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:

<u>Region Surrounding Cusco</u>

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

<u>Sacred Valley Region</u>

Chinchero
Pisac
Quespiwanka
Cerro Pumahuachana
Cerro Unoraqui
Choquequilla
Ollantaytambo

<u>Machu Picchu Region</u>

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 16^{th} 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.

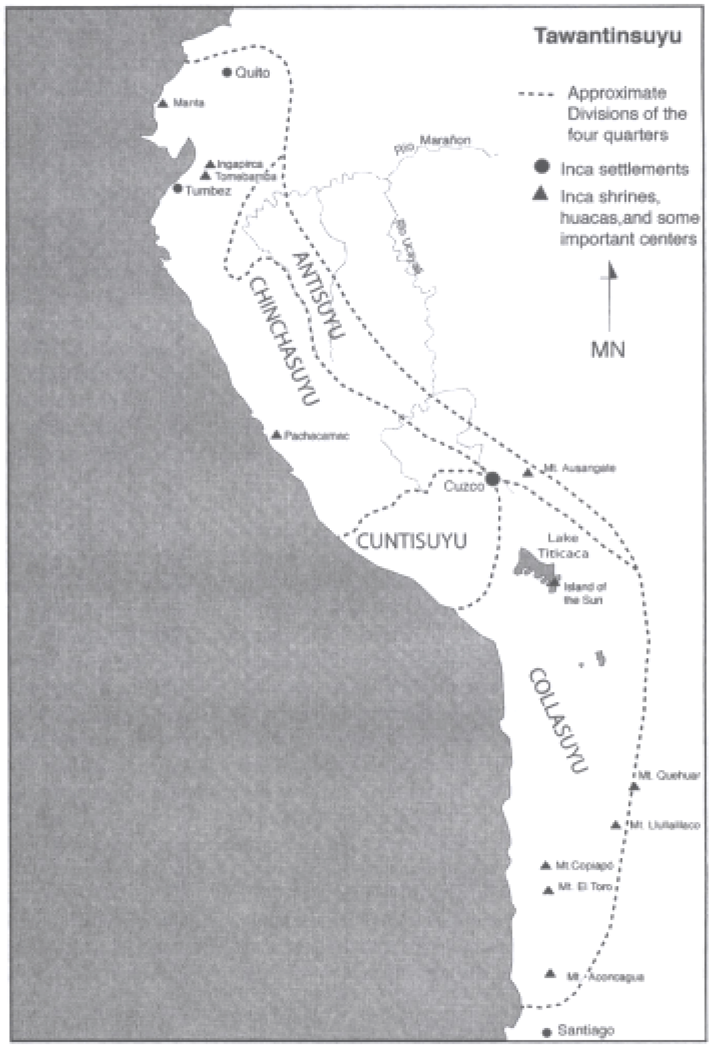

Figure 5-1: The four suyus of Tiwantinsuyu (from Staller, 2008: 279).

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.

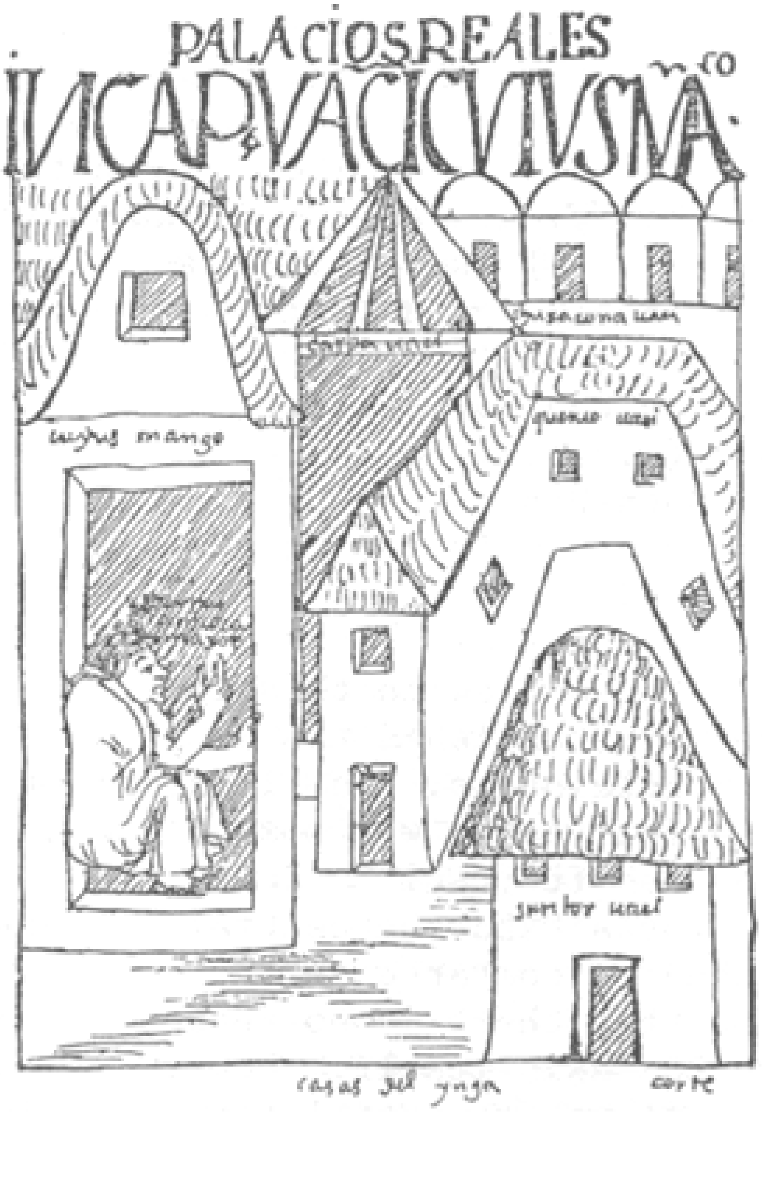

Figure 5-4: Drawing depicting the Sunturhuasi (Guaman Poma, f. 329).

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 15th (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).

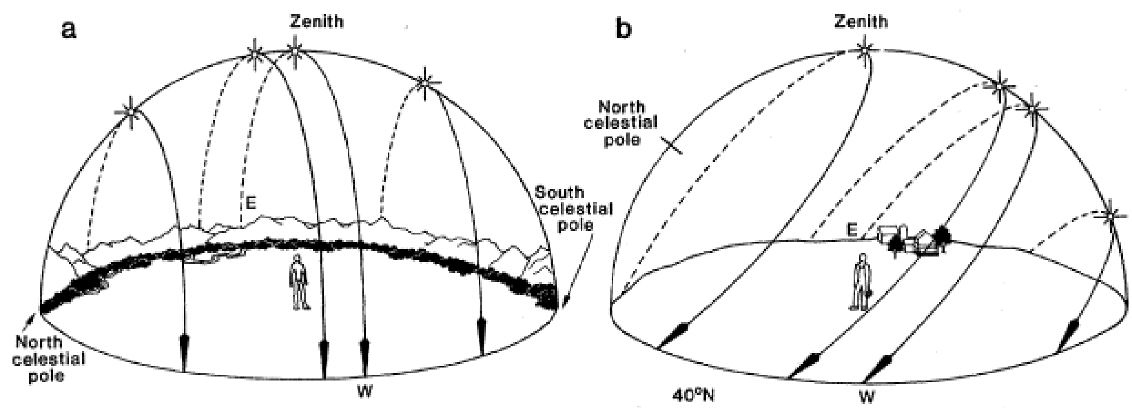

Figure 7-1: Paths of apparent celestial travel in the equatorial latitudes (a) and the mid-latitudes (b). Motion in the tropics is vertical while that in the temperate-zones is oblique and circular (from Aveni, 1981c: 163).

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:

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

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

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

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:

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

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).

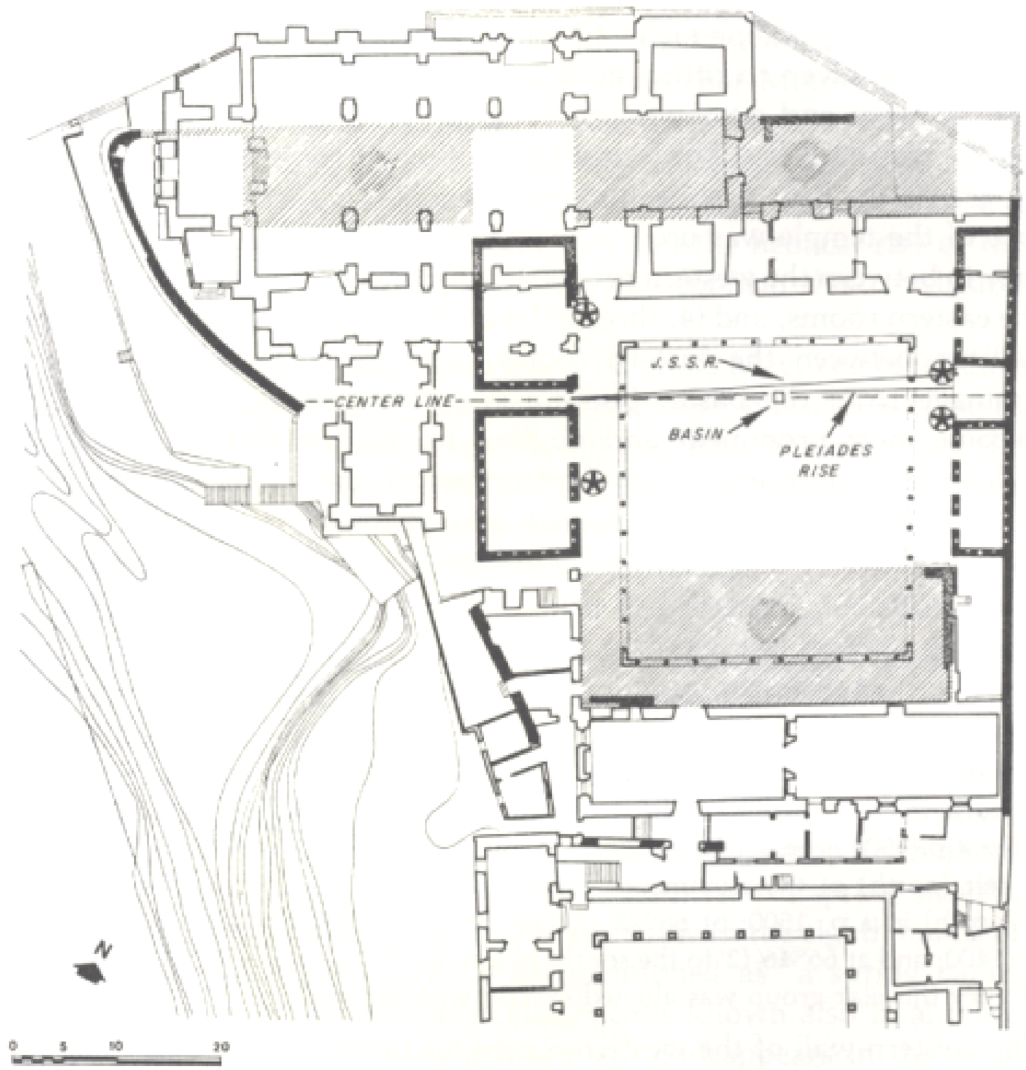

Figure 8-1: Plan of the Coricancha. The sightline for the Pleiades heliacal rise passes between two western rooms, across a ceremonial basin and between two eastern rooms. The asterisks indicate positions found to be used for gold or precious stones (from Zuidema, 1982a: 213).

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).

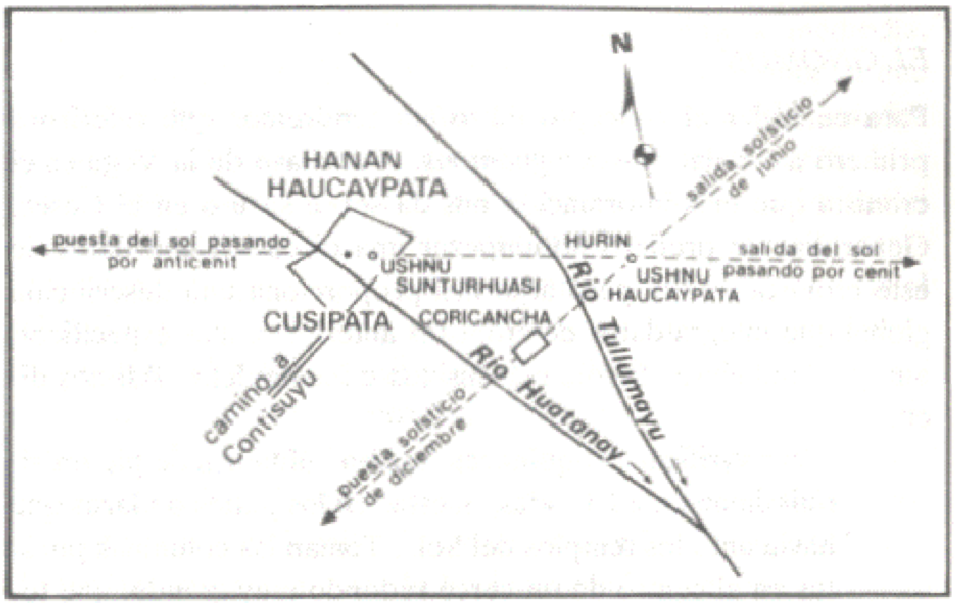

Figure 8-2: In Cusco the Coricancha and the Hurin Huacaypata Ushnu were aligned for the axis of the June solstice sunrise and December solstice sunset. The Hanan Haucaypata Ushnu, the Sunturhuasi, and the Hurin Huacaypata Ushnu were aligned for the axis of the zenith sunrise and the antizenith sunset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

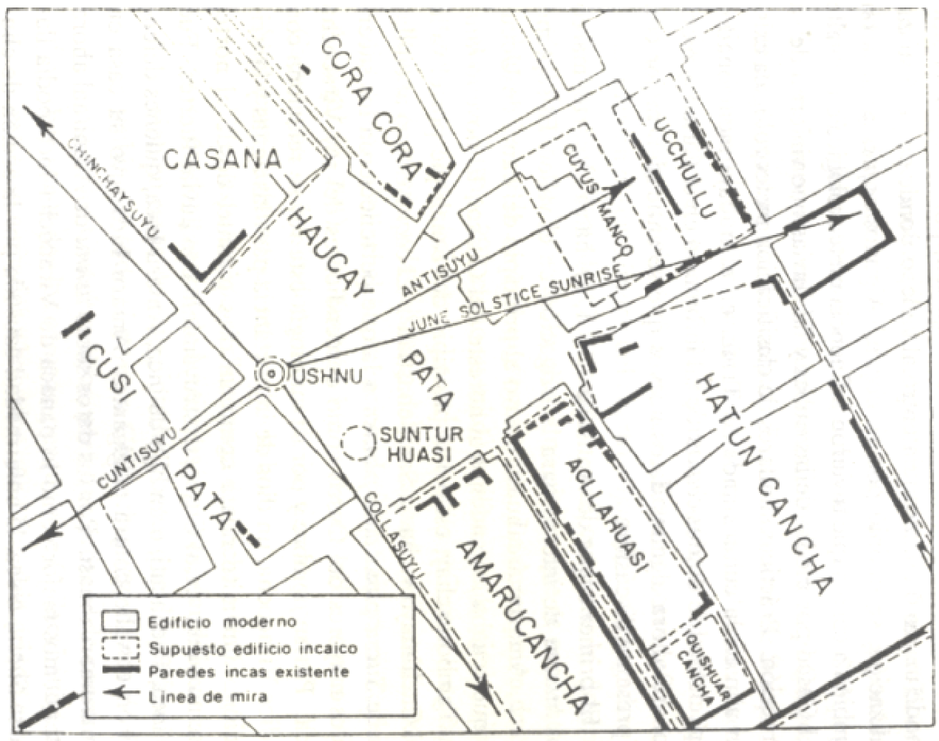

Figure 8-3: Locations of the Ushnu and the Sunturhuasi depicted in the plaza of Haucaypata. Note the axis of the June solstice sunrise and that the four suyus of Cusco each radiate from the Ushnu (from Zuidema, 1989c: 431).

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.

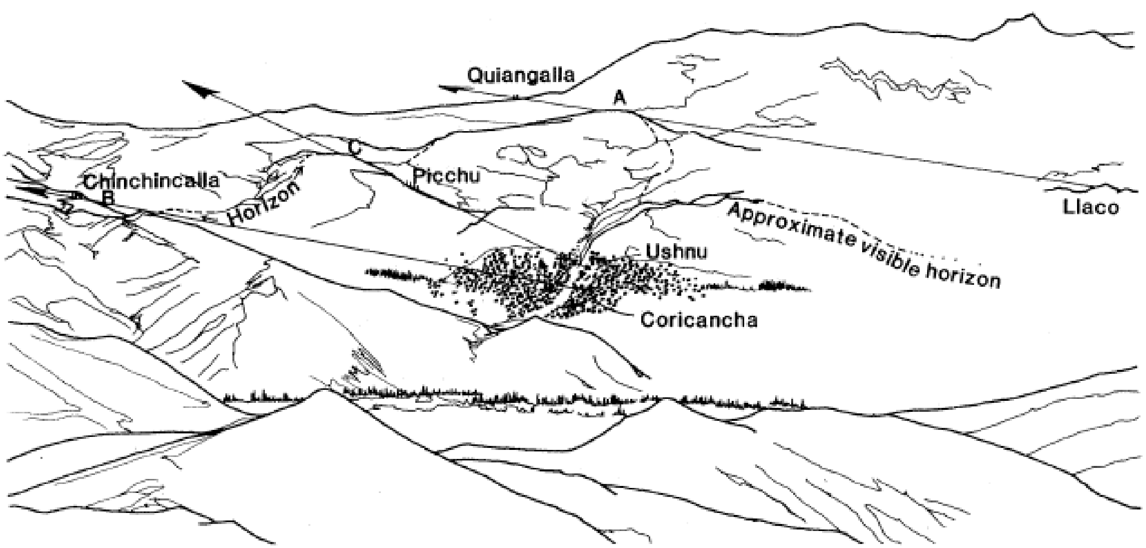

Figure 8-6: (A) The pillars of Quiangalla viewed from Lacco, (B) the pillars of Chinchincalla viewed from the Coricancha, and (C) the sucanca of Cerro Picchu viewed from the ushnu of Hanan Haucaypata (E. C. Krupp, from Aveni, 1981c).

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).

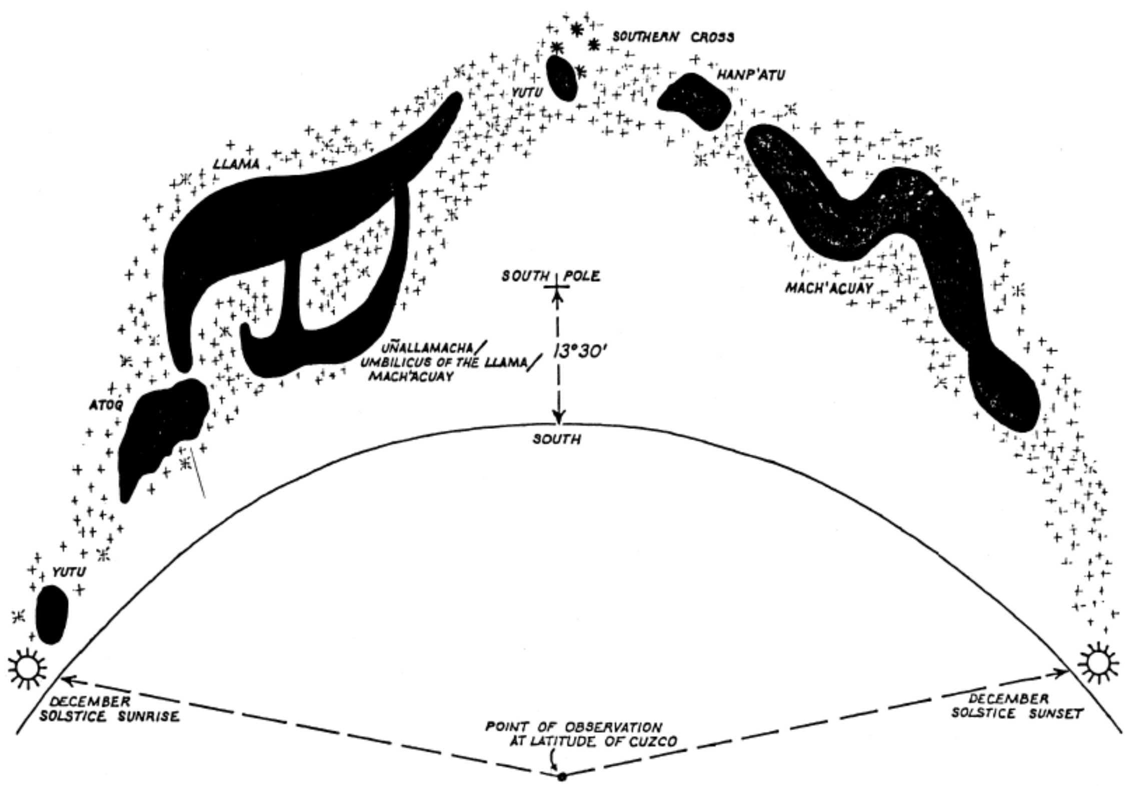

Figure 8-9: Dark Constellations of the Milky Way (from Urton, 1981c: 112)

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.