggest a strong interest in the solstices, especially that of June.

4.4.2 Topa Inca Yupanqui

Topa Inca acceded to the throne in 1471 and continued his father's massive campaign of territorial expansion. He also is noted for his construction projects, among them the establishment of his royal residences. Topa Inca claimed the Chinchero valley as the site for his rural estate and set about construction of its palace, courtyard, support buildings and agricultural terraces. The estate extended to the salt terraces of Maras and perhaps also included the terraced collapsed basins of Moray. The style of architecture and design suggests a view of nature similar to that of Pachacuti's in which natural rock and landscape features were included in structural forms. Also on the estate are several intricately carved rock huacas (Niles, 1999).

While the sites of Pachacuti are steeped with solstitial orientations, his son may have embraced a different philosophy. The many walls and terraces of the Chinchero estate are oriented cardinally, precisely north-south and east-west. This in itself represents astronomical prowess as the cardinal direction of south might first have to have been determined by the shadow plot of a vertical gnomon. North, east and west would then follow geometrically.

Topa Inca is credited with completing the complex of Sacsahuaman at the northwest edge of Cusco. He ruled until 1493 (Niles, 1999).

4.4.3 Huayna Capac

Huayna Capac was the son of Topa Inca and Mama Ocllo who, as his father's wife and sister, was both mother and aunt. In this way his parents belonged to a lineage both patrilineal and matrilineal, just as the creator god Viracocha was said to have founded both patrilineal and matrilineal lineages (Zuidema and Quispe, 1973).

Huayna Capac was born at Tomebamba, near modern Cuenca in Ecuador. Niles (1999) states that Pachacuti designated this grandson to succeed Topa Inca to the throne. She says that Huayna Capac remained close with his mother, who made him promise not to leave her to do battle – a pact he honored until her death.

Coya Cusirimay, Huayna Capac's legitimate wife, was his full sister, but did not give him an heir (Niles, 1999). He next chose another sister, but she did not receive the blessing of his father's mummy. Ultimately he took Cibichimpo Rontocay as his principle wife. He is reputed to have had more than 50 others. Huayna Capac fathered scores of children, among them his sons Huascar and Atahualpa. They were half-brothers and Atahualpa was the elder. When Huayna Capac departed on a protracted campaign to subdue rebellious tribes in the north, he left Huascar in Cusco to govern in his absence and took Atahualpa with him into battle (Niles, 1999). This action ultimately would take its toll on the empire.

Huayna Capac built his country estate in the Sacred Valley placing his palace, Quespiwanka, near the modern village of Urubamba. He, like his grandfather Pachacuti, exhibited interest in the solstices through astronomical orientations. Huayna Capac additionally built a palace in Cusco and commissioned architecture at Tomebamba, the place of his birth (Niles, 1999).

Huayna Capac was skilled in diplomacy and genuinely cared about his subjects (Niles, 1999). He spent a great deal of time to the north, away from Cusco, and considered making Quito a second capital (Hemming, 1970).

Huayna Capac died without a designated heir in 1527, most likely from the sweeping epidemic of smallpox brought from Europe. His mummy was prepared, adorned and taken on a litter to Cusco (Betanzos, 1996 [1576]: 185; Poma de Ayala, 2006 [1616]: 108). Later the mummy was taken to Quespiwanka where it was hidden from the Spaniards for more than 20 years (Betanzos, 1996 [1576]: 190). A civil war ensued as Huascar in Cusco assumed the throne (Sarmiento, 2009 [1572]) and Atahualpa, with the Imperial army in Quito, challenged him from the north. The epidemic swept the empire killing thousands, and the civil war claimed many more. The timing of the arrival of a small, but determined band of mounted and armored conquistadors couldn't have been much better (Hemming, 1970; Niles 1999).

4.5 Spanish Conquest

Following Huayna Capac's death Huascar controlled the southern part of the empire and worked to establish himself as his father's successor. Atahualpa controlled the north, however, and had his own designs on the throne of the Incas. A great battle erupted between them that embroiled and decimated the nation. Atahualpa's followers challenged the legitimacy of Huascar's claim to rule and supporters of Huascar characterized Atahualpa as a usurper of royal power (Hemming, 1970). The Empire eroded to a considerably weakened state, first due to the decimation of smallpox and then by the death-toll and chaos of civil war.

Many of the Incas' recently conquered tribes hated their new masters passionately, a factor that would serve the Spaniards well. These natives found they disliked the Incas more than the Europeans and some seized the opportunity to strike back at their conquerors by aiding the

Spanish effort against them. When combined with plague and civil war these events softened the battle-hardened empire to the point where the invading conquistadors met with what proved to be insufficient resistance (Hemming, 1970).

Fifty-four years after Pachacuti defeated the Chancas, Columbus sailed to the West Indies in 1492. Spain had amassed considerable, but costly, military prowess and sought new fortunes to help fund their expansions. Once word of the riches found by Columbus reached the Old World, the new one would never be the same (Hemming, 1970).

Captain Francisco Pizarro crossed the Panamanian Peninsula and reached the Pacific in 1513. A base for exploring the Pacific shores was founded there and named Panama (Hemming, 1970).

In 1519 Hernán Cortés invaded Mexico and set out to conquer the Aztecs with as few as 500 men and 16 horses. With assistance from some of the Aztec's subject tribes Cortés succeeded and subsequently shipped much wealth to his king (Hemming, 1970). The promise of untold riches brought many to the Americas, and ultimately Peru, in search of their personal fortunes.

The year 1522 saw Pascual de Andagoya explore 200 miles of the Columbian coastline and land at the San Juan River in search of the *Viru*, the name which later gave rise to *Peru*. Pizarro set out in 1524 and 1526 to find his fortune, but fell short on both occasions (Cieza de Leon, 1998 [1555]: 48-51; Hemming, 1970).

Before a single European set foot in Peru, smallpox, brought to the Americas by livestock, swept the country from the north, killing a great many of the empire's subjects as well as their emperor (Betanzos, 1996 [1576]: 160-161). Spanish presence in Central America also introduced diseases such as measles and diphtheria for which the Andeans likewise had little resistance. The effect was devastating as routines normal for maintaining daily life were abandoned and society ground to a halt.

The civil war continued to drain the empire for five years until Atahualpa ultimately defeated Huascar and captured Cusco in 1532. Atahualpa's reign would be short-lived, however, as the Spaniards under Pizarro were soon to arrive (Hemming, 1970).

Intrigued by the new world riches of Cortés, in 1529 the Spanish Queen authorized Pizarro to conquer Peru and named him as its governor. Taking three half-brothers with him he sailed from Panama to Ecuador in 1530 and ultimately reached the northern boundaries of the Inca Empire in 1531. It was there he first found the carnage that had been left by plague and civil war (Hemming, 1970).

Atahualpa captured Cusco and placed Huascar under custody, but soon after he was himself imprisoned by Pizarro. The Spaniards later moved into Peru with 62 cavalrymen and 106 soldiers, advancing just as the civil war was coming to an end. Technological superiority of armored and mounted soldiers, prefaced by plague and internal warfare, was responsible for Spanish success against massive indigenous forces fighting with slings and spears (Hemming, 1970).

Atahualpa sent an envoy to Pizarro and extended him an invitation to meet. The Spaniard agreed, but instead plotted to kidnap the Inca, as had been done so successfully by Cortés with the Aztecs in Mexico. The Spanish attack worked and Pizarro held Atahualpa for eight months before finally executing him in July of 1533. During the interim Atahualpa paid Pizarro a ransom consisting of most of the empire's gold for his release, but this became a bargain that was never honored on the Spanish side. While imprisoned Atahualpa sent an order to have Huascar murdered, so with both of them dead the Incas were once again left with a vacuum of leadership in a time of great crisis (Sarmiento, 2009 [1572]: 238-240, Hemming, 1970).

Pizarro likely never intended to release Atahualpa, but he collected a great fortune during the Inca's captivity. The Spaniards, concerned with potential rebellion, ultimately garroted the Inca, but only after he first nominally converted to Christianity. King Charles was quite disturbed that Pizarro executed a royal monarch, but several local tribes were pleased to realize an end to Incan oppression (Hemming, 1970).

4.6 Inca Resistance

The Spaniards took Cusco in 1533, entering the city without a struggle on November 15th. Word of Peruvian treasure spread widely throughout Spain and a rush of fortune seekers descended upon the empire. Soldiers were richly rewarded if they agreed to remain rather than return to Europe (Hemming, 1970).

Tupac Huallpa, the son of Huayna Capac and brother of Huascar, was allowed by Pizarro to be coronated immediately following Atahaulpa's execution. The Spaniards were viewed as liberators in Cusco, having rid the empire of Huascar's rival, and Pizarro sought to establish a puppet regime (Betanzos, 1996 [1576]: 276-277; Hemming, 1970). Tupac Huallpa's reign was short-lived, however, as he soon died of illness and once again left Pizarro with the task of installing a controllable head of state. For this he chose another of Huascar's sons, Manco Inca Yupanqui (Betanzos, 1996 [1576]: 278-279).

Pizarro, concerned about an attack from Quito, now openly embraced the Incas in Cusco. He felt Manco, a legitimate heir, would be a popular choice and saw to it he was installed as the new leader. The relationship worked at first, but it ultimately was undermined by Spanish greed and arrogance. Spanish treatment of Manco, even as the Incas' leader, eroded over time to where possessions from his home were stolen and ultimately his princess wife was taken by Gonzalo Pizarro for his own. In the wake of such events Manco evolved from a compliant puppet into a revolutionary leader (Betanzos, 1996 [1576]: 280-284; Cobo, 1983 [1653]: 172-177; Hemming, 1970).

By 1535 Manco had suffered long enough and realized that his people were faring no better. He decided he could no longer support the Spanish regime and left Cusco under the cover of darkness. Manco soon, however, was captured, imprisoned and tortured. He was released in 1536 and it was ordered by King Charles that he be given the due of a hereditary monarch. Manco once again fled Cusco and assembled a great army at Calca. Villca Umu, the chief priest of the empire, occupied Sacsahuaman with additional forces. With Manco on the run Pizarro installed another puppet, Cusi-Rimac, in his place (Hemming, 1970).

The Incas struggled to kill armored cavalrymen and rarely succeeded. Slings were their best weapons as they laid siege to the Spanish occupied Cusco. The thatched roofs of the capital were set on fire in an effort to drive the Spaniards out. Flooded fields, pits, and bolas all were employed to combat the mounted threat. At times it looked as if the Incas might succeed, only to be thwarted once again as the Spanish persevered to victory (Betanzos, 1996 [1576]: 289-290; Cieza de Leon, 1998 [1555]: 455-462).

Defeated at Cusco and Sacsahuaman, Manco fell back to Ollantaytambo to make his next stand and secured one of the Incas' few victories against their foes. As Spanish cavalrymen approached the monumental terraced walls of Ollantaytambo the Incas released great waters and flooded the fields below them. At the same time attacks were made from the flanks on those caught in the deluge and the Spaniards narrowly were able to flee to safety. The following year, in 1537, the Spanish attacked with better preparation and forced Manco to retreat once again, this time to the fabled Vilcabamba. Much to the consternation of Pizarro, as long as the Inca lived so did the empire (Betanzos, 1996 [1576]: 290-291).

An ambitious rival of Pizarro, Diego de Almagro seized Cusco in 1537 leaving the Spaniards with a civil war of their own. Paullu Inca assisted Almagro, who later rewarded him with his brother Manco's title. The battle between Pizarro and Almagro continued into 1538 when Francisco's brother Hernando recaptured Cusco and had Almagro executed (Hemming, 1970).

The Inca rebellion continued in 1539 while deep in the forests of the Amazon Manco's forces established the Vilcabamba as their new capital. Vilcabamba grew to be a significant settlement and served to preserve Inca culture and religion. Pizarro and Manco killed each other's men in skirmishes, but the Vilcabamba remained secure with Incas in Cusco comforted in the knowledge that their emperor was still alive (Hemming, 1970).

Paullu thrived under the Spaniards and was later baptized as a Christian. It was Paullu who ultimately gave up his father, Huayna Capac's, mummy from its hiding place at Quespiwanka. Sarmiento de Gamboa (2009 [1572]: 217) relates that it was Polo de Ondegardo who found the emperor. The Indians in Cusco did not regard Paullu as their Inca, however, and instead looked for guidance from Manco, many defecting to join him. Francisco Pizarro was murdered by sympathizers of Almagro in 1541, who then quickly moved to install Almagro's son as Governor of Peru. The assassins fled and found refuge with Manco in the jungle. Almagro's son was put to death in 1542 (Cobo, 1983 [1653]; Hemming, 1970).

The Spaniards showed little interest in Inca astronomy and at the time of the conquest were still influenced by the geocentric teachings of Claudius Ptolemy. The heliocentric theory of the universe was only first introduced in Europe by Copernicus in 1543 and received little acceptance for decades. The conquistadors were preoccupied with wealth and power while the interests of the Catholic priests largely centered upon the extirpation of indigenous sun-worship idolatries.

Manco welcomed the Almagrist's, but they grew weary of their exile in the rain forest. In 1544 they reasoned that they might be able to return to Cusco by ridding the Spaniards of Manco and thereby stabbed him to death. None of them escaped, however, as all were quickly hunted down while they fled and put to gruesome deaths (Cobo, 1983 [1653]: 175-177; Hemming, 1970).

Manco lived long enough to learn of his assassins' demises and also to name his son, Sayri Tupac, as his successor (Betanzos, 1996 [1576]: 297-299; Cobo, 1983 [1653]: 175-177). Sayri Tupac was five years old at the time and ruled peacefully for thirteen years through his regents and advisors. He was influenced by his uncle in Cusco, Paullu Inca, and significantly reduced hostilities toward the Spanish. Sayri was enticed by Paullu to leave exile for Cusco. In 1557 he was given a full pardon and a large estate in Yucay, where he and his wife, María Cusi Huarcay, both having been baptized lived until his death in 1561 (Farrington, 1995). This left the Spaniards no living Incan heir in Cusco (Hemming, 1970). Niles (1999) says it was widely believed Sayri Tupac was poisoned.

Meanwhile Titu Cusi Yupanqui usurped Tupac Amaru as Inca upon Sayri Tupac's departure from the Vilcabamba. Titu Cusi was a very capable ruler and was well supported by the empire's military commanders. The Spaniards tried to entice Titu Cusi to leave the Vilcabamba for Cusco. He played them masterfully for years, but never left the sanctity of his jungle refuge (Hemming, 1970).

By the 1560's, as priests learned Quechua they became aware of a great resurgence of indigenous sun-worship and idolatry, in part inspired by perpetuation of Inca culture in the Vilcabamba. Eradication of everything associated with these pagan beliefs became of top concern for the Church and renewed effort was put into the campaign initiated for that purpose (Hemming, 1970).

Titu Cusi became so adept at giving the Spaniards just enough hope for a peaceful conclusion that he was able to forestall an invasion for years. In 1568 Titu Cusi learned the catechism and was baptized by a priest who had braved the jungle. He was christened Don Diego de Castro Titu Cusi Yupanqui, but came to resent some of the lifestyle constraints the friars tried to impose (Cobo, 1983 [1653]: 181; Hemming, 1970).

Francisco de Toledo was appointed as the fifth Viceroy of Peru in 1569. He was said to be a great administrator and that he instituted tenets of government that functioned well for generations. Conversely Toledo legalized the mita labor system with the result being a great number of deaths and a drastic decrease in population. He resented the former Inca monarchy and argued that the empire was no more legitimate in its rule of Peru than were the Spanish – both were conquerors of indigenous tribes. He maintained that the Incas were decadent in the eyes of God and that the Inca nation in Vilcabamba could not be allowed to continue to exist (Hemming, 1970).

In May of 1571 Titu Cusi became ill and died, but the Incas kept his passing a secret from Cusco. Some thought he had been poisoned and Martin Pando, Titu Cusi's mestizo advisor, was promptly executed. The other in Vilcabamba with Spanish ties, Friar Diego Ortiz, was stripped and bound, but only killed later on command of the new Inca (Hemming, 1970).

Titu Cusi's captains decided that his brother Tupac Amarú should lead them instead of his son Quispe Titu. Tupac Amarú rejected Christianity in favor of traditional worship. He closed the Vilcabamba to all from the outside and ordered obliteration of anything Christian. Peaceful coexistence with the Spaniards came to an end (Hemming, 1970: 418).

Toledo did not know of Titu Cusi's death and continued efforts of diplomacy. He dispatched an emissary who was killed to preserve the secret. By early 1572 Toledo was sure he needed to conquer the Vilcabamba and sought the King's permission to attack what was viewed as a sovereign monarchy. War was declared on April 14th and Toledo prepared for the invasion which ensued soon after. On June 24th the Spaniards marched into the Vilcabamba, but found it deserted and burned while the Incas had retreated further into the jungle (Hemming, 1970).

Quispe Titu and his wife were captured in the rain forest six days later. The Manari's helped the Spanish locate Tupac Amarú, who was captured along with his pregnant wife some 275 kilometers from the Vilcabamba. Tupac surrendered peacefully and was promised safe passage and fair treatment. Upon his arrival in Cusco, however, Toledo had him immediately tried, convicted, and sentenced to death (Hemming, 1970).

Like several of his predecessors, Tupac Amarú was instructed in Christianity and baptized before his death. At the gallows this final Inca gave a compelling speech to a massive crowd of his subjects. He denounced paganism and extolled Christianity. When finished he received his blessing and was decapitated by a Canarí executioner (Hemming, 1970; Lee, 2000). The lineage of Inca kings had come to an end. After a struggle lasting for 40 years the conquest was finally complete and the Spaniards were in total command of Peru.

4.7 The Catholic Purge

The Catholic Church saw it as its mission to convert all they encountered to Christianity (Hemming, 1970). Natives in foreign lands, previously unexposed to Church teachings, were considered of prime importance for religious education and to be saved from their pagan ways. The Vatican often failed to acknowledge that many native cultures had deeply rooted belief systems that would be hard to eliminate. This certainly was the case with the Incas.

Spain sought Vatican permission to conquer the Americas and was granted this by Pope Alexander VI as long as they converted all they dominated to Christianity. Chapels, cathedrals and monasteries were built in the major centers of Peru, but progress was limited at first due to the insufficient number of priests available to do the work. The Spaniards were somewhat successful in suppressing public practice of the Incas' religion, but found certain fundamental elements hard to eliminate (Hemming, 1970).

Soon after their invasion of the Inca homeland, the Spanish looted and destroyed the most important shrines, such as the Temple of Pachacamac and the Coricancha of Cusco. In 1539 the Spanish began a ruthless campaign against the indigenous religion and set about to systematically destroy as many huacas as possible (Arriaga, 1968 [1621]; Bauer, 1998). Attendants and worshippers of known huacas were prosecuted, tortured, and/or put to death, the foundations of the shrines were dug out, the object of worship was destroyed, anything flammable was burned, and finally a cross was built over the ravaged space. The one fortunate aspect of this campaign of destruction was that the names and locations of these huacas were recorded so that they could be checked-out in the future to make certain no religious activity continued. Some of the huacas, namely the carved limestone outcrops, could not be obliterated and remain to this day. The Spanish lacked the technology to destroy them and some have been preserved retaining a remarkable integrity. These shrines serve as a primary focus of this study.

In 1567 an ecclesiastical council was conducted in Lima with its aim to eradicate pagan rites. Hemming (1970) tells us that priests were instructed to abolish superstitions, ceremonies, arrest witch doctors and destroy any shrines or talismans. With this action the Church began an aggressive effort to erase all elements of the indigenous religion. Father Pablo Joseph de Arriaga described in detail the process of idolatry extirpation followed in Peru. He told of the indigenous worship and how it should be eradicated. Arriaga said (1968 [1621]: 24-25) that the "moveable huacas" once discovered were taken away and burned. Huacas that could not be removed, such as "high hills and mountains and huge stones" could still be worshipped. Of these he stated "…we must try to root them out of their hearts, showing them truth and disabusing them of error." The Spanish succeeded in destroying the most important shrines of Cusco, but the priests remained unable to obliterate rock and the life force believed by the Incas to be contained within.

Incan temples were either destroyed or their stone bases were used as the foundations for such as Catholic chapels. Many ruins survived, however, in remote areas. The extirpation of idolatries consumed members of the clergy for decades (Bauer, 1998; Gasparini and Margolies, 1980; Hemming, 1970).

4.8 Summary

In an effort to fully comprehend the intrinsic celestial orientations of Inca huacas the shrines must be examined not just astronomically, but also holistically with regard to their total function in society and cosmology. An understanding of the history of Inca culture and what influenced its cosmological and religious beliefs is required before it can be determined why these astronomical orientations grew to be of such great importance.

The Inca Empire was relatively short-lived, but Inca culture was built upon a long line of preceding societies. This is important for Incan astronomy because certain celestial knowledge had to be obtained cumulatively through observations of repetitive cycles made over very long periods of time. Astronomy was a major part of Inca cosmology, religion and agriculture and the significance of such is evident in many of the shrines and structures left by the emperors Pachacuti, Topa Inca, and Huayna Capac.

Our knowledge of Inca astronomical practices suffers from the lack of a written language and the desire of the Catholic Church to eradicate anything viewed as being related to indigenous religion. This extirpation of idolatries continued for decades and destroyed countless shrines. The Church accelerated their efforts during the latter part of the 16th century when a religious resurgence was discovered, partly inspired by the protracted survival of Inca culture in the Vilcabamba.

Records of huacas were maintained by the Church after the shrines were destroyed and Spanish chroniclers recorded information from conversations held with local informants. These do not give true contextual perspective to Inca astronomy, however, as the writings were from a European point of view at a time when even the teachings of Copernicus were new. The Spaniards failed to realize that the Incas saw the cosmos in their own unique and sophisticated way.

As part of the extirpation effort the Spaniards sought to obliterate anything related to worship of the sun or the earth. Eradicating all evidence of solar pillars or other constructs designed to monitor the progress of the sun was of prime importance as the Incas were a sun-worshipping society (Arriaga, 1968 [1621]). The efforts of the Catholics were quite effective and Inca horizon astronomy quickly faded from use.

Certain carved rock huacas and temple ruins survived the purge and provide us with a glimpse of Inca astronomy through examination of their celestial orientations. The remote solar pillars at Urubamba remain and certain isolated sites, such as Machu Picchu, were never discovered by the Spanish. Untouched by the priests, they are of prime importance for research today.

Chapter 5

Religion, Cosmology and Culture

5.1 Introduction

Astronomy was an integral part of Andean mythology and creation, and was at the very heart of the Incas' religion and agriculture. This chapter will discuss many aspects of Incan society in an effort to both show direct association with astronomy, where applicable, as well as describe other cultural aspects that influenced Incan thought and reasoning.

5.2 Religion

The Incas proclaimed themselves to be the children of the sun. They worshipped it and viewed their emperor as being the sun's direct descendant.

The Incas benefitted from existing Andean astronomical knowledge and beliefs and made solar worship the official religion of their empire. Pachacuti imposed it across the realm, maintaining that he was the son of the sun and his wife the daughter of the moon. The Incas venerated the sun, the Inca and his predecessors. Their religion was tied closely to nature with the prosperity of the world at the whim of supernatural forces found within mountains, caves and streams, as well as in huacas and celestial objects such as the moon, stars, rainbows and thunder (Hemming, 1970; Hemming and Ranney, 1982). Conquered tribes were made to accept state religious beliefs, but were allowed continued worship of their lesser gods.

The ruling Inca was the central figure in solar worship, supporting the assertion that he was the descendant of the sun. The emperor was the intermediary between the heavens and the populace of the realm (Bauer and Stanish, 2001). This deification was necessary to solidify the ruling Inca's legitimacy, to justify his absolute authority and also establish that of the state (Hemming, 1970).

The Incas associated the moon with *Coya*, the queen of the ruling Inca (Bauer and Stanish, 2001). The moon served both as the wife and the sister of the sun, a relationship that was also promoted for the empire's ruling couple (Zuidema and Quispe, 1973). The moon, in Inca culture, was feminine and the Inca's Coya its daughter. Women worshipped the moon and made offerings to it during eclipses and when giving birth. Descriptions of Inca lunar worship are rare, perhaps because of its feminine role in society (Bauer and Stanish, 2001).

State worship took place at temples and huacas as well as in pilgrimage centers designed to promote the authority of the ruling elite. Private worship proliferated as well with the veneration of deities located in niches built into walls of the home. Individuals led lives filled with rigid rituals they felt would enhance their personal well-being (Hemming, 1970).

Pachacuti established his religion as a state institution and organized a priesthood to attend to its temples and huacas. Pachacuti constructed many temples as he expanded his empire and decreed solar worship for everyone. The three most significant sites of worship became the Temple of Pachacamac, the Coricancha, and the Islands of the Sun and Moon (Bauer and Stanish, 2001).

5.3 Cosmology

The Incas believed the world was created by their god Viracocha at Lake Titicaca. Viracocha was the father of the sun and the moon. He was both male and female which enabled him to be the founder of both patrilineal and matrilineal descent lineages (Zuidema and Quispe, 1973). Viracocha first made people of stone and then made the sun, stars, and moon. He gave the stones life as they appeared from caves, rocks and springs (Paternosto, 1996). The Incas worshipped many deities in a hierarchal pantheon.

A common Inca creation myth related that Manco Capac, with his three brothers and four sisters, left Lake Titicaca in a migration beneath the earth and emerged from a cave south of Cusco (Hemming and Ranney, 1982). This is important as caves and other natural features of the earth became focal points of Inca veneration. They viewed caves and rock outcroppings as connections with their underworld.

Inca cosmology begins with Lake Titicaca, a large lake at an altitude of 3810 masl on the border between present-day Peru and Bolivia. The temperature-retentive waters create a microclimate very conducive for growing at that altitude, a factor that has attracted humans to the region since at least 2000 BC. Earliest occupation may date prior to 6000 BC and perhaps long before (Bauer and Stanish, 2001).

According to Bauer and Stanish (2001) the area surrounding Lake Titicaca took on more than local importance during the Tiwanaku period of AD 400 – 1100. It was perhaps then, long before the Incas, that the lake and its islands first drew pilgrims for reasons of cosmological significance.

Pachacuti conquered the Lake Titicaca region, sent thousands of mitmaes to occupy it, and also was alert for local practices that might be beneficial to his empire. Legend claimed the Island of the Sun and the Island of the Moon to be the points of origin for the sun, the moon, and the entire Inca tribe. As such, Pachacuti was quick to capitalize on these shrines and quickly incorporated both into cultural practice regarding Inca origins (Bauer and Stanish, 2001).

Pachacuti constructed a temple of the sun and shrine to the moon on the islands and, as the Incas' cosmological points of origin, they were instituted as state-sponsored ritual pilgrimage centers (Bauer and Stanish, 2001).

The Incas believed that the sun first rose from a sacred rock called Titicaca on the north end of the Island of the Sun, thus annual rituals were orchestrated there for both the June and December solstices. Non-elites were unable to view solar orientations at the sacred rock itself, and were instead required to observe from a platform at a distance (Bauer and Stanish, 2001). I found this ceremonial class separation to be a recurring theme with additional examples identified in my field research at Urubamba and Tipon.

The cosmos of the Incas existed in three distinct worlds – that of Ucu Pacha, the underworld; Kay Pacha, the here and now; and Hanan Pacha, the world above (Urton, 1981a). There are many extant examples of symbolic sets of three stairs representing transition between the three worlds of the Incas' being. Caves figure prominently in Inca origin myths and were thought also to be chthonic connectors to the underworld (Van de Guchte, 1990).

5.4 Sacred Landscape

The Incas venerated natural features such as mountains, outcroppings, caves, springs, and rivers, all believed to be endowed with sacred powers. Most of all the Incas revered mountains and the great entities within them. Sacred mountains are prominent on the horizons of Cusco and Machu Picchu and the Incas' great reverence for the earth was no better displayed than in their worship of these majestic snow peaks. Quechua populations today view mountains either as powerful deities themselves or the residences of deities. They are worshipped as ancestors, sources of water and weather, and in the case of Ausangate, the father of alpacas and lamas. Mountains were often venerated as the most important of deities throughout the empire (Reinhard, 1985:306).

Similar to sacred mountains, many rock outcrops were also understood to be hierophanies, or manifestations of the sacred. Pachacuti apparently believed that he could improve upon these revered stones and, as the son of the sun and co-creator of the land, he could modify and enhance the work of the creator. The carved huacas are bedrock features with their roots in the earth, an important aspect of the symbolism involving three worlds. They also seem to be laid out across the landscape in meaningful patterns. A limited number of motifs were used in the shaping of huacas suggesting that the carvings were not a form of mindless or inventive graffiti, but elements in a symbolic language with cosmological significance.

5.5 Camay

The Incas believed that all things had a point of vitalization, or *camac*, and this for a group of humans was their huaca of origin. Camay was *a concept of specific essence and force, 'to charge with being, to infuse with species power'* and camac was one "who charges the world with being" (Salomon and Urioste, 1991). The camac for llamas was a constellation in the shape of a llama that, upon descending to earth, was responsible for giving a general vitality that allowed for all terrestrial llamas to thrive. Camay was thought to give form and force and to animate (Salomon and Urioste, 1991; Taylor, 1974) in a continual process that brings something into being through the energization of matter.

Running water was understood to be an energizing and animating life force in Andean cultures and was also associated as an agent of *camay*. In the cosmology described in the *Huarochirí Manuscript*, life is born from the embrace of feminine earth by masculine water, homologous to the growth of plants from soil when moistened by water (Salomon and Urioste, 1991). The circulation of running water and the pouring of offertory liquids could animate certain inanimate objects to become huacas, which were understood to be sentient beings with extraordinary and superhuman powers. Running water was located near most huacas suggesting that camay was thought to vitalize the life within each of them.

Water empowered huacas through a life-energizing force that could be used to provide sentience to the inanimate or renew power in the living (Salomon and Urioste, 1991). The world's water cycled through the heavens and earth in its journey down the Vilcanota with return via the Milky Way (Urton, 1981a). Inca cosmology viewed the Milky Way as a river flowing across the night sky in a very literal sense. They saw earthly waters as being drawn into the heavens and then later returned to earth following a celestial rejuvenation. The earth was thought to float in a cosmic ocean (Urton, 1981a). When the celestial river's orientation was such that it dipped into that ocean, waters were drawn into the sky. "The Milky Way is therefore an integral part of the continuing recycling of water throughout the Quechua universe" (Urton, 1981a: 60).

Salomon and Urioste (1991) suggest that huacas were understood to be living, energized beings brought to sentience by the earth's waters. A common motif found at several huacas is that of straight or zigzagged channels constructed for the purpose of guiding ceremonial fluids. Paternosto (1996: 66, 129) also writes of a *paqcha* he describes as being a portable cup and handle with a zigzagged channel for similar use. A flow of energy was stimulated by the pouring of liquid offerings into these channels. Reinhard (2002) suggests the importance of an Incan water cult at Machu Picchu. One example of this is found in the stone-lined channel that leads from the double-jambed door of the Llactapata Sun Temple that points across the River Intihuatana to Machu Picchu's Sacred Plaza and beyond to the approximate horizon location of the sunrise at June solstice.

Life was given to inert matter through the action of the cosmological life-blood of flowing water cycling from the ocean to the sky and back to the land. The powers of camay were great as objects, stones and even places could be animated through running water or offertory liquids.

Snow peaks were especially revered because the Incas recognized them as their immediate source of water in this cycle (Salomon and Urioste, 1991).

While many huacas were animated by the camay of water, this concept was not exclusive to fluids. All things were said to have vitalizing entities, or *camac*. A llama-shaped constellation infused earthly llamas and the camac for humans was their huaca of origin. Therefore energized huacas were also responsible for bringing life to others (Salomon and Urioste, 1991).

The Incas also believed that rock could be empowered and energized by elaborate carving (Paternosto, 1996) as displayed by those huacas that are intricately sculpted outcroppings. Carved huacas were given life, however, through the circulation of the earth's life-force, its running waters, and all of the astronomical shrines of this study were found to have such a hydraulic source nearby.

5.6 Intihuatanas

Bingham identified a carved stone adjacent to the Urubamba River as an intihuatana, probably guided to such a conclusion by local informants. He described his understanding intihuatanas in the following passage:

> Inti means "sun" and huatana is "a place where animals are tied." The intihuatana would seem to be "the place to which the sun was tied," so that it could not escape. A primitive folk so extremely dependent on the kindly behavior of the sun as were the Peruvian highlanders must have been in terror each year, as the shadows lengthened and the sun went farther and farther north, that he would never return but would leave them to perish of cold and hunger. Hence it seems likely that these short stone posts represented the post to which a mystical rope was tied by the priests to prevent the sun from going too far away and getting lost (Bingham 1930: 52).

There are differing interpretations of intihuatanas and "hitching post of the sun" may be more of a modern myth inspired by local villagers. The term "intihuatana" only began to appear during the 19th century. Even should Bingham's explanation be applicable in certain cases, other suggestions that the carvings were devised as astronomical sighting devices are not supported. Although often identified by tour guides as a calendrical shadow-casting gnomon, there is really no evidence that the intihuatana stone of Machu Picchu was used for observing and establishing dates of the solstices or even the zenith sun.

Intihuatanas are also found at Pisac and Tipon. Squire (1878: 524) said that "Inti-huatana resolves itself into *Inti*, sun, *huatana*, the place where, or thing with which, anything is tied up". In Pisac the intihuatana is a large, partially carved rock in the temple group that is enclosed by a semi-circular masonry wall adjoining a straight masonry wall (see Figure 10-20). It displays a stone carved cylinder on its flat upper surface within the walled enclosure. Squier was informed by the Governor of Pisac that this cylinder had been once clad with a bronze sheath. The primary rock extends beneath and beyond the wall of the structure where a second carved cylinder is located.

The Intihuatana of Tipon (see Figure 9-53) exhibits a different style in that the in situ rock remains unimproved although a platform has been built around it. The June solstice sunset can be viewed over the Intihuatana from a vantage point on a mesa to the east of the site's extensive terrace system.

5.7 Sacred Animals

Many animals, both living and symbolic, were revered and worshipped in Andean culture. Of the highest order, the Incas venerated the condor, puma and serpent with regard to their sacred correlations with the three cosmological worlds of the sky, earth, and underworld.

Urton (1981a: 169) relates Polo de Ondegardo to have said that *in general, [the Incas] believed that all the animals and birds on the earth had their likeness in the sky in whose responsibility was their procreation and augmentation*. The dark cloud constellations recognized in the Milky Way are replete with examples of animals such as the serpent, the fox, the llama, the toad, and the tinamou, each bearing supernatural influence over its terrestrial counterparts (Urton, 1981a).

5.8 Ancestors

The Peruvian archaeologist, Julio Tello, recognized that ancestor veneration has been one of the major and enduring features of Andean civilizations (DeLeonardis and Lau, 2004). Huacas appear to be major elements in Andean cosmology extending back to 1000 or 2000 B.C. and often were shrines to ancestors who, it was believed, could influence the living. Feeding of huacas was a major motivation for communication with ancestor-gods and for sacrifices (Benson and Cook, 2001). Mummies of Inca emperors were considered as deified ancestors (Zuidema, 1983). They were carried in processions or placed on platforms, carved steps, and altars. Shamanic communication with the supernatural world of the ancestors and movement between the three cosmological worlds were intertwined with ancestor worship (Eliade, 1972). Ancestor worship included the sun and moon as well as fundamental themes in origin mythologies such as rocks, caves, and water. Huacas were often places where the ancestors could be called upon for assistance in agriculture, warfare, health, and fertility.

Mummies of ruling Incas played a significant role in Inca culture and worship of them was an integral part of state religion. These preserved royal bodies were treated as if still alive (Niles, 1987). When a ruling Inca died his *panaca*, or royal descent group, continued to manage his property and wealth as if he were still living. Each new Inca was required to build a palace and establish his own estate and riches. The mummy continued to occupy his palace, was clothed and 'fed' and was consulted on matters of significance. The Inca's descendants remained responsible for his mummy and possessions and would help the mummy participate in state ceremonies (Hemming and Ranney, 1982). Mummies sometimes were called upon to visit other mummies, or even the living (Niles, 1999). All mummies of the ruling Incas were paraded at a new coronation, an exercise which emphatically displayed the dynastic lineage of the empire.

5.9 Social Issues

5.9.1 Royal Marriage

The ruling Inca had many wives, but only one was primary. It was prescribed he marry his own sister because then he and she would then belong to a lineage both patrilineal and matrilineal and therefore the emperor would lead a social hierarchy similar to the creator, Viracocha's, cosmological hierarchy (Zuidema and Quispe, 1973). They were married on the day of his accession as ruler and the children she bore also became primary, the eldest son heir to the empire (Zuidema, 1964). Primary children were born by the primary wife and subsidiary children by the Inca's subsidiary wives. In the event of the death of a primary wife the Inca was required to marry another woman qualified as such.

5.9.2 Moieties, Suyus, Panacas and Ayllus

The Incas divided Cusco, and many other locations, into upper and lower halves, or moieties. These divisions were both geographical and social. The upslope half of Cusco was *hanan* (upper), while the lower half was *hurin* (lower). Hanan Cusco held higher status than did Hurin Cusco, which was closer to the non-Inca population (Zuidema, 1983). There were also parallel social halves with the first five royal descent groups assigned to Hurin Cusco and the next five to Hanan Cusco. The upper and lower moieties were considered equivalent (Zuidema, 1964). Gasparini and Margolies (1980) feel that the concept of such upper and lower divisions may have originated in the mountains from the need for coordination between different ecological zones.

Both Cusco and the empire were divided into quarters, or suyus. These were called *Chinchaysuyu, Antisuyu, Collasuyu, and Cuntisuyu* (see Figure 5.1). The ceques of Cusco were organized within these divisions.

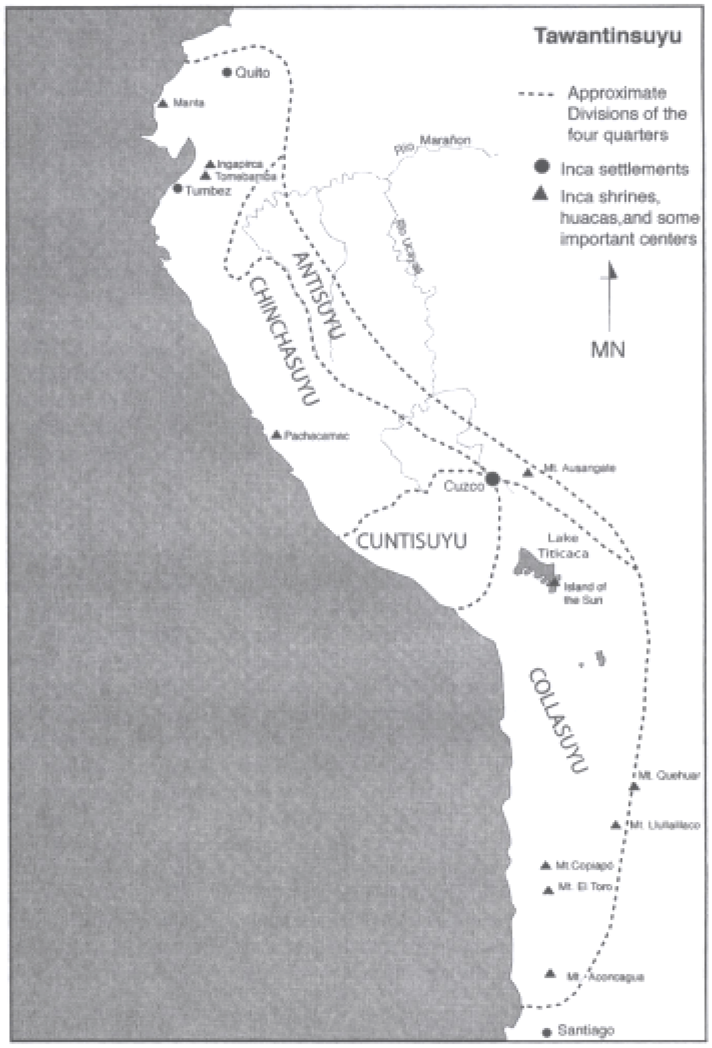

Figure 5-1: The four suyus of Tiwantinsuyu (from Staller, 2008: 279).

A panaca was a patrilineal royal descent group established by a newly installed Inca. The panaca supported the emperor and was typically led by his second son as the first son would be required to leave the panaca once he succeeded his father. As successor to the throne he inherited the empire, but not any of his father's wealth or possessions. A panaca took on increased importance upon the death of its patriarch as they then became responsible for the care and ceremonial functions of his mummy (Niles, 1999).

An *ayllu* was a non-royal extended kinship group from the same patrilineal ancestor that provided structure for the regulation of marriage and inheritance. It was the basic social unit beyond immediate relatives (Niles, 1987). It has been said that there were ten ayllus, five in

Hanan Cusco and five in Hurin Cusco, which were paired in the same ceque groups as the royal panacas (Sarmiento, 2009 [1572]: 73-75; Zuidema, 1964).

Panacas and ayllus were assigned to specific ceques and were responsible for their care and that of their associated huacas. Ceques were normally divided into groups of three, *collana, payan, and cayao*, the payan ceques associated with panacas and the cayao ceques with ayllus (Zuidema, 1964).

5.9.3 Money

The Incas lived in a society without personal property or money. The state provided for them and determined the labor they would contribute for the common good. Following the Spanish conquest it was difficult for Inca citizens to grasp the concept of earning money to spend for one's needs (Hemming, 1970).

5.9.4 Writing and Remembrance

The Incas never developed a system of writing and they therefore have no recorded history. All dates and events prior to the Spanish conquest are approximate from verbal accounts. Early chroniclers attempted to relate culture and history through interviews of Inca citizens, but in many ways failed in their task due to a cultural preconception that left them unable to truly comprehend Inca society (Lee, 2000; Niles, 1987). Art, architecture and carvings remain as the primary sources of Inca history.

Other means for transmitting thoughts and ideas evolved in tapestries and other weavings that included the knotted quipu. These artistic substitutes contributed to the hindrance of the invention of an alphabet (Paternosto, 1989).

The Incas considered it of primary importance to preserve royal history. Oral legends were recited during ritual festivals, telling tales of dynastic greatness. Even the responsibility for maintaining non-royal family history was passed from generation to generation. Niles (1999: 24) tells us that …*the deeds of an ancestor were related to the prestige accorded his living descendants....* Relatives were acutely aware of this when remembering those that came before.

Lacking a written language “Inca royal histories were works of oral literature…” (Niles, 1999: 28). The Incas also made graphic history of their battles in conquest, turning their defeated foes into trophies. Human skin covered drums, heads were used as flasks, bones as pipes and teeth worn as necklaces. Many artifacts and much temple wealth were acquired through this warfare (Niles, 1999).

5.9.5 Quipus

The system developed by the Incas for ‘permanent’ recording was that of the quipu, a memory aid that employed a series of knotted strings and cords in a certain order and with various colors. This substitute for writing was used as a means of storing information regarding production, storage, distribution, census data and tax records (Niles, 1987; Paternosto, 1989). One function of quipus was to aid in the passing of oral histories from generation to generation (Sherbondy, 1992). Based upon his research Urton (2003) now feels that quipus may have been an actual system of writing, or at least a hybrid between that and a mnemonic aid.

While numbers were known to many, a limitation of the quipu was the likelihood that only its maker could fully interpret much of the other information recorded there. The Incas had a special class of civil servants, *quipucamayos*, who were trained as experts in recording and interpreting quipu data (Figure 5-2). The quipucamayos therefore had great influence over the content and meaning of Inca official records (Niles, 1987).

Quipus were also used to record Inca calendrical information and may have provided a mnemonic aid for family oral histories. Ceques were recorded on quipus, one example of which is the obvious conceptual correlation with the pattern of ceques and huacas surrounding Cusco (Niles, 1987; Paternosto, 1989; Zuidema, 1977).

Figure 5-2: A quipu and specialist for the calendar (Guaman Poma, f. 360).

5.9.6 Textiles

Another form of preserving elements of a society's history is in that of its textiles. Weaving preceded even ceramics as an art form in the Andes. Textiles dating as far back as 3000 – 2500 B.C. have been recovered that display the condor, puma, and serpent – prominent symbols adopted four millennia later by the Incas. Textiles record many thoughts such as evidence of the gods and other beings that influenced or concerned these ancient societies. The Incas continued the use of ceremonial textiles and the art form still exists in the Andes today (Paternosto, 1989).

5.10 Organization

All of the important government positions were held by members of the Inca royal family. Other nobility served in supportive administration roles (Hemming, 1970).

The Incas divided their world into four quarters and from these their empire evolved. They thought of Cusco as the navel of the world and the center of their universe and it served as both a government and ceremonial center (Niles, 1987). Cusco became the focal point of Inca religion.

Homes largely were made of masonry with thatched roofs and were generally built on hillsides to save more valuable land for crops. Community sites were selected so as to be a short distance from the fields where their residents would work (Hemming and Ranney, 1982). Streets were made of stone with central water channels and constructed in grids. Architecture represented a form of status and residents of similar stature lived in similarly constructed homes (Niles, 1987).

Betanzos (1996 [1576]: 50-58, 69-73) discusses the organization Pachacuti brought to the Cusco valley. Zuidema (1990a) describes a system of *chapas* used to divide responsibility for the lands surrounding the city. Each of 10 Inca lords was granted one of the 10 chapas of land that surrounded Cusco through the mountainsides. Produce from the villages on the land would then be collected in storehouses erected for that purpose. Chapas were a fourth method used by the Incas for society organization. The others were panacas, ayllus and the calendar. Chapas were distinguished from panacas and ayllus as they had separate functions (Zuidema, 1990b).

Taxpayers in the empire were organized by a decimal system. A *Pachaca* was a group of 100 taxpayers and a *Huaranca* was a group of 1000 that included 10 Pachaca. A *Huno* was comprised of 10 Huaranca and represented 10,000. Pachacas were divided into two groups of 50 and further into groups of 10. A *huamani,* or province, contained 40,000 families. Officials were appointed at each level of administration (Hemming, 1970; Zuidema, 1964; Zuidema, 1990a).

5.11 Succession

Succession as ruling Inca normally passed to the eldest primary son. However, if this son was thought to be weak or incompetent he might be challenged and deposed by a stronger brother. Royal blood was important to the Incas, but they also valued powerful leadership and accepted the occurrence of these struggles for control. Most of the eleven historical Incas are thought to have acceded to the throne only after such an event (Hemming, 1970).

Because the son did not inherit his father's property or riches when succeeding him, this created a need for continued conquest as each new Inca sought to establish his fortune. After several generations a significant portion of the lands in Cusco were occupied by palaces and estates of the Incas, or their mummies, and royal family members of the panacas.

5.12 Festivals

Pachacuti instituted a ritual calendar that was measured by the position of the sun on the horizon. Religious and agricultural ceremonies and festivals were celebrated and served to reinforce the legitimacy of the emperor and the ruling elite. Rituals marked times for planting and harvesting, as well as major religious celebrations of the sun. Examples of prominent festivals were those of Inti Raymi at the June solstice, Capac Raymi at the December solstice, Inti Raymi at the March Equinox, and Coya Raymi at the September equinox.

Inti Raymi was the Inca's solar festival at the time of the June solstice and it is still celebrated in Cusco today. Garcilaso (1961 [1609]: 217) wrote that the feast of Inti Raymi was the most important one of the year. It was a festival for the masses that brought many pilgrims to Cusco (Dearborn, Schreiber, and White, 1987). It was an elaborate ritual that took place over many days where thanks were given to the sun and prayers said for the crops. Inca citizens chanted throughout day, the volume of their voices rising as the sun rose higher, and falling when it descended again (Zuidema, 1986).

Capac Raymi was another festival of the sun, in this case at the time of the December solstice. This was a celebration of crop germination and the start of a new season. It also was important as the annual time for young Inca adolescents to undergo their rituals of coming-of-age (Hemming, 1970). Capac Raymi was principally celebrated by the nobility rather than the masses (Dearborn, Schreiber, and White, 1987).

5.13 Climate

The cold Humboldt Current flows northerly along South Americas Pacific coast and is responsible for upwelling an abundance of marine life off the shores of Peru. The cooling influence of the current extends to the surrounding marine air, hampering precipitation and creating a very arid coastal climate.

Conversely the climate further inland and higher in the Andes experiences great amounts of rainfall during annual rainy seasons. An additional biome existed for the Incas in the low Amazonian rain forest below the Andes' eastern slopes.

The annual rainy season in Cusco extends basically from October to April, followed by a dry season from May to September. The Incas coordinated the planting of maize with the beginning of the rainy season and harvested their crop as the dry season approached (Urton, 1981a). The comings of such agricultural events were tracked by following the position of the sun on the horizon.

Weather patterns were occasionally interrupted by what we know as El Niño. Modern Andeans predict its coming through observance of the relative brilliance of the heliacal rise of the Pleiades in early June. Orlove, Chiang, and Cane (2000: 68-71) have studied this procedure and say that it may be more than 400 years old.

The Incas maximized efficiency of their agricultural environment through cultivating produce optimal for specific environmental zones. Certain crops thrived at high altitudes, while others needed to be grown much lower. Cooperative efforts exchanged foods between these regions. Astronomical agricultural calendars varied for proper planting and harvest in each of these zones (Urton, 1981a).

5.14 Agriculture

The importance of the sun for agriculture in the Andes was known long before the Incas. The Incas pursued agriculture aggressively and achieved considerable success. Agricultural practices freed the general populace from the need for subsistence farming and thus many of them became available for military service and construction projects (Niles, 1987).

Agricultural terraces greatly benefitted the Inca empire and they used them extensively. Inca engineers adopted the concept from the Huari, who in turn had discovered the technique from earlier cultures (Wright and Valencia, 2000). These terraces were designed to maximize crop productivity and efficiency in a mountainous environment. Not only were they quite effective in this regard, but terraces also served to protect against erosion and assist in irrigation. Mountains were terraced throughout many parts of the empire enabling cultivation in fertile topsoil in areas that would otherwise have been untillable (Niles, 1987).

Planting required many decisions as to its timing. Observations of both the sun and moon were used to determine optimal dates for sowing. Maize was the most significant crop in the empire and it is thought that pillars were built on Cusco's horizon to establish the proper time for planting (Urton, 1981a).

Maize was a major nutrition source and was also the primary ingredient in *chicha*, the corn beer widely consumed throughout the empire and that also figured prominently in most religious and state ceremonies. It transcended all social echelons and was not only ingested, but also used as a liquid in ceremonial rituals (Bauer and Stanish, 2001). Its growing season is from October to May, with the fields first plowed in August. Cobo (1990 [1653]: 144) describes a ritual planting in August to begin the maize season as taking place in a *chaucara*, or field, east of Cuzco called Sausero.

Large tracts of land were set aside to till maize in support of members of cults of Inca deities such as the sun, moon, stars, thunder and lightning. Capac Raymi and Inti Raymi, the two most significant of Inca festivals, celebrated the planting and harvest of maize near the respective times of the December and June solstices (Bauer and Stanish, 2001).

Potatoes were another staple of the Andes and ultimately spread from the region throughout the world. Coca was revered for its stimulant qualities. Its leaves were chewed to produce an effect that minimized hunger and fatigue. It was grown primarily on the eastern side of the Andes far below the Incas' primary habitat and found use in many religious ceremonies (Hemming, 1970).

5.15 Irrigation

The Incas were masters of hydraulic engineering, expertly irrigating their agricultural terraces and fields. There are many extant examples of fountains and canals at numerous archaeological sites in Peru.

The Incas designed fountains to be both practical and ceremonial and they likely served as well to facilitate the life-force energizing effects of camay. The series of 16 fountains at Machu Picchu appear quite to be quite practical with regard to consumption, while fountains at Ollantaytambo and Tipon seem more ceremonial in nature.

Canals were fed by streams, springs and reservoirs. Some were large while others quite narrow and focused with means of diverting water flow to selected branches. Many were lined with stone or carved into walls, often between 40 and 80 cm in width. Terraces were irrigated through such channel systems and often included parallel channels to back up the first should it become non-functional (Niles, 1987).

5.16 Imperial Expansion

Starting with Pachacuti the Incas began a great period of conquest and expansion that was continued by his son, Topa Inca, and grandson, Huayna Capac. In a matter of decades the Incas subjugated peoples and territory spanning over 4800 km along the Andes, all without benefit of the wheel or horses.

The Incas preferred to assimilate tribes willingly rather than by force. Many complied while others were ultimately compelled to submit. Certain practices of these conquered peoples were adopted by the Incas, an example of which is exhibited by the similarity of masonry techniques between those of the Incas and what has been found of the Tiwanaku near Lake Titicaca.

The Incas were adept at dealing with newly assimilated subjects and were rather tolerant of their local religious practices providing that they first acknowledged the superiority of the state solar worship. Recently acquired idols, along with priests to attend them, were transported to Cusco and honored with proper respect, while at the same time providing collateral for the willing cooperation of their associated tribes (Bauer and Stanish, 2001; Hemming, 1970).

5.17 Pilgrimage

Pilgrimage existed in the central Andes long before the rise of the Incas to power. Early examples in the time of the Huari and the Tiahuanaco can be found in the temple of Pachacamac on the coast near Lima and the Island of Titicaca in Lake Titicaca. These sites figured prominently in Andean mythology and cosmology and became focal points for ritual movements (Zuidema, 2008a).

Certain pilgrimages to state shrines were instituted to reinforce values of Inca society and religion and to serve as a form of indoctrination for the legitimacy of the ruling elite. The Incas found it imperative to ideologically assimilate tribes after conquering them militarily (Bauer and Stanish, 2001). A pilgrimage center contained what was sacred to the pilgrims who traveled there to worship (Silverman, 1994).

The Incas were experts at influencing the thinking of their citizens. As pilgrims neared the shrine their experience each step of the way was carefully orchestrated by state and religious officials. Tenets of the solar cult were instilled and association of the Inca as the son of the sun was paramount. Each aspect served to carefully exert control over the perceptions of the population. The experience allowed persons making the pilgrimage to transform from residents of mountain villages to members of the greater empire (Bauer and Stanish, 2001).

Zuidema (2008a; 2008b) discussed three other forms of pilgrimage that were practiced along the southeast to northwest axis of the solstices between Vilcanota to the southeast and Ollantaytambo to the northwest. He calls these three ritual movements (1) a procession, (2) a pilgrimage, and (3) a race. The first two were conducted by Tarpuntay priests near the time of the June solstice while the third involved younger men, perhaps of more common status (Zuidema, 2008a; 2008b).

The *procession* took place daily during this period. Priests traveled from Huanacauri on the southeast side of Cusco to Quiancalla on the northwest. They sacrificed lambs at their journey's beginning at dawn, its end at sunset, and along the way at the Coricancha at noon (Zuidema, 2008a; 2008b).

In the *pilgrimage* another group of Tarpuntay priests traveled southeast from Huanacauri and Mutu to Vilcanota. Their round-trip journey lasted for a month as they worshipped the sun while moving through the mountains to Vilcanota, with return by the Vilcanota River and Quispicancha, or Tipon. The process was to help the sun turn around at the June solstice (Zuidema, 2008a; 2008b).

Zuidema says that a *race* called *Mayucati* complemented the *pilgrimage*. In the *race* young men competed after the December solstice by running alongside sacrificial ashes cast upon the Vilcanota River as they flowed northwest to Ollantaytambo. They then raced each other through the mountains back to Quiancalla and Cusco in an event set to end at the time of the February zenith passage (Zuidema, 2008a; 2008b).

Figure 5-3: Routes of travel for the procession, pilgrimage, and race (from Zuidema, 2008b: 257).

5.18 Building an Empire

During the period between Pachacuti's conquest of the Chanca and the beginning of the Spanish invasion building and construction proceeded at a rapid pace. Workers freed by surpluses in agriculture were used for both conquest and construction while artisans and their building techniques were assimilated from throughout the realm (Hemming and Ranney, 1982).

An essential element of this massive building campaign was that of the use of mitmae labor from across the empire. This system provided temporary labor on a rotating basis and worked well in a society without money. Major public works projects such as buildings, palaces, agricultural terraces, canals, bridges and roads were all constructed through the use of such work forces. Village men were required to take part in the rotations as a service to the state and the Incas were careful to relocate them to work in compatible climates and elevations. Once their period of service was over they returned to their regular homes and were replaced by new mitmaes from another area (Gasparini and Margolies, 1980; Niles, 1987).

5.19 Architecture

Every new emperor ascending to the throne built his own palace and monuments. All Incas had palaces in Cusco maintained by their panacas long after their deaths. Pachacuti, Topa Inca, and Huayna Capac were no exceptions as they constructed fine palaces in the capital and other estates in the countryside. Niles (1999) argues that these architectural examples were manifestations that require knowledge of Inca history to truly appreciate.

Royal architecture was a means used by Inca emperors to enhance their status as rulers and visibly represent their inclusion in the dynastic succession of kings since Manco Capac. Rules of succession left a new emperor none of his father's possessions and required him to build his own palaces and country estates and amass his own wealth, a system that allowed for great expression by each new Inca while establishing his relative stature.

Most civil works of the Incas were built by Pachacuti, Topa Inca and Huayna Capac during a 77 year period between 1450 and 1527. Pachacuti established the empire's architectural style and spread it throughout his realm (Gasparini and Margolies, 1980). Topa Inca followed his father's basic model, but with innovations of his own. His son, Huayna Capac, did likewise.

The Incas did not normally rebuild atop earlier ruins, instead choosing original sites for their construction. The degree of craftsmanship in the masonry used in a building directly indicated the structure's relative importance. The finer the cut and fit of the stones, the higher the stature of the building. Double-jambed doors denoted entries for use only by elites. Construction variances sometimes existed due to building location or function (Hemming and Ranney, 1982).

Inca masonry was generally of two types, polygonal and coursed, and both are incredibly precise without benefit of mortar (Paternosto, 1989). In polygonal masonry random interlocking faces of stones were cut and polished to fit together with precision, but no two walls were the same. Coursed masonry consisted of polished surfaces laid in precisely fitting and orderly horizontal rows, each successive row slightly smaller than the one below. Examples of stone types used include andesite, diorite, porphyry, granite and limestone. The Incas were fond of trapezoidal doorways and niches and never invented the arch. These trapezoidal constructs were a hallmark of the Incas and their empire (Gasparini and Margolies, 1980; Hemming and Ranney, 1982).

Niles (1987: 41) describes that building proportions were standard in Inca designs. This is in keeping with other Inca precision and she claims a ratio of short to long sides between 1:1.71 and 1:2.07. Structural size was important for status and prestige and significant buildings often incorporated open spaces to increase the effect. Higher status was implied by multiple doors, often double-jambed, and masonry that was coursed and tightly fitted (Niles, 1987).

Inca structures were almost always single-storey with roofs that were thatched. When a second storey did exist the stairway was often outside. Common residences were primarily single-room and buildings with multiple rooms generally did not connect them internally. Windows were uncommon and most extant second storeys were added by the Spanish after the conquest (Gasparini and Margolies, 1980).

Inca buildings normally followed a standard rectangular plan established during Pachacuti’s reign that was employed in distant conquered territories as well as Cusco. Doors were all generally located on one of the rectangle’s long walls, but side doors were sometimes added to the largest of buildings (Gasparini and Margolies, 1980).

The Incas also used a circular plan for certain buildings not used as residences. Storehouses were often circular, as were funerary structures called *chullpas*. Examples of curved walls not completing a circle can also be found at sites such as the River Intihuatana, Machu Picchu, Cusco, Tipon and Pisac (Gasparini and Margolies, 1980). The Sunturhuasi in Cusco was circular with windows, a high roof, and a mast. Its astronomical uses are described in sections 8.6 and 8.8. Figure 5-3 is a drawing of the Sunturhuasi by Guaman Poma.

Figure 5-4: Drawing depicting the Sunturhuasi (Guaman Poma, f. 329).

Canchas were walled rectangles surrounding a number of one room structures designed for a similar purpose. *Kallankas* were great halls with many doorways intended for festival observance in inclement weather (Niles, 1999).

Most niches are located on the inside of building walls. Niles (1987: 215) finds them symmetrical on walls facing doorways and many of a standard size close to 80-90 cm in height and 1.25 m above floor level, however some were much larger to accommodate mummies. Others are symmetrical on opposing walls. As with trapezoidal doorways, stone lintels were placed to complete the tops of niches and those found on exterior walls often exhibit double or triple jams as signs of status. Niches were commonly used to display items of religious veneration.

5.20 Inca Roads

The Incas built an impressive system of roads for movement throughout their empire. These thoroughfares were constructed of carefully fitted stones and spread throughout the realm in a network extending for a total of over 16,000 km. Most roads were built higher on the sides of mountains, thus placing them in the best positions for travel during the rainy season and keeping them apart from land that was prime for agriculture. The network was critical for rapid travel of the emperor’s armies and also in maintaining control over conquered territories. Administrative centers were instituted systematically along the many routes established, particularly to the north toward Quito (Hemming and Ranney, 1982; Niles, 1987).

The most important highways were reserved for official use and the main roads leading to the four suyus of the empire all radiated from Cusco. The network extended north to Quito, west to the Pacific, and south past Lake Titicaca. These roads were sometimes used as well to establish and designate boundaries. The system was constructed and maintained largely by the system of mita labor (Gasparini and Margolies, 1980; Hemming and Ranney, 1982; Niles, 1987).

Roads were meant for foot travel as the Incas had no horses or wheeled vehicles. Llamas could be used as pack animals, but were not suitable for riding. As carts were impractical on these mountain highways the Incas never had the need for nor developed the wheel. Llamas, however, were well suited for transporting goods on their backs along these often vertical Inca trails. The many bridges required throughout the empire were normally engineered as spans by rope suspension (Hemming, 1970).

5.21 Carved Rocks

Examples of carved rock sculptures can be found throughout the Inca Empire and are a primary focus of this study. Inca emperors felt it their right to improve upon nature by sculpting in situ outcrops that often became huacas. Improvements to rocks appear to have been state-controlled and likely guided by a certain class of artisans as evidence does not suggest innovation. These methods also were not sudden inventions, but instead had developed over time with knowledge acquired from other societies (Niles, 1987; Paternosto, 1989).

Pachacuti commanded a study of techniques of the Tiwanaku, the most likely source of Inca interest and expertise in masonry. The Incas had only soft metals, but found that they were able to shape blocks with harder stones to achieve desired results. Sculpture was a religious art form, as well as practical, and new examples were quite prevalent during Pachacuti's reign as emperor (Gasparini and Margolies, 1980; Paternosto, 1989; Van de Guchte, 1990).

Paternosto (1989) tells us that geometric symbols found carved in stone often originated first in textile designs. Primary cosmological figures such as pumas, serpents and condors began that way, as well as did the human form.

Limestone was commonly selected for carving, but Van de Guchte (1990) also describes examples where diorite was used at Suchuna, andesite at Rumihuasi and Saihuite, black granite at Choquequilla, and porphyry at Ollantaytambo. He also mentions a division of labor with specialized workers trained for such as stone cutting, carving and construction.

Van de Guchte has identified three styles of rock carvings: severe, composite and figurative. The severe is characterized by geometric cuts, with examples found at Kenko, Sacsahuaman, Chinchero and Machu Picchu. Composite style includes carvings in high relief as evidenced at Lacco and Chinchero. Figurative style carvings depict plants and animals in both high and low relief, with Saihuite holding a fine example.

The Incas used carved rocks as a vehicle for promoting state ideology and the solar religion. They were symbols of commemoration, mediation with the cosmos, and state identity, all the while remaining part of the Incas' perception of their sacred relationship with nature and the land (Van de Guchte, 1999).

A rock, once carved, became a hierophany and was worshipped by the Incas in a way quite foreign to us. Embedded in the earth, these sculpted manifestations of the sacred were connected with the powers of the underworld and became venerated when enhanced by elaborate carving. Sculpted outcroppings, as huacas, were an important part of cosmological symbolism regarding the three worlds of the Incas (Paternosto, 1989).

Examples of reverence for stone are prominent throughout Inca culture. In Inca mythology the first beings emerged from places such as caves, rocks and springs, all connected with the underworld. Each king had an effigy called a *huauque*. These "stone brothers" were treated similarly to their likenesses and "possessed" houses, fields and servants. The huauque was a companion to the emperor and provided advice as required (Paternosto, 1989; Van de Guchte, 1990).

Ritual stairs are a dominant motif, perhaps expressing movement from the underworld to the earth to the heavens and are often associated with these three realms. Carved stairs are quite common and frequently non-functional, such as those on inaccessible cliff sides at Ollantaytambo and within a cave at Machu Picchu. They normally include three steps, corresponding with the three worlds, and likely were symbolic representations of this cosmology. Carvings of condors, pumas, and serpents proliferate as representatives of these respective spiritual domains.

The *chakana*, or Andean square cross of three levels, is another stepped symbol representing transition between the three worlds. Chakana, in Quechua, means bridge, or to cross from one place to another. Sculpted on each of the four sides of the cross are surfaces resembling three stairs, the common motif of the underworld, our world, and the heavens.

Seat carvings are common and Van de Guchte (1990) believes they may have been meant to be altars as well as chairs. I have found several that face in the directions of significant sunrises or sunsets. Examples are given in Part IV.

5.22 Summary

To gain a true appreciation for the context of astronomy carved into sculptures such as rock huacas we must first gain an understanding of Inca culture and the way within it that the world was viewed. We have to be careful not to make the same mistake as the 16th century Spaniards by interpreting what we see through our own frame of reference.

The Incas have a special relationship with the sun. It formed the basis of their religion and they believed their royal ruler to be the son of the sun. Their veneration in this regard was something that we have no match for today. The moon also was viewed with great reverence and was thought to be both the wife and sister of the sun and, by extension, the mother of the queen. Daily movements of these bodies were observed and tracked closely.

Solar worship helped to reinforce the divine authority of the emperor, the son of the sun. Shrines and pilgrimages were created to ensure the population understood without question the royal relationship between the sun and the ruling elite.

Mountains and rock were worshipped for the spiritual powers held within them. Deities within snow peaks held the power of the earth’s life-giving force of water and supplied it in the cosmological cycle to the people living below them. Camay, was thought to bring life and animation to otherwise inanimate objects. Outcroppings were carved at the direction of ruling Incas to further energize them while enhancing the work of the creator.

The Incas’ cosmos included three worlds, the below, the here and now, and the above. Each was represented by an animal, respectively the serpent, puma, and condor. Carved stairs with three steps representing the three cosmological Andean worlds and similar Andean crosses are frequent motifs symbolizing the transition between these worlds.

Solar regulation of agriculture was of paramount importance. Pillars were constructed and other means established to make use of the sun’s position when determining the proper times to sow and harvest specific crops. Festivals of the sun were established to commemorate these dates, which also served to reinforce the belief that the Inca had a special relationship with the solar deity.

Many huacas were carved from outcroppings and other stones that survive to this day. The Incas believed that carving and camay energized a spiritual force giving huacas animation and life. I have found many astronomical orientations to exist within the sculpting of these stones and will discuss them in Part IV. The Incas did not view astronomy as a separate entity, but instead as an integral part across many components of their culture. It is only through an understanding of such complex interrelationships that we can begin to fully comprehend what the sun, moon, planets and stars meant to the peoples of the Andes.

Chapter 6

Ceques and Huacas

6.1 Introduction

According to R. T. Zuidema, the shrines of Cusco were part of a great system devised to organize Inca society and religion, as well as give order to astronomy and the calendar. The ceque system was a "device for integrating astronomy, cosmology, and sociopolitical structure" (Zuidema, 1981c: 169). In "Catachillay: The Role of the Pleiades and of the Southern Cross and α and β Centauri in the Calendar of the Incas" (1982a) Zuidema described a two-dimensional, walk-through calendar of 41 *ceques*, or lines, radiating from Cusco that collectively contained 328 *huacas*, or shrines, some of them carved outcrops featured in this study. While this chapter describes both ceques and huacas, my field research near Cusco focuses on the many carved rock huacas located in the region surrounding the city. Several of these were found to have astronomical orientations.

6.2 History

The Incas venerated many features of the natural landscape thought to be endowed with meaning and sacred power. These shrines were known as *huacas* and prior to the Spanish invasion there were many hundreds of smaller ones. Major huacas required maintenance and caretaking. Gifts were made to the powers of the shrines. Animals and produce were sometimes sacrificed to the huaca and used to support the attendants. Around Cusco huacas were organized in lines or *ceques*. Pachacuti was concerned about the lands held by mummies and thus redistributed land and water rights in a manner organized by the ceque system (Betanzos, 1996 [1576]: 69-70; Sarmiento, 2009 [1572]: 132).

In 1653 the Jesuit priest Bernabé Cobo published a list of huacas in the vicinity of Cusco. In *Historia del Nuevo Mundo* he gave the names, descriptions, locations, and offerings of each.

Cobo (1990 [1653]: 51-84) provides a list of 328 huacas. Of that total 261 are natural features of the landscape, 89 involving water, 82 were geographic features, 83 were rocks, and 2 were botanical (Niles, 1987).

According to Cobo, the huacas were organized along ceques, partially to regulate their maintenance and organize sacrifices at proper times (Rowe, 1980). The shrines were arranged on ceques and registered on *quipus* (see Figure 5-2), which ordered them in a manner consistent with the highly organized administration of the Inca kingdom, itself. The huacas were arranged outward from the Coricancha along four groups corresponding to the four administrative quarters of Tawantinsuyu. There were nine each in Chinchaysuyu, Antisuyu, Collasuyu, and 14 in Cuntisuyu. The lines did not overlap so that progression from one shrine to the next along a particular ceque was a straightforward matter. In all there were 42 ceques, but the last two were grouped together as one leaving 41 ceques in all (Zuidema, 1983). The first ceque was royal and called capac and so there were 40 non-royal ceques and one royal ceque. The huacas were not placed in a geometrically regular sequence along the ceques, i.e., they were not equidistant. They were typically within a half-day walk from the Coricancha. The ends of many ceques were reported to be where one would lose sight of Cuzco (Niles, 1987).

Cobo was not the original author accounting for ceques and huacas, however. An earlier manuscript called *Relación de las Huacas,* whose author is not certain, was written c. 1569. Cobo appears to have relied extensively upon this text while compiling his own. Zuidema (2008b) argues this original author to have been Juan Polo de Ondegardo.

6.3 Ceques

Ceques were important features of the shrines in the Cusco valley, and one of their symbolic roles may have been to affirm and supplement the inherent directionality of huacas. They are reminiscent of the famous Nasca lines, for which there are a variety of interpretations such as water rituals, astronomical sightlines, and depictions of star patterns. Ceques were organizational in intent, indicating sequences of ritual visits, responsibilities for individual panacas and ayllus, and assignment of territory and irrigation sources. Sherbondy (1992: 60) says that the Incas encoded the responsibilities for huacas “into a map whose physical representation was probably a quipu.” She also states that the ceque system codified water rights for panacas and ayllus.

Cobo (1990 [1653]: 51) speaks of the ceques prior to his listing of the 328 huacas:

> From the Temple of the Sun, as from the center, there went out certain lines which the Indians call *ceques;* they formed four parts corresponding to the four royal roads which went out from Cuzco. On each one of those *ceques* were arranged in order the *guacas* and shrines which were there in Cuzco and its region like stations of holy places, the veneration of which was common to all. Each *ceque* was the responsibility of the kinship units and families of the city of Cuzco, from within which came the attendants and servants who cared for the *guacas* of their *ceque* and saw to offering the established sacrifices at the proper times.

The huacas surrounding Cusco were arranged on these lines. Ceques helped to divide the region into four suyus emanating from Cusco. Zuidema (1964) found the ceque system to be a significant component of social classification. He also maintains its usefulness for calendrical purposes and the accomplishment of tasks at specific times throughout the year (Zuidema, 1981b).

When viewed on a map from above the ceque system resembles a quipu radiating from Cusco's Coricancha. This may be more than just coincidence. The knots of quipus were used as mnemonic aids and huacas on the ceques served also to facilitate remembrance (Niles, 1999; Paternosto, 1989).

Cusco society was divided into two moieties and each moiety into two suyus. Ceques appear to have delineated these geographical divisions and the modern cataloguing of ceques is organized by the suyus in which they lie. Hanan Cusco encompassed Chinchaysuyu to the northwest and Antisuyu in the northeast. Hurin Cusco included Collasuyu to the southeast and Cuntisuyu in the southwest (Zuidema, 1964).

Zuidema (1964) argues that ceques marked the route of sequential offerings to adjacent huacas. Some of the ceques may also have served as pathways and convenient routes of movement. Instead of simple trails for ritual-pilgrimage, ceques may have established administrative socio-political boundaries and may have at times followed existing roads. Both interpretations of ceques, as social and administrative delineators and as symbolic geometrical and astronomical orientations, seem to have merit. Some ceques marked sightlines with astronomical intent, while others were used to organize and indicate the responsibilities for the care and maintenance of huacas provided by individual panacas and ayllus.

Zuidema (1964) describes ceques as comprising four groups corresponding with Cusco's four administrative quarters. Nine ceques fall within Chinchaysuyu, nine within Antisuyu, nine within Collasuyu, and the remaining fourteen in Cuntisuyu. Within the suyus they were ordered primarily in groups of three and the names *Collana, Payan, and Cayao* were assigned, one to each in a triad of ceques. The ceques of Chinchaysuyu were ordered counter-clockwise while all the others were clock-wise in progression (Zuidema, 1964).

Zuidema (1964) further describes the social class association with these ceque delineations. Collana, Payan, and Cayao refer to panaca and ayllu status and Zuidema (1983) states that Collana was the most prestigious and was made up of members of pure Inca descent. Payan included subsidiary kin such as offspring born from a Collana man with a non-Collana woman. Cayao comprised the remainder of the population that were not of Inca descent. No more than one panaca was assigned to each ceque cluster (Bauer, 1998; Zuidema, 1964).

The ceques within a suyu are sequentially numbered and Bauer (1998) refers to them by this number along with the suyu's abbreviation. The first ceque of Chinchaysuyu is therefore known as *Ch. 1* and the last one *Ch. 9.* Bauer (1998: 49) says that the ceque Ch. 1 "[defined] the division between Chinchaysuyu and Antisuyu." He continues that Ch. 9 "marked the division between Chinchaysuyu and Cuntisuyu, and the western boundary between Hanan and Hurin Cusco." Zuidema (2002: 593) points out that Bauer is incorrect with regard to ceque borders "as then those ceques would have coincided with bordering ceques of the next suyus."

Polo de Ondegardo (1965 [1571]) and later Cobo (1990 [1653]) related that every village had ceques. While the ceque system of Cusco is the only one to have been extensively substantiated, the preponderance of huacas surrounding Machu Picchu and certain alignments suggest there may have been a ceque organization employed in this area as well. One such set of alignments connects the Sacred Plaza of Machu Picchu with the Sun Temple of Llactapata along the axis of June solstice sunrise and December solstice sunset.

Salazar (2004) notes the large number of shrines at Machu Picchu, similar to the huacas that surround Cusco. She suggests that Pachacuti invested a large amount of skilled labor in establishing these because of the special association he felt with the “supernatural forces immanent in the landscape and the celestial sphere”, and that his connection with these forces needed to be “actively reaffirmed through daily ritual” (Salazar, 2004: 41).

Below Machu Picchu, near the confluence of the Aobamba and Urubamba rivers, lies a large and complex shrine, initially identified by Bingham as the Intihuatana of the Urubamba River, which may be part of a ceque. Its massive carved granite stone is approximately in line with the June solstice sunrise as viewed from the Llactapata Sun Temple and will be examined in detail in section 11.3.

6.4 Huacas

Many features of the Andean landscape were venerated by the Incas as they felt them to be endowed with supernatural powers. Cobo (1990 [1653]: 44-45) stated that the Incas venerated large trees, roots, springs, rivers, lakes, hills and mountains. He continued “They also did reverence to these places and made offerings,” and that they worshipped anything natural that was perceptibly different. “All of these idols were worshipped for their own sake, and these simple people never thought to search or use their imaginations in order to find what such idols represented.” Huacas were systematically worshipped and cared for and were integral parts of Inca religion and culture. They often were shrines to ancestors who, it was believed, could influence the living. The most powerful huacas required maintenance, care-taking, and offerings.

Salomon and Urioste (1991: 17) state that “a huaca was any material thing that manifested the superhuman: a mountain peak, a spring, a union of streams, a rock outcrop, an ancient ruin, a twinned cob of maize, a tree split by lightning.” Mummies could become huaca as well as could the children sacrificed in *Capac Hucha* by being buried alive.

In 1539 the Spaniards began a campaign against the indigenous religion and proceeded systematically to extirpate huacas, with the consequences that attendants and worshippers of known huacas were prosecuted, sometimes tortured, and even put to death. The foundations of the shrines were dug out, the objects of worship were destroyed, anything flammable was burned, and finally a cross was often built over the site (Arriaga, 1968 [1621]; Bauer, 1998). An unintended consequence of this campaign of destruction was that the names and locations of huacas were recorded so that they could be examined in the future to make certain no religious activity continued. Some of the huacas, namely large carved rocks, could not be eradicated and remain to this day.

Huacas were part of the officially organized worship of the Inca capital, and Cobo's above account provides insight into what things were considered sacred. Sacrifices and offerings were made at the shrines of such as gold, silver, clothing, sea shells, and sheep. Extraordinary offerings involved the sacrifice of children, human and animal figurines, coca, llama blood, and firewood dressed as people (Cobo 1990 [1653], 109-114). Winding or zigzagged channels were carved into certain huacas, perhaps for the flow of chicha or blood which may have been used for divination.

Two shrines marked the spot where travelers would first lose sight of Cusco and where they were given coca for a safe journey. Direct views from huacas were important, not only for the first and last views of Cusco by travelers, but also for the replication of form (Niles, 1987). According to Cobo, several huacas were important because they resembled the form of a sacred mountain, the human form, or a creature such as a serpent, puma, and condor.

Huacas often played a role in Inca festivals with *huacacamayocs*, or huaca specialists, coordinating shrine worship and offerings. Huacas were holy places and varied in size from major state shrines to those worshipped by one household (Bauer, 1998; Bauer and Stanish, 2001; Niles, 1987).

Certain huacas were thought to be oracles with powers to counsel the emperor. The Huacacamayocs acted as facilitators for messages between the oracle and their king. Huacas were focal points of communication with the Pachamama by virtue of their physical connections with the earth (Hemming and Ranney, 1982; Van de Guchte, 1990).

Cobo (1990 [1653]: 51-84) provides a comprehensive list and description of all 328 huacas of the Cusco ceque system. Cobo was not the original author, however, and he presumably referenced a much older document written by Polo de Ondegardo. Cobo mentions that the Coricancha was counted as an extra huaca.

Bauer uses Cobo's description to identify huacas by their sequence within the ceque that they lie upon. In it ceques and huacas are classified in the order in which they were presented by Cobo. Kenko Grande, for instance, is the second huaca on Chinchaysuyu's first ceque and, as such, is designated Ch. 1:2. The Tired Stone at Sacsahuaman is referred to by Ch. 4:6. Lacco is An. 3:6. (Bauer, 1998; Cobo 1990 [1653]; Rowe, 1980). I have elected to use Cobo's method for my research.

Carved rock huacas are bedrock features with their roots in the earth, an important aspect of symbolism involving the three Inca worlds. The Incas viewed them as stone deities (Bray, 2009). Pachacuti apparently believed that as the son of the sun and co-creator of the land he could modify and enhance the work of the creator. The carving of huacas may be attempts to express the inherent meaning contained in a unique rock, its "endogenous" meaning (Paternosto, 1996). Replica rocks share the shape of distant horizons. The chthonic power of rocks, emerging from deep underground, seems manifest in many of these carved stones. The in situ stone is rooted in the earth, providing contact with those primordial powers and with the Pachamama. Stones that were unusual in shape or in location seemed to have been especially venerated. If nature had marked out such a stone, it may have been viewed as something miraculous, an entry of the divine into the ordinary, a hierophany (Eliade, 1972).

Carved huacas may also express mytho-historic traditions of the Inca, such as creation mythologies dealing with water and caves, animism, and shamanistic ritual. Ritual stairs are a dominant motif, perhaps expressing movement from below to the heavens, and are frequently associated with the three realms. Seats or thrones were often sculpted as part of these huacas providing orientation to view mountains or solar events on the horizon. There is an association of stone huacas with water (Solomon and Urioste, 1991) or other ceremonial liquids, joining origin myths and the practical needs of agriculture. Rituals may have involved the pouring of liquids into basins and channels. Most astronomical huacas are near to streams or canals and appear to have been "given sentience" through camay. Most of the carved rocks surrounding Cusco are located in Chinchaysuyu and Antisuyu (Farrington, 1992: 373).

Certain shrines were dedicated to the sun with light and shadow effects highlighting times such as solstices and equinoxes. These huacas also may express explicit orientations to sunrise or sunset at specific times of the year. Features designate vantage points for observing astronomical phenomena, guide the eye to solar horizon events or the rising of the Pleiades, and mark approximate dates by shadow or the casting of light onto altars in caves.

6.5 Huaca Maintenance and Worship

Huacas required many prayers and offerings and the responsibility for such was assigned to specific panacas and ayllus. Panacas were assigned for the care and conduct of rituals at huacas on certain ceques while ayllus were designated for others. Every ceque had a kin group assigned to manage its affairs (Zuidema, 1964).

By design, huacas were self-sufficient with large tracts of land and animals to fulfill the needs of their attendants. These caretakers belonged to the panacas and ayllus of Cusco and many thousands were employed and supported in this manner (Bauer and Stanish, 2001). This system served as the state's method of allocating territory and irrigation sources (Niles, 1987).

Van de Guchte (1990) relates that a huaca was draped with textiles designating the specific panaca or ayllu responsible for its care. The attendants farmed the huacas' land, tended its flocks, and brought it special offerings on its specific day of celebration. Sacrifices were made at huacas, in part to support the attending panaca or ayllu, and these varied with the status of the shrine (Bauer, 1998: 27; D'Altroy, 2002: 167).

6.6 Ceque and Huaca Astronomy

Huacas can exhibit explicit cases of astronomical orientation and I have found examples to exist in the shrines examined as part of this study. These often were orientations for the June solstice sunrise, while others pointed to the sun at December solstice. Light tubes or cave openings allowed altars to be illuminated at specific times and orientations guide the eye to the horizon on solar significant dates. Pillars were set on hills to calendrically mark the passage of the sun on the horizon. A ceremonial staircase was illuminated and an animistic character created from light and shadow, both among numerous examples of the astronomical passion of the Incas and their solar religion.

Zuidema has found through the chronicles and field research that many ceques were astronomically oriented and pointed to the horizon to guide the eye to the sun and stars. Additionally he tells us that each of the 328 ceques represented a day of the year, with the remaining 37 days allocated to the approximate period of time that the Pleiades are blocked from our view by the sun. This calendar breaks into 12 sidereal lunar months of 27 1/3 days and the 41 ceques may represent 41 weeks of eight days each (Bauer and Dearborn, 1995: 64-65; Zuidema, 1982a).

6.7 Ceque System Controversy

Zuidema argues that the ceque system was utilized as a walk-through ritual calendar, with each huaca honored and worshipped on its own specific day of the year. He also proposed the alignment of certain huacas to have astronomical significance. The specific number of huacas, 328, is important as it represents the lunar sidereal year, 12 x 27.3, the number of days in a sidereal lunar month. Zuidema suggests that the 37 days missing between this calendar and the tropical year may be the approximately 37 days that the Pleiades are not visible in the sky because of the proximity of the sun. The period from May 2nd to June 9th also was one where there were no agricultural rituals to be timed and executed (Zuidema, 1989a). The ceque calendar therefore breaks into 12 sidereal lunar months of 27 1/3 days with the 41 ceques also representing 41 weeks of eight days each. The days of twelve month-like periods were counted by the huacas within each ceque group of three. In this way the number of days per month varied between 22 and 33 (Zuidema, 1989a).

The astronomical and calendrical basis of ceques has been rigorously argued by Zuidema and Aveni, but Bauer and Dearborn state that they find less evidence for ceque celestial sightlines (Bauer and Dearborn, 1995: 64-65; Zuidema, 1977; Zuidema, 1982a). Bauer and Dearborn (1995: 65) point out that the period of disappearance for the Pleiades can vary from year to year depending on the moon's phase, the horizon altitude, and atmospheric conditions. They state that "For the Pleiades, a disappearance from the night sky lasting forty to fifty days is quite reasonable" (1995: 130). Even if the specific reason for the 37 day gap remains elusive the ceque calendar as described would have been a most efficient tool for the Incas to use in the management of Cusco and their empire.

Zuidema (1977: 251; 1982a: 204) argued that ceques formed straight lines. Others doubt that the paths of ceques were this direct. Niles (1987: 177-179), using descriptions by Cobo, place names, and Inca roads, finds ceques not to be straight and instead that they follow paths with changing courses. One of Cobo's (1990 [1653]: 61) huaca descriptions states "[Ch-9:4] The fourth *guaca* was a fountain named Pomacucho which was somewhat separated from the *ceque*." Still, this may not mean that ceques were not intended to be straight as the related huacas may have straddled a conceptually straight sight-line. Niles maintains that while ceques never crossed one another, they did not proceed straight from the Coricancha to the horizon. Bauer (1998: 11) mentions that "Zuidema and Aveni do not state that all of the ceques were straight," but also adds "it is the specific locations of the huacas that define the course of the lines and not vice versa." Bauer agrees with Niles and says that certain huacas on certain ceques varied considerably to the left or right of a straight line. They assert that this variance was great enough to have made it unlikely that ceques could have formed sightlines to guide the eye to celestial horizon events (Bauer and Dearborn, 1995:132-133; Niles, 1987: 177-179). Zuidema (1977: 251) states that "While keeping the concept of ceque as a straight line, huacas of one ceque could be found to the right or left with some margin of freedom." Aveni (1981d) argues that his research with Zuidema demonstrates that some ceques are straight, one represented an astronomical sight line, three locations were used for observations, and two sightlines crossed ceques employing certain huacas on those ceques for astronomical observations.

Niles (1987: 178) says that while certain huacas played a role in Cusco's calendrical system it is difficult to argue that astronomical orientation was a determining factor in the placement of all shrines and ceques. Bauer and Dearborn (1995: 130-133) feel that evidence does not support that ceques were associated with specific stars. Farrington (1992: 370) states "Importantly, in contrast to the work of Niles (1987: 178), Zuidema and Aveni (Aveni 1981a: 313) have established by field verification and toponymy that the lines are straight, even over distances up to 20 km; about thirty of them have been mapped with reasonable precision. Zuidema (2007: 279) asserts that the "ceque system does account well for the Cuzco calendar as reconstructed from the solar and lunar data and corroborated by the information on ritual movements." Cobo (1990 [1653]: 60-61) listed the tenth huaca on Chinchaysuyu's eighth ceque to be called *Catachillay*, a name also related to the Pleiades. The seventh huaca on the same ceque was called *Sucanca*. The pillars of Sucanca, as viewed from the Coricancha, indicated the position of the Pleiades' last heliacal set about April 15^{th} (Zuidema, 1977). The evidence from the chronicle of Cobo, when taken with observations in the field, supports that this ceque had an astronomical alignment from the Coricancha to the horizon.

While Bauer says that ceques could not have been straight because of their huacas having been situated in zigzag-like patterns, Zuidema could be correct. Zuidema (1977: 251) states that ceques were sightlines to points on the horizon and not necessarily direct connectors of huacas. He adds that the huacas associated with a particular ceque could fall to the left or right of this sightline. Such a case would negate Bauer's argument that ceques followed zigzagged paths connecting their corresponding huacas and could allow further support of Zuidema's model of ceque sightlines to the horizon. Bauer's statement that ceques did not cross each other (Bauer, 1998: 11) works with this interpretation of Zuidema's concept. The ceques in Zuidema's model do not cross, even if their haucas lie not on them but only in close proximity. Even though many of these huacas did not fall exactly on the straight-lines that gave them order, the actual sightlines between them were important factors in their care and worship. "A ceque probably was something more than a loose line drawn from one accidental huaca location to the next" (Zuidema, 2002: 593).

Bauer and Dearborn agree with Zuidema that the Incas appeared to exhibit definite interest in the Pleiades (Bauer and Dearborn, 1995, p. 124). This might have been in part as an Andean methodology for agricultural forecasting by observing the relative brilliance of this star group upon its heliacal rise (Orlove, Chiang, and Cane, 2000: 68). Zuidema and Aveni found a corridor in the Coricancha that opens though the southwest wall of the of the temple's courtyard to face in the direction of the rise of the Pleiades, c. A.D. 1500 (Zuidema, 1982a: 212-214). Such an orientation to guide the eye seems plausible for a society observing the Pleiades due to concern about future harvests. The sun temple at Llactapata exhibits a similar orientation, which I will discuss with my research in section 11. 4.

6.8 Summary

The Incas ordered their religion and society by the ceques and huacas of Cusco. The ceque system exhibits certain similarities with the quipu, a woven mnemonic aid whose many strands and knots also radiate from a central focal point. Ceques may as well have been used to organize shrines of worship at other key locations within the empire, one potential example of such found in the vicinity of Machu Picchu. The specific purpose and alignment intended for Cusco's ceques remain a matter of dispute.

Huacas were shrines venerated due to the great spiritual entities within them and at least 328 were known to surround Cusco at the time of the Spanish invasion. There likely were many more, especially those intended for personal worship not sponsored by the state. Ceques were assigned to specific panacas and ayllus, who in turn were responsible for the care and worship of the huacas found along them. Catholic priests set out to extirpate everything regarding the indigenous religion and succeeded in most cases, exceptions being the many carved rock huacas they could not destroy.

The astronomy encoded in many of the rock huacas surrounding Cusco, the Sacred Valley and Machu Picchu will be explored in Part IV.

Part III: Astronomy

Chapter 7

Archaeoastronomy

7.1 Introduction

Archaeoastronomy is sometimes said to be the study of the anthropology of astronomy. Researchers seek to establish cultural patterns for alignments associated with heavenly bodies that are easily observable to the naked eye. Celestial orientations appear in the architectural constructs of several societies, implying there was a great ancient interest and dependence upon the sun, planets and stars to regulate or otherwise influence many functions of everyday life. Astronomical positioning was far more than just a means of telling time, however, as celestial occurrences appear to have been intertwined with multiple aspects of society and culture. While classic archaeoastronomy has concerned itself more with alignments while leaving cultural interpretations to ethnoastronomers, today lines have become much more blurred as archaeoastronomers, too, seek answers to why and for what purpose the orientations they discover exist.

Certain research has been aided with written records left by societies of their astronomical activities, such as the Babylonians, Egyptians and Maya. Others like the Inca had no system of writing, thus complicating efforts to place their celestial practices into proper context. Archaeoastronomy in relies heavily upon interpretations of the azimuths and elevations of sightlines crafted into constructs such as shrines and temples. It also measures effects of light and shadow.

In this chapter I explore some of the interests, methods, parameters and celestial occurrences that have been observed and practiced for millennia. I examine archaeoastronomical practices that relate to ancient societies and especially to the Incas with regard to their version of astronomy and cosmology.

7.2 The Celestial Sphere

People of all civilizations throughout history have observed similar celestial motions. Their interpretations, explanations, and uses for them are what differ. Most present day astronomers have very little time to contemplate repetitive patterns and positions of heavenly bodies as they rise or set on the horizon. Many ancient cultures studied such events closely, however, and were very much experts on what can be called “horizon astronomy.”

These astral phenomena result from the diurnal motion of the earth’s rotation as well as the annual travel of the planet in its orbit about the sun. In the Southern Hemisphere the earth’s apparent motion is from left to right, or clockwise, when looking north toward the equator. As a result the stars, sun, moon and planets all rise from the east to the right and set to the left in the west. They appear to be on a celestial sphere, equidistant in the sky, and travel upon it in their daily motions. Predictable movement upon this sphere caught the attention of many an ancient observer and gave rise to the surprisingly sophisticated astronomies that we discover today.

7.3 Motions of the Heavens

While all have looked essentially upon the same sun, moon, planets, Milky Way and certain stars, ancient observers envisioned many different things. The figures imagined in the sky by one civilization did not necessarily match the constellations devised by another. These individual reflections gave rise to a number of different cosmologies that were influenced by the orientation of the view of the heavens offered by the geographic location of the civilization in question (Urton, 1981a). We often view astronomical occurrences from our own perspective and therefore need to make a conscious effort to see the sky from the eyes of those we study (Aveni, 1981c).

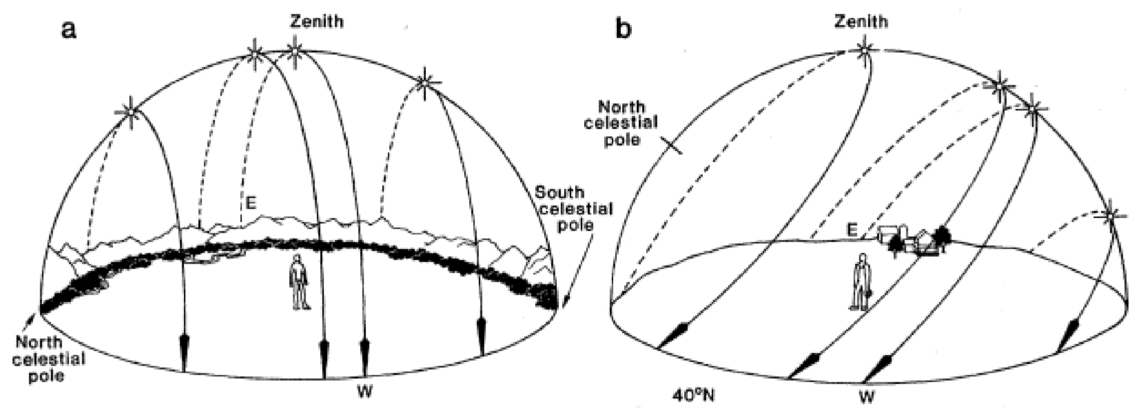

Figure 7-1: Paths of apparent celestial travel in the equatorial latitudes (a) and the mid-latitudes (b). Motion in the tropics is vertical while that in the temperate-zones is oblique and circular (from Aveni, 1981c: 163).

7.3.1 Mid-Latitudes

In the mid-latitudes bodies traveling on or near the ecliptic appear to rise in the east, cross the sky in an arc, and set on the western horizon (see Figure 7-1). If viewed from the Southern Hemisphere these bodies travel right to left, and in the Northern Hemisphere from left to right. The altitude of the arc of travel may vary throughout the year and is dependent upon the latitude of the observer and the position of the earth in its annual orbit with regard to the 23.44° tilt of the earth's axis. Annual variations in the height of this arc are responsible for the consistently changing solar rising and setting points on the horizon that gave rise to many of the astronomical practices of ancient civilizations.

Stars, as well as the sun and moon, travel east to west on their own respective arcs. In the Southern Hemisphere, when looking to the south those stars in proximity to the south celestial pole are seen to travel in circles around the pole due to the earth's rotation about its axis. These stars are called *circumpolar* and the number of them that can be viewed as such, always above the horizon, is dependent upon the latitude of the observer. As viewed from Cusco, these would be the stars whose circles' lower limbs lie within 13° of the southern horizon.

7.3.2 Polar Latitudes

In the polar regions, more specifically at 90° north or south at the celestial poles, all visible stars appear as circumpolar and trace concentric circles in the sky. The sun, moon, and planets cross the sky on or near the arc of the ecliptic, which is at an altitude dependent upon the seasonal variation of the orientation of the earth in its orbit.

As viewed from the poles the ecliptic can cross the sky no higher than 23.44° above the horizon during the hemispherical summer. For half the year during the winter the ecliptic is below the horizon and those bodies traveling on or near its path cannot be seen. These orientations result in days without sunset or sunrise. The sun will rise once at the associated spring equinox and does not set until the corresponding equinox of the fall. Latitudes greater than 66.56° experience lesser degrees of total day or night, accordingly.

7.3.3 Equatorial Latitudes

Observers on the equator see stars rise perpendicular to the eastern horizon, climb directly up and across the sky, and set perpendicularly on the western horizon (see Figure 7-1). The lines traced by each star are parallel to one another.

On the equinoxes the ecliptic is oriented with the celestial equator so that bodies traveling on or near it rise and set straight up from the east and down in the west. During the rest of the year the sun travels as much as 23.44° north and south of the celestial equator.

7.3.4 Cusco, Peru

Cusco lies in the Andes at approximately 13.5° south latitude. In such a tropical region the Incas experienced apparent celestial motions between those of the equator and middle latitudes. Facing north, the sun and other ecliptic bodies rise to the east on the right, cross the sky in arcs to the north, and set to the left in the west. The region surrounding Cusco experiences a sun in June that rises in the northeast, crosses the sky on a relatively lower arc, and correspondingly sets in the northwest. In December the solstice sun rises in the southeast, follows a higher path, and sets again in the southwest.

The Incas and the civilizations preceding them apparently observed and carefully noted the repetitive and predictable patterns of the horizon positions of sunrises and sunsets. They used this knowledge to develop a calendrical system for crop management and denoting recurring religious festivals. The Incas built pillars on certain smooth horizons to predict and mark the positions of solar events at key times of the year in public displays affirming the status of the ruling elite. In other locations they may have observed the same with rugged natural geographic features.

Inca knowledge of solar alignments extended into their architecture and shrines, where I have found many to be oriented for purposeful effects of light and shadow. Certain temples were oriented for solar and Pleiades horizon events, as well as were huacas designed for special ceremony and purpose. Several of these shrines have features that are illuminated by the sun or moon during significant time periods.

7.4 Solstices and Equinoxes

The moment that the sun on its apparent ecliptic path crosses the celestial equator is called an equinox. This occurs twice each year on or about March 21st and September 22nd and on those dates the crossing results in days with equal periods of sunlight and darkness. The longest days and nights occur annually when the sun reaches the northernmost and southernmost points in its ecliptic travel (23.44° north or south) on or about June 21st and December 21st. These are the June and December solstices, and are more commonly known as the summer and winter solstices at opposing times in their respective hemispheres.

Awareness in ancient cultures of the existence of solstices and equinoxes likely came through observations made over many years. Persons of intellectual curiosity such as priests or scribes watched the recurring motions of the sun, moon, stars and planets with wonder and noted the patterns that they made. Given enough time they found dependable cycles and devised methods to both predict and utilize them. Inca awareness of the equinoxes is mentioned in the chronicles (Garcilaso, 1961[1609]: 72), but conclusive structural evidence has been elusive. Additionally, in his narrative Garcilaso confuses equinoxes with zenith passage. Solstices are easy to see when the sun ceases to move on the horizon, but horizon observations at times of the equinoxes at the latitude of Cusco are less precise due to the 25 arc-minute per day rate change in the position of the sunrise (Dearborn and White, 1989: 468).

The Incas learned the cycles of solstices and equinoxes and used this knowledge as a key component of their annual crop management activities. Zuidema (1981b) and Aveni (1981a) describe pillars, no longer extant, on the horizon of Cusco that were mentioned by chroniclers following the Spanish conquest. These are discussed in section 8.8.

7.5 Cardinal Directions

Cardinal directions were known to the ancients and could be described by using the shadow plots of gnomons. On a curve traced by points plotted of the tip of the gnomon's shadow throughout the day, the point at which the shadow was closest to the gnomon indicates true south in the Southern Hemisphere (Evans, 1998). North is opposite south and the directions of east and west are perpendicular to this line.

A circle that is traced through the shadow plot at two points, with its center at the gnomon, can be used for more precise measurement. Lines may be drawn from the intersecting points to the gnomon thus forming an angle that, when bisected, indicates through the shortest shadow to the south (Evans, 1998). While within their technological capabilities, there is no evidence that the Incas used these procedures.

7.6 Zenith Sun

As the sun travels along the ecliptic, twice per year it passes directly above any point lying between the Tropics of Cancer and Capricorn. Locations on either tropic experience the *zenith sun* only once on the day of the associated solstice. All sites between the latitudes of N23.44° and S23.44° observe times without shadow when the sun passes directly overhead. This includes all of Peru and most of the former Inca Empire. Exposed to the phenomenon of zenith passage, civilizations between the tropics developed cosmologies that differed from those further to the north or south (Urton, 1981b).

Dates of the zenith sun vary according to the latitude of the observer. In the vicinity of Cusco the two dates for zenith passage occur on February 13th and on October 30th (Zuidema, 1981b:

322-323). Zenith passage can be observed when a vertical gnomon casts no shadow and on those dates the sun rises on the Cusco horizon at approximately 103.5° and sets at about 256.5°. This is discussed further in section 8.6.

Zuidema gives strong arguments that the Incas also observed days of anti-zenith, or nadir, passage of the sun, determined when the sun sets 180° from the position of the zenith sunrise (Zuidema, 1981b: 322-326). Anti-zenith passage therefore occurs in Cusco on April 26th or 27th and August 18th or 19th, with sunrise on these days occurring at 076.5° and sunset at 283.5°. These dates closely correlate with Inca festivals of maize planting and harvest. The Incas used the zenith sunrise and anti-zenith sunset (Zuidema, 1981b).

Garcilaso (1961 [1609]: 72) gives an account related to a method of observing zenith passage. In it he describes priests as making daily observations of a shadow cast by a column as the time of the equinox approached. A large circle was drawn with an east-west line through the column at its center. They observed the approach of the equinox with this shadow and, according to Garcilaso, when the shadow was “reduced by half, from sunrise to sunset” and the column cast no shadow at noon, they knew the equinox had arrived. Garcilaso’s wording exhibits confusion between the observance of the equinox and that of the zenith sun.

Inca interest in the anti-zenith passage of the sun is further discussed in section 8.6.

7.7 Horizon Astronomy

As the earth revolves its axial tilt causes a daily change in the horizon positions of sunrises and sunsets. Ancient civilizations used this knowledge to develop systems of timekeeping to regulate planting and harvesting, as well as recurring religious festivals and other civic events.

Natural features were identified to mark the positions of the sun on days of solstices and equinoxes. Alignments of buildings and shrines were also crafted to assist in identifying these important dates. The Incas erected pillars on the relatively smooth horizons of Cusco to assist in observing these solar phenomena, and possibly as well for zenith and anti-zenith sunrises and sunsets (Zuidema, 1981b). Observations were made from key points in Cusco to identify such annual events. It is suggested that the Incas may even have erected sufficient pillars to denote "months" throughout the solar year. For these and other events the Incas made valuable use of the predictable and reliable patterns of the sun on the horizon as a calendar to regulate their daily lives.

Many of the huacas in this study have been found to be oriented to one or more of these key horizon events, especially that of the June solstice.

7.8 Spherical Trigonometry

Movement of astral bodies on the celestial sphere is defined mathematically and can be precisely calculated with spherical trigonometry, a mainstay of archaeoastronomical research. If a spherical triangle is defined as having three angles labeled A, B and C, and the sides opposite those angles are correspondingly labeled a, b and c, then according to Smart (1977) the following are the basic formulae for solving such a triangle:

$$\cos a = \cos b \cos c + \sin b \sin c \cos A \tag{1}$$

$$\sin A / \sin a = \sin B / \sin b = \sin C / \sin c \tag{2}$$

$$\sin a \cos B = \cos b \sin c - \sin b \cos c \cos A \tag{3}$$

$$\cos a \cos C = \sin a \cot b - \sin C \cot B \tag{4}$$

These may be used in archaeoastronomy to calculate angles and distance that specify horizon points of celestial bodies and verify field data taken by sighting compass, GPS and theodolite. Aveni (1980) gives specific formulae useful for such purposes:

$$\textit{Hour angle of the sun in degrees} = (GMT-12)15 - LONG - (EOT)15 \tag{5}$$

$$\textit{Altitude of the sun} = \mathrm{Arcsin}\,(\mathrm{Sin}\,(LAT)\mathrm{Sin}(DEC)+\mathrm{Cos}(LAT)\mathrm{Cos}(DEC)\mathrm{Cos}\;HA)) \tag{6}$$

$$\textit{Azimuth of the sun} = \mathrm{Arcsin}\,(\mathrm{Sin}(HA)\mathrm{Cos}(DEC)/\mathrm{Cos}(ALT)) \tag{7}$$

Where HA = Hour Angle, GMT = Universal Time Coordinated, LONG = Longitude, EOT = Equation of Time, LAT = Latitude, and DEC = Declination.

In horizon astronomy research, when the angular altitude of the horizon at or above level is known by measurement with such as an inclinometer, the latitude of the site in question is taken from a chart or GPS measurement, and the declination of the sun is derived from the nautical almanac, the following formula is most useful for calculating the position on the horizon that the sun will rise:

$$\text{Azimuth of sun} = \text{Arccos}\,((\text{Sin}(DEC) - \sin(LAT)\text{Sin}(ALT))/(\text{Cos}(LAT)\text{Cos}(ALT)) \quad (8)$$

7.9 Archaeoastronomical Implements

Tools typical in archaeoastronomy include theodolites, GPS receivers, sighting compasses, inclinometers, digital cameras, tape measures, computers and astronomical software. The theodolite, or surveyor's transit, measures angles very precisely, as much as to the arcsecond, and is used to verify orientations requiring the utmost of accuracy. GPS receivers provide coordinates of latitude and longitude, as well as elevation above sea level for each research object or site. These values may then be used with appropriate formulae found in section 7.8. A sighting compass is useful for measuring azimuths and orientations in far less time than that required by a theodolite. An inclinometer is used to determine angles to objects above or below the level horizon. Digital cameras and photographs are useful for documenting every aspect of a research site, including any evidence of effects of light and shadow. Tape measures are used to record dimensions of certain object(s) under study. Computers and astronomical software provide insight into skies that were viewed by ancient societies and are useful in predicting orientations and celestial events. *Google Earth* is emerging as a valuable tool as well. This program makes available world-wide satellite imagery in formats that allow visual evaluation of potential orientations.

7.10 Temporal and Atmospheric Phenomena

Several factors can affect the precision of archaeoastronomical field work. Such considerations involve precession and obliquity, refraction, extinction, and horizon deviation.

7.10.1 Precession and Obliquity

Precession of the equinoxes occurs due to the slow wobble of the earth's axis. This nearly 26,000-year cycle causes the celestial poles and equator to migrate when compared against the background of the stars. Right ascension and declination change over time as a result and the difference in declination leads to new rising and setting azimuths for stellar objects. Ancient astronomical orientations that might not be obvious today can be determined with declinations adjusted for the time period when a temple or shrine was designed.

Bodies within our solar system traveling on or near the ecliptic are not affected by precession. The obliquity of the ecliptic, however, changes at a rate of about 50 arcseconds per year and therefore is a consideration for celestial measurements regarding ancient structures.

7.10.2 Refraction

Celestial bodies appear higher in the sky than they actually are due to atmospheric refraction. This is the result of light being slightly deflected due to differences in atmospheric density and has a greater effect near the horizon (Schaefer, 1993). The azimuth of an object is shifted due to refraction, an effect which is more pronounced at higher latitudes with smaller incident angles to the horizon than in the tropics. The effect of refraction becomes negligible at altitudes 20° or more above the horizon. Since refraction is sensitive to the atmospheric profile integrated along the line of sight and since that profile is influenced by local parameters, corrections are increasingly uncertain for objects near the horizon. The effect becomes pronounced at higher latitudes and is generally insignificant in the tropics.

7.10.3 Extinction

The absorption and scattering of photons when colliding with particles or air molecules is known as atmospheric extinction. Atmospheric water, carbon dioxide and oxygen are primary absorbers.

Rayleigh Scattering occurs with air molecules smaller than the wavelength of the photons in question. *Mie Scattering* results similarly with photons striking small atmospheric particles of similar wavelengths (Bely, 2003). Extinction is not an issue when dealing with the sun and moon, but becomes a serious consideration when observing faint stars near the horizon, such as the Pleiades (Schaefer, 1986).

7.10.4 Horizon Deviation

Horizon deviation occurs wherever the visible horizon differs from the astronomical horizon. This happens commonly in areas of mountainous terrain and is most extreme at higher latitudes where the arc of travel for a specific body will yield a significantly different point for rising or setting than that given for the astronomical horizon. Examples showing the magnitude of shift on the horizon due to increased inclination are given in Table 7-1. The values of Table 7-1 are presented only for demonstrative purposes in this chapter. The solar horizon positions in Part IV Field Research were adjusted for horizon deviation using formula (8) in section 7.8 and are listed in Appendix A4.

Inclination above astronomical horizon	Latitude 13.5°	Latitude 40°
1°	0.27°	0.99°
2°	0.54°	2.01°
4°	1.12°	4.11°
6°	1.74°	6.33°
8°	2.39°	8.68°
10°	3.09°	11.19°

Table 7-1: Horizon Azimuth Shift for Inclination.

7.10.5 Research Considerations

Precession is not a concern for solar observations, but for measurements involving stars such as the Pleiades it must be taken into consideration. The obliquity of the ecliptic has changed 0.0649°

since the time of the Incas, resulting in a difference in azimuth of 4’ at a latitude of 13° and is therefore negligible for the purposes of my research. While refraction and extinction can be important when examining the rising and setting of stars, they also are not a concern for research involving the sun. The rising and setting of all celestial bodies at the S13.5° latitude in Cusco, the Sacred Valley, and Machu Picchu must take horizon deviation into account.

7.11 Summary

Study of the constructs of ancient societies in an astronomical context requires both careful measurement and the consideration of pertinent phenomena. Paths of heavenly bodies on the celestial sphere vary with latitude and throughout Cusco, the Sacred Valley, and Machu Picchu motions observed are typical of those found in areas throughout the tropics. Solar paths arc across the northern sky, both rising and setting with pronounced angles of incidence with the horizon. The region also experiences solar zenith on February 13th or 14th and October 30th each year.

Solstices and equinoxes of the sun were of primary interest in several ancient cultures and were sometimes used, including by the Incas, as a calendar to regulate crop management and recurring religious festivals. The Incas erected pillars and other devices to assist them in recognizing these key astronomical events, especially when natural horizon features were insufficient.

Cardinal directions were important to certain ancient civilizations and could be determined through the use of gnomons designed for this purpose. The precise moment of the zenith sun could also be observed through the absence of shadows from such vertical devices.

Horizon astronomy is the observation of solar, lunar, planetary and stellar rising and setting events on the horizon. Several ancient civilizations, including the Incas, practiced horizon astronomy in an effort to better regulate their society on an annual basis.

Various instruments and spherical trigonometry have become staples used in the archaeoastronomer’s research. These include theodolites, GPS receivers, sighting compasses, inclinometers, digital cameras, tape measures, computers and astronomical software. Mathematical formulae and/or computer software may be used to accurately depict, predict, or verify the horizon positions of various astronomical events. Researchers must also be cognizant of, and adapt for when necessary, the effects of precession, obliquity, refraction, absorption, scattering and deviation of the skyline from the astronomical horizon. Of these factors horizon deviation is the principle concern for solar research in the Andes.

Chapter 8

Inca Astronomy and Cosmology

8.1 Introduction

Astronomy in the Andes was well developed by the time the Spaniards arrived in the Inca Empire. This was due in large part to the accumulation of knowledge through observation made by the many civilizations preceding the Incas. Astronomy was not simply observing and understanding celestial movement, however, as it was integrally woven into the very fabric of Andean existence, throughout myth, cosmology and culture, playing an important role in daily life.

The Incas were a sun-worshipping people and their emperor was said to be "the son of the sun." Their cosmology begins with the primordial rising of the sun, and also that of the moon. In their astronomy they were aware of many stars and planets and paid particular attention to the Milky Way and the Pleiades.

In a practical sense this knowledge was put to work via horizon astronomy as the Incas marked the passage of sunrises and sunsets on their horizons in order to keep time for agriculture and religion. Ultimately celestial orientations were integrated into their temples and huacas, as well as other constructs such as solar pillars built more specifically for astronomical purposes.

The intriguing astronomy found in Incan huacas is much better understood when placed in the context of Andean astronomy as a whole.

8.2 Complex Astronomy

Pachacuti Inca Yupanqui was the 9th emperor of the Incas and succeeded his father, Viracoca Inca, following a legendary battle with the Chanca where Pachacuti led his people to victory while his father fled from Cusco. This pivotal conflict took place a mere two centuries after the founding Incas first entered the Cusco valley. Nine decades later Spaniards began their invasion of the Incas' domain and thought them to be far too undeveloped to have any understanding of the heavens (Aveni, 1981a). The earth was still at the center of the European universe and its flatness only recently had become publically questioned.

The conquistadors and priests were far from correct, however, and the Incas' astronomical traditions began long before the beginnings of their empire. As the Incas conquered the Andes and assimilated tribe after tribe they also took possession of their cultural traditions and collective knowledge. Descriptions of recurring astronomical patterns realized through centuries of celestial observations made by successive civilizations were part of this adopted store of intelligence. Inca emperors refined this cosmology to best support the legitimacy of their power, but their concepts had long before begun with others such as the Huari, Nasca and Chavín (Aveni, 1981a). By the time of the 1532 invasion Inca astronomy had developed to where it was as complex as any (Urton, 1981a). We must attempt to examine their astronomy through the eyes of Andean civilization and not that of the Europeans.

8.2.1 An Astronomical Society

Astronomy in Cusco was interwoven with religion and everyday life and the Incas believed heavenly activity to be directly connected with that on the earth (Urton, 1981a). Constellations were established with heliacal risings that foretold of coming terrestrial events. State efforts to promote the legitimacy of both solar worship and the emperor's power required an intimate knowledge of the observable phenomena of the sun. These demonstrations were both for the benefit of the Inca populace and for newly conquered tribes. Successful crop management is dependent upon optimal times for planting and harvest. The Incas regulated this by horizon positions of the sun. The spiritual world of the empire was also entwined with the heavens, not only by the gods of the constellations, but also through an intimate cosmology emanating from the Milky Way. Inca emperors had temples and huacas built with orientations for solar worship, festivals and agriculture. Their ancient society was continually aware of happenings in the heavens.

8.2.2 Misminay

Many Incan traditions survived the Spanish conquest through the residents of remote Andean villages. While priests made fervent efforts to convert the country to Christianity, many practices of indigenous culture and religion, including those astronomical, survived in these distant communities.

In the mid 1970's Gary Urton (1981a) made a breakthrough in understanding Andean cosmology that may hold insight for Inca astronomy. In fieldwork for his doctoral dissertation he lived for extensive periods amongst the villagers of Misminay in rural Peru, in a culture where Quechua is still the daily language. Many of the ancient traditions remain and Urton eventually was able to earn the trust of the residents. Gradually they shared cosmological philosophies that had been passed down through the ages, since the time of the Incas (Urton, 1981a).

Urton learned of their system of time reckoning using the sun by day and the moon or stars by night, and also the ancient names of 40 stars and constellations. The planting and harvest of various crops were regulated month by month on an annual schedule that included the use of cycles of the moon. Sunrises were utilized for times of planting and related horizon positions had been carefully determined to minimize crop failure (Urton, 1981a).

Villagers also described the sky as being quadrapartitioned into four parts as defined by two alternating intercardinal axes of the Milky Way. The community below mirrored this quadripartition and an intricate cosmology was found to relate the two (Urton, 1981a).

Urton determined that:

> It seems reasonable to conclude that the concept of the center/planting sun (the sun from August to late October) which is found today in Misminay is a "descendant" of the Incaic practice of calculating the time of planting maize by means of solar pillars. Even though the solar pillars (sucancas) which were in Cuzco during the time of the Incas were systematically destroyed during the "extirpation of idolatries," we may see the virtual embodiment of them in the saints' days (i.e., four saints' days = four solar pillars) and in such concepts as a planting and harvesting sun (Urton, 1981a: 77).

While there is no conclusive evidence, much of the Inca's astronomy may have survived and exists through the memories and practices of these contemporary Andean peoples.

8.2.3 Coricancha

The Incas' most significant Temple of the Sun, the Coricancha of Cusco, was of preeminent importance as a focal point of state astronomy. The Coricancha's west wall is aligned with approximately the same azimuth as that for the horizon point of the heliacal rise of the Pleiades in June (Zuidema, 1982a). Additionally, the December solstice sunset was observed from the Coricancha to two pillars on the horizon at Chinchincalla (Aveni, 1981a: 308).

> [Cu-13:3] The third, Chinchincalla, is a large hill where there were two markers; when the sun reached them, it was time to plant (Cobo, 1990 [1653]: 83).

In a nation whose religion and power centered on the sun, astronomy and its related demonstrations were key. Maintaining public festivals as precise annual recurrences was an important part of exerting this influence over the masses (Bauer and Stanish, 2001). Elaborate ceremonies for both the elite and the common were carefully crafted and celebrated, especially at the time of the June solstice.

The Incas knew that the sun took a year to complete its cycle (Hemming and Ranney, 1982) and their view of this journey included its path along the horizon. The exact solstices and equinoxes of the sun were well familiar, as were eclipses and the days of zenith and antizenith suns. The sun was used to determine exact days and hours for planting (Hemming and Ranney, 1982) and became part of religious ceremony through carefully designed effects of light and shadow. In a society that preceded Copernicus, Kepler and Galileo, Incan astronomy was relatively well developed.

8.3 Sun -Worship

Founders of the Inca Empire sought to legitimize their power through state-mandated worship of the sun. They created an elaborate cosmology centered on solar relationships and developed ceremonies and rituals to reinforce and perpetuate these state-serving myths.

The Empire maintained the sun to be the Inca's preeminent ancestor and the emperor to be the son of the sun. Therefore the power base and the legitimacy of the Inca royals depended upon the sun as their source. The sun also was revered for its life-giving role in agriculture.

Rituals and ceremonial travel to pilgrimage centers were both part of an elaborate system developed to establish and maintain these solar relationships and state ideology (Bauer and Stanish, 2001). Zuidema (2008a; 2008b) discussed three forms of pilgrimage, a procession, a pilgrimage, and a race, along the southeast to northwest axis of the solstices that traveled as far as Vilcanota to the southeast and Ollantaytambo to the northwest. The emperor Pachacuti ordered all his subjects to worship the sun and constructed solar temples throughout the empire for that purpose. Conquered tribes were made to accept the Inca as a descendent of the sun and to join in prescribed worship. The year was organized for annual religious and agricultural festivals. Solar pillars near Cusco described by Spanish chroniclers were likely built to signal such events (Zuidema, 1981b; Aveni, 1981a).

8.4 Cosmology and Origins

Lake Titicaca lies on the border between Peru and Bolivia at an altitude of 3812 masl. It covers more than 58,000 square kilometers and is host to many islands, two of which figure centrally in Inca cosmology and origins.

The Inca believed the sun and moon to have been born from Lake Titicaca and its *Isla del Sol* and *Isla del Luna*, respectively. The sun was thought to have risen from an outcrop of rocks on the island that now bears its name and the moon likewise from a smaller island in the vicinity nearby. The original Inca and his queen were royal descendants of the sun and moon and these islands became great huacas and state pilgrimage centers. Offerings were made amidst intricate ceremonies as Inca culture and religion grew around these origin myths (Bauer and Stanish, 2001).

The sun of the Incas is further linked with water as their cosmology tells of its daily rebirth from the Vilcanota River. After the western sunset the sun travels beneath the Vilcanota and is therefore rejuvenated by the powers of its waters before being born again in the morning on the eastern horizon. During the summers' rains the river runs deep and fully charges the hot sun. In the dry winters the sun is dimmer and temperatures colder as the lower river waters cannot fully replenish solar powers (Urton, 1981a).

8.5 Principle Festivals and Ceremonies

Integral with the role of the sun in Inca society were several prominent festivals. Inti Raymi, the festival of the sun at the time of the June solstice, was one of the most significant of the Inca's year. The Incas commenced ceremonies for eight days attended by the royal mummies and complete with sacrifices and great chanting. Gratitude was expressed to the sun for present and future harvests (Hemming and Ranney, 1982).

The time of the December solstice was the other great pinnacle of Inca solar worship with the festival of Capac Raymi (Dearborn, Schreiber, and White, 1986). The pillars of Cusco, described by the chroniclers, could well have been used to forewarn of and celebrate both of these annual solar events.

8.6 Inca Horizon Astronomy

As sun worshippers and followers of solar events the Incas became masters of *horizon astronomy*, which is the tracking of celestial events as they occur on the horizon. The Incas practiced horizon astronomy through positional observations of the rising and setting sun on days of ceremonial and agricultural significance. As the earth orbits the sun the tilt of its axis causes the horizon positions of sunrises and sunsets to move accordingly north or south ever so slightly each day. The Incas identified these astronomical events on the horizons of Cusco and monitored them with pillars (Aveni, 1981a; Cobo, 1990 [1653]; Zuidema, 1981b).

Alternate methods of establishing sunrise positions appear to have been practiced at Machu Picchu and the neighboring ceremonial center of Llactapata, where the irregularities of the horizon provided natural calendrical markers for such as the June solstice. In addition, a 33 meter long corridor at Llactapata establishes a 4.3° window along the horizon that frames both the rising positions of the June solstice sun and that of the Pleiades. A similar sighting device may have been established at the Coricancha of Cusco.

8.6.1 Solar events

8.6.1.1 Solstices

The sun's southernmost declination on its apparent ecliptic path of travel is currently S23.44° and when it reaches this point we observe what is called the December solstice. In the Southern Hemisphere this is also known as the summer solstice and throughout the months leading up to it there are small southward movements of the sun on the horizon each day, except for about two days before and after the solstice when there is no observable motion as the sun "stands still" before reversing course back to the north (Kelley and Milone, 2005; Urton 1981a). The sun's northernmost declination, N23.44°, occurs at the June, or winter, solstice when similar motions are observed, only in the opposite direction. The sun travels on a lower arc in June, but crosses high in the sky at the time of the solstice in December. In the region around Cusco there is a difference on the horizon of approximately 50° between the solstitial sunrises.

The Incas staged the great festivals of Inti Raymi and Capac Raymi at times of these prominent annual June and December solar events.

8.6.1.2 Equinoxes

Like with solstices, there are two solar equinoxes. The March and September equinoxes occur when the sun crosses the celestial equator, from south to north in March and from north to south in September. In the Southern Hemisphere the September and March equinoxes signal the beginnings of spring and fall respectively and on those particular dates the hours of daylight and darkness are equal.

Andean tradition links the equinoxes with fertility, September in the Spring when the soil is first prepared for planting and in March, the Fall, when maize was harvested. The chronicles do not support Incan observation of equinox sunrises and sunsets (Zuidema, 2007). Equinoxes are mentioned in section 7.4.

8.6.1.3 Zenith Sun

Between the times of the December and June solstices the sun's apparent travel twice takes it directly over each geographical point lying between S23.44° and N23.44°. At the latitude of Cusco, about S13.5°, the two zenith passages occur on February 13th and October 30th (Zuidema, 1981b: 322-323). On these dates the sun passes directly overhead at local noon when vertical objects do not cast a shadow, a phenomenon of which the Incas were well aware. While this specific event took place overhead and not on the horizon, in their system of horizon astronomy the Incas included observations of the position of sunrise on days they knew to be of a zenith passage (Zuidema, 1981b). This recorded position could then be used to determine the date of nadir, or the anti-zenith sun. Vertical towers, such as the Sunturhuasi in Cusco, were used to facilitate the observation of the sun or moon at zenith.

Chavín de Huántar, the Chavín site of the late Initial Period, has been found to exhibit an alignment that coincides with the zenith sunrise and anti-zenith sunset. Burger (1992: 132) describes Gary Urton measuring the construction of the Old Temple and finding it to be oriented to 103.5° and 283.5°. The latitude of the site is at S09.6°, resulting in a flat horizon zenith sunrise of 099.6° and anti-zenith sunset of 279.6°. Burger states that when Chavín's horizon is taken into consideration that the anti-zenith sunset would occur at 280.6°. Urton also observed that the setting of the Pleiades at the time of construction would have been at 283.5°, the same alignment as the walls (283° 31' walls; 283° 41' Pleiades).

8.6.1.4 Anti-Zenith Sun

Zuidema developed the concept of Inca observation of the anti-zenith passage of the sun, the dates that the sun passes through nadir. The sun cannot be seen at nadir, but Zuidema relates that the Incas observed solar horizon positions on these dates as well as those of the zenith passage (Zuidema, 1981b).

Zuidema states that dates of anti-zenith are those when sunset occurs 180° from the position of the related zenith sunrise. On days of anti-zenith in Cusco at S13.5° the sun is at zenith at N13.5° (Zuidema, 1989c). Zuidema maintains that a pillar of Cusco and several ceques were aligned as such to designate days of the anti-zenith sun. Zuidema proposed a zenith/anti-zenith alignment between sucancas on Cerro Picchu and at Tipon, 24 km to the southeast. He states that the zenith sunrise could be observed from Picchu to Tipon and the anti-zenith sunset from Tipon to Picchu (Zuidema 1977; 1981b; 1982a).

Zuidema (1982a) states that the Incas were very interested in the dates of August 4th and August 18th. On August 18th the sun goes through nadir, or anti-zenith passage. While the sun cannot be seen at nadir, the full moon closest to the 18th will pass at or very near zenith. The date of August 4th is nearly midway between the June solstice and the September equinox, specifically on August 5th. When a full moon occurs on the June solstice another one will take place on August 18th, two lunations later.

Anti-zenith passage occurs in Cusco each August 18th and April 26th and coincides with the planting and harvest of maize, times of Inca ceremony and celebration (Zuidema, 1981b; 1982a). Recording of zenith sunrises facilitated the calculation of anti-zenith dates. Maize-related agricultural festivals would likely be associated with anti-zenith observances.

Two structures were central to solar observations. The first, known as the ushnu, was a pillar in the plaza of Huacaypata in Hanan Cusco that served as an observation point for the position of the sun between two horizon pillars called Sucanca. Garcilaso (1961 [1609]: 267) describes Huacaypata as the "main square of the city." Zuidema (1981b: 320-321) states that the ushnu served to define the months of September and August. He adds that the Incas were interested in August and April as the respective beginning and end of their agricultural season and maintains that they could only have determined the corresponding dates of August 18th and April 26th through anti-zenith observance (Zuidema, 1981b: 322).

A structure located on the central plaza called the Sunturhuasi figured centrally in zenith and anti-zenith observations. It was located close to the ushnu and both are thought to have been aligned with the central of the four pillars of Sucanca on Cerro Picchu. The Sunturhuasi was a cylindrical tower with windows and a mast on its top that could have been used vertically to identify the zenith sun and horizontally to observe the associated point of sunrise. The round tower of the Sunturhuasi helped to facilitate the prediction of the position of the anti-zenith sunset by reversing the zenith sunrise direction. Upon reaching the appropriate day the confirming anti-zenith observation could also be made from the Sunturhuasi. A second ushnu in Hurin Cusco may have been used in conjunction with the one in Hanan Cusco to establish the axis of zenith and anti-zenith. The Sunturhuasi was situated about 3° south of this axis. Zuidema asserts that the Sunturhuasi, the sucancas and the ushnus all likely had other purposes besides those that were astronomical (Zuidema, 1981b: 323-324).

Without adequate support, Bauer and Dearborn (1995: 94-98) maintain that they find insufficient evidence to support anti-zenith celebrations by the Inca. They state that no direct historical data or archaeological remains have been found to support any Inca interest in the anti-zenith. Zuidema's (1981b; 1982a; 1989c; 2005; 2008a; 2008b) research and arguments are significant.

Vertical observations of the zenith sun and horizontal observations of solar pillars for anti-zenith events appear to distinguish astronomical observational philosophy within the city of Cusco from the more solstitial orientations found with many of the outlying huacas of this study. Aveni (1981c) points out the brilliance of using the zenith-nadir axis and the horizon to determine the day of anti-zenith.

8.7 Architectural Alignments

Architectural structures sometimes played a role in Inca cosmology and, if so, were frequently designed with astronomical orientations. Certain structures were situated to use local geographic features with regard to solar alignments while others relied solely upon specific architectural designs. It is likely that in each such case those alignments with the sun were carefully considered before construction began. There is also evidence that alignment with the heliacal rise of the Pleiades was observed and that such an orientation served to guide the viewer's eyes to the desired celestial object. Zuidema and Aveni examined the Coricancha of Cusco and found it to be oriented in this manner (Figure 8-1). Their measurements discovered an alignment for the Pleiades that passed between two western rooms, across a ceremonial basin, between holes for gold and precious stones and then through a space between two eastern rooms. They found this alignment with the western and eastern walls of the Coricancha to be to an azimuth of 66° 44'.

Their calculations further show that the Pleiades rose at 65° 58’ in AD 1500; 66° 22’ in AD 1400; and 66° 46’ in AD 1300. (Zuidema, 1982a: 212-214).

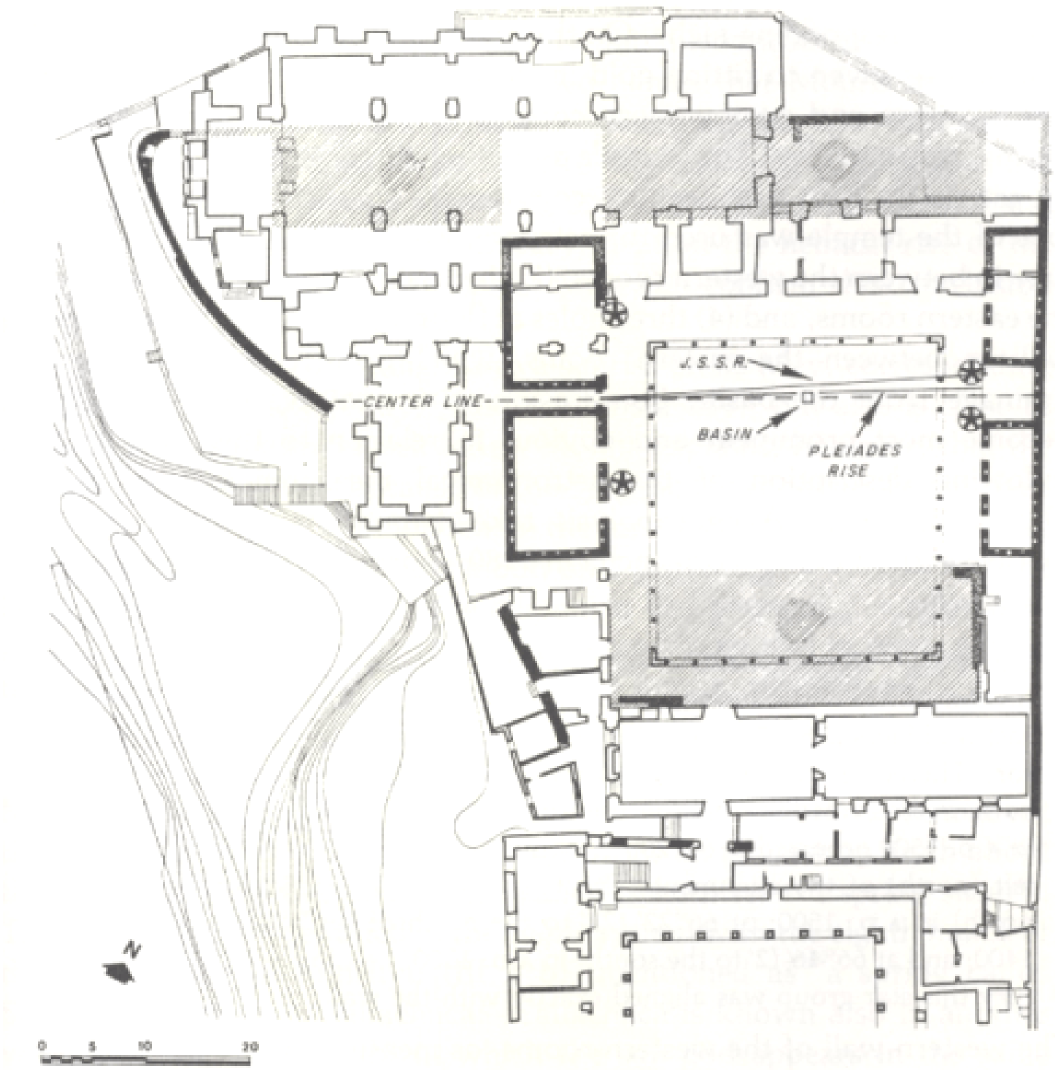

Figure 8-1: Plan of the Coricancha. The sightline for the Pleiades heliacal rise passes between two western rooms, across a ceremonial basin and between two eastern rooms. The asterisks indicate positions found to be used for gold or precious stones (from Zuidema, 1982a: 213).

Many structures throughout the Incas' former empire display evidence of celestial orientations. Certainly the many temples of the sun received such considerations when they were built. Two additional examples are the Torreon of Machu Picchu and the Sun Temple at Llactapata which each have orientations toward the rise of both the June solstice sun and the Pleiades.

The sophisticated astronomy of the Incas was dependent upon precise observations of events on the horizon. In this effort they employed windows aligned for the sun and solar pillars. While the towers of Cusco no longer remain, my field research in Section 10.4 includes study of two such pillars above the modern village of Urubamba.

8.8 Ushnus, Sucancas, Pillars and Gnomons

Zuidema (1989c: 406-407) states that observations of Cusco's horizon were made with three types of constructions: two ushnus, one near the Sunturhuasi and the other further to the southeast; the Sunturhuasi, a building that served as a state gnomon; and the gnomon, a vertical pole used mainly to measure the sun on the day of zenith passage. He asserts that precise anti-zenith sunset observations were made with pillars on Mount Yahuira (Cerro Picchu) from the ushnu at the Plaza of Hanan Haucaypata (Zuidema, 2007). The ushnus joined the Sunturhuasi for observations of the central horizon somewhat east and west (Zuidema 1989c: 404).

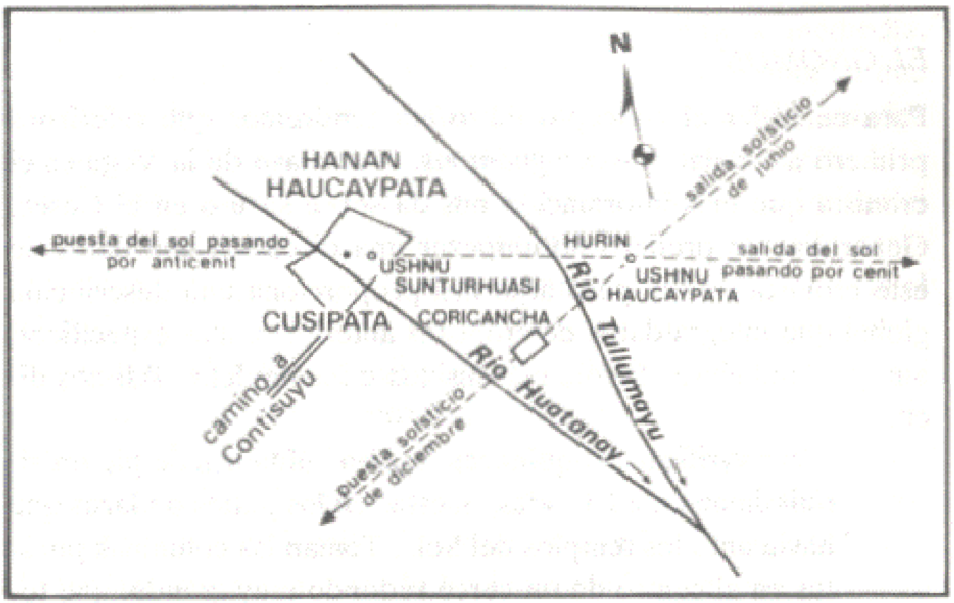

Figure 8-2: In Cusco the Coricancha and the Hurin Huacaypata Ushnu were aligned for the axis of the June solstice sunrise and December solstice sunset. The Hanan Haucaypata Ushnu, the Sunturhuasi, and the Hurin Huacaypata Ushnu were aligned for the axis of the zenith sunrise and the antizenith sunset (from Zuidema 1989c: 407).

8.8.1 Ushnus

Ushnu is a Quechua word meaning the concept of a specific space created for the use of the emperor or certain other government officials. The status assigned to such a platform allowed for visual affirmation of divine and state authority. Ushnus were built away from Cusco as part of the effort to exercise control over the populations of conquered territories. "[Pachacuti] also directed that there be a throne and seat of the Incas called *usno* in each *uamani* [district]" (Guaman Poma, 2009 [1615]: 205). Morris and Thompson (1985: 59) discuss the Ushnu located at the site of Huánaco Pampa and state that "Large ushnu platforms may still be observed at Vilcas Waman, in the Peruvian south central highlands, and at Pumpu, on the shores of Lake Junin. They are all roughly pyramidal in shape and associated with open plaza areas, although none are exactly alike or closely similar in detail." They describe the ushnu at Huánaco Pampa as a platform sitting on top of two lower platforms with steps on its side to the south. Another potential ushnu exists at Saihuite and is shown in Figure 9-68.

Ushnus were platforms for making sacrifices, for observing visual sightlines and for receiving liquid offerings, such as chicha, made to the Pachamama by allowing fluids to flow into the earth. The Inca sat atop the ushnu when he dispensed justice (Zuidema and Quispe, 1973). Some ushnus were not huacas – they were not prayed to or asked for advice and guidance. Ushnus were also related to child sacrifice. "The Incas have places called *usnos* designated throughout this kingdom for sacrifice, which is always for the *capacocha* to the sun and the *huacas* … The Inca made sacrifices to his father the Sun with gold, silver, handsome ten-year old boys and girls who had no blemishes, not even a mole" (Guaman Poma, 2009 [1615]: 201).

An ushnu was located on the Plaza of Huacaypata in Cusco. Zuidema (1989c: 453) states "The *ushnu* was the architectural center of the plaza of Cuzco and joined with the Temple of the Sun influenced the outline of the general plan of the city." "The Ushnu itself is a very elusive concept; its relation to verticality in the Inca cosmos has been fully developed by Zuidema [1977-8], who has demonstrated that it was manifested in a multitude of material objects including an altar of sacrifice, a platform of stones, a mojon, and even a hole in the earth" (Aveni, 1981a: 313).

Huacas were animate or inanimate objects that were specially venerated. As described in Chapter 6, they could be many things including such as natural features of the landscape, trees, springs, and rocks. Huacas were thought to be possessed by the local deity whose essence of force gave prosperity to those around it (Staller, 2008: 272-274) and received commensurate worship and offerings.

While an ushnu imbued the divine power of the empire to those seated upon it, it differed from a huaca in that it did not emanate prosperity and was not worshipped. An ushnu was a platform with several tiers and a staircase on one of its sides. Its purpose was for viewing and rituals by the king or other prominent government officials. Ushnus figured prominently in ceremonies regarding the sanctification of divine rule (Staller, 2008: 285), and it also played a role in Capac Hucha, or child sacrifice (Guaman Poma, 2009 [1615]: 201). The ushnu in the Plaza of Hanan Huacaypata was the viewing point for anti-zenith sunset between the pillars on Cerro Picchu (Zuidema, 2008b: 250).

Zuidema (1989c) found the three main elements common to ushnus to be that they were multi-tiered platforms, they were associated with pillars, and they had basins where chicha or water could be deposited. These fluids would then flow into the earth.

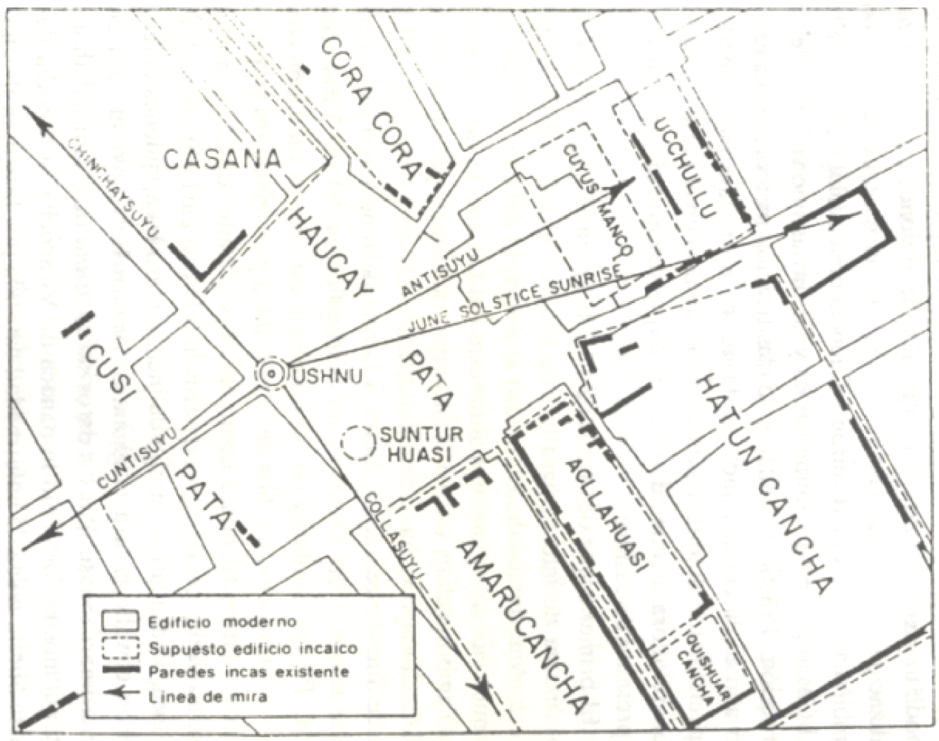

Figure 8-3: Locations of the Ushnu and the Sunturhuasi depicted in the plaza of Haucaypata. Note the axis of the June solstice sunrise and that the four suyus of Cusco each radiate from the Ushnu (from Zuidema, 1989c: 431).

Figure 8-4: Drawing of the Ushnu (Guaman Poma, f. 160).

8.8.2 Sucancas

Zuidema (2005) relates that according to Polo de Ondegardo the pillars of Pucuy Sucanca marked the start of the rainy season while the pillars of Chirao Sucanca conversely indicated the beginning of the dry part of the year. He maintains that other pillars were erected to establish the time of various festivals and even indicate the passage of months. Pucuy Sucanca and Chirao Sucanca were each huacas as a part of the Cusco ceque system (Zuidema, 2005).

Zuidema (1981b) gives an excellent discussion of these two sucancas, which appears to be a much more satisfactory explanation than that suggested by Bauer and Dearborn. He includes both *sucancas* and *sayhuas* in his description. Sucancas, by definition, were sunrise or sunset points and the pillars of Pucuy and Chirao helped to define the axis of the zenith sunrise and the anti-zenith sunset. Sayhuas were markers and these near Cusco also used the position of the sun on the horizon, in this case to denote the start of Incaic months. Zuidema points out that this system likely included 12 sayhuas and two sucancas. The Chirao sucanca was likely located on Cerro Picchu to the northwest of Cusco and the Pucuy sucanca far to the southeast on a mountain in *Quispicancha*, or Tipon. Zuidema continues that the names *Pucuy* and *Chirao* referred to seasons - Pucuy to "the time when fruits ripen during the latter part of the rainy season" and Chirao to "the time when the first changes in the weather occur after the dry season" (1981b: 330). Solar alignment with the Pucuy sucanca therefore likely indicated a date in February, also the time of the zenith sunrise, and the Chirao sucanca in August, corresponding with the anti-zenith sunset.

Zuidema (2008b: 252-254) describes four sucancas, three identified as such in the Cusco ceque system plus Quiancalla whose usage appears very similar to the other three. Two of these are those mentioned previously as Pucuy and Chirao. Two sucancas were east of the city, the first near Cerro Mutu and the other, Chirao, near Cerro Quispicancha. The third, Pucuy, was to the west of Cusco on Cerro Yahuira, now known as Cerro Picchu. Quiancalla, the last, was also on the west side of the city. The relatively close western sucancas had pillars, while the more distant eastern ones did not.

Quiancalla was observed at the time of the June solstice sunset from north of Cusco at Chuquirmarca on a hill called Manturcalla. The sucanca near Cerro Mutu served to observe the December solstice sunrise from the temple of Puquincancha to the south of Cusco (Zuidema, 2008b: 255). The zenith sunrise and anti-zenith sunset were observed between the Chirao Sucanca on Cerro Picchu and the Pucuy Sucanca at Cerro Quispicancha. The sucanca on Cerro Picchu also was observed from the ushnu of the Hanan Huacaypata plaza at the time of the anti-zenith sunset. The sucancas all played a role in ritual movements during the month of the June solstice, in the second month before the December solstice, and in the second month following the December solstice (Zuidema, 2008b: 256-260).

Figure 8-5: The Chirau Sucanca on Cerro Picchu was used in the observation of the anti-zenith sunset from the Ushnu at the plaza of Hanan Huacaypata; it was also used in conjunction with the Pucuy Sucanca at Cerro Quispicancha in the observation of the zenith sunrise and the anti-zenith sunset (from Zuidema, 2008b: 250).

8.8.3 Pillars

The Incas were devoted students of astronomy and likely tracked sunrises and sunsets, the moon and certain stars whenever possible with existing geographical features. Certain horizons presented a challenge to precision, however, that apparently was solved with pillars built to mark annual positions. Cobo (1983 [1653]: 251-252) related that pillars were erected on the horizon of Cusco to track solar movement. These structures no longer remain, but two such sun pillars are located at 3860 meters on a ridge above the palace of Huayna Capac and are aligned to mark the rising of the June solstice sun when viewed from a large boulder located in the center of the palace courtyard. There is ethno-historical description by Spanish chroniclers of pillars surrounding the city of Cusco, but none survived the Spanish purge of idolatry. These towers, near the modern community of Urubamba, provide some of the first direct evidence of this type of Inca celestial alignment, demonstrate that such solar pillars did exist for the purpose of marking significant Inca astronomical events, and add credibility to the colonial reports of similar structures on the horizons of Cusco. Other examples have been identified above the Isla del Sol (Dearborn, Seddon, and Bauer, 1998) and near Puncuyoc (Bernard Bell, personal communication).

There are differing accounts as to how many pillars actually surrounded Cusco. Betanzos (1996 [1576]: 68) describes eight pillars in two sets of four – one set where the sun comes up and the other where the sun goes down. Cobo (1983 [1653]: 251-252) states that there were four pillars – two on the eastern and two on the western sides of Cusco. He continues that there were additional markers placed on the horizon where the sun would reach each month. Garcilaso (1961 [1609]: 71) says that there were "eight towers on either side of the city of Cuzco, four of which faced the rising, and four the setting sun." His wording can be misleading, but he describes a combined total of eight towers on the two horizons.

Aveni, with Zuidema, identified pillars and observing axes from three locations in Cusco:

> (a) A pair of pillars which mark the June solstice sunset point as viewed from Lacco, a complex of rock carvings on a hill north of Cuzco.
> (b) A pair of pillars to mark the December solstices as seen from Coricancha, the center of the ceque system.
> (c) The sucanca, four pillars situated on Cerro Picchu to mark time for the planting season, centered on the place where the sun sets on the day of passage through the antizenith (Aveni, 1980: 303).

The pillars were viewed from the ushnu in the plaza of Hanan Huacaypata. The zenith/antizenith axis also passed through the ushnu in the plaza of Hurin Huacaypata (see Figure 8-1). The Sunturhuasi lied close to this axis and close to the Hanan Huacaypata ushnu (Aveni, 1981a). The Incas would not have had to understand the physical concept of nadir passage of the sun to have made and utilized such an observation (Zuidema, 2008b).

Cobo (1990 [1653]: 59, 60-61, 83) supports this with his descriptions of corresponding huacas (also see Figure 8-2):

[Ch-6:9] The ninth *guaca* was a hill named Quiangalla, which is on the Yucay Road. On it were two markers or pillars which they thought denoted the beginning of summer when the sun reached there.

[Ch-8:7] The seventh was called Sucanca. It was a hill by way of which the water channel from Chinchero comes. On it there were two markers which indicated that when the sun arrived there they had to begin to plant the maize. The sacrifice which was made there was directed to the Sun, asking him to arrive there at the time which would be appropriate for planting, and they sacrificed to him sheep, clothing, and miniature lambs of gold and silver.

[Cu-13:3] The third, Chinchincalla, is a large hill where there were two markers; when the sun reached them, it was time to plant.

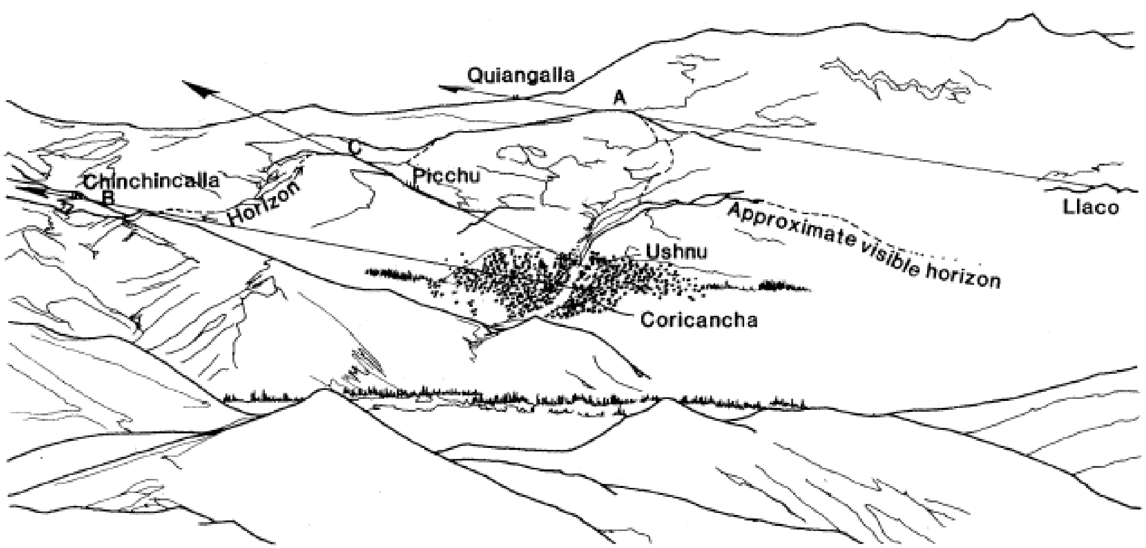

Figure 8-6: (A) The pillars of Quiangalla viewed from Lacco, (B) the pillars of Chinchincalla viewed from the Coricancha, and (C) the sucanca of Cerro Picchu viewed from the ushnu of Hanan Haucaypata (E. C. Krupp, from Aveni, 1981c).

Zuidema suggests that Lacco is the most likely candidate for *Chuquimarca* (Aveni, 1981a). Cobo (1990 [1653]: 65) gave the following description of this huaca:

> [An-3:4] The fourth was called Chuquimarca; it was a temple of the Sun on the hill of Mantocalla, in which they said that the Sun descended many times to sleep. For this reason, in addition to everything else, they offered it children.

An anonymous chronicler c. 1570 describes the ushnu (Aveni, 1981a: 311):

> And when the sun stood fitting in the middle between the two pillars they had another pillar in the middle of the plaza, a pillar of well worked stone about one estado high, called the Ushnu, from which they viewed it. This was the time to plant in the valley of Cuzco and surroundings.

Soon after the conquest Spanish priests began a campaign to eradicate whatever supported the indigenous religion of solar worship, including the means to track movement of the sun on the horizon (Garcilaso, 1961 [1609]: 73). Ultimately all of the solar pillars of Cusco were destroyed, but the aforementioned pair above the modern community of Urubamba survived. These are discussed more fully in Section 10.4.

Figure 8-7: Drawing depicting pillar construction (Guaman Poma, f. 352)

Figure 8-8: Drawing depicting Cusco pillars (Guaman Poma, f. 354)

8.8.4 Gnomons

The Incas used gnomons for shadow effects, solar tracking and related calculations. Horizontal gnomons, such as those found at the Incamisana in Ollantaytambo, were carved to cast images in shadow at certain times of the year. Vertical gnomons were used to judge time or direction, such as indicating zenith passage of the sun by the withdrawal and disappearance of the gnomon's shadow. Use on the day of the zenith sun was primary for gnomons.

Pillars functioned as gnomons (Staller, 2008:287), were instruments viewable by all and could very well have been intended for public spectacle as well as solar measurements. The observance of shadows cast by gnomons, however, was not practical for large groups and therefore their use was more probably confined to small gatherings of elites making solar determinations (Bauer and Dearborn, 1995).

8.9 Inca Calendar

Time reckoning by lunar months was practiced in the Andes as it was a simple exercise for anyone to count and keep track of lunar cycles. Garcilaso de la Vega (1961 [1609]: 71) relates that the Incas counted months by moons. The Incas used a synodic lunar calendar measured by moon phases. Rituals falling between solar observations were determined by the moon (Zuidema, 2007). Events associated with the sun were tied to the lunar calendar as such celebrations required the observance of a new or full moon in temporal proximity to the solar occurrence (Zuidema, 1981c). Pillars helped to track the months of the sun-based calendar while lunar phases were incorporated for festivals by proclaiming the first new moon of the solar month to have the same name as that month (Bauer and Dearborn, 1995; Zuidema, 2007). The year was divided into "two equal periods, four nearly equal periods, twelve periods of rather unequal length, and 41 very unequal periods" (Zuidema, 1982b: 61).To define the calendar the Incas use six rising or setting horizon positions:

1. Sunrise on May 26
2. Sunrise at zenith passage
3. Sunrise at December solstice
4. Sunset at December solstice
5. Sunset at anti-zenith passage
6. Sunset at June solstice (Zuidema, 1982b: 73)

"Moons," or lunar cycles have long been used by ancient peoples to define months as they follow a readily recognizable pattern. The Inca were no exception and, just as our English terms are similar, the Quechua language employs only one word, *quilla*, for both month and moon. Bauer and Dearborn (1995: 30-31) relate the following names of month equivalents according to the chronicler Guaman Poma de Ayala:

January	*Capac Raymi*
February	*Paucar Uaray*
March	*Pacha Pocay Quilla*
April	*Ynca Raymi*
May	*Atun Cusqui*
June	*Cuzqui Quilla*
July	*Chacra Conocuy*
August	*Chacra Yapuy Quilla*
September	*Coya Raymi Quilla*
October	*Uma Raymi Quilla*
November	*Aya Marcay Quilla*
December	*Capac Ynti Raymi*

Zuidema (1977) discusses a method of time tracking in Cusco related to Inca huacas and ceques (see sections 6.7 and 6.8). He finds in the chronicles that the ceque system was a means for counting days of the year with each of the 328 huacas used in order to mark daily passage of time. Ceques were grouped by threes and each of these groups represented one month (Zuidema, 2007). He suggests the remaining 37 days in a 365 day tropical solar year equate to the approximate period the Pleiades is invisible by proximity to the sun between 3/4 May and 8/9 June. He continues that the 41 ceques could be used in association with the passage of 41 eight-day weeks.

When seeking to compare dates in the Inca Empire with those of the Gregorian calendar it must be remembered that when the Vatican first instituted the Gregorian calendar in 1582 (ten years after the execution of Tupac Amaru at the end of the Spanish conquest) it necessitated an adjustment that deleted 10 days in October of that year. The same adjustment was ordered in Peru in October, 1584. Historical accounts before this event that have been given Gregorian dates must add 10 days for accurate accounting.

8.10 The Moon

Lunar cycles of approximately 29.5 days divided the year in the Andes. The solar calendar instituted by the Incas retained similar monthly subdivisions and likely was periodically intercalated.

Inca cosmology describes the sun as first rising from the Island of the Sun in Lake Titicaca. It also relates the moon's first ascent from the nearby Island of the Moon. Both islands were important state pilgrimage and worship centers (Bauer and Stanish, 2001). The ruling Inca was the son of the sun and his wife the daughter of the moon. The sun was male and the moon female, the female association made perhaps due to the moon's relation with the female menstrual cycle that falls between the sidereal and synodic lunar cycles (Urton, 1981a).

Bauer and Stanish (2001) also tell us that the Spanish chronicler Polo de Ondegardo recorded that offerings were given to the moon both at the time of eclipses and during childbirth and it was the woman's role to do so. They continue that Garcilaso recorded that a hall of the Coricancha was dedicated to the moon and the moon's image was placed in it along with mummies of the empire's dead queens. The moon was called *Pacsamama* (Moon Mother) or *Mamaquilla* (Mother Moon).

Urton (1981a) found dark spots seen on the surface of the moon to have names and significance. Such were as a woman and a llama or a woman holding her baby daughter. Urton compares these images as similar with those the Incas placed in the darkened parts of the Milky Way.

Certain crops were planted with regard to lunar cycles. Maize was sown with a waxing moon, from new to full, but potatoes were to be planted while the moon was waning. The lighted portion of the moon was called *pura* and the dark portion *wañu*. In general terms underground crops were sown while the moon was waning, from *pura* to *wañu*, and above ground crops while waxing from *wañu* to *pura* (Urton, 1981a).

Zuidema (1981b) states that the full moon is at zenith when the sun is at nadir and has found this to be related to the Inca's timing of the anti-zenith sun.

8.11 The Milky Way

Inca cosmology viewed the Milky Way as a river flowing across the night sky in a very literal sense. They saw earthy waters as being drawn into the heavens and then later returned to earth after a celestial rejuvenation. The earth was thought to float in a cosmic ocean and when the “celestial river’s” orientation was such that it dipped into that ocean the waters were drawn into the sky. “The Milky Way is therefore an integral part of the continuing recycling of water throughout the Quechua universe” (Urton, 1981a: 60).

8.11.1 Orientation and Quadripartition

The Milky Way passes brightly overhead at southern latitudes such as that of Cusco and the Incas observed it closely (Urton, 1981a). They saw it as two separate rivers, due to the earth’s rotation and the Milky Way’s alternating position on the horizon each twelve hours. The plane of the Milky Way is inclined between 26° and 30° with the axis of the earth’s rotation. This orientation is 26° degrees toward the south celestial pole and 30° toward the north (Urton, 1981a). The Milky Way at times will be viewed as rising in the southeast, passing through the zenith, and setting in the northwest. Twelve hours later the horizon positions have shifted and the band of stars rises instead from the northeast, traveling again through the zenith, but now setting in the southwest. This 24-hour rotation cycle creates two zenith-intersecting intercardinal axes that divide the celestial sphere into four observable quarters (Urton, 1981a).

The Milky Way risings are interesting because of correlations with their intercardinal axes and the four points of solstice horizon events. At the time of the December solstice, when the sun rises at 114° on the Cusco horizon, the evening positioning of the band of the Milky Way lies similarly to the southeast. During the June solstice sunrise at 064° the Milky Way is situated in like fashion in the northeast. Times of the solstices are the only ones when the sun rises and travels with the Milky Way (Urton, 1981a). Both the celestial river and the sun rise together at the dry season’s beginning in June and the rainy season’s start in December (Urton, 1981a) and the villagers in Urton’s study use this correlation to explain the seasonal intensity of the sun, which feeds upon the powerful waters.

The Inca's might have ordered their sky by this celestial quadripartition, in contrast to the ecliptic system of reference used by other ancients such as the Babylonians. There is no evidence to confirm this, however. Urton (1981a) says that this gave those in the Andes a nearly 90° difference in their perspective of the heavens and the cosmological constructs that were developed accordingly. He asserts that the primary axis for celestial references was east-west, rather than north-south, as was common in systems of the Northern Hemisphere. The quadripartition also appears to have influenced orientations on earth. Urton found evidence that the two primary trails of Misminay follow the same terrestrial axes as those above in the night sky.

8.11.2 Celestial River

Andean cosmology ties the Milky Way with the Vilcanota River. The Vilcanota flows southeast to northwest through the Sacred Valley, past Machu Picchu and beyond. Its waters are thought to rise into the Milky Way and, once having traveled its celestial course, fall again to the earth as rain. The sun is stronger in the summer because it drinks from the swollen Vilcanota as it travels beneath it at night. It is weaker in the winter because it has had less to drink (Urton, 1981a: 69). The Milky Way is said to be a heavenly reflection of the Vilcanota.

8.11.3 Dark Constellations

The Milky Way provided visual inspiration for several themes of Inca cosmology. Andeans recognized *dark constellations*, or the shapes of beings formed by dark *clouds* in the visible band of the galaxy. These dark spots in the glow of the Milky Way's stars are formed by interstellar dust blocking the light from the bright array of stars behind them. The Incas saw in them great cosmological characters meant to guide them in their daily lives.

The dark constellations of the Incas stretch across nearly 150° of the Milky Way's expanse (see Figure 8-9). Most are animals that figure prominently in Andean cosmology and myth (Urton, 1981a). Urton relates that the Spanish chronicler Polo de Ondegardo found the Incas to believe that "the animal constellations were responsible for the procreation and augmentation of their animal counterparts on the earth" (Urton, 1981a: 176).

The dark constellations are most visible at the time of the March equinox when they span the band of the Milky Way at midnight. During the September equinox the fewest will be seen as they have since rotated to be beneath the horizon for much of the night. At the solstices the Milky Way briefly aligns with the horizon points of the respective solstitial sunrise and sunset and the animals of the dark constellations appear to follow the solar path on these significant occasions (Urton, 1981a). Urton finds the dark constellations to be related to the rainy season and asserts that "it is ... essential to study the Dark Cloud constellations by analyzing the connections between sky and water and earth and water" (Urton, 1981a: 173).

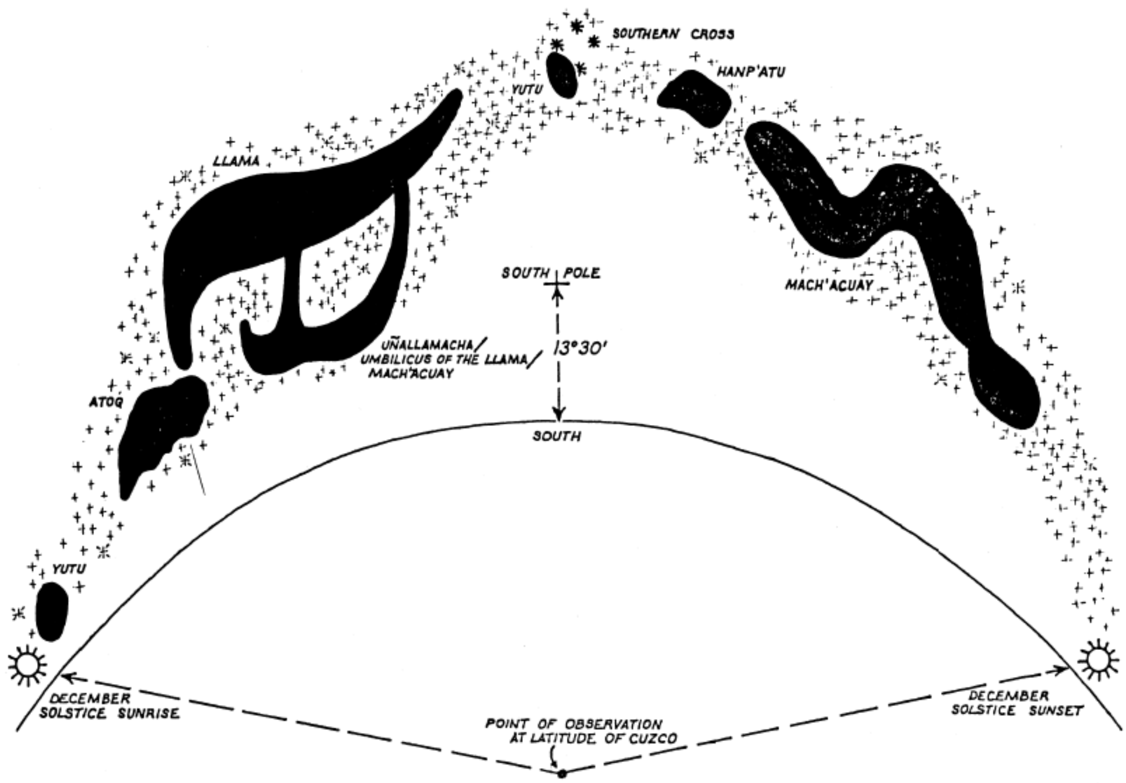

Figure 8-9: Dark Constellations of the Milky Way (from Urton, 1981c: 112)

The following are descriptions of the primary dark constellations, from right to left, in the order that I was able to view them during my field research.

8.11.3.1 Mach'acuay - the Serpent

Serpents figure prominently in Inca cosmology and are the creatures representing Ucu Pacha, the underworld and lowest of the three worlds of Inca existence. Mach'acuay leads this dark celestial procession as the constellations move left to right across the night sky. Van de Guchte (1990) says that the amaru, or serpents, emerged from their underworld environs via rivers and are thought to be related to rainbows and to foretell of rain. Mach'acuay can be seen at the beginning of the rainy season. The serpent's dark figure is long like a snake and travels head before the tail (Urton, 1981a).

8.11.3.2 Hanp'atu – the Toad

Hanp'atu follows closely behind Mach'acuay. Toads were thought of as bad omens as they were created by the devil. Hanp'atu is a much smaller dark section of the Milky Way to the left of the snake (Urton, 1981a).

8.11.3.3 Yutu – the Tinamou

Tinamou are birds indigenous to the Andes and are of very ancient lineage. Yutu follows Hanpatu in the Milky Way and likewise is much smaller than Mach'acuay. This Yutu is adjacent to what we refer to as the Southern Cross, is at zenith on the December solstice, and nadir on the June solstice. We know Yutu as the *Coalsack* in Western astronomy (Urton, 1981a).

8.11.3.4 Yacana – the Llama

The first dark constellation shown to me by my Peruvian assistants was Yacana, the llama. Llamas figure prominently in many aspects of Inca culture and this celestial figure was thought to animate the llamas on the earth (Salomon and Urioste, 1991). Yacana is a constellation much larger than Hanpatu or Yutu and dominates the Incas' dark constellation section of the Milky Way. Yacana is situated between Centaurus and Scorpio. The prominent stars α and β Centauri serve as the llama's eyes and as such are known as *Llamacñawin*, the "eyes of the llama" (Urton, 1981a).

8.11.3.5 Uñallamacha – the Baby Llama

Below Yacana is a smaller dark constellation called Uñallamacha that is said to be a baby llama suckling its mother.

8.11.3.6 Atoq – the Fox

Following Yacana and Uñallamacha in the sky from the left is the somewhat smaller constellation of Atoq, the fox. Atoq lies on the ecliptic between the constellations of Scorpio and Sagittarius and the sun enters it during the December solstice. Urton (1981a) relates that the Milky Way and Atoq catch up and rise with the summer solstice sun in the southeast during the same period of time that terrestrial baby foxes typically are born. *... the sun rises into [Atoq] ... from about December 15 to December 23* (Urton, 1981a: 70).

8.11.3.7 Yutu – the Tinamou

Urton (1981a) lists a second constellation called Yutu. This additional tinamou follows Atoq and completes the celestial procession.

8.12 Stars

The people of the Andes, like other cultures around the world, gazed at the heavens in wonder and found imaginary shapes in the stars above. For the Incas, however, these constellations were only a part of a celestial landscape that was filled with beings found in many astral shapes and meteorological phenomena. Spanish accounts speak of stars within a zodiac, but this was from a purely European perspective not shared in South America. The Incas often did not distinguish between planets and the brightest stars. The Quechua word *chasca* was used for both, while *coyllur* was the term for stars of lesser prominence (Bauer and Dearborn, 1995).

The Incas believed there to be a close association between animals on the earth and in the sky and that celestial counterparts had influence over the health and reproduction of those below. Many names for stars existed as the Incas did not impose their astronomical taxonomy on the peoples they conquered (Bauer and Dearborn, 1995).

8.12.1 Planets

Planets were likely recognized among the stars, though observation of the planets is not well documented in Inca astronomy. Venus is noted, however, both as an evening and a morning star. The planet is bright enough to be seen in the daytime, but never crosses the sky at night. Bauer and Dearborn (1995: 138) point out that Venus was referred to by many names such as *Chasca Cuyor, Pacaric Chasca, Pacari Cuylor, Auquila, Pachahuárac, Chachaquaras, and Atungara*.

8.12.2 Constellations

Constellations have been traced in the night sky by every culture that has observed the heavens. Evidence has been found to support that certain star groupings, such as the Hyades, the Pleiades, or Orion have been recognized many times. Spaniards attempted to define Andean astronomy in European terms familiar to them, failing to fully realize that the Incas viewed the cosmos from a different perspective.

In addition to the dark constellations previously discussed, the Incas also recognized certain star to star groupings. While European astronomy followed a zodiac that centered around the ecliptic, the Incas oriented their sky with the Milky Way. Their star constellations are located in close proximity, especially between Taurus and Orion where the Milky Way is less brilliant. While dark constellations primarily represented animals, star to star constellations were more often objects (Urton, 1981a). Cobo (1990 [1653]: 30-31] writes of the Inca designating corresponding stars as patrons for each animal species. The stars thusly were worshipped by various groups with vested interests.

Examples of Andean constellations are as follows: (Bauer and Dearborn, 1995; Urton, 1981a)

8.12.2.1 Santissima Cruz

"The Sacred Cross"

α, β, δ, π, and σ Scorpio

8.12.2.2 Amaru

"The Serpent"

Scorpio

8.12.2.3 Llamacñawin

"The Eyes of the Llama"

α and β Centauri

8.12.2.4 Huchuy Cruz

"The Small Cross"

The Southern Cross

8.12.2.5 Hatun Cruz

"The Great Cross"

Rigel, Sirius, Procyon, and Betelgeuse

8.12.2.6 Hatun Cruz

"The Great Cross"

Procyon, Castor, η and μ Gemini

8.12.2.7 Collca

"The Storehouse"

The Pleiades

(Also Qutu, The Pile)

8.12.2.8 Collca

"The Storehouse"

The Hyades

(Also Pisqacollca, The Five Storehouses)

8.12.2.9 Chakana

"The Bridge"

Orion's Belt

8.12.2.10 Chakana

"The Bridge"

ε, δ, and η Canis Major

8.12.2.11 Pachapacariq Chaska

"The Venus of the Western Suyu"

Canopus

8.12.2.12 Collca

"The Storehouse"

η, θ, ι, κ, λ, and υ Scorpio

8.12.2.13 Pachapacariq Chaska

"The Venus of the Northern Suyu"

Altair

8.12.2.14 Urcuchillay

"Llama of Many Colors"

Lyra

8.12.2.15 Catachillay

"Female Llama with Lamb"

Altair and Deneb

8.12.2.16 Chasca Cuyllor

"Morning Star" "Evening Star"

Venus

8.12.3 The Pleiades

The Pleiades were of great importance in Inca astronomy as the Incas found them useful in predicting and planning for harvests. Cobo (1990 [1653]: 30) states that they were called *Collca* and that the "power that conserved the animals and birds flowed from this group of stars." The Pleiades disappear behind the sun for approximately 37 days and first return to view about June 9th, about 12 days before the solstice sunrise. The stars in this prominent grouping are viewed by Andean villagers with regard to their relative brilliance. A bright appearance during the heliacal rise of the cluster near the time of the June solstice indicated a future of season of rain followed by an ample harvest. A dull appearance due to atmospheric obscuration by high cirrus clouds indicated there would be drought in the months to come. In actuality, a method had been discovered of anticipating the arrival of El Niño in a manner still used today. Orlove, Chiang, and Cane (2000: 68) "…find that poor visibility of the Pleiades in June – caused by an increase in subvisual high cirrus clouds – is indicative of an El Niño year, which is usually linked to reduced rainfall during the growing season several months later."

Cobo (1990 [1653]: 61) writes of a name associated with the Pleiades, *Catachillay*, in his huacas descriptions:

> [Ch-8:10] The tenth *guaca* was called Catachillay. It is a fountain which is in the first flat place that descends to the Road of Chinchaysuyu.

Zuidema (1982a: 211-214) argues that this ceque that includes the pillars of Sucanca indicates the horizon position of the last heliacal set of the Pleiades on or about April 15th. He continues that this observation served to relate the set of the Pleiades with the position of the sun on the horizon. The first heliacal rise of the Pleiades could then have been observed from the alignment of the west wall of the Coricancha.

Observations were likely made in late June at the time of the solstice in an effort to foretell the weather for crops that were to be planted in the fall and harvested the following spring. Sightings were likely made over several days until the festival of Inti Raymi on the 24th (Orlove, Chiang, and Cane, 2000). Rural Andeans continue this practice and when poor rains have been predicted they delay the planting of potatoes, which are especially susceptible to drought at the time of planting. Orlove points out that the Andean practice is likely more than 400 years old, but no chronicle recorded that the Incas used the Pleiades for weather prediction.

The Incas worshipped *Collca*, as they called the Pleiades. They seem to have viewed it as a prognosticator of life and death. Its brilliance foretold when maize was to be planted and how plentiful a harvest could be expected (Paternosto, 1996). The date of the heliacal rise is somewhat a function of the moon's phase and atmospheric conditions and from six to nine stars might be visible (Schaefer, 2000). The Pleiades figured prominently in several ancient civilizations, but were especially important in the Andes because of the utility of their visibility in predicting the dramatic climatic changes during El Niño years (Orlove, Chiang, and Cane, 2000).

Several structures have been found to incorporate alignments for the heliacal rise of the Pleiades. The Coricancha of Cusco (see section 8.7) and the Sun Temple at Llactapata (see section 11.4) are oriented as such for the first appearance of both the Pleiades and the June solstice sun. Corridors were constructed at each location that may well have served to guide and focus attention at the correct point on the horizon so as to detect the group of stars on the earliest possible date. Dearborn and Schreiber (1986) finds that the window in the tower above the Royal Mausoleum in Machu Picchu is aimed for these risings as well.

8.13 Ceque System and the Stars

As discussed in Chapter 6, the Incas' ceque system surrounding Cusco was extensive. The 41 ceques were filled with huacas for worship and care, at least 328 of them likely being maintained by panacas and ayllus as part of a state-promoted responsibility.

Zuidema argues certain ceques as being straight with intentional astronomical orientations for marking the rising and setting of certain stars. Among these are ceque alignments with such as Betelgeuse, the Pleiades, Vega, the Southern Cross and α and β Centauri. The latter could be used to establish the southern direction (Zuidema, 1977: 250-258; Zuidema, 1982a: 219-224, Zuidema, 1990a: 75).

8.14 Cosmology and Atmospheric Phenomena

The Incas viewed the three worlds of their cosmology to be intertwined by supernatural manifestations. This could be such as the emergence of snakes from the underworld beneath, or in the form of a rainbow from the world above. Many aspects of nature were thought to be sacred and spiritual, such as mountains, rocks, rivers and caves. Water, in the concept of camay, was thought to be a life-energizing force that was used in many ways to provide life to the inanimate or renew power in the living. Water might charge a huaca with sentience, or be cycled through the heavens, as in its journey down the Vilcanota with return via the Milky Way. The Inca often did not make clear distinctions between celestial and atmospheric phenomena and viewed them all as related to the gods above. The following are occurrences of the atmosphere or seldom recurring astronomical events that helped fill Inca cosmology.

8.14.1 Rainbows

Rainbows were likened with serpents that emerged from springs in the earth and the underworld. Urton (1981a) says that the Incas believed the rainbow serpents to rise from one spring and descend into another. Serpents were identified with the rainy season, and rainbows, of course, are associated with rain. The rainy season is also the time when the dark constellation Mach'acuay is most prominent. In Quechua rainbows are referred to as *k'uychi*. (Urton, 1981a).

8.14.2 Solar and Lunar Haloes

Urton (1981a) says that solar haloes were referred to as *intita chimpusahan k'uychi* and lunar haloes as *quillata chimpushan k'uychi*. K'uychi became part of these terms as halos, like rainbows, were also colored atmospheric phenomena. Haloes were used to predict rain, based on the size of the halo. Larger haloes foretold of impending rain, and smaller ones of rain in the future (Urton, 1981a).

8.14.3 Lightning

Zuidema (1964) says that thunder was the messenger of the sun. In Quechua lightning is referred to as *illapa.* In Urton's study (1981a) he finds it can be either male or female. Female lightning was thought a demon and was of the variety that arrives without sound. It was also said to have the power to harm shepherds who were women, but not their male counterparts. Male lightning came with loud thunder, but did not strike the ground.

8.14.4 Meteors

The Quechua word for shooting star is *ch'aska plata*, or "silver star." Meteors were used at times by priests for divination. Shooting stars were said to point to thieves, and also foretell of illness or death (Urton, 1981a).

8.14.5 Comets

Comets inspired both awe and fear in the Incas. Many of the celestial bodies of the Incas' cosmos centered on the band of the Milky Way, but a comet could appear anywhere in the night sky and moved from day to day with an ominous tail. Bauer and Dearborn (1995: 148-151; 157) say that Cieza de Leon "suggests that comets were seen on the eve of Atahualpa's death as well as on that of his father, Huayna Capac."

8.14.6 Eclipses

Eclipses could be frightening occurrences for many in ancient civilizations. The Incas worshipped the sun and moon as preeminent ancestors and, as such, their sudden disappearances were unnatural events that elicited uncertainty and apprehension. Solar eclipses in a particular region are rare – 17 occurred in the Inca Empire during the reigns of Pachacuti, Topa Inca, and Huayna Capac, including one very prominent eclipse near Cusco in 1513 (Bauer and Dearborn, 1995: 143). While a solar eclipse may not be visible again in the same location for hundreds of years, lunar eclipses are visible over wide areas and therefore more common. Incas believed that when the sun eclipsed he was angry and when the moon did so she was ill and they would wail. Following a darkening of the sun rituals were performed and sacrifices made of livestock and children. With the loss of the moon dogs were tied and beaten so that they would howl and bring her back (Cobo, 1990 [1653]: 27).

8.14.7 Twilight

Andean cosmology views twilight as a region of space that trails the sun in the evening and preceded it in the morning, more so than simply a period of time. This "space" was important as it was where the heliacal rises of certain celestial bodies were witnessed (Urton, 1981a: 151-153). While not proven, this may be a long-standing tradition.

8.15 Summary

Many of the huacas and temples that remain in the former Inca Empire are testaments to the sophisticated celestial system that developed in the Andes. Cosmology began with worship of the sun, and to a lesser extent the moon, with the state promoting the ruling Inca as the “son of the sun.” With such basic tenets to build upon, it was inevitable that the Incas would adopt and develop an astronomy of a significant solar nature.

Their celestial interests were much broader, however, and included many other objects in the heavens. The axis of the Milky Way is very prominent at the latitude of Cusco and the Andean peoples adopted it as their primary reference in the night sky. While European constellations evolved around the ecliptic path of the sun, celestial images in the Inca Empire remained within or close to and ordered by the brilliant band of our galaxy.

The moon played a significant role, but due to its female connotations those functions are far less documented when compared with the masculine sun. The Incas used both the sun and the moon in the regulation of their year (Zuidema, 2007).

The calendar of Cusco was publically observed by solar pillars constructed on the city’s horizons. A sophisticated horizon astronomy developed where such towers were use to assist in monitoring the annual path of sunrises and sunsets. The pillars of Cusco were destroyed in a Spanish purge of idolatry and varying accounts disagree as to their numbers and placement. It is almost certain that they marked the times of the December and June solstices, and likely as well the days of the zenith and anti-zenith sun. Away from Cusco two towers still exist above the modern village of Urubamba and are examined in detail in Chapter 10. Solar events also were likely observed with reference to the natural horizon in areas where those features were significant.

Evidence of the importance of astronomy in Inca culture can be seen in the many celestial alignments to be found at temples and in surviving huacas of carved rock. These are discussed throughout Part IV: Field Research in Chapters 9 through 11.

Zuidema proposed an astronomically based calendar using 328 huacas on 41 ceques surrounding Cusco. The remaining 37 days of the 365 day tropical solar year were then represented by the approximate period of the annual disappearance of the Pleiades behind the sun.

The Pleiades were worshipped by the Incas and played a major role in society as a harbinger of maize production. While being unaware of the true nature of El Niño, the Andeans had discovered a means by which to predict its imminence. Orlove, Chiang, and Cane (2000: 68) argue that the degree of brilliance and visibility of the stars of the Pleiades following their heliacal rise in June bode for a bountiful crop in normal years, or a depleted one with El Niño.

Much of Inca cosmology and myth was represented in the system of dark constellations they visualized in the regions of the Milky Way blocked by interstellar dust and gas. The world of the heavens above was closely intertwined with both their terrestrial world and the subterranean underworld. Powerful and influential spirits lived in many features of the natural worlds and also in the cosmos. The entities of these dark constellations figured prominently in the direction of everyday life.

Inca astronomy appears to have permeated their society and culture. The state purposely created numerous constructs with astral orientations, both to take advantage of the regulatory nature of recurring celestial events and also to create an aura of connectivity with the heavens in an effort to further establish their power and legitimacy. The astronomical alignments that remain in huacas and temples today are testaments to the sophistication of the system that evolved. The many celestial orientations exhibited in my field research can only be fully understood when taken in context with the Incan astronomy described in this chapter, an astronomy that was founded upon principles in a frame of reference very different from that of our own.

Part IV: Field Research

I collected field data during five separate research trips that took place in October 2006, June 2007, October 2007, June 2008, and October 2008. My field assistant, Carlos Aranibar, at my direction took additional photos on other key dates. Certain background information is provided, but astronomical orientations are listed regardless of whether or not they were also supported by historical references. Most of the orientations of this research are sightlines to the horizon that do not involve alignments with walls. This study searched for intentional orientations, but it is possible that a few could be coincidental. Without conclusive evidence for elimination, all that were found to exist are included. I performed research at 29 sites and have divided them into three regions. Chapter 9 covers sites of the region surrounding Cusco, Chapter 10 sites of the Sacred Valley Region, and Chapter 11 those of the Machu Picchu Region. The Region Surrounding Cusco includes 19 sites south of Tambomachay, including Tipon to the east and Saihuite to the west. The Sacred Valley Region is north of Tambomachay and includes seven sites from Pisac to Ollantaytambo. The Machu Picchu Region consists of three sanctuaries in the northwest area of my study. Figures IV-1 and IV-2 show the locations of the sites examined. Chapter and section numbers are included with each site for reference. Most of the sites in chapters 9 through 11 include data taken during my field research that is presented in the appropriate sections. In a few locations I did not attempt to duplicate existing research, but still cite information gathered by others in an effort to present additional information regarding the astronomy of the Incas in the associated region.

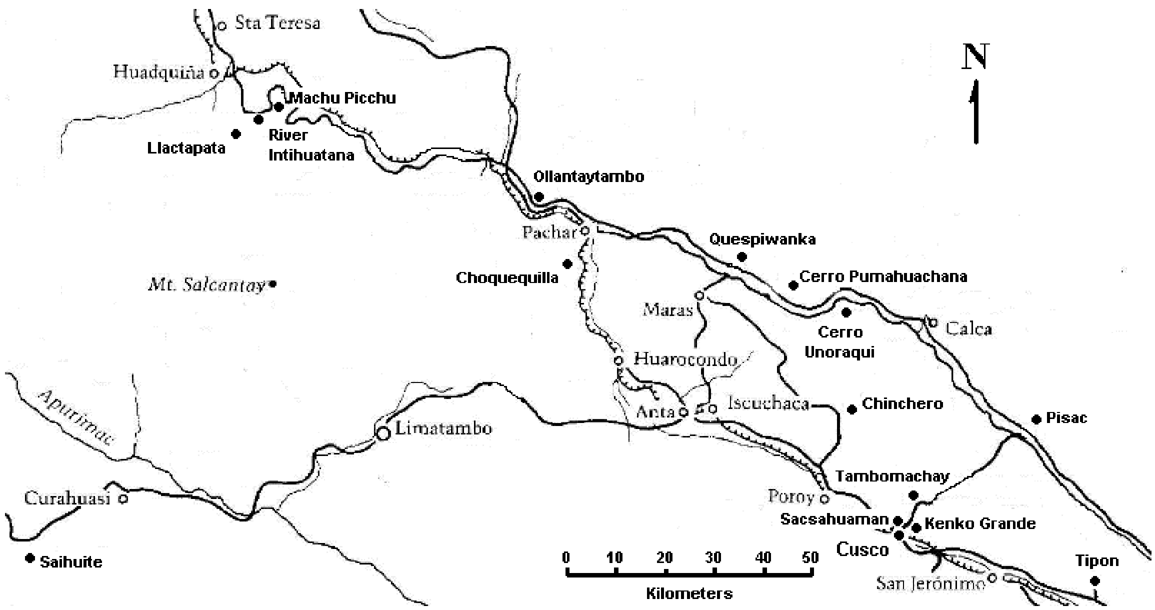

Figure IV-1: Research Site Locations (modified from Hemming and Ranney, 1982).

Legend:

9.2 Kenko Grande*	10.2 Chinchero*	10.7 Choquequilla*
9.12 Tambomachay*	10.3 Pisac*	10.8 Ollantaytambo*
9.13 Sacsahuaman*	10.4 Quespiwanka*	11.2 Machu Picchu*
9.19 Tipon*	10.5 Cerro Pumahuachana	11.3 River Intihuatana*
9.20 Saihuite*	10.6 Cerro Unoraqui	11.4 Llactapata*

* actual or potential astronomical orientation or sightline present

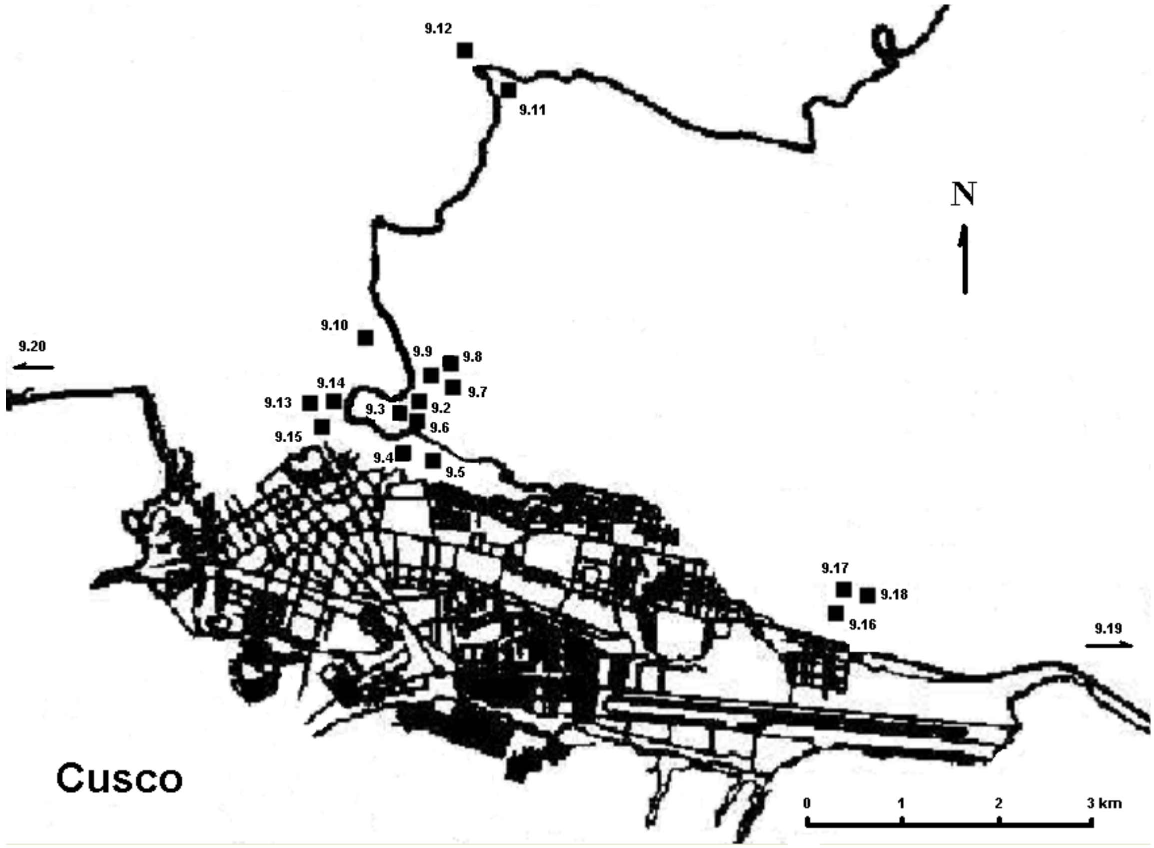

Figure IV-2: Local Cusco Research Site Locations (modified from Bauer, 1998).

Legend:

9.2 Kenko Grande*	9.9 Solar Horizons*	9.15 Sapantiana
9.3 Kenko Chico*	9.10 Lanlakuyok*	9.16 Rumiwasi Bajo*
9.4 Mesa Redonda	9.11 Puca Pucara*	9.17 Rumiwasi Alto*
9.5 Tetecaca	9.12 Tambomachay*	9.18 Kusicallanca*
9.6 Patallacta	9.13 Sacsahuaman*	9.19 Tipon*
9.7 Kusilluchayoc*	9.14 Mollaguanca*	9.20 Saihuite*
9.8 Lacco*		

* actual or potential astronomical orientation or sightline present

Chapter 9

Region Surrounding Cusco

9.1 Introduction

Pachacuti instituted a great system of ceques and huacas that emanated in all directions from Cusco's Coricancha, the primary sun temple of the Incas. He ordered sun temples to be built across the empire so that all could worship the sun (Cobo, 1983 [1653]: 134). Structures in Cusco such as the Coricancha, the Sunturhuasi, and the ushnu of the Hanan Huacaypata plaza figured prominently in Inca astronomy, but are not subjects of my research that involved mainly more rural huacas, especially those that are carved outcroppings. At least 328 huacas were worshipped and cared for, but most did not survive the Catholic purge of idolatries following the Spanish conquest. Those that remain were carved from rock and many of these are examined in this chapter. I have followed the designation system of ceques and huacas that was first mentioned by Cobo (1990 [1653]: 51-84) and later put forth by Bauer (1998). Certain huaca descriptions by Cobo are included in this chapter. A major part of the field data presented is a photographic survey of the astronomical orientations found in many of the carved rock huacas, stones and structures of the area surrounding Cusco. Also included are negative findings for certain huacas and carved rocks that exhibited no signs of celestial orientation. This field research does not involve buildings within Cusco and does not attempt to duplicate the work of others regarding such structures. Certain celestial orientations among buildings of the city, such as the Sunturhuasi, previously have been shown to vertically measure the zenith sun (Zuidema, 1981b). I found huacas in the surrounding countryside to tend more toward horizontal observations. The contrast between city and countryside may indicate why this research found so many orientations to be solstitial rather than for the zenith or anti-zenith sun. Vertical zenith observations could have easily been made among certain structures of Cusco, thus leaving horizontal solar observations for outlying huacas with relatively clear horizons. Figure IV-1 is a location map of the sites of my field research presented in this chapter.

9.2 Kenko Grande

Kenko Grande is located at S13°-30.53’; W071°-58.24’ and 3614 masl.

Motifs and Features: Kenko Grande is a carved rock and was found to exhibit light and shadow effects, solstitial orientations, east-west orientations, stairs, seats, niches, a water source, basins, a cave, a light-tube, altars, a monolith, animal replica stones, and a zigzag channel.

Visible from the Coricancha, Kenko Grande (Figure 9-1) is a sculpted limestone outcrop north of Cusco that incorporates carvings and crevices as well as a stone monolith surrounded by a series of niches along an arced plaza. My field research examined several of Kenko Grande’s rock features for potential astronomical orientations.

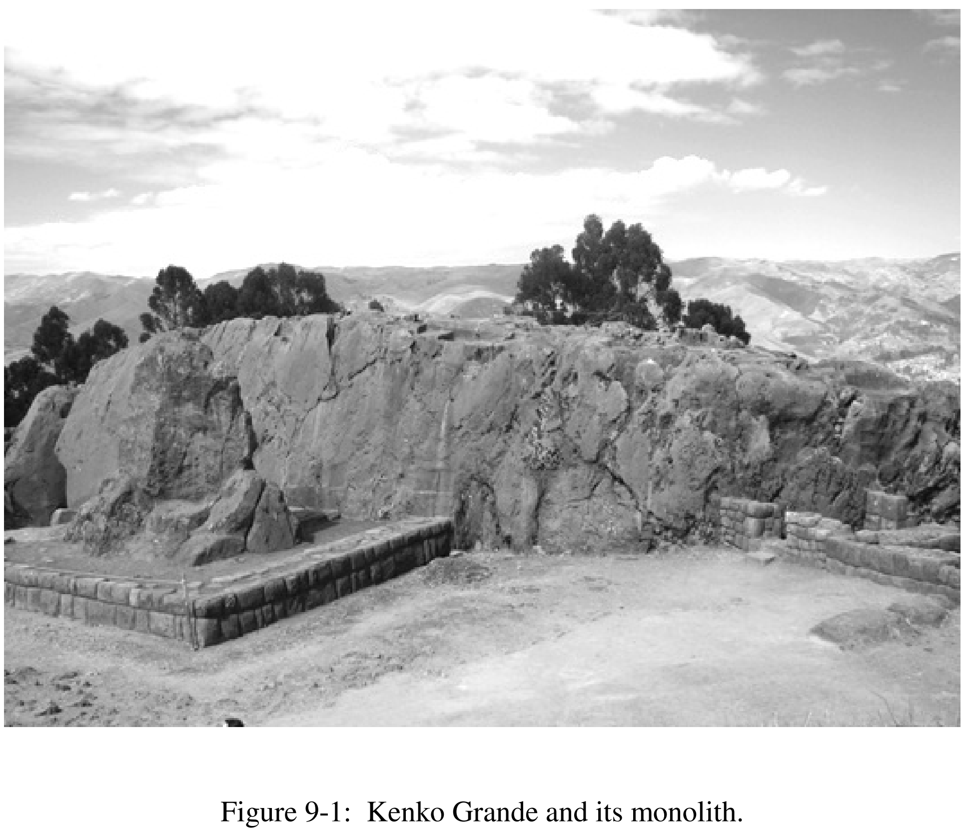

Figure 9-1: Kenko Grande and its monolith.

9.2.1 "The Awakening of the Puma"

Kenko Grande exhibits a visually dramatic phenomenon at the time of the June solstice which is known locally as "the awakening of the puma." The Inca venerated the condor, puma and snake with regard to cosmological correlations with the sky, earth, and underworld (Van de Guchte, 1990). Located atop the huaca and carved into the stone are two carved cylinders designed for effects of light and shadow (Figure 9-2). The cylinders are about 25 cm high and are spaced 35 cm apart. In close proximity is a small wall with a fissure (Figure 9-3) aligned for the sunrise at the June solstice. Light from the morning sun passes through the fissure and first touches the left side of the left cylinder. As the sun continues to rise its rays move across the cylinder and then illuminate the opposite one as well. The cylinders are situated in such a way that the glowing pair and the relative shadows now resemble a puma – "the puma's awakening" (Figure 9-4).

Figure 9-2: Cylinders carved on top of Kenko Grande.

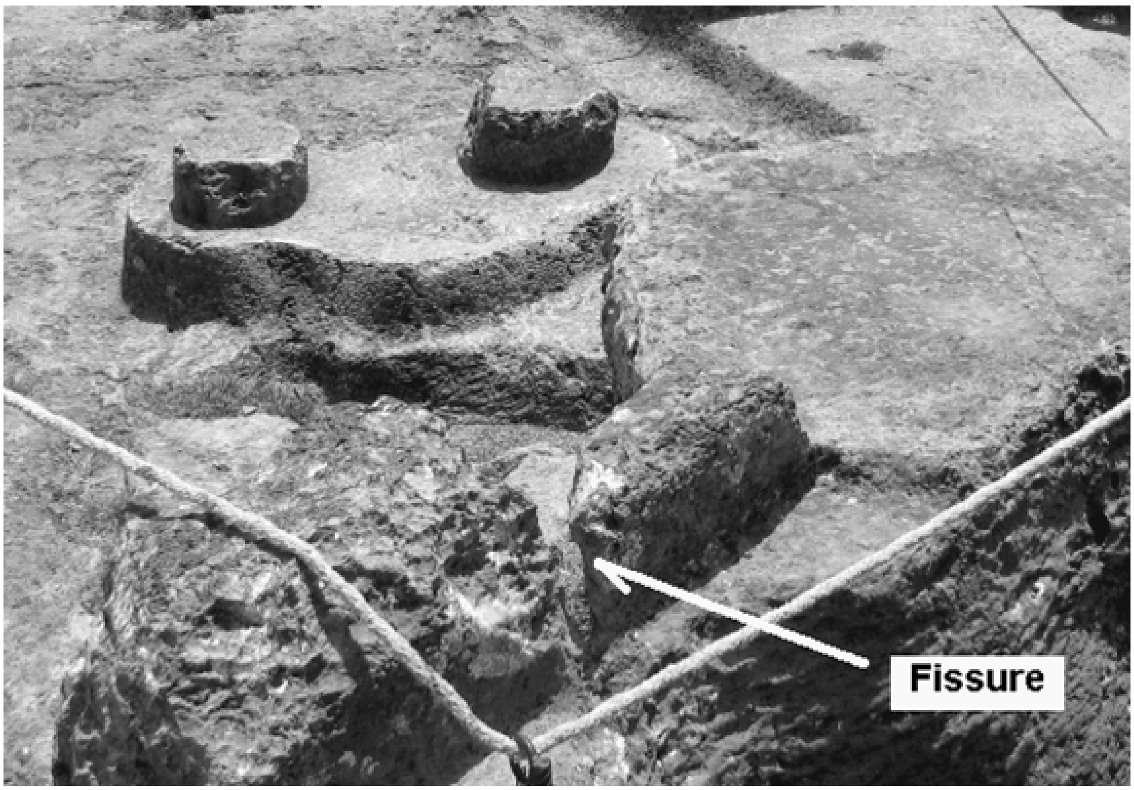

Figure 9-3: Fissure aligned for the June solstice sunrise.

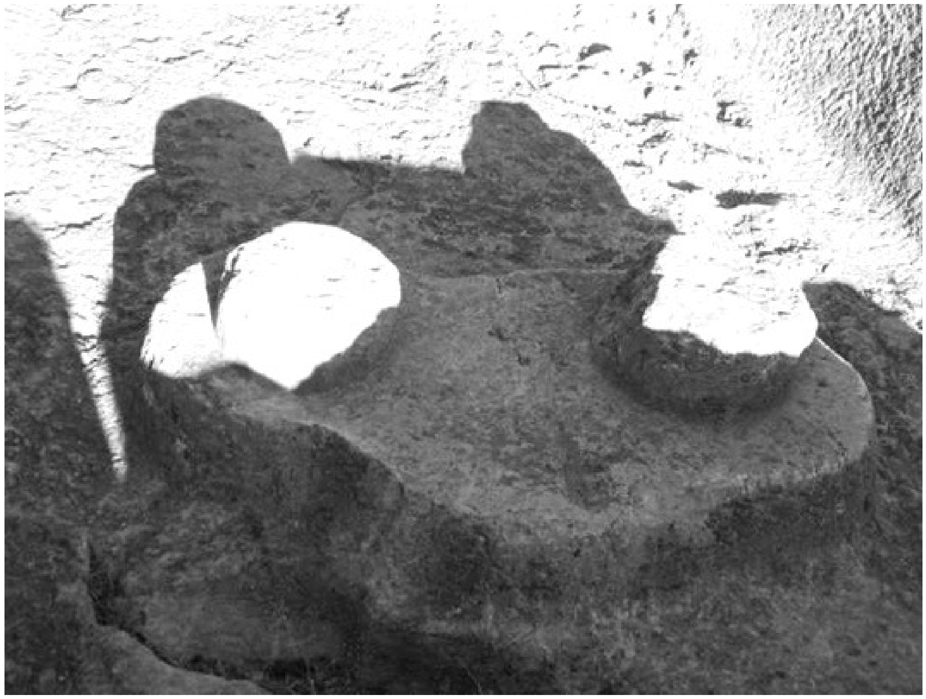

Figure 9-4: “The Eyes of the Puma” at June solstice sunrise.

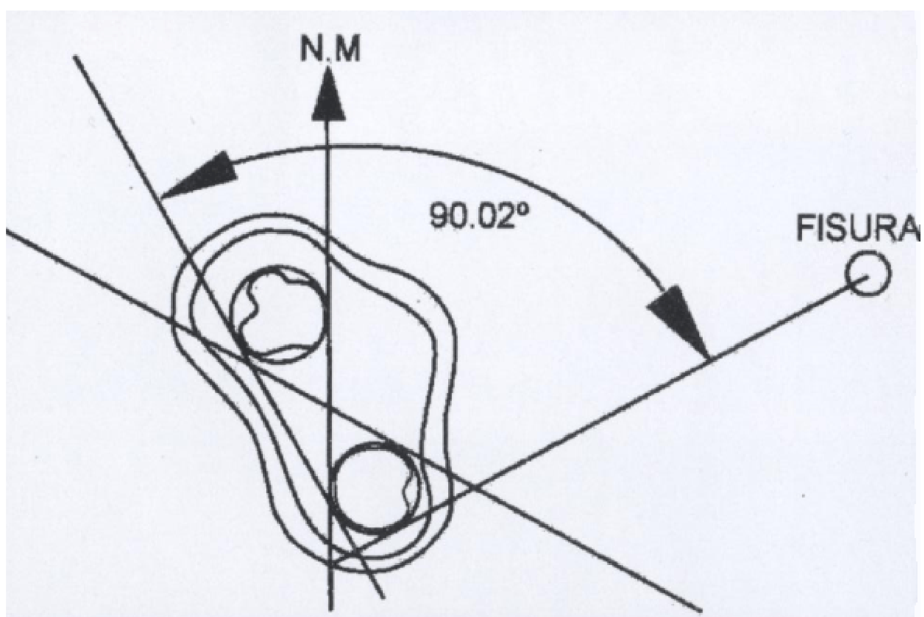

Figure 9-5: Plan of the cylinders and fissure. The line of the fissure (fisura) in the drawing is 62° from north (from Arévalo, 2007).

Light falling on the cylinders also helps mark the equinoxes and the December solstice. The photo in Figure 9-6 was taken on 20 March 2008. On the day of an equinox the sun rises between the cylinders on the eastern horizon. Its rays soon cast an effect of light and shadow that splits the carving into dark and light halves thought to represent the equal periods of day and night.

Figure 9-6: According to local folklore light and shadow effects at equinox represent the division of day and night.

The December solstice sun rises over the 6372 meter snowpeak Nevado Ausangate on an orientation that crosses between and is tangent to both cylinders.

9.2.2 Zigzag channel

The top of Kenko Grande exhibits many once-fine carvings including an offertory/divination channel flowing to a cave (Figure 9-7). A common motif of carved huacas is a straight or zigzag channel through which liquids, most probably chicha, could flow. The current of energy necessary to establish harmony and maintain equilibrium in the world was stimulated by the pouring of liquid offerings into these channels. The channel begins with a cup-like basin, extending first for 130 cm and then 145 cm before splitting into two 80 cm branches. *Kenko* in Quechua means a zigzag (Paternosto, 1996).

Figure 9-7: The zigzag channel carved on top of Kenko Grande.

9.2.3 Interior cave and altars

Located within Kenko Grande is a sculpturally-enhanced cave with two entrances, two altars, niches, and a set of three ritual stairs (Figure 9-8). Locals maintain that light entering the cave within the niche shown at the rear of this photo was reflected by the Incas with gold or silver plates in order to illuminate the entire chamber. The cave is oriented along a southeast-northwest axis and includes an additional niche to the right of the altar large enough to hold a mummy.

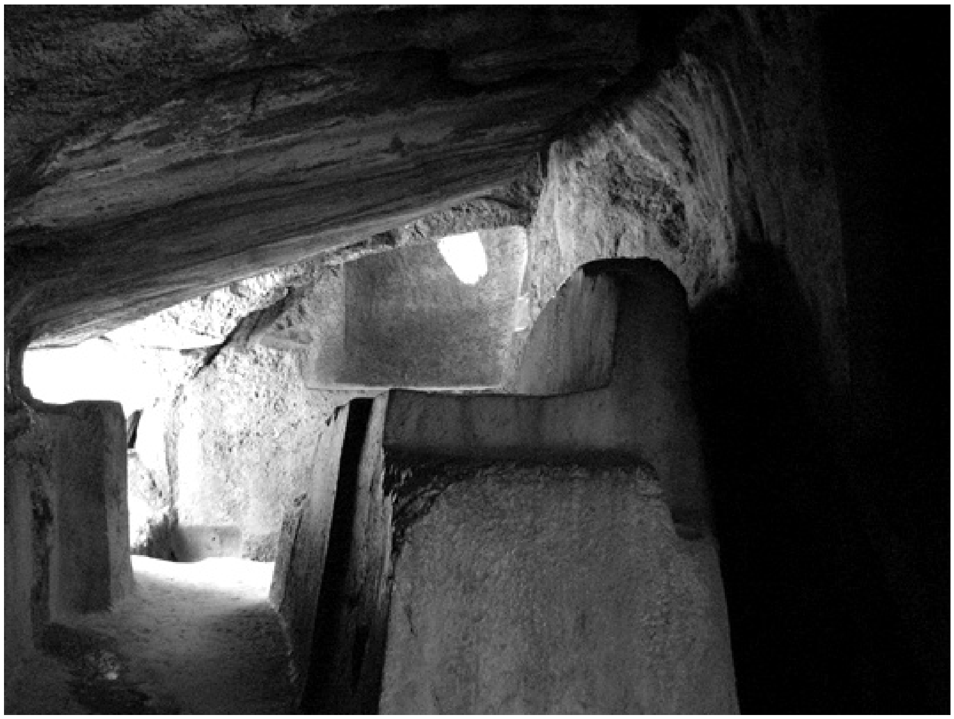

Figure 9-8: Kenko Grande's primary altar.

The primary altar was carved and polished with three ritual stairs at its northwestern end (the far side in Figure 9-8). During the time nearing the June solstice sunlight enters the cave, approaches the altar and climbs the three stairs (Figure 9-9). Ritual stairways are common features, symbolizing shamanic movement between the three worlds. Such a cave could serve as a portal for communication with Ucu Pacha, the world below. Light enters through an opening approximately 341.5° in azimuth and an inclination of +40°.

Figure 9-9: Symbolic stairs illuminated by the midday sun in June.

At times of the solar equinoxes the cave's secondary altar is illuminated at sunrise, a shown in a photo take on 20 March 2008 (Figure 9-10). The opposite entrance of the cave near the main altar is oriented to the equinox sunset. The meaning of this remains uncertain as ethnohistorical evidence has not been found to support Inca interest in equinox horizon observations.

<u>Calculated azimuth of equinox sunrise from the center of the cave opening</u>

<u>Measured azimuth from the center of the cave opening to the horizon</u>

Measured Azimuth:	094.0°
Magnetic Declination:	3.9° W
True Azimuth:	090.1°
Calculated ESR Azimuth:	089.9°
Δ True Az & Calc ESR Az:	0.2°
Measured Inclination:	+2.0°

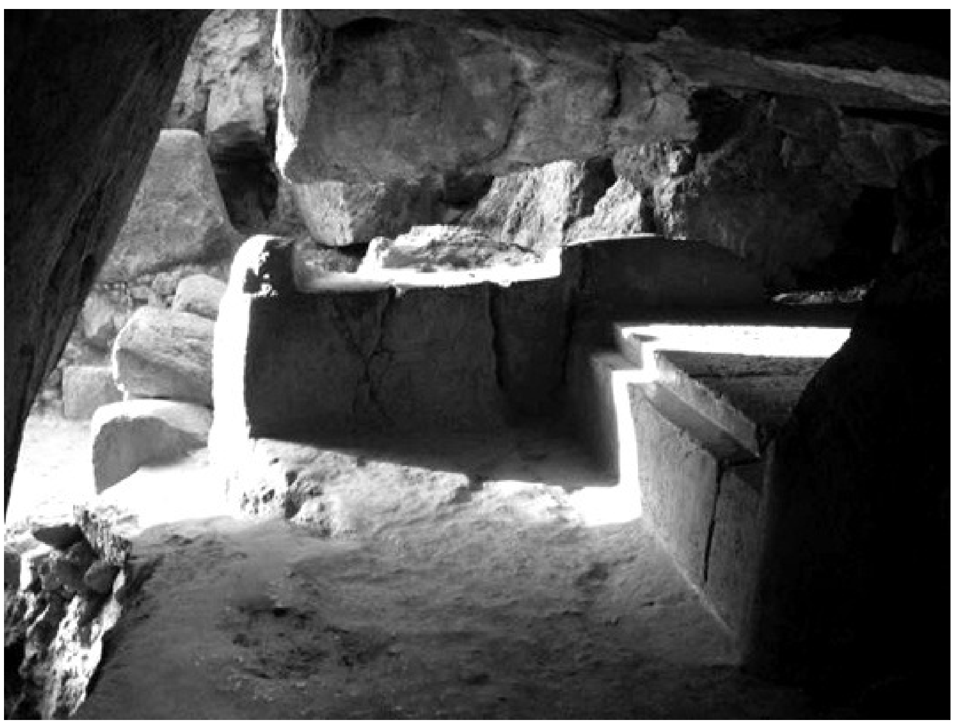

Figure 9-10: The secondary altar within Kenko Grande's cave at equinox sunrise.

9.2.4 Monolith

Kenko Grande's 5.5 meter high monolith (Figure 9-11) is located near the focal point of a semi-circular shaped plaza that includes a partially destroyed wall containing 19 body-sized niches, plus a 20^{th} opening for an entranceway. Modern interpretations describe this as a puma, a phallic symbol or an *axis mundi*; the monolith may also have functioned as a gnomon.

Figure 9-11: The monolith at Kenko Grande.

9.3 Kenko Chico

Kenko Chico is located at S13°-30.62'; W071°-58.32' and 3598 masl.

Motifs and Features: Kenko Chico is a carved rock and was found to exhibit a potential solstitial orientation, stairs, seats, a water source, basins, and a gnomon.

Kenko Chico (Figure 9-12) is located near Kenko Grande to its southwest, separated by a ravine and a small stream. Kenko Chico contains a stone stairway leading to its summit, terraces, and large stone blocks similar in size to many of those used at Sacsahuaman. It is surrounded by a moat and exhibits many carvings, such as steps and seats, in its limestone. Kenko Chico is oriented generally east-west and, while not a structural alignment, Nevado Ausangate can be viewed on the horizon in the direction of the December solstice sunrise. The central staircase is aligned north and south.

<u>Calculated azimuth of December solstice sunrise from the southeast end of Kenko Chico</u>
<u>Measured azimuth from the southeast end of Kenko Chico to Nevado Ausangate</u>

Measured Azimuth:	116.0°
Magnetic Declination:	3.9° W
True Azimuth:	112.1°
Calculated DSSR Azimuth:	113.6°
Δ True Az & Calc DSSR Az:	1.5°
Measured Inclination:	+2.0°

Figure 9-12: Kenko Chico.

9.4 Mesa Redonda

Mesa Redonda is located at S13°-30.80'; W071°-58.18' and 3474 masl.

Motifs and Features: Mesa Redonda is a group of carved rocks and was found to exhibit stairs, a water source, and an altar.

In the residential area immediately below Kenko Chico and visible from the Coricancha is a flat rock known as Mesa Redonda (Figure 9-13). Bauer (1998) states that the boulder and adjacent carved rock are likely candidates for Pachatosa (An 2:2).

> [An-2:2] the second *guaca* of this *ceque* was named Pachatosa; it was a large stone which was next to [Diego] Cayo's house. The sacrifice was burned on top of it, and they said that the stone ate it (Cobo, 1990 [1653]: 64).

Figure 9-13: Mesa Redonda.

9.5 Tetecaca

Tetecaca is located at S13°-30.90’; W071°-57.93’ and 3492 masl.

Motifs and Features: Tetecaca is a carved rock and was found to exhibit a niche, a water source, a cave, an altar, a carved cylinder, and a channel.

To the east of Mesa Redonda and also visible from the Coricancha is a large carved outcrop known locally as Tetecaca (Figure 9-14). The boulder includes a modern shrine and has a carved cylinder sculpted upon its upper surface. The site has a good view of the valley and surrounding horizons and the top of the rock includes a mini-landscape reminiscent of the one found at Saihuite.

Figure 9-14: Tetecaca.

9.6 Patallacta

Patallacta is located at S13°-30.75'; W071°-58.11' and 3492 masl.

Motifs and Features: Patallacta is a carved rock and was found to exhibit seats.

Van de Guchte (1990) calls this outcrop Patallacta (Ch 1:2). Cobo describes a house which may have been nearby.

> [Ch-1:2] The second *guaca* of the *ceque* was called Patallacta. It was a house which Inca Yupanqui designated for his sacrifices, and he died in it. The Incas who succeeded him thereafter made ordinary sacrifice here. In general, all the things which they consumed in sacrifice were offered for the health and prosperity of the Inca (Cobo, 1990 [1653]: 51).

The rock is visible from the Coricancha and has been damaged by the modern road cut below it (Figure 9-15). Carvings, especially those of seats, are extant and from the top of the rock there is a commanding view of the north half of the valley where horizon events could have been observed.

Figure 9-15: Patallacta.

9.7 Kusilluchayoc

Kusilluchayoc is located at S13°-30.51’; W071°-57.94’ and 3637 masl.

Motifs and Features: Kusilluchayoc is a carved rock with adjacent structures and was found to exhibit a solstitial orientation, niches, a water source, a basin, animal replica stones, and a channel.

Proceeding upslope from Patallacta is another large limestone outcrop, Kusilluchayoc, which is situated about 300 meters south of Lacco. Kusilluchayoc consists of two rocks separated by a central corridor and a series of walls constructed on its western side (Figure 9-16). In Quechua *Kusilluchayoc* means ‘the one with the monkey’ (Van de Guchte, 1990) and among the carvings on the huaca are those of three monkeys, a serpent and a puma.

Figure 9-16: The western face of Kusilluchayoc.

Several masonry walls form multiple rooms with windows and niches on Kusilluchayoc's western face. Both a corridor between the rocks and a body-size niche face the setting point of the June solstice sun (Figure 9-17).

<u>Calculated azimuth of June solstice sunset from the center of the corridor</u>

<u>Measured azimuth along the corridor to the horizon</u>

Measured Azimuth:	297.5°
Magnetic Declination:	3.9° W
True Azimuth:	293.6°
Calculated JSSS Azimuth:	295.3°
Δ True Az & Calc JSSS Az:	1.7°
Measured Inclination:	+4.0°

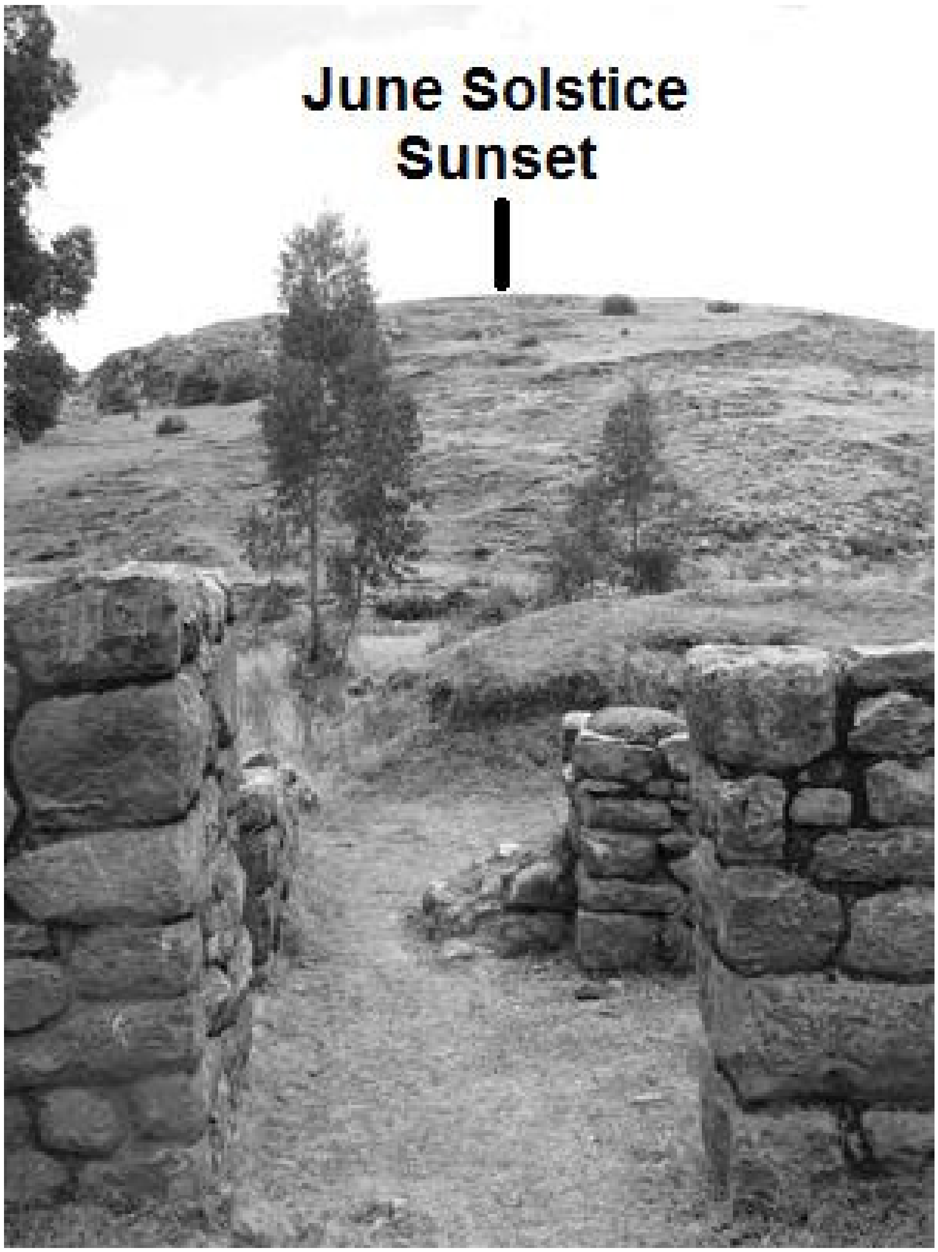

Figure 9-17: View from Kusilluchayoc in the direction of
the June solstice sunset.

9.8 Lacco

Lacco is located at S13°-30.29'; W071°-57.89' and 3662 masl.

Motifs and Features: Lacco is a carved rock and was found to exhibit light and shadow effects, a solstitial orientation, a zenith orientation, stairs, seats, niches, a water source, basins, caves, light-tubes, altars, a carved cylinder, animal replica stones, and channels.

Lacco is a carved limestone outcropping incorporating several astronomical orientations (Figure 9-18). It was barely visible from the Coricancha. The elaborate huaca, also known as Salonpuncu, is located above Cusco to the northeast of Kenko Grande. Zuidema (1977) and Aveni (1981a) suggest Lacco as being near the site of Chuquimarca (An 3:4).

> [An-3:4] The fourth was called Chuquimarca; it was a temple of the Sun on the hill of Manto calla, in which they said that the Sun descended many times to sleep. For this reason, in addition to everything else, they offered it children (Cobo, 1990 [1653]: 65).

Lacco is the largest limestone outcrop in the vicinity, covering an area of some 1670 square meters, and contains elaborately carved stairways, caves and niches. There are at least seven other carved outcrops located within a 1 km radius. Two stairways face the northwest toward the June solstice sunset. Lacco's upper surface is extensively carved with examples such as seats, sacred animals and a carved cylinder. A fault runs like a corridor between the northeast and southeast sides of the rock. There are short sections of stairways and a series of niches, like doorways, large enough to stand inside. A canal, originating at Ucu Ucu some 3 kms distant, runs near the base of the rock and the Inca road to Pisac is nearby. Three caves were modified with altars and exhibit astronomical orientations.

Figure 9-18: Lacco with Nevado Ausangate in the distance.

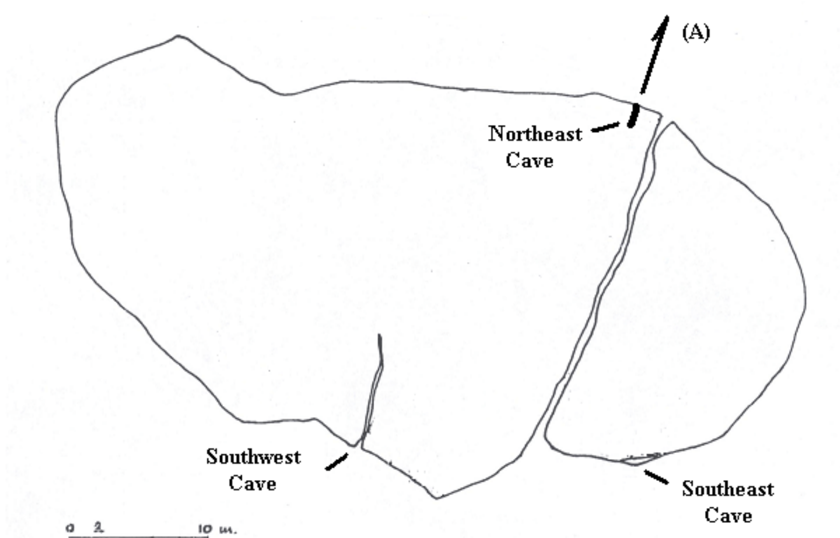

Figure 9-19: Plan of Lacco. (A) is the 065° direction of the June solstice sunrise from the Northeast Cave. The other two caves have vertical alignments (modified from Van de Guchte, 1990).

9.8.1 Northeast Cave

Lacco, on its northeast face, has a cave opening which is oriented for the June solstice sunrise (Figure 9-20). The greatest eastward angle as viewed through the cave's entrance is 078°, therefore at least some sunlight is admitted to a portion of the interior for several days before and after the solar standstill. The sun centers on the cave opening at the time of the June solstice as show in a photo taken on 22 June 2007 (Figure 9-21). During this period sunlight enters the portal, illuminating the altar and cave interior (Figure 9-22). I first noted the solar alignment in October 2006 and returned in June 2007 to document the phenomenon. The process began very quickly at 06:25 and persisted until the last vestiges of light disappeared from the altar's stone surface nearly two hours later at 08:24. The Northeast Cave is located at S13°-30.34'; W071°-57.86' and 3650 masl.

Calculated azimuth of June solstice sunrise from the center of the cave opening

Measured azimuth from the center of the cave opening to the sunrise position on the horizon

Measured Azimuth:	067.5°
Magnetic Declination:	3.9° W
True Azimuth:	063.6°
Calculated JSSR Azimuth:	065.0°
Δ True Az & Calc JSSR Az:	1.4°
Measured Inclination:	+3.0°

Immediately to the east of the Northeast Cave is the north opening of the crevasse running across Lacco. It also is oriented approximately to the June solstice sunrise. Two ceremonial thrones are situated in front of and below two large steps leading to the Northeast Cave's opening. The thrones might have been occupied during the rising of the solstice sun.

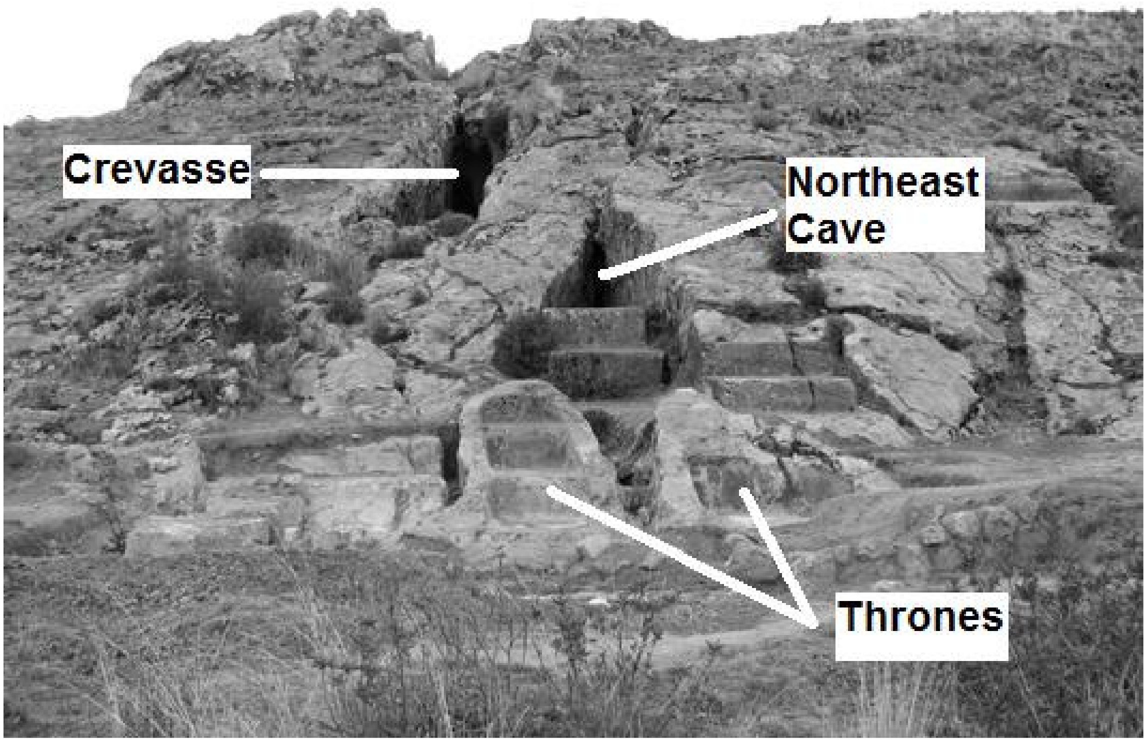

Figure 9-20: Lacco's Northeast Cave and two ceremonial thrones to the right of the huaca's crevasse.

Figure 9-21: June solstice sunrise as seen from Lacco's Northeast Cave. The sun advances each day from the right until reaching the central standstill as depicted, after which it reverses course and retreats.

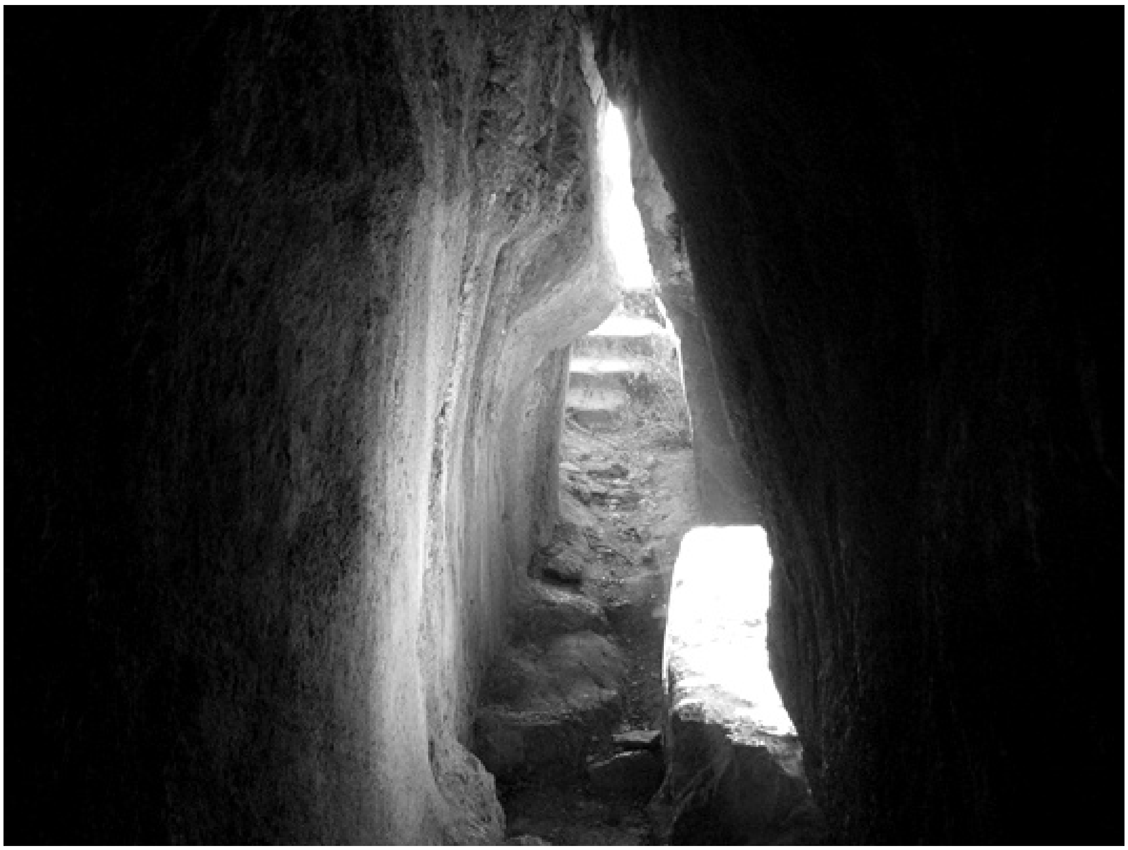

Figure 9-22: Lacco’s Northeast Cave and altar illuminated by the June solstice early morning sun.

9.8.2 Southwest Cave

Lacco's Southwest Cave contains a small altar below a light-tube oriented to the ecliptic at times when the sun's path is between 70° and 75° above the horizon. When properly positioned, either the sun or a full moon can illuminate the altar within. A waxing crescent moon was viewed through the light tube on 26 October 2006, near the October 30th date of the zenith sun (Figure 9-23). The cave's door is oriented facing 235°. The Southwest Cave is located at S13°-30.35'; W071°-57.89' and 3662 masl.

A small altar was carved within the cave and is aligned to be illuminated by light passing through the tube. The elevation from the altar to the lower edge of the light tube is approximately 70° at an azimuth of 211°. The cave includes two recesses cut into its western wall.

Figure 9-23: A waxing crescent moon as viewed through the light-tube in Lacco's Southwest Cave.

9.8.3 Southeast Cave

Lacco's second cave with light-tube illumination is known both as the Temple of the Moon and the Temple of the Sun. This chamber is the most elaborate found within the huaca and the remains of carvings of both a puma and a snake adorn its entrance (Figure 9-24), the serpent symbolizing passage into the realm of Ucu Pacha (Paternosto, 1996). I found sunlight to be admitted through the cave's light-tube near solar noon on 26 October 2007. The shaft aligns vertically to admit the light of the zenith sun. This occurrence took place with the sun at an elevation of 89° (Figure 9-25). The high aspect of this opening makes illumination possible from September through March when the sun's altitude is greatest in the Southern Hemisphere sky. The light-tube is directed at a finely carved altar (Figure 9-26) on an azimuth of 055°, which also can be illuminated by the moon. The Southeast Cave is located at S13°-30.36'; W071°-57.86' and 3655 masl.

Figure 9-24: A snake is carved into the entrance of Lacco's Southeast Cave.

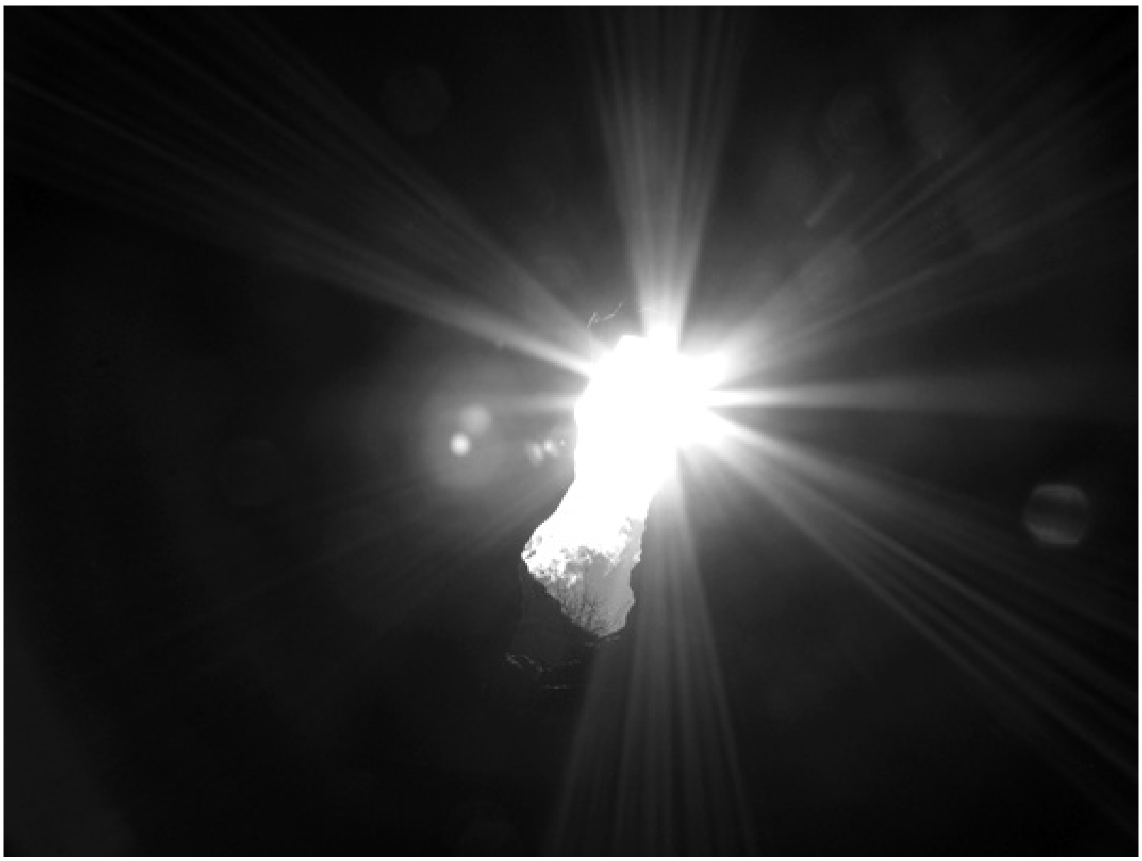

Figure 9-25: The sun as viewed through Lacco's Southeast Cave's light-tube.

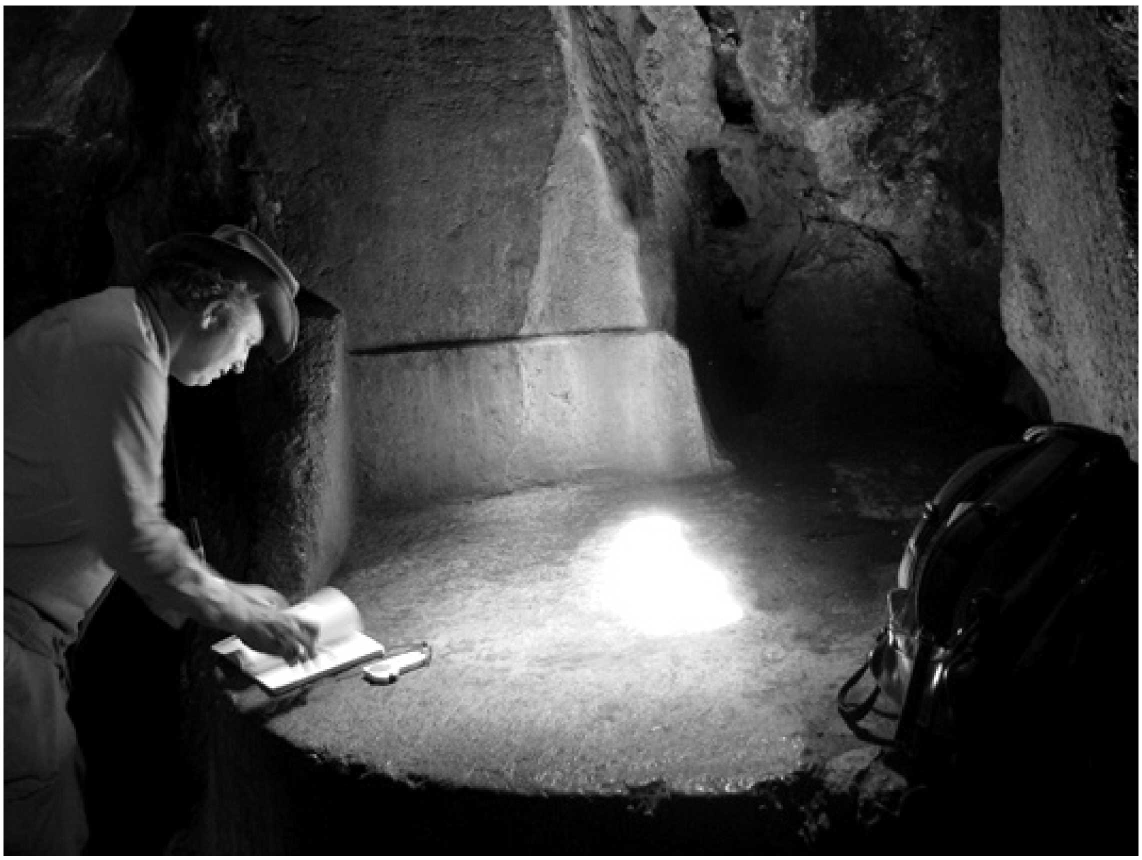

Figure 9-26: Recording data on the illuminated altar.

9.9 Huaca with two circles oriented for solar horizon events

The huaca is located at S13°-30.30'; W071°-58.07' and 3662 masl.

Motifs and Features: The huaca is a carved rock and was found to exhibit solstitial orientations, east-west orientations, seats and carved cylinders.

Located between Kenko Grande and Lacco (Figure 9-27) is a small huaca exhibiting interesting orientations for the solstices and equinoxes (Figure 9-28). Within it are two flat circular carvings, one large and one small, oriented in such a way that they could have had utility as solar gauges (Figure 9-29). A line drawn across the circular carvings, aligned east-west with respect to one another, would indicate the horizon positions of the equinox sunrises and sunsets. Intersecting lines drawn tangent to the carvings point to the sunrises and sunsets of the June and December solstices (Figure 9-30).

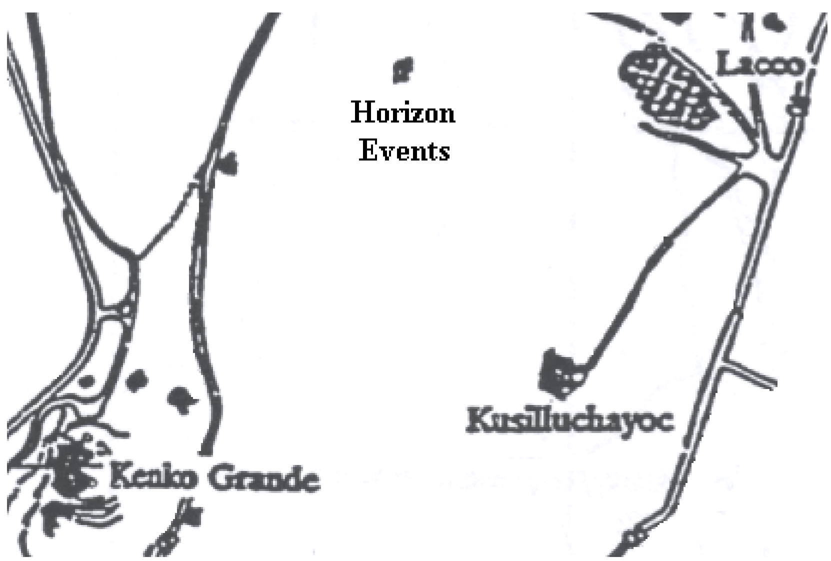

Figure 9-27: Location of the huaca with two circles oriented for solar horizon events (modified from Van de Guchte, 1990).

Figure 9-28: The huaca with two circles oriented for solar horizon events.

Figure 9-29: Two circles, large and a small, are carved into the huaca's base.

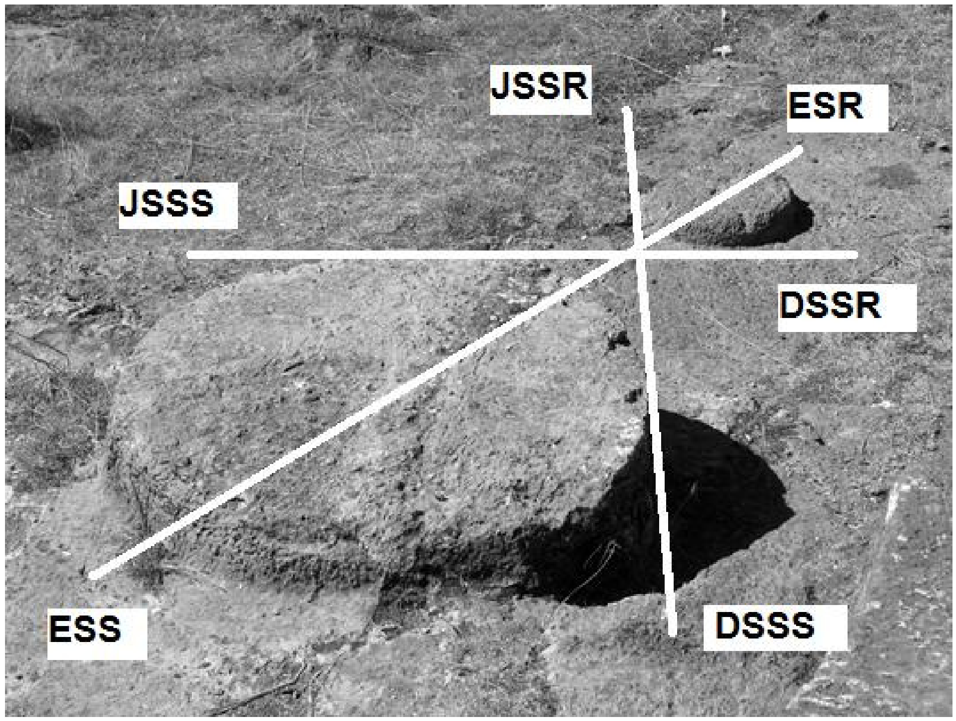

Figure 9-30: Circle orientation indicates the directions of the horizon positions of sunrise and sunset on the solstices and equinoxes.

The larger circle has a diameter of approximately 110 cm while the smaller circle's diameter is 43 cm. The two are 131 cm apart and the upper surface of the large carving is 55 cm higher than that of the lower carving. The two are aligned on a true azimuth of 088.6°/268.6° with respect to one another and the tangential lines crossing between them are approximately oriented 064.1°/244.1° and 111.1°/291.1° (Figure 9-31). I have taken compass error at +/- 0.5° throughout my study. The center points of the circles were measured so as to minimize any error resulting from misalignment. This then established the centerline between the two circles. The tangential lines were also established before the observations were made. Figure 9-32 shows the June solstice sunrise as viewed along the tangential line between the carvings. This photo was taken on 9 June 2008. The sun will move 0.8° further to the left by June 21st.

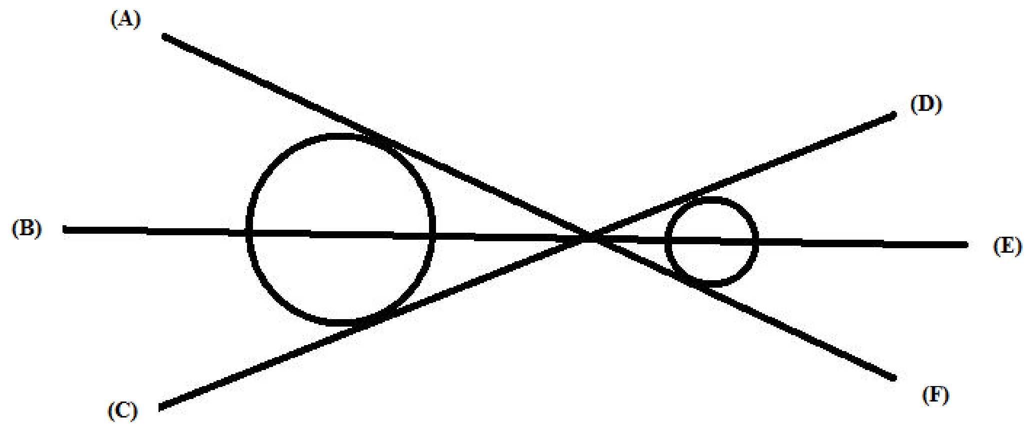

Figure 9-31: Orientation of the circles for six solar horizon events. Line B-E is oriented for the equinox sunrise and sunset. Line C-D is oriented for the June solstice sunrise and the December solstice sunset. Line A-F is oriented for the December solstice sunrise and the June solstice sunset.

Figure 9-32: Sunrise near the June solstice as viewed between the circles.

<u>Calculated azimuth of June solstice sunrise from the carved circles</u>

<u>Measured azimuth along the right edge large circle and left edge small circle to the horizon</u>

Measured Azimuth:	068.0°
Magnetic Declination:	3.9° W
True Azimuth:	064.1°
Calculated JSSR Azimuth:	065.0°
Δ True Az & Calc JSSR Az:	0.9°
Measured Inclination:	+3.0°

<u>Calculated azimuth of equinox sunrise from the carved circles</u>

<u>Measured azimuth along the center of the carved circles to the horizon</u>

Measured Azimuth:	092.5°
Magnetic Declination:	3.9° W
True Azimuth:	088.6°
Calculated ESR Azimuth:	089.6°
Δ True Az & Calc ESR Az:	1.0°
Measured Inclination:	+2.0°

<u>Calculated azimuth of December solstice sunrise from the carved circles</u>

<u>Measured azimuth along the left edge large circle and right edge small circle to the horizon</u>

Measured Azimuth:	115.0°
Magnetic Declination:	3.9° W
True Azimuth:	111.1°
Calculated DSSR Azimuth:	113.6°
Δ True Az & Calc DSSR Az:	2.5°
Measured Inclination:	+2.0°

Seats and stairs are carved in the huaca and several seats are oriented in a manner that directs them toward the viewing of each of these solar horizon events, with the exception of the June solstice sunset. That area of the stone is severely eroded but may originally have contained the missing seat. The seats are oriented to 063°, 092°, 116°, 247°, and 272°.

The overall purpose of this shrine remains enigmatic. While astronomical orientations are present, it is likely that the Incas used the site for other purposes as well. The two carvings might have served as ceremonial platforms, giving rise to the possibility of an additional astronomical function whereas the day of the zenith sun could be determined when a figure placed on one of the carvings cast no shadow.

9.10 Lanlakuyok

> Lanlakuyok is located at S13°-29.82'; W071°-58.41' and 3727 masl.
>
> Motifs and Features: Lanlakuyok is a carved rock and was found to exhibit an east orientation, stairs, seats, niches, a water source, caves, and light-tubes.

Sherbondy and Van de Guchte have suggested that Lanlakuyok is a candidate for Amaromarcaguaci (An 1:7).

> [An-1:7] The seventh *guaca* was called Amaromarcaguaci; this was a house of Amaro Tupa Inca, which was on the road of the Andes (Cobo, 1990 [1653]: 63].

Lanlakuyok is a large carved outcrop along the road to Pisac that has an extensive system of passageways within it illuminated by occasional tubes or openings to the sky (Figure 9-33). The position of the huaca has a clear view of both Lacco and Sacsahuaman (Figure 9-34). Kenko Grande would also have been visible, but is presently blocked by trees. A primary cave opening faces sunrise at the time of an equinox.

<u>Calculated azimuth of equinox sunrise from the center of the cave opening</u>

<u>Measured azimuth from the center of the cave opening to the horizon</u>

Measured Azimuth:	091.5°
Magnetic Declination:	3.9° W
True Azimuth:	087.6°
Calculated ESR Azimuth:	089.6°
Δ True Az & Calc ESR Az:	2.0°
Measured Inclination:	+2.0°

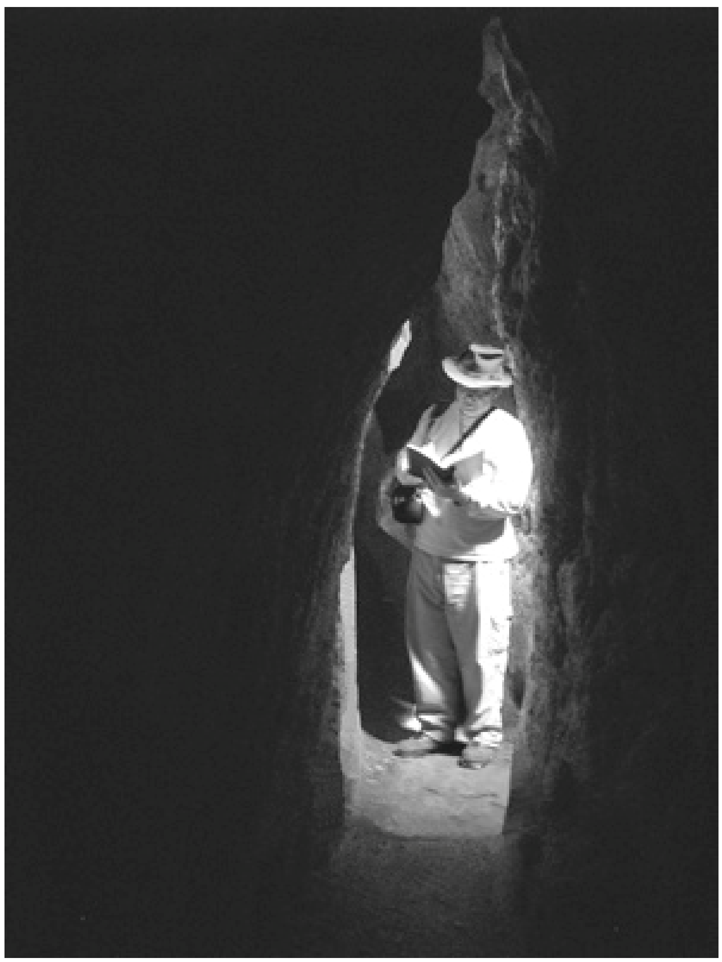

Figure 9-33: Recording data at a naturally lit point in a passageway within Lanlakuyok.

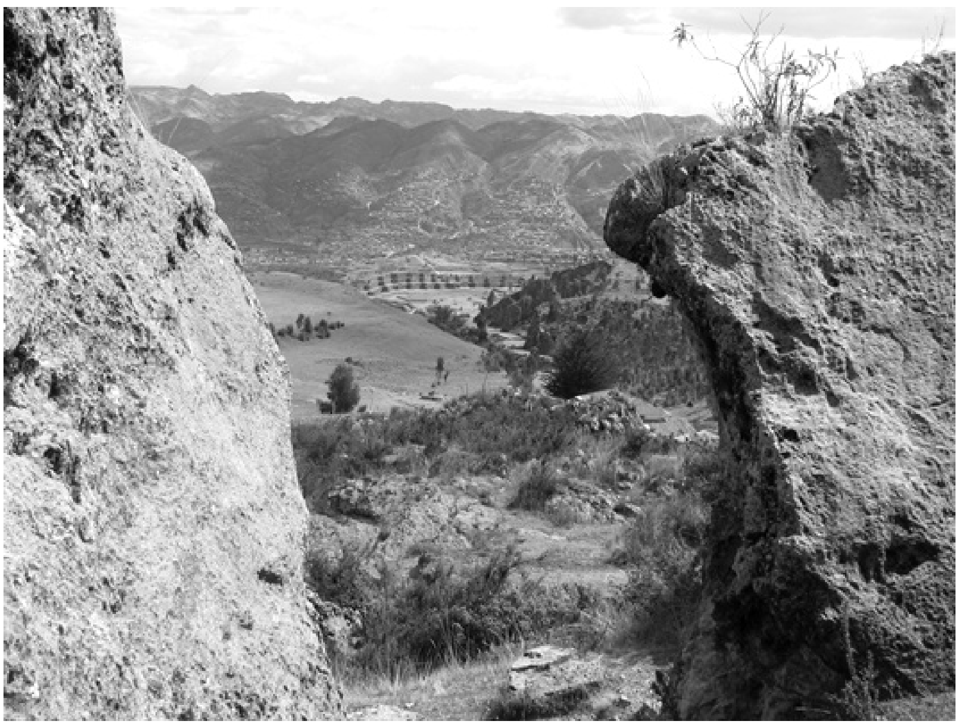

Figure 9-34: Sacsahuaman's zigzagged walls as viewed from Lanlakuyok.

9.11 Puca Pucara

Puca Pucara is located at S13°-29.00'; W071°-57.72' and 3805 masl.

Motifs and Features: Puca Pucara is a group of structures and was found to exhibit east-west orientations, a water source, a fountain, platforms, and double-jambed doorways.

Puca Pucara is said to have been one of Pachacuti's residences (Bauer, 1998) and Niles (1987) has suggested it as the location of An 1:9.

> [An-1:9] The ninth was named Tambomachay; it was a house of Inca Yupanqui where he lodged when hunting. It was set on a hill near the road of the Andes. They sacrificed all kinds of things to it except children (Cobo, 1990 [1653]: 63].

The huaca is located at the top of a small hill along the road to Pisac and consists of several structures and a fountain. Entry to the main part of the compound is through a pair of double-jambed doorways connected by a corridor. The doors and corridor are oriented approximately east-west on an axis that also aligns with the fountain (Figure 9-35). This east-west orientation aligns with the positions of sunrise and sunset on the equinoxes. Because the orientations exist and were potentially available for use I include them, but further research will be necessary to establish if the Incas actually did so.

Figure 9-35: Double–jambed doorways and corridor at Puca Pucara oriented east-west.

Bauer (1998) states that the fountain at Puca Pucara (Figure 9-36) should be considered as a candidate for Puquiu (An 2:8).

> [An-2:8] The eighth *guaca* was called Puqui; it was a fountain which is at the end of Tambo Machay. They offered it sheep, clothing, and shells (Cobo, 1990 [1653]: 64).

Figure 9-36: A fountain is aligned on the east-west axis with the double-jambed doorways.

<u>Calculated azimuth of equinox sunrise from the center of the corridor</u>

<u>Measured azimuth along the axis of the corridor to the horizon</u>

Measured Azimuth:	093.0°
Magnetic Declination:	3.9° W
True Azimuth:	089.1°
Calculated ESR Azimuth:	089.7°
Δ True Az & Calc ESR Az:	0.6°
Measured Inclination:	+3.0°

<u>Calculated azimuth of equinox sunset from the center of the corridor</u>

<u>Measured azimuth along the axis of the corridor to the horizon</u>

Measured Azimuth:	273.0°
Magnetic Declination:	3.9° W
True Azimuth:	269.1°
Calculated ESR Azimuth:	270.5°
Δ True Az & Calc ESR Az:	1.4°
Measured Inclination:	+4.0°

9.12 Tambomachay

The mouth of the cave is located at S13°-28.58'; W071°-58.09' and 3900 masl.

Motifs and Features: The cave of Tambomachay is part of a rock outcrop and was found to exhibit a solstitial orientation, stairs, and a platform. A water source is found at the Fountain of Tambomachay below.

The cave of Tambomachay (Figure 9-37) is associated with an Inca platform and staircase and Bauer (1998) suggests it to be the best candidate for Cirocaya (Ch 1:4).

> [Ch-1:4] The fourth *guaca* was called Cirocaya. It is a cave of stone from which they believed the hail issued. Hence, at the season when they were afraid of it, all went to sacrifice in the cave so that hail should not come out and destroy their crops (Cobo, 1990 [1653]: 54).

The cave opening looks out on a bearing of 135° while the 028°/208° platform in front of it more directly faces the December solstice sunrise. The site is positioned with a clear view of Tambomachay, Puca Pucara, and parts of the Cusco Valley. A stairway leads to the south end of the platform. A boulder rests centrally on the terrace of the platform and a wall was constructed on the side of the terrace closest to the outcrop. The cave is shallow and its interior is extensively eroded.

<u>Calculated azimuth of December solstice sunrise from the cave and platform</u>

<u>Measured azimuth perpendicular from the platform in front of the cave to the horizon</u>

Measured Azimuth:	118.0°
Magnetic Declination:	3.9° W
True Azimuth:	114.1°
Calculated DSSR Azimuth:	113.9°
Δ True Az & Calc DSSR Az:	0.2°
Measured Inclination:	+1.0°

Figure 9-37: The cave of Tambomachay with a platform approximately oriented to the December solstice sunrise.

Bauer (1998) proposes that the highly structured fountain at Tambomachay (Figure 9-38) may have been Quinoapuquiu (An 1:10).

> [An-1:10] The tenth *guaca* was called Quinoapuquiu; it was a fountain near Tambo Machay which consists of two springs. Universal sacrifice was made to it, except children (Cobo, 1990 [1653]: 64).

The fountain is situated on the main level of the complex, well below the cave and platform.

Figure 9-38: The fountain of Tambomachay.

9.13 Sacsahuaman

The base of Sacsahuaman's zigzag walls are located at S13°-30.50'; W071°-58.91' and 3595 masl.

Motifs and Features: Sacsahuaman is a multi-faceted complex and exhibits carved rocks, zenith and anti-zenith alignments, stairs, seats, niches, a water source, basins, a cave, and altars.

Niles (1999) feels that construction of Sacsahuaman (Figure 9-39) may have been started by Topa Inca and completed by Huayna Capac. Zuidema and Quispe (1973) state that Sacsahuaman was regarded as a temple of the sun. The orientation of Cusco with Sacsahuaman northwest and above it ensured the June solstice sun would first strike Sacsahuaman before illuminating the city.

Zuidema says that a seat in Sacsahuaman is on a northwest/southeast line running from Ollantaytambo to Cusco and on to Lake Titicaca (personal communication).

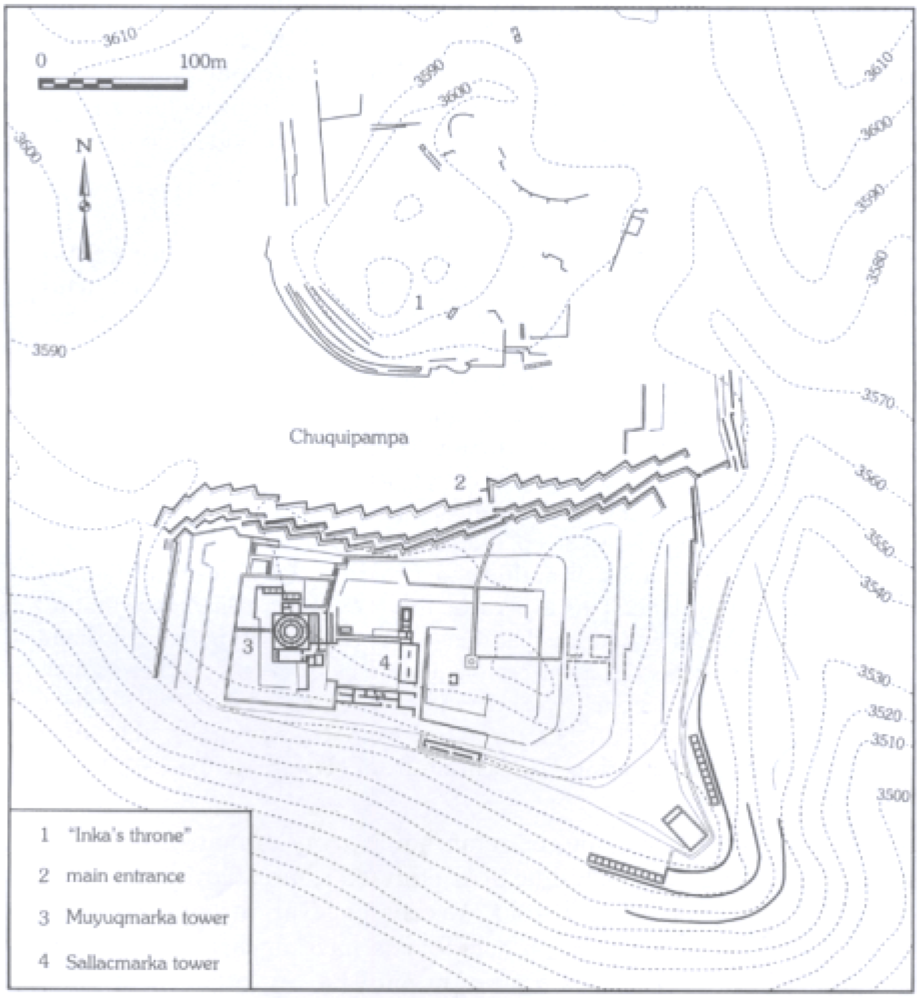

Figure 9-39: Plan of Sacsahuaman (from D'Altroy, 2002).

9.13.1 Muyucmarca

Above the zigzagged walls of Sacsahuaman (Figure 9-41) lies the foundation of a round building called Muyucmarca (Figure 9-40), which Zuidema describes as having three concentric round walls divided by interior walls and three gutters. He states that the central of three water channels, its opposing niche, and the walls that parallel them are all aligned along the axis of the zenith sunrise and anti-zenith sunset. Muyucmarca's round tower and related buildings could have been used to observe the zenith sun overhead, as well as the horizon positions of the sunrise at zenith and the sunset at anti-zenith (Zuidema, 1981b: 326). Garcilaso (1961 [1609]: 287) says that Muyucmarca "…contained rooms with gold and silver painted walls, on which animals, birds, and plants figured in relief, as though in tapestry. It was here that the king lived when he came for a rest in the forest …."

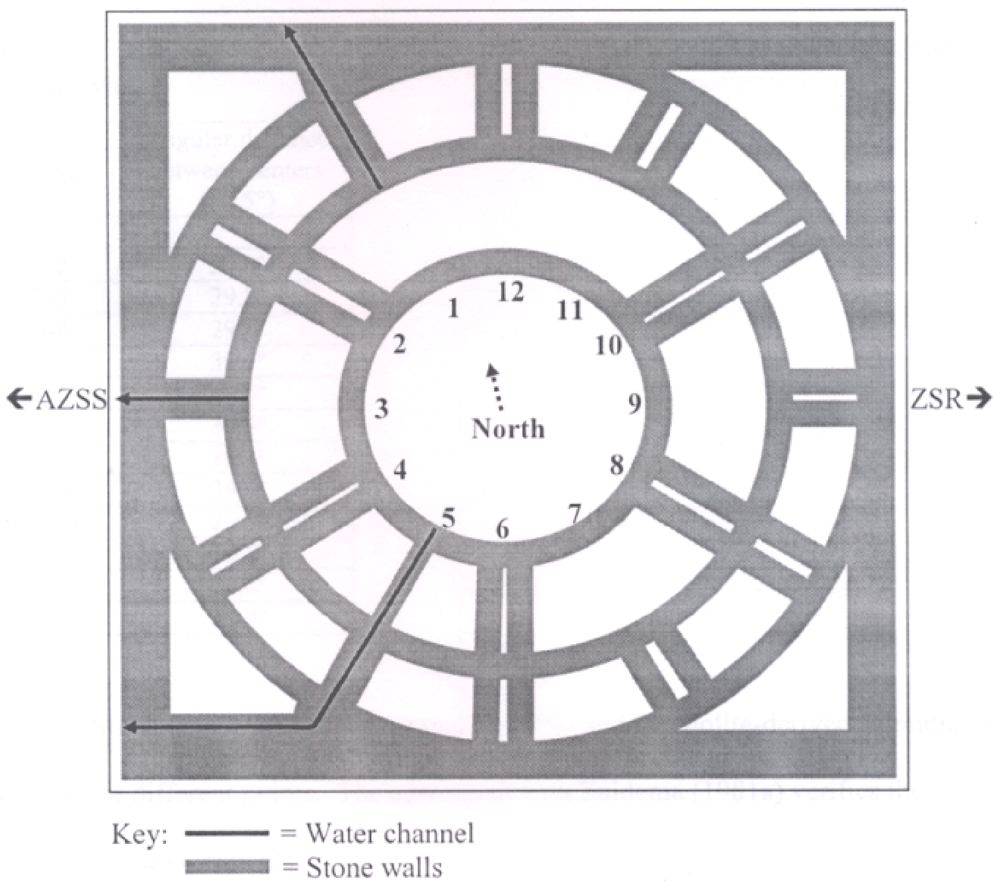

Figure 9-40: The zenith and anti-zenith alignments of Mayucmarca (from Zawaski, 2007:58).

Figure 9-41: The zigzagged walls of Sacsahuaman.

9.13.2 Tired Stone

The Tired Stone (Figure 9-42) is Piedra Casada (Ch 4:6).

> [Ch-4.6] The sixth *guaca* was a large stone named Collanconcho which was in the fortress. They declared that, bringing it for that structure, it fell three times and killed some Indians. The sorcerers said that it had replied to questions they put to it that, if they persisted in wanting to put it in the structure, all would have a bad end, apart from the fact that they would not be able to do it. From that time on it was considered a general guaca to which they made offerings for the strength of the Inca (Cobo, 1990 [1653]: 56-57).

The limestone huaca is extensively carved with many examples of seats and stairs. Legend has it that as the massive stone was being brought to Sacsahuaman it became "tired" and could move no further (Hemming and Ranney, 1982). Van de Guchte (1990) argues the exclusion of the Tired Stone and the subsequent incompletion of Sacsahuaman to be intentional. This would leave the project's completion for supernatural assistance. The Tired Stone is located at S13°-30.25'; W071°-58.86' and 3610 masl.

Figure 9-42: The Tired Stone.

9.13.3 Throne of the Inca

Across the plaza from Sacsahuaman's ramparts is a huaca known as the Throne of the Inca (Figure 9-43), or Sabacurinca (Ch 5:6).

> [Ch-5:6] The sixth *guaca* was named Sabacurinca; it was a well-carved seat where the Incas sat. It was very venerated, and solemn sacrifices were made to it. On account of this seat, the whole fortress was worshipped, for the seat must have been inside or next to the fortress (Cobo, [1653]: 57).

The series of massive steps or tiers were carved from diorite and are said to have served as a place where ruling Incas sat, in particular in a seat carefully carved for that purpose. The Throne of the Inca faces Cerro Huanacauri, the mountain mentioned with the *procession* and the *pilgrimage* in section 5.17. The Throne of the Inca is located at S13°-30.43'; W071°-58.93' and 3618 masl.

Figure 9-43: The Throne of the Inca.

9.14 Mollaguanca

Mollaguanca is located at S13°-30.35’; W071°-58.74’ and 3581 masl.

Motifs and Features: Mollaguanca is a carved rock and was found to exhibit solstitial orientations, stairs, seats, and a water source.

To the east of Sacsahuaman lies a small huaca that may be Mollaguanca (Ch 3:6).

> [Ch-3:6] The sixth *guaca* was named Mollaguanca; it was a certain stone which was in the middle of a flat place which they called Calispuquiu. Inca Yupanqui ordered it to be placed there and considered it a shrine (Cobo, 1990 [1653]: 55).

The crevasse in the center of the boulder (Figure 9-44) is aligned on the axis for June solstice sunrise and December solstice sunset. There are carvings of stairs and seats, but erosion is extensive thus leaving these potential orientations for June solstice sunrise and December solstice sunset inconclusive.

<u>Calculated azimuth of June solstice sunrise from the center of the crevasse</u>
<u>Measured azimuth from the axis of the crevasse to the horizon</u>

Measured Azimuth:	068.0°
Magnetic Declination:	3.9° W
True Azimuth:	064.1°
Calculated JSSR Azimuth:	065.0°
Δ True Az & Calc JSSR Az:	0.9°
Measured Inclination:	+3.0°

<u>Calculated azimuth of December solstice sunset from the center of the crevasse</u>

<u>Measured azimuth from the axis of the crevasse to the horizon</u>

Measured Azimuth:	248.0°
Magnetic Declination:	3.9° W
True Azimuth:	245.1°
Calculated DSSS Azimuth:	246.4°
Δ True Az & Calc DSSS Az:	1.3°
Measured Inclination:	+4.0°

Figure 9-44: Mollaguanca.

9.15 Sapantiana

Sapantiana is located at S13°-30.73'; W071°-58.68' and 3465 masl.

Motifs and Features: Sapantiana is a carved rock and was found to exhibit a water source, and an animal replica stone.

In a residential area below Sacsahuaman and within view of the Coricancha is a huaca known as Sapantiana (Figure 9-45). Homes have grown to surround this shrine that Bauer (1998: 53) says is the "best possible location for Ch 2:4."

> [Ch-2:4] The fourth guaca was called Viroypacha; it is a conduit of fairly good water which was declared a guaca by Inca Yupanqui. It was prayed to for the tranquility of the Inca (Cobo, 1990 [1653]: 54).

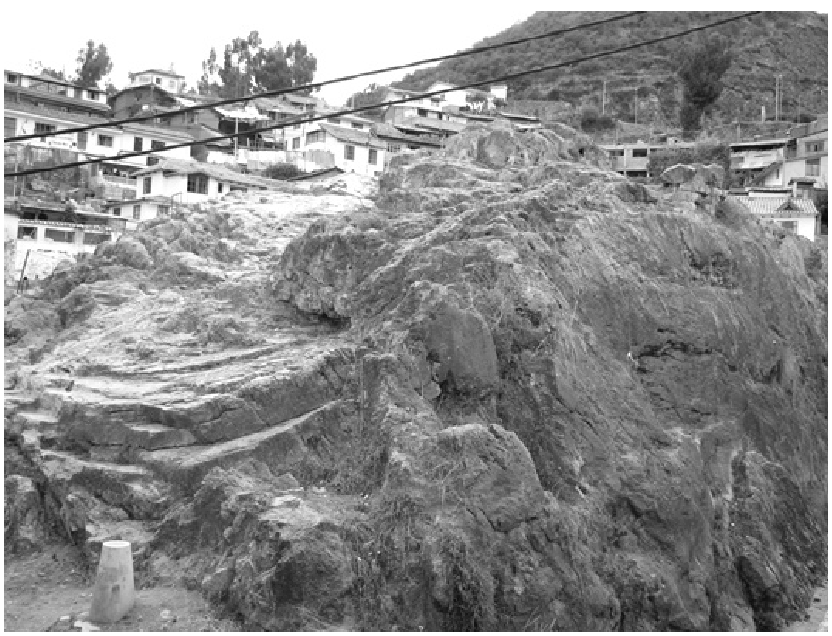

Figure 9-45: Sapantiana is currently surrounded by homes.

9.16 Rumiwasi Bajo

Rumiwasi Bajo is located at S13°-31.17’; W071°-56.42’ and 3470 masl.

Motifs and Features: Rumiwasi Bajo is a group of structures and was found to exhibit a solstitial orientation, niches, and a cave (tunnel).

To the east of Cusco above San Sebastián lies Rumiwasi Bajo. The rock of Rumiwasi Bajo contains a number of niches and a nine meter-long passageway. One doorway to the passageway through the huaca looks out close to the June solstice sunset, but is 12° off. The other doorway opens to the December solstice sunrise (Figure 9-46).

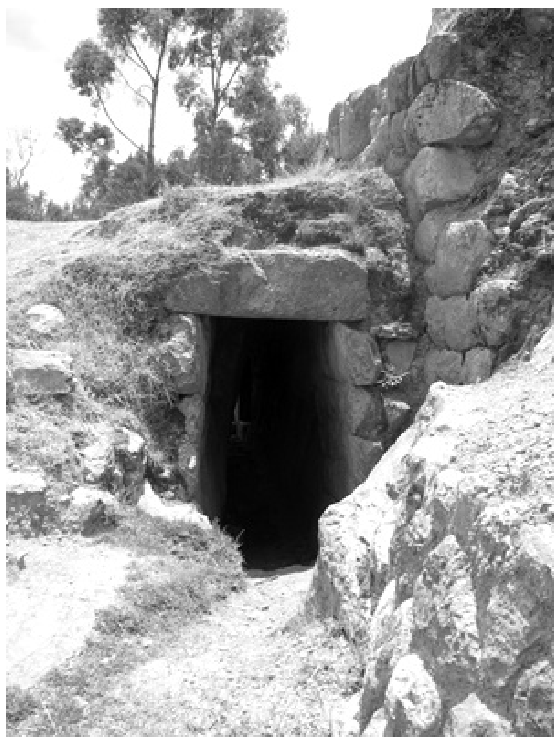

Figure 9-46: The southeastern door to the passageway of Rumiwasi Bajo.

Calculated azimuth of December solstice sunrise from the southeastern tunnel door

Measured azimuth from the axis of the tunnel door to the horizon

Measured Azimuth:	116.0°
Magnetic Declination:	3.9° W
True Azimuth:	112.1°
Calculated DSSR Azimuth:	113.9°
Δ True Az & Calc DSSR Az:	1.8°
Measured Inclination:	+2.0°

Calculated azimuth of June solstice sunset from the northwestern tunnel door

Measured azimuth from the axis of the tunnel door to the horizon

Measured Azimuth:	286.0°
Magnetic Declination:	3.9° W
True Azimuth:	281.1°
Calculated JSSS Azimuth:	294.4°
Δ True Az & Calc JSSS Az:	2.0°
Measured Inclination:	+12.3°

9.17 Rumiwasi Alto

Rumiwasi Alto is located at S13°-30.97'; W071°-56.36' and 3563 masl.

Motifs and Features: Rumiwasi Alto is a group of structures and was found to exhibit a potential solstitial orientation, niches, and terraces.

Another carved rock lies several hundred meters uphill, known as Rumiwasi Alto. The site includes four terraces bound by walls, one with four niches facing out to 195° (Figure 9-47). Several other niches have not survived. Rumiwasi Alto looks 13.5° down upon Rumiwasi Bajo at an angle of 206°. The walls of the terraces are aligned at 118° and nearby Kusicallanca is oriented with this site on the December solstice sunrise axis.

<u>Calculated azimuth of December solstice sunrise from the central terrace wall</u>

<u>Measured azimuth along the central terrace wall to the horizon</u>

Measured Azimuth:	118.0°
Magnetic Declination:	3.9° W
True Azimuth:	114.1°
Calculated DSSR Azimuth:	113.9°
Δ True Az & Calc DSSR Az:	0.2°
Measured Inclination:	+1.0°

Figure 9-47: Walls and niches of Rumiwasi Alto.

9.18 Kusicallanca

Kusicallanca is located at S13°-31.02'; W071°-56.23' and 3573 masl.

Motifs and Features: Kusicallanca is a group of structures and was found to exhibit a potential solstitial orientation, niches, and terraces.

Kusicallanca neighbors Rumiwasi Alto to the southeast. It exhibits three terraces with several masonry walls, including an upper one with two extant niches (Figure 9-48). The original wall likely contained two to four additional niches. The wall is oriented such that the December solstice sun will rise behind it.

<u>Calculated azimuth of December solstice sunrise from the upper wall with two niches</u>
<u>Measured azimuth perpendicular from the upper wall with two niches to the horizon</u>

Measured Azimuth:	120.0°
Magnetic Declination:	3.9° W
True Azimuth:	116.1°
Calculated DSSR Azimuth:	114.1°
Δ True Az & Calc DSSR Az:	2.0°
Measured Inclination:	+0.0°

Figure 9-48: Wall with two niches at Kusicallanca.

9.19 Tipon

Tipon is located at S13°-34.25’; W071°-46.99’ and 3460 masl.

Motifs and Features: Tipon is a multi-faceted complex and was found to exhibit sacred rocks, a solstitial orientation, niches, a water source, fountains, a double-jambed doorway, and terraces.

Tipon is situated approximately 26 km to the southeast of Cusco and was an Incan city most likely originally known as *Quispicanche*. Zuidema (1981b: 331-335) argues Tipon to have been part of a ritual pilgrimage that took place at the time of the June solstice (see section 5.17). The modern village of *Quispicanchis* lies along the highway in the valley below Tipon. Wright (2006) suggests that Tipon was an estate for Inca nobility.

The site (Figure 9-49) includes two main sections, the lower area consisting of masonry structures, fountains fed by a mountain spring, and thirteen finely-constructed terraces (Figure 9-50). The upper area includes a complex of masonry structures with a shrine known as an *Intihuatana*. Further north is a ceremonial plaza, an aqueduct and a residential area. On the top of the mountain above the plaza is *Limaqawarina* (Zuidema, 1981b: 333). Upper sections of Cusco may be seen to the northwest from both Limaqawarina and the Intihuatana. Limaqawarina is on the zenith sunrise axis as viewed from the Chirao sucanca on Cerro Picchu and is the likely site of the Pucuy Sucanca (Zuidema, 1981b: 335).

Figure 9-49: Plan of Quispicanche, or Tipon (Fidel Ramos, from Zuidema, 1981b: 334).

Figure 9-50: The terraces of Tipon looking to the southwest. Iglesia Raqui is to the left and the Intihuatana is to the right.

Two structures are located above the eastern flank of the terraces. One is called Iglesia Raqui and the other is immediately adjacent to it on its northeast side. The structures are located at S13°-34.24'; W071°-46.95' and 3476 masl. Iglesia Raqui has three windows and two doors facing out over the terraces and the opposite rear wall contains six windows. The northeastern structure has one door facing northeast, twelve interior niches and one window looking northwest over the terraces (Figure 9-51).

Figure 9-51: Structure immediately northeast of Iglesia Raqui.

Structures in the Intihuatana complex can be seen from Iglesia Raqui and the northeastern structure. The window in the northeastern structure faces out at 312° (Figure 9-52) and the Intihuatana is 297.4° from the structure, 1° from the predicted point of the June solstice sunset.

<u>Calculated azimuth of June solstice sunset from Iglesia Raqui</u>

<u>Measured azimuth from the northeastern structure to the intihuatana</u>

Measured Azimuth:	301.5°
Magnetic Declination:	4.1° W
True Azimuth:	297.4°
Calculated JSSS Azimuth:	298.4°
Δ True Az & Calc JSSS Az:	1.0°
Measured Inclination:	+13.0°

Figure 9-52: The Intihuatana as viewed from the window in the northeastern structure.

The Tipon Intihuatana differs from the intihuatanas at Machu Picchu, the River Intihuatana and Pisac in that those intihuatanas are all finely carved while Tipon's consists of unimproved rocks (Figure 9-53). Similarly to the ones at Machu Picchu and Pisac, the Tipon Intihuatana is situated on high ground facilitating "access" to the sun. It is located at S13°-34.16'; W071°-47.13' and 3554 masl.

<u>Calculated azimuth of June solstice sunset from the intihuatana</u>

<u>Measured azimuth from the intihuatana to a raised feature on the horizon</u>

Measured Azimuth:	298.0°
Magnetic Declination:	4.1° W
True Azimuth:	293.9°
Calculated JSSS Azimuth:	294.4°
Δ True Az & Calc JSSS Az:	0.5°
Measured Inclination:	+1.0°

Figure 9-53: The Intihuatana of Tipon.

The Intihuatana stones lie at the southern end of a complex of associated structures and overlook much of the site below. Many of the structures near the Intihuatana are crumbling and are the subjects of current reconstruction efforts. Iglesia Raqui is at a 13° angle of depression from the Intihuatana (Figure 9-54). Tipon has a sightline aligned for the June solstice sunset that may have played a role in pilgrimage and ceremonies during the time of the festival of Inti Raymi. The Pucuy Sucanca of Quispicancha is oriented with the Chirao Sucanca at Picchu along the axis of the zenith sunrise and anti-zenith sunset (see section 8.8.2). Priests would pass through Quispicancha on their return from their pilgrimage to Vilcanota (see section 5.17). As with certain other Inca pilgrimage centers there could have been separate areas for elites and non-elites to view the solstice sunset. A double-jambed doorway on the trail leading from the terraces to the Intihuatana would indicate that only elites were permitted past this point (Niles, 1999: 295) and they alone would be able to view the sunset from the Intihuatana (Figure 9-55). Non-elites, however, could still have viewed the June solstice sun setting over the Intihuatana from a flat area near Iglesia Raqui, a location that could accommodate a large number of observers. The orientation of the June solstice sunset axis is shown in Figure 9-56.

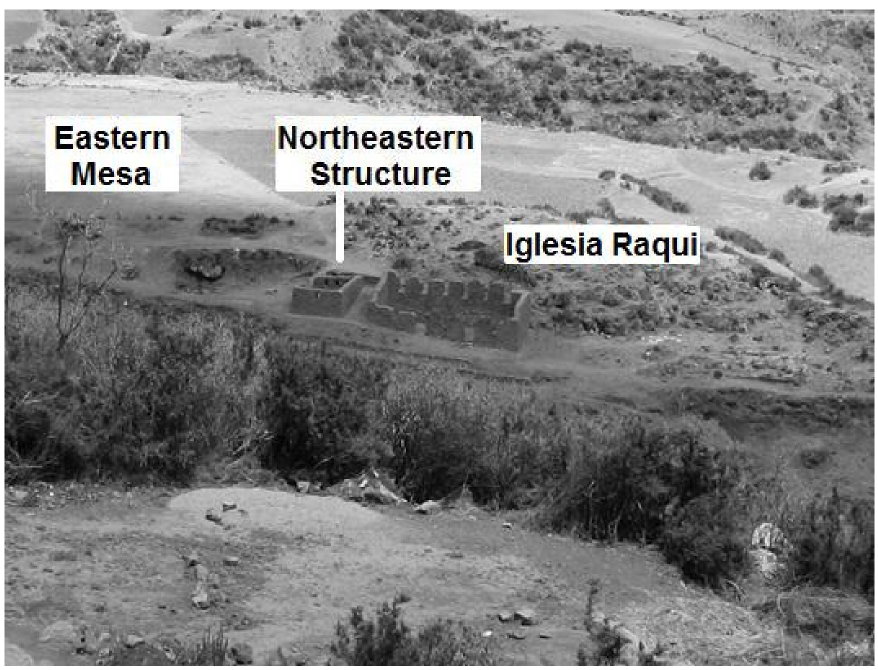

Figure 9-54: The eastern mesa as viewed from the Intihuatana.

Figure 9-55: The horizon position of the June solstice sunset as viewed from Tipon's Intihuatana.

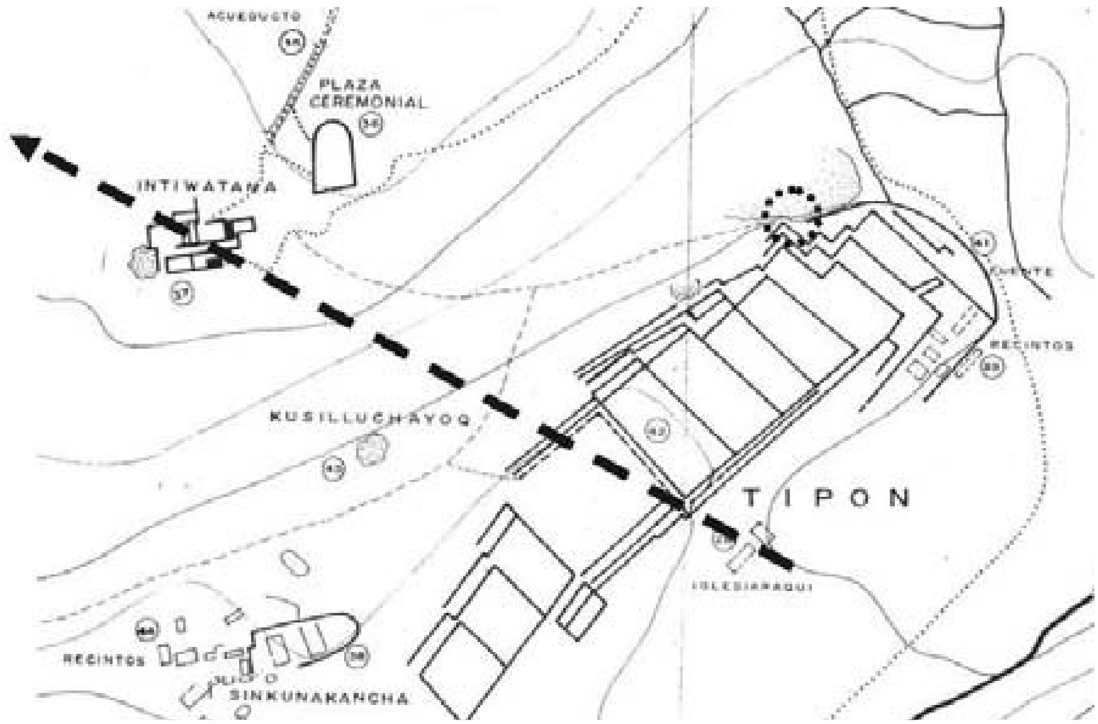

Figure 9-56: The June solstice sunset could have been viewed over the Tipon Intihuatana from a mesa behind Iglesia Raqui (modified from Malville, 2008).

9.20 Saihuite

Saihuite is located at S13°-32.82’; W072°-48.11’ and 3623 masl.

Motifs and Features: Saihuite is a multi-faceted complex and was found to exhibit carved rocks, light and shadow effects, a solstitial orientation, east-west orientations, stairs, seats, niches, a water source, fountains, platforms, animal replica stones, and channels.

Saihuite, well within the ancient territory of the Chanca and the modern province of Abancay, is situated some 160 km west of Cusco. The site’s Principal Stone is a striking rock of andesite that has been carved extensively. The stone’s upper half is completely sculpted with zoomorphic carvings as well as channels, possibly for fluids of divination.

The site is divided into upper and lower sectors and in addition to the Principal Stone includes the Rumihuasi ruins and an ushnu (Figure 9-57). The Principle Stone and a structure with several rooms and a large niche rest on a raised platform in the upper sector which is situated on a terraced hilltop called Concacha. Beyond this platform the terrain descends rapidly and a great multi-tiered fountain that includes a staircase was constructed down the side of the hill. Located in the lower sector are several features that include additional carved stones and a major platform.

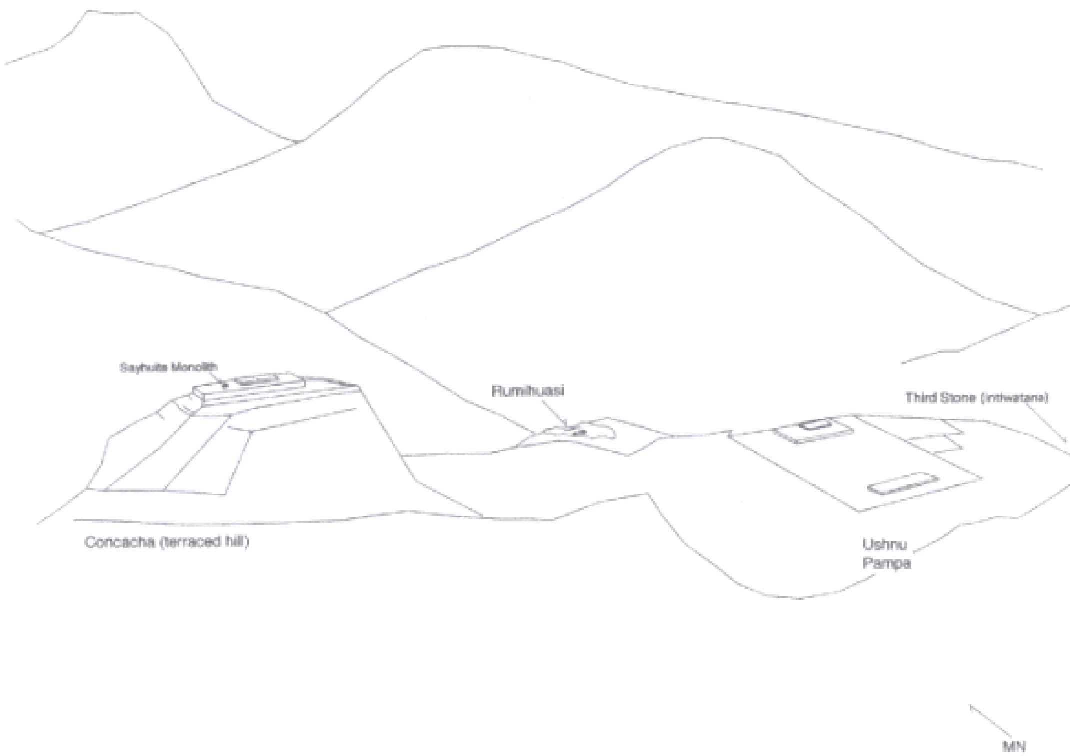

Figure 9-57: Plan of Saihuite. The Principle Stone, or monolith, is to the left; to the east are the Rumihuasi; the Ushnu Pampa and Chingana; and the Third Stone. The fountain and stairs are on the hill between the monolith and Rumihuasi (Van de Guchte, from Staller, 2008: 300).

9.20.1 Principal Stone

Saihuite is oriented generally southeast to northwest and the upper sector that includes the Principal Stone is at the northwest end of the site (Figure 9-58). The features of the upper sector rest on an earthen platform. The stone is extensively sculpted and is currently protected by a wrought-iron fence (Figure 9-59). Among the many fine carvings found on the stone are those of symbolic steps, pumas, lizards, frogs, snakes, llamas, humans and a monkey. Carvings are in high relief, but most have been mutilated, presumably during the period of the Spanish extirpation of idolatries (Hemming and Ranney, 1982; Paternosto, 1996). Van de Guchte (1990) argues the carvings of the Principal Stone to be a figurative landscape or map of the Inca Empire. The Principal Stone is located at S13°-32.84'; W072°-48.18' and 3652 masl.

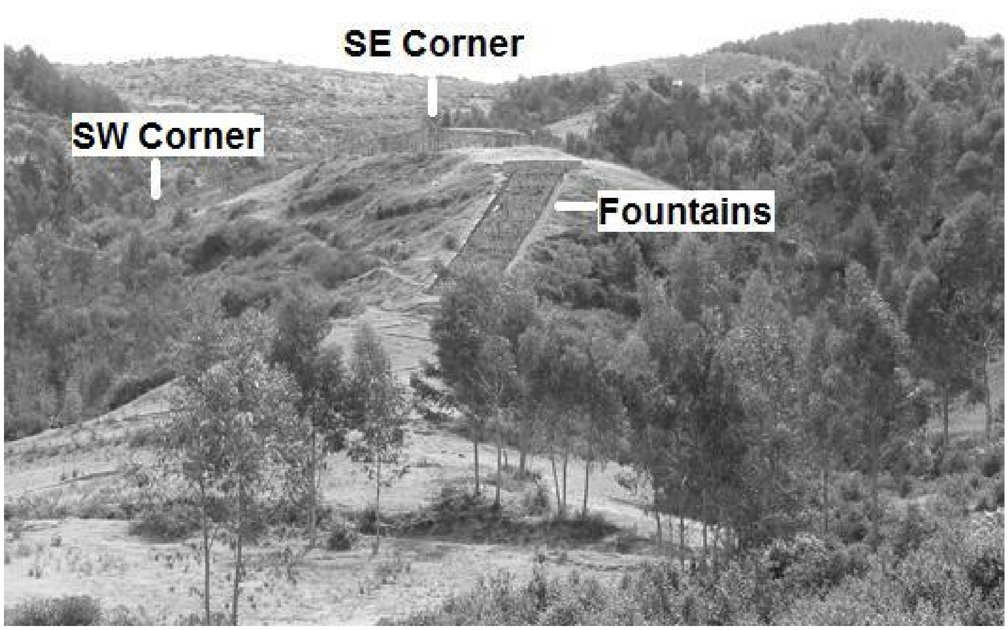

Figure 9-58: Saihuite's upper sector and the corners of its earthen platform on the terraced hill of Concacha. The Principal Stone is nearest the southwest corner of the platform.

Figure 9-59: The Saihuite Principal Stone

A complex series of channels and cups begins at the top of the stone and is carved throughout (Figure 9-60). Ceremonial fluids would have been fed to the channels by hand. The rock may also have been given sentience through the power of camay by water flowing in these channels across its surface.

The Principal Stone lies with the adjacent structure on the axis of the June solstice sunrise and December solstice sunset.

Figure 9-60: Carvings of figures, stairs and fluid channels.

9.20.2 Upper Structure

Adjacent to the Principal Stone on the raised grassy platform is a structure with several rooms and a door with a niche facing to the southeast (Figure 9-61). The upper sector of Saihuite is predominantly oriented to the axis of the June solstice sunrise and December solstice sunset. The long retaining walls of the earthen platform measure approximately 064.3°/244.3° as well as do walls of the Upper Structure. The Upper Structure is located at S13°-32.83'; W072°-48.19' and 3657 masl.

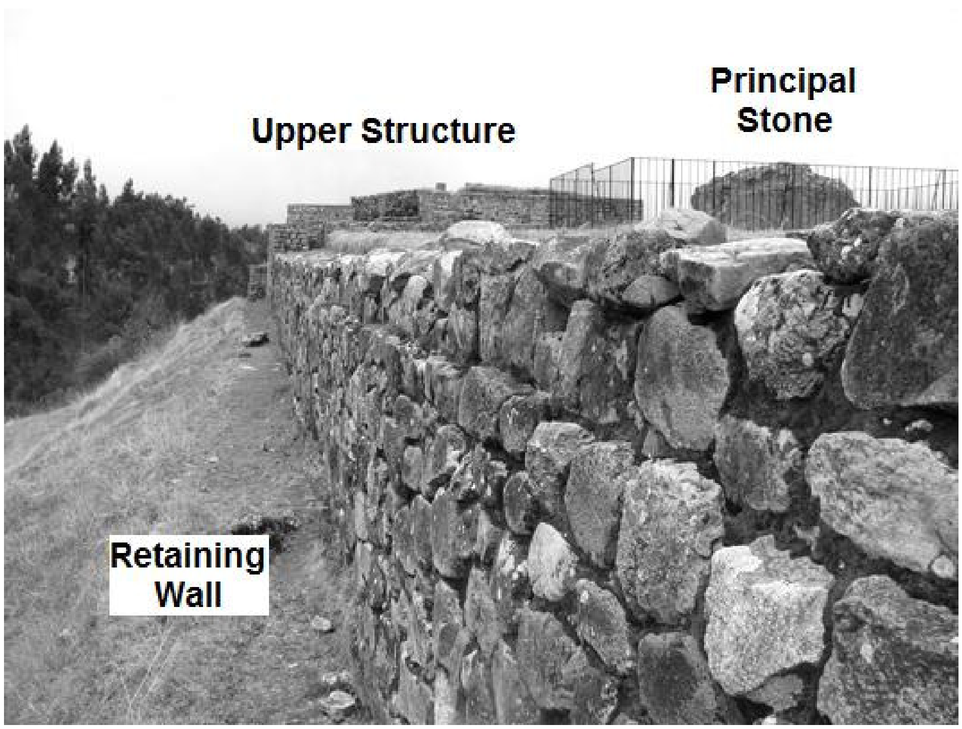

Figure 9-61: Elements of the upper sector of Saihuite.

The Upper Structure's northeast face includes a corridor and niche that are oriented to view the June solstice sunrise (Figure 9-62). The niche is large enough that a priest could stand within it to view the events on the distant horizon (Figure 9-63). Additional features of the Upper Structure align on this axis as well.

<u>Calculated azimuth of June solstice sunrise from the niche</u>

<u>Measured azimuth along the axis of the niche and corridor to the horizon</u>

Measured Azimuth:	067.5°
Magnetic Declination:	3.2° W
True Azimuth:	064.3°
Calculated JSSR Azimuth:	065.3°
Δ True Az & Calc JSSR Az:	1.0°
Measured Inclination:	+2.0°

Figure 9-62: Niche and corridor aligned for the June solstice sunrise.

Figure 9-63: View in the direction of the June solstice sunrise from the niche.

9.20.3 Multi-Tiered Fountains

A set of 69 stairs and an adjacent multi-tiered fountains connect Saihuite's upper and lower sectors (Figure 9-64). The fountain has 22 tiers oriented to 098°/278° with a 24° slope. The lower portion of the fountain complex has six sections of two-tier fountains, while the upper portion uses three sections of three-tier fountains. There is one additional fountain in a top tier. The original source came from the terrace above and markings on the stones would indicate that water has flowed through the fountain in modern times. The top of the fountain is located at S13°-32.82'; W072°-48.14' and 3640 masl, and the bottom is at S13°-32.82'; W072°-48.11' and 3623 masl.

Figure 9-64: A multi-tiered fountain descends the slope leading to Saihuite's lower sector.

9.20.4 Rumihuasi Stone

The Rumihuasi Stone lies in the Rumihuasi area of Saihuite's lower sector (Figure 9-65). The stone is finely carved (Figure 9-66) on all sides and exhibits features in common with other sculptures such as the Ceremonial Rock of Machu Picchu (see Figure 11-37) and the River Intihuatana (see Figure 11-23). It exhibits shelves, seats and symbolic steps, as well as possible divination channels on its southern side (Figure 9-67). Fluids might have been poured into a cup on top of the rock to flow through a channel, first to a fork and then through either of two additional channels to small niches with drains. Paternosto (1996) writes that the stone is still used for marriage ceremonies, the bride and groom each drinking water from the two channels. I found no apparent celestial orientations in the Rumihuasi Stone and it now is split in two, perhaps as the result of an earthquake. The Rumihuasi Stone is located at S13°-32.77'; W072°-47.97' and 3584 masl.

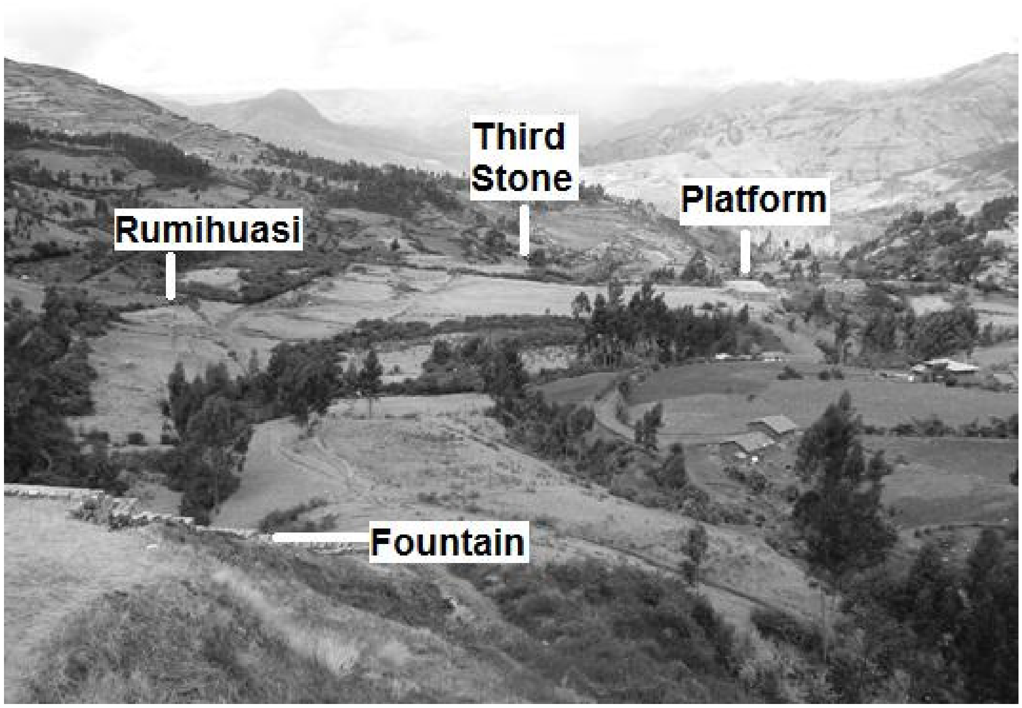

Figure 9-65: The lower sector of Saihuite.

Figure 9-66: The Rumihuasi Stone of Saihuite.

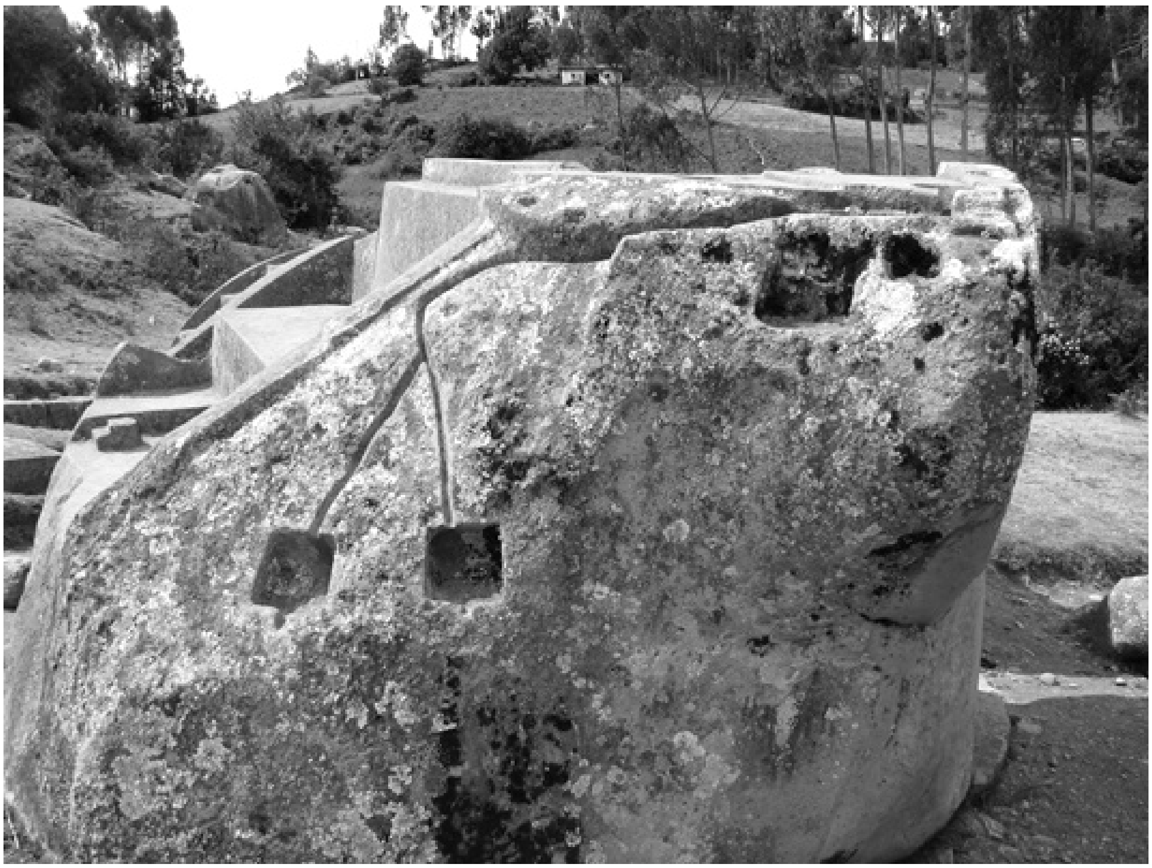

Figure 9-67: Ceremonial channels in the Rumihuasi Stone.

9.20.5 Chingana

The platform of Chingana ("where one gets lost") in the lower sector is cardinally oriented (Figure 9-68), with the long walls measuring east-west and the shorter ones nearly north-south. The rear wall of the platform extends for 38 meters at 090°/270°. The front wall measures 091° and 271°. Both side walls are 21 meters long at 008°/188°. The staircase includes 16 steps that are eight meters wide and face 003°.

Platforms, as ushnus, were used for ceremony and sacrifice, but the specific function of this site remains unclear. It is a raised platform with stairs that has at its center a one square meter depression that may have served to drain fluids – two of the three elements typical of an ushnu. Chingana's size would also make it suitable as a place to gather for viewing ceremonies held on Ushnu Pampa immediately to its north. On the north side of Ushnu Pampa (see figure 9-57) lays the remains of a considerably deteriorated platform called Rauraq'asa. Chingana is located at S13°-32.88'; W072°-47.89' and 3565 masl.

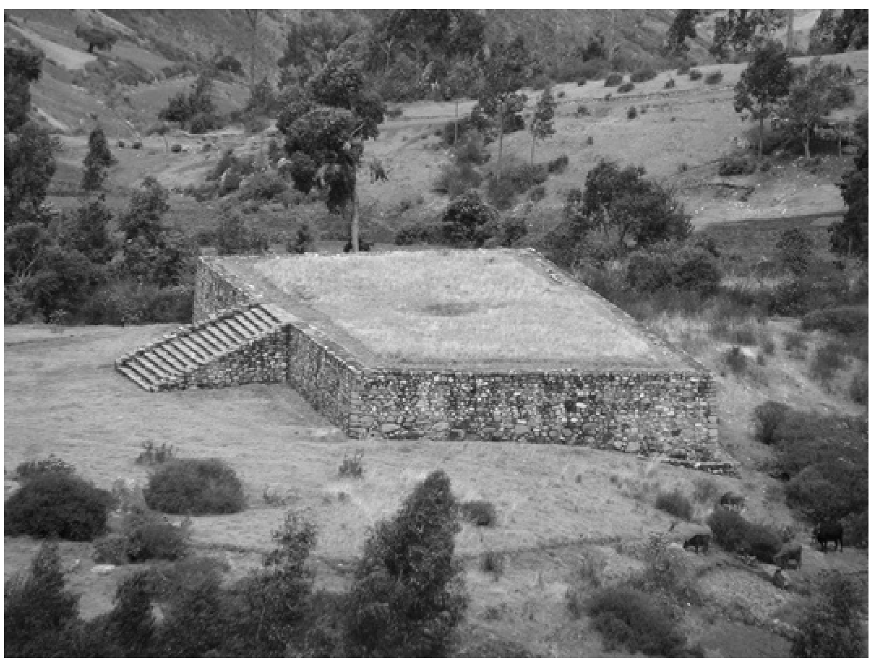

Figure 9-68: *Chingana* in Saihuite's lower sector. A depression can be seen in the center.

9.20.6 Third Stone

Paternosto (1996) says the Third Stone (Figure 9-69) was first published in 1972 by Hébert-Stevens. Hemming and Ranney (1982: 176) refer to it as “a pumalike stone at Saihuite” in the caption of one of their photos. Paternosto (1996: 135) continues that “this Third Stone is the best instrument for watching the movement of the sun between the solstices, as the shadow projected by the stepped quarter-disc – the ‘gnomon’ – demonstrates.” Paternosto refers to following the shadow of the central arm as if it were a sundial depicting the extremes at solstices and without shadow at the equinoxes. Staller (2008: 298) says that the stone’s carvings are oriented in such a way that it can serve observation of the annual cycle of solar movement. As such it acts as a gnomon or pillar, the last of the three prescribed elements for an ushnu at Saihuite.

The Third Stone is finely carved on all sides. The axis of its central arm is 057°/237°, or a 33° difference from the 090°/270° east-west axis. The arm with a hole suggests potential use as an intihuatana, but the true purpose of the Third Stone remains enigmatic. The stone lies at the opposite extreme of Saihuite from the Principal Stone. The Third Stone is located at S13°-32.84’; W072°-47.79’ and 3545 masl.

Figure 9-69: The Third Stone.

9.21 Summary

The region outside of Cusco exhibits many fine examples of Inca astronomy encoded into its huacas and other structures. The "Eyes of the Puma" at Kenko Grande and the solar orientations within the huaca's cavern readily demonstrate the Inca's fascination with the sun and their propensity for utilizing their astronomical knowledge when constructing important shrines. No where better is this shown than within the caves of Lacco where their altars are illuminated by the sun or the moon at specific times of the year.

The huaca with two circles aligned for solar horizon events is especially interesting. The Incas seem to have designed multiple meaning and purpose into most everything they carved and this huaca is certainly no exception. The astronomical orientations of the circles and the sculpted seats are unmistakable and their use would have been a prominent feature of this site. The full significance of this huaca, however, is as of yet unknown and remains to be determined.

At Tipon the orientation for viewing of the June solstice sunset by elites and non-elites is intriguing as this becomes part of a potential emerging trend found in common with other pilgrimage sites. In Saihuite the axis between the horizon points of the June solstice sunrise and December solstice sunset dominates the upper sector of the complex.

Chapter 10

Sacred Valley Region

10.1 Introduction

Pachacuti celebrated his victory over the Cuyos by establishing an estate and palace at Pisac. Later he established Ollantaytambo after conquering the Tambos and apparently built Machu Picchu to commemorate further conquests in the Vilcabamba (Niles, 1999; Rowe, 1990). Pachacuti's son, Topa Inca, established his royal estate at Chinchero and his grandson, Huayna Capac, in Urubamba. Machu Picchu is explored in Chapter 11, while the rest are among the sites examined with the field research presented in this chapter. All are well beyond the reach of the Cusco ceque system (Figure IV-1).

10.2 Chinchero

Chinchero is located at S13°-23.40'; W072°-02.78' and 3790 masl.

Motifs and Features: Chinchero is a multi-faceted complex and was found to exhibit carved rocks, light and shadow effects, solstitial orientations, cardinal orientations, stairs, seats, niches, a water source, basins, caves, altars, animal replica stones, channels, and terraces.

One of the first tasks before each new Inca was the establishment of his royal residence (Niles, 1999). Topa Inca, the son of Pachacuti, claimed the Chinchero valley as the site for his estate and soon set about construction of its palace, courtyard, support buildings and agricultural terraces. Also at the site are several intricately carved rock huacas. The style of architecture and design suggests a view of nature similar to that of Pachacuti, in which natural rock and landscape features were included in structural forms.

The sites of Pachacuti are steeped with solstitial orientations, but his son may have included a different construction philosophy. The many walls and terraces of the Chinchero complex are oriented cardinally, north-south and east-west. This in itself represents a significant astronomical effort as the cardinal direction of south would first have to be determined by the shadow plot of a vertical gnomon. North, east and west would then follow geometrically. Alternately, east and west might be traced on the day of an equinox. There is no record that the Inca's performed either of these exercises.

Chinchero was found to exhibit the most extensive cardinal orientations in my study, but Morris and Thompson (1985:60) tell of similar alignments at Huánaco Pampa. They describe an ushnu and gateways as being aligned approximately on an axis of 088° and mention this as being close to the direction of the equinox sunrise. Remains of a canal were found near the center of the gateways with a similar east – west orientation. Specific Inca interest in the equinoxes is subject to debate, however, as the Spanish chronicles make no mention of equinoctial observations on the horizon.

East-west cardinal alignments posed a recurring question for my research as they also align for the horizon positions of the rising and setting sun on days of the equinoxes. There is no historical record regarding Inca interest in such observations as there is for days of the solstices and the zenith and anti-zenith suns, but it still remains a possibility that this orientation was not lost upon them. The Incas may not have used equinox horizon observations with their calendar, but in a society that paid such close attention to the sun's position it would seem that they could have been aware of the days when the sun rose along these cardinal orientations. For that reason I include them in my study.

There are two major carved rocks; the first to the south of the plaza, Titikaka, has two carved stairways, one of which leads upward to the top of the rock through a cave with an axis approximately north and south. On the top there are a series of cut rectangular trays similar to those of Kenko and Lacco. To the southwest is a second large carved stone, Chinkana, containing an elaborate stairway, enclosures, altars, and carved trays. At its lower end is a flowing stream beneath carved teeth. A triangular basin opens approximately toward sunset on the December solstice. Above and to the south are carved stones known as Mesakaka and Kondorkaka. In contrast to the solstitial orientations of the Cusco valley, the majority of the features of Chinchero emphasize cardinal directions. Still, solstitial orientations are not totally absent. The two primary carved rock huacas, Titikaka and Chinkana lie near to the axis of the June solstice sunrise and December solstice sunset.

The primary entry to Chinchero opens onto a town plaza that serves as a market with a modern building situated on the edge of its lower western half. A Catholic chapel was built upon an earlier Inca structure on the eastern upper extreme. The upper and lower terraces of the plaza are separated by a retaining wall containing three doorways and twelve large niches (Figure 10-1). This wall is aligned with a true azimuth of 177.8°/357.8° along its length.

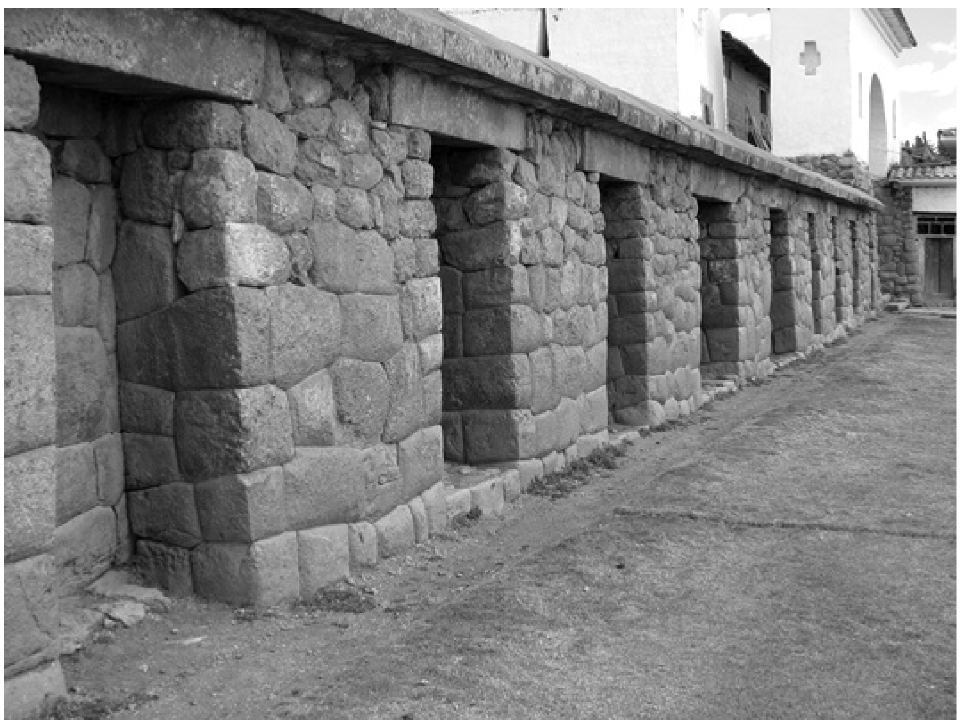

Figure 10-1: Town plaza retaining wall at Chinchero.

North of the town plaza and chapel are the remains of three rectangular structures oriented on a true azimuth of 087.8°/267.8° and beyond this is the great plaza that Gasparini and Margolies (1980) tell us is now called *Capallanpampa* (Figure 10-2). Their orientation is shown in Figure 10-3. Further to the east is an expansive system of agricultural terraces retained by walls of fine masonry. These walls are also oriented 087.8°/267.8° true and the carved rock huacas of Chinchero surround them.

Figure 10-2: East-west structural remains and the plaza of Capallanpampa.

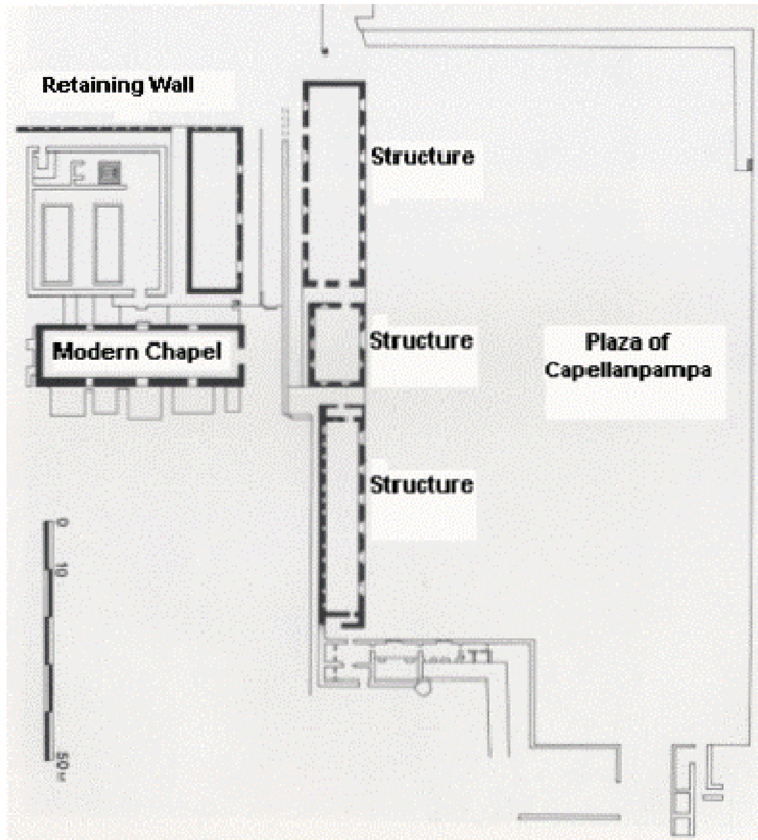

Figure 10-3: Plan of Chinchero (modified from Gasparini and Margolies, 1980).

10.2.1 Cardinal Orientations

I found many solstitial orientations at the sites examined in the Cusco region. Chinchero is different, however, in that it includes cardinal orientations of north-south and east-west. Solstitial orientations exist as well for the June solstice sunrise and December solstice sunset.

The palace, terraces, and structure walls near the plazas tend toward east-west and most features of Chinchero seem to demonstrate awareness by Topa Inca of this cardinality (Figure 10-4). Other walls are north-south and the huacas of Mesakaka and Kondorkaka are aligned south of the Chinkana stone. South may be related to the Incas' interest in the Southern Cross.

Figure 10-4: The long wall of this rectangular structure in Chinchero is oriented east-west, while the shorter is north-south.

It is possible to determine east-west at times of the equinoxes when a gnomon casts its shadow in these cardinal directions. Finding true south is perhaps even more definitive by tracking the gnomon’s shadow over a period of time and recording the endpoint of its midday position each day, as described in section 7.5. A parabolic curve is the ultimate result, and while the Incas likely did not recognize parabolas as such, they certainly would have been able to recognize the point in such a curve closest to the gnomon. A line drawn from the gnomon through this point is aligned directly with true south. East and west could then be found as being perpendicular with this south-north axis, but there is no historical reference of them using such techniques.

10.2.2 Solstitial Orientations

The two primary carved rock huacas of Chinchero, Titikaka and Chinkana, are approximately aligned on the axis of the June solstice sunrise and December solstice sunset (Figure 10-5). Both of these huacas are very large and were carved in situ. The existence of this orientation was not lost upon the Incas while developing this site.

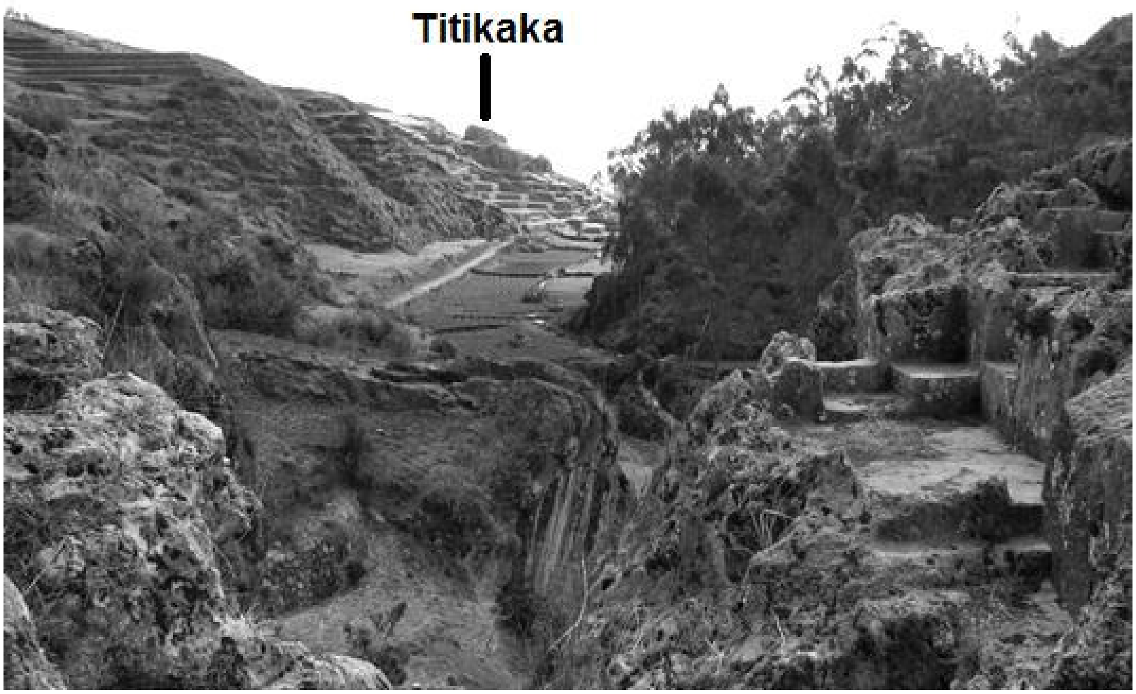

Figure 10-5: Titikaka and the direction of December solstice sunset as viewed from the top of Chinkana.

10.2.3 Zigzag Channel

Located near the main entrance to the town plaza is a carved zigzagged offertory/divinatory channel (Figure 10-6). It is reminiscent of the one found atop Kenko Grande, but this one might well have been transported from its original location. Liquids would have been poured into the cup on the upper side by the rock and then observed as they flowed to the opposite end.

Figure 10-6: The zigzagged channel at Chinchero.

10.2.4 The First Rock east of the chapel.

Once beyond the modern chapel heading to the east, the first carved rock exhibits a giant seat facing back to the southwest (Figure 10-7). The seat is oriented to a bearing of 253.0°, near enough to easily view the December solstice sunset, but the outcrop appears to exhibit no astronomically related orientations. The First Rock is located at S13-23.40°; W072-02.78° and 3790 masl.

Figure 10-7: The First Rock east of the chapel at Chinchero.

10.2.5 Kondorkaka

Continuing east and at the end of the upper terraces is a huaca called *Kondorkaka* (Figure 10-8). Kondorkaka is significantly eroded, but still exhibits carved seats facing generally north, northeast, and Nevado Chicon. Several seats were sculpted on this side of the outcrop, with one of them oriented to the mountain. Near the base are some carvings of animals. Kondorkaka is located at S13-23.35°; W072-02.61° and 3773 masl.

Figure 10-8: Kondorkaka.

10.2.6 Mesakaka

North of Kondorkaka and heading downslope is *Mesakaka* (Figure 10-9), a carved rock with many square tables or trays. In keeping with the predominant theme of Chinchero, these squares also are oriented on true azimuths of 001.3°/181.3° and 091.3°/271.3°. The view aligns perfectly to overlook Chinchero's central valley and sunsets on the western horizon (Figure 10-10). Immediately on Mesakaka's northern side is a smaller rock with a single seat. Mesakaka is located at S13-23-29°; W072-02.59° and 3744 masl.

Figure 10-9: Mesakaka.

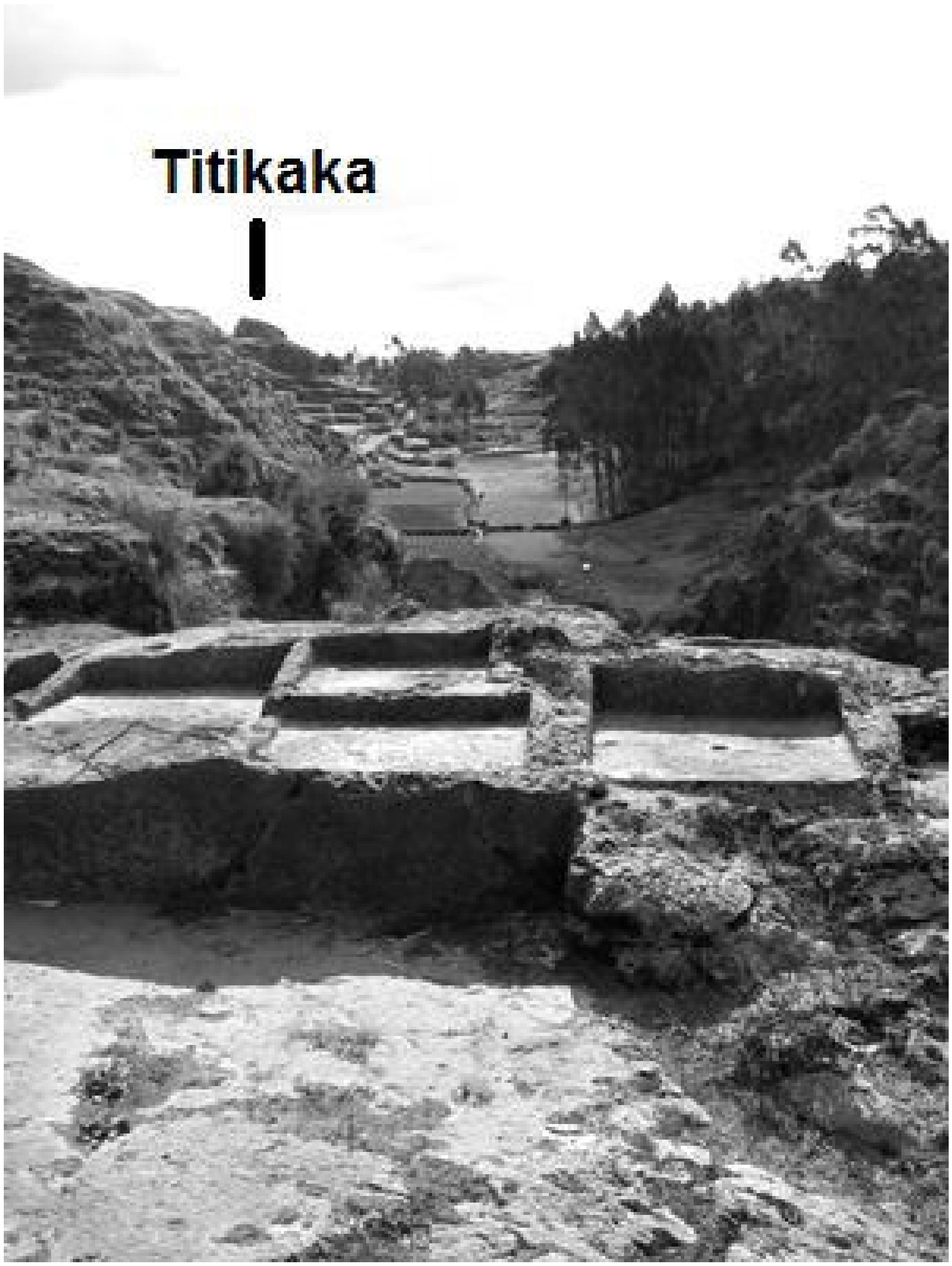

Figure 10-10: The western view from Mesakaka.

10.2.7 Chinkana

Chinkana is an outcropping of limestone and is one of the two principle huacas of Chinchero (Figure 10-11). Chinkana lies low on the eastern end of Chinchero's central valley and has been extensively carved on all sides with such as seats, stairs, shelves and niches. A stream was routed to pass beneath the base of the rock on its western side, likely to energize the huaca through camay (Figure 10-12). A niche by the creek faces 346.3° and a notch on the horizon that is inclined by 12.0° up. Chinkana faces Titikaka and the approximate direction of the December solstice sunset. Chinkana is located at S13°-23.27'; W072°-02.58' and 3724 masl. The short distance between the GPS coordinates of Chinkana and Titikaka may be a factor in the discrepancy between the GPS azimuth and true azimuth.

<u>GPS azimuth from Chinkana to Titikaka</u>

<u>Calculated azimuth of December solstice sunset from Chinkana</u>

<u>Measured azimuth from Chinkana to Titikaka</u>

GPS azimuth with Titikaka:	250.085°
Measured Azimuth:	248.0°
Magnetic Declination:	3.8° W
True Azimuth:	244.3°
Calculated DSSS Azimuth:	248.1°
Δ Calc DSSS Az & True Az:	0.5°
Δ GPS Az & True Az:	5.8°
Δ GPS AZ & Calc DSSS Az:	2.0°
Measured Inclination:	+10.0°

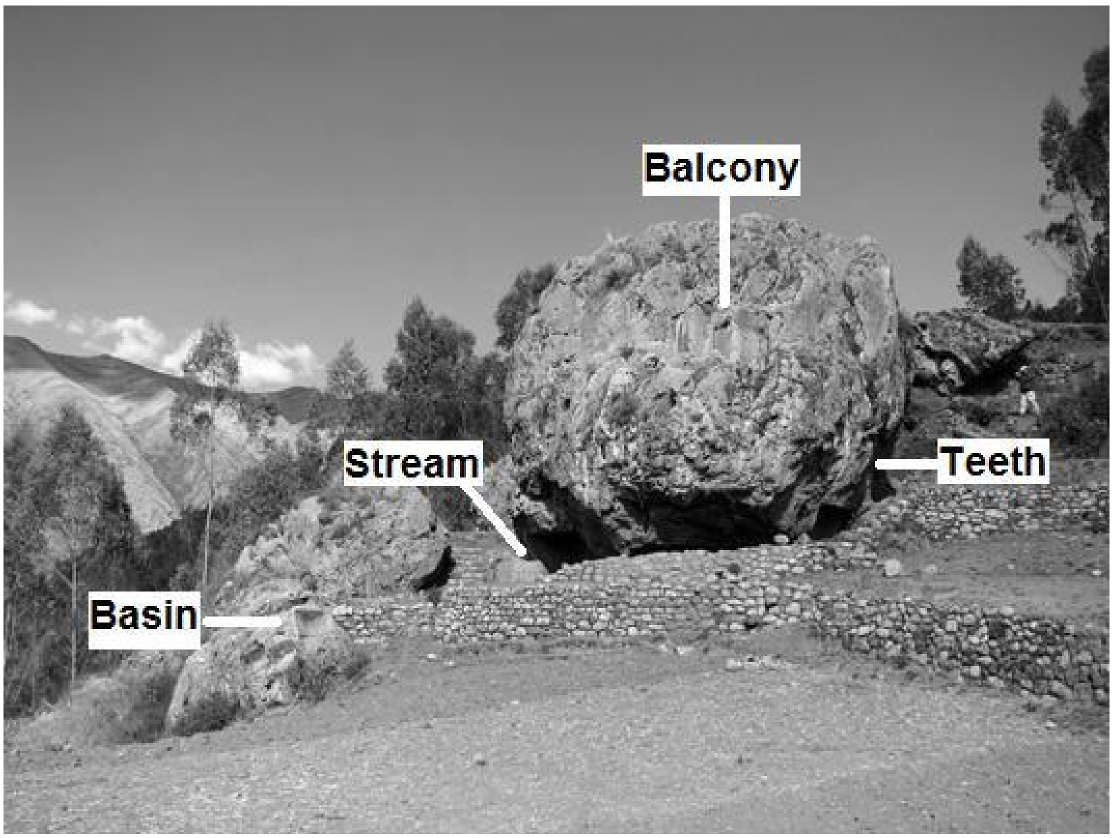

Figure 10-11: The western face of Chinkana.

Figure 10-12: A stream runs along the base of Chinkana to the right of a niche.

On Chinkana's lower northern face is carved a large but shallow niche with a row of what resembles teeth across its top (Figure 10-13). The niche is carved east-west and faces north. A functional staircase descends from the top of the huaca and winds from north around to the west as it descends to a balcony carved into the side of the stone. The balcony looks up the valley and faces 278.0° giving it a view of Chinchero sunsets.

Figure 10-13: A carving resembling teeth on Chinkana's northern face.

A triangular basin exists on a separate stone immediately northwest of Chinkana (Figure 10-14) and faces a 236.2° true azimuth. This is only a general orientation toward the December solstice sunset. A seat carved on top of Chinkana at its northern edge faces Nevado Chicon.

Figure 10-14: The triangular basin.

10.2.8 Titikaka

Approximately 360 meters west of Chinkana and north of the great plaza of Capallanpampa is Chinchero's largest carved outcrop, *Titikaka* (Figure 10-15). Titikaka displays many carvings including two prominent stairways, one external, and the other within a break in the center of the rock leading to its top (Figure 10-16). The central stairway exhibits figurative carving.

Figure 10-15: Titikaka.

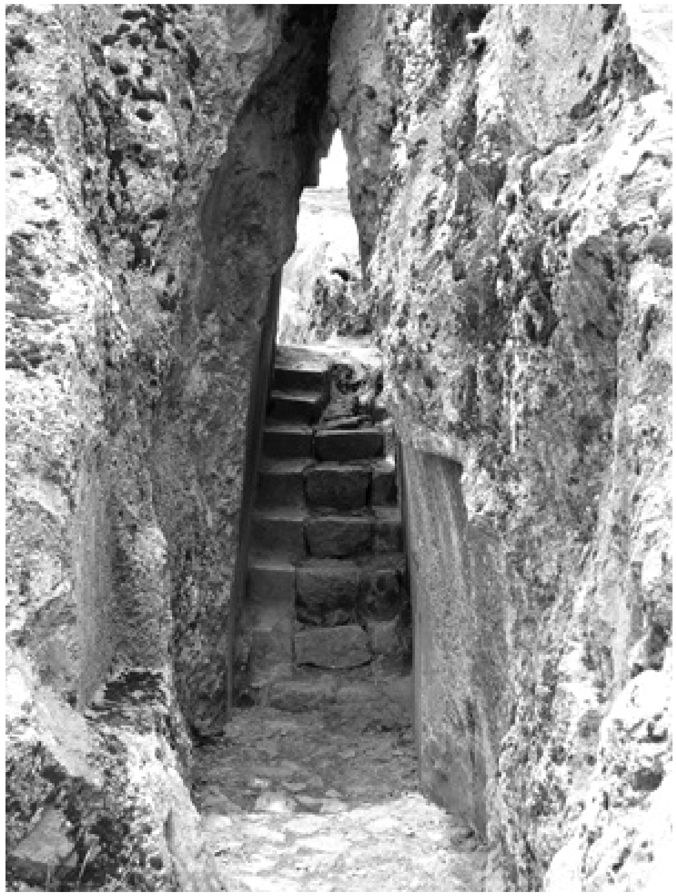

Figure 10-16: The central stairway of Titikaka.

The upper surface of the stone is extensively carved and displays several examples of seats or trays and animals such as a condor and a snake. Titikaka and Chinkana both lie on the approximate axis of the June solstice sunrise and December solstice sunset. There is a deep hole, perhaps to hold a pole for a textile banner, carved on the top of Titikaka that may have helped to mark this orientation. The bearing to Chinkana and the triangular basin as measured from this hole is near to the axis of the June solstice sunrise (Figure 10-17). Titikaka is located at S13°-23.35'; W072°-02.80' and 3753 masl. The short distance between the GPS coordinates of Titikaka and Chinkana may be a factor in the discrepancy between the GPS azimuth and true azimuth.

<u>GPS azimuth from Titikaka to Chinkana</u>

<u>Calculated azimuth of June solstice sunrise from Titikaka</u>

<u>Measured azimuth from Titikaka to Chinkana</u>

GPS azimuth with Chinkana:	070.085°
Measured Azimuth:	068.0°
Magnetic Declination:	3.7° W
True Azimuth:	064.3°
Calculated JSSR Azimuth:	064.5°
Δ Calc JSSR Az & True Az:	0.2°
Δ GPS Az & True Az:	5.785°
Δ GPS Az & Calc JSSR Az:	5.585°
Measured Inclination:	+5.0°

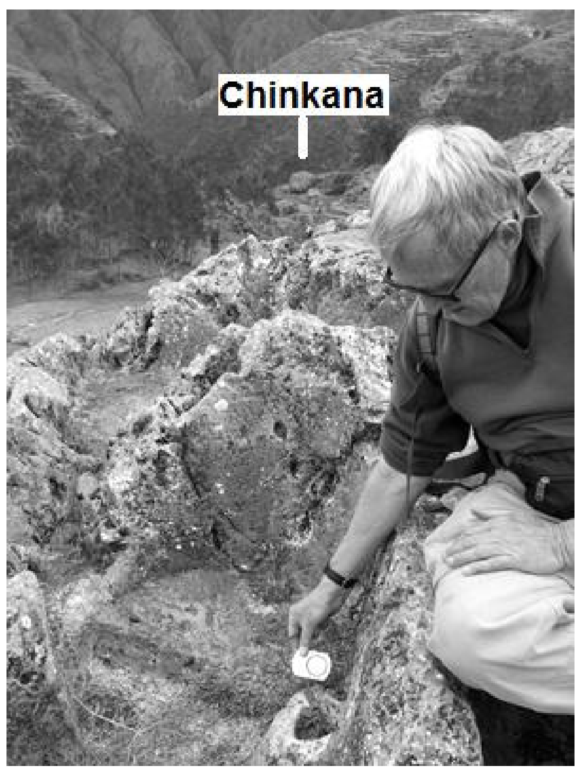

Figure 10-17: Chinkana aligns near to the June solstice sunrise as viewed from Titikaka. The hole is below the compass.

At the base of the rock, lower on the western side, are more carvings, a large crevasse and an opening to a shallow cave (Figure 10-18). The crevasse looks out on a 278.0° bearing and the cave opens to 254.5°. A large niche was carved near the mouth of the cave and looks out at 293.5°.

Figure 10-18: Crevasse and cave opening in Titkaka's lower western face.

10.3 Pisac

Pisac’s Intihuatana is located at S13°-24.86’; W071°-50.64’ and 3390 masl.

Motifs and Features: Pisac is a multi-faceted complex that exhibits carved rocks, light and shadow effects, solstitial orientations, niches, a water source, fountains, platforms, and curved-wall structures.

Seventeen kilometers northeast of Cusco and high above the Vilcanota River lay the ruins of Pisac, with its impressive mountainside terracing, its many examples of fine masonry, water channels, and a carved shrine known as the Intihuatana. Niles (1999) states that Pisac was established by Pachacuti in commemoration of his defeat of the Cuyos.

Sites known as intihuatanas, or “hitching places of the sun,” (Hemming and Ranney, 1982) are also found at Machu Picchu (see Figure 11-5), the Urubamba River near Machu Picchu (see Figure 11-23), and Tipon (see Figure 9-53) and possibly were places of solar worship. “Intihuatana” seems to be a modern term that first began to appear in the 19th century (see section 5.6). In Pisac the intihuatana is a large, partially carved rock in the temple group that is enclosed by a semi-circular masonry wall adjoining a straight masonry wall in the form of the letter “D” (Figure 10-20). It displays a small carved cylinder on its flat upper surface within the walled enclosure. Dearborn and Schreiber (1986: 24-25) say that the intihuatana at Pisac exhibits more of a resemblance to the upper structure of the Torreon (see section 11.2.3 and Figure 11-10) at Machu Picchu. Like the Torreon, Pisac’s intihuatana was built upon a rock prominence with a view to the east. If upper wall sections at Pisac did exist they are no longer extant. Dearborn and Schreiber (1986: 25) also describe an edge in the primary rock of Pisac’s intihuatana to have been carved with a June solstice orientation similar to the carved ledge on the rock in the Torreon. Bernard Bell (personal communication) states that design similarities between Pisac’s intihuatana and Machu Picchu’s Torreon also suggest similarities of function (Dearborn and Schreiber, 1986: 24-25). Evidence for such usage is not conclusive, but both have D-shaped curved structures and each has a flat edge oriented toward the June solstice (Bernard Bell, personal communication).

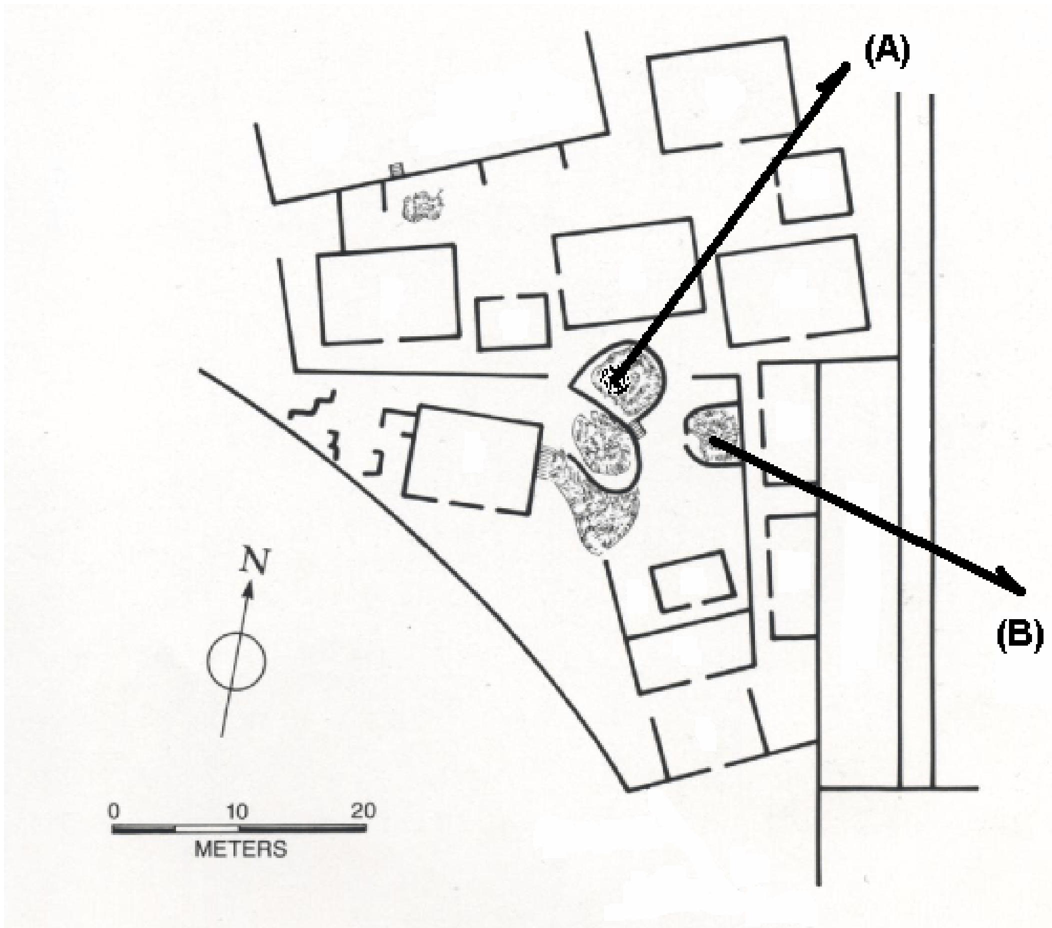

Figure 10-19: Plan of Pisac's Temple Group. (A) is the direction of the horizon point of June solstice sunrise from the Intihuatana. (B) is the direction of the horizon point of December solstice sunrise from the platform (modified from Hemming and Ranney, 1982).

Figure 10-20: The Intihuatana of Pisac.

Immediately to the east of the Intihuatana is a second rock enclosed by a circular wall. Bernard Bell (personal communication) relates this, too, as having an edge, in this case aligned for the direction of the December solstice sunrise. The intihuatana and this structure would then be noteworthy for their similarities with each other and with the Torreon. The alignment of edges at two different structures, one for each of the solstices, would serve to underscore the possibility of solar intent akin to that posited for the Torreon (Bernard Bell, personal communication).

While these similarities are clear for Bell, Dearborn and Schreiber they were not as distinct for me. The stone of Pisac's intihuatana is different from the one at the Torreon and Pisac's carved edges are much less pronounced. We also have no evidence that the curved walls at Pisac were ever high enough to have included windows similar to those in the Torreon. Even the use of a string and plum-bob in the Torreon's southeast window for the observance of June solstice sunrise has yet to be generally accepted. Multiple interpretations are valuable tools, however, and the hypothesis that Pisac shared similarities of design and solar usage with the Torreon is intriguing.

10.4 Quespiwanka

Quespiwanka is located at S13°-18.05’; W072°-06.71’ and 2934 masl.

Motifs and Features: Quespiwanka is a multi-faceted complex and was found to exhibit a sacred rock, solstitial orientations, niches, a water source, pillars, double and triple jambed doorways and structures.

Niles (1999) made a detailed study of Quespiwanka’s physical designs as they appear in the archaeological record. Huayna Capac began construction of Quespiwanka some time prior to A.D.1499, three to four years after the death of his mother. At that time he was involved in a military campaign against the Chachapoyas, and the design of his royal palaces was apparently left to one of his half-brothers, Lord Sinchi Roca.

The estate spanned the Yucay Valley combining some 20 separate properties of maize fields, including both the valley floor and agricultural terraces (Farrington, 1995). Farrington identifies three sectors: (A) an agricultural zone to the north, (B) the structural zone, and (C) the zone south of the palace where the remains of a reservoir have been found. The majority of the palace grounds consisted of a great plaza (in sector B), at the center of which was a large white granite boulder (Figure 10-21) and, as suggested by Niles (1999), a platform which has now been replaced by a modern chapel (Figure 10-22). The eastern wall of the plaza was an impressive sight with twin double-jambed gate houses, a large ramp and a triple-jambed entranceway. As Niles (1999) describes it, the architectural design of the eastern face of the palace was designed to impress whoever approached. Upon entering the main gateway a visitor would first see the huge plaza, perhaps empty except for the white boulder and its adjacent platform. The platform was in the geometric center of the plaza, along the center-line of the triple-jambed entry portal, and it seems likely that the precise placement of the palace and the plaza was established by the location of the boulder. Niles suggests that a channel was designed to carry water from an area in the north to the boulder and its platform. The white granite boulder is located at S13°-18.05’; W072°-06.71’ and 2934 masl.

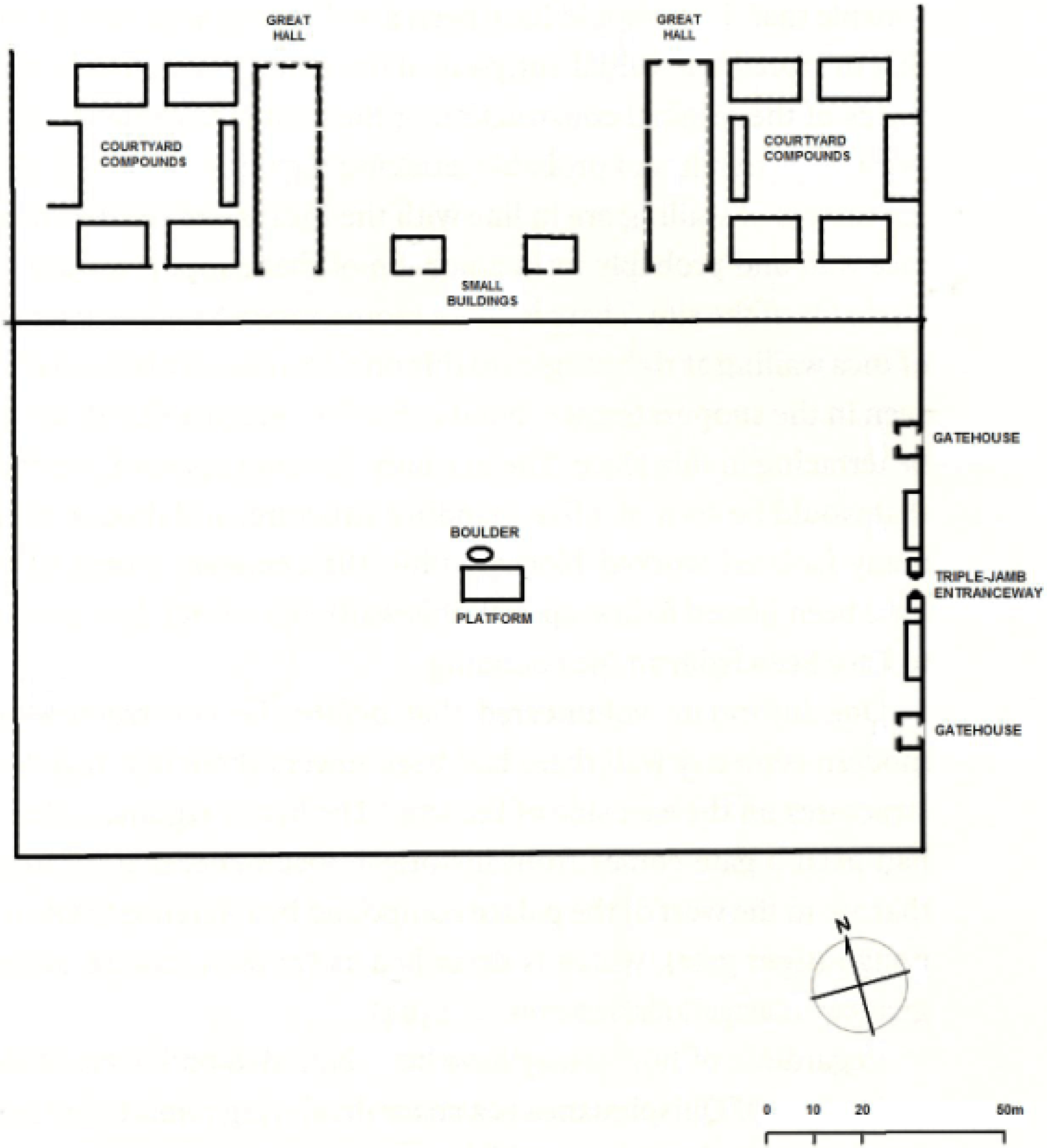

Figure 10-21: Plan of Sector B of Quespiwanka (modified from Niles, 1999).

10.4.1 Solar Pillars

On top of the Cerro Sayhua ridge (modern nomenclature) northeast of Quespiwanka there are two pillars long known to the inhabitants of the nearby modern village of Urubamba (Figure 10-23). There is ethno-historical description by Spanish chroniclers of similar pillars surrounding the city of Cusco (see chapter 8), but none of those structures remain. If Quespiwanka's pillars were similar in design and intent to those that have been reported on the horizons of Cusco, then they would be two of the only extant examples. Although known to the local community and identified by Bauer and Dearborn (1995: 69) as "useful examples of what Inca solar pillars may have looked like," the astronomical functions of these pillars had not been verified until recently. Zawaski in 2005 observed that the Urubamba pillars marked June solstice sunrise and I found in June 2007 that a large white granite boulder in the courtyard of Quespiwanka is approximately the point for viewing this phenomenon. The granite boulder may, in fact, be responsible for the Quechua name of the palace, Quespiwanka "meaning a shimmering or crystal sacred rock" (Farrington, 1995: 59). Stone-lined channels in the courtyard of Quespiwanka could have surrounded the boulder with water, and today a modern channel carries water past its flank. The boulder appears to be the approximate location for observing June solstice sunrise between the horizon pillars. Figure 10-24 shows the sun rising along the eastern pillar on 8 June 2008, nearing the end of a northward journey that culminates between the pillars at the time of the solstice. Theodolite measurements were through the courtesy of Mike Zawaski and his assistance in 2008.

<u>Theodolite azimuth from the boulder to the center between the pillars</u> (std dev 3')

<u>Calculated azimuth of June solstice sunrise from the boulder</u>

<u>Measured azimuth from the boulder to the center between the pillars</u>

Theodolite Azimuth	Center:	056.89°	Left Pillar: 056.58°	Right Pillar: 057.19°
Measured Azimuth:		061.0°		
Magnetic Declination:		3.8° W		
True Azimuth:		057.2°		
Calculated JSSR Azimuth:		056.5°		
Δ Theodolite Az & Calc JSSR Az:		0.39°		
Δ Theodolite Az & True Az:		0.31°		
Δ Calc JSSR Az & True Az:		0.7°		
Measured Inclination:		+24.0°		

Figure 10-22: The white granite boulder of Quespiwanka in front of a modern chapel.

Figure 10-23: The pillars on Cerro Sayhua.

Figure 10-24: Sunrise over the Cerro Sayhua pillars as viewed from Quespiwanka's white boulder on 8 June 2008. On this date the sun rises at 057.3° and will move left 0.8° to 056.5° for the standstill. The pillars are 0.6° apart and the solstice sun will rise over the left pillar when viewed from the boulder.

The granite boulder sits near the center of the ancient plaza and immediately adjacent to the modern chapel which Niles (1999: 173) suggests was the location of Quespiwanka's platform. As described in Figure 10-24 the June solstice sun will rise over the left tower when viewed from the boulder. To center the sun between the pillars the solstice sunrise would be viewed to the left of the boulder. It remains uncertain as to whether the sunrise was viewed between the pillars or over the left pillar with the right pillar serving as a warning of the upcoming standstill. The granite boulder is 5.15 meters long, 3.73 meters wide and 2.47 meters high.

Natural features on the ridgeline alone might have been sufficient for priests to determine the time of the approaching solstice. Construction of the towers underscores the importance that the Incas placed on the June solar event and the significant role that this site may have played in their ritual. The pillars might have been designed as a visual element of Inti Raymi ceremonies held below.

The pillars are 35.3 meters apart on either end of a level terrace and are constructed of sandstone (Figure 10-25). They are aligned with each other on an azimuth of 101.5° at an elevation of approximately 3860 meters. The eastern pillar has a height of 4.3 meters and a base 1.5 meters by 3.3 meters; the base of the partially restored western pillar is 1.5 meters by 3.4 meters (Zawaski, 2007).

Figure 10-25: The eastern pillar above Quespiwanka.

10.4.2 Viewing from the south wall of the palace

Quespiwanka’s courtyard may not have been an area intended for public ceremonies because the palace’s eastern wall contains a massive triple-jambed doorway (Figure 10-26) surrounded by two double-jambed gatehouses. Inca doorways with multiple jambs typically marked entry into a space used only by elites (Niles, 1999: 295). Cobo (1990 [1653]: 96] describes elite pilgrims as having to satisfy multiple conditions before being allowed to get close to the sacred rock on Lake Titicaca’s Island of the Sun. The courtyard in Quespiwanka may have been similar to the sanctuary of the Island of the Sun with non-elites being barred from entry (Dearborn, Seddon, and Bauer, 1998).

Figure 10-26: Remains of the triple-jambed entranceway in Quespiwanka’s eastern wall.

June solstice sunrise, however, would have also been viewable from outside the southern wall of the palace. The wall is oriented on a true azimuth of 108.2°/288.2° and Niles (1999) suggests that there were 40 double-jambed niches along its 190 meter length (Figure 10-27). The wall faced an artificial lake and large granite boulders. This area may have been used for public viewing as a place where pilgrims and non-elites were allowed to observe the solstice sunrise between the pillars in a manner similar to ceremonies held on the Island of the Sun (Dearborn, Seddon, and Bauer, 1998). As with the platform alignments at the Island of the Sun, the public viewing area for the June solstice sunrise outside of Quespiwanka might have been designed to feature the sun rising over Huayna Capac, the ruling Inca and son of the sun, perhaps as he stood upon the platform proposed by Niles. This photo was taken on 8 June 2008 (Figure 10-28). A potential viewing location outside the southern wall is at S13°-18.08'; W072°-06.78' and 2922 masl.

<u>Calculated azimuth of June solstice sunrise from the point near the west end of the wall</u>

<u>Measured azimuth from the point near the west end of the wall to the center between the pillars</u>

Measured Azimuth:	061.5°
Magnetic Declination:	3.8° W
True Azimuth:	057.7°
Calculated JSSR Azimuth:	057.0°
Δ Calc JSSR Az & True Az:	0.7°
Measured Inclination:	+23.0°

Figure 10-27: Quespiwanka's southern wall.

Figure 10-28: The rise of the June solstice sun over the pillars and southern wall.

A potential third site for the June solstice solar ceremonies was the 40 meter-long terraced platform that was built between and around the pillars. Retaining walls, which are approximately one meter high, are on its northern and southern sides. Both ends of the sightline connecting the palace and the pillars appear to have been huacas. As part of the celebration a group of celebrants would have climbed the 950 meters from the valley to the platform where they could place offerings, make sacrifices, and celebrate the passage of the sun as it traveled across the sky from dawn to dusk.

The question arises as to how the Urubamba pillars escaped the Catholic extirpation of idolatries that destroyed the pillars of Cusco. It could be said that they were relatively modest features on the high horizon and escaped detection from below.

10.4.3 Other Orientations

The white granite boulder in Quespiwanka's courtyard may also have been situated for other solar orientations with respect to natural features. The boulder is situated to approximately observe the December solstice sun to rise on the horizon near the 12 km-distant peak of Cerro Unoraqui (Figures 10-29). The photo in Figure 10-30 was taken on 20 December 2008. Cerro Unoraqui is discussed further in section 10.6 of this chapter. On the day of the December solstice the sun will rise 2.4° to the right of the peak. The following azimuths show that over the 12 km distance the compass and the theodolite readings were only 7' apart.

As a possible solstice marker Cerro Unoraqui was not as precise as the pillars on Cerro Sayhua. The mountain is too distant to be practical for for calendrical use, but could have served as a symbolic marker for the approximate rising point of the sun. Remains exist of what may have been two walls on the Cerro Pumahuachana Ridge (see section 10.5) in the foreground of Figure 10-29. These could have played a possible role in a December solstice observance. These theodolite measurements were also through the courtesy and assistance of Mike Zawaski.

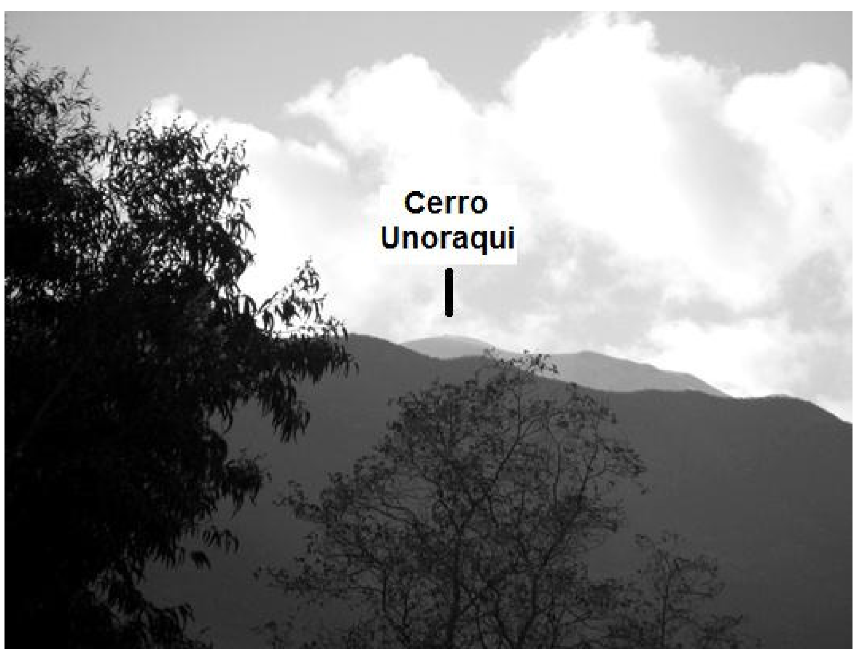

Figure 10-29: Cerro Unoraqui as viewed from Quespiwanka. Cerro Pumahuachana is the ridgeline in the foreground.

Theodolite azimuth from the boulder to the Cerro Unoraqui mountaintop (std dev 3')

GPS azimuth from the boulder to the Cerro Unoraqui mountaintop

Calculated azimuth of December solstice sunrise from the boulder

Measured azimuth from the boulder to the Cerro Unoraqui mountaintop

Theodolite Azimuth	110.277°
GPS Azimuth	110.7°
Measured Azimuth:	114.0°
Magnetic Declination:	3.6° W
True Azimuth:	110.4°
Calculated DSSR Azimuth:	112.7°
Δ Theodolite Az & True Az:	0.1°
Δ GPS Az & True Az:	0.3°
Δ Theodolite Az & GPS Az:	0.4°
Δ Theodolite Az & Calc DSSR Az:	2.4°
Δ GPS Az & Calc DSSR Az:	2.0°
Δ Calc DSSR Az & True Az:	2.3°
Measured Inclination:	+6.0°

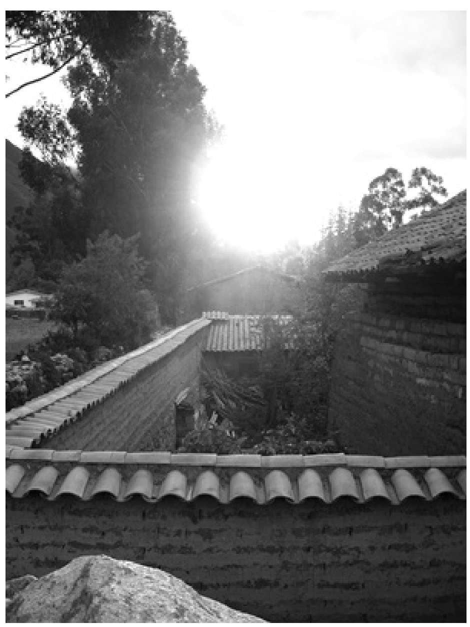

Figure 10-30: December solstice sunrise in the direction of Cerro Unoraqui as viewed from Quespiwanka's white boulder.

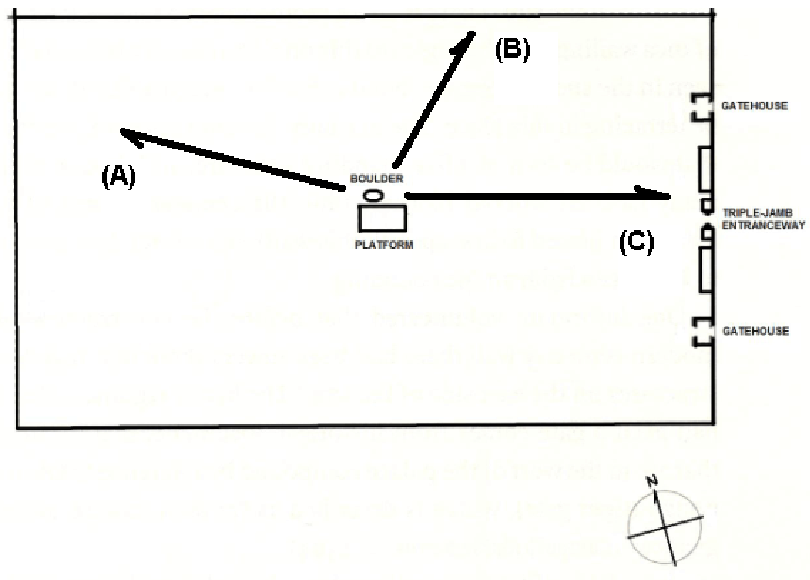

Figure 10-31: Orientations from Quespiwanka's boulder for the June solstice sunset (A), the June solstice sunrise (B), and the December solstice sunrise (C) (modified from Niles, 1999).

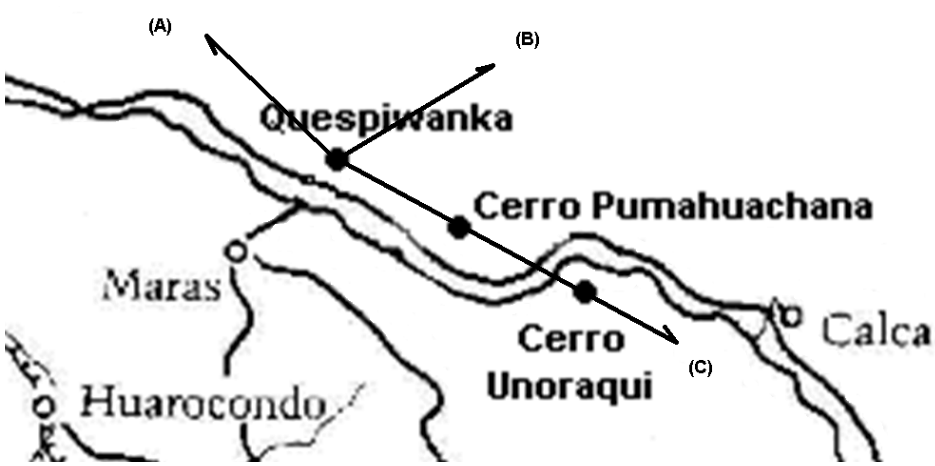

Figure 10-32: The orientation of Cerro Unoraqui as viewed across Cerro Pumahuachana from Quespiwanka in the direction (C) of the December solstice sunrise. (B) is the direction of the June solstice sunrise and (A) the June solstice sunset (modified from Hemming and Ranney, 1982).

The sun sets over a nearby peak on 7 June 2008 when witnessed from Quespiwanka's white boulder (Figure 10-33). Natural features on the mountain could have made the point of sunset predictable, but are subtle enough to remain inconclusive. There is no evidence, however, of Inca interest in this June solstice sunset observation.

<u>Calculated azimuth of June solstice sunset from the boulder</u>

<u>Measured azimuth from the boulder to the mountain</u>

Measured Azimuth:	298.0°
Magnetic Declination:	3.6° W
True Azimuth:	294.4°
Calculated JSSS Azimuth:	295.5°
Δ True Az & Calc JSSS Az:	1.1°
Measured Inclination:	+5.0°

Figure 10-33: June solstice sunset from Quespiwanka's white boulder.

I also examined the horizons around Quespiwanka for potential natural features marking the solar horizon positions of the December solstice sunset, equinox sunrise, equinox sunset, zenith sunrise and anti-zenith sunset. In each case a subtle landscape feature on the horizon could have identified the event, but none of the features stood out enough to support such usage.

<u>Calculated azimuth of December solstice sunset from the boulder</u>

<u>Measured azimuth from the boulder to a slightly raised terrain feature on the horizon</u>

Measured Azimuth:	250.0°
Magnetic Declination:	3.6° W
True Azimuth:	246.4°
Calculated DSSS Azimuth:	247.1°
Δ True Az & Calc DSSS Az:	0.7°
Measured Inclination:	+5.0°

<u>Calculated azimuth of equinox sunrise from the boulder</u>

<u>Measured azimuth from the boulder to a raised terrain feature on the horizon</u>

Measured Azimuth:	090.0°
Magnetic Declination:	3.6° W
True Azimuth:	086.4°
Calculated ESR Azimuth:	087.0°
Δ True Az & Calc ESR Az:	0.6°
Measured Inclination:	+14.0°

<u>Calculated azimuth of equinox sunset from the boulder</u>

<u>Measured azimuth from the boulder to a raised terrain feature on the horizon</u>

Measured Azimuth:	273.0°
Magnetic Declination:	3.6° W
True Azimuth:	269.4°
Calculated ESS Azimuth:	270.8°
Δ True Az & Calc ESS Az:	1.4°
Measured Inclination:	+5.0°

<u>Calculated azimuth of sunrise from the boulder on the day of the zenith sun</u>

<u>Measured azimuth from the boulder to a raised terrain feature on the horizon</u>

Measured Azimuth:	106.0°
Magnetic Declination:	3.6° W
True Azimuth:	102.4°
Calculated ZSR Azimuth:	103.1°
Δ True Az & Calc ZSR Az:	0.7°
Measured Inclination:	+4.0°

<u>Calculated azimuth of sunset from the boulder on the day of the anti-zenith sun</u>

<u>Measured azimuth from the boulder to a slightly raised terrain feature on the horizon</u>

Measured Azimuth:	287.0°
Magnetic Declination:	3.6° W
True Azimuth:	283.4°
Calculated AZSS Azimuth:	284.9°
Δ True Az & Calc AZSS Az:	1.5°
Measured Inclination:	+5.0°

10.5 Cerro Pumahuachana

The center of Cerro Pumahuachana is located approximately at S13°-19.03'; W072°-03.92' and 3575 masl.

Motifs and Features: Cerro Pumahuachana is a ridge that was found to exhibit structural remains and is situated along a sightline between Quespiwanka and Cerro Unoraqui.

Cerro Pumahuachana looms above the village of Yucay and the palace of Sayri Tupac. The ridge is oriented approximately on a bearing of 025.0°/205.0° (Figure 10-34) and includes the remains of two stone wall segments. A modern chapel is located on a crag above the ridge's northern end. What is extant of these walls is at ground level and stretches over 200 meters along the top of the ridgeline. Local villagers relate that rocks from the walls were taken to the site of the chapel and were used in the construction of its base. While this chapel is modern, it may have been built on a site that was of interest to the Incas (Figure 10-35). As of yet such historical evidence has not been found.

Figure 10-34: Cerro Pumahuachana.

Figure 10-35: Chapel on the crag of Cerro Pumahuachana.

The chapel is clearly visible through the southern double-jambed gate house at Quespiwanka (Figure 10-36) and would be as well through the triple-jambed entrance if the view were not blocked by trees. Relatively little remains of the northern gate house.

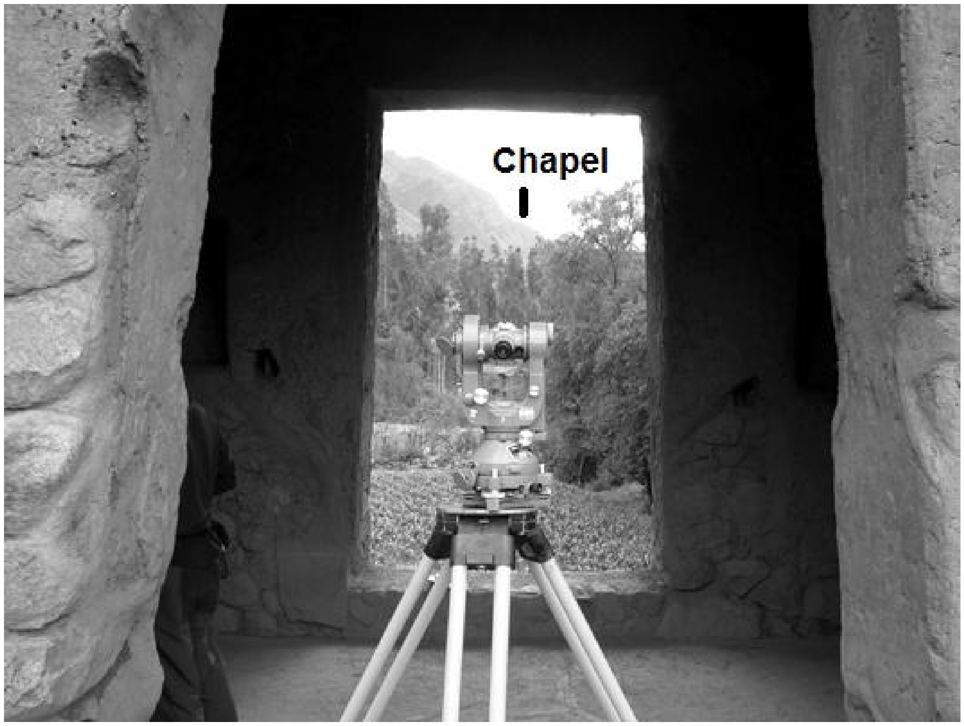

Figure 10-36: The chapel as viewed through the southern double-jambed gate house.

When Cerro Unoraqui is viewed from the white boulder at Quespiwanka the line of sight crosses Cerro Pumahuachana (see Figure 10-29). The four ends of the two sections of wall remains are at GPS azimuths from the boulder of 109.11°, 109.82°, 110.56° and 110.64°. Cerro Unoraqui's GPS azimuth from the boulder is 110.73°. The north wall is 66 meters long and the south wall is 19.4 meters in length. There is an 85 meter gap between the two wall segments. The crag and chapel are several hundred meters to the left of the sightline between the white boulder and Cerro Unoraqui.

North Wall – North End: S13° 18.987' W072° 03.930' 3592 masl
North Wall – South End: S13° 19.028' W072° 03.921' 3575 masl
South Wall – North End: S13° 19.071' W072° 03.912' 3572 masl
South Wall – South End: S13° 19.078' W072° 03.904' 3568 masl

10.6 Cerro Unoraqui

Cerro Unoraqui's pillars are located at S13-20.36°; W072-00.44° and 4377 masl.

Motifs and Features: Cerro Unoraqui is a mountain that was found at its peak to exhibit pillars with a north-south orientation. It is on a sightline near to the December solstice sunrise as viewed from Quespiwanka.

Cerro Unoraqui is a 4377 masl peak on the southern side of the Urubamba River between Yucay and Calca (Figure 10-37). The mountain first drew my attention while examining the points of solar horizon events from the white boulder at Quespiwanka. Cerro Unoraqui was approximately oriented for the December solstice sunrise across the Cerro Pumahuachana Ridge and was a natural feature that could have been used to help locate the event. Through binoculars the mountain appeared to have structures on top that bore closer investigation.

Figure 10-37: Cerro Unoraqui from Cerro Pumahuachana.

We climbed to the summit and found three rock pillars. Local villagers claim that the site of the pillars was first established in the time of the Incas (Figure 10-38). The pillars are encircled by a low stone wall and are oriented on a true azimuth of 178.6°/358.6° with respect to one another. Such north and south orientations may possibly relate to Inca interest in the Southern Cross and certain Inca dark constellations within the Milky Way.

Figure 10-38: Pillars on top of Cerro Unoraqui.

The wall around the pillars is oval in shape with its longer axis 10.70 meters and the shorter 7.80 meters. The walls of the oval average 0.80 meters in height. From south to north each pillar is on slightly higher ground. The south pillar has a base of 1.60 meters and is 1.73 meters high. The mid pillar's base is 1.80 meters and its height is 1.70 meters. The north pillar is 2.30 meters wide and 2.20 meters high. The north and mid pillars are 1.10 meters apart and there are 0.70 meters between the mid and south pillars. The north and south pillars are each 1.60 meters from the oval wall along its long axis. On the short axis mid pillar is 4.20 meters from the east wall and 3.60 meters from the west. With regard to these rock and mud pillars on top of Cerro Unoraqui, Ian Farrington (personal communication) noted that they look like what he would expect for the core of pillars that have had their exterior stones removed for other purposes. Quespiwanka is on a 290.316° GPS azimuth from the peak of Cerro Unoraqui.

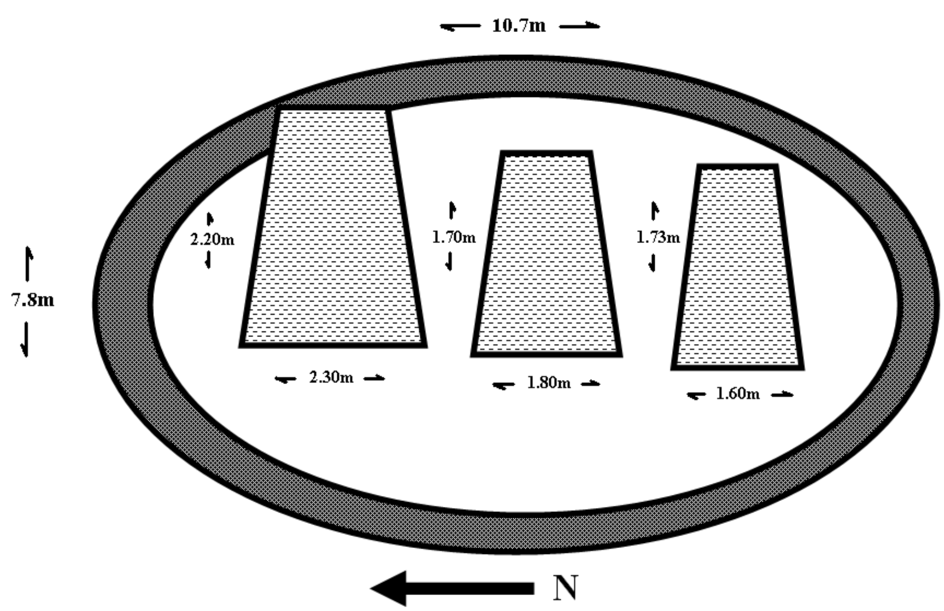

Figure 10-39: Plan of Cerro Unoraqui Pillars.

Dominating Cerro Unoraqui's northern horizon is the Cordillera Urubamba, including the 5530 meter Nevado Chicon and the 5818 meter Nevado Ccolque Cruz (Figure 10-40).

Figure 10-40: Cerro Unoraqui pillars aligned north-south.

10.7 Choquequilla

Choquequilla is located at S13°-17.53'; W79°-13.93' and 3627 masl.

Motifs and Features: Choquequilla is a complex that was found to exhibit a carved rock, a solstitial orientation, niches, a water source, a cave and terraces.

Above the Rio Huarocondo, 5 km southeast of Ollantaytambo and 14 km west of Urubamba, are the ruins of Choquequilla. This remote huaca lies within the mouth of a cave opening to the approximate direction of the December solstice sunrise. The intricately carved shrine faces inward toward the cave, away from the horizon, and is flanked to the south by a wall constructed with two rows of four double-jambed niches, emphasizing the site's significance. The roof of the cave is formed by two relatively flat stone faces that form an inverted "V" (Figure 10-41). Light from the December solstice sun as it rises above the opposing horizon brightly illuminates the cave and huaca.

Figure 10-41: The cave of Choquequilla.

The cave is situated on the mountainside above agricultural terraces that have fallen into disuse. A central staircase ascends the terraces and at the top a trail proceeds north to the cave. A small masonry structure with a door and windows is situated immediately to the cave's north. The carved rock of black granite (Figure 10-42) is said to be among the finest examples in existence and exhibits great symmetry and exquisite carving (Paternosto, 1996). The sculpting greatly resembles that of the Baño de la Ñusta at Ollantaytambo (Figure 10-50), but the Choquequilla rock was damaged by looters.

Figure 10-42: The carved black granite rock and wall with niches at Choquequilla.

Paternosto (1998: 89) calls this "the cave of *Choqequilla*, the Golden Moon," and Van de Guchte (1990: 191) calls it the "Moon Temple" of Choquequilla. The cave opens to the December solstice sunrise and the carved stone is slightly offset at 130°. The horizon is inclinated +32.0°. The rise of the sun on 20 December 2008 illuminates the cave brightly (Figure 10-43). The light of a rising moon could create a dramatic effect.

<u>Calculated azimuth of December solstice sunrise from the cave</u>

<u>Measured azimuth through the inverted V in the cave's roof to the horizon</u>

Measured Azimuth:	114.0°
Magnetic Declination:	3.6° W
True Azimuth:	110.4°
Calculated DSSR Azimuth:	109.5°
Δ True Az & Calc DSSR Az:	0.9°
Measured Inclination:	+32.0°

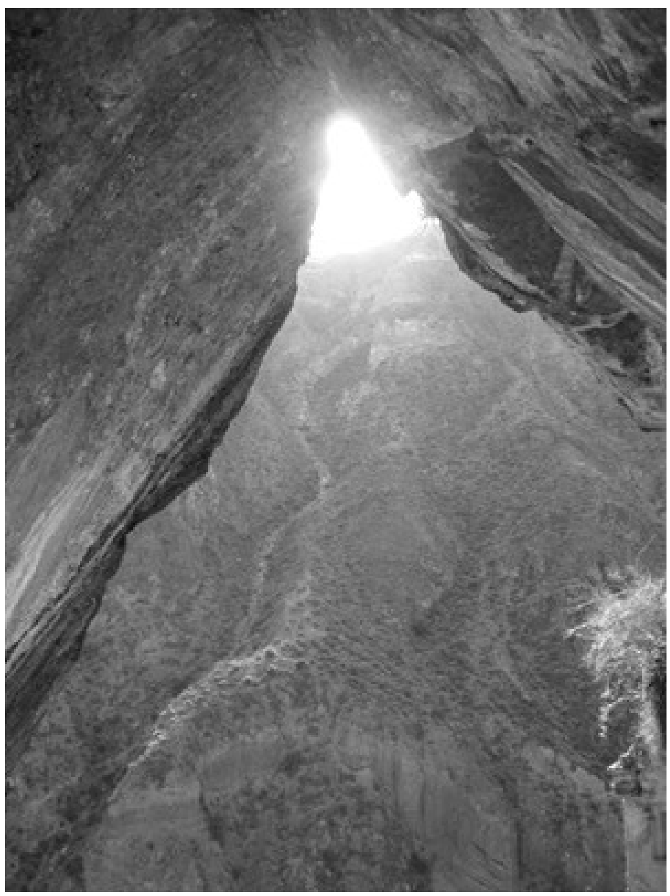

Figure 10-43: The December solstice sunrise is oriented to brightly illuminate Choquequilla's cave.

10.8 Ollantaytambo

Ollantaytambo is located at S13°-15.95’; W072°-16.03’ and 2818 masl.

Motifs and Features: Ollantaytambo is a multi-faceted complex that was found to exhibit carved rocks, light and shadow effects, solstitial orientations, zenith orientations, seats, a water source, fountains, gnomons, structures and terraces.

Ollantaytambo is located about 90 km from Cusco in the Urubamba River valley. Niles (1999) states that Pachacuti developed the area after defeating the Tambos and that both Huayna Capac and Manco Inca made subsequent improvements. This was the site of one of the few great victories of the Incas over the Spaniards when Manco Inca had the plain below flooded, thus miring the conquistadors’ invading horses (Hemming and Ranney, 1982).

10.8.1 Terraces

The most striking feature when first approaching Ollantaytambo is a magnificent set of 17 stone terraces that ascend the hillside (Figure 10-44). The extensive terraces of Pumatillis face out to the rise of the December solstice sun and, in the opposite direction, face in toward and frame nicely the June solstice sunset. A staircase begins right of center and continues along the left side of the terraces. The terraces would have provided an excellent platform for a large group of people to view the sunrise during the time of Capac Raymi.

Figure 10-44: The terraces of Pumatillis at Ollantaytambo.

10.8.2 Temple of the Sun

What is known as Ollantaytambo's Temple of the Sun (Figure 10-45) was extensively damaged by the Spanish in their purge of indigenous religion, however a foundation and a wall of six monoliths survives (Hemming and Ranney, 1982). The wall faces the Pinkuylluna mountain (see Figure 10-47), which from this location is close to the orientation of the rise of the June solstice sun. The exact purpose for viewing the solstice sunrise from this vantage point remains uncertain. The photo in Figure 10-46 was taken from the plaza below the terraces on 20 June 2007.

Figure 10-45: Ruins known as the Temple of the Sun.

Figure 10-46: June solstice sunrise over the Pinkuylluna mountain.

10.8.2 Pinkuylluna Mountain

The Pinkuylluna mountain (Figure 10-47) lies opposite Ollantaytambo to the northeast and aligns with the June solstice sunrise as viewed from the Temple of the Sun. The mountain exhibits two structures and a face on its side (Figure 10-48).

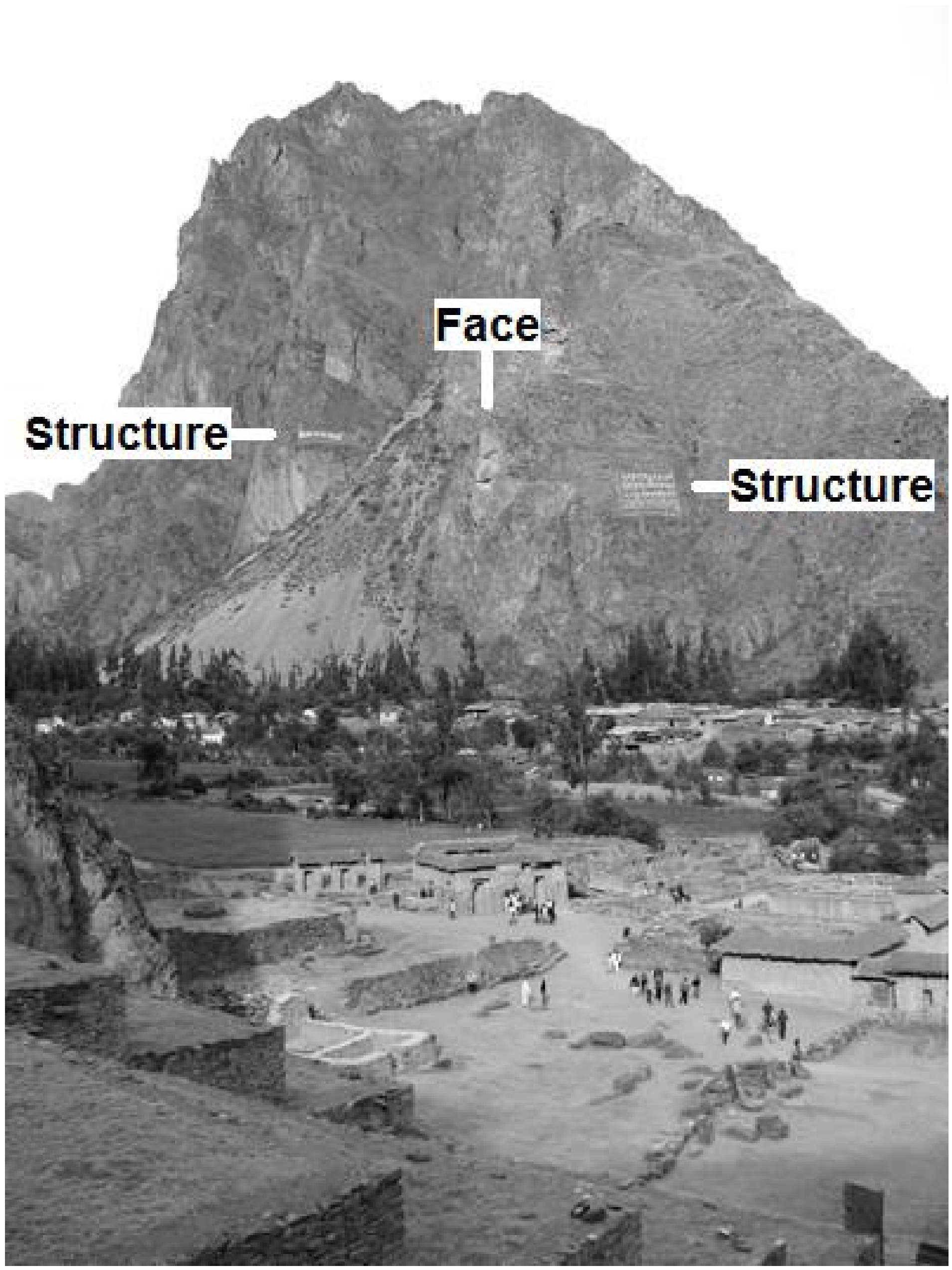

Figure 10-47: Pinkuylluna mountain.

Figure 10-48: The face on Pinkuylluna mountain.

10.8.4 Incamisana

Paternosto (1996) says while the Temple of the Sun was the primary site for ceremony in Ollantaytambo's hanan, or upper, sector, that the Incamisana was its ceremonial counterpart in the lower hurin sector (Figure 10-49). Horizontal gnomons project distinct shadow effects at two times of solar significance. My field assistant, Carlos Aranibar, related that at the time of the equinoxes a face is projected toward the lower left in shadow by the gnomons and rock. The face is said to be that of a man playing a *quena*, or flute. On the December solstice at local noon the shadow of one of the gnomons is said to reach down and "insert" itself to fill a carved triangular notch in the base below. At the time of the zenith sun the shadows of the three lower gnomons are said to touch each of the three lower steps.

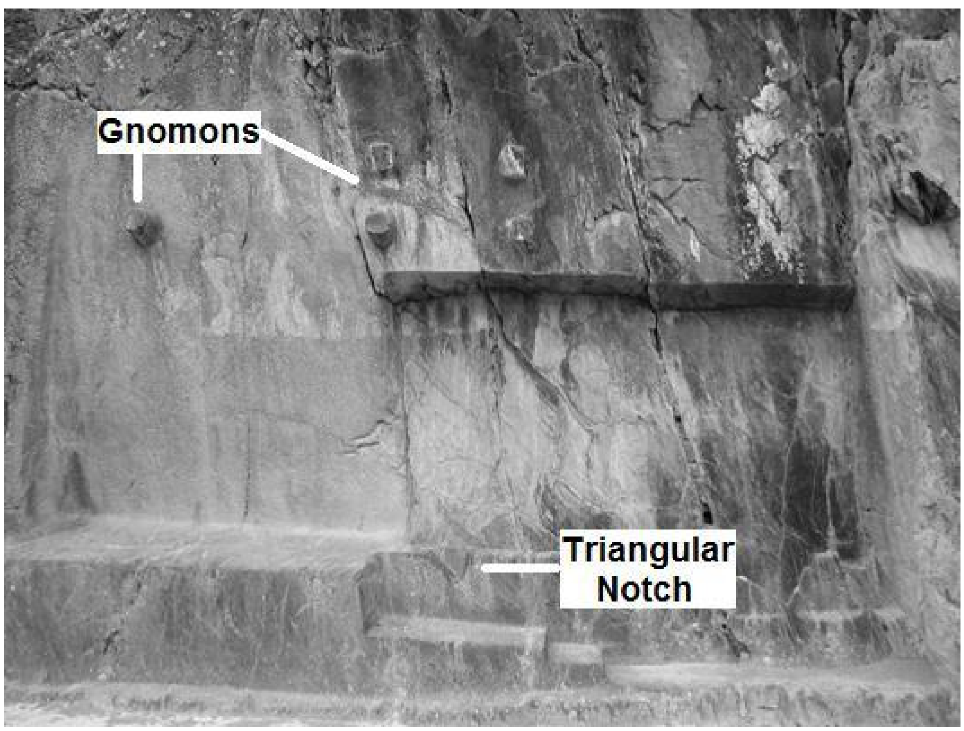

Figure 10-49: The horizontal gnomons of the Incamisana.

10.8.5 Bañjo de la Ñusta

The Bañjo de la Ñusta, or "Bath of the Princess," is a striking fountain set in Ollantaytambo's lower urban sector (Figure 10-50). Ollantaytambo contains many water channels and fountains and the Bañjo de la Ñusta is noteworthy for its sculptural similarity with the 5 km-distant black granite rock at Choquequilla (Figure 10-42).

Figure 10-50: The Bañjo de la Ñusta

10.9 Summary

In my research of sites in the Sacred Valley I continued to find examples of astronomical orientations. Chinchero's many masonry walls exhibit cardinal orientations of north and south that may have been determined by astronomical means. The site's two major huacas also take advantage of an orientation for the June solstice sunrise and December solstice sunset. The significant interest in this sunset is evidenced by a balcony carved on Chinkana that faces it, by a nearby triangular basin that is appropriately aligned, and by the shelves or trays of Mesakaka that are oriented in this direction as well.

Pisac displays a carved stone called the Intihuatana that has a cylindrical carving on its top and an edge said to be aligned for the June solstice sunrise. A nearby platform has a potential orientation with the rise of the sun on the December solstice. Bernard Bell suggests that both bear similarity to the Torreon of Machu Picchu.

The finely carved huaca of Choquequilla is located in the mouth of a cave that is oriented with the December solstice sunrise and is brilliantly illuminated at that time. Ollantaytambo's outstanding terraces of Pumatillis align for the December solstice sunrise and June solstice sunset, while the site's Temple of the Sun is oriented for a commanding view of the June solstice sunrise over the nearby Pinkuylluna mountain. The gnomons of Ollantaytambo's Incamisana exhibit interesting shadow effects.

The most significant astronomical orientation in the Sacred Valley, however, is that of the solar pillars above Quespiwanka. These structures are extant examples of a type of horizon astronomy reported in the Spanish chronicles to have existed around Cusco. The pillars are aligned so that the sun will rise over them on the morning of the June solstice as viewed from the vicinity of the palace's white granite boulder. It is also possible to view the December solstice sunrise over the distant Cerro Unoraqui from this same location. Non-elites may have viewed the June sunrise from a separate location outside the palace's southern wall as entry to the main plaza would have been restricted to elites only by virtue of the double and triple jambed entries.

Chapter 11

Machu Picchu Region

11.1 Introduction

Machu Picchu has been variously described as a Citadel (Bingham, 1930), a Lost City (Bingham, 1948), a royal estate (Rowe, 1990), and a sacred center (Reinhard, 2002). Machu Picchu was recognized by the Incas as a place of power, inpart because of its many granite outcrops and caves and the cardinality of mountains such as Veronica, Huayna Picchu, Pumasillo, and the snow peak of Salcantay. Salazar (2004) notes the large number of shrines at Machu Picchu, similar to the huacas that surround Cusco, and acknowledges that there are more such shrines at Machu Picchu than are found at other royals estates such as Pisac, Chinchero, Huamanmarcha, and Callachaca.

Machu Picchu may also have been the focal point of a regional pilgrimage center that included Llactapata (Figure 11-1). Pilgrimage is discussed in section 5.17.

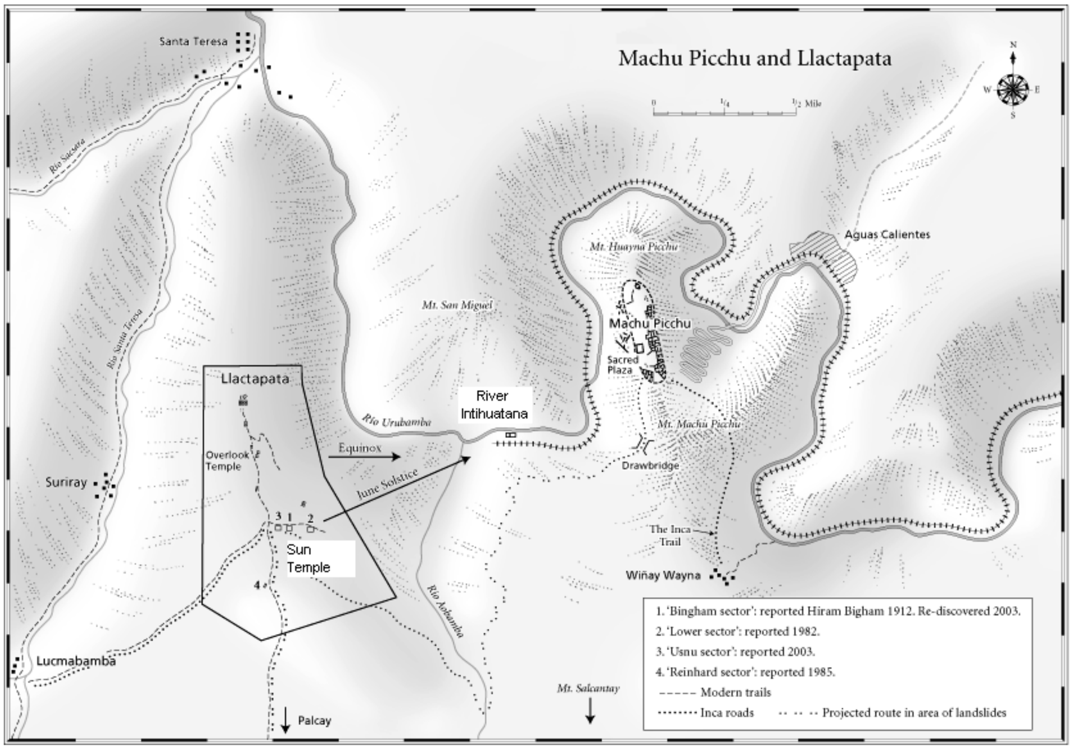

Figure 11-1: Machu Picchu, Llactapata and the River Intihuatana (modified from Malville, Thomson, and Ziegler, 2006).

The Inca trail was the primary means of access to Machu Picchu from Cusco. Pilgrims would arrive on the horizon through the Sungate and then proceed past a check post to the mountain shrine. The main section of Machu Picchu could have served as an elite pilgrimage area with access through its principal doorway. Others may have remained outside in the vicinity of the Ceremonial Rock (see figure 11-37) or possibly continued along the trail across the drawbridge and on to Llactapata.

Niles (2004) notes that the series of royal estates in the Vilconata-Urubamba Valley are like a string of named places, similar to the sequential organization of huacas along ceques in the Cusco valley, all of which could be recorded on quipus. Pachacuti's assimilation of the Cuyos was commemorated by the establishment of an estate at Pisac. When the Tambos were conquered, he is said to have built his estate at Ollantaytambo. When he obtained control of the Vilcabamba, he may have constructed Machu Picchu (Niles, 1999: 133). Pachacuti's son, Topa Inca, established his estate at Chinchero, and his grandson, Huayna Capac, built a palace at Urubamba.

A major function of royal estates was to produce food and some, such as at Topa Inca's palace, contain extensive terraces and others, such as Pachacuti's estate at Ollantaytambo and Huayna Capac's at Urubamba, had rich and well irrigated river-bottom land. Topa Inca's properties also included salt production at the salt flats near Maras. Niles (2004: 60) argues that the estates also supported significant ritual activities as required by petitions to certain gods and regularly occurring events of the sacred calendar "...in addition to the inherent sacredness of a particular location on an estate, estates likely had provisions for royal worship." It can be assumed that ritual activities were major features of Machu Picchu.

The handiwork of Pachacuti can be seen in the elaborately carved huacas of the Cusco valley and the carefully fitted andesite blocks of the Coricancha. The stone work of Pisac is similarly executed, but there seem to be few examples of symbolic iconic motifs except for water channels and the intihuatana enclosure. The next royal estate to be established by Pachacuti, Ollantaytambo, exhibits iconic features such as the massive stones of the "sun temple," elaborate fountains and water channels, sections of stairways in the cliffs, as well as a horizontal gnomon. But it is in the third of his estates, Machu Picchu, that Pachacuti's apparent penchant for improving on the "handiwork of the creator" becomes fully evident. Perhaps it was because Machu Picchu offers so much in terms of granite outcrops, boulders, and caves that Pachacuti committed so much energy to these creative activities.

Machu Picchu may have been vacated when the empire fell during the Spanish conquest (Rowe, 1990; Wright and Valencia, 2000). Opinions vary as to whether the departure took place during or prior to the conquest. In either case the abandonment is likely a significant reason that the conquistadors never found the site. There is speculation that the abandonment might have been due to a smallpox epidemic that swept the empire prior to the European invasion. Another hypothetical reason is because Machu Picchu was Pachacuti's estate. In accordance with Inca custom it was not inherited by his son, Topa Inca, and instead would have become the responsibility of Pachacuti's panaca. Topa Inca built his own country estate and thus Machu Picchu may have simply been deserted for reasons of disuse. Machu Picchu remains a previously undisturbed example of Inca culture and, as such, a valuable location for research of Andean culture.

11.1.1 Architectural Plan and Engineering

The site for Machu Picchu lies some 500 meters above the Urubamba River between two reverse faults that have given it the drop down area between them. Fracturing at the faults created building material for Inca masons and facilitated the spring necessary for the site's water supply (Wright and Valencia, 2000). When selecting this location Pachacuti would have been impressed by the magnificent views of several sacred mountains.

The estate appears to have been carefully planned and was likely built with mitmae workers. Like Cusco, Machu Picchu was divided into hanan and hurin sectors, and also included a separate agricultural sector on higher terrain immediately to the south (Gasparini & Margolies 1980). Principal temples and palaces were constructed in the hanan sector.

Extensive agricultural terraces were built above and below Machu Picchu. These were constructed for erosion control, aesthetic appeal, and crop production. The terraces were not capable of producing enough to feed the site's population, thus the majority of food products were brought in from below (Wright and Valencia, 2000).

11.1.2 Ceques, Axes, and Sight-lines

The large number of huacas in Machu Picchu is reminiscent of the concentration of huacas near the Coricancha of Cusco, where 41 ceques originate. Juan Polo de Ondegardo (1965: 67 [1571]) wrote "In each village the organization was the same; the district was crosscut by ceques and lines connecting shrines or various consecrations and all the things which seem notable: wells and springs and stones, hollows and valleys and summits which they call apachetas." Ceques have many interpretations, one of which is that of visual alignments. One hypothesis is that ceques may have existed at Machu Picchu and a potential such orientation involves Machu Picchu, Llactapata, and the River Intihuatana.

The River Intihuatana lies below the intersection of two major axes (see Figure 11-1). The first is a solar axis formed between the horizon points of the June solstice sunrise and December solstice sunset, which includes Llactapata's Sun Temple and Machu Picchu's Sacred Plaza. The second is an east-west axis proceeding directly from Llactapata's Overlook Temple across the

River Intihuatana and on to Cerro Machu Picchu. It remains possible that the River Intihuatana's location relates directly to these relationships and that the River Intihuatana may have been part of a ceque connecting Machu Picchu with Llactapata. It is also a possibility that the precise geographic location of the River Intihuatana at the junction of these axes or ceques was intentional and that this may be a testament to the power and status of this huaca.

Gary Ziegler (personal communication) feels that a petroglyph (Figure 11-2) located north of Machu Picchu's main plaza serves as a map and that the essentially straight lines etched upon it represent the ceque system of Machu Picchu. The carvings have suffered much erosion, but are distinctly reminiscent of the strings of a quipu, or of a ceque system such the one found in Cusco. Two of the petroglyph's sixteen lines are directionally oriented for the June solstice sunrise/December solstice sunset axis, while certain of those that remain point to mountains. This concept is a subject of Ziegler's continuing research.

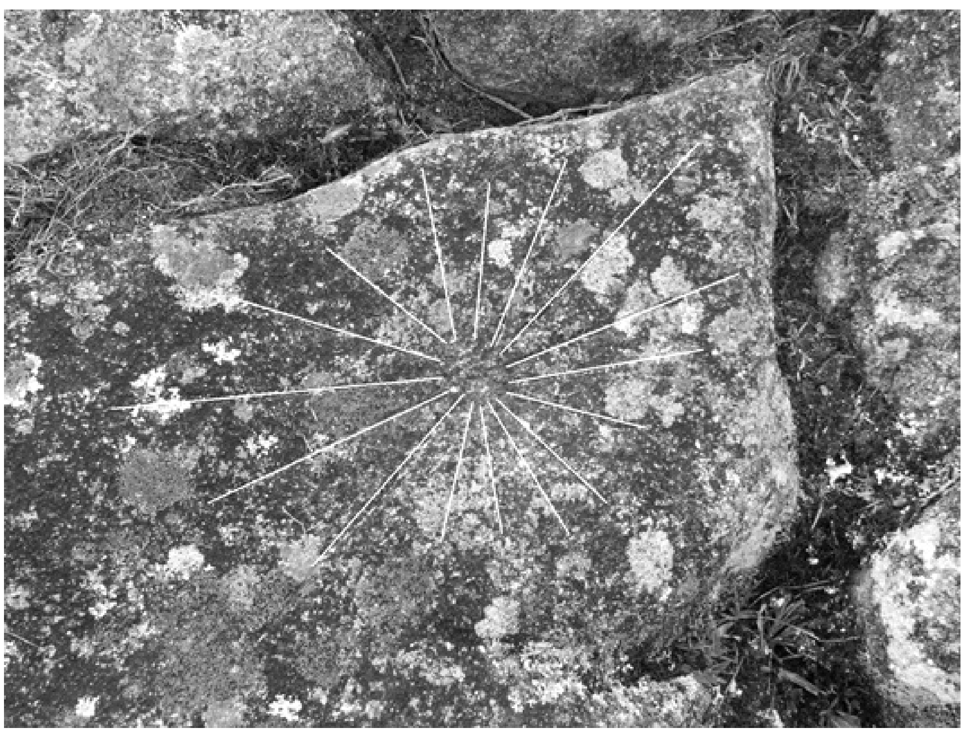

Figure 11-2: Enhancement of lines carved on the petroglyph at Machu Picchu.

Figure 11-3 displays the view from Machu Picchu's Sacred Plaza down to the River Intihuatana as part of a potential ceque. Figure 11-4 shows the reverse sightline from the River Intihuatana up to Machu Picchu.

Figure 11-3: The River Intihuatana as seen from Machu Picchu's Sacred Plaza. The southwestern terraces from which a trail leads down to the river are visible in the foreground. Also visible is the bridge of PeruRail.

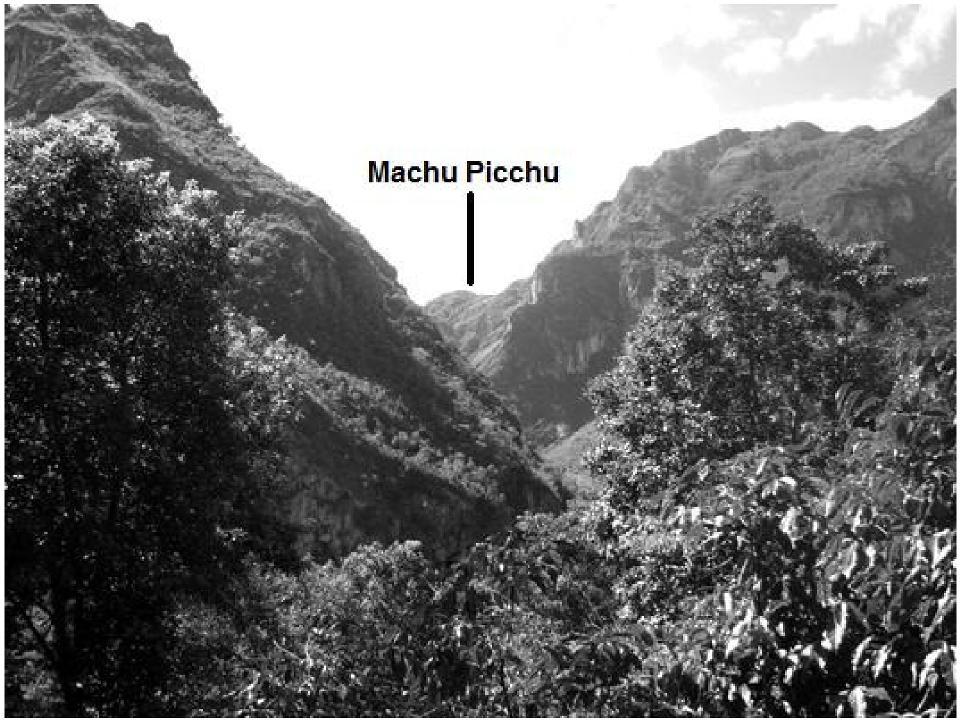

Figure 11-4: Machu Picchu as viewed from the River Intihuatana.

11.2 Machu Picchu

Machu Picchu is located at S13°-09.79’; W072°-32.74’ and 2468 masl.

Motifs and Features: Machu Picchu is a multi-faceted complex that was found to exhibit carved rocks, light and shadow effects, solstitial orientations, an east-west orientation, a zenith orientation, an anti-zenith orientation, a Pleiades orientation, stairs, seats, niches, a water source, fountains, basins, caves, altars, platforms, double-jambed doorways, animal replica stones, horizon replica stones, structures, and terraces.

11.2.1 Intihuatana

The Intihuatana is a focal point of Machu Picchu located with a commanding view of the surrounding area and the canyons and mountains beyond (Figure 11-5). It was carved in situ and exhibits a vertical column on top of a sculpted platform. Intihuatanas are discussed in section 5.6.

Figure 11-5: The Intihuatana of Machu Picchu.

Intihuatanas are also found by the Urubamba River (see Figure 11-23) and at Pisac (see Figure 10-20) and Tipon (see Figure 9-53). In Pisac the intihuatana is a large, partially carved rock that is enclosed by a semi-circular masonry wall that adjoins a straight masonry wall. There is a vertical stone on its flat upper surface. The primary rock extends beneath and beyond the wall of the structure where a second carved cylinder is located. The Intihuatana of Tipon exhibits a different style in that the in situ rock remains unimproved although a platform has been built around it. The Pisac intihuatana shares structural similarities with Machu Picchu's Torreon (Bernard Bell, personal communication; Dearborn and Schreiber, 1986: 24-25).

Evidence has not been found to indicate that Machu Picchu's intihuatana served as an astronomical observing instrument, but its unobstructed views may have made it valuable for other observations. On an expedition with Dearborn, as viewed from the intihuatana, Bernard Bell observed two pillar-like objects on San Miguel. These were not substantiated, but similar observations might be a possibility from such a vantage point (Dearborn and White, 1982).

The Intihuatana was built upon the highest point in Machu Picchu's urban sector and is positioned well for visual alignments with Llactapata and the River Intihuatana by the Urubamba. Llactapata is inclinated at 2.0° at a true azimuth of 241.2°. The River Huaca has an inclination of -20.0° on a 225.7° true azimuth. The June solstice sunrise is easily viewed from the Intihuatana inclined 13.0° up on a 061.2° true azimuth, as shown below. Machu Picchu's Intihuatana is located at S13-09.79°; W072-32.74° and 2468 masl.

<u>Calculated azimuth of June solstice sunrise from the intihuatana</u>

<u>Measured azimuth from the intihuatana to observed point of June solstice sunrise on the horizon</u>

Measured Azimuth:	064.5°
Magnetic Declination:	3.3° W
True Azimuth:	061.2°
Calculated JSSR Azimuth:	061.8°
Δ Calc JSSR Az & True Az:	0.6°
Measured Inclination:	+13.0°

11.2.2 Sacred Plaza

Below Machu Picchu's Intihuatana to the south is the Sacred Plaza (Figure 11-6). The Sacred Plaza includes the Principle Temple and the Temple of Three Windows. The Temple of Three Windows faces toward Llactapata to the southwest and the setting sun at December solstice. The axis of the plaza and the walls of the temples are aligned with the axis connecting June solstice sunrise and December solstice sunset. A sunrise photo was taken on 19 June 2007 (Figure 11-8). On the Plaza's southwest side is a semi-circular platform open to December solstice sunset which overlooks the Urubamba valley with views of the River Intihuatana and the Llactapata Sun Temple. The Sacred Plaza is located at S13-09.82°; W072-32.73° and 2460 masl. The following are for the June solstice sunrise and December solstice sunset from the Sacred Plaza:

<u>Calculated azimuth of June solstice sunrise from the Sacred Plaza</u>

<u>Measured azimuth from the Sacred Plaza to observed point of June solstice sunrise on the horizon</u>

Measured Azimuth:	065.0°
Magnetic Declination:	3.3° W
True Azimuth:	061.7°
Calculated JSSR Azimuth:	062.2°
Δ Calc JSSR Az & True Az:	0.5°
Measured Inclination:	+12.0°

<u>Calculated azimuth of December solstice sunset from the intihuatana</u>

<u>Measured azimuth from the Sacred Plaza to a terrain feature on the horizon</u>

Measured Azimuth:	248.0°
Magnetic Declination:	3.3° W
True Azimuth:	244.7°
Calculated DSSS Azimuth:	246.6°
Δ Calc DSSS Az & True Az:	1.9°
Measured Inclination:	+3.0°

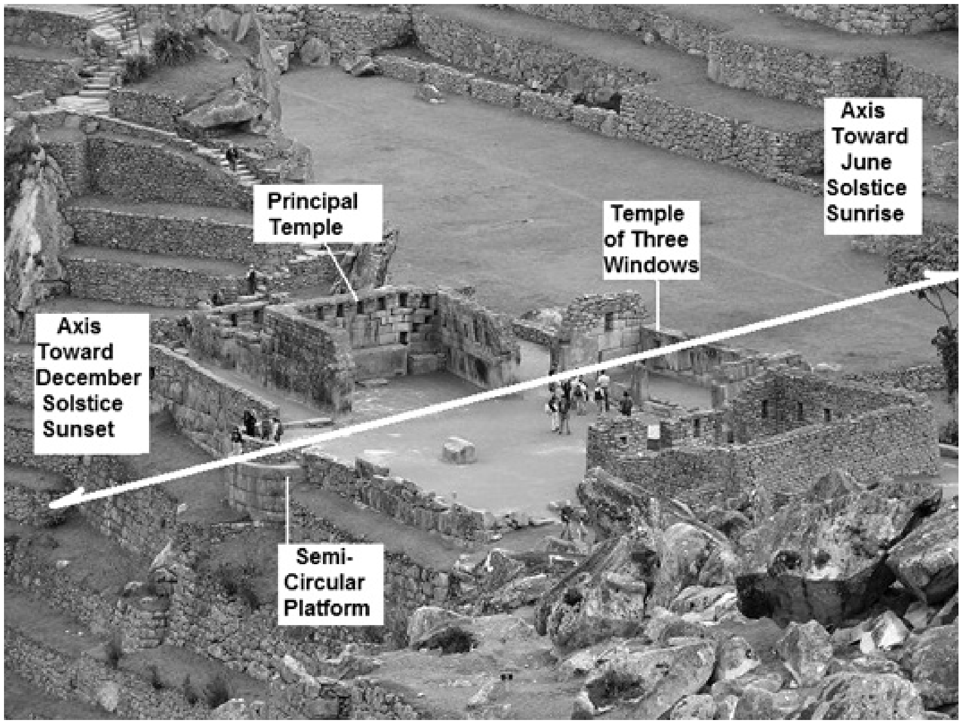

Figure 11-6: Machu Picchu's Sacred Plaza orientations

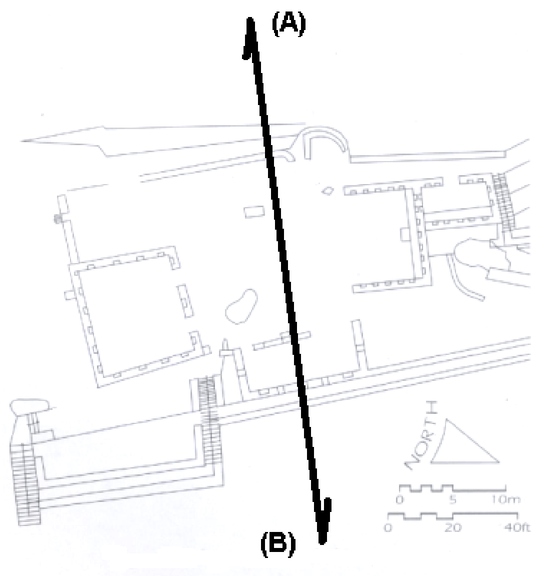

Figure 11-7: Plan of the Sacred Plaza. The general axis of the (A) December solstice sunset and the (B) June solstice sunrise is depicted (modified from Wright and Valencia, 2001).

Figure 11-8: June solstice sunrise over the Sacred Plaza and Temple of Three windows.

The Sacred Plaza may be part of an intentional ceque that includes the River Intihuatana and the Llactapata Sun Temple; all three are approximately aligned with the axis of the June solstice sunrise and December solstice sunset. A possible Inca June solstice ceremony may have taken advantage of the alignment and elevation of Llactapata's Sun Temple as viewed from the Sacred Plaza. On the morning of the solstice the sun's rays first strike Llactapata before illuminating Machu Picchu. Golden medallions might hypothetically have cast a brilliant reflection of the Llactapata dawn's first light back to the onlookers at the Sacred Plaza. This is discussed further in section 11.4.

The Llactapata Sun Temple has a 239.874° GPS azimuth from the Sacred Plaza and is inclined 2.5° higher. The River Huaca has an inclination of -20.0° below the Sacred Plaza on a 223.552° GPS azimuth.

11.2.3 Torreon, Royal Mausoleum, Temple of the Sun

The Torreon/Royal Mausoleum was one of the major shrines of Machu Picchu (Figure 11-10). Very fine masonry crowns the top where it was carefully fitted into the rock with a wall that includes a window open to the horizon positions of the June solstice sunrise and the heliacal rise of the Pleiades. A stone surrounded by the walled enclosure is illuminated through the window at sunrise during the time of the June solstice (Figure 11-12). A ledge cut into the top of the stone nearly bisects the early rays of the solstice sun (Dearborn and Schreiber, 1986: 22-23).

Below the Torreon is the Royal Mausoleum, a cave which contains a set of symbolic stairs, niches, and other stonework (Figure 11-11). The cave gives the impression of a passageway to the underworld and the carved, stepped stone a shamanic stairway of ascent. The proximity of the Torreon to the major fountains of Machu Picchu is consistent with the importance of water in the symbolic meaning of rock.

Research at Pisac's Intihuatana (see Figure 10-20) revealed a structure with certain similarities to the Torreon (Dearborn and Schreiber, 1986: 24-25). Comparisons have also been made between the Torreon and the Coricancha with regard to Pleiades observations. The respective horizon points of the June solstice sunrise and the heliacal rise of the Pleiades are both visible through the Torreon's northeastern window. Dearborn and White (1989: 466) found the window to be more closely aligned with the Pleiades, while the ledge on the rock is oriented for the solstice (Figure 11-9).

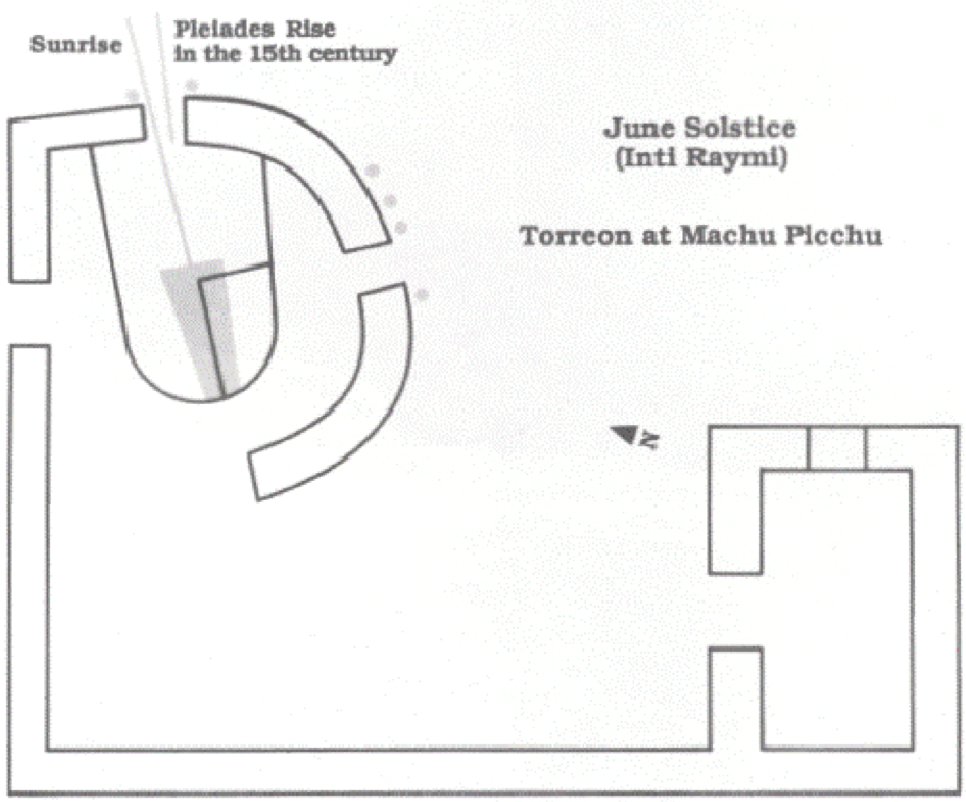

Figure 11-9: Plan of the Torreon (from Dearborn and Schreiber, 1986).

Figure 11-10: The Torreon's northeast window within its curved stone wall constructed seamlessly atop natural rock.

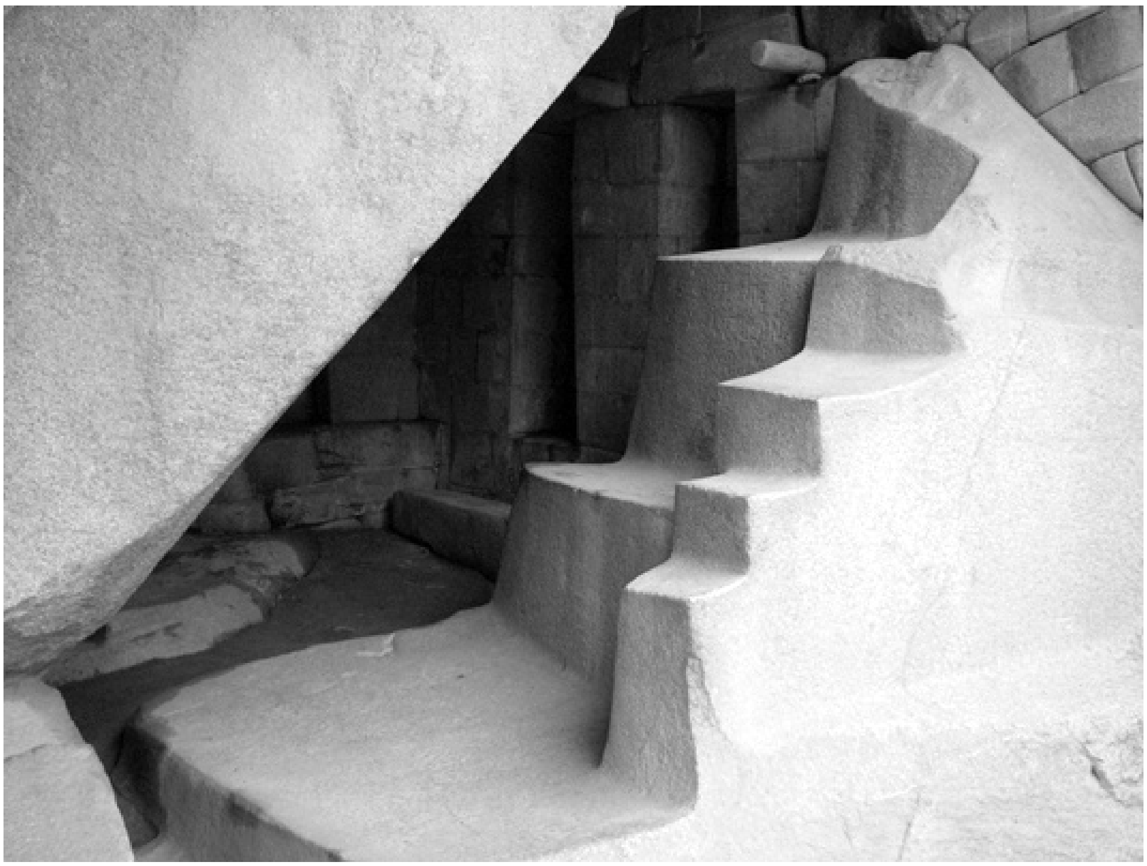

Figure 11-11: The Royal Mausoleum beneath the Torreon.

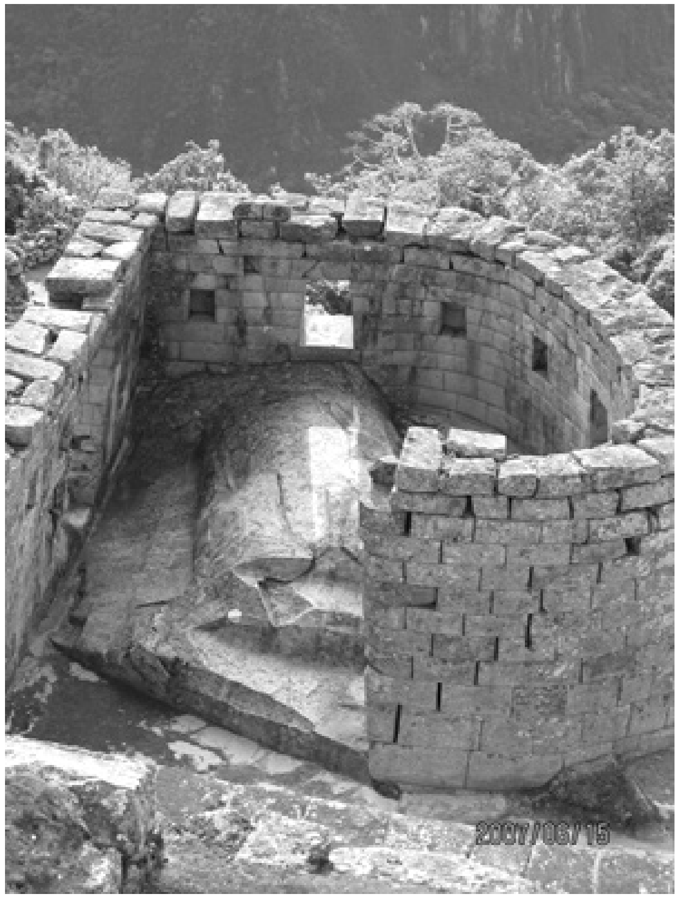

Figure 11-12: June solstice sunlight illuminating the boulder within the curved masonry wall of the Torreon.

The site of the Torreon is a promontory with an eastern view. The circular structure includes two windows – one oriented to the northeast and the other to the southeast. While the northeast window allows for the illumination of the stone at the June solstice, Dearborn and White (1989: 463) say that precise observation of the event is difficult at best. They suggest the use of an object suspended from pegs at the window's corners to cast a more useful shadow. When the shadow parallels the ledge on top of the rock the solstice can be accurately measured.

Dearborn and White (1982: 252) described a process by which if a plumb-bob is suspended in the northeast window its shadow will be cast upon the rock and touch its solstice-aligned ledge. Each day as the horizon point of the sunrise moves northward, the angle between the plumb-bob's shadow and the ledge becomes smaller until they meet on the day of the solstice. If the string is positioned carefully (which is not in the center of the window) the shadow will align with the boulder's ledge, but the ledge was not carved so that it could have been used as a direct sighting device. Further research is required to determine if this procedure was used by the Incas during the 15th and 16th centuries.

Dearborn and White (1982: 253) also describe a method for using the Torreon to indicate the time of zenith passage. This procedure utilizes both the northeast and the southeast windows. Light at sunrise passes through the northeast window from February through October and the southeast window from October through February. At the end of either period illumination at dawn enters both windows at the same time for about five or six days. Dearborn and White state that the time of zenith passage could be identified by observing the area illuminated through both windows.

11.2.4 The Mortars

Carvings called The Mortars, located within a building in the Eastern Urban Sector, proved to be of interest (Figure 11-13). They are two carved shallow basins situated on a floor surrounded by walls and are oriented such that on the day of an equinox mid-morning sunlight will pass thru an adjacent window (to the right of the mortars in Figure 11-13) and cast a reflection off the water within the northern mortar basin. The two mortars are aligned approximately north and south with respect to one another. The photo in Figure 11-13 was taken at noon on 19 June 2007, but this date is is not related to the discussion.

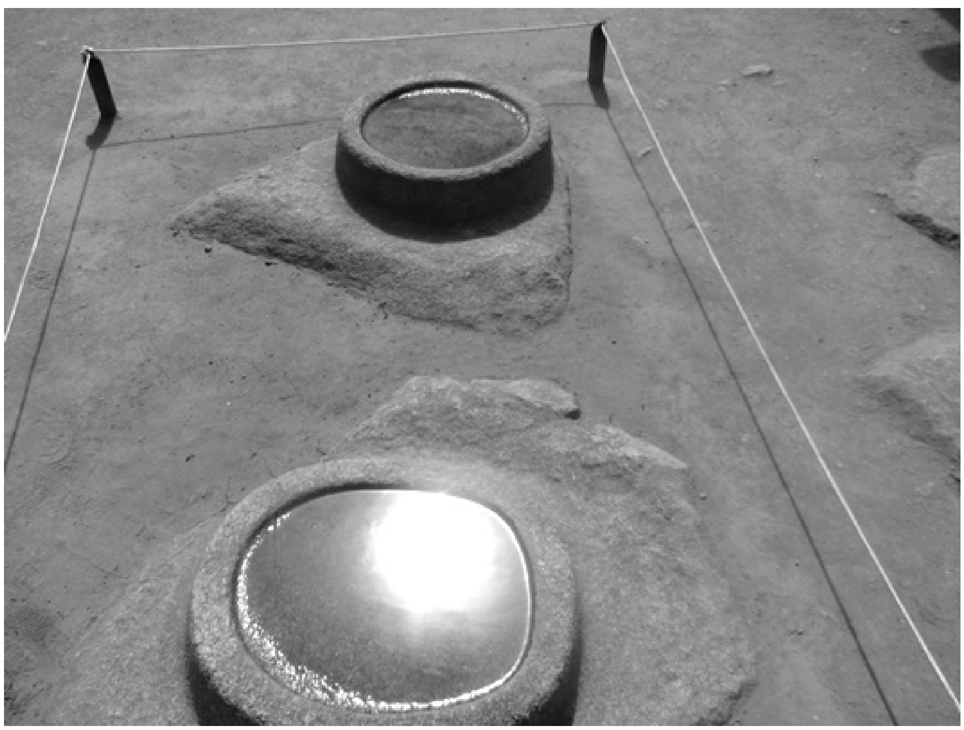

Figure 11-13: The sun's reflection in the southern mortar.

Water-filled basins might have been used for indirect viewing of the sun and moon. The building has been depicted without a roof (Wright and Valencia, 2001). The walls surrounding the mortars are lined with niches, perhaps for religious artifacts. The Southern Cross is one of the most prominent constellations in the southern sky and therefore draws attention in the direction of south. Zuidema (1982a: 218) describes Inca interest in the Southern Cross and argues that in Cusco the 14th ceque of Cuntisuyu was aligned to indicate the direction of the rising of the constellation.

The window adjacent to the mortars is aligned to 073.7° true azimuth. The bearing from the north mortar through the window is 080.2° and from the south mortar it is 060.7°. The inclination from the north mortar to the bottom of the window is 33.0° and to its top is 38.0°. The mortars are located at S13-09.80°; W072-32.67°.

<u>Calculated azimuth of equinox sunrise from the mortars</u>

<u>Measured azimuth from the north mortar across the window bottom center to the horizon</u>

Measured Azimuth:	083.5°
Magnetic Declination:	3.3° W
True Azimuth:	080.2°
Calculated ESR Azimuth:	081.8°
∆ Calc ESR Az & True Az:	1.6°
Measured Inclination:	+33.0°

11.2.5 Intimachay

Also in the Eastern Urban Sector lies a cave called the Intimachay. Dearborn, Schreiber and White (1987: 349) argue that this cave was constructed to observe sunrise at the time of the December solstice and the festival of Capac Raymi. A tunnel, like a horizontal light-tube, (Figure 11-14) was oriented to admit sunlight to the cave for about 10 days before and after the solstice. It was aligned so as to cast a shaft of light to the back of the cave during this period. The window did not function to illuminate the cave, but instead was aligned precisely with the December solstice sunrise (Dearborn and White, 1989: 467). The view of the horizon was constrained by an interior stone that limited the field of view to 10 arc-minutes. Reconstruction performed in 2006 narrowed the window and presently inhibits direct view of the horizon from the cave's interior.

Capac Raymi was a festival celebrated by the nobility that included ceremonies of passage to manhood for young Inca noblemen (Cobo, 1983 [1653]: 126-134). A site such as this could have played a role.

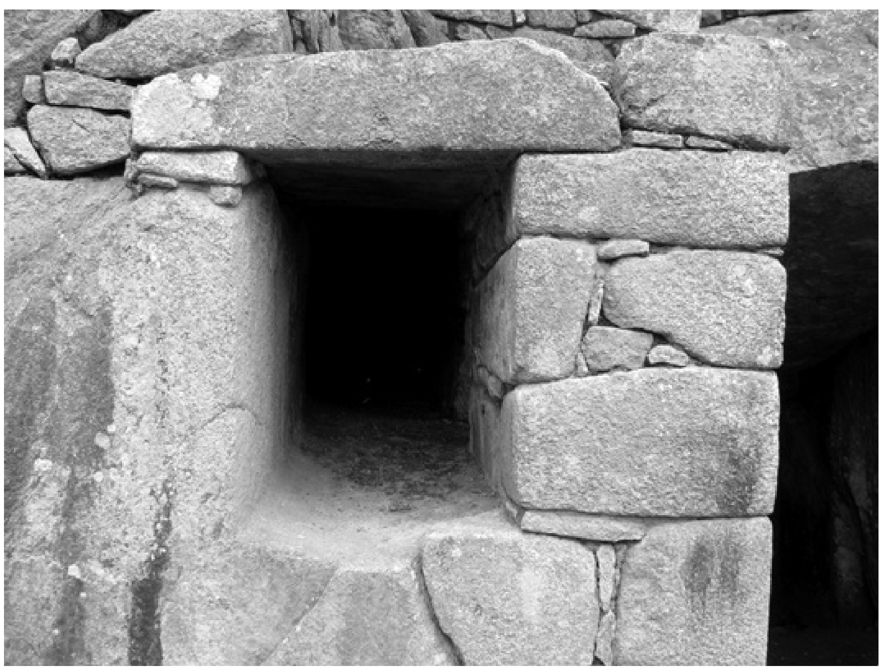

Figure 11-14: The tunnel of the Intimachay.

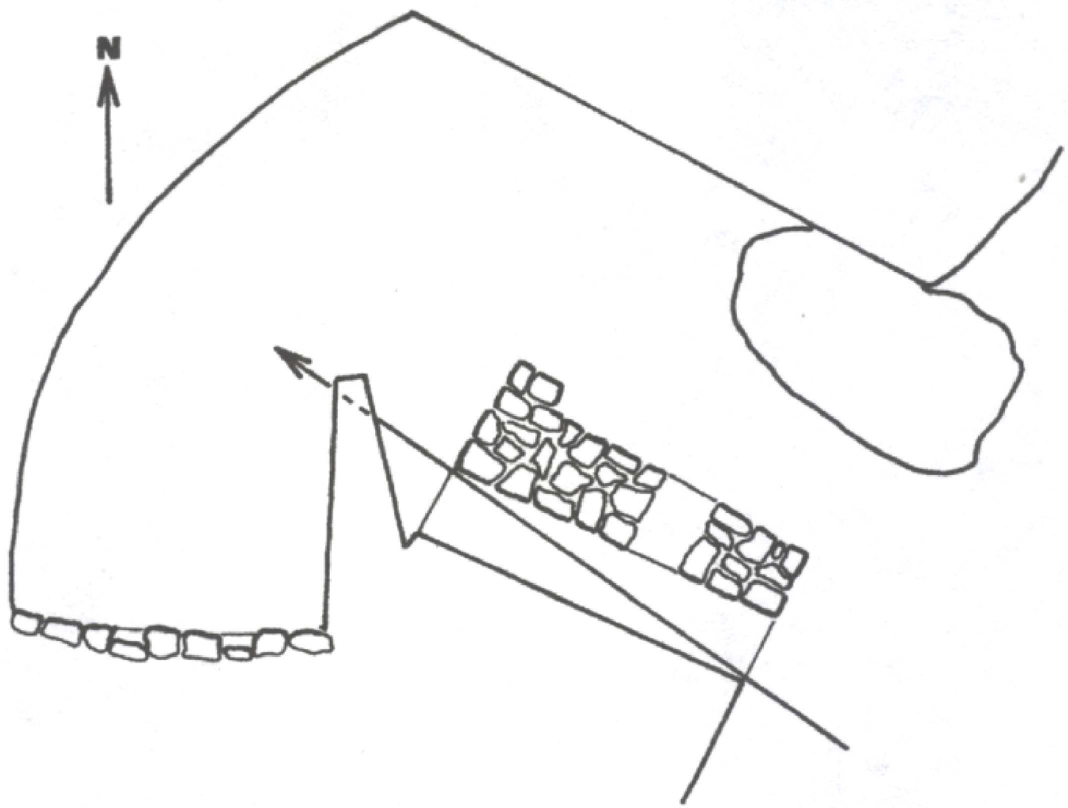

Figure 11-15: Plan of the Intimachay. Reconstruction affecting the field of view took place with the blocks to the right (north) of the sightline arrow (from Dearborn, Schreiber, and White, 1987: 347).

11.2.6 Temple of the Condor

South of the Intimachay is the Temple of the Condor (Figure 11-16) where designers carved a head in stone while incorporating in situ rock as wings in the site's overall visual image of a condor, the creature that represented Hanan Pacha, their world above. The site's cosmological significance continued to the underworld through a system of three caves with an entrance below the boulder representing the left wing of the condor. Steps downward are found at the rear of this entrance area. James Westerman (2005) and Alfredo Valencia excavated the caves in 1995, finding fissures, stairs, walls, rooms, and numerous bones of guinea pigs, animals which were frequently used as food in Inca ceremonies.

Zuidema (1981b) strongly argues that the Inca were interested in the timing of the region's anti-zenith passages of the sun, occurring on April 26th and August 18th, the two days that the sun is at nadir for the latitude of Cusco. Anti-zenith is discussed in section 8.6. The Temple of the Condor's cave is oriented to the anti-zenith sunrise with a true azimuth of 074°, and therefore could have played a role in associated ceremonies if such festivities took place (Westerman, 2005: 343-344). Westerman relates that as the sun rises on or near days of the anti-zenith, or nadir, its rays pass between two external structures, illuminate the condor stone, and extend beneath the boulder to the stairs at the cave's entrance. This orientation supports Zuidema's research regarding anti-zenith observations.

Figure 11-16: Condor stone and cave entrance in the Temple of the Condor.

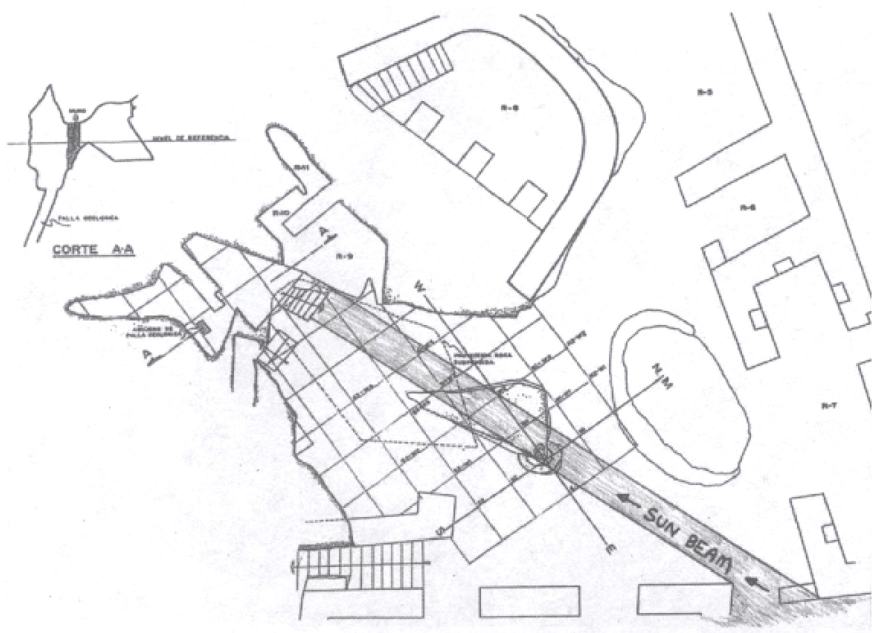

Figure 11-17: Plan of the Temple of the Condor (Alfredo Valencia, from Westerman, 2005: 347).

11.2.7 Huayna Picchu

Huayna Picchu was one of the major sacred features of Machu Picchu. The primary trail to Huayna Picchu leads north from Machu Picchu, while a secondary trail begins with a double-jamb doorway at the Temple of the Moon and ascends the mountain's northern face. Near the top of the mountain is the Building of Three Windows, some limited terracing and a tunnel, perhaps as a portal for ritual movement between the worlds of Kay Pacha and Hanan Pacha. The Building of Three Windows (Figure 11-18) approximately faces December solstice sunset, the River Intihuatana, and Llactapata. The structure has been identified as a storehouse by Wright and Valencia (2001) and contains a carved stone which appears to be a replica of the Llactapata ridge. A store house may have provided supplies for elite pilgrims who had climbed the mountain. The building is aligned 5.1° from the December solstice sunset. It has been reconstructed. Huayna Picchu's summit is located at S13-09.40; W072-32.57 and 2698 masl. The Building of Three Windows is at S13-09.40; W072-32.76 and 2690 masl. It faces a true azimuth of 241.0°.

<u>Calculated azimuth of December solstice sunset from the Building of Three Windows</u>

<u>Measured azimuth perpendicular from the Building of Three Windows to the horizon</u>

Measured Azimuth:	244.5°
Magnetic Declination:	3.5° W
True Azimuth:	241.0°
Calculated DSSS Azimuth:	246.1°
Δ Calc DSSS Az & True Az:	5.1°
Measured Inclination:	+1°

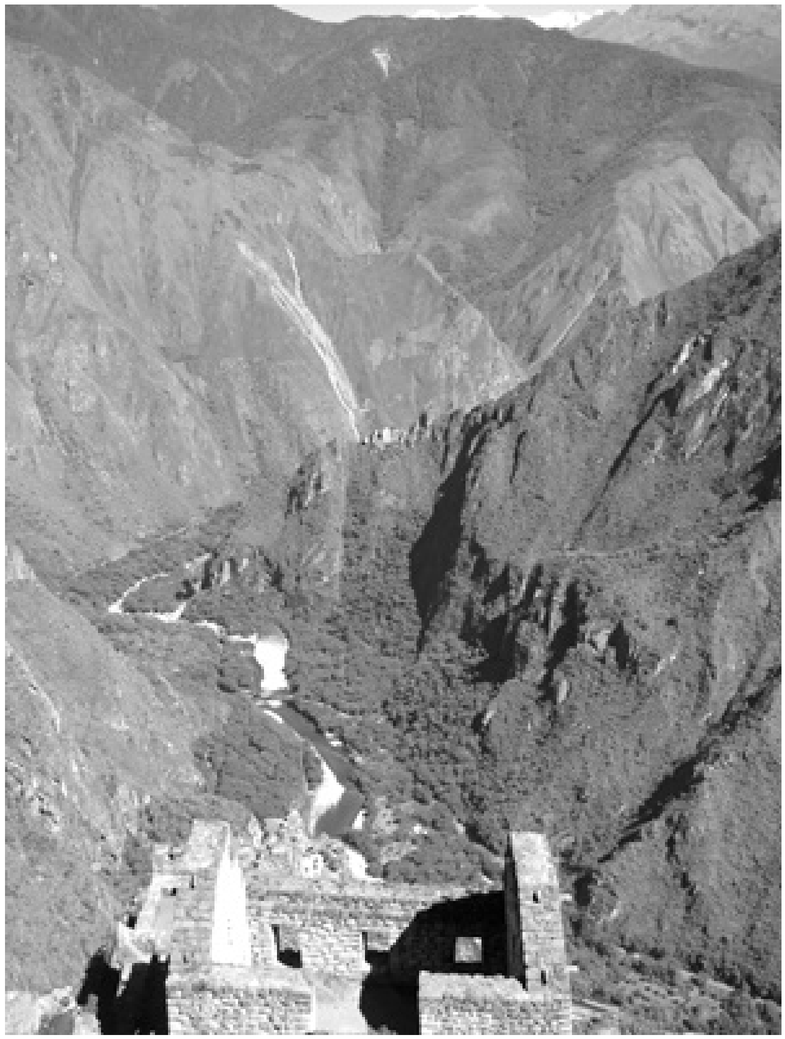

Figure 11-18: The view of the Urubamba River canyon and the Llactapata ridge from above the Building of Three Windows near the top of Huayna Picchu.

11.2.8 Temple of the Moon

Low on the northwest face of Huayna Picchu is a shrine referred to as the Temple of the Moon. This site includes an upper and a lower cave. The upper cave is the larger and within it contains five finely constructed double-jambed niches (Figure 11-19). The double-jambs indicate this site as being significant and might have been a place for the storage of mummies. The cave is oriented in the approximate direction of the June solstice sunset and can also be illuminated by the moon. The December solstice sunset orientation is only approximate as it differs by approximately 7°. Two routes approach the site. One branches downward from the main trail between Machu Picchu and Huayna Picchu, while the other descends directly from Huayna Picchu's summit. A lower trail passed through a gateway on its way to the river and to the vicinity of the River Intihuatana. The upper cave is located at S13-9.09°; W072-32.78° and 2277 masl.

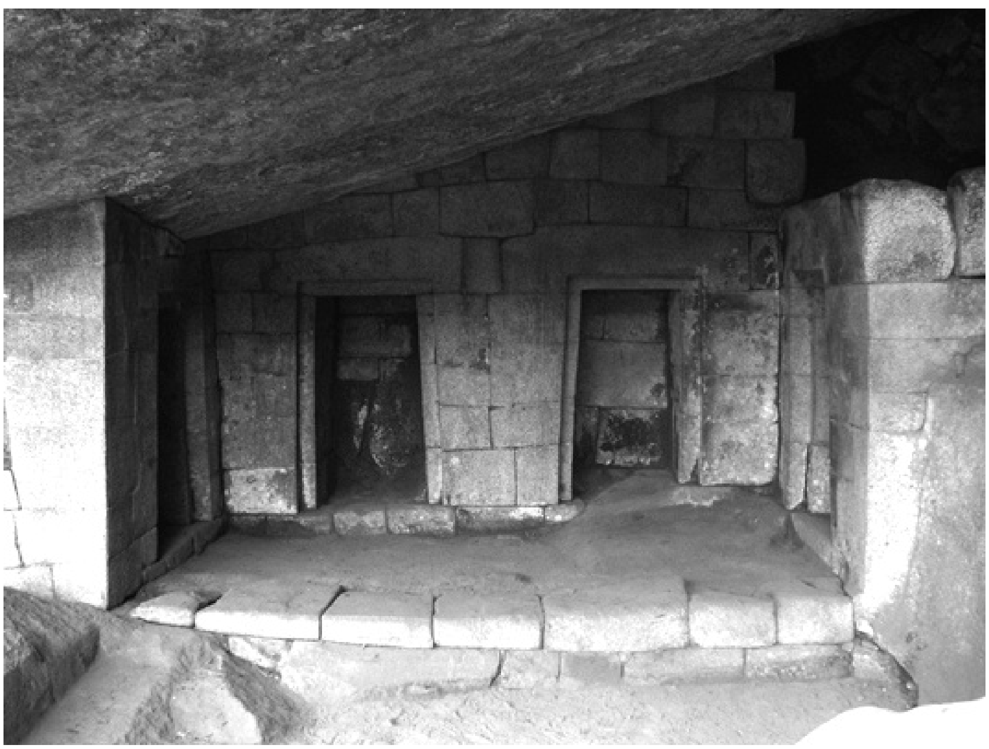

Figure 11-19: Double-jambed niches in the Temple of the Moon's upper cave.

Further northeast and lower on the slope is the lower cave which features a constructed doorway bracketed by two windows (Figure 11-20). As with the upper cave, the lower cave's door and flanking windows are approximately aligned with the June solstice sunset.

Figure 11-20: Door and windows aligned for the June solstice sunset in the lower cave of the Temple of the Moon

Calculated azimuth of June solstice sunset from the lower cave

Measured azimuth perpendicular from the lower cave door to the horizon

Measured Azimuth:	295.0°
Magnetic Declination:	3.2° W
True Azimuth:	291.8°
Calculated JSSS Azimuth:	298.6°
Δ Calc JSSS Az & True Az:	6.8°
Measured Inclination:	+14.0°

11.3 River Intihuatana

The River Intihuatana is located at S13°-10.54’; W072°-33.44’ and 1819 masl.

Motifs and Features: The River Intihuatana is a multi-faceted complex that was found to exhibit carved rocks, east-west orientations, a potential zenith orientation, stairs, niches, a water source, fountains, basins, caves, a platform, a carved cylinder, structures and terraces.

During his exploration of the Vilcabamba, Hiram Bingham located two carved rocks that he identified as intihuatanas. One of these, the Intihuatana of Machu Picchu, is arguably the best known carved rock of the Inca world. The second intihuatana, lying deep in the Urubamba canyon to the west of Machu Picchu, has been visited far less frequently. When examined this shrine was found to be rich with cosmological symbolism. The River Intihuatana is an important element of the extended ceremonial complex that combines Machu Picchu with sites on the Llactapata ridge. It is located on a hillside between PeruRail switchbacks near a hydroelectric complex (see Figure 11-1).

The principle element of the shrine is a rock carved with steps and tiers (Figure 11-21). The adjacent upslope section of the sanctuary contains two water basins aligned east-west and has an elaborately engineered water fountain that is situated over a small cave. Eastward of these granite carvings are the remains of several support structures and a tower attached to a large boulder with a second cave beneath. The area exhibits agricultural terraces, but they are presently engulfed by trees.

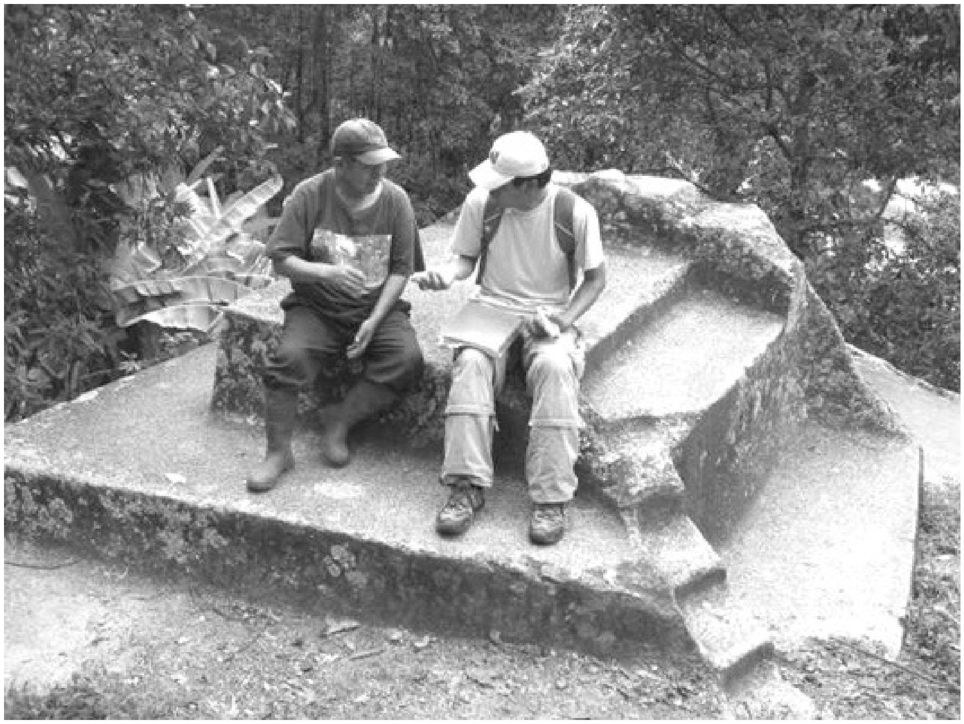

Figure 11-21: Carlos Aranibar interviews Esteban Mayta, property owner, as they sit on the River Intihuatana.

The significance of the River Intihuatana has become clearer since the rediscovery of the Llactapata Sun Temple in 2003. The site can now be identified as a major shrine (a huaca sanctuary) connected to Machu Picchu by two intersecting sightlines or ceques from the Llactapata ridge. The concentration of symbolic motifs suggests ceremonial significance at the site.

The massive carved stone lies close to the June solstice sunrise sightline as traced from the Llactapata sun temple across the canyon and over Machu Picchu’s Sacred Plaza. The sanctuary employs east-west sightlines and adjacent to the Intihuatana is a platform that provides views of the Overlook Temple on the Llactapata ridge and the Intihuatana of Machu Picchu. The grounds also include several common motifs found in other Incan huacas: a fountain, basins, symbolic stairs, and caves.

The large number of huacas in Machu Picchu is reminiscent of the concentration of huacas near the Coricancha of Cusco, where 41 ceques originate. Ceques have many interpretations, one of which is that of visual alignments. A compelling such orientation involves the River Intihuatana. The large granite rock includes a leveled platform that also provides views of the Llactapata's Overlook Temple and Machu Picchu's Intihuatana. The location of the rock is critical for its viewscape; if it had been located a few meters to the south, the view of the Overlook Temple would have been blocked by canyon walls. The Machu Picchu Intihuatana is clearly visible (see Figures 11-3, 11-4 and 11-22) and the base of the River Intihuatana's carved stone is oriented approximately in its direction.

The River Intihuatana lies above the Urubamba River hydroelectric compound that is situated 5 kilometers southwest of Aguas Calientes. The primary carved stone is located approximately 20 meters downslope (north) from the upper PeruRail tracks entering the area. About 30 meters below the sanctuary platform is the mid set of tracks of the switchback and then the slope continues downward to a final set of tracks and across to the hydroelectric compound and the river.

Figure 11-22 is a ground plan of the sanctuary's major features. The upper set of tracks run left to right above this diagram and from it a trail descends the slope, passing just to the left of the basins before reaching the Intihuatana and platform. The walls of the support structures begin five meters to the east of the Intihuatana with Structure A possibly having served as quarters for the huaca's attendants and Structure B perhaps functioning to house stores. Structure B is four meters from Structure A. Immediately upslope from the two structures is a very large unimproved boulder. Approximately two meters upslope from Structure A begins a terrace that extends until reaching a wall that runs nearly eastward for 22 ½ meters along the hillside.

Fifteen meters northeast of Structure B and set into the ground is a set of three steps. Further downslope exists the site's remaining major structure, a circular tower built into the side of the hill. Five functional stairs descend from the base of this tower, ending near the switchback's mid tracks.

Extending to the east and encompassing the majority of the slope between the upper and mid sets of tracks is a group of multiple andenes. These agricultural terraces may have been used in partial support of the huaca's attendants, but currently are hidden by a thick expanse of trees. The complex likely was clear when it was occupied some 500 years ago.

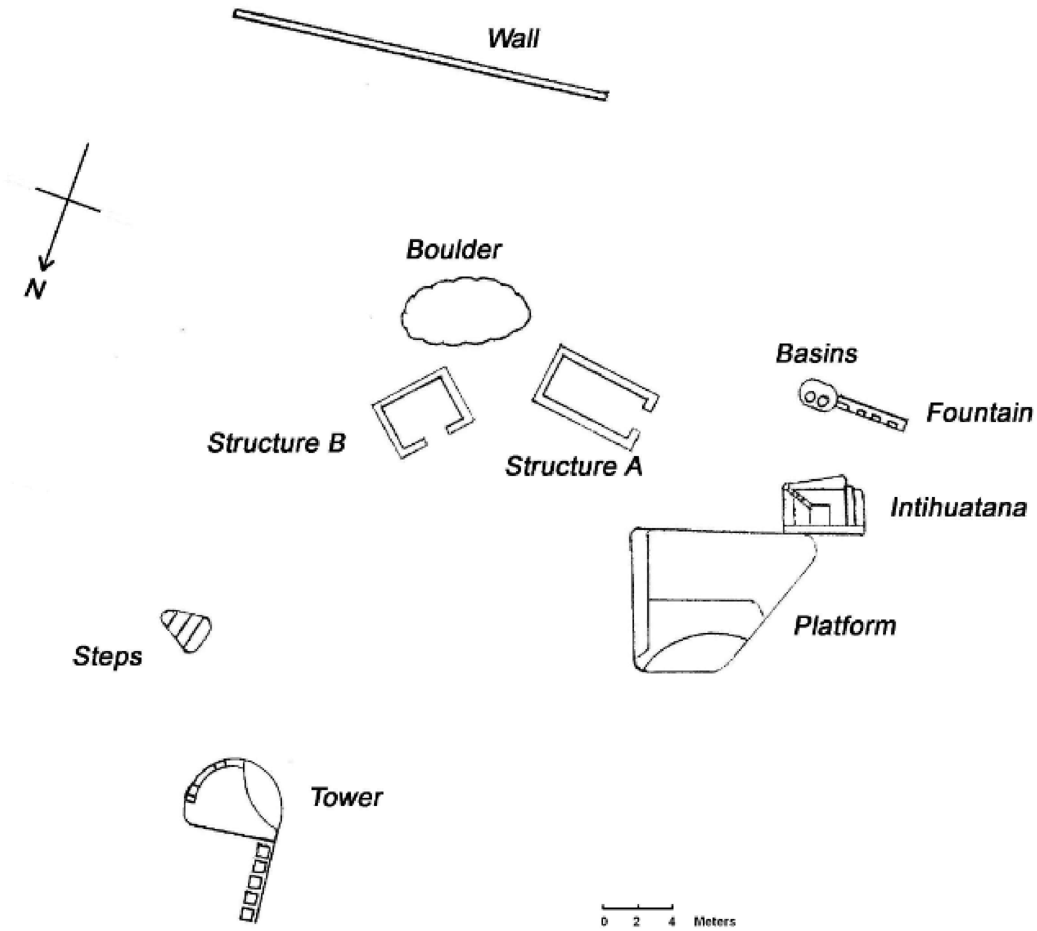

Figure 11-22: Ground plan of the River Intihuatana sanctuary.

11.3.1 Intihuatana

The site's primary feature is the Intihuatana (Figures 11-23 through 11-27), a somewhat worn, but finely carved stone situated at the sanctuary's western boundary. Its dimensions overall are 4.27 meters along the flat northern face by 3.20 meters wide. The tiers get increasingly smaller as they rise. The middle tier measures 2.17 meters by 2.14 meters and the top tier 1.50 meters by 1.70

meters. On the east side of the top tier is an intermediate level measuring 48 cm by 1.70 meters and both are adjoined by a set of descending steps too small to serve any necessary function as they are situated. There appears at present to be three steps, but the stone has been subject to enough erosion to make the original number uncertain. The northern face of the Intihuatana is a flat wall angled from the west toward the top. Its eastern side is also angled, but the surface is broken, thus masking its original shape. The top of the northern face is flat and includes the remains of a cylindrical carving. The base of the shrine is partially covered by soil and the western edge of the area encompassing the Intihuatana and the fountain drops vertically along a sheer stone face. The Intihuatana may also have had a higher portion that was broken by a landslide.

The lines of the River Intihuatana have been rotated from the site's predominant east-west orientation to point in the direction of Machu Picchu's intihuatana on a GPS azimuth of 044.315°. The line of sight is clear between the two intihuatanas and they may easily have been viewed from one another (Figure 11-24 and Figure 11-27).

Figure 11-23: The River Intihuatana as viewed looking downslope to the north.

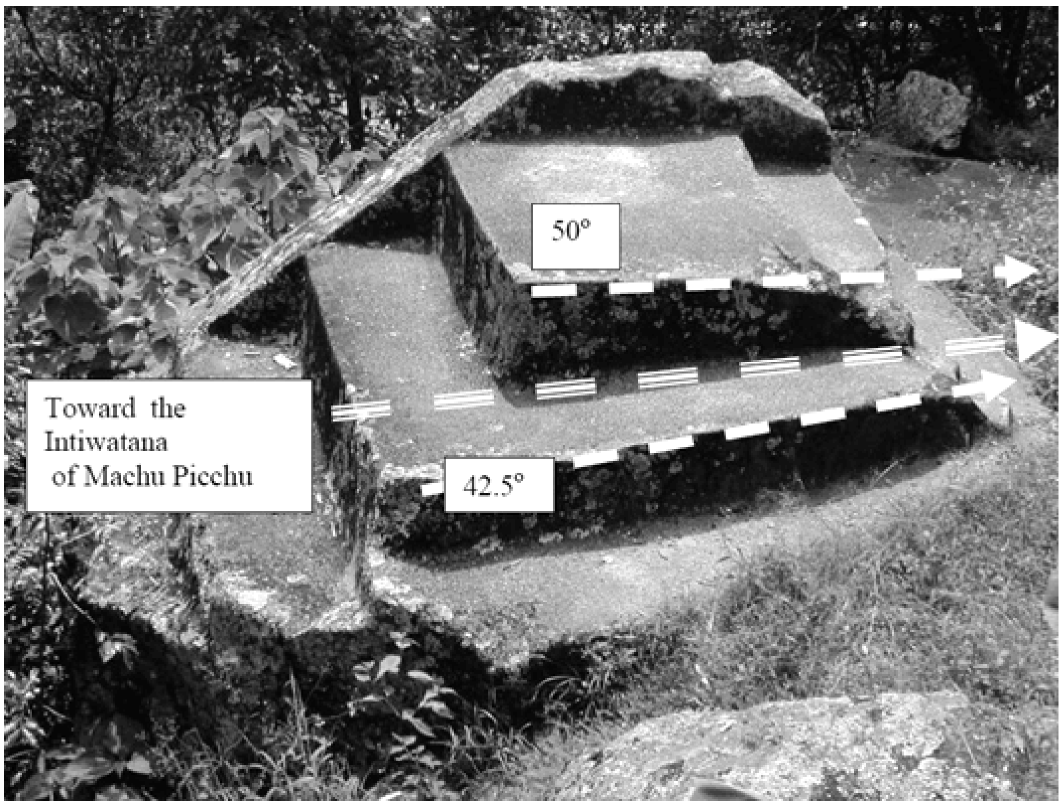

Figure 11-24: River Intihuatana's alignments toward Machu Picchu's Sacred Plaza (courtesy of Kim Malville).

Figure 11-25: The River Intihuatana from the east.

Figure 11-26: The River Intihuatana's western side.

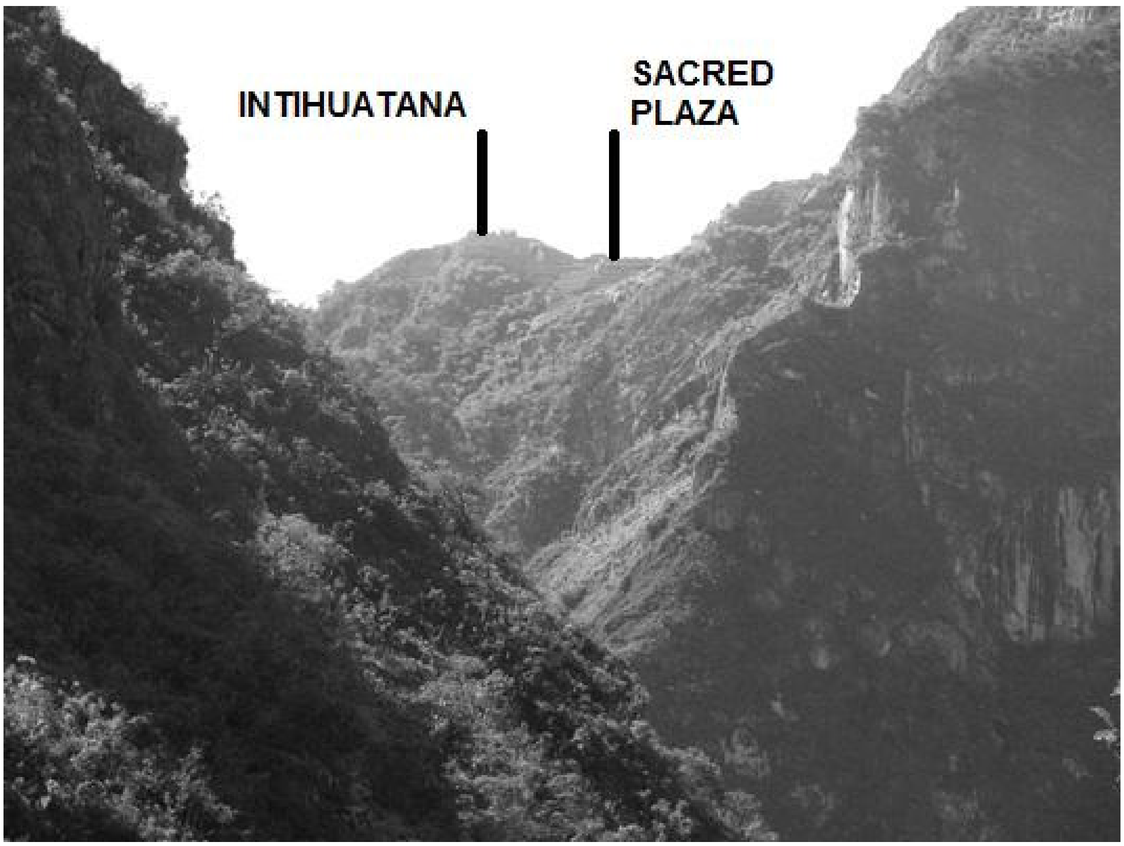

Figure 11-27: A magnified view of the locations of Machu Picchu's Intihuatana and Sacred Plaza as seen from the River Intihuatana.

11.3.2 Platform

Adjacent to the northeast corner of the Intihuatana lays an expansive stone platform (Figure 11-28). This construct is larger than the Intihuatana with overall dimensions running 7.64 meters wide and 10.38 meters long. An angled edge extends from the Intihuatana on a bearing of 20° for 8.80 meters. The platform incorporates some carved tiering and ends downslope in a descending vertical masonry wall.

Figure 11-28: Tiers of the platform adjacent to the River Intihuatana.

11.3.3 Fountain

One of the more intriguing areas found on the site is a complex incorporating several common huaca motifs: a fountain, two basins and a cave. The fountain structure (Figure 11-29) is situated 3.84 meters upslope from the Intihuatana and spans 5.60 meters at its extremes. The face of the fountain points approximately north, is oriented approximately east-west, and was designed to receive water from the east into the channel shown in Figure 11-30. A ledge was carved 1.56 meters below the top of the fountain and worn examples of sculpted seats or shelves remain to the west. The channel was engineered to distribute water to each of the four outlets on the fountain's face. The outlets measure 16.5 cm by 9 cm and are spaced 61 cm apart. Within the channel a small baffle was constructed at each outlet to enhance an even diversion of water flow through that opening. The fountain is now dry, but would have once been fed by an upslope spring.

Figure 11-29: Carlos Aranibar measures the fountain water outlets.

Figure 11-30: Canal with carved baffles designed to produce equal water flow in the four fountain outlets.

11.3.4 Basins

Immediately adjacent to the eastern end of the fountain is a boulder with two large carved basins (Figure 11-31). The boulder is 3.20 meters from the Intihuatana and measures 2.80 meters wide by 1.55 meters deep. The basins face approximately north and are aligned approximately east-west with the eastern basin measuring 66 cm wide by 33 cm deep. The western basin has dimensions of 56 cm by 33 cm and the two are 13 cm apart.

The basins are also oriented for the axis between Llactapata's Overlook Temple and Cerro Machu Picchu. This orientation allows possible use for observing reflections of the sunset at the Overlook Temple. The east-west orientation of the basins is consistent with the overall organization of the site.

Figure 11-31: Two water-filled basins aligned on an east-west axis.

11.3.5 Caves

A small cave also exists within the fountain-basin complex (Figure 11-32). This orifice extends beneath the fountain with its opening situated between the fountain and the boulder with the basins. The cave has enough space for an attendant or priest to function and also could possibly have been used for mummy storage. Above the cave entrance and carved into the boulder is a set of three symbolic stairs, in this case perhaps representing transition between the underworld and the world of the here and now. The Incas felt caves to express deep connections with the forces of nature.

Figure 11-32: Inspecting the cave below the fountains.

A second cave was described by Esteban Mayta, the property owner, and exists beneath the base of the boulder that forms part of the tower constructed on the sanctuary hillside. Mayta reported that the cave was deep enough to occasionally entrap animals.

11.3.6 Structure A

Structure A has rectangular stone walls and lies to the east of the Intihuatana, 4.72 meters from Platform P. This appears to have been a building able to serve as housing for the huaca's priests or other caretakers. The length of the structure is 6.40 meters and its width is 4.45 meters. Its western wall contains a door 1.04 meters wide. The long walls are oriented approximately 100/280°, with the side walls about 010/190°.

11.3.7 Structure B

Structure B is situated 3.58 meters east of Structure A and is more nearly square in shape with sides 3.83 meters long and 3.81 meters wide. A 97 cm door is situated at the center of the north wall and the structure is oriented approximately 050/230° and 130/310°. This building might have been used as a storehouse.

11.3.8 Boulder

Immediately upslope of Structure A and Structure B is a very large, unimproved boulder. It is curious that this rock was left uncarved.

11.3.9 Steps

At a distance of 14.9 meters northeast of Structure B lies a small set of isolated stairs embedded in the ground (Figure 11-33). Their positioning is of little practical use and they also exhibit the three traditional steps of Inca cosmology.

Figure 11-33: Three symbolic steps on the huaca sanctuary grounds.

11.3.10 Tower

Further downslope and built into the side of the hill is a round tower (Figures 11-34 through 11-36). The stones of an eastern circular wall adjoin a large in situ boulder that was used for the tower's southwestern side. The northern face is presently open. The eastern wall contains a door (Figure 11-35) oriented to 086.7° true azimuth and the door is 2.10 meters opposite the in situ boulder. The sun will rise on the horizon at 085.8°. The doorway is 1.28 meters high, 60 cm wide at the lintel, and 74 cm wide at its base. Approximately equidistant between the door and the rock is an internal niche with an upper lintel at the same height as that of the door. The niche is 56 cm high, 29 cm wide at the lintel, and 34 cm wide at its base. A trapezoidal upper window is situated 78 cm above the niche and slightly offset toward the door. The window is 55 cm high, its upper surface measures 28 cm and its base measures 40 cm. The window is oriented to 121.7°.

<u>Calculated azimuth of equinox sunrise from the tower</u>

<u>Measured azimuth from the axis of the tower door to the horizon</u>

Measured Azimuth:	090.0°
Magnetic Declination:	3.3° W
True Azimuth:	086.7°
Calculated ESR Azimuth:	085.8°
Δ Calc ESR Az & True Az:	0.9°
Measured Inclination:	+19.0°

A stone wall holds back the earth outside of the doorway's entrance on the east side of the tower and continues downslope for 8 meters. Another stone wall retains the soil on the downslope of the north side. On the tower's west side a stone staircase with five steps descends the slope on a north bearing toward the railroad. The top of the tower is open. A circular tower reaching to the sky while sitting atop a cave may have served to symbolize and facilitate strong connections between this world and those of the heavens and of the underworld.

Zuidema (1981b: 340-341) describes the sunturhuasi in the Hanan Haucaypata plaza in Cusco as being a circular building with windows, a high roof, and a mast on top. He identifies it as a site for visual observations of the sun and a marker of the zenith sun with similar use and stature as the Coricancha or the Muyucmarca tower of Sacsahuaman. He mentions them all as belonging to the same category of “temple of the sun.” The utility of the River Intihuatana’s circular tower might also have been effective for zenith solar observations.

Figure 11-34: Looking down into the tower from above. The doorway is to the left of center. The entrance to the cave is immediately below and adjacent to the free stone.

Figure 11-35: The tower's eastern side.

Figure 11-36: A curved masonry wall with a door, niche and window adjoins an in situ boulder in the River Intihuatana tower. The cave entrance is to the right of the stone.

11.3.11 Andenes

A system of andenes extends along the hillside to the east of the sanctuary and are oriented generally east-west. The terraces may have been used both to control erosion and also for agriculture in support of the sanctuary's attendants. This area would have been clear in the time of the Incas, but presently is embedded in the rain forest.

11.3.12 Design Similarities

The relationship between the River Intihuatana and Machu Picchu is evident in certain similarities found in architectural style and stone carving common to both sites. The tower found near the River Intihuatana exhibits similarities with the Torreon of Machu Picchu. Both share plans that incorporate walls of curved masonry that include straight and open sections. The masonry of each adjoins in situ rock used to form the remainder of the structure and both exhibit caves at their bases. They each employ windows and niches and both exhibit solar orientations, the Torreon for June solstice sunrise and the River Intihuatana tower for sunrise at equinox (see Figures 11-12 and 11-36).

The carved stone of the River Intihuatana exhibits similarities with a carved stone near the "Guardhouse" in Machu Picchu's Upper Agricultural Sector. This stone is located on a terrace and is known as the "Ceremonial Rock" (Figure 11-37). Both it and the River Intihuatana (see Figure 11-23) share several distinct features. They are each carved from granite with multiple tiers or shelves and have upper ceremonial platforms as well as steps sculpted into one corner of each structure. Both carvings seem to follow the same philosophy of design with similar craftsmanship and give further indication of the River Intihuatana's close association with Machu Picchu.

Figure 11-37: Carved steps and tiers in the Ceremonial Rock of Machu Picchu's Upper Agricultural Sector resemble those of the River Intihuatana. Scattered stones carried to Machu Picchu are visible in the foreground.

Numbers of small-elongated stones, many about 30 cm by 15 cm in size, are seemingly arranged in upright groups around the Ceremonial Rock. The stones are andesite, limestone, and metamorphic rocks carried in from other regions. Some are river-rounded shaped rocks. Ruth Wright and Alfredo Valencia suggest that “river rocks symbolically bring the sacred river to the mountain site” (Wright and Valencia, 2001: 8). This may have been the case but the diversity of rocks more likely indicates that they were ritual offerings/burdens carried and placed by visitors at a shrine requiring this activity upon arrival at Machu Picchu. Modern Quechua travelers carry small stones to the top of mountain passes to leave as offerings to the Apus, in this case perhaps to Huayna Picchu. The Ceremonial Rock is the only huaca placed outside the walls of the main section of Machu Picchu. In a manner similar to the social differentiation that occurred at the Sanctuary of Isla del Sol (Bauer and Stanish, 2001), these offerings may have been carried to and placed there by pilgrims who were not allowed to pass through the main gate of Machu Picchu. Potsherds of chicha vessels have also been found in this area (Wright and Valencia, 2001).

The carved Ceremonial Rock, River Intihuatana (see Figure 11-23), Machu Picchu’s Intihuatana (see Figure 11-5) and the Rumihuasi Stone at Saihuite (see Figure 9-66) have similar sizes and are carved on all sides. The Intihuatana at Pisac is of an appropriate size, but is carved on top and enclosed by masonry walls (see Figure 10-20). The Intihuatana of Tipon (see Figure 9-53) is an exception in that it consists of several unimproved boulders atop a rock platform overlooking the site’s terraces and horizon. The similarities in the carvings of Machu Picchu’s Intihuatana, the River Intihuatana, the Ceremonial Rock, and the Rumihuasi Stone, such as multiple sets of steps with different scales, suggests that these huacas shared common symbolic meaning and function.

11.3.13 Access

Access to the River Intihuatana may have been by a trail leading down from the double-jambed doorway of Machu Picchu’s Temple of the Moon. That route would have required a bridge to cross the Urubamba River from the Inca trail on the north side of the river. A trail leading downward from the southwestern terraces of Machu Picchu leads directly to the Intihuatana, without a need to cross the river. The trail from the River Intihuatana to Llactapata may be similar to the modern one: proceeding downstream to the confluence with the Aobamba and then up that river for a short distance before turning and ascending the Llactapata Ridge.

11.4 Llactapata

> Llactapata is located at S13°-11.12'; W072°-35.08' and 2740 masl.
>
> Motifs and Features: Llactapata is a multi-faceted complex that was found to exhibit light and shadow effects, a solstitial orientation, a Pleiades orientation, niches, double-jambed doorways, a channel, and structures.

The 2003 re-discovery of Llactapata, which overlooks Machu Picchu from a distance of 5 km (see Figure 11-1), was reported at Oxford VII (Malville, Thomson, and Ziegler, 2006). A remarkable feature of Llactapata is the Sun Temple of Sector I (Figure 11-38), which has an orientation similar to that of the Coricancha of Cusco. The courtyard in front of the double-jambed doorway of Sector I contains a stone-lined channel (Figure 11-39) leading from the doorway toward the Sacred Plaza of Machu Picchu, in the approximate direction of the June solstice sunrise and also the point of the heliacal rise of the Pleiades. The River Intihuatana lies in the canyon below. The position of the sunrise could have been predicted by sighting a recess on the jagged horizon. The Llactapata Sun Temple has a 059.874° GPS azimuth to Machu Picchu's Sacred Plaza and a 069.298° GPS azimuth to the River Intihuatana.

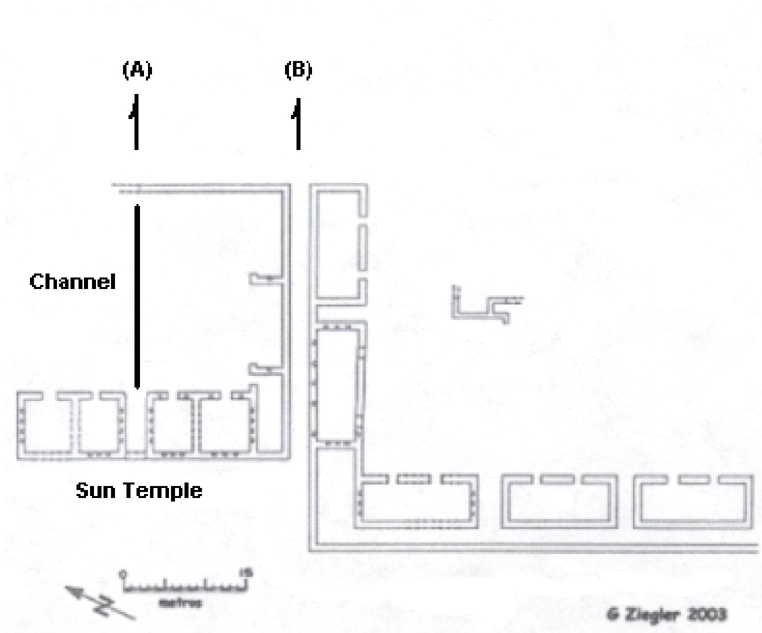

Figure 11-38: Plan of Llactapata Sector I. The channel from the Sun Temple's primary door is aligned for (A) the Machu Picchu Sacred Plaza, and approximately for the June solstice sunrise and the rise of the Pleiades. The adjacent corridor is approximately aligned for (B) the June solstice sunrise and the rise of the Pleiades (Gary Ziegler, modified from Malville, Thompson, and Ziegler, 2006: 330).

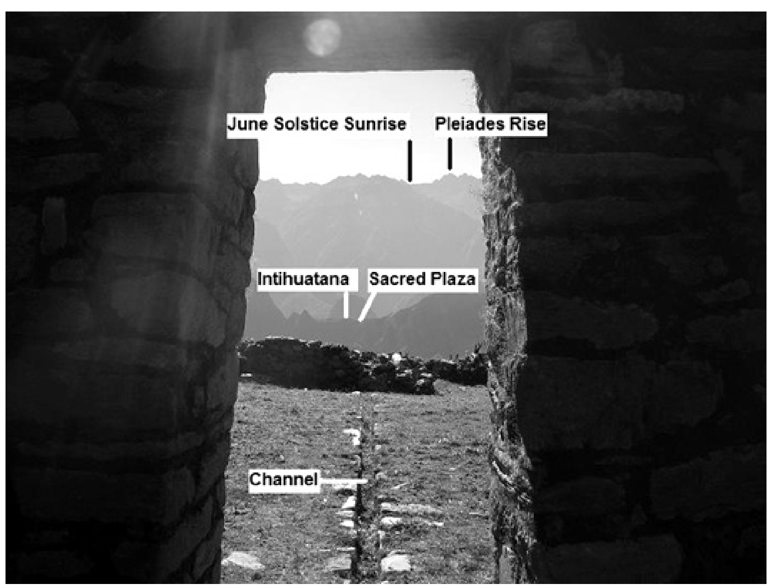

Figure 11-39: The view from the primary door of Llactapata's Sun Temple.

Llactapata was likely an integral part of the cosmological orientations of Machu Picchu. A photo taken from Machu Picchu's Intihuatana (see Figure 11-5) points to the location of Llactapata's Sun Temple on a ridge which is surrounded by some 100 other structures, still engulfed by the cloud forest.

11.4.1 June Solstice Sunrise

The rugged Andean peaks surrounding Machu Picchu and Llactapata provide ample reference for marking solar horizon events, thus natural features may have been used to identify sunrises or sunsets from either location. On 18 June 2007 I documented the Llactapata sunrise over Machu Picchu and its close alignment with the water channel extending from the Sun Temple (Fig. 11-40). A similar sunrise orientation was observed from an adjacent 33 meter corridor, which additionally aligns for the heliacal rise of the Pleiades. Rooms of the Coricancha of Cusco were constructed so as to frame the rise of the Pleiades (Zuidema, 1982a: 212-214) (see Figure 8-1). In a similar fashion the corridor adjacent to the Llactapata Sun Temple appears to have been constructed to frame this event (Figure 11-38).

GPS azimuth from the Sun Temple to Machu Picchu's Sacred Plaza
Calculated azimuth of June solstice sunrise from the Sun Temple
Measured azimuth from the Sun Temple door to the Sacred Plaza

GPS Azimuth:	059.9°
Measured Azimuth:	064.0°
Magnetic Declination:	3.3° W
True Azimuth:	060.7°
Calculated JSSR Azimuth:	063.2°
Δ GPS Az & True Az:	0.8°
Δ Calc JSSR Az & True Az:	2.5°
Measured Inclination:	+5.0°

Figure 11-40: Sunrise from Llactapata's Sun Temple. The water channel is below the camera tripod.

Water or other liquid offerings would have had to have been carried up to the double-jambed doorway at the Sun Temple to be poured into the channel as an offering to the solstice sun. Reinhard (2002) suggests the importance of an Incan water cult at Machu Picchu. The mythical and ritual connections between the sun, sacred mountains, the deity Viracoca, the Vilconata/Urubamba River, and the Milky Way (Urton 1981a) may have been especially powerful there. A belief among modern Quechua people living near Cusco is that the sun is revitalized nightly from the Vilconata River, which becomes the Urubamba River before reaching Machu Picchu (Urton, 1981a: 68-69). According to these traditions, the sun moves underground along the Vilconata River during the night, is refreshed from those waters, and is born again from the river. At the time of the June solstice the river is low and does not have sufficient water to fully refresh the sun, hence its relative dimness. The pouring of water into the Llactapata channel may have symbolically represented the feeding of the sun during the dry season.

11.4.2 Pleiades Rise

A 33 meter-long corridor lies east of and adjacent to Llactapata's Sun Temple. Similarly, the corridor is orientated toward both the June solstice sunrise and the nearby point of the heliacal rise of the Pleiades. The corridor, which is 33 meters long and 2.5 meters wide, is oriented on an azimuth of 063.5°. When viewed from the corridor's rear, a field of view is created extending 4.3° along the horizon. In A.D. 1500, the June solstice sun rose at an azimuth of 064.3° while the heliacal rise of the Pleiades ranged from 064.9° to 065.6° (Malville, Thomson, and Ziegler, 2006: 333).

The Pleiades were of great importance in Inca astronomy as the Incas found them useful in predicting and planning for harvests. The stars in this prominent grouping were viewed with regard to their relative brilliance. Orlove, Chiang, and Cane (2000) argue that a bright appearance by the Pleiades indicated a future of ample rain with a correspondingly good harvest. Correspondingly, a dull appearance (caused by atmospheric obscuration) indicated that there would be drought in the months to come. In actuality, a method had been discovered to anticipate the future arrival of El Niño in a manner still used by Andean farmers today (Orlove, Chiang, and Cane, 2000: 68).

11.4.3 Linked Ceremonialism between Llactapata and Machu Picchu.

Sun worship was the official religion of the Inca Empire and the royal family claimed descent from the sun. Their legendary ancestor, Manco Capac, was said to have used a suit of gold and a golden disk to reflect sunlight (Hemming, 1970: 52).

The account by Cristobal de Molina of a ceremony conducted by the Incas might provide insight for similar ceremonies that would have been possible at the Llactapata Sun Temple at the time of June solstice (Hemming, 1970: 172). The 33 meter corridor is of the appropriate size to allow passage for a procession of pairs of people facing the rising sun. At the head of the column the Inca wearing gold-plated attire could have generated a brilliant reflective image at sunrise.

The Coricancha means the “golden enclosure.” The sides of the temple facing sunrise were covered with gold by at least 700 plates averaging 2 kgs each, amassing more than 1,400 kgs. Additionally there was a band of gold with a width of 20 cm that ran along the entire building at roof level (Hemming, 1970: 64; Hemming and Ranney, 1982: 78).

If the Llactapata Sun Temple was plated similarly to the Coricancha it would have been a brilliant sight when reflecting the light of the dawn sun at the time of the June solstice. We have no record of such plating, however. Llactapata is higher than Machu Picchu and it receives illumination first on the morning of the solstice.

To demonstrate such a ceremony, I positioned a field assistant at the Sun Temple the day prior with a 15 cm by 20 cm mirror. Sunrise occurred at Llactapata at 06:41 and on cue my assistant captured the sun in the mirror and reflected its light toward me, now standing in Machu Picchu’s Sacred Plaza. The reflections from 5 km across the canyon were prominent and continued through the Sacred Plaza’s sunrise at 07:17 and beyond. The 36 minute period between the Llactapata and Machu Picchu sunrises would have afforded ample time for a special ceremony celebrating the morning solstice sun. A magnified view of the ridge (Fig. 11-41) clearly shows the reflection from the Sun Temple. This demonstration exhibited the reflection from only a hand-held mirror. Larger medallions worn by the emperor or plates mounted on the temple could have produced a more brilliant effect.

Figure 11-41: Reflection of the June solstice sunrise at the center of the Llactapata Sun Temple as seen from Machu Picchu's Sacred Plaza.

11.5 Summary

The Incas encoded many examples of astronomical and cosmological significance at Machu Picchu and the surrounding region. The Sacred Plaza and Torreon are aligned along a solar axis extending from the horizon point of the June solstice sunrise to that of the December solstice sunset. The Torreon has orientations for the June solstice sunrise and the heliacal rise of the Pleiades. The Intihuatana is one of Machu Picchu's most prominent features and can also be said to look out over the December solstice sunset. The mortars may have been used for indirect observations of the sun and moon or to reflect sunlight through a window on days of equinox. The Intimachay was designed to observe sunrise at December solstice and the Temple of the Condor has a potential sunrise alignment for days of the anti-zenith sun. The Building of Three Windows near the top of Huayna Picchu is oriented to the December solstice sunset and features of the Temple of the Moon on Huayna Picchu's side align for sunset at June solstice.

The River Intihuatana lies at the junction of two solar axes, a northeast-southwest solstitial one and another with an east-west orientation. The features of the River Intihuatana sanctuary are also oriented predominantly east-west.

The River Intihuatana exhibits many motifs found in other Inca huacas with features such as stairs, fountains, basins, and caves. Three examples of ritual stairs found within the River Intihuatana sanctuary: standing alone on the grounds of the complex, situated above the cave entrance between the basins and the fountain, and carved into the Intihuatana itself. None of these were carved in a way that suggests any practical need and the steps above the cave are totally non-functional.

The Incas designed fountains to be both practical and ceremonial and they may have served to facilitate the life-force energizing effects of camay. Carved basins were used to hold gifts and liquid sacrifices and might have been employed to observe reflections of the sun or moon.

The River Intihuatana's circular tower reaching to the sky while sitting atop a cave may have served to symbolize and facilitate strong connections between the world of the present and both the gods of the heavens and the forces of the underworld. The tower is also a possible location for observance of zenith passage of the sun.

Llactapata and its extensive array of structures suggest an even greater significance for the Machu Picchu region, including a hypothesis that Pachacuti may have created a ceque system here not unlike the one he instituted surrounding Cusco. A stone-lined channel in front of Llactapata's Sun Temple is aligned toward Machu Picchu's Sacred Plaza and approximately for the June solstice sunrise and the heliacal rise of the Pleiades. An adjacent corridor points to the rise of the Pleiades and that of the June solstice sun. The Sun Temple, the River Intihuatana, and the Sacred Plaza lie along a solar axis from the June solstice sunrise to the December solstice sunset. Llactapata's Overlook temple is approximately aligned across the River Intihuatana to Cerro Machu Picchu on an east-west axis. The Emperor could possibly have conducted June solstice sunrise ceremonies at Llactapata where he reflected the light of the rising sun to onlookers at Machu Picchu's Sacred Plaza, but there is no evidence to support this hypothesis.

Part V: Results

Chapter 12

Findings and Discussion

12.1 Introduction

I present evidence that the Incas practiced horizon astronomy in the Peruvian Andes through positional observations of the rising and setting sun on days of ceremonial significance. The majority of the sites examined in the areas of this study were found to involve attention to the solstices.

The Urubamba pillars and the palace of Huayna Capac lie on a sightline to the June solstice sunrise. The Sacred Plaza of Machu Picchu, the River Intihuatana, and the Llactapata Sun Temple lie approximately along a line established by the June solstice sunrise and December solstice sunset. The River Intihuatana is a classic huaca containing caves, fountains, steps and platforms. The Temple of the Moon at Machu Picchu exhibits approximate orientations for the June solstice sunset. The shrine at Choquequilla contains some of the finest carvings extant on any huaca and aligns for the December solstice sunrise. Chinchero adds cardinal with solstitial orientations. The carved rock huaca at Kenko Grande is rich with astronomical orientation and its neighbor at Lacco features even more. The huaca with two circles exhibiting orientations for solar horizon events may have been used in part to determine the positions of related sunrises and sunsets.

12.2 Findings

During the course of this study I searched for evidence of astronomical orientation in the features found at 29 sites surrounding Cusco, in the Sacred Valley, and in and surrounding Machu Picchu.

The sites selected primarily were based on Bauer (1998), Hemming and Ranney (1982), Gasparini and Margolies (1980), and suggestions from Dr. Kim Malville. Twenty-three of these sites were either carved rock huacas or sanctuaries that included carved or otherwise significant rocks. The remaining six sites were huacas or sanctuaries with structures, but lacking in intrinsic rock shrines. These rock and non-rock huacas were categorized further as to whether or not they exhibited any potential astronomical orientation. My research in the Region Surrounding Cusco included huacas at 19 locations, seven of the sites were in the region of the Sacred Valley, and the remaining three sanctuaries were related to Machu Picchu.

12.2.1 First Hypothesis

> *The majority of* the currently identified *rock huacas in the Cusco Valley, the Sacred Valley, and surrounding Machu Picchu* are *associated with visual solar phenomena.*

Huacas were first divided into two groups – those that were or included rock shrines and those that didn't (Tables 12-1, 12-2, and 12-3). For the purposes of this study a huaca was considered astronomical if it, or an element of it, was found to have a solar light and shadow effect or potential orientations related in any way to the sun. If an orientation was found to exist and was available for potential use it was included. This was the case with certain east-west alignments that might have been used at the time of the equinoxes, even though it yet has to be proven that the Incas were concerned with horizon positions of the sun on those days. At the same time it hasn't been proven that they did not use any of these east-west orientations when the sun rose and set accordingly. Of the 29 shrines examined in this study 23, or 77%, were found to fit at least one of the above criteria. Sixteen of the sites included ceremonial rocks with celestial orientations and eight more had structures oriented with an aspect of the solar horizon. This equates to 55% and 28% respectively. The 16 sites that include rocks with orientations are categorized as "Astronomical Rock." Sites such as Sacsahuaman and the River Intihuatana have ceremonial rocks, but those rocks were not found to exhibit examples of astronomy. The sites did possess other astronomical orientations, however, and were included with those displaying structural celestial orientations in the "Astronomical Non-Rock" category. Five sites with boulders displayed no evidence of solar orientations and one of the sites without a rock had none. The non-celestial huacas comprised 21% of the sites of the study. Four of the "Non-Astronomical Rock" huacas (without observable astronomical orientations) were Mesa Redonda, Tetecaca, Patallacta, and Sapantiana, each among the closest to Cusco. They likely served purposes independent of the sun. The fifth was Cerro Unoraqui which was part of a sightline from Quespiwanka, but exhibited no additional orientations of its own. The other site without specific celestial orientation ("Non-Astronomical Non-Rock") was the ridgeline of Cerro Pumahuachana. It includes two sections of wall ruins and a chapel on a crag, but displayed no distinct solar orientation. The ridge does, however, lie under the same sightline between Quespiwanka and Cerro Unoraqui. The existence of astronomical orientations at 79% of the sites studied supports this hypothesis and indicates that many Inca huacas may well have been associated with solar observation and ceremony. If the equinoxes are discounted then Lanlakuyok moves to the non-astronomical rock category and Puca Pucara becomes non-astronomical non-rock, thus lowering this to 72%. Percentage summaries are given in Tables 12-16 through 12-19.

Section	Huaca	Astronomical Rock	Astronomical Non-Rock	Non-Astronomical Rock	Non-Astronomical Non-Rock
9.2	Kenko Grande	X			
9.3	Kenko Chico	X			
9.4	Mesa Redonda			X	
9.5	Tetecaca			X	
9.6	Patallacta			X	
9.7	Kusilluchayoc	X			
9.8	Lacco	X			
9.9	Solar Horizons	X			
9.10	Lanlakuyok	X			
9.11	Puca Pucara		X		
9.12	Tambomachay	X			
9.13	Sacsahuaman		X		
9.14	Mollaguanca	X			
9.15	Sapatiana			X	
9.16	Rumiwasi Bajo		X		
9.17	Rumiwasi Alto		X		
9.18	Kusicallanca		X		
9.19	Tipon	X			
9.20	Saihuite	X			

Table 12-1: Huaca Classifications for the Region Surrounding Cusco.

Section	Huaca	Astronomical Rock	Astronomical Non-Rock	Non-Astronomical Rock	Non-Astronomical Non-Rock
10.2	Chinchero	X			
10.3	Pisac	X			
10.4	Quespiwanka	X			
10.5	Cerro Pumahuachana				X
10.6	Cerro Unoraqui			X	
10.7	Choquequilla	X			
10.8	Ollantaytambo	X			

Table 12-2: Huaca Classifications for the Sacred Valley Region.

Section	Huaca	Astronomical Rock	Astronomical Non-Rock	Non-Astronomical Rock	Non-Astronomical Non-Rock
11.2	Machu Picchu	X			
11.3	River Intihuatana		X		
11.4	Llactapata		X		

Table 12-3: Huaca Classifications for the Machu Picchu Region.

12.2.2 Second Hypothesis

> *Those huacas found to be associated with visual solar phenomena* (*solar huacas*) *exhibit orientations related to the solstices, equinoxes, zenith suns and anti-zenith suns.*

Eighty-three percent (19) of the solar huacas were found to exhibit orientations for the solstices and 38% (9) displayed specific effects of light and shadow (Figures 12-13, 12-14, and 12-15). Twenty-nine percent (7) had east and/or west orientations that potentially included the equinoxes and 21% (5) had zenith or anti-zenith orientations (Tables 12-4, 12-5 and 12-6).

Sixty-three percent (10) of the 16 astronomical rock huacas had orientations for the June solstice sunrise, 38% (6) for the June solstice sunset, 56% (9) for the December solstice sunrise and 25% (4) for the December solstice sunset. Thirty-one percent (5) had east orientations with possible utility at an equinox sunrise and 19% (3) had west orientations with similar potential for the equinox sunset. There were three instances of zenith sun orientations (19%) and one (6%) anti-zenith orientation.

The number of examples for June and December solstice is fairly even, somewhat unexpected since the solstice in December is in the rainy season when observations of the horizon on specific days would be expected to be far less reliable. There is a marked difference between the numbers of orientations for solstice sunrises in both seasons when compared to those for the associated sunsets. Results would imply a much greater ceremonial interest in the rising sun.

Two of the seven astronomical non-rock huacas had June solstice sunrise orientations (29%), none for the June solstice sunset, three for the December solstice sunrise (43%) and none for the December solstice sunset.

Of the 23 huacas with any astronomical association 96% held at least one orientation for one of the six primary solar horizon events of sunrise and sunset at June solstice, December solstice and the equinoxes. If the equinoxes are removed then this figure becomes 83%. There were a total of five possible examples of zenith sun alignments (22%) and two instances of potential alignments related to the anti-zenith sun (9%). While there were fewer examples regarding the zenith sun and anti-zenith sun found with these rural huacas, the zenith-related events were a significant interest within the city of Cusco. June solstice sunrise orientations were noted 19 times in all (including multiple orientations at the same site), June solstice sunset 7 times, December solstice sunrise 12 times, December solstice sunset 8 times, east/equinox sunrise 10 times and west/equinox sunset 9 times.

While major sites such as Kenko Grande, Saihuite, Chinchero and Machu Picchu were found to have multiple solar horizon orientations, many of the rest exhibited only one or two.

Thus the 2nd hypothesis was supported in part as 96% of solar huacas appear to have incorporated direct observation of horizon events when both solstices and equinoxes are included, and 83% when the equinoxes are not.

Section	Huaca	JSSR	JSSS	DSSR	DSSS	East/ESR	West/ESS	Zenith	Anti-Zenith
9.2	Kenko Grande	X		X		X	X		
9.3	Kenko Chico			X					
9.4	Mesa Redonda								
9.5	Tetecaca								
9.6	Patallacta								
9.7	Kusilluchayoc		X						
9.8	Lacco	X						X	
9.9	Solar Horizons	X	X	X	X	X	X		
9.10	Lanlakuyok					X			
9.11	Puca Pucara					X	X		
9.12	Tambomachay			X					
9.13	Sacsahuaman							X	X
9.14	Mollaguanca	X			X				
9.15	Sapantiana								
9.16	Rumiwasi Bajo			X					
9.17	Rumiwasi Alto			X					
9.18	Kusicallanca			X					
9.19	Tipon		X						
9.20	Saihuite	X							

Table 12-4: Huaca Astronomical Orientations in the Region Surrounding Cusco.

Legend:

JSSR–June Solstice Sunrise DSSR–December Solstice Sunrise ESR–Equinox Sunrise

JSSS–June Solstice Sunset DSSS–December Solstice Sunset ESS–Equinox Sunset

Section	Huaca	JSSR	JSSS	DSSR	DSSS	East/ESR	West/ESS	Zenith	Anti-Zenith
10.2	Chinchero	X			X	X	X		
10.3	Pisac	X		X					
10.4	Quespiwanka	X	X	X					
10.5	Cerro Pumahuachana								
10.6	Cerro Unoraqui								
10.7	Choquequilla			X					
10.8	Ollantaytambo	X	X	X				X	

Table 12-5: Huaca Astronomical Orientations in the Sacred Valley Region.

Section	Huaca	JSSR	JSSS	DSSR	DSSS	East/ESR	West/ESS	Zenith	Anti-Zenith
11.2	Machu Picchu	X	X	X	X	X		X	X
11.3	River Intihuatana					X		X	
11.4	Llactapata	X							

Table 12-6: Huaca Astronomical Orientations in the Machu Picchu Region.

12.2.3 Third Hypothesis

All solar huacas are associated with flowing water.

Water sources were found to be associated with 72% (21) of the huacas in this study. With the exception of the huaca with two circles aligned for solar horizon events (section 9.9), the 16 astronomical rock huacas all had sources of water (94%). While no evidence was found for water at this site, due to its proximity to Lacco and the Ucu Ucu canal it cannot be ruled out that water was once provided to this shrine as well (Tables 12-7, 12-8, and 12-9). Therefore it is reasonable to suggest that 100% of the astronomical rock huacas in this study likely had sources of water for camay and other purposes.

Of the non-astronomical rock huacas near Cusco, only Patallacta exhibited no evidence of a water supply, but there are canals in the area and modern construction of roads and buildings may mask the path of ancient hydraulics. Immediate sources of water were not identified at the astronomical non-rock sites of Rumiwasi Bajo, Rumiwasi Alto and Kusicallanca. The peak of Cerro Unoraqui was understandably without a water source, as was the Sun Temple on the Llactapata ridge. Water would have had to have been carried to the channel that leads from the temple toward Machu Picchu and the June solstice sunrise.

One-hundred percent (16) of the solar rock huacas were found to have or were likely to have had sources of flowing water. Only 38% (3) of the eight astronomical non-rock sites of this study were found to have water sources, either present or past. The 3rd hypothesis was supported for huacas made of rock, but not for other huacas. This finding is in keeping with forces of camay being employed to bring life to these venerated stones.

Section	Huaca	Water Source
9.2	Kenko Grande	X
9.3	Kenko Chico	X
9.4	Mesa Redonda	X
9.5	Tetecaca	X
9.6	Patallacta	
9.7	Kusilluchayoc	X
9.8	Lacco	X
9.9	Solar Horizons	
9.10	Lanlakuyok	X
9.11	Puca Pucara	X
9.12	Tambomachay	X
9.13	Sacsahuaman	X
9.14	Mollaguanca	X
9.15	Sapatiana	X
9.16	Rumiwasi Bajo	
9.17	Rumiwasi Alto	
9.18	Kusicallanca	
9.19	Tipon	X
9.20	Saihuite	X

Table 12-7: Huacas with a Water Source in the Cusco Region.

Section	Huaca	Water Source
10.2	Chinchero	X
10.3	Pisac	X
10.4	Quespiwanka	X
10.5	Cerro Pumahuachana	
10.6	Cerro Unoraqui	
10.7	Choquequilla	X
10.8	Ollantaytambo	X

Table 12-8: Huacas with a Water Source in the Sacred Valley Region.

Section	Huaca	Water Source
11.2	Machu Picchu	X
11.3	River Intihuatana	X
11.4	Llactapata	X

Table 12-9: Huacas with a Water Source in the Machu Picchu Region.

12.2.4 Fourth Hypothesis

Solar huacas in the form of carved rocks contain traditional Andean motifs.

This again was a hypothesis with results differing for rock huacas and non-rock huacas. Fifty-six percent (9) of the 16 astronomical rock huacas had shamanic stairs, 38% (6) had caves, 69% (11) employed niches, 75% (12) exhibited seats, 31% (5) had basins, 38% (6) had animal carvings, 31% (5) had channels for ceremonial fluids, and 38% (6) had fountains. One hundred percent of the astronomical rock huacas exhibited at least one or more of these motifs (Tables 12-10, 12-11, and 12-12).

Of the eight astronomical sites without celestially oriented rocks, 25% (2) had stairs, 38% (3) were associated with caves, 75% (6) had niches, 13% (1) had seats, 25% (2) displayed basins, none had animal carvings, 13% (1) had a ceremonial channel and 25% (2) had fountains. Cerro Unoraqui was the only site in this category found to be devoid of any of the Andean carvings.

As might be expected, major sites such as Kenko Grande, Lacco, Saihuite, Chinchero, and Machu Picchu exhibited the greatest number of these motifs. Most of the huacas without astronomical rocks displayed only one or two. This hypothesis was largely supported for major carved rock solar huacas, but not as much for the others.

Section	Huaca	Shamanic Stairs	Caves	Niches	Seats	Basins	Animal Carvings	Ceremonial Channels	Fountains
9.2	Kenko Grande	X	X	X	X	X	X	X	
9.3	Kenko Chico	X			X	X			
9.4	Mesa Redonda	X							
9.5	Tetecaca		X	X				X	
9.6	Patallacta				X				
9.7	Kusilluchayoc			X			X	X	
9.8	Lacco	X	X	X	X	X	X	X	
9.9	Solar Horizons				X				
9.10	Lanlakuyok	X	X	X	X				
9.11	Puca Pucara								X
9.12	Tambomachay	X							X
9.13	Sacsahuaman	X	X	X	X	X			
9.14	Mollaguanca	X			X				
9.15	Sapatiana						X		
9.16	Rumiwasi Bajo		X	X					
9.17	Rumiwasi Alto			X					
9.18	Kusicallanca			X					
9.19	Tipon			X					X
9.20	Saihuite	X		X	X		X	X	X

Table 12-10: Huaca Andean Motifs in the Cusco Region.

Section	Huaca	Shamanic Stairs	Caves	Niches	Seats	Basins	Animal Carvings	Ceremonial Channels	Fountains
10.2	Chinchero	X	X	X	X	X	X	X	
10.3	Pisac			X					X
10.4	Quespiwanka			X					
10.5	Cerro Pumahuachana								
10.6	Cerro Unoraqui								
10.7	Choquequilla		X	X					
10.8	Ollantaytambo				X				X

Table 12-11: Huaca Andean Motifs in the Sacred Valley Region.

Section	Huaca	Shamanic Stairs	Caves	Niches	Seats	Basins	Animal Carvings	Ceremonial Channels	Fountains
11.2	Machu Picchu	X	X	X	X	X	X		X
11.3	River Intihuatana	X	X	X		X			X
11.4	Llactapata			X				X	

Table 12-12: Huaca Andean Motifs in the Machu Picchu Region.

12.2.5 Additional Motifs and Features

The remaining motifs and features listed in Table 3-1 that were recorded during my field research are outlined in Tables 12-13, 12-14 and 12-15. Effects of light and shadow were identified at 31% (9) of the sites and cardinal orientations were found at 17% (5). Light-tubes were used in 14% (4) of the locations and altars were employed at 24% (7). There were platforms at 21% (6) of the sites and 34% (10) had gnomons or pillars. As with the features listed in Tables 12-10, 12-11, and 12-12, the primary shrines and sanctuaries included more of these elements than did the others.

Section	Huaca	Sacred Rock	Light and Shadow	Cardinal Alignments	Light-Tubes	Altars	Platforms	Gnomons or Pillars	Horizon Replicas
9.2	Kenko Grande	X	X		X	X		X	
9.3	Kenko Chico	X						X	
9.4	Mesa Redonda	X				X			
9.5	Tetecaca	X				X		X	
9.6	Patallacta	X							
9.7	Kusilluchayoc	X							
9.8	Lacco	X	X		X	X		X	
9.9	Solar Horizons	X						X	
9.10	Lanlakuyok	X			X				
9.11	Puca Pucara			X			X		
9.12	Tambomachay	X					X		
9.13	Sacsahuaman	X				X			
9.14	Mollaguanca	X							
9.15	Sapatiana	X							
9.16	Rumiwasi Banjo								
9.17	Rumiwasi Alto								
9.18	Kusicallanca								
9.19	Tipon	X							
9.20	Saihuite	X	X	X			X		

Table 12-13: Huaca Features in the Cusco Region.

Section	Huaca	Sacred Rock	Light and Shadow	Cardinal Alignments	Light-Tubes	Altars	Platforms	Gnomons or Pillars	Horizon Replicas
10.2	Chinchero	X	X	X		X			
10.3	Pisac	X	X				X		
10.4	Quespiwanka	X						X	
10.5	Cerro Pumahuachana								
10.6	Cerro Unoraqui	X		X				X	
10.7	Choquequilla	X							
10.8	Ollantaytambo	X	X					X	

Table 12-14: Huaca Features in the Sacred Valley Region.

Section	Huaca	Sacred Rock	Light and Shadow	Cardinal Alignments	Light-Tubes	Altars	Platforms	Gnomons or Pillars	Horizon Replicas
11.2	Machu Picchu	X	X		X	X	X	X	X
11.3	River Intihuatana	X	X	X			X	X	
11.4	Llactapata		X						

Table 12-15: Huaca Features in the Machu Picchu Region.

12.2.6 Statistical Summaries

Percentages for each recorded feature per huaca category are given in Tables 12-16 through 12-19. Astronomical Rock Huacas led or tied in all but one of the categories in Table 12-16 when compared with the Astronomical Non-Rock category. By definition the non-astronomical categories are not represented. Orientations for sunrises on the June and December solstices were the most common and, by definition, 100% of the astronomical huacas were found to have orientations for any of the horizon events. The remaining columns of Table 12-16 give a breakdown for each individual solar event. An associated graph is presented in Figure 12-1.

As described in Table 12-17, all rock huacas were found likely to have been associated with water, while less than half of the non-rock sites exhibited such hydraulic sources. Table 12-18 shows that seats, niches and stairs were the most common motifs found on or near the astronomical rock huacas and niches built into walls were the predominant feature in the astronomical non-rock huacas. An associated graph is presented in Figure 12-2. Table 12-19 follows with cardinal orientations having been found at 38% of astronomical non-rock huacas and gnomons, carved circles or pillars were associated with 44% of astronomical rock huacas. An corresponding graph is presented in Figure 12-3. The majority of the Table 3-1 motifs and features observed in this study were found in huacas that were used for astronomical purposes.

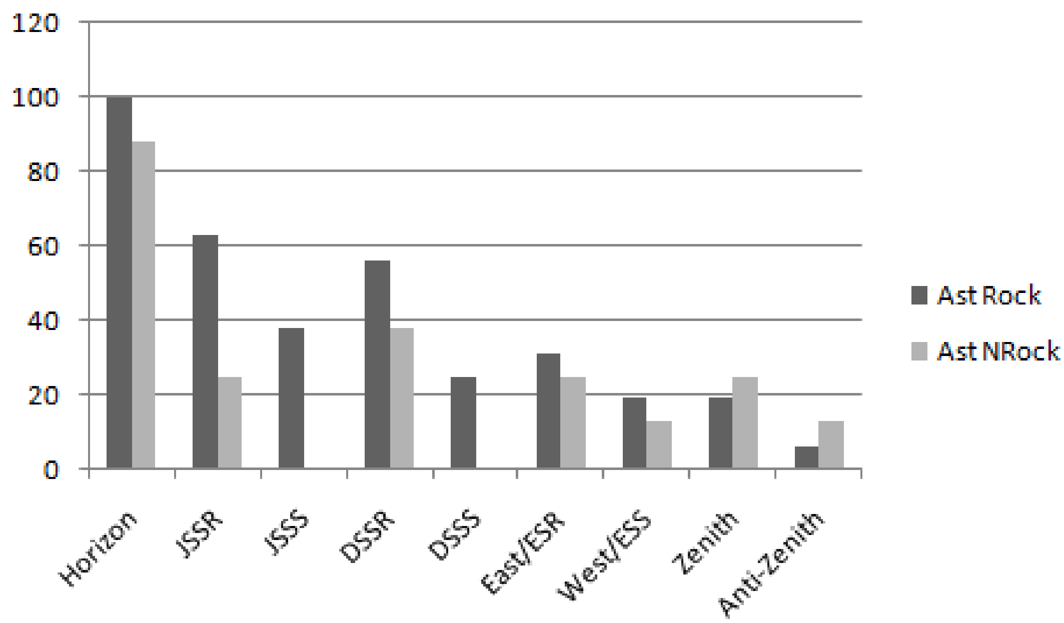

Figure 12-1: Percentages of Astronomical Orientations per Huaca Category.

Category	Horizon Events	JSSR	JSSS	DSSR	DSSS	East/ESR	West/ESS	Zenith	Anti-Zenith
Astronomical Rock	100%	63%	38%	56%	25%	31%	19%	19%	6%
Astronomical Non-Rock	88%	25%	0%	38%	0%	25%	13%	25%	13%

Table 12-16: Percentages of Astronomical Orientations per Huaca Category.

Legend:

JSSR–June Solstice Sunrise   DSSR–December Solstice Sunrise   ESR–Equinox Sunrise

JSSS–June Solstice Sunset   DSSS–December Solstice Sunset   ESS–Equinox Sunset

Ast Rock- Astronomical Rock   Ast NRock-Astronomical Non-Rock

NAst Rock-Non-Astronomical Rock   Nast NRock-Non-Astronomical Non-Rock

Category	Water Source
Astronomical Rock	100%
Astronomical Non-Rock	50%
Non-Astronomical Rock	100%
Non-Astronomical Non-Rock	0%

Table 12-17: Percentages of Huacas with Water Sources.

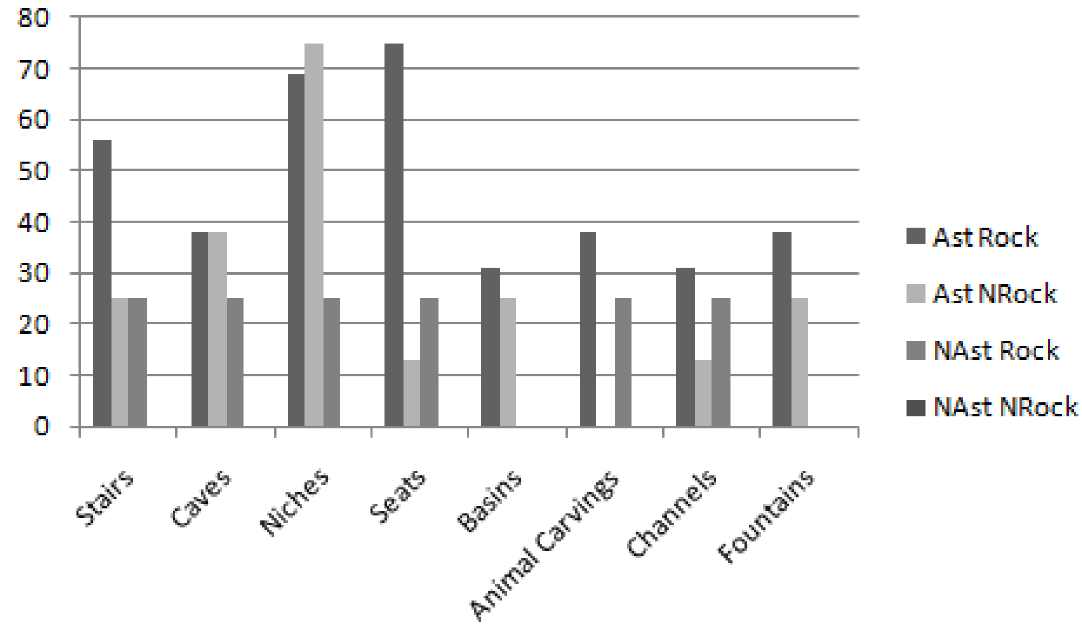

Figure 12-2: Percentages of Andean Motifs per Huaca Category.

Category	Shamanic Stairs	Caves	Niches	Seats	Basins	Animal Carvings	Ceremonial Channels	Fountains
Astronomical Rock	56%	38%	69%	75%	31%	38%	31%	38%
Astronomical Non-Rock	25%	38%	75%	13%	25%	0%	13%	25%
Non-Astronomical Rock	25%	25%	25%	25%	0%	25%	25%	0%
Non-Astronomical Non-Rock	0%	0%	0%	0%	0%	0%	0%	0%

Table 12-18: Percentages of Andean Motifs per Huaca Category.

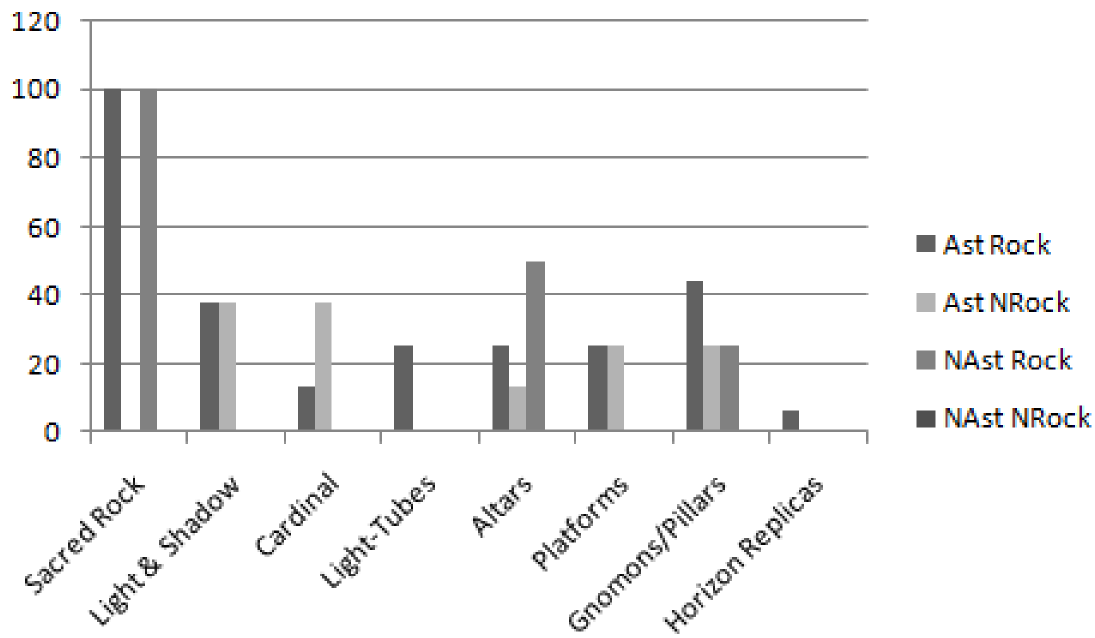

Figure 12-3: Percentages of Features per Huaca Category.

Category	Sacred Rock	Light and Shadow	Cardinal Alignments	Light-Tubes	Altars	Platforms	Gnomons or Pillars	Horizon Replicas
Astronomical Rock	100%	38%	13%	25%	25%	25%	44%	6%
Astronomical Non-Rock	0%	38%	38%	0%	13%	25%	25%	0%
Non-Astronomical Rock	100%	0%	0%	0%	50%	0%	25%	0%
Non-Astronomical Non-Rock	0%	0%	0%	0%	0%	0%	0%	0%

Table 12-19: Percentages of Features per Huaca Category.

12.3 Discussion

12.3.1 Cusco Region

Examples such as the "Eyes of the Puma" at Kenko Grande demonstrate a considerable knowledge of horizon astronomy and the degree of the creativity that the Incas were capable of in the development of their shrines. On the top of the outcrop they carved two carved cylinders that form the puma's eyes and then created a fissure in the nearby wall that allows light to fall upon those carved cylinders at the appropriate time during the June solstice sunrise in a manner that completes the "puma" visual effect, as shown in Figure 9-4.

With its many carvings and motifs, Kenko Grande was truly a most important huaca. Near the puma is the kenko, or zigzagged channel, from which the huaca appears to derive its name. Such channels appear at several locations in the empire for supposed purposes of offerings and divination. The most likely offering was chicha, or corn beer, which is still traditionally homebrewed and available in rural villages at bars and restaurants. The drink was common in Inca times and must have held significant spiritual value. "These women made large amounts of high-quality *chicha* which was for offerings to the gods and for the priests to drink" (Cobo, 1990 [1653]: 174). Other fluids could be used as well. Certainly water with its sacred connotations was incorporated into ritual, and blood, such as of the llama, may have been used at times of sacrifice. Many channels incorporated multiple paths and the specific flow of the liquid was likely used for divination.

The chamber within Kenko Grande exhibits traditional motifs of caves, niches and steps. The primary altar is finely carved and may have served in one or more types of ceremonial functions. The tube in the cave's upper northwest corner admits light that could be reflected from plates in a niche to illuminate the entire chamber. It also facilitates a special effect of light and shadow on the ceremonial steps adjacent to the primary altar, as depicted in Figure 9-9. The huaca has an east or west opening at respective ends of its cave, with the southeastern one oriented to to the east that will receive the light of the equinox sunrise, and the one to the northwest to the west admitting illumination from the equinox sunset. The secondary altar, situated near the southeast entry, is illuminated at dawn during the time of the March and September equinox sunrises.

Lacco exhibits fine examples of the Incas' passion for using light from the sun or moon in their shrines and ceremonies. The huaca was finely carved across its top and still shows many examples of Inca sculptures such as seats, steps and animals. It is the caves, however, that truly demonstrate the prowess the Incas had for solar orientation. Each of the three has altars that the Incas deemed important enough to illuminate at certain times by the sun or moon. The exact ceremonies performed remain subject to interpretation, but the ability to utilize solar or lunar light while conducting them is clear. The Northeast Cave's altar is fully illuminated in the early morning on days approaching, during, and following the June solstice. The alignment of the cave opening's center with the sunrise point on the horizon is striking, as was shown in Figure 9-21. The sun's rays are cast directly upon the altar and reflections brightly illuminate the rest of the chamber. Two large steps are situated immediately in front of the cave and may have been a part of associated ceremonies. In front of the steps are two large separate thrones that also are oriented toward the solstice sunrise. The thrones would have been excellent locations for observing the rising sun.

The Southeast and Southwest Caves incorporate specifically oriented light-tubes to admit the rays of the sun or moon. The Southwest Cave is the smaller of the two and also has a smaller altar. Its light-tube's alignment with the region of the ecliptic was shown with the waxing crescent moon in Figure 9-23 and light will be admitted when the sun or moon crosses the sky at an angle of 70°-75° above the horizon. The Southeast Cave appears to have been the most prominent of the three as evidenced by the degree of workmanship in its sculpture, complete with fine carvings of a puma and snake near its entrance and the highly polished altar within its inner chamber. The altar is of an appropriate size and height for ceremony and sacrifice and is brilliantly illuminated by the sun when it approaches 90° above the horizon near the time of the zenith, as was shown with Figure 9-26. The zenith orientation of this light-tube is important due to the significance that zenith passage plays in the Inca calendar. There is a deep chamber adjacent to the altar that gives the appearance of entry into the underworld, a cosmological connection that is common with many Inca caves.

The huaca located between Kenko Grande and Lacco with the two circles that exhibit orientations indicating horizon positions of the solstice and east-west/equinox solar events is especially interesting. While this site is known to the locals, its function appears to have been overlooked by previous scholarly investigation. It is intriguing to find a construct that includes orientations for all primary solar horizon positions and I have drawn these orientations in Figure

9-30 and Figure 9-31. I first observed the east-west orientations of the circles and then noted the additional orientations for the solstices. This site may as well have had other functions, but for reasons yet to be determined watching solstice and eastern/equinox sunrises and sunsets appears that it my have been important here. The many seats carved upon the huaca underscore this relationship as there is at least one oriented for each of the associated sun risings or settings, with the exception of the June solstice sunset where that part of the outcrop has eroded extensively. The full extent of the Incas' purpose for this huaca remains to be seen.

The separation of elites and non-elites for the viewing of special solar events is an interesting concept that is also possible at Tipon and Quespiwanka. Bauer and Stanish (2001) suggested that the Incas separated such viewings at the Island of the Sun in Lake Titicaca. I observed that both Tipon and Quespiwanka also appear to be oriented for class division regarding solar ceremonies. At Tipon there is a double-jambed door along the trail leading up the hill to the Intihuatana complex. Inca rulers desiring to indoctrinate the masses appear to have created separate viewing areas for them aside from those of the elite. In each case orientations were such that the non-elite viewers would see the sun rise or set over the elites, perhaps even the ruling Inca himself. As the son of the sun, this effect would certainly be a valuable part of the state-sponsored indoctrination received by pilgrims. The same could have occurred at Quespiwanka where non-elites were barred from the main palace grounds by a triple-jambed entranceway, but could view the June solstice sun rise over the palace from outside its south wall.

12.3.2 Sacred Valley Region

Many structures at Chinchero were constructed with cardinal orientations and a question that remains is by what means did the Incas determine them? It is possible to determine these directions by shadow at the times of equinoxes. Otherwise a gnomon shadow plot could be used to establish true south. No matter which method was used, the end result is impressive.

I found several orientations during my research that were cardinally east and west. A lingering question concerns whether or not the Incas recognized the exact dates of the equinoxes on the horizon. There is no record of such interest in the Spanish chronicles. What did the equinox mean to the Incas? Their understanding of the event was likely quite different from ours.

Chinkana, Mesakaka, and Kondorkaka are all aligned north and south with regard to one another. While it is unlikely that Chinkana was moved, the other two huacas are small enough to have had their positions adjusted. Chinkana and Titikaka are aligned approximately on the axis of the June solstice sunrise and December solstice sunset. Both rocks would seem to be immovable, so how were the Incas fortunate enough to have these two major outcrops align with this most important axis? Regardless, they used the orientation to their advantage with the orientation of the triangular basin and the balcony on Chinkana, as well as the hole on the upper surface of Titikaka. Paternosto (1996) talks much about Inca textiles and it would seem possible that they may have hung a banner from a pole set into this post-hole. The banner, or flag, could then have been a visual part of the orientation of the rocks for the June solstice sunrise or the December solstice sunset. As viewed from Chinkana's balcony, a large banner atop Titikaka could help accentuate the ritual setting of the December solstice sun.

Pisac's most distinguishing feature is its Intihuatana. The name and meaning of *intihuatana* is a matter of debate and is now thought to be somewhat of a misnomer applied in more recent times. Traditionally these may have been "hitching posts of the sun," or the term simply may have been given to them by local villagers in later years. The stones are normally the most impressive of the sites they occupy, and the one at Pisac is no exception. It is a carved huaca with a carved cylinder on top. Unlike other intihuatanas, though, this one is enclosed by masonry walls in the shape of the letter "D." At Tipon the intihuatana is different still as it has not been carved and instead consists of several unimproved boulders that are gathered together on a prominent point of the site. The intihuatanas at Machu Picchu and the Urubamba River are both finely carved on all four sides. The Machu Picchu Intihuatana is located on high ground, while the River Intihuatana is low in a river valley. The River Intihuatana also shares features in common with stones such as the Ceremonial Rock of Machu Picchu and the Rumihuasi Stone of Saihuite. Neither of these rocks are commonly known as intihuatanas, but they are quite similar to the one by the Urubamba River. Perhaps there is no definitive answer as to whether some of these sites actually constitute intihuatanas in the traditional sense, if some of those that are not should be, or even what intihuatana really means.

The pillars above Quespiwanka are remarkable examples of a piece of Inca history. Spanish chroniclers recorded solar pillars on the horizons of Cusco, but all were eradicated, presumably in the Catholic purge of Inca idolatries. Their locations were recorded, but no remains have been found. Accounts speak of them being used to monitor solar positions, but there is no extant evidence to this effect. The pillars near Urubamba give credibility to the reports in Cusco and enable us to study this form of horizon astronomy first-hand. The two towers survive very well on the Cerro Sayhua ridge and show the feasibility of this method to mark the June solstice sunrise. The alignment supports Bauer's and Dearborn's 1995 hypothesis with regard to these structures as well as Niles' (1999) suggestions regarding the prominence of the white granite boulder and the adjacent platform that were the central features of Huayna Capac's palace grounds. The utility of the boulder and platform as the focal point of the plaza is supported by this orientation and, to a lesser extent, by potential alignments with natural horizon features for the December solstice sunrise and the June solstice sunset. The remains of a wall on top of Cerro Pumahuachana and the three pillars at the peak of Cerro Unoraqui remain enigmatic and inspire many questions as to their meaning and purpose.

12.3.3 Machu Picchu Region

Machu Picchu is rich with astronomical symbolism. The orientations exhibited for the major solar axis of the June solstice sunrise/December solstice sunset are especially noteworthy. Within Machu Picchu the Torreon, Royal Mausoleum and the Sacred Plaza each have orientations associated with these horizon events and form one end of what could have been an intentional ceque that included the River Intihuatana and Llactapata Sun Temple. This orientation is clearly demonstrated when sunrise over Machu Picchu is viewed from Llactapata on the morning of the June solstice. Polo de Ondegardo (1965 [1571]) tells us that each Inca village had ceques connecting shrines and it appears possible that a ceque system may have been established at Machu Picchu, smaller but similar to the one in Cusco. An additional ceque possibility in this area is the alignment of Llactapata's Overlook Temple with the River Intihuatana and Cerro Machu Picchu. The possibility of ceques and huacas other than in Cusco is intriguing. Certain Machu Picchu huaca locations and alignments lend themselves in support of this concept and ultimately may validate Polo de Ondegardo's claim.

The Intihuatana of Machu Picchu is perhaps the best known stone of the empire. It is finely carved in its entirety and includes a vertical column in the center of its upper surface. The meaning and purpose of the Intihuatana is subject to debate, but it appears to exhibit no apparent functions regarding any astronomical orientations. It is similar to most of the other intihuatanas in that it is sculpted on all four sides, but the specific carvings of Machu Picchu's Ceremonial Rock bear a much closer resemblance to those found on others such as the River Intihuatana. The stones from the river that were brought to surround the Ceremonial Rock emphasize the potential relationship between these two. The Rumihuasi Stone at Saihuite also is similar and taken together these likenesses suggest common purpose for these three stones. If the River Intihuatana was indeed an intihuatana, then were the Ceremonial Rock and the Rumihuasi Stone intihuatanas as well? If not, then was the River Intihuatana, first named so by Bingham, really an intihuatana at all? At the bottom of a river valley it certainly was not in a position as favorable to the sun as were its counterparts. The intihuatanas at Machu Picchu, Pisac, Tipon and the Urubamba River have been described as "hitching posts of the sun," but perhaps their true functions were somewhat different.

The River Intihuatana appears to have played a much more significant role in the overall complex surrounding Machu Picchu than was previously known. It provides a distinct link between the huacas and structures of Machu Picchu and Llactapata and may be part of a ceque system connecting them both. In addition to lying on the June solstice sunrise/December solstice sunset axis, the River Intihuatana also is part of an alignment between the points of an east-west/equinox sunrise and sunset that includes Llactapata's Overlook Temple and Cerro Machu Picchu. This potential ceque emphasizes the possible significance of the River Intihuatana as it is positioned at the junction of these two prominent axes. The locations of Llactapata's Sun Temple and Overlook Temple may have been selected specifically to form these alignments. The Sun Temple is remarkable in its orientation with Machu Picchu near to the axis of June solstice sunrise and December solstice sunset. The placement of the River Intihuatana between them was likely deliberate. The rediscovery of Llactapata and all of its many structures has suggested that an intricate system existed throughout the area that was both planned in location and linked in function. The prominence of the River Intihuatana began to emerge as a result of these Llactapata orientations. This appears to be a site selected for great significance.

The location of the River Intihuatana is noteworthy as it lies near the banks of the powerful Urubamba River as well as at the junction of two prominent solar axes. Upstream the Urubamba is known as the Vilcanota, the river central to the circulation of cosmological energy from the earth, through the Milky Way, and then back again by way of sacred mountains. Great power was thought by the Incas to emanate from these waters, thus the river's southeast to northwest orientation makes for a third celestial/cosmological associated orientation that intersects at the site of the River Intihuatana, a correlation of which the Incas would have been well aware.

The features incorporated into this huaca also imply its importance to the Incas. The River Intihuatana exhibits examples of many of the motifs found in other Inca shrines. Its stairs, fountain, basins, and caves, along with the platform and tower, would all indicate that a great effort was put into establishing this sanctuary and of the significance that it held.

The platform at the River Intihuatana is situated such that it has a clear view of both the Llactapata Overlook Temple and the Machu Picchu Intihuatana. Platforms were often constructed for spiritual use and frequently served as ceremonial locations for sacrifices. These platforms were called *usnu* and Hemming and Ranney (1982: 37) tell us that the Spanish chronicler Cabello de Balboa stated "[Huayna Capac] had erected in the square a structure called usnu or chinquin-pillaca, where sacrifices might be offered to the sun and its different phases, with chichi [maize beer] poured out in its honor." The River Intihuatana's platform is adjacent to the Intihuatana, well situated to appease the sun with appropriate sacrifice.

The second cave on the sanctuary is located beneath the boulder forming the western side of a tower with a rounded wall. The location of this tower at the bottom of a canyon is interesting. Its utility in solar observations would be limited by high horizons, but it still could have been used to note passage of the sun at zenith. A circular tower reaching to the sky while sitting atop a cave may have served to symbolize and facilitate connections between the world of the present and both the gods of the heavens and the forces of the underworld. The cave could have symbolically provided access to the Pachamama and might also have served to preserve a mummy.

The symbology found at the River Intihuatana appears to have been significant, perhaps diminishing the possibility that it was a simply a stop for pilgrims in the area. Instead the primary function of the huaca seems more likely to have been as a ritual center for ceremonies that served to connect with forces of the supernatural. The River Intihuatana may have been a key component in the power and significance of the greater Machu Picchu complex.

The 2003 rediscovery of Llactapata has given rise to many new questions regarding the overall extent, orientation, and function of the entire Machu Picchu ceremonial complex. Its many structures suggest a significant enlargement of the overall estate and introduce the possibility that there may have been a ceque system here as well as the one located in Cusco. The orientation of the stone-lined channel and Sun Temple at Llactapata with the River Intihuatana and Machu Picchu's Sacred Plaza is striking and, as shown in Figures 11-33b and 11-34, can be clearly seen from Llactapata at sunrise on the day of the June solstice. Orientations with the Pleiades exist both from Llactapata's Sun Temple and at Machu Picchu's Torreon.

Another interesting supposition concerns the role that Llactapata may have played in the ceremonies of Machu Picchu. The two sites appear directly associated with one another and it is likely that Llactapata was an extension of and supported ritual activities in the area. The demonstration I show in Figure 11-41 with solar reflections from Llactapata's Sun Temple to Machu Picchu's Sacred Plaza at the time of the June solstice indicates that solar ceremonies including the two sites were possible.

12.4 Future Research

Additional sites exist across the former Inca Empire that are beyond the boundaries of my present research. I have examined huacas and shrines mainly between Cusco and Machu Picchu, but others certainly exhibit intentional astronomical orientation.

I sense that there is still more to be learned about the pillars above Quespiwanka and the solar orientations of the related carved granite boulder. These pillars may now serve to validate claims that similar structures surrounded Cusco. The structures on top of Cerro Unoraqui are fascinating, but their purpose at present remains a mystery. More research should be done that includes further questioning of the villagers living on the mountainside. The original purpose for the wall whose remains run along the ridge top of Cerro Pumahuachana bears additional investigation as well. These are among the most prominent of several unsolved questions remaining for future research at these two sites.

Pillars have been identified at Quespiwanka, the Island of the Sun, and Punkuyoc. Where else in the empire may Pachacuti, Topa Inca, or Huayna Capac have employed similar devices on another horizon? Could there be pillars on sightlines from the Intihuatana of Pisac or Tipon, or perhaps the temple at Raqchi? Research in these areas might add valuable insight with regard to understanding the chronicled pillars of Cusco.

The River Intihuatana now emerges from its former status as a little known and misunderstood huaca to assume prominence as a major and important component of the overall Machu Picchu ceremonial complex. Additional research will help to further develop the context within which it functioned.

The huaca between Kenko Grande and Lacco that has the two circles aligned for each of the solstice and east-west/equinox horizon events is an area that I plan to examine further in an attempt to understand the intended purpose for these orientations, as well as the other non-astronomical functions for which the huaca was most likely used.

The concept of segregated elite/non-elite areas for viewing of key solar events may have exhibited examples at Lake Titicaca, Quespiwanka and Tipon. Other known and potential pilgrimage centers should be examined for the possibility that segregated viewing was conducted there as well.

Establishing that ceques existed outside of Cusco warrants further study and present research indicates that the huacas of Machu Picchu well may have been organized along such lines. Additional investigation should help to either substantiate or refute this concept.

12.5 Concluding Remarks

At first glance solar huacas and non-astronomical shrines appear quite similar. Their features exhibit little or nothing that would immediately indicate any astronomical orientation. Certain huacas without celestial meaning are very finely carved, yet a significant rock with solar orientations at Quespiwanka was not sculpted at all. Astronomical huacas do have more instances of water sources, but others have channels as well.

The picture emerges of a culture interwoven with cosmology and astronomy. The Incas possessed celestial knowledge and as solar worshippers they chose to incorporate and display orientations and features of the sun, their god, in their many temples and shrines throughout the empire. The huacas of this study point to a society that was both infatuated with the sun and that possessed the technical ability to use their celestial knowledge with any structure or carving they so desired.

Appendices

A1 Glossary

Aclla - a chosen woman serving the ruling Inca

Acllahuasi - house of the chosen women

Amaru - snake

Anti - dawn or east

Antisuyu - the northeast quadrant of both Cusco and of the Inca Empire

Apu - sacred mountain

Ayllu - a non-royal kin group

Camayoc - attendant or specialist

Cancha - an enclosed compound and courtyard

Capac - royal

Capac Raymi - a festival at the time of the December solstice

Ceque - a sightline that organizes huacas around its direction

Chaca - bridge

Chasqui - courier

Chicha - maize beer

Chinchaysuyu - the northwest quadrant of both Cusco and of the Inca Empire

Chulpa - burial tower

Citua Raymi - Inca festival in September

Cocha - lake

Collana - something that is principal or first

Collasuyu - the southeast quadrant of both Cusco and of the Inca Empire

Coricancha - the principal sun temple of Cusco

Coya - the sister-wife of a ruling Inca

Coya Raymi - see Citua Raymi

Cunti - sunset, the west

Cuy - guinea pig

Cuntisuyu - the southwest quadrant of both Cusco and of the Inca Empire

Curaca - chief or leader

Hanan - upper

Hatun - large or great

Huaca - shrine

Huaman - falcon

Huayna - young

Huasi - house

Huatana - hitching post

Huauque - totem

Huchuy - small

Hurin - lower

Illapa - thunder

Inti - the sun

Intihuatana - hitching post of the sun

Inti Raymi - a festival at the time of the June solstice

Kallanka - long rectangular hall with many doors

Kenko - zigzagged

Llacta - town

Machay - cave

Mama - mother

Mamacona - holy woman

Mayu - river

Mita - labor service for the Empire

Mitmae - resettled colonists

Moiety - One of two parts. Inca communities were often divided into upper and lower sectors

Ñusta - princess

Macarena - place of origin of mythical ancestors as they emerged from the earth

Pacariqtambo - place of Inca origin

Paccha - waterfall

Pacha - earth

Pampa - plain

Panaca - a kin group formed of the royal descendants of an Inca

Pata - platform or terrace

Picchu - mountain

Pirua - storehouse

Puma - mountain lion

Puna - high savannah

Punchao - a golden sun idol

Puncu - entrance or gate

Puquiu - a spring or fountain

Pururaucas - stones mythically transformed into warriors when the Inca defeated the Chanca

Qollca - storehouse

Quilla - the moon, also a month

Quipu - a knotted cord used to record information

Quipucamayoc - person who kept, recorded and interpreted quipus

Racay - hall or shed

Raymi - festival

Rimac - oracle

Rumi - stone

Sayhua - marker

Sucanca - solar marker

Suyu - a geographical division. The region of Cusco was divided into four quadrants, or suyus

Tahuantinsuyu - the name for the Inca empire as a whole

Tambo - place of lodging

Taqui - dance

Tocco - a cave

Urco - hill

Usnu - administrative or religious platform

Vilca - sacred

Yunga - lowland

Wak'a - huaca, shrine

Warachikoy - a December ritual for recognizing young noblemen as adults

Zeq'e - ceque, line

A2 GPS Data

Region Surrounding Cusco

9.2 Kenko Grande

Main entrance to cave
S13° 30’ 33” W071° 58’ 14”
3596 masl

Secondary entrance to cave
S13° 30’ 33” W071° 58’ 14”
3594 masl

9.3 Kenko Chico

Upper surface center
S13° 30’ 37” W071° 58’ 19”
3590 masl

9.4 Mesa Redonda

Base
S13° 30’ 48” W071° 58’ 11”
3474 masl

9.5 Tetecaca

Base
S13° 30’ 54” W071° 57’ 56”
3492 masl

9.6 Patallacta

Base
S13° 30’ 45” W071° 58’ 06”
3543 masl

9.7 Kusilluchayoc

Kusilluchayoc west corridor
S13° 30’ 29” W071° 57’ 57”
3625 masl

9.8 Lacco

Northeast Cave
S13° 30’ 20” W071° 57’ 52”
3655 masl

Southwest Cave
S13° 30’ 21” W071° 57’ 54”
3662 masl

Southeast Cave
S13° 30’ 22” W071° 57’ 51”
3648 masl

9.9 Huaca with two circles aligned for solar horizon events

Two circles
S13° 30’ 18” W071° 58’ 41”
3662 masl

9.10 Lanlakuyok

Eastern opening

S13° 30’ 21” W071° 58’ 44”

3727 masl

9.11 Puca Pucara

West doorway

S13° 29’ 0” W071° 57’ 43”

3805 masl

9.12 Tambomachay

Cave Opening

S13° 28’ 35” W071° 58’ 5”

3900 masl

9.13 Sacsahuaman

Tired Stone

S13° 28’ 35” W071° 58’ 5”

3610 masl

Throne of the Inca

S13° 30’ 48” W071° 58’ 11”

3618 masl

Top of zigzag walls

S13° 30’ 26” W071° 58’ 54”

3607masl

Base of zigzag walls

S13° 30’ 30” W071° 58’ 55”

3595 masl

9.14 Mollaguanca

East end crevasse

S13° 30’ 21” W071° 58’ 44”

3581 masl

9.15 Sapantiana

Base

S13° 30’ 44” W071° 58’ 41”

3465 masl

9.16 Rumiwasi Bajo

East end tunnel

S13° 31’ 12” W071° 56’ 26”

3740 masl

9.17 Rumiwasi Alto

Wall with niches center

S13° 30’ 58” W071° 56’ 21”

3563 masl

9.18 Kusicallanca

Wall with niches center

S13° 31’ 13” W071° 56’ 14”

3573 masl

9.19 Tipon

Iglesia Raqui

S13° 34’ 14” W071° 46’ 15”

3476 masl

GPS azimuth Iglesia Raqui to Tipon Intihuatana*

292.35

Top of terrace system

S13° 34’ 9” W071° 46’ 54”

Intihuatana

S13° 24’ 10” W071° 47’ 8”

3554 masl

GPS azimuth Tipon Intihuatana to Iglesia Raqui*

112.35°

9.20 Saihuite

Principle Stone

S13° 32’ 50” W072° 48’ 11”

3653 masl

Niche toward horizon

S13° 32’ 50” W072° 48’ 11”

3654 masl

Top of fountain with stairs

S13° 32’ 49” W072° 48’ 8”

3640 masl

Bottom of fountain with stairs

S13° 32’ 49” W072° 48’ 7”

3623 masl

Rumihuasi Stone

S13° 32’ 46” W072° 47’ 58”

3584 masl

Chingana Platform

S13° 32’ 53” W072° 47’ 54”

3565 masl

Third Stone

S13° 32’ 50” W072° 47’ 47”

3545 masl

Sacred Valley Region

10.2 Chinchero

First rock east of the chapel
S13° 23 24” W072° 02’ 47”
3790 masl

Kondorkaka
S13° 23’ 21” W072° 02’ 37”
3773 masl

Mesakaka
S13° 23’ 17” W072° 02’ 35”
3744 masl

Chinkana
S13° 23’ 16” W072° 2’ 35”
3724 masl

GPS azimuth Chinkana to Titikaka*
250.085°

Titikaka
S13° 23’ 48” W072° 2’ 48”
3753 masl

GPS azimuth Titikaka to Chinkana*
070.085°

10.3 Pisac

Pisac intihuatana

S13° 24' 51" W071° 50' 38"

3395 masl

10.4 Quespiwanka

Boulder

S13° 18' 5" W072° 6' 47"

2922 masl

GPS azimuth Quespiwanka boulder to Cerro Unoraqui mountaintop*

110.316°

Triple-jamb doorway

S13° 18' 4" W072° 6' 40"

2933 masl

Outside south wall

S13° 18' 5" W072° 6' 47"

2922 masl

10.5 Cerro Pumahuachana

South wall remains – south end

S13° 19' 5" W072° 3' 54"

3568 masl

South wall remains – north end

S13° 19' 4" W072° 3' 55"

3572 masl

North wall remains – south end
S13° 19' 2" W072° 3' 55"
3575 masl

North wall remains – north end
S13° 18' 59" W072° 3' 56"
3592 masl

Below chapel
S13° 18' 50" W072° 3' 56"
3618 masl

10.6 Cerro Unoraqui

Village on side of mountain
S13° 20' 6" W071° 59' 20"
2937 masl

Mountaintop
S13° 20' 21" W072° 0' 27"
4377 masl

GPS azimuth Cerro Unoraqui mountaintop to Quespiwanka boulder*
290.316°

10.7 Choquequilla

Choquequilla carved stone
S13° 17' 32" W072° 13' 56"
3627 masl

10.8 Ollantaytambo

Ollantaytambo base of terraces
S13° 15’ 17” W072° 15’ 48”
2792 masl

Machu Picchu Region

11.2 Machu Picchu

Intihuatana

S13° 9’ 47” W072° 32’ 44”

2468 masl

Sacred Plaza

S13° 9’ 49” W072° 32’ 44”

2466 masl

GPS azimuth Machu Picchu Sacred Plaza to River Intihuatana*

223.552°

GPS azimuth Machu Picchu Sacred Plaza to Llactapata Sun Temple*

239.874°

Inca Bridge

S13° 10’ 13” W072° 32’ 40”

2550 masl

Mortars

S13° 9’ 48” W072° 32’ 40”

2460 masl

Huayna Picchu mountaintop

S13° 9’ 24” W072° 32’ 45”

2698 masl

Huayna Picchu Building of Three Windows

S13° 9’ 24” W072° 32’ 45”

2690 masl

Temple of the Moon

S13° 9’ 5” W072° 32’ 47”

2277 masl

11.3 River Intihuatana

River Intihuatana

S13° 10’ 32” W072° 33’ 26”

1819 masl

GPS azimuth River Intihuatana to Machu Picchu Sacred Plaza*

043.552°

GPS azimuth River Intihuatana to Llactapata Sun Temple*

249.298°

11.4 Llactapata

Base Camp
S13° 11 10” W072° 34 53”

2601 masl

Sun Temple
S13° 11’ 9” W072° 35’ 5”
2740 masl

GPS azimuth Llactapata Sun Temple to Machu Picchu Sacred Plaza*

059.874°

GPS azimuth Llactapata Sun Temple to River Intihuatana*
069.298°

*Azimuths between GPS positions were calculated as the arctangent of the opposite over the adjacent, opposite being the difference in latitude and adjacent the difference in longitude.

A3 Magnetic Declination

(From the National Oceanic and Atmospheric Administration: National Environmental Satellite, Data and Information Service - National Geophysical Data Center)

Region Surrounding Cusco

9.2 Kenko Grande

S13° 30’ 31” W071° 58’ 14”

10/26/06 3° 35’ W

9.3 Kenko Chico

S13° 30’ 37” W071° 58’ 19”

6/5/08 3° 51’ W

9.4 Mesa Redonda

S13° 30’ 48” W071° 58’ 11”

10/17/08 3° 55’ W

9.5 Tetecaca

S13° 30’ 54” W071° 57’ 56”

10/17/08 3° 55’ W

9.6 Patallacta

S13° 30' 45" W071° 58' 06"

10/17/08 3° 55' W

9.7 Kusilluchayoc

S13° 30' 29" W071° 57' 57"

10/17/08 3° 55' W

9.8 Lacco

S13° 30' 21" W071° 57' 51"

10/17/08 3° 55' W

9.9 Huaca with two circles aligned for solar horizon events

S13° 30' 18" W071° 58' 41"

10/17/08 3° 55' W

9.10 Lanlakuyok

S13° 30' 21" W071° 58' 44"

10/14/08 3° 55' W

9.11 Puca Pucara

S13° 29’ 0” W071° 57’ 43”

10/14/08 3° 55’ W

9.12 Tambomachay

S13° 28’ 35” W071° 58’ 5”

10/17/08 3° 55’ W

9.13.2 Sacsahuaman – Tired Stone

S13° 30’ 15” W071° 58’ 52”

10/14/08 3° 54’ W

9.13.3 Sacsahuaman – Throne of the Inca

S13° 30’ 48” W071° 58’ 11”

10/14/08 3° 54’ W

9.14 Mollaguanca

S13° 30’ 21” W071° 58’ 44”

10/14/08 3° 54’ W

9.15 Sapantiana

S13° 30’ 44” W071° 58’ 41”

10/14/08 3° 54’ W

9.16 Rumiwasi Bajo

S13° 31’ 12” W071° 56’ 26”

10/14/08 3° 55’ W

9.17 Rumiwasi Alto

S13° 30’ 58” W071° 56’ 21”

10/16/08 3° 56’ W

9.18 Kusicallanca

S13° 31’ 13” W071° 56’ 14”

10/16/08 3° 56’ W

9.19 Tipon

S13° 34’ 14” W071° 46’ 15”

10/16/08 4° 3’ W

9.20.2 Saihuite – Upper Structure

S13° 32’ 50” W072° 48’ 11”

10/15/08 3° 13’ W

Sacred Valley Region

10.2.7 Chinchero – Chinkana

S13° 23’ 16” W072° 2’ 35”

10/25/07 3° 43’ W

10.2.8 Chinchero – Titikaka

S13° 23’ 48” W072° 2’ 48”

10/25/07 3° 43’ W

10.3 Pisac

S13° 24’ 51” W071° 50’ 38”

10/16/08 4° 2’ W

10.4 Quespiwanka

S13° 18’ 5” W072° 6’ 47”

6/8/08 3° 47’ W

10.5 Cerro Pumahuachana

S13° 19’ 4” W072° 3’ 55”

6/7/08 3° 49’ W

10.6 Cerro Unoraqui

S13° 20’ 21” W072° 0’ 27”

10/17/08 3° 55’ W

10.7 Choquequilla

S13° 17’ 32” W072° 13’ 56”

10/17/08 3° 55’ W

10.8 Ollantaytambo

S13° 15’ 17” W072° 15’ 48”

10/27/06 3° 25’ W

Machu Picchu Region

11.2.1 Machu Picchu – Intihuatana

S13° 9’ 47” W072° 32’ 44”

6/19/07 3° 19’ W

11.2.2 Machu Picchu Sacred Plaza

S13° 9’ 49” W072° 32’ 44”

6/19/07 3° 19’ W

11.2.4 Machu Picchu – Mortars

S13° 9’ 48” W072° 32’ 40”

6/19/07 3° 19’ W

11.2.7 Machu Picchu – Huayna Picchu

S13° 9’ 24” W072° 32’ 45”

6/6/08 3° 29’ W

11.2.8 Machu Picchu – Temple of the Moon

S13° 9’ 5” W072° 32’ 47”

10/28/06 3° 13’ W

11.3 River Intihuatana

S13° 10’ 32” W072° 33’ 26”

6/17/07 3° 18’ W

11.4 Llactapata

S13° 11’ 9” W072° 35’ 5”

6/18/07 3° 17’ W

A4 Solar Horizon Positions

Calculated for horizon deviation using:

Azimuth of sun = Arccos ((Sin(DEC) – sin(LAT)Sin(ALT))/(Cos(LAT)Cos(ALT))

Region Surrounding Cusco

9.2 Kenko Grande

S13° 30’ 31” W071° 58’ 14”

ESR Alt 2° up; ESS Alt 6° up

March 20

Dec -0.400

ESR	089.93°
ESS	271.03°

9.3 Kenko Chico

S13° 30’ 37” W071° 58’ 19”

DSSR Alt 2° up

December 21

Dec -23.433

DSSR	113.63

9.7 Kusilluchayoc

S13° 30’ 29” W071° 57’ 57”
JSSS Alt 4° up

June 21
Dec 23.433
JSSS 295.26°

9.8 Lacco

S13° 30’ 21” W071° 57’ 51”
JSSR Alt 4° up

June 22
Dec 23.433
JSSR 064.74°

9.9 Huaca with two circles aligned for solar horizon events

S13° 30’ 18” W071° 58’ 41”
JSSR Alt 3° up
ESR Alt 2° up
DSSR Alt 2° up

June 21
Dec 23.433
JSSR 065.03°

March 20
Dec -0.400
ESR 089.56°

December 21

Dec -23.433

DSSR 113.63°

9.10 Lanlakuyok

S13° 30’ 21” W071° 58’ 44”

ESR Alt 2° up

March 20

Dec -0.400

ESR 089.56°

9.11 Puca Pucara

S13° 29’ 0” W071° 57’ 43”

ESR Alt 3° up

ESS Alt 4° up

March 20

-0.400

ESR 089.69°

ESS 270.55°

9.12 Tambomachay

S13° 28’ 35” W071° 58’ 5”

DSSR Alt 1° up

December 21

Dec -23.433

DSSR 113.88°

9.14 Mollaguanca

S13° 30’ 21” W071° 58’ 44”

JSSR Alt 3° up

DSSS Alt 2° up

June 21

Dec 23.433

JSSR 065.03°

December 21

Dec -23.433

DSSS 246.37°

9.16 Rumiwasi Bajo

S13° 31’ 12” W071° 56’ 26”

DSSR Alt 2° up

December 21

Dec -23.433

DSSR 113.63°

9.17 Rumiwasi Alto

S13° 30’ 58” W071° 56’ 21”

DSSR Alt 1° up

December 21

Dec -23.433

DSSR 113.88°

9.18 Kusicallanca

S13° 31’ 13” W071° 56’ 14”
DSSR Alt 0°

December 21
Dec -23.433
DSSR 114.14°

9.19 Tipon

S13° 34’ 14” W071° 46’ 15”
JSSS Iglesia Raqui Alt 13° up
JSSS Intihuatana Alt 1° up

June 21
Dec 23.433
JSSS Iglesia Raqui 298.37°
JSSS Intihuatana 294.42°

9.20.2 Saihuite – Upper Structure niche

S13° 32’ 50” W072° 48’ 11”
JSSR Alt 2° up

June 21
Dec 23.433
JSSR 065.31°

Sacred Valley Region

10.2.7 Chinchero – Chinkana

S13° 23’ 16” W072° 2’ 35”

DSSS Alt 10° up

December 21

Dec -23.433

DSSS	248.09°

10.2.8 Chinchero – Titikaka

S13° 23’ 48” W072° 2’ 48”

JSSR Alt 5° up

June 21

Dec 23.433

JSSR	064.46°

10.3 Pisac

S13° 24’ 51” W071° 50’ 38”

JSSR Alt 8°

DSSR Alt 10°

June 21

Dec 23.433

JSSR	063.49°

December 21

Dec -23.433

DSSR	111.91°

10.4 Quespiwanka

S13° 18’ 5” W072° 6’ 47”

JSSR Outside Palace 23° up

JSSR Boulder 24° up

JSSS Alt 5° up

DSSR Alt 6° up

DSSS Alt 5° up

ESR Alt 14° up

ESS Alt 5° up

ZSR Alt 4° up

AZSS Alt 5° up

June 21

Dec 23.433

JSSR Outside Palace	057.82°
JSSR Boulder	056.46°
JSSS	295.52°

March 20

Dec -0.400

ESR	087.05°
ESS	270.77°

December 21

Dec -23.433

DSSR	112.69°
DSSS	247.31°

February 13

Dec -13.301

ZSR	103.08°

August 18

Dec -13.301

AZSS 284.95°

10.7 Choquequilla

S13° 17' 32" W072° 13' 56"

DSSR Alt 32° up

December 21

Dec -23.433

DSSR 109.53°

Machu Picchu Region

11.2.1 Machu Picchu – Intihuatana

S13° 9' 47" W072° 32' 44"

JSSR Alt 13° up

June 21

Dec 23.433

JSSR 061.76°

11.2.2 Machu Picchu Sacred Plaza

S13° 9' 49" W072° 32' 44"

JSSR Alt 12° up

June 21

Dec 23.433

JSSR 062.16°

11.2.4 Machu Picchu – Mortars

S13° 9’ 48” W072° 32’ 40”

ESR Alt 33° up

March 20

Dec -0.400

ESR 081.76°

11.2.7 Machu Picchu – Huayna Picchu

S13° 9’ 24” W072° 32’ 45”

DSSS Alt 1° up

December 21

Dec -23.433

DSSS 246.15°

11.2.8 Machu Picchu – Temple of the Moon

S13° 9’ 5” W072° 32’ 47”

JSSS Alt 14° up

June 21

Dec 23.433

JSSS 298.63°

11.3 River Intihuatana

S13° 10’ 32” W072° 33’ 26”

ESR Alt 19° up

March 20

Dec -0.400

ESR 085.81°

11.4 Llactapata

S13° 11’ 9” W072° 35’ 5”

JSSR Alt 5° up

June 21

Dec 23.433

JSSR 064.50°

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