ISBN
978-1-931745-67-3

Authors
Protzen, Jean-Pierre
Nair, Stella

Publication Date
2013-02-01

The Stones of Tiahuanaco

A Study of Architecture and Construction

Jean-Pierre Protzen
and Stella Nair

The Stones of Tiahuanaco

UCLA COTSEN INSTITUTE OF ARCHAEOLOGY PRESS

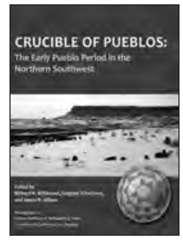
Monograph Series

Contributions in Field Research and Current Issues
in Archaeological Method and Theory

Monograph 74

**Rock Art at Little Lake:
An Ancient Crossroads in
the California Desert**

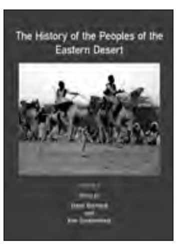
*Jo Anne Van Tilburg, Gordon E. Hull,
and John C. Bretney*



Monograph 71

**Crucible of Pueblos:
The Early Pueblo Period in
the Northern Southwest**

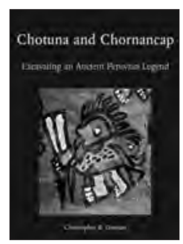
*Richard H. Wilshusen, Gregson Schachner,
and James R. Allison (eds.)*



Monograph 73

**The History of the Peoples
of the Eastern Desert**

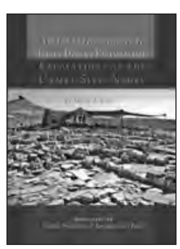
Hans Barnard and Kim Duistermaat (eds.)



Monograph 70

**Chotuna and Chornancap:
Excavating an Ancient
Peruvian Legend**

Christopher B. Donnan



Monograph 69

**An Investigation into Early Desert Pastoralism:
Excavations at the Camel Site, Negev**

Steven A. Rosen

The Stones of Tiahuanaco

A Study of Architecture and Construction

Jean-Pierre Protzen
and Stella Nair

Monograph 75
Cotsen Institute of Archaeology Press
University of California, Los Angeles

THE COTSEN INSTITUTE OF ARCHAEOLOGY PRESS is the publishing unit of the Cotsen Institute of Archaeology at UCLA. The Cotsen Institute is a premier research organization dedicated to the creation, dissemination, and conservation of archaeological knowledge and heritage. It is home to both the Interdepartmental Archaeology Graduate Program and the UCLA/Getty Master's Program in the Conservation of Archaeological and Ethnographic Materials. The Cotsen Institute provides a forum for innovative faculty research, graduate education, and public programs at UCLA in an effort to impact positively the academic, local and global communities. Established in 1973, the Cotsen Institute is at the forefront of archaeological research, education, conservation and publication and is an active contributor to interdisciplinary research at UCLA. The Cotsen Institute Press specializes in producing high-quality academic volumes in several different series, including *Monographs*, *World Heritage and Monuments*, *Cotsen Advanced Seminars*, and *Ideas*, *Debates and Perspectives*. The Press is committed to making the fruits of archaeological research accessible to professionals, scholars, students, and the general public. We are able to do this through the generosity of Lloyd E. Cotsen, longtime Institute volunteer and benefactor, who has provided an endowment that allows us to subsidize our publishing program and produce superb volumes at an affordable price. Publishing in nine different series, our award-winning archaeological publications receive critical acclaim in both the academic and popular communities.

This book is set in 10.2-point Janson Text, with titles in 36-point Trajan Pro.
Edited by Barbara Kohl
Layout by William Morosi

Library of Congress Cataloging-in-Publication Data

Protzen, Jean-Pierre.
The stones of Tiahuanaco : a study of architecture and construction / Jean-Pierre Protzen and Stella Nair.
p. cm.
ISBN-13: 978-1-931745-67-3 (alk. paper)   ISBN 978-1-938770-99-9 (eBook)
Includes bibliographical references and index.
1. Tiwanaku Site (Bolivia) 2. Tiwanaku culture. 3. Indian architecture--Bolivia--Tiwanaku River Valley. 4. Quarries and quarrying--Bolivia--Tiwanaku River Valley. 5. Stonemasonry--Bolivia--Tiwanaku River Valley. 6. Tiwanaku River Valley (Bolivia)--Antiquities. I. Nair, Stella. II. Title.
F3319.1.T55P96 2013
984'.01--dc23
2012042334

Contents

Preface

First, a word about spelling: Is it "Tiahuanaco" or "Tiwanaku"? "Tiahuanaco" or "Tiaguanaco" is the name the Spanish chroniclers of the sixteenth and seventeenth centuries recorded for the archaeological site in Bolivia near the southern shore of Lake Titicaca. And "Tiahuanaco" is how researchers continued to spell the name throughout most of the twentieth century. The orthography was changed to "Tiwanaku" in more recent times in much of the new literature. Echoing John H. Rowe, the eminent linguist Rodolfo Cerrón-Palomino (personal communication, 2007) argues that the new spelling results from linguistic and documentary disinformation, and because, to his knowledge, there exists to this day no convincing etymology for the name, he stays with the tradition and continues to write it as "Tiahuanaco." In this book, we follow his example. The original name for Tiahuanaco is unknown. The only hint we have is from Bernabé Cobo, who visited the site in 1610. When he asked the indigenous people, he was told that the name was "Taypi Cala," which means "Stone in the middle" (Cobo 1964:Book 2, 196).

At Tiahuanaco one finds one of the world's most artful and skillful stone architectures. Its precision rivals that of the Incas to a point that Spanish chroniclers of the sixteenth century to writers of the twentieth century claimed that Tiahuanaco not only served the Incas as a model for their architecture and stonemasonry, but that they even imported stonemasons from the Titicaca Basin to construct their buildings. After having worked for more than a decade on the architecture and construction techniques of the Incas, I turned my attention to Tiahuanaco because I wanted to examine these claims. Thus, in the summer of 1993, Elsbeth Protzen and I undertook an initial foray into Tiahuanaco to explore the site's putative influence on the Incas. During the few weeks we spent at Tiahuanaco, we recorded a variety of masonry bonds, and analyzed, measured, and photographed many stones. This material formed the basis for a paper that I presented at the Thirty-fourth Annual Meeting of the Institute of Andean Studies at Berkeley in January 1994, entitled, "Who Taught the Inca Stonemasons Their Skills?" In this paper, I first advanced the hypothesis that Inca stonecutting and masonry were indigenous inventions and not Tiahuanaco derivatives.[1]

As different as Tiahuanaco stonecutting and masonry are from those of the Incas, my argument then did little to answer the question of how the Tiahuanacans built their monuments, how they quarried, cut, and assembled stones, nor did it address the question of how the difference between Inca and Tiahuanaco construction techniques affected respective architectures. Literature on Tiahuanaco architecture is scant and on construction technology nonexistent, and having argued that Tiahuanaco construction differed from that of the Incas, I felt compelled to elaborate on the topic and to find answers to my own questions. In 1994, Stella Nair, then a doctoral student in the Department of Architecture, University of California-Berkeley, joined me in Tiahuanaco, and we worked together for seven field seasons. This assistance led to a fruitful collaboration and to the joint authorship of the present work. Furthermore, Stella contributed a series of experiments aimed at replicating the astounding feats of the Tiahuanaco stonecutters: perfectly planar surfaces, perfect exterior and interior right angles, and a precision measured in plus or minus 1 mm. The lessons learned from these experiments were most valuable for our appreciation and understanding of the stonemasons' skills and knowledge, especially of geometry and mathematics. Our detailed analyses of building stones little by little yielded insights into the architecture of Tiahuanaco, including its appearance, rules of composition, canons, and production.

We believe that our study of architecture has filled a significant gap in the understanding of Tiahuanaco's material culture. We cannot claim, however, that our work is complete. As the reader will see, there are still many unanswered questions. Unfortunately for future researchers, the Tiahuanaco site has undergone some rather drastic changes since the time of our investigations. A new and much larger museum has been built on the site, and in an effort to "sanitize" the site for tourism—the monument of Pumapunku in particular—the ruins have been "cleaned up." At Pumapunku, stones have been removed from the positions in which they are shown in the earliest plans and drawings of the nineteenth century and where they have remained until recently. Furthermore, what we called Pumapunku's Platform Area has been completely and most inexpertly remodeled (see Epilogue). Thus, much of our description of Pumapunku (and of other parts of the site) will have to be read in the past tense; phrases such as "there are rows of stones" should now be read as "there once were rows of stones." In this sense, our text is now historic; it is a record of a situation that no longer exists, and we have not tried to adjust our text to the current situation.

Since we concluded our research, several new publications on Tiahuanaco have been released. Inasmuch as we are aware of these works and publications, we have made an effort to incorporate and address the new research wherever it appears relevant to our topic and where it directly involves our arguments.

Jean-Pierre Protzen
Berkeley, California

NOTES

1. A revised version of this paper was later published with Stella Nair: Who Taught the Inca Stonemasons Their Skills? A Comparison of Inca with Tiahuanaco Cut-Stone Masonry, *Journal of the Society of Architectural Historians* 56(2):146–167.

Acknowledgments

It is not possible to acknowledge here all the people who made our research at Tiahuanaco possible and who assisted us directly or indirectly in our work. However, our thanks go first to Oswaldo Rivera Sundt, the director of what in 1993 was the Instituto Nacional de Arqueología of Bolivia (INAR). He took great interest in our work, liberally shared his knowledge of Tiahuanaco with us, and provided us with the necessary permits. Oswaldo's successor, Javier Escalante (of what now has become the DINAAR), continued to give us official support. Alan Kolata and his crew showed Protzen around Tiahuanaco and pointed out the latest discoveries. Other members of the INAR, in particular Sonia Alconini and Eduardo Pareja, gave us valuable hints. In addition, Eduardo introduced us to other sites on the Copacabana Peninsula and on the Islands of the Sun and the Moon. At the site of Tiahuanaco the supervisor Cesar Callizaya and members of his crew—Telésfero, Mario, and the workers Marcelino and Roger—provided us with whatever help we needed. Both Elsbeth Protzen and Robert Batson, joined us in the field on occasion and helped measure the stones. In particular, Elsbeth Protzen not only worked in the field, but she was critical to the logistics of every single field season. Without her, none of this would have been possible. We also express our special appreciation to Wolfgang Schüler, who time and again let us stay at his apartment in La Paz and put his car and driver, Don Rene Irahola, at our disposition. Many thanks also to Javier Nuñoz de Arco, an antiquarian in La Paz, who had bought a large part of Arthur Posnansky's legacy, for letting us see his archive of glass plates, notes, publications, and artifacts.

We would like to give special thanks to Chip Stanish, Director of the Cotsen Institute, for encouraging us to submit our manuscript to the Cotsen Institute Press and shepherding our manuscript through the process. In addition, we would like to thank the anonymous reviewers, whose insights and questions have helped to improve and refine the arguments articulated in this book, and Julie Nemer, Benedicte Gilman, and Astrid Virding, whose careful editing and oversight have strengthened the final manuscript in many ways.

Our work was supported, in part, by several units at the University of California, Berkeley. These include funding in the form of a Stahl Endowment Grant; a Summer Research Grant from the Committee on Research at the University of California; a Tinker Grant from the Center for Latin American Studies; a Chester Miller Fellowship, UCB; and a Humanities Research Grant.

JPP and SEN
Berkeley

Introduction

> And I may say, once and for all, carefully weighing my words, that in no part of the world have I seen stones cut with such mathematical precision and admirable skill as in Peru, and in no part of Peru are there any to surpass those which are scattered over the plain of Tiahuanaco [Squier 1877:279].

People have been building in stone for thousands of years. Stone is ubiquitous and durable, and it has an infinite variety of colors, shades, textures, patterns, and mechanical properties. Architects of all times and the world over made stone their favorite construction material. Many of their works of cut stones, some more than four thousand years old, have endured and are considered among the greatest works of art: the pyramids of Giza, the trefoiled temples of Malta, the acropolis of Athens, the temple precincts of Angkor, the great stone city of Zimbabwe, the cathedral of Chartres, and the Taj Mahal, to name but a few. Much less known, but no less remarkable than any of these examples, is the cut-stone architecture of Tiahuanaco (Figure I.1) near the southern shores of Lake Titicaca in Bolivia (Figure I.2).

To properly appraise Tiahuanaco's significance and to appreciate the uniqueness of its architecture, we must place it in its chronological context. The standard framework that most Andeanists and historians use follows John H. Rowe. They divide Andean prehistory into periods and horizons, where the horizons designate eras of cultural developments with pan-Andean influences, and the periods stand for more regional cultural phenomena (Rowe and Menzel 1967:Introduction):

Initial or Formative Period	ca. 1800 to 900 B.C.E.
Early Horizon	ca. 900 to 200 B.C.E.
Early Intermediate Period	ca. 200 B.C.E. to 550 C.E.
Middle Horizon	ca. 550 to 900 C.E.
Late Intermediate Period:	ca. 900 to 1438 C.E.
Late Horizon	ca. 1438 to 1532 C.E.

From rise to fall, Tiahuanaco had a very long life, more than a millennium. Its origins go back to about 200 B.C.E., the beginning of the Early Intermediate Period, and its collapse dates to around 1000 C.E. in the Late Intermediate Period. The dating of Tiahuanaco's cultural development is still somewhat in flux, but a more advanced understanding is emerging. There are several proposals, such as Ponce Sanginés (1972), Arellano (1991), Kolata (1993), Stanish and Cohen (2005), and Janusek (2008) they differ from each other in some detail, but are in general agreement regarding the larger picture:

Late Horizon		Inca
	1438 C.E.	Pacajes
Late Intermediate		
	900 C.E.	Tiahuanaco V
Middle Horizon		Tiahuanaco IV
	550 C.E.	
Early Intermediate Period		Tiahuanaco III
	0	Tiahuanaco II
		Tiahuanaco I
	250 B.C.E.	

I.1. The Gateway of the Sun is the showpiece of Tiahuanaco architecture.

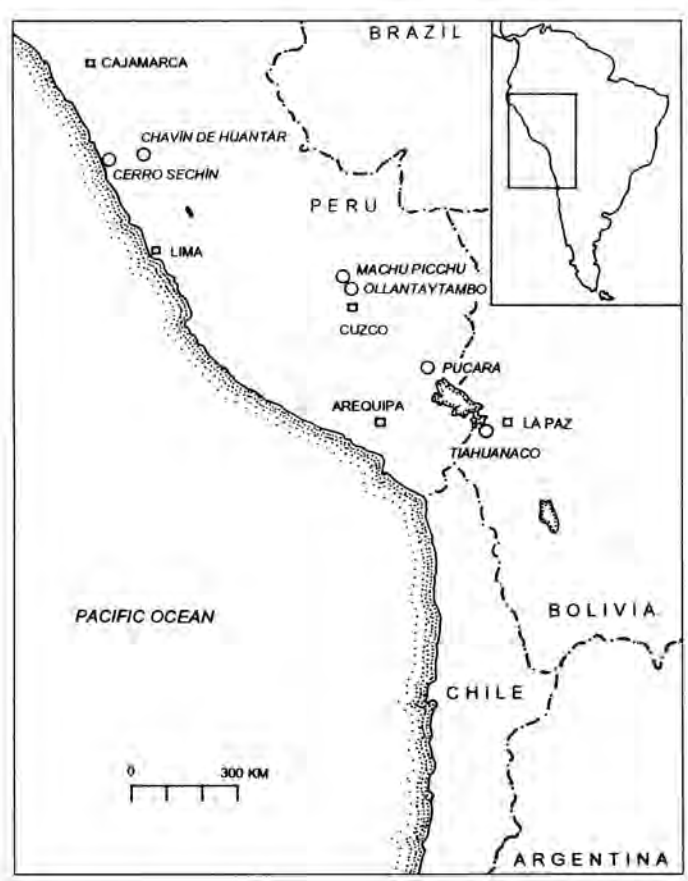


Figure I.2. Map locating Tiahuanaco (drawing by Jean-Pierre Protzen, first published in *Journal of the Society of Architectural Historians*).

Tiahuanaco is thought to have reached its apogee somewhere between 500 and 900 C.E., that is during the Tiahuanaco phase IV, during which time it extended its influence north to Cuzco and perhaps even Ayacucho, west and south to the coastal lowlands in southern Peru and northern Chile, and east to Cochabamba and the lower valleys of the Andes eastern slope. It is this expansion of its influence that earned Tiahuanaco the status of one of the defining cultures of the Middle Horizon. What exactly was the nature of this expansion? Whether it was military conquest, trade alliances, or missionary zeal is still debated, as is Tiahuanaco's relationship to Huari, the other important and contemporaneous Andean culture of the Middle Horizon. Janusek (2008:287) describes the two as "peer-polities" that "were very different types of imperial states," but that "shared core elements of a more ancient Andean cosmology that emphasized the spiritual and practical power of mountains, water, and ancestors." It is not that one state dominated the other; rather they had a mutual interaction, the nature of which is not yet clear. To what extent this interaction had any effect on the architecture of either Huari or Tiahuanaco, we will discuss again in the Conclusion.

If at Tiahuanaco, as we shall show, the art of cut-stone construction reached unprecedented and unsurpassed maturity and perfection, Tiahuanaco architecture is not the first manifestation of cut-stone masonry in the Andean realm. One finds, for example, cut-stone architecture at Cerro Sechín in the Casma Valley of northern Peru during the Initial Period. There it takes the form of an enclosure wall composed of large, dressed, loosely fit granite slabs engraved with bas-reliefs depicting grisly war or sacrifice scenes, and forming a kind of frieze or mosaic. Well-joined cut-stone masonry, together with exquisite bas-relief carvings and sculptures in the round, emerges in the northern Andes at Chavín de Huántar in the Early Horizon (Figure I.3). In the southern Andes, elaborate cut-stone masonry and carved stelae are found at Pukara at the beginning of the Early Intermediate Period just before, or contemporaneous with, early Tiahuanaco. The question of what, if anything, Tiahuanaco architecture and construction owes to these precedents is one we will come back to in the Conclusion.

After Tiahuanaco, in the Late Intermediate Period, there appears to have been a lull in fine-fitted cut-stone construction activities across the Andes; no major new centers were built, nor were there any architectural or technological innovations, although some cut-stone masonry may have been built within the Lake Titicaca Basin. In the Late Horizon, however, the art and techniques of cut-stone construction experienced a remarkable revival and attained new heights under the Incas.

Tiahuanaco as a Model for the Inca

In the eyes of many scholars, Tiahuanaco provides the crucial link to explain the sudden emergence of the highly advanced stone-cutting technology of the Incas. Despite the fact that the Inca were centered in and around Cuzco, some 600 km to the northwest from Tiahuanaco and rose to prominence at least four hundred years after Tiahuanaco's demise, scholars have actively advocated Tiahuanaco as the precursor to Inca architecture and construction (Figure I.4). Indeed, over the centuries, various authors have argued that Tiahuanaco architecture and stonework provided the model from which the Incas learned. Of all scholars, John Hemming is the most emphatic on this subject:

> The high skills of Inca masons *cannot* have developed during the century or less of Inca ascendancy.... Their brilliant stonecutting clearly came from the Lake Titicaca.... Rectangular ashlars, huge stone blocks, tight polygonal joints and beveling of junctions are all found in the buildings of the Tiahuanaco civilization... [Hemming 1982:26; emphasis added].

On a more immediate level, the German investigators Heinrich Ubbelohde-Doering, Alphons Stübel, and Max Uhle noted Tiahuanaco influences in the stonework at the Inca site of Ollantaytambo. Ubbelohde-Doering (1941:36–37) saw a similarity between Ollantaytambo's so-called Temple of the Sun and the Temple of Pumapunku at Tiahuanaco. He based his argument on the T-shaped cramp[1] sockets, the sharpness and straightness of the edges, and the perfection of the angles that he saw on blocks at both sites. Stübel and Uhle (1892:Part 2, 48) likened Ollantaytambo's great upright monoliths to those of Tiahuanaco and also found similarities in the stones elaborated with what they believed to be right angles.

Ephraim G. Squier (1877:275) reported that Akapana, the most prominent structure at Tiahuanaco, "as tradition affirms, suggested the plan of the great fortress of Saqsahuayman, dominating the city of Cuzco." The tradition Squier spoke of also holds that the astounding Inca stonework was not an indigenous invention, but

Figure I.3. Cut-stone architecture at Chavín de Huántar.

Figure I.4. Inca cut-stone architecture at Saqsawaman.

rather a derivative of Tiahuanaco masonry, and that to build their monuments the Incas did not use their own, but imported stoneworkers from the Lake Titicaca area, the Qollasuyu. In part, this tradition is based on the writings of, among others, Pedro Sarmiento de Gamboa in the sixteenth century, and of Cobo in the seventeenth century. The former remarked that:

> [F]ué por el mesmo valle y río de Yucay abajo á un asiento que agora llaman Tambo, ... adonde hacía unos suntuosísimos edificios. Y la obra y albañería de los cuales andaban trabajando como captivos los hijos de Chuchi Capac, el grand cin[che] del Collao, á quien, ... venció y mató el inga en el Collao" [Sarmiento de Gamboa 1906:Chapter 40, 81].

> [H]e [Pachakuti] went down the Yucay Valley and River to a place that now is called Tambo [Ollantaytambo], ... where he built some of the most lavish buildings. The construction and *stonemasonry* [emphasis added] work were done by captives, the sons of Chuchi Capac, the great sinchi of Collao, whom … he had defeated and killed in the Collao [translated by authors].

Cobo wrote:

> Llegó Pachacutic a ver los soberbios edificios de Tiaguanaco, de cuya fábrica de piedra labrada quedó muy admirado por no haber visto jamás tal modo de edificios, y mandó los suyos que advertiesen y notasen bien aquella manera de edificar, porque quería que las obras que se labrasen en el Cuzco fuesen de aquel género de labor [Cobo Book 12, Chapter 13; 1964:Book 2, 82].

> Pachacutic came to see the superb buildings in Tiaguanaco; he greatly admired the cut stone craft, for he had never seen buildings like these, and he ordered his people to observe and carefully note the manner of construction, because he wanted the works built in Cuzco to be of the same kind of masonry [translated by authors].

There is little question that the Incas conquered the area around Lake Titicaca and visited the site of Tiahuanaco sometime before 1470. Also not disputed is that the Incas enlisted men from the Lake Titicaca area to serve as construction workers. However, how much the Incas learned or copied from Tiahuanaco architecture and construction and what the role the enlisted workers might have played in the development of Inca construction techniques are questions that cannot be answered without a prior understanding of the architectural and construction practices of the Tiahuanacans. Hence, we will return to these questions in the Conclusion.

Alan Kolata (1993:31, 32) was certainly correct when he wrote that "in many respects Tiwanaku's nature and cultural significance in the ancient Andean world remain an enigma"; yet, much can still be learned about its architecture and its makers by investigating the architectural remains and the construction processes. The present text is intended to contribute to a better understanding of the material world of Tiahuanaco, not only within the context of Andean architecture and history, but also to highlight its unique importance in a global setting. However, before we can begin to discuss the larger issues of Tiahuanaco architecture and construction, we must begin by examining its complicated history and greatly damaged material remains.

Early Portraits of Tiahuanaco

The archaeological site has suffered unspeakable damage ever since the arrival of the Spanish (Figure I.5). Not only did they mine the ruins to construct the colonial town and church of Tiahuanaco, but carted away building stones to as far away as La Paz, approximately 70 km from Tiahuanaco (Castro y del Castillo 1906:211).[2] Further havoc was brought about by colonial era treasure hunters who believed that major caches of gold and precious stones were waiting to be carted away. One such treasure hunt left a big and deep gash on Akapana, one of Tiahuanaco's major platform mounds, destroying whatever architecture crowned the mound. Worse than the Spanish colonialists were the railroad barons of the early 1900s. The railroad line connecting the capital city of La Paz to the port of Guaqui on the shores of Lake Titicaca was run precisely through the archaeological site of Tiahuanaco. In the process uncountable building blocks, statues, and stelae were blown up with dynamite to provide ballast for the tracks (Baptista 1975:41). To add insult to injury, the inhabitants of the modern town of Tiahuanaco dismantled and destroyed nearly everything Georges Courty uncovered within days, even hours, of his excavations in 1903–1904 (Posnansky 1945:Vol. 2, 106). The depredation did not end there, but continued for many years and culminated in the probably well-intentioned, but ill-conceived and uninformed, reconstruction of the Kalasasaya, a large, enclosed platform structure (Figure I.6).

Figure I.5. Jumble of building stones at Pumapunku.

Figure I.6. Reconstructed eastern Gateway to Kalasasaya.

Because what can still be observed today at Tiahuanaco is so much poorer than what once was, with evidence not only destroyed and now lost, but also moved and altered, the eyewitness reports, observations, and depictions of early travelers, explorers, and investigators have become an indispensable archive for the study of Tiahuanaco architecture and the culture that created it.

Eyewitness Accounts

The earliest eyewitness accounts of Tiahuanaco that we have today are in the writings of the Spanish chroniclers Pedro Cieza de León and Bernabé Cobo, who were both careful observers (Cieza de León 1553:Part 1, Chapter 105/1984:282–285; Cobo Book 13, Chapter 19; 1964:Volume 2, 194–198). Cieza reached Tiahuanaco in 1549, less than 20 years after the Spanish first entered Cuzco, and Cobo visited the site twice, the first time in 1610, and the second probably around 1620. Both these authors gave us a picture of a site already in ruins, wasted by time, and as Cobo noted, by looting. Much of their descriptions will be extensively quoted further on in the text, suffice it then to say that they were agreed that the site is very ancient and predates the Inca conquest. Cieza was laughed at when he asked the local inhabitants whether the Incas had made the buildings of Tiahuanaco. He was told that the architecture of Tiahuanaco was there long before the Incas conquered this territory. But who specifically built Tiahuanaco, they could not say. Cobo, who heard a similar argument, judged the ruins to be very old on two counts: first, he noticed the erosion suffered by stones still standing, that he thought only the passage of time could have brought about, and second, he took as evidence of old age the multitude of stones that, besides those visible, could be found one to two fathoms deep under the grass and dirt, half a league around. Both these chroniclers were in awe of the ruins, the size of the stones used at the site, and the precision with which the stones were worked and fitted. Neither could explain how the stones were moved nor with what tools they had been shaped.

The first known drawings of Tiahuanaco are by the hand of the German naturalist Thaddäus Haenke. According to Renée Gicklhorn (1969), his biographer, Haenke, who had traveled with a Spanish expedition under the command of captain Malaspinas, took leave from the expedition in Lima in September of 1794, with the intent of crossing the continent to rejoin the expedition in Buenos Aires on its return to Spain. He made it from Lima to Cochabamba where he settled for while. On his way he may have come through Tiahuanaco as early as 1794. But it was in 1799 that Haenke retired to Guaqui, some 20 km from Tiahuanaco, to map Lake Titicaca and make an extensive survey of its shores, including the ancient monuments. According to Gicklhorn, Haenke's report is lost as are many of his sketches. Of nine sketches he made at Tiahuanaco she found only four. One seems to represents a portion of the main frieze of the Gate of the Sun (Gicklhorn 1969:8, Figure 1) (Figure I.7), another rough sketch represents what Gicklhorn interprets as the unfinished figures on the Gate of the Sun (Gicklhorn 1969:22, Figure 6). These two sketches are, according to Gicklhorn, of historic significance, since they represent the first evidence of the existence of the famed Gate of the Sun, which had never been mentioned before. However, Gicklhorn's Figure 1, while clearly depicting an iconography very similar to that found on the Gate of the Sun, is not a

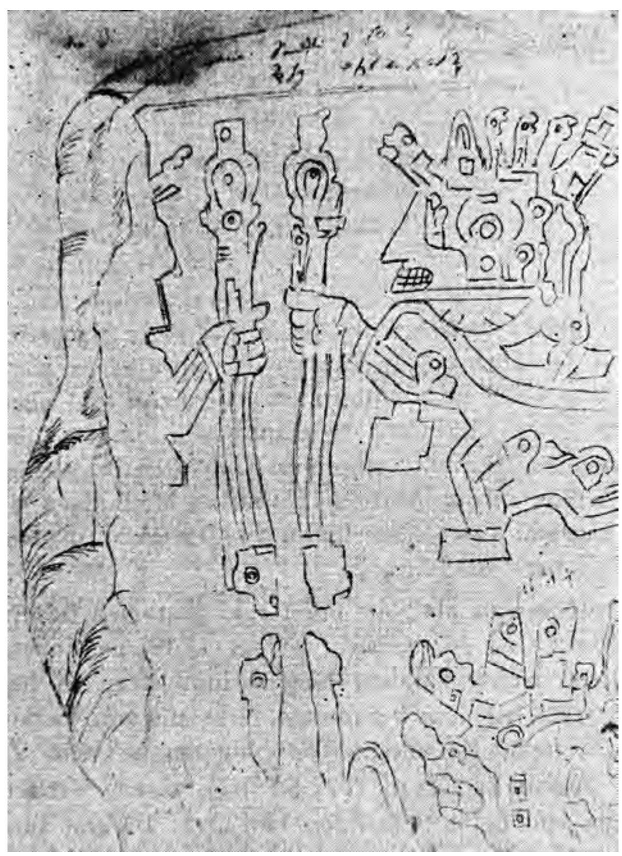


Figure I.7. Sketch of figures by Taddäus Haenke, presumably of the Gateway of the Sun.

sketch of the gate of the Sun: nowhere on this gate are the kneeling figures with staffs facing one another as is shown by Haenke. Nor can her Figure 6 unequivocally be identified with the Gate of the Sun. This does not diminish the historic value of Haenke's sketches, they remain the first representation of Tiahuanaco iconography and they may represent elements that no longer exist, but they cannot be taken as evidence for the existence of the Gate of the Sun. Haenke's third sketch (Gicklhorn 1969:10, Figure 2) is of a colossal head, probably the same as the one illustrated by Squier (1877:296), and the fourth represents one of the two statues now in front of the church at Tiahuanaco (Gicklhorn 1969:14, Figure 4).

Also, Gicklhorn's account of surviving sketches is not quite accurate. On the sketches she published one can clearly discern other elements of Tiahuanaco architecture. On the left side of her Figure 4 there is a sketch of a stone commonly referred to as the "Escritorio del Inca," and at the top of her Figure 2 there is a representation of yet another stone fragment that we could not identify. Furthermore, as Gunther Krauskopf (1972) argued, Gicklhorn overlooked several pages of Haenke's note book where indeed he describes the Gate of the Sun, and missed yet two more sketches, one representing the so called "Model Stone," the other showing the platform stones at Pumapunku. Unfortunately, Krauskopf could not decipher all of Haenke's notes.

It was not until the nineteenth century that extensive descriptions of the ruins of Tiahuanaco, including the first maps of the site, were published. These publications were the outcome of the work of inquisitive, dedicated individuals, Léonce Angrand (1808–1886), Ernst W. Middendorf (1830–1908), Alcide d'Orbigny (1802–1857), Johann Moritz Rugendas (1802–1858), E. George Squier (1821–1888), Alphons Stübel (1835–1880), Johann Jakob von Tschudi (1818–1889), and Richard Inwards (1840-1937) to name but a few, and government-sponsored expeditions like that of the Frenchman Francis de Castelnau (1810–1880).

The oldest son in a family of eminent French naturalists, Alcide Dessaline d'Orbigny explored meridional South America from 1826 to 1833, studying its geography, geology, flora and fauna, its inhabitants, and antiquities. While prospecting the shores of Lake Titicaca, d'Orbigny came through Tiahuanaco in early June 1833. During his two-day stay, he produced several sketches and plans, and pondered the questions of the source of all the stones and how they had been cut. If his sketches are not very accurate, his description of the site, as we shall see, is more pertinent (d'Orbigny 1836; 1835–1847).

The German painter Johann Mortiz Rugendas traveled extensively throughout Mexico and most of the South American continent, between 1831 and 1847. Alexander von Humboldt, the great naturalist and stalwart sponsor of Rugendas, said that in his art he was guided by "the sure feeling, that ... the painterly effect will always emerge from the truth and the faithful imitation of forms" (Rugendas 1960:10). And indeed, Rugendas made some of the most accurate renderings of pre-Columbian ruins, including a few of Tiahuanaco (Figure I.8).

Sponsored by the French government, Count Francis de Castelnau undertook a well-appointed expedition to the central parts of South America in the years 1843 to 1847. Castelnau came upon Tiahuanaco in early December of 1845. He left us with a few engravings of the site and a description in which he noted that, in his view, it is the extreme complications of details that distinguishes the architecture of Tiahuanaco from that of the Incas (Castelnau 1850–1859:Part 1, Vol. 3, 392).

Léonce Angrand, a French diplomat and envoy to Bolivia, made numerous sketches of the site and measured drawings of many building stones in December of 1848. He later rendered the measured drawings in exquisite, Beaux Arts style *épures* with a gray and pink *lavis* that are now housed in the Bibliothèque Nationale de France in Paris. Angrand had planned to publish a major work on the ruins of Tiahuanaco that never materialized. In it, he was to explain in more detail his arguments, first made in a letter, regarding a Toltec origin of the builders of Tiahuanaco. Angrand based his arguments on the perceived similarities between the figures on the Gateway of the Sun at Tiahuanaco and the deities represented on the temples of ancient Mexico. In his view this similarity could only be explained by migration (Prümers 1993:388, Stübel and Uhle 1892:Part 2, 50–51).

Johann Jakob von Tschudi, a Swiss naturalist, physician, and explorer, traveled through Tiahuanaco on October 19 and 20, 1858. Like others before him, he marveled at the beautiful finish and enormous size of the many stones, but had no answer as to how the stones were cut or quarried, nor about who the builders might have been: "In Tiahuanaco

Figure I.8. View of Kalasasaya from the west with Akapana in background by Moritz Rugendas (courtesy of Staatliche Graphische Sammlung, Munich).

we stand on a soil full of riddles" (1971:Vol. 5, 293). Tschudi did at some point enthusiastically embrace Angrand's hypothesis of the Toltec migration (Tschudi 1846:177–179), only to cautiously criticize it later (Tschudi 1891:209–211).

After completing a diplomatic mission to Peru for the United States of America, Ephraim G. Squier embarked on an extensive exploration of Peru's antiquities. During his peregrinations, he came upon the ruins of Tiahuanaco some time in the middle of 1864. He left a careful and extensive description of what he saw (Squier 1877:272-301). Squier was much impressed by the quality of the stonework at Tiahuanaco, which in his eyes was unsurpassed anywhere in the world (see epigraph to this chapter). He did not even want to speculate about how the stones might have been cut. Of the site itself, his view was that one could "hardly conceive of remains so extensive as those of Tiahuanaco, except as indications of a large population, and as evidences of the previous existence on or near the spot of a considerable city" (Squier 1877:300). But, because of the lack of obvious remains of residential structures, and because the harsh climate seemed to him to forbid the support of a large population, Squier (1877:300) concluded that Tiahuanaco could not have been a capital, but rather "may have been a sacred spot or shrine, the position of which was determined by accident, an augury, or a dream."

The Englishman Richard Inwards, a Fellow of the Royal Astronomical Society, was sent in 1866 to Bolivia by a mining company. He spent about a year in Bolivia, during which time he observed the habits and language of the indigenous people and made a number of detailed sketches at Tiahuanaco. He later published his work in a book entitled *The Temple of the Andes* (Inwards 1884). Like others before and after him, Inwards was stunned by the high precision with which the stones at Tiahuanaco were cut. Inquiring about it, he was told by the curate of Tiahuanaco "that it was commonly supposed that the blocks were not stone at all, but of a kind of cement. Without believing this, I must admit having seen artificial stones so closely resembling natural ones that it would be difficult to distinguish the difference" [Inwards 1884:22]. Inwards also noted that he could not see chisel marks on any of the stones. We will return to this subject later in this book.

Alphons Stübel, a German geologist and student of volcanoes, measured many gates, gate fragments, and numerous building stones in the very short period between December 31, 1876, and January 8, 1877. His painstaking work was later published with the assistance of Max Uhle and constitutes still today a mainstay of Tiahuanaco research that nobody can afford to ignore (Stübel and Uhle 1892). Uhle compiled the first survey of all that was known about Tiahuanaco at the time and thus laid the foundation for the scientific investigation of the site, its builders, and their culture. It was his view that all the monuments at Tiahuanaco were essentially of the same age. He saw a stylistic similarity and continuity between the stonework and aesthetic qualities from Kantatayita to Pumapunku (Stübel and Uhle 1892:Part 2, 46). Uhle, who did not see the site until several years after the publication of the joint work with Stübel, had no choice but to base his argument on the material brought back by Stübel. That material was doubtless selective; Stübel, it should be remembered, spent only nine days at Tiahuanaco. We will have ample opportunity to discuss Stübel and Uhle's work, as well as that of Angrand, in subsequent chapters.

At the end of November 1887, Ernst W. Middendorf, a German physician, scholar, and longtime resident of Peru, visited the site for two days. To him, the ruins of Tiahuanaco were a riddle not to be easily solved. Nevertheless, he thought that some light could be shed on the past by a careful contemplation of the ruins. From his own observations, he concluded that only a highly organized society, with enough resources to muster a large labor force could have built Tiahuanaco, and that its builders, whoever they were, had to have had advanced knowledge of mathematics to plan their buildings in their finest detail before they were executed, and of mechanics to move stones of enormous masses. And finally, Middendorf (1895:394–396) argued that the manifest skills of the Tiahuanacans would have taken many centuries to develop. Finding that the physical characteristics and rough climate of the Altiplano were not conducive to the development of a high culture, he concluded that the builders of Tiahuanaco had to have come from elsewhere. Earlier he had also given credence to the Toltec origin hypothesis (Middendorf 1890:Vol. 3, 8), but rejected it shortly thereafter to replace it with an Aymara migration also originating in Mesoamerica (Middendorf 1890:Vol. 5, 28).

In September of 1894, the renowned Swiss-American anthropologist Adolph Bandelier spent nineteen days at Tiahuanaco studying the ruins and the social structure of the people living there at that time. He made a small but informative map of the site (Figure I.9). What is curious about Bandelier's report on the site is that contrary to all other observers, he belittled the quality of the stone work: "One of the chief wonders of Tiahuanaco has always been the cutting and joining of the stone-work. But no attention has been paid to its imperfections. The edges and planes, the angles and the faces, do not bear the test of the level and of the square.... The stone work at Tiahuanaco is by no means superior to that of Sillustani and Cuzco" (Bandelier 1911:16–17). There is a great variability in masonry quality and bond patterns at Tiahuanaco. We do not know what Bandelier had been looking at, but it may be that he only saw the cruder masonry and overlooked the fine work. Bandelier's remarks, as we will show, certainly do not apply to the stones recorded by Angrand, Stübel, and ourselves.

The first official excavations at Tiahuanaco were carried out in 1903 by Georges Courty of the *Mission scientifique française à Tiahuanaco* under the direction of Georges de Créqui-Montfort and E. Sénéchal de la Grange. Apart from a brief report by Créqui-Montfort before the International Congress of Americanists held in Stuttgart in 1904 and a few photographs published by Posnansky, all other documentation of these very important excavations, if it ever existed, has been lost (Créqui-Montfort 1906).

Arthur Posnansky (1873–1946), a naval engineer and Austrian émigré to Bolivia, became obsessed with Tiahuanaco. In a reversal of previous speculations that held that the builders of Tiahuanaco had to have come from elsewhere, Posnansky professed that Tiahuanaco was the origin from which the Americas were populated. He is often reviled and ridiculed (and justifiably so) for his naive views and hare-brained theories about Tiahuanaco's age and development,

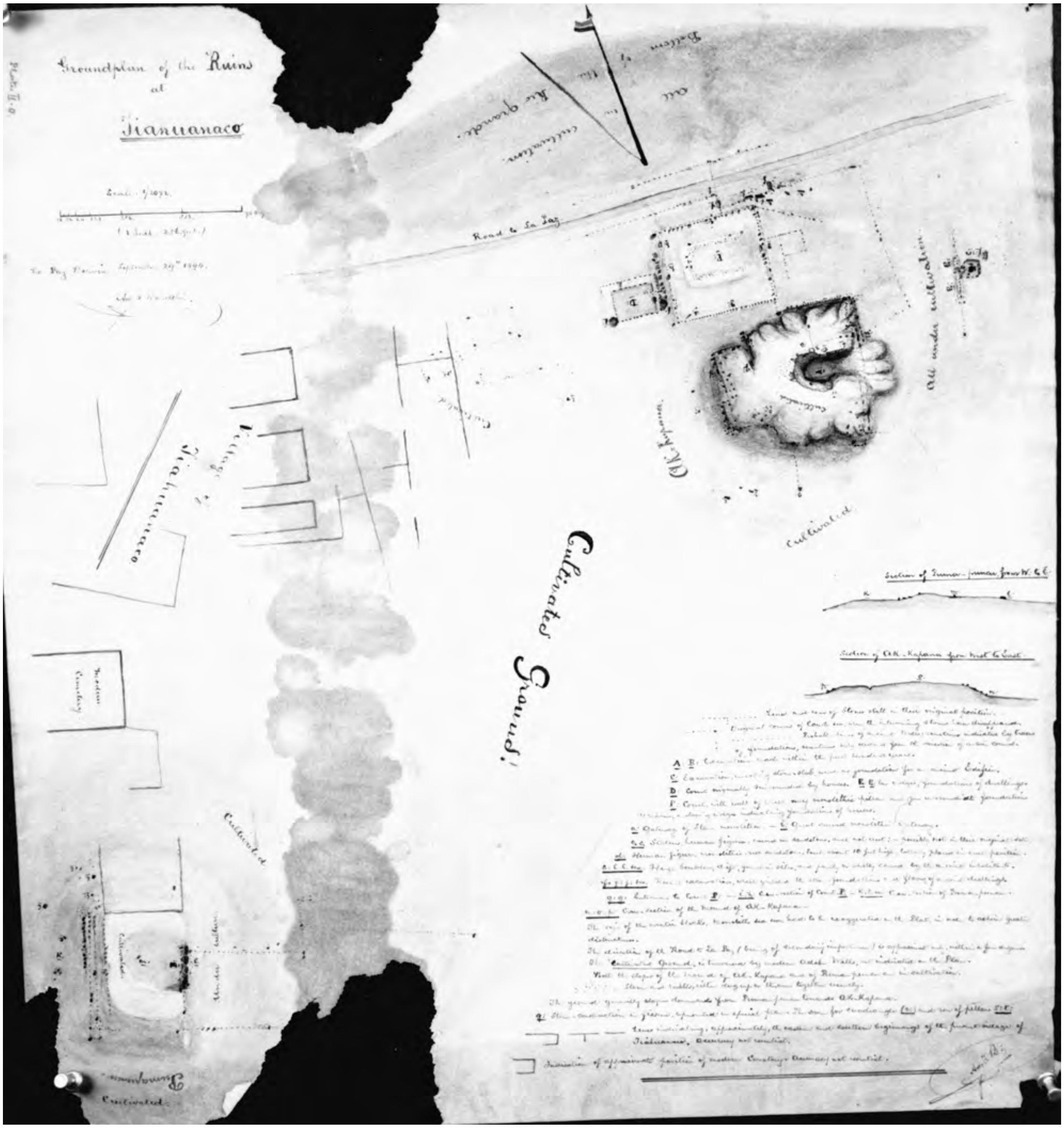


Figure I.9. Map of the ruins at Tiahuanaco by Adolph F. Bandelier (courtesy of American Museum of Natural History).

and his fanciful interpretations of the meaning of its monuments and iconography. Yet, as self-proclaimed expert and guardian of the site, Posnansky rendered an important service in raising awareness of the site's historic significance, in documenting it, and in sheltering many of its important pieces (but also selling some to friends, collectors, and foreign museums). His magnum opus, *Tihuanacu: The Cradle of American Man* (1945), remains an indispensable reference work for students of Tiahuanaco architecture.

In 1932 the American archaeologist Wendell C. Bennett was given permission by the Bolivian government to sink ten test pits in various locations around the central district of Tiahuanaco (1934). His were the first systematic excavations at site. The stylistic analysis of the excavated ceramics allowed Bennett to establish for the first time a relative chronology of cultural development based on stratigraphy. His sequence of styles, "Early Tiahuanaco," "Classic Tiahuanaco," and "Decadent Tiahuanaco," followed by a "Post Tiahuanaco" occupation, still underlies "contemporary formulations of Tiwanaku cultural chronology" (Kolata 1996a). Bennett definitively demonstrated that Tiahuanaco was not all of one age as Uhle had earlier speculated. On the other hand, Bennett did nothing to dispel Squier's notion of Tiahuanaco as an uninhabited ceremonial center; on the contrary, he reinforced the idea.

Recent Contributions

The toils, cogitations, and speculations of the early travelers, explorers, and scholars leave the modern researcher with many unanswered questions about the site and its denizens: What kind of a settlement was Tiahuanaco? How old is it? Who were its builders and inhabitants? Where did they come from? And last, but not least, what was their architecture like and how did they build it? Systematic excavations made since Bennett at Tiahuanaco itself, and related sites nearby, are slowly yielding new information about Tiahuanaco's setting and its architecture.

Excavations and Fieldwork

The Bolivian archaeologist Carlos Ponce Sanginés, head and co-founder with Maks Portugal Zamora and Gregorio Cordero Miranda of the Centro de Investigaciones Arqueológicas en Tiwanaku (CIAT), conducted large-scale excavations and reconstruction at Tiahuanaco from 1957 to about 1980. CIAT's work, which we will have ample opportunity to discuss later in the book, launched an era of intense and systematic archaeological investigations that greatly enhanced our understanding of the site and of Tiahuanaco culture.

If Middendorf, echoing Squier, presumed that the physical characteristics and rough climate of the Altiplano were not conducive to the development of a high culture, the work of the American archaeologist Alan Kolata and his Bolivian associates of the Proyecto Wila Jawira (Kolata 1996c) have convincingly shown that the Tiahuanacans had developed a sophisticated agricultural technology, adapted to Altiplano conditions, capable of producing the economic surplus thought to be critical to the development of so-called high culture (Kolata 1996a). Many square kilometers of ancient raised fields (*suka kollu*); elaborate irrigation systems with dams, canals, and river corrections; and causeways connecting local and regional administrative centers, suggest that Tiahuanaco was more than just a pilgrimage center, as Squier and Bennett, among others, thought. Indeed, it was the seat of an elite in control of its surrounding territory and attendant economic resources, human and natural.

Excavations at the site of Tiahuanaco proper by *the International Seminar of Archaeology* coordinated by Alan Kolata and Carlos Ponce Sanginés during the 1988 and 1989 seasons, and by the former Instituto Nacional de Arqueología (INAR) of Bolivia, then under the directorship of Carlos Urquizo Sossa, yielded evidence of extensive domestic architecture to which Squier had no access and that eluded Bennett. Within the framework of the International Seminar, graduate students who have now become notable scholars in their own right, conducted important investigations. John W. Janusek (2003), Christopher Begely, and Claudia Rivera Casanova (2003) excavated residential compounds in the flat expanses to the east of the site's core, and Nicole Claire Couture (2003) to the south, at Mollo Kontu. Participating in that same seminar, the Mexican archaeologist Linda Manzanilla (1990) and the Bolivian archaeologist Sonia Alconini Mujica (1995) both conducted excavations that revealed new information about the structure and ritual uses of Akapana. In 1991–1992, INAR member Javier Escalante Moscoso (1993:255–287; 2003) excavated domestic architecture at La K'araña just to the north of the core. As a consequence of these finds, the prevalent view of Tiahuanaco now is that of a major capital, the seat of power, both religious and political, with a substantial population. A survey of settlement patterns in the lower Tiahuanaco Valley, conducted by Juan Albarracín-Jordán and James E. Mathews (1990), who worked in conjunction with the Proyecto Wila Jawira, lends further support to this view. In their work, they found "the first concrete manifestation of a planned administrative structure" in the Tiwanaku IV period, with "a hierarchy of settlements headed by Tiwanaku" (Albarracín-Jordán and Mathews 1990:189).

During the years 1993 to 1996, Oswaldo Rivera Sundt, then director of INAR, conducted several excavations, both at Pumapunku and on Akapana's south side. In these excavations several important features came to light, which we will have the opportunity to discuss in more detail in Chapter 2.

Recently, the American archaeologist Alexei Vranich has excavated at Pumapunku and Akapana, revealing a number of interesting features and adding new insights into Tiahuanaco's architecture (Vranich 2001; 2006).

During the various excavation campaigns mentioned above, several of Tiahuanaco's most important structures were either fully or partially excavated and cleared (and some entirely and questionably reconstructed[3]), providing important new windows on the site's architecture and construction practices. These excavations and their findings will be discussed in detail in subsequent chapters. Here, we wish to acknowledge the ground-breaking efforts of our colleagues, without whose work our research would have been much more constrained.

Architectural Investigations

Many authors who have worked at and written on Tiahuanaco have touched on the subject of its architecture, directly or indirectly. To name them all would be impractical, but we will call upon their work as it becomes relevant to our narrative. A few authors, however, have commented specifically on the architecture.

In his many publications, Carlos Ponce Sanginés repeatedly touched on the design, construction, uses, and function of the structures at Tiahuanaco (some of which he had excavated and reconstructed) and wrote about the extension, organization, and meaning of the site. Jorge Arellano (1991) discussed the design and construction of the most significant structures at the site and proposed a chronology for their construction and occupation periods. William Conklin (1991) has written on some characteristics that differentiate Tiahuanaco from Huari architecture. Alan Kolata (1993; 1996b) has given an extensive exposition on the layout of the city, the planning principle underlying it, the design of Tiahuanaco's structures, and the meaning of its architecture. Javier Escalante, who has participated in several of the excavation campaigns referred to above, and who heads the Archaeology Division of the newly constituted Dirección Nacional de Arqueología y Antropología (DINAAR), formerly called INAR, made architecture and construction the sole focus of his book on the pre-Hispanic architecture of the Bolivian Andes (1993). His text includes summary descriptions and short architectural analyses of Tiahuanaco's main structures, as well as details concerning their construction. Isbell and Vranich have attempted to reconstruct how the "prehistoric people experienced their world" at Tiahuanaco and Huari (Isbell and Vranich 2004).

Clearly, there is emerging a substantive discourse on the subject, but a comprehensive study of Tiahuanaco architecture and the corresponding construction practices has yet to be written. None of the above texts tackle systematically issues of construction practices, such as, for example, the variety of methods used in the construction of foundations or in wall assemblies. There are no comprehensive inventories of architectural motifs and building stone types. The questions of how stones were quarried, transported, cut and dressed, and hoisted into place are largely ignored. More significant yet, there is no systematic treatment of the architectural principles that order spaces, govern the placement of buildings relative to each other, or guide the proportions of buildings in plan, section, or elevation. The present text is meant as a contribution toward an encompassing understanding of Tiahuanaco architecture, as process, product, and experience.

THE STUDY OF ARCHITECTURE

What Is Architecture?

Historians of architecture and architects, bent on understanding architecture foremost as an art form, tend to distinguish between architecture and mere buildings. Only buildings that have this *je ne sais quoi*, an added aesthetic value, do qualify as architecture. Many, if not most, books on the history of architecture reflect this attitude. Only structures of a certain status, prominent religious buildings, eminent public edifices, and the residences and palaces of the powerful receive any attention.

Archaeologists speak of domestic architecture, military architecture, or monumental architecture, but they do not make the distinction between building and architecture; to them all buildings represent architecture. We follow this more inclusive approach, specifically one that has been advocated by contemporary architectural historians such as Dell Upton, who defines architecture "to stand for the entire cultural landscape, including so-called designed landscapes, urban spaces, and human modification of natural spaces" (Upton 1998:12).

The "Total Context of Architecture"

To fully understand and appreciate architecture, its study cannot be limited to its physical manifestation alone; it has to be considered in what Spiro Kostof called the "total context of architecture":

> Architecture, to state the obvious, is a social act—social both in method and purpose. It is the outcome of teamwork; and it is there to be made use of by groups of people, groups as small as the family or as large as an entire nation. Architecture is a costly act. It engages specialized talent, appropriate technology, handsome funds. Because it is so, the history of architecture partakes, in a basic way, of the study of the social, economic, and technological systems of human history [Kostof 1985:7].

And to speak with Upton again, the study of architecture

> should account for the entire life of a structure from its initial planning to its destruction and even its afterlife in history and myth. Those who use architecture and those who interpret it are its makers as much as those who draw plans or drive nails. Buildings are changed in construction and they are changed in use. They are used differently from the ways they were intended and they are appreciated or experienced differently from the ways their architects or patrons might have imagined [Upton 1998:12].

Limitations on the Total Context

The scope of the study of architecture, as outlined above, is daunting. We have no illusions about our ability to fulfill this expectation; there are too many limitations set on such a comprehensive study of Tiahuanaco architecture, among them being the ruined and pilfered state of the site, the scarcity of historic visual and literary documents, and, last but not least, the limitations of our own approach.

Open Questions

Several authors have filled in significant parts of the "Total Context" of Tiahuanaco architecture. Among them, Charles Stanish (2003) wrote about the evolution of complex societies in the Titicaca Basin, John Janusek (2004; 2008) elaborated on the notions of identity and power in the Altiplano, and Alan Kolata (1996a) investigated what he calls Tiahuanaco's "political economy." Kolata's (1996a:20) work sheds light on "the aggregate processes of production, distribution, and consumption by which populations reproduce the biological and cultural bases of their society." Within this broad picture of a hierarchically organized agro-economy, questions need to be asked about the production of architecture. For example, who were the patrons, the architects, and the builders, if indeed these were different constituencies? And if they were, what were the social and power relationships among them? How did the patron and the architect communicate their ideas between them and to the builder? What was the organization of the labor force? Were there specializations? What were they? How was the labor force recruited and trained? What technologies and what tools were applied? What were the tools made of? Some of these and other questions one might want to ask may elude answers forever. Of the political economy Kolata (1996a:20) wrote that "generically economic mechanisms may entail and entangle a variety of processes that do not necessarily emerge from or partake intimately in the technoeconomy of production itself," and that "[t]hese more purely *social* dimensions ... are inordinately difficult to access in the archaeological and historical record" (1996a:20, emphasis in original). What holds for the political economy, holds for the production of architecture; not all activities necessary to the production of architecture leave material traces and may be difficult, if not impossible, to infer from the physical remains.

Conditions of the Ruins

If recent excavations have clarified several architectural features and provided new understandings of various structures, it is also evident that many pieces of the puzzle are missing or have been irretrievably destroyed. Apart from the monumental mounds, not a single building has survived beyond its foundations. Buildings are different from almost every other artifact in the archaeological record: they are rooted to a site, they cannot be moved; buildings are big, at least big enough for human occupation; and buildings are eminently public, public in the sense that they impinge on all of us, that they cannot be avoided. To apprehend architecture, it is not sufficient to examine a building as an object from a distance; one must experience it, walk around it, through it, and be in it.

To quote John Whiteman (1987:140), "[W]e become unwillingly subject to architecture. It envelops us and controls our experience extensively.... Architecture... works on us even when we are not looking." In other words, an understanding of the use, function, and meaning of architecture cannot be derived from a mere contemplation of its artifacts; it also has to be tied to the human experience of the architecture itself.

Obviously, we cannot fully apprehend Tiahuanaco architecture in this way: we cannot move through it, nor be in it in the same state that it was when people occupied the site. Yet, an experiential apprehension is a prerequisite for any plausible interpretation of the possible functioning and symbolic significance of the architecture. Whether we will be able to experience architecture vicariously in some kind of virtual reconstruction is contingent on our ability to tease out from the scant materials available information on building configurations, building heights, roof construction, compositions of façades, and so forth. In that sense, our research can be understood as an effort to recover as much of Tiahuanaco's architecture as possible.

Our Own Approach

We are professional architects. As such we can speak with some authority on issues of structure, construction, and tectonics. Eduard Sekler clarified the use of these terms when applied to architecture as follows:

> *Structure* as the more general and abstract concept refers to a system or principle of arrangement destined to cope with forces at work in a building, such as post-and-lintel, arch, vault, dome, and folded plate. *Construction* on the other hand refers to the concrete realization of a principle or system—a realization which may be carried out in a number of materials and ways. For example, the structural system which we call post-and-lintel may occur in wood, stone and metal and its elements may be fastened together by a number of methods...
>
> When a structural concept has found its implementation through construction, the visual result will affect us through certain expressive qualities which clearly have something to do with the play of forces and the corresponding arrangement of parts in the building, yet cannot be described in terms of construction and structure alone. For these qualities, which are expressive of the relation of form to force, the term *tectonic* should be reserved (Sekler 1965:89; [emphasis added]).

From the observation and analysis of the structure and construction of a building we often can draw inferences on the structural knowledge of its builders, the tools they used, the sequences in which the building has been put together, which in turn may yield clues to labor organization, the builder's understanding of the properties of the various materials and how they interact, of the environmental forces that act on a building and how to prevent damage from these forces, and other similar questions. Our work will also lay the groundwork for further research by other scholars in a variety of disciplines.[4]

We can comment with some competence on the formal properties of the architecture—its tectonics—and the spatial organization. We can speak to the questions of measurements, proportions, and ordering principles, from the small scale of an ornament, to a façade's composition, to the large scale of a site's layout. We can address the characteristics of spaces within a building and between buildings, and their relationship to each other and to the environment beyond. Investigating such issues, we may be able to draw inferences about the builders' knowledge of mathematics and geometry, about their aesthetic preferences, and about their conception and structuring of physical space. We may be able to suggest uses and functions of some buildings and spaces, but the answers to the actual functions and use patterns have to come from the archaeological material and its interpretations by the archaeologist. How Tiahuanaco's residents perceived the spaces and what they meant to them, are questions about which we can only speculate.

We do not excavate, we only investigate the architectural remains still visible above ground (and those that have been unearthed by archaeologists). Our work, then, is focused on what has endured at Tiahuanaco and what is visible above ground. This is the architecture that has been solidly built in stone. It is architecture into which its builders have invested enormous resources, that is structures of significance and prestige. Perforce, then, are we limited to the investigation of monumental architecture in spite of our ambitions for a broader study of architecture. Yet, we argue that much can be learned from what is still standing and visible, and that what can be learned by this approach has the advantage of being nondestructive. Furthermore, a careful analysis of what is visible sharpens our understanding of what is not visible, of what is still buried, and helps the formulation of pertinent questions for future excavations.[5]

Methods and Scope

Our methods of investigations include observation, measured drawings, and experimentation. One of us (Protzen) wrote elsewhere that

> the making of measured drawings of existing buildings is a time-honored didactic device by which students in architecture learn how buildings are put together. Measuring a building in order to make working drawings from which a contractor could rebuild that building informs one about the building's components, the method of joining them, and the sequence in which they were assembled [Protzen 1993:vi].

Measuring and drawing with the attendant necessary observation of details are painstaking activities that seem no longer to be in fashion. Yet, to exhaust all the information that the standing or visible remains at a site may yield, such activities are indispensable. Through measuring, sketching, and the preparation of formal architectural drawing, which represent the many aspects of the built remains at Tiahuanaco, we learned about the construction methods used by Tiahuanaco's builders, and about their formal preferences. Coupled with observation of the surfaces and shapes of building stones, the measuring and drawing gave us clues to the characteristics of the tools used to carve the stones. In subsequent experiments, one of us (Nair) was able to replicate Tiahuanaco stonecutting with considerable success. Replicative experiments are

> most valuable in testing whether a postulated technology works, and in finding out how it works and what its implications are. However, from a successful experiment alone, it cannot be concluded that the postulated technology was actually used; at most it is a demonstration of a possibility. Other technologies may yield the same results (Protzen 1993:vi).

In that sense, Nair's experiments underscore the challenges that an explanation of Tiahuanaco stonecutting puts forth.

Our study of Tiahuanaco architecture, for reasons given above, falls considerably short of being comprehensive. Nevertheless, we have tried to cover as many aspects as possible, from site planning to the minutiae of carving perfect right angles. We deal with the site, its organization, and its architecture in Chapter 1; and the main structures at the site, their architectural configuration and construction in Chapter 2. We investigate the design elements, motifs, ornamentation, and types of building stones in Chapter 3, and rules of composition, proportions, and dimensions, and of architectural configurations in Chapter 4. Chapter 5 is dedicated to the art of stonecutting, and finally, we discuss a range of construction issues, from the extraction of raw materials to the production of finished products, and the erection of buildings from the foundation to the roof in Chapter 6. And in the conclusion we review our findings and attempt to put them into the perspective of the ancient Andes, and of world architecture.

NOTES

1. Cramp, or clamp, is a construction device of metal or wood to hold together adjoining masonry units.
2. We are indebted to Patricia Lyon for this interesting reference.
3. The "Charter for the protection and management of the archaeological heritage," also known as the "Lausanne Charter", adopted by the International Council on Monuments and Sites (ICOMOS) in 1989 states in its Article 7: "Reconstructions serve two important functions: experimental research and interpretation. They should, however, be carried out with great caution, so to avoid disturbing any surviving archaeological evidence, and they should take account of evidence from all sources in order to achieve authenticity. Where possible and appropriate, reconstructions should not be built immediately on the archaeological remains and should be identifiable as such."

   As will be seen in the subsequent chapters, the reconstructions at Tiahuanaco violate nearly every feature of the above recommendations. Granted, the reconstructions we discuss at Tiahuanaco precede the Lausanne Charter, yet the recommendations are common sense and should have guided reconstruction then.
4. For example, questions about rituals that were followed in construction, beliefs held by the labor force, its social status, and the exercise and delegation of authority in the labor force, while of great interest to us, are probably better dealt with by anthropologists and ethnographers, if they can be elucidated at all.
5. As the reader will see, some questions we have regarding the configuration of specific structures could probably be answered by small-scale, strategically placed excavations, and thus may have easy answers.

PART I

The Site and its Architecture

CHAPTER 1

THE SITE

Su sitio es en un llano frío del secundo grado de Sierra, cuya longitud corre muchas leguas, si bien de ancho tendrá no más de una y media, porque lo cercan por los lados dos pequeñas sierras. En esta sabana y llano está asentado el pueblo de Tiaguanaco.... El nombre que tuvo este pueblo antes que fue señoreado de los Incas era Taypicala ... quiere decir “la piedra de en medio”; porque tenían por opinión los indios del Collao que este pueblo estaba en medio del mundo... [Cobo Book 13, Chapter 19; 1964:Vol. 2, 194].

Its site is a cold plain of the second degree, whose length runs many leagues, whereas its width might not exceed one and a half, because it is enclosed on the sides by two small mountain ranges. The settlement of Tiahuanaco is located on this savanna and plain.… Before it was lorded over by the Incas, the name of this settlement was Taypicala … which means “the stone in the middle,” because the indios of the Collao were of the opinion that this settlement was in the center of the world… [translation by authors].

GEOGRAPHY AND CLIMATE

TIAHUANACO, TODAY A SMALL FORLORN town dominated by a huge church dating back to the sixteenth century, lies in an almost treeless valley at an elevation of 3840 m above sea level, about 70 km due west of La Paz, Bolivia (Figure 1.1). The road to Tiahuanaco from La Paz winds its way out of the valley of Chuquiago Marka to the El Alto airport on the altiplano. From here the road continues in a westerly direction to Laja, where Alonzo de Mendoza originally founded La Ciudad de Nuestra Señora de La Paz on October 20, 1548, but moved it to its present-day location shortly thereafter. From Laja the road winds through rolling hills to Tambillo, from where it climbs over a pass in the Kollu Kollu range. Seen from the pass is the majestic Cordillera Real, a formidable barrier of eternal snow and ice that separates the Altiplano from the Amazon Basin. This vista encompasses some of the most sacred peaks in the indigenous Aymara people’s religious beliefs, from Illimani in the east, to Mururata, Wayna Potosí, and Illampu to the west. At the foot of the pass to the north stretches a vast flat expanse, the Catari River Basin. This basin and the Pampa Koani in particular are laced with remnants of the ancient Tiahuanacans’ agricultural technology, including the raised fields seen in Figure 1.2, who made of this region a major breadbasket (Figure 1.2).

Descending from the pass, the road continues into the Tiahuanaco River Valley and to the town of Tiahuanaco farther west. On approach, the church’s silhouette looms against the sky from miles away, challenged only by the mass of Akapana, a man-made platform mound and a beacon of the civilization that once flourished here (Figure 1.3). At Tiahuanaco, the valley is about 8 km wide and is bordered on the south by the Quimsachata mountain range, and separated on the north from the smaller, southern basin of Lake Titicaca, also known as Lake Wiñaymarka, by the Taraco Formation. Both ranges are criss-crossed

Figure 1.1. Map of Tiahuanaco and its environment (drawing by Jean-Pierre Protzen, first published in *Journal of the Society of Architectural Historians*).

Figure 1.2. Raised fields near Lukurmata.

Figure 1.3. Akapana and town of Tiahuanaco on approach from La Paz.

by ravines carved by permanent and seasonal watercourses feeding into the Tiahuanaco River. The modern town of Tiahuanaco, located in the lower third of the valley, overlooks the Tiahuanaco River, which empties into the lake just 12 km farther west. The town and the archaeological site surrounding it to the east and south are confined by a pronounced escarpment falling off to the west toward the lake basin. This escarpment likely marks an ancient lake terrace formed in the Late Pleistocene (Kolata 1996a:76). To the north, the site borders onto another escarpment, this one cut by the Tiahuanaco River carving its way through the lake terrace. To the east and south the site blends almost indistinguishably into the surrounding plains of alluvial and lacustrine deposits.

Of interest in the present study is the geology of both the Taraco Formation and the Quimsachata range. The formation consists of a conglomerate with clasts of sedimentary and igneous rocks (Departamento Nacional de Geología, hoja 4844). Some of the clasts are comprised of "Devonian mudstones, quartzites, vein quartz, Permian calcareous rocks, and granodiorites" (Kolata 1996a:69). Cobbles of quartzite were extensively used by the Tiahuanacan builders in foundations and likely served as hammer stones. The Taraco Formation was a potential, if perhaps indirect source for these materials, as they washed out of the formation and were deposited on the alluvial and lacustrine plains. The Quimsachata range consists predominantly of reddish to whitish sandstone, also known as the Tiahuanaco Formation (Departamento Nacional de Geología, hoja 4844). It is a heavily folded formation with isolated intrusions of andesitic or dacitic rocks (Departamento Nacional de Geología, hoja 4844). Sandstone and andesite were the principal building materials of the ancient Tiahuanacans. As we discuss in more detail in Chapter 6, the sandstone used at Tiahuanaco almost certainly came from the Quimsachata range; the andesite, however, is of another origin.

The weather and climate at Tiahuanaco are primarily determined by alternating wet and dry seasons, with the rainy season lasting from about the beginning of October to the end of March. The average annual precipitation for the Lake Titicaca Basin is about 750 mm (Kolata 1996a:32). To the changes in precipitation correspond changes in average temperature: colder in the dry season, warmer in the wet season. In the wet season, at lake level, nighttime mean temperature minima generally remain above freezing, while "[m]ean daytime maximum temperatures range from 16.4°C in July to 19.1°C in November" (Kolata 1996a:32). Useful as these figures are to describe the general conditions in the lake basin, they do not account for local variations, or microclimates induced, for example, by topographic idiosyncrasies, nor do they speak to short- or long-term climate fluctuations. To obtain a picture of the climatic condition during the rise and fall of Tiahuanaco civilization, from about 300 B.C.E. to about 1100 C.E., with the peak development probably between 800 to 1000 C.E., Alan Kolata and associates have engaged in a variety of studies, among which was a study of lake-level fluctuations:

> The large basin of Lake Titicaca may have undergone fluctuations of +10 to –50 meters during the Holocene, while Lake Wiñaymarka dried out completely.... The entire lake declined rapidly beginning about 10,000 to 11,000 years ago and reached its minimum elevation between 7700 and 7250 B.P., when the two basins became separated. This low stand was followed by a rise in Lake Wiñaymarka to about 10 meters below its present level by about 6000 B.P., then by another decline beginning about 4500 B.P. After 4000 B.P., the lake rose gradually, reaching its present level at about 2000 B.P.... Consequently, if the lake attained its present elevation about 2000 B.P., then the general extent of available moisture, wetlands, and periodic flooding at the time would have been about the same as it is today [Kolata 1996a:37–39].

The rise in lake level created the favorable conditions for the emergence of the Tiahuanaco civilization. Earlier than about 3500 B.P., the "aridity in the altiplano precluded intensive agriculture" but the ensuing wetter climate permitted "the Tiahuanaco civilization and its immediate predecessors" to develop "specialized agricultural methods that stimulated population growth and sustained large human settlements" (Binford 1997:235). The collapse of Tiahuanaco civilization correlates with another decline in lake levels of 12 to 17 m around 1100 C.E. that lasted about 200 to 300 years before it returned to roughly its present level (Binford et al. 1997).

The Site and Its Plan

The archaeological site of Tiahuanaco today consists of two distinct areas. The larger of the two, about 1 km east of the modern town, comprises several structures clustered around Akapana; the smaller area is about 1 km to the southwest of Akapana and consists of only the man-made mound of Pumapunku. The earliest known plan of the site is by Angrand (Prümers 1993).[1] It is reasonably accurate in its details, but the overall plan suffers from distortions of scale and a blatant misplacement of Pumapunku relative to the rest of the site. To Posnansky we owe the first topographic survey of Tiahuanaco and its immediate surroundings made in 1927 (Figure 1.4). This plan serves researchers to this day, for it is the only published topographic site plan readily available. With this map in hand, we will take readers unfamiliar with the site on a quick tour of Tiahuanaco's many remains and their relative situation. Along the path we will give summary characterizations of the major monuments. A more in-depth treatment of the most important structures will follow in Chapter 2.

A Tour

We begin our journey from the little museum[2] opposite the railroad station and head in a northeasterly direction to the western base of Akapana[3], a man-made mound. Akapana covers about 3.2 ha and reaches a height of about 16 m. Climbing the mound we arrive on its highest level from where, on clear days, one catches a glimpse of the three snow-capped peaks of distant Illimani to the east, and to the west Lake Titicaca. Over 6400 m high, Illimani is one of the tallest mountains of the Cordillera Real and is still today venerated by Andean people as a deity. It is noteworthy that there are only *two* places at Tiahuanaco from where Illimani *and* the lake can be seen, Akapana and Pumapunku, suggesting that the view of this sacred mountain may have played a significant role in the location of these structures.[4] Continuing our path to the east we skirt a large, deep depression, which holds water year-round. The hole is the work of Spanish colonial treasure hunters, in which they possibly obliterated some structures on top of the mound and what probably was a sunken court, albeit smaller and shallower than today's pit. What remains are the foundations of a series of contiguous small rooms, and a row of six stone pillars, the remains

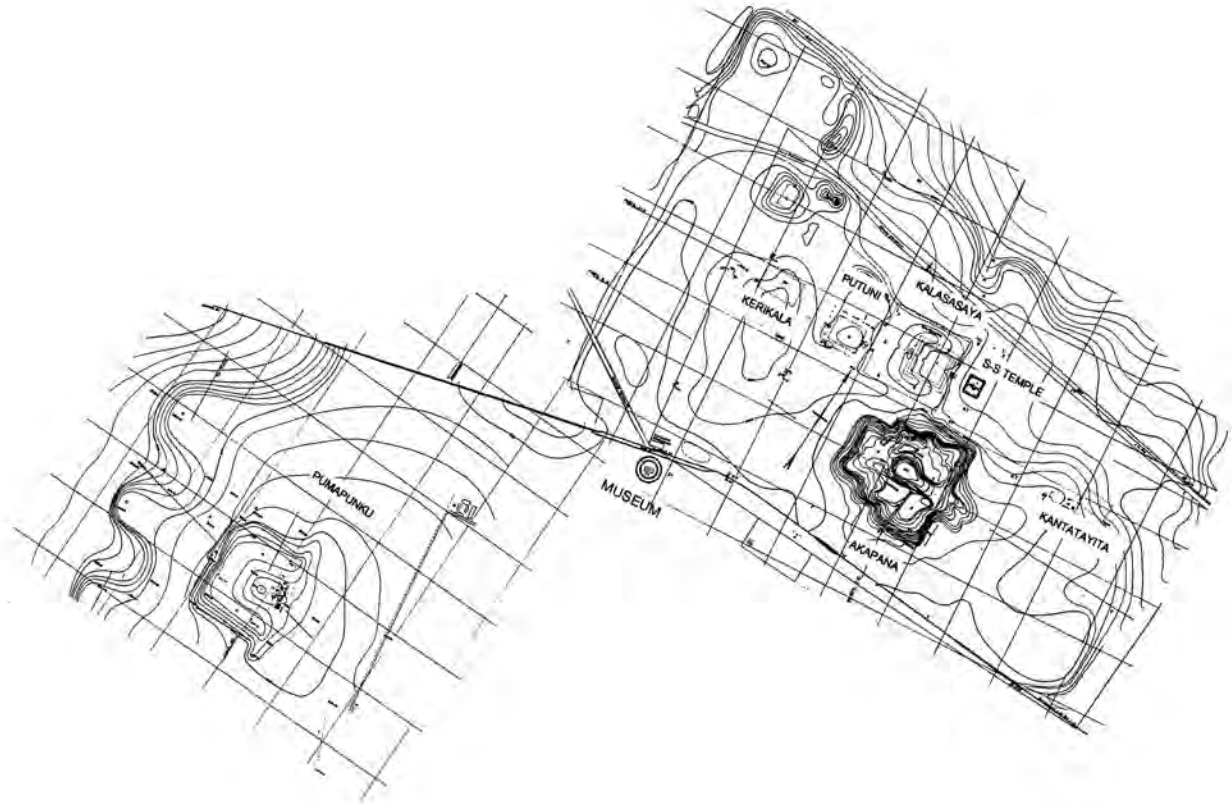


Figure 1.4. Map of Tiahuanaco (after Posnansky).

of a wall. As we climb down the eastern slope over the tailings left by the treasure hunters to the base of the mound, the visitor can appreciate that Akapana once was a terraced platform mound: visible are the remains of several, successive retaining walls and terraces brought to light through excavation (Figure 1.5).

From here, about 170 m to the east, we reach Kantatayita (Figure 1.6). Very little of this structure remains above ground; not much is to be seen except the so-called "Model Stone" and a beautifully decorated curved lintel, both to be treated in detail in subsequent chapters. The surfaces of fairly large rectangular stones, barely emerging from the ground, spaced at more or less regular intervals, suggest that some rectangular structure may have enclosed this area in a manner similar to that of Putuni to be visited later. Turning west, we cross open land and about 200 m farther we come upon the completely reconstructed Semi-Subterranean Temple (Figure 1.7). It is a roughly square sunken court, the walls of which are animated by "tenon-heads"—heads carved in the round and tailed into the wall with long "necks." Each head appears to have its own facial expression, some of which now strike us as outright comical.[5] In the courtyard several stelae were found, along with a colossal statue named after its discoverer, Wendell C. Bennett (Figure 1.8) (Bennett 1934) Some of the stelae are now set up in the center of the court; the "Bennett" was moved to La Paz by Posnansky and has since been returned to the new museum at Tiahuanaco (where this photograph was taken).

Immediately to the west of the Semi-Subterranean Temple is the monumental staircase leading into the Kalasasaya, an extensively reconstructed, huge rectangular enclosure and raised platform roughly oriented east to west (Figure 1.9). Its main entrance, a monumental staircase facing east, was first uncovered by Georges Courty of the French Mission in 1903. The massive gateway atop the staircase at present is the work of Carlos Ponce Sanginés, a rather problematic reconstruction to be discussed in Chapter 2. Today, access to Kalasasaya is provided through a narrow,

Figure 1.5. Platforms or terraces on Akapana.

Figure 1.6. Kantatayita with Akapana in left background and the so-called Model Stone in the foreground.

Figure 1.7. The Semi-Subterranean Temple with Akapana in background.

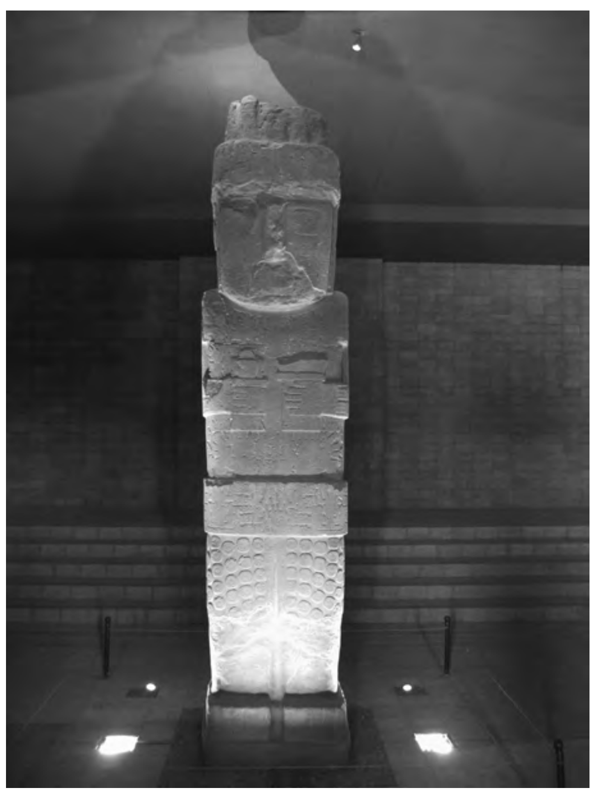


Figure 1.8. "Bennett" Statue (Photo by Clare Sammells)

Figure 1.9. Kalasasaya and Semi-Subterranean Temple seen from Akapana.

secondary staircase at the west end of the structure's north wall. To the right, at the top of the stairs in the northeastern corner stands the arguably "most famous stone sculpture in the ancient Andean world" (Kolata 1993:148), the Gateway of the Sun (Figure 1.10). In the opposite southwestern corner stands a colossal statue, commonly known as "El Fraile" (Figure 1.11). The eastern half of Kalasasaya is occupied by a sunken court, within which stands another colossal statue re-erected by, and named after, Ponce Sanginés who found it there (Figure 1.12). This court is flanked to the north and south by small rooms, seven to each side.

The central section of Kalasasaya's west wall projects out about 6 m beyond the main corpus and is known as the Balcony Wall. Exiting Kalasasaya by a narrow stair at the northern end of the Balcony Wall, we observe immediately to the north or our right, the foundations of what used to be three carefully constructed small chambers excavated by Courty. Unfortunately, this place, also known as Chunchukala, was sacked very shortly after Courty uncovered it. Only photographs and drawings published by Posnansky (1945:Vol. 2, Figures 37, 38, 39) provide an idea of what Chunchukala was when excavated.

Turning around and walking now to the south along the Balcony Wall, we soon come upon the entryway to Putuni on our right or to the west (Figure 1.13). Putuni is another rectangular courtyard enclosed by extremely thick walls, today about 1.2 m high. Several small chambers, with access from the court, were built into the enclosure wall. The long axis of Putuni is oriented approximately east to west. Presumably, a statue once stood there as well, of which only the lower half of the body is preserved. Deep under the western enclosure wall of Putuni runs a major canal (Figure 1.14). A fairly long section of this canal has been excavated and now lies open to view. At least two other, smaller canals emptying into the big one, give the visitor an idea of Tiahuanaco's sophisticated and carefully planned system of canals. The possible functions of this canal system are discussed later in this

Figure 1.10. Gateway of the Sun (back side; for front side, see Fig. I.01).

Figure 1.11. The "El Fraile" stela.

Figure 1.12. The "Ponce" stela.

Figure 1.13. Putuni as seen from Balcony Wall.

Figure 1.14. Major Canal just west of Putuni.

chapter. Adjoining Putuni on the northwest side, Kolata and associates excavated the so-called Palace of the Multicolored Rooms, where several burials with prestigious grave goods such as a miniature golden face mask were found (Couture 2003:251ff).

Sixty meters to the west of Putuni lies a complex called Kerikala, also a courtyard structure about 70 by 50 m with its long axis oriented approximately east to west (Figure 1.15). The structure is very badly preserved, but one does recognize that the court was once enclosed by a continuous wall of rooms. This wall was at least two rooms deep, such that only the rooms facing the court had direct access to it. The rooms are all contiguous, long, and narrow, at less than 2 m wide. All that is preserved of the rooms are the bases of the walls, which appear to have been built of two shells of small reused cut stones filled with rubble. Where the court was entered is not known (Arellano, 1991:267).

In a north-northwesterly direction, and about 120 m from Kerikala is an artificial mound, on top of which was built a cemetery for the victims of smallpox in colonial times. The cemetery is now gone, but what served as its entrance, the so-called "Gateway of the Moon," is still there to be seen (Figure 1.16). This ancient gateway, which is carved from a single slab of andesite and was brought to its current location from elsewhere, is discussed in detail in Chapters 3 and 4. Looking from the Gateway of the Moon back toward the northwest corner of Kalasasaya, one will see yet another artificial mound, today called Lakakollu.

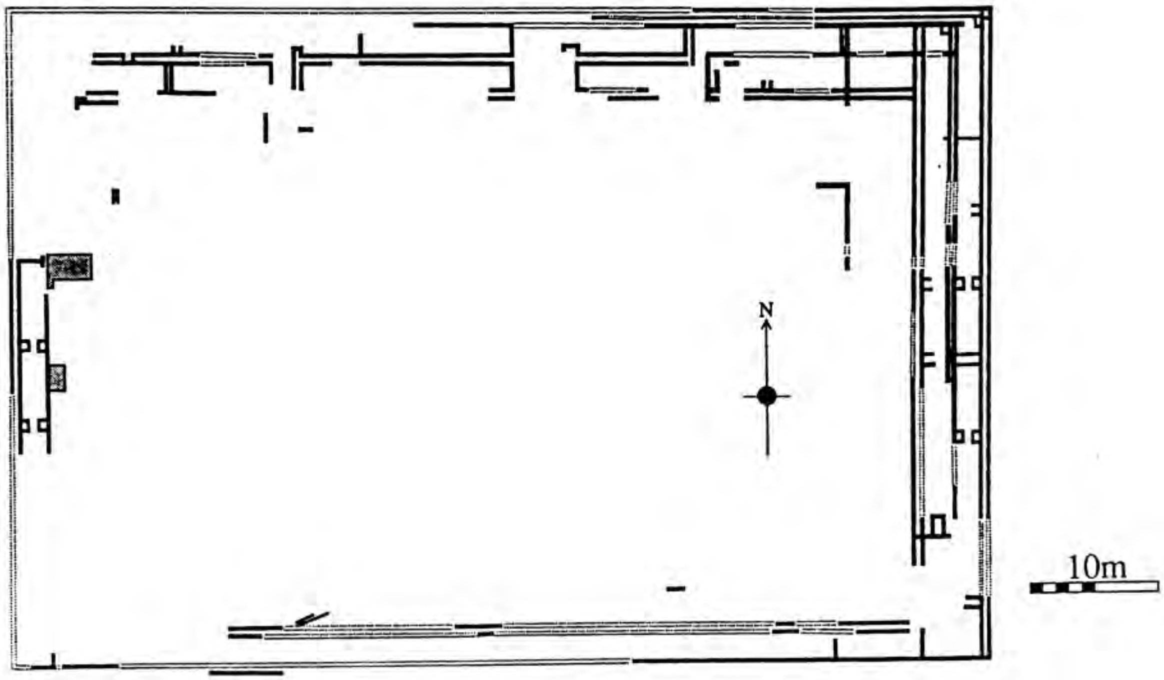


Figure 1.15. Plan of Kerikala (Escalante 1993:244).

Figure 1.16. Gateway of the Moon, front side.

Information gathered by Ponce Sanginés, who in 1958 cut a few test trenches into this mound, suggests that it was comprised of at least two platforms (Ponce Sanginés 1995:237). The original configuration of the mound with the Gateway of the Moon is not known.

From the Gateway of the Moon we now return to the museum from where we continue on to the southwest to Pumapunku, a little more than half a kilometer distant (Figure 1.17). This part of the site feels rather isolated and is rarely visited by tourists.[6] We have often worked there for days on end without encountering a soul. Yet, Pumapunku is the most interesting, fascinating, and enigmatic part of Tiahuanaco. Nowhere on the site is one so much in touch with, and exposed to, the stark beauty and overwhelming power of the surrounding landscape. From here one enjoys far-reaching views. To the east are the cultivated fields and steppes of the upper Tiahuanaco Valley, and on a clear day, emerging above the distant pass of Tambillo are the three peaks of Illimani. To the west, one overlooks the lower Tiahuanaco Valley with a distant view of Lake Titicaca and the mountains of Desaguadero beyond. The serenity and peace experienced on a balmy and sunny winter day contrast sharply with the violence and howl of winds and storms that sweep over the site in the rainy season.

Pumapunku, like Akapana, is a man-made terraced platform mound, but with a much lower profile. It covers about 2.25 ha and reaches a height of about 6 m. Sunk into the highest platform of the mound is a courtyard that on the east side is closed off by an area with huge sandstone slabs—which we call the Platform Area—that may have been the foundations for some important structure. Of that structure, all that remains are hundreds of finely wrought stones and fragments of intricately carved gateways and windows, scattered around the slabs like the pieces of a giant puzzle (Figure 1.18).

Organization

If one detects a high degree of geometric rigor and symmetry in the layout of the individual structures, the organizing principles that governed the layout of the site and the placing of the individual structures

Figure 1.17. Seen from the town, Pumapunku appears to be a minor hill.

Figure 1.18. Scattered around Pumapunku, like a giant puzzle are hundreds of finely wrought stones.

relative to each other are far more elusive. The various reconstruction drawings of Tiahuanaco's core with wide avenues and a strictly orthogonal layout are difficult to reconcile with what is experienced on the ground (Escalante 1993:128–133). Although the existing structures are roughly oriented to the cardinal directions, they do not line up according to a specific grid or to each other, nor do they form a grand axis, as one can observe, for example, at Huaca de los Reyes or other U-shaped structures on the Peruvian coast. They do not create an enfilade of open and narrow spaces as at Machu Picchu, nor do they define a plaza as at Chavín de Huántar, and they do not stake out an obvious street pattern. It is true that from within the Semi-Subterranean Temple today one has an imposing perspective of the east entrance to Kalasasaya, yet the various structures, other than proximity, seem not to have any specific relation to each other. There is no obvious path that leads from the entrance or access of one structure to that of another, nor are they oriented to each other.

If the structures do not neatly line up—one observes deviations of three to four degrees in their relative orientations—nevertheless, with the exception of the Semi-Subterranean Temple with its north-south axis, most major structures at Tiahuanaco are oriented roughly east-west. Kolata (1993:96–98) sees in this orientation an embodiment of the solar path as one of the organizing principles for Tiahuanaco's urban layout. The other two principles proposed by Kolata are the "concentric cline of the sacred" and a "dual division."

A moat, even a series of moats, that presumably encircled "the civic-ceremonial core of the city evoked the image of a sacred island" and the "moat served to physically demarcate the concentrated, sacred essence of the city. The moat acted as a psychological and physical barrier, setting up by its very shape, dimensions, and symbolic representation, a concentric hierarchy of space and time" (Kolata 1993:93). The meaning of the central island was that of the origin of the human race, "but at Tiahuanaco, only *some* humans [emphasis in original], the elite of Tiahuanaco society, appropriated the special right of residence in this sacred core. The barrier of *water* [added emphasis], then, also marked a point of transition that distinguished the residences of elites from those of commoners: social inequality and hierarchy were encoded in Tiahuanaco's urban form" (Kolata 1993:93).

The notion that Tiahuanaco was surrounded by a moat was, to our knowledge, first proposed by Posnansky. He imagined that Lake Titicaca had a much higher level in ancient Tiahuanaco times than today and that the archaeological site lay directly on the shores of Lake Titicaca. Accordingly, he interpreted the features seen to the west of Pumapunku, at the edge of the escarpment, as wharves; a small bay near the north entrance for him became a port; and in the depressions to the east and west of Akapana he saw a moat.[7] As mentioned above, and as Binford et al. have convincingly shown, Lake Titicaca rose to its modern level about 2000 years ago (Binford 1997). Thus, Tiahuanaco was never at the lake's edge, and the putative moats would have been dry. But were they moats? Posnansky's own topographic survey shows that the depression, or swale, to the west of Akapana was not connected to the depression on the east; in other words, to the south of Akapana the moat, if indeed it was intended, was never completed. Posnansky (1945:Plate 3) acknowledged this fact in his plan of 1904 (with 1912 revisions) in which he connected the depressions on the west and east with dotted lines.[8] Our own inspection of the depressions, or ditches, rather suggests natural drainage basins. Many more very similar drainage basins are found all along the Tiahuanaco River to the east of the town of Tiahuanaco. Now, it is possible, as Posnansky postulated, that the Tiahuanacans mined the surrounding area for dirt to build Akapana, and thus enlarged the drainage basins, but a thousand years or more of erosion may well have obliterated all evidence that the depressions were actually man-made. The question of whether there ever was an intention to build a dry moat may have to go unanswered.

Inspired perhaps by the knowledge that Cuzco, the capital of the Incas, was divided into two moieties, *hanan* Cuzco and *hurin* Cuzco (Cobo Book 12, Chapter 24; 1964:Volume 2, 112), Kolata wrote that "[c]ross-cutting the east-west axis generated by the solar path, there was a further bipartition of social and symbolic space at Tiahuanaco into northern and southern segments..." (1993:98). This division, he argued, "may be inferred from the distribution of its two principal terrace-mounds: Akapana to the north and Pumapunku to the south" (Kolata 1993:99). As Kolata (1993:99–103) goes on to show, there is ample support, albeit indirect, for the conjecture of a sociopolitical bipartition of Tiahuanaco. Whether this partition manifested itself in the physical structure of the urban plan is another question. The known division of Cuzco, which was located at the Qorikancha, does not have an architectural referent; it cannot be read from the urban fabric. Yet, at Tiahuanaco, the setting of Akapana and Pumapunku does suggest a division, but a division of distance and isolation, more than of north-south. Had the moat existed, the separation between the two mounds would have been even more striking and significant. The "concentric cline of the sacred" would have to be reinterpreted in a very different light, for Pumapunku would then have lain *outside* the sacred core of the city.

Extent

We mentioned in the Introduction that the earlier held notion of Tiahuanaco as mainly a pilgrimage spot with at best seasonal occupation has given way to the conception of the city as a major seat of power, a true capital with a permanent population. Ponce Sanginés (1995:249) estimated that the city covered an area of about 420 ha, or a little over 4 km^2. The location of the city's boundaries and the nature of its composition are still very uncertain. Apart from the ceremonial core, we have but scant knowledge of Tiahuanaco's urban character. Did it have administrative buildings, a market, caravansaries, shops, lodgings for pilgrims, and manufacturing and storage facilities? Excavations by Claudia Rivera (2003) revealed a possible ceramic workshop at what might be the eastern edge of the city; Javier Escalante's (2003) excavations at La Karaña north of the core brought to light foundations of circular buildings that just might be storehouses; and John Janusek's (2008:148) excavation on the east side of Akapana "revealed a remarkable transformation in which one neighborhood was completely refashioned as an urban sector dedicated to elite-sponsored ceremony and feasting." Significant as these findings are, much more needs to be done before a picture of daily life in Tiahuanaco can be painted. In part, the problem is that a "city of such huge spatial reach and protracted occupation is seldom explored in depth, simply because the logistics of large-scale archaeological investigation are so daunting" (Kolata 1993:89).

Relation to Other Tiahuanaco Sites in the Region

Tiahuanaco is seen as the primary center in a hierarchy of secondary, tertiary, and quaternary settlements spread throughout the city's hinterland. The respective functions of the settlements in this hierarchy are interpreted as capital, regional administration, local administration, and agricultural production (Kolata 1996a:16). Kolata found evidence of such a hierarchy in the Pampa Koani and its environs, and, as mentioned before, Juan Albarracín-Jordán and James Mathews noted a similar pattern in the Tiahuanaco Valley:

> El patrón de asentamiento del Período Tiahuanaco IV representa la primera manifestación concreta de una estructura administrativa planificada. Se nota en primer lugar la presencia de una jerarquía de asentamientos encabezada por Tiahuanaco. El segundo aspecto está conformando por asentamientos extentos, espaciados a intérvalos regulares.... Los sitios tericiarios éstan constituidos por extensiones que oscilan entre una y tres hectáreas, cuya distribución sigue el espaciamento regular de los secundarios. Los sitios de cuarto orden forman la mayoría de los asentamientos de este período. Casi todos éstos se encuentran vinculados con campos agrícolas.... [Albarracín and Mathews 1990:189].
>
> The settlement pattern of the Tiahuanaco IV Period represents the first concrete manifestation of a *planned* administrative structure [added emphasis]. In the first place one notes a hierarchy of settlements headed by Tiahuanaco. The secondary aspect is formed by large settlements [*3 to 10 ha, Albarracín-Jordán and Mathews, Map 4*], spaced at regular intervals.... The tertiary sites cover an area that varies between one and three hectares, whose distribution follows the regular spacing of the secondary sites. The sites of the fourth order [*0.01 to 0.9 ha, Albarracín-Jordán and Mathews, Map 4*] account for the majority of settlements during that period. Almost all of the latter are related to agricultural plots. [Notes in italics added by the authors.]

What kind of sociopolitical organization brought about such hierarchical structured settlement patterns seems to be in dispute. In Kolata's (1996a:16) view, such structures "clearly signal the action of a supracommunity, central authorities. "The argument that the observed hierarchy of settlements implies a *planned* administrative structure, or the intervention of an authoritative agency, such as a state, is not incontrovertible. Walter Christaller (1968) successfully explained the size, number, and distribution of settlements, as found for instance in preindustrial southern Germany, in purely economic terms: supply and demand for goods and services (including administrative functions); and the costs of production, storage, and transportation, among others. Christaller's theory of "central places" predicts for the ideal case of a featureless plain on which is located a settlement hierarchy of increasing centrality (size) arranged in a pattern of nestled hexagons of increasing diameter. The theory was later expanded and generalized, and found to apply, albeit with modifications, to a great variety of contexts and geographic areas (Berry and Pred 1965; Johnson 1972; 1977). Several studies have shown how *planned* interventions can distort the "naturally" grown settlement pattern and disturb the system's economic equilibrium, possibly to the point of dysfunctionality (Berry and Pred 1965).

A different view is presented by John Janusek who cites and discusses research that

> has explored heterarchy in regional settlement patterns focusing on functional differences between settlement and settlement clusters. This work has investigated nonranked differentiation among economic, political, religious and other nonkin institutions. As such, heterarchy "simply means that different functions can exist in a system *without* [added emphasis] their arrangement being hierarchical" [Janusek 2004:24].

Juan Albarracín-Jordán, who, at first, saw in the settlement pattern the "manifestation of a planned administrative structure" (see above), later, in a discussion of various models of possible social organization, challenges Kolata's "centralized bureaucracy" model and argues that the

> Tiahuanaco settlement configuration within diverse agricultural regimes bespeaks a nodal distribution of sites. Tiahuanaco's agricultural hinterland was articulated through local organizations, which in turn, maintained reciprocal relationships with the urban center through the exchange of unique goods and services. Nevertheless, differences in the hierarchical order must have been maintained by commonly held ideological principles perpetuated through rituals and feasting [Albarracín-Jordán 2003:111].

Central places theory, which is not without pitfalls (see Paynter 1982), heterarchy, and the nodal distribution model, all offer alternatives to the centralized bureaucracy model for explaining the relationships among the various ranks in the observed hierarchy of Tiahuanaco settlements and may even give clues to the collapse of its civilization. With regard to site planning, architecture, and construction, the different social models suggest different forms of spatial perception and organization, and different modes of allocation of resources, labor recruitment and organization, and more. To what extent, if any, the prevailing social model can be read from architecture and construction practices remains to be seen.

The Architecture at the Site

From the tour of the site, the reader will have realized that the ruins are not very glamorous: there is little standing architecture to be visited and what is standing is largely and questionably reconstructed. Apart from the standing architecture, what the visitor encounters are the foundation outlines of buildings, segments of retaining walls, enormous stone slabs, fragments of elaborate gateways, sculptures, lots of carved building blocks strewn about the site, all dressed with astonishing skill, and the remains of water canals, some found deep underground. The jumble of ruins taxes one's imagination; it takes a considerable effort to visualize what the architecture of Tiahuanaco might have been. Are the beauty and sophistication of the Gateway of the Sun a predictor of what Tiahuanaco architecture once was?

Major Components of Tiahuanaco Architecture

Of the architecture at Tiahuanaco, Paul Goldstein wrote:

> For Tiahuanaco, the monumental representation of state power crystallized in a characteristic ceremonial architecture whose archetypes are found at Tiahuanaco and its altiplano satellites. In the broadest sense, the key elements can be categorized as (a) artificial terraced mounds, (b) rectangular enclosures, including walled precincts and sunken courts, and (c) a complex of doorways and staircases that channeled access to a ceremonial core [Goldstein 1993:24].

We follow Goldstein's categorization in a first approximation, but will want to modify the categorization of the structures and expand on the categories beyond the monumental mounds and gateways, to include buildings, stelae and statues, and canal systems.

Structures

We propose to categorize the structures visited on the tour above into three types: platform mounds, courtyards, and the combination of the two. Individually and together, the structures set up an intriguing layering of horizontal planes. Starting with the base plane of the surrounding terrain, the mounds with their successive platforms define one or more horizontal planes above the base plane. The courtyard structure of the Semi-Subterranean Temple, and possibly Kantatayita and Putuni, establish horizontal planes below the base plane. The courtyards atop of platform mounds, Kalasasaya and Pumapunku, for example, repeat the pattern of stepping below the immediate surrounding plane. It is tempting to think that the people of Tiahuanaco attached a special significance to each of these planes and the relationships among them. Moving on and about the Earth must have had a meaning quite different from that of stepping down into the Earth, and that again a meaning different from stepping up and above the Earth. Stepping down into a courtyard set on the summit of a mound, while recalling the act of descending into the Earth, again must have had a meaning different from the latter. It is doubtful that we ever will elucidate these meanings, but no harm is done in thinking about the possibilities. We will return to the question of horizontal planes in the Conclusion to this book.

The geometry of Tiahuanaco architecture is orthogonal, with the still visible structures exhibiting a rigorous bilateral symmetry around the east-west axis, with the exception of the Semi-Subterranean Temple whose axis of symmetry is oriented north-south.

Of the east-west oriented structures, Kolata (1993:97) wrote that they all possessed "axial twin staircases constructed centrally into their east and west facades." He further noted that the "sets of western staircases are significantly smaller in scale than their eastern counterparts" and that "the western staircases lack the elaborate, monumental carved stone jambs and lintels that grace the eastern entries" (Kolata 1993:97). As seen above, Kolata (1993:98) relates these arrangements to the "symbolism of the solar path: the ascending sun of the east is energetically more powerful than the waning sun of the west."

We appreciate the argument that the east-west orientation of most of the important structures at Tiahuanaco is likely related to the path of the Sun. The assertion that each structure was designed with twin staircases built with different elaboration on the east and west side, however, does not correspond to what is known or can be observed at the site. Manzanilla, who excavated the beginning of a stair on Akapana's west side, indeed surmised that the principal access may have been a double staircase (Manzanilla 1992:41). What the configuration of Akapana's eastern access was, if it had one, is today unknown, as is that of Pumapunku. The western access to Pumapunku is not a twin, but a wide, single staircase that appears to have been rather monumental. The eastern access to Kalasasaya is a single, broad staircase, and there are serious questions about the configuration of its western access (see Chapter 2). If it existed, it most likely was not centrally located on the major axis. In its current stage of excavation, there is no evidence of a western access to Putuni. The eastern stairs to the latter have vanished, but the old records suggest not a twin, but a single staircase (see Chapter 2).

Gateways

Goldstein mentions gateways that "channeled access to the ceremonial core," and we have seen on the tour above that, indeed, there are numerous gateways at the site, some intact, others shattered but still recognizable. The magnificent elaboration of these gateways with friezes and niches suggests that they had a very special meaning within the architectural context of Tiahuanaco. In what relationship these gateways stood to the structures and what their function was, however, is not really known, but are questions that we will address later in the text.

Buildings

In the late nineteenth century, Stübel and Uhle (1892a:Part 2, 26–27) wondered about the abundance of gateways and the scarcity of buildings. If Stübel did not see any buildings at Tiahuanaco when he visited the site, it is because all had been reduced to their foundations, which he could not see because they were buried. But as the many excavation campaigns have revealed, buildings once stood on the mounds—for example, on the summit of Akapana, and near ceremonial structures at the Palace of the Multicolored Rooms at Putuni. Georges de Créqui-Montfort (1906:540–541) mentioned the remains of an adobe building with a paved floor and walls colored in white and red immediately south of the small chambers found by Courty. Buildings lined the periphery of Kerikala, and domestic buildings were found beyond the ceremonial core of the city. Not much is known about these buildings beyond their footprint and indications that they were built of adobe. Nevertheless, these adobe buildings were a significant component of Tiahuanaco architecture.

Stelae, Statues, and Sculptures

Colossal statues, stelae, and other sculptures were another notable component of Tiahuanaco architecture. Unfortunately, the relation of the statuary to the architecture is not very well known; little information exists regarding much, if not most of the statuary's original location, position, or arrangement. Some colossal statues may have stood in the center of courtyards, such as the "Ponce" stela in the Kalasasaya. Some effigies of pumas, called "chachapumas," may have flanked stairways, such as the exquisitely carved chachapuma excavated by Manzanilla at the base of the western staircase of Akapana. Créqui-Montfort (1906:538), in his report on Courty's excavation of Kalasasaya's monumental stairway, wrote: "Au pied de l'escalier on trouva deux piliers en retrait avec un puma sculpté destiné sans doute à les couronner." (At the foot of the stairs were found two recessed pillars with a sculpted puma destined without doubt to crown them [translation by authors].) This passage, while somewhat obscure, suggests that sculptures of pumas may have flanked this monumental stairway. Other statuary may have been erected in places without direct relationship to the architecture, as, for example, the statue that is now standing in the open just north of Kalasasaya.

Ancient statuary is known to wander about the Altiplano. We mentioned that in recent times, the "Bennett" statue moved from Tiahuanaco to La Paz. It has since been returned to the site, albeit not to where it was found but to a new museum. The two statues sometimes referred to as Peter and Paul guard the entrance to the town of Tiahuanaco's church, but according to Posnansky, they originally come from Pokotia,[9] In addition, "El Fraile" (Figure 1.11) may not always have stood in the Kalasasaya (see Chapter

2). The most celebrated story of a wandering sculpture, the so-called Arapa-Thunderbolt stela, dates to prehistoric times. Sergio Chávez (1975) demonstrated that two separate stela fragments carved in Pukara style, one from Arapa in the northern end of the Lake Titicaca Basin in Peru, and one excavated in Putuni at Tiahuanaco, were in fact fragments of one and the same stela. Why the stela was broken up and one section transported and relocated some 220 km away remains an open question.

Canal System

Earlier explorers already noted the many precisely carved stones, U-shaped in cross-section, scattered around the site (Squier 1877:280). These stones suggest that the Tiahuanacans had a network of canals. The first indications that Tiahuanaco was indeed laced with sophisticated canal systems derived from Courty of the French Mission. He uncovered a substantial canal, 47 by 70 cm in cross-section, constructed with finely cut stones held together with copper cramps, stepping down the mound of Akapana (Créqui-Montfort 1906:533). Posnansky later gave this canal the most unfortunate name of "Cloaca Maxima," thus comparing it to the main sewer of ancient Rome.

While excavating the Semi-Subterranean Temple, Courty was caught by torrential rains that flooded his trenches. Just before the flooding, he had found the mouth of an ancient drain in the northeast corner of the structure. To Courty's great surprise, all the water, some 20 m^3, drained out of the trenches within minutes after he dug a quick channel connecting the excavation to the ancient drain (Créqui-Montfort 1906:536). Courty came upon yet another piece of Tiahuanaco's canal system when he dug a trench on the west side of Putuni: another well-constructed canal, big enough for human passage, some 2.5 m below the surface (Créqui-Montfort 1906:541). This canal is presumably the same one that is visible today (Figure 1.14). Since then, several more canals have been excavated, heightening our appreciation for the accomplishments of Tiahuanaco's engineers. While drainage is an obvious function for the canals, some of them have such an enormous capacity that one wonders what other functions they may have had. The subject of the canal systems will be revisited in the next chapter in the discussion of particular structures.

Subterranean Chambers?

Posnansky described the three small structures excavated by Courty at Chunchukala as subterranean chambers. He made further mention of one more such chamber found by looters to the north of the previous three (Posnansky 1945:Vol. 2, 113–115). Posnansky took great pains in imagining how these structures were entered and roofed (1945:Vol. 2, 115, Figure 40). But were these chambers really subterranean? In his report on Courty's excavation, Créqui-Montfort did not say they were, nor are we convinced when looking at the photographs published by Posnansky (1945:Vol. 2, Figures 37 and 38). The three chambers seem to have clear entrances at the ground level. The photograph of the fourth chamber shows too little detail to come to an unequivocal decision about its nature (Posnansky 1945:Vol. 2, Figure 39). The reader will recall that small chambers were built into the enclosure wall of Putuni. These chambers give the feel of underground rooms and thus are perhaps analogous to the chambers described by Posnansky.

Summary Observations

If Tiahuanaco was laid out according to some master plan, the manifestations of its underlying organizing principles—if they ever existed—have been lost or are still buried deep under its ruins. Because the various structures do not have obvious relationships to each other, and because each structure appears self-contained, the still visible remains give the impression of piecemeal growth rather than planned development. Clues to urban-scale and long-term planning practices at Tiahuanaco could perhaps be inferred from its underground canal system, but for that we must first know more about its layout and extent. The fragments of that system uncovered to this day do not yet tell a coherent story.

The builders of Tiahuanaco did plan, if not at the urban scale, at least at the level of individual structures. To lay out a structure with the dimensions of say Akapana, Kalasasaya, or Pumapunku, with perfect right angles, and to prepare the site for its construction defies improvisation; it demands some vision of the structure's final appearance and some foresight about the construction processes, necessary materials, and needed manpower. The requisite vision and foresight suggest that there may have been a division of labor between those who conceived and those who constructed a building. Whether or not such a division of labor existed, the sheer volume of construction implies tasks of communication and coordination, communication of what needed to be done how, when, where, and by whom, and coordination of the various construction activities from quarrying, laying of foundations, to erecting walls, and so on. The structures themselves with their relatively consistent alignments to the cardinal directions and rigorous bilateral symmetries betray the Tiahuanacans' explicit knowledge of astronomy, geometry, and of the attendant surveying techniques for fixing and maintaining alignments, constructing right angles, leveling, and measuring.

The key elements of Tiahuanaco architecture that we have identified, including platform mounds, sunken courts, the combination of platform mounds with sunken courts, buildings, statuary, canal systems, and possibly subterranean chambers, are quite generic, or as Goldstein says, archetypal. As such they do not uniquely characterize Tiahuanaco architecture. Similar elements are found at many prehistoric sites throughout the Andes, from the Initial Period to the Late Horizon. Chavín de Huántar in Peru, for example, combines almost all of the same elements found at Tiahuanaco: there are several platform mounds, albeit not terraced, sunken courts, underground galleries, underground drainage systems, and stelae. What, then, are the design elements, the underlying orders that govern the layout of buildings, the spatial characteristics, and the proportions and dimensions that give Tiahuanaco architecture its cultural identity and distinguishes it from other architecture? These remain to be established. A closer look at the site's major monuments may afford some answers.

NOTES

1. Kolata (1993:27) and Uhle (Stübel and Uhle 1892a: Part II, 15) attributed the first formal plans of the site to Squier.
2. Since the writing of this text, the "little museum" has been replaced by a much larger one.
3. For a discussion of the names of the various structures we refer the reader to Appendix 1.
4. Kolata (1993:97) says that at Tiahuanaco, both the lake and Illimani can be seen "*only* from the summit of Akapana" (emphasis in the original).
5. Most heads seen today are replicas, not originals.
6. This is bound to change: the new road from La Paz to Tiahuanaco passes right by the entrance to Pumapunku.
7. Posnansky's idea persists to this day, in spite of evidence to the contrary. For example, the site plan of Tiahunaco given in the *Atlas of Ancient America* shows the city at the edge of a lake with a canal, or moat, encircling it (Coe et al. 1989:190).
8. Posnansky (1945:Vol. 2, 121) argued that the southern section of the moat had been silted in by alluvia.
9. Posnansky (1945:II, Figures 91–94) reports that these statues and two more were found at Pokotia, some 10 km southeast of Tiahuanaco at the foot of the Quimsachata range. He does not say when they where "discovered," nor who placed them at the church's entrance. A comparison with Posnansky's photographs shows that the statues in front of the church today are not the same. It may be interesting to note that Cobo (1964, Vol. 2:197) relates a story according to which the priest of Tiahuanaco in charge of the construction of the church ordered an artist to carve two statues of St. Peter and St. Paul from ancient stone blocks found at the site to adorn the church's entrance.

CHAPTER 2

THE MAIN MONUMENTS

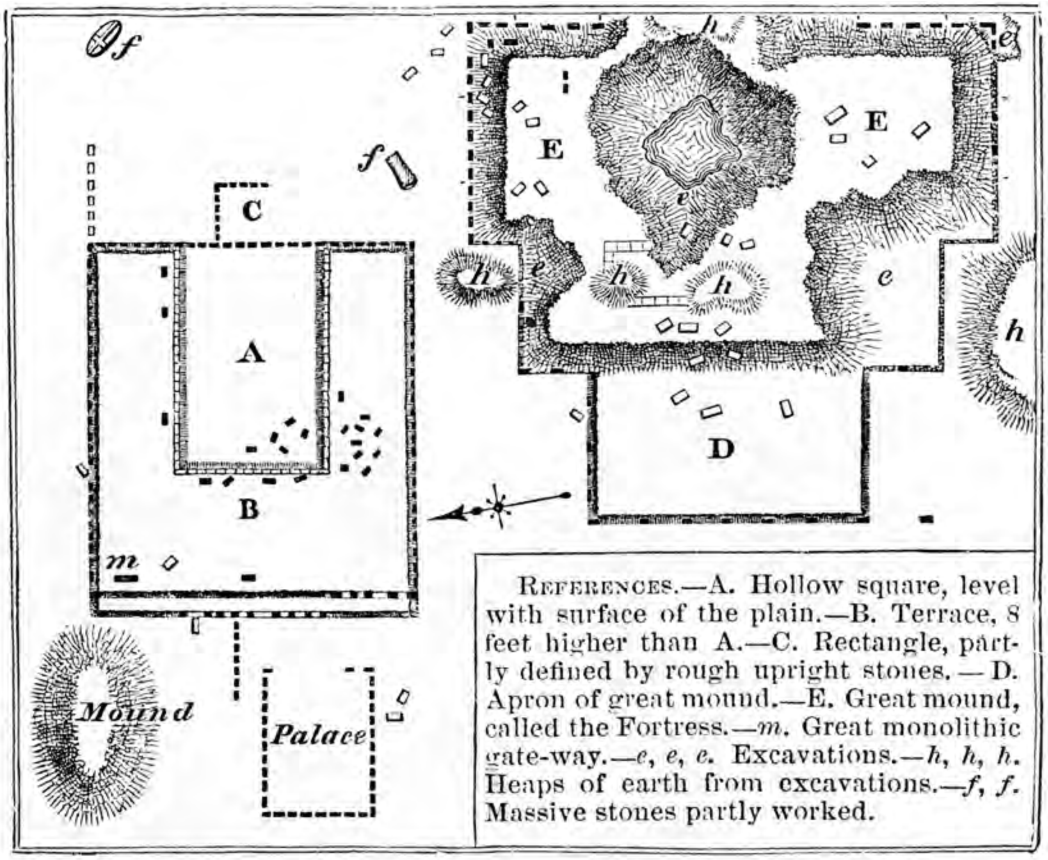
"Tiahuanaco no es pueblo muy grande, pero es mentado por los grandes edificios que tiene que cierto son cosas notable y para ver" [Cieza de León 1986:Part 1, 282). (Tiahuanaco is not a very big settlement, but it is known for its great edifices, which certainly are things noteworthy and to be seen [translation by authors].)

SEMI-SUBTERRANEAN TEMPLE

IN ORDER TO UNDERSTAND THE DISTINCTIVE qualities of Tiahuanaco architecture, we must look closely at its major monuments. It is only by examining the history of research as well as the buildings' configurations, plans, architectural details and masonry styles that a fuller picture of Tiahuanaco emerges. We begin with the Semi-Subterranean Temple, a critical focal point at Tiahuanaco. In a site made up of impressive and sometimes massive above ground structures, the Semi-Subterranean Temple is striking in its small size and sunken space. Made with elegant if simple masonry walls that were punctuated by carved tenon-heads, the Semi-Subterranean Temple served as a self contained space that is visually connected to two of the most important monuments at Tiwanaku, the Akapana and the Kalasasaya.

The earliest indication of a structure in the area of the Semi-Subterranean Temple is to be found on Squier's plan (Figure 2.1). He shows a row of stones (C) extending east from the Kalasasaya, which then turns south at a right angle. This latter section could represent the Temple's west wall. It was left to Courty of the *Mission Française* to uncover the structure. He excavated all around the inner perimeter of the structure and cut a trench east-to-west across its center. We know from this excavation that the walls were built of random-range work, that is "masonry of rectangular stones not laid in regular courses but broken up by the use of stones of different heights and width" (Harris 1975:396), interspersed with tenon-heads, and set between upright, pillar-like stones placed at random intervals (Figure 2.2). The height of the upright stones, too, varies greatly—some barely reach mid-height and others emerge above the surrounding ground level. Courty's excavations further revealed that the sunken patio was drained by a carefully crafted gutter running along the base of the walls (Posnansky 1945:Vol. 1, Plates 6 and 7). In the northeast corner of the patio, Courty uncovered a stela some 70 cm tall, of which Créqui-Montfort (1906:536) said that it had only four fingers on one of its hands.

The reader will remember that in 1932 Bennett received permission from the Bolivian government to sink a number of test pits at Tiahuanaco. One of these pits, Pit VII, he placed in the northern half of the Semi-Subterranean Temple, and as noted before, it is here that he came upon a colossal statue of red sandstone, standing about 5.5 m from head to toe, and two much smaller stelae (Bennett 1934:385–387). It is generally assumed that the statue and stelae were found in their original place, if not position, that is, that they once stood at the center of the sunken court. Given the size of the "Bennett," there is little doubt that it required a substantial socket to keep it upright and from toppling. Indeed, the statue has a shank or tenon some 1.8 m long below its feet that must



PLAN OF A PART OF THE RUINS OF TIAHUANUCO.

Figure 2.1. Squier's plan showing the outlines of the Semi-Subterranean Temple (letter C).

Figure 2.2. Walls of the Semi-Subterranean Temple with uprights and tenon heads.

have fitted into an appropriate socket or mortise that would have been difficult to overlook. Even a simple hole in the ground would have left its traces. Neither Bennett, who found the statue, nor Posnansky who had it moved to La Paz, nor Ponce Sanginés who, as will be seen below, re-excavated the Temple, make mention of a base or foundation for either the statue or the stelae. All that is known, is that Ponce Sanginés (1969:56) reported the floor of the temple to be at an approximate, average depth of 1.7 m below the surrounding surface, and that Bennett (1934:386) wrote that the head of stela B, which he found along side of "his" statue, was at a depth of 1.9 m and its feet at 2.6 m (Bennett 1934:386). This would indicate that stela B was entirely buried *below* the floor of the temple. In absence of more detailed information, it is difficult to interpret this situation, and it cannot be known whether the statue and stelae actually stood were they were found, nor what their relationship was to the stela excavated by Courty. Worse, this information is probably lost forever, because the floor of the Semi-Subterranean Temple has been replaced by a thick concrete slab (Ponce Sanginés 1969:94).

General Configuration

The Semi-Subterranean Temple was fully excavated, and completely rebuilt by the Centro de Investigaciones Arqueológicas en Tiwanaku (CIAT) under the direction of Carlos Ponce Sanginés during the years 1960 to 1964. This excavation brought to light the entrance to the sunken court on the south side, a stairway of six steps between two upright stones. The survey of the excavated Temple revealed that it is not quite square in plan. The east and west sides are slightly longer, 28.57 and 28.47 m, respectively, than the north and south sides, which measure 26.0 and 26.05 m, respectively (Ponce Sanginés 1969:58).[1]

The random-range work and the uprights were predominantly of sandstone, with an occasional andesite block. The uprights were set at variable intervals measuring from 1 to 4 m approximately. Their height varies between roughly 0.6 and 3.0 m. Some of the uprights showed evidence of having been carved in high relief on the side facing the court. The tenon-heads were mostly carved in limestone and volcanic tuff, with a few in sandstone (Ponce Sanginés 1969:74–76). The random-range work was assembled without mortar and, erected directly on tamped earth without a proper foundation course (Ponce Sanginés 1969:68). The CIAT scrupulously documented the conditions of the court's four walls with scale drawings and photographs before their restoration (Ponce Sanginés 1969:Plates 8–11). From these documents it can be seen that, in places, there were up to three rows of tenon-heads (Figure 2.3). Since there is no telling how high the walls might have been, there is also no telling how many rows of tenon-heads there were originally. With one exception, the heads found by the CIAT were encountered still stuck in the walls, or very near the base of the walls. On the north side, a large number of heads was scattered inside the court, up to 6 m from the wall (Ponce Sanginés 1969:Plate 12). A comparison of the CIAT documents and photographs of Courty's excavations (Créqui-Montfort 1906:Plate 1, Figure 4; Posnansky 1945:Vol. 1, Plates 6 and 7) shows that both the north and west walls suffered further damage between the two excavations; many more tenon-heads were still in situ at the time of the first excavation. Yet, many of the heads found by the CIAT on the north side must have been there before

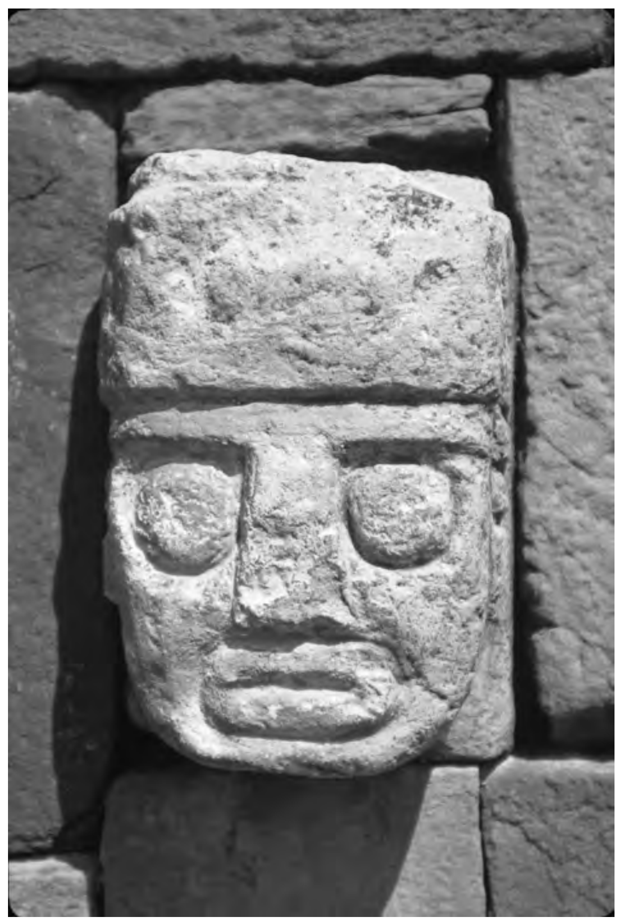


Figure 2.3. Tenon head.

the French excavation, for they were laying beyond Courty's trench, suggesting that the dismantling of the Semi-Subterranean Temple has a history predating the nineteenth century during which time it was already buried to the level of the surrounding terrain and hidden from the inquisitive eyes of the early voyagers and explorers.

Judging from Posnansky's Plates 6 and 7, it appears that Courty excavated at least some walls of the Semi-Subterranean Temple on both, front and back sides. With the excavation reports lost, it is thus not known how the court was sunk into the terrain, nor how the backing of the walls was constructed. The confines of the CIAT excavations were such that it is not known how the entrance to the Semi-Subterranean Temple was related to the surrounding terrain. Ponce Sanginés (Ponce Sanginés 1964:55-57) surmised that perhaps the top step was missing, that the stairway may have had seven rather than six steps, but he says nothing about where the stairway ended, that is, whether the stairway led to some pathway or street connecting the Semi-Subterranean Temple to the surrounding structures and the rest of the site. A related question is how the temple was delimited against its surroundings. As is, the walls of the temple have been brought up to be roughly level with the natural terrain. Since some of the upright stones, even in their eroded state, protrude above this surface, it is possible that the walls did too, thus creating a sort of parapet around the sunken court. It is impossible to know how the walls were crowned because all evidence has been lost.

Akapana

Next to the small, sunken Semi-Subterranean Temple is the massive Akapana.[2] Today it towers over all structures at Tiahuanaco, and most likely did so when the city was teaming with people. It is narrower on one end than on the other, but its precise appearance has been intensely debated by scholars. In this section, we examine the evidence regarding Akapana and the major hypotheses regarding this important monument's former appearance. In doing so, we will explore its footprint (or plan), the type and number of vertical layers that gave rise to the structure, and its surprisingly diverse masonry styles. As we shall see, the Akapana is an enigmatic structure that holds many interesting clues.

Today, Akapana resembles a plain and severely eroded hill, and if it were not for excavations carried out in the last 30 years or so, visitors would be unaware of the hill's many retaining walls and terraces. Most of the retaining walls that were still visible in the mid eighteen hundreds have since disappeared (see, for example, Angrand in Prümers 1993:Figure 29), as have the "pillar" stones on the north side shown in the photograph published by Stübel and Uhle (1892:Part 1, Plate 2, Figure 1) and to be seen in a drawing by Angrand's (Figure 2.4). Because of the erosion,

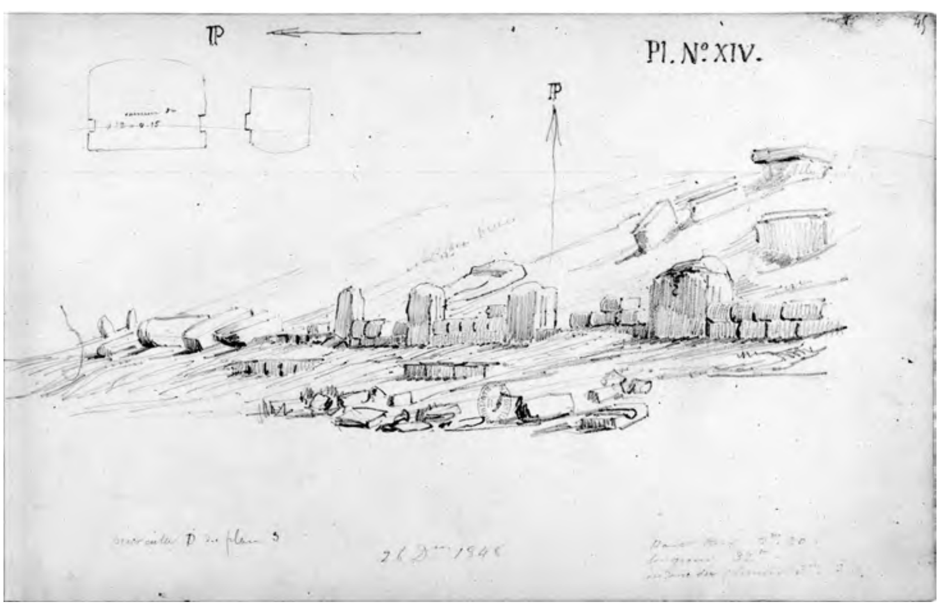


Figure 2.4. Sketch by Léonce Angrand showing retaining wall on Akapana's north side and a detail of a rabbet and tenon joint (upper left). (Bibliothèque nationale de France)

the visitor would also find it difficult to identify the hill's general layout without a plan view. The widely diverging plan views produced by earlier scholars are testimony to this difficulty.

General Configuration

The Akapana's plan is still not entirely clear. Two plans of the mound are found in contemporary publications, both of which seem to go back to Posnansky. The first, made by Posnansky in 1904 (Figure 2.5a), revised in 1912, and published as Plate 3 (1945:Vol. 1), shows 10 salient and six re-entrant corners. The second, also by Posnansky, likely dating to May 1927 (Figure 2.5b), and published as Plate 8 (1945:Vol. 1), suggests only eight salient and four re-entrant corners. In the second plan, the east side of Akapana appears as a straight line, whereas in the first it is broken, with the middle section jutting out. The second plan is often described as representing half of an Andean cross. Since to our knowledge, neither the northeastern-most, nor the southeastern-most corners have been located, and since the tailings from dredging during the Spanish colonial period obscure the central section of the east side, not enough information is available today to decide in favor of one or the other plan. However, as we discuss below, excavations made by Oswaldo Rivera Sundt in 1995–1996 and our own investigation seem to lend support to Posnansky's first version.

Because of the remains of terrace walls, most authors refer to Akapana as a stepped pyramid. Given its basic configuration, it is, strictly speaking, not a pyramid; it might better be referred to as a stepped, or terraced, platform mound. The mound is about 16.5 m high, and its largest dimensions at the base measure roughly 194 m from east to west and 182 m from north to south. The mound is thought to have had seven tiers or steps (Manzanilla 1992:22). Based on her excavations, Linda Manzanilla proposed a reconstruction of Akapana (1990:Figure 4). In this reconstruction—and that suggested later by Escalante (1993:158, Figure 30)—the seven tiers or terrace walls are shown with a uniform height all around the mound (Figure 2.6). Yet, the remains of the terrace walls on the south, east, and west side of the mound differ significantly in height, width, and construction from side to side.

Variety of Masonry and the Question of Levels

The observable variations in masonry bonds, and the differing wall heights raise the question of how the three sides (south, east, and west) met at the corners and how the different levels were related to each other. A close look at the three sides may pave the way toward some answers.

East Side

In 1979, Cordero Miranda excavated a section of the Akapana on the east side, just north of the tailings of the Spanish looting (Escalante 1993:134) (Figures 2.7 and 2.8). What came to light is the base wall, about 1.9 m high. It is built of sizable, wide upright sandstones, set at more or less regular intervals of about 5.8 m. The space between the uprights is filled in with perfectly fitted and coursed sandstone ashlars. This masonry is akin to an *opus quadratum*, that is "masonry of squared stones in regular courses" where the height of the courses may vary from course to course, and the ashlars are not all of the same size (Harris 1975:339). The wall is capped with big sandstone slabs (Figure 2.9). Kolata (2003:183) noted "the distinct rounded, beveled edges of the stones employed in the basal terrace." The "pillowed" appearance of these stones, however, was not a deliberate act by the Tiahuanaco builders; rather, it is the effect of erosion that has taken its toll: the deep-set joints and the "pillowed" appearance of the stones is the result of exfoliation. On close inspection it is evident that the face of the wall once was perfectly smooth and planar. The face has a batter of two degrees.

Above the base wall, about 2.87 m inward from its edge are the remains of a second wall of exactly the same execution (Figure 2.10). Because this wall is partially dismantled, one can appreciate its construction. The beddings of every course are smooth and perfectly planar, and the vertical joints stand at exact right angles to the face of the wall, and to the bedding joints forming a perfect *opus quadratum* (Figure 2.11). Where the ashlars meet an upright, they are notched to hook into a comparable projection on the upright (a detail to be discussed in more detail in Chapter 6). This wall is built on a carefully leveled foundation course. The outer face of this wall has a batter of four degrees.

Behind the second wall and about 2.83 m from it, is a third wall. This wall, in its lower half, is built of quasi-coursed masonry, that is, of masonry with the appearance of coursed masonry, but in which some horizontal joints are discontinuous—some courses are offset against others—and the courses' beddings

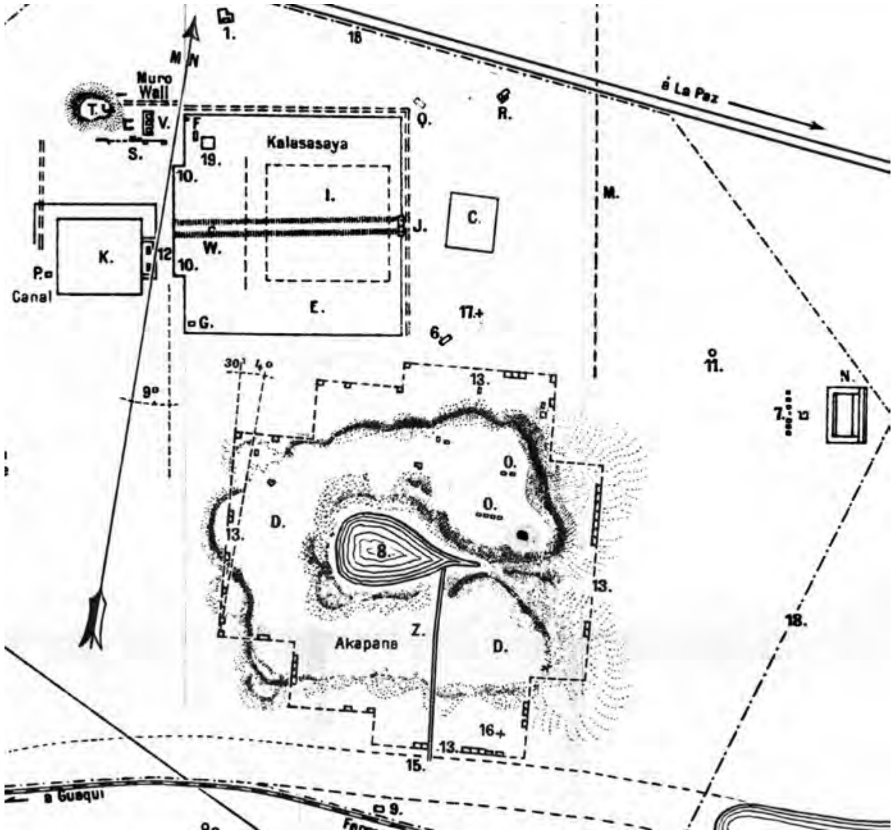


Figure 2.5a. Posnansky's plan of Akapana with ten salient and six re-entrant corners. (Posnansky 1945, Vol 1-2. Plate III)10418 J.J. Augustin publishers NY.

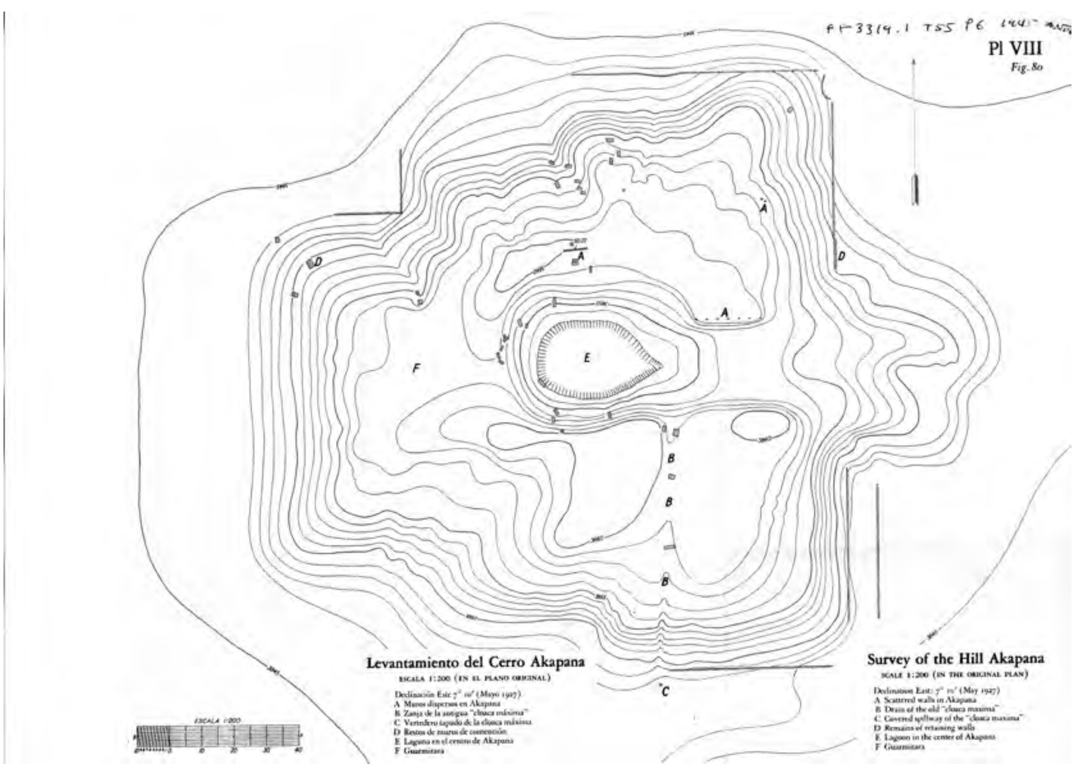


Figure 2.5b. Posnansky's plan of Akapana with straight east side (Posnansky 1945, Vol 1-2, Plate VIII).

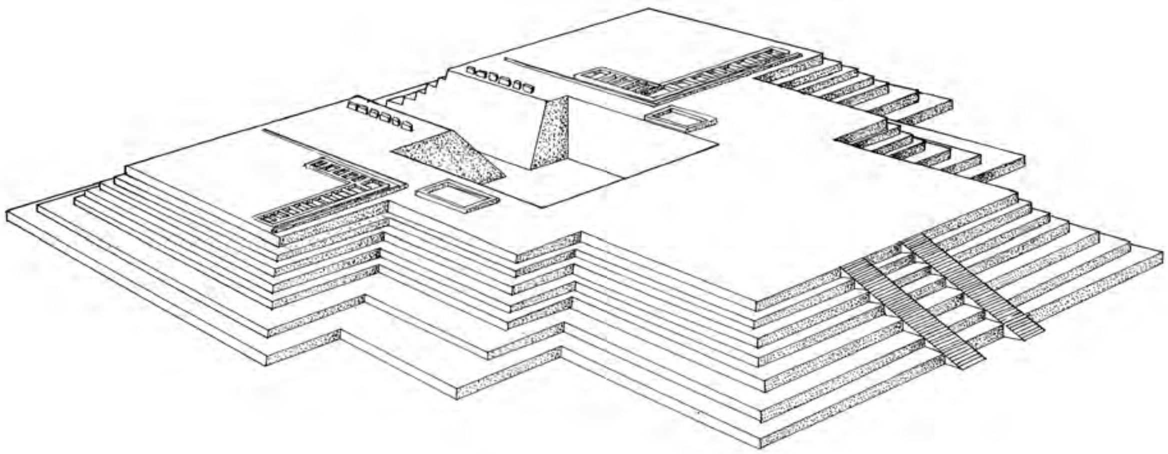


Figure 2.6. Drawing based on a reconstruction of Akapana redrawn from Linda Manzanilla (drawing by Stella Nair, first published in *Journal of the Society of Architectural Historians*).

Figure 2.7. Akapana's east side seen from the south.

Figure 2.8. Akapana's east side seen from the northeast.

Figure 2.9. Basewall of Akapana's east side.

Figure 2.10. Second wall of Akapana's east side.

Figure 2.11. Opus quadratum of second wall.

often are not planar (Figure 2.12). It is built of very fine cut stones with a perfectly planar face. The upper half of this wall is built exactly like the first two: big uprights filled in between with *opus quadratum*. The two halves are separated by a distinct change in batter. The lower half has a batter of 1.5 degrees, as compared with four degrees for the upper half. The change of batter occurs at about 2.14 m above the top of the base wall. A short segment of the upper half is shown in Posnansky as it appeared at the beginning of the twentieth century (1945:Vol. 1, Plate 9, Figure b). Above the third wall, and about 5.6 m from its edge, appear the stubbles of a fourth retaining wall, built in the same fashion as the base, the second, and the upper half of the third wall.

While the base, third, and fourth walls are obviously retaining walls, the second wall appears free standing. It is built in front of what looks like a series of compartments, the partitions of which are carefully tenoned into the third wall (Figure 2.13). The partitions are sometimes labeled *contrafuertes*, or buttresses (Escalante 1993:143). What is the role of these partitions and compartments? Alexei Vranich suggested that here we have a glimpse of how Akapana was built. He argued that first a retaining wall—like the lower half of our third wall—was built in front of which were then built the compartments. These were then filled with earth and a wall with uprights and ashlars—like the first or our second wall—was added as a sort of revetment to the compartment (Vranich 2001:300–305). He further argued that this massive construction kept the pressure of the mound above and the movement from swelling and shrinking of the fill material off the revetment wall. The effect of this is that the stones in the revetment walls have kept their tight fit even many centuries after they have been built.

Vranich's interpretation raises some issues. The partitions, which are so carefully tenoned into the third wall, are *not* connected to the front wall of the compartments (Figure 2.14). The latter, built of carelessly fitted stones appears like an after-thought. The compartments are not of one design, but seem to reflect two distinct construction episodes. The

Figure 2.12. Quasi-coursed masonry of third wall of Akapana's east side.

Figure 2.13. Third wall with buttresses on Akapana's east side.

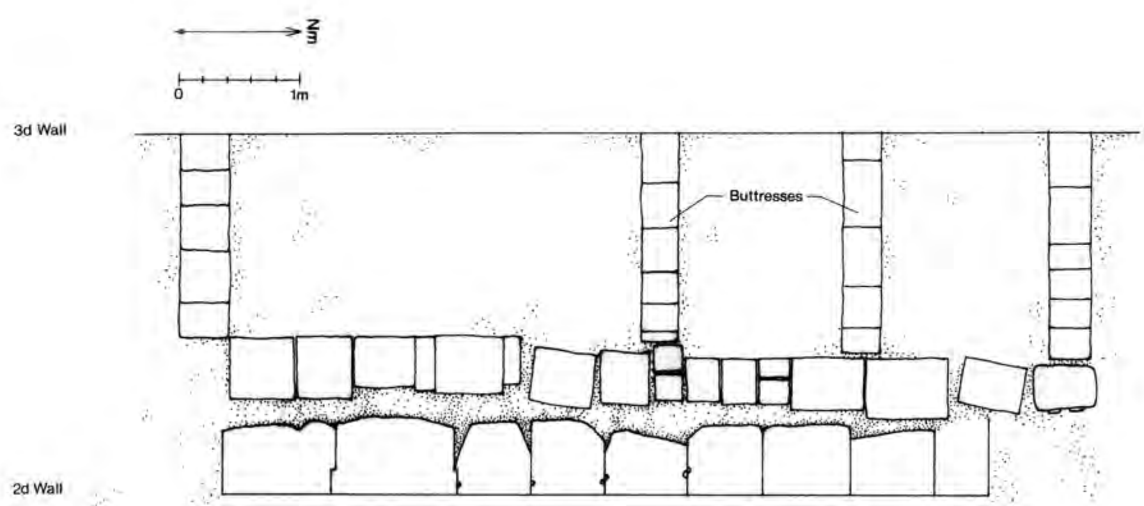


Figure 2.14. Plan of second and third walls (drawing by Jean-Pierre Protzen).

pressure, or push, that a retaining wall must sustain depends on the height of the wall, the sloping angle[3] of the fill material behind the wall and the weight of the structures on the terrace above that fall between the wall and the sloping angle. Our rough calculations show that, for example, the sheer weight of the base wall is sufficient in and of itself to retain the material behind it. The reconstruction of the east side of Akapana proposed by Vranich assumes that the successive terraces all were of equal width, that is of roughly 2.8 m—the distance from the first to the second wall (Vranich 2001:Figure 7)—ignoring the remnants of a fourth retaining wall at a distance of approximately twice that much from the third wall. And there is the question of why one would invest so much effort in a wall as beautifully crafted as the lower part of the third wall, with its tightly fitting stones and perfectly planar face, if that wall was to be covered up and never seen? We will come back to these issues below when discussing how the different sides of Akapana came together at the corners.

Based on excavations on Akapana's east side, Jorge Arellano has tried to reconstruct how the natural hill of Akapana was gradually transformed into a terraced platform mound (Arellano 1991). He proposed a construction sequence in five steps. Unfortunately, his description fails to explain the actual configuration of what we call the second and third wall.

About 58 m to the north of Cordero Miranda's excavation the top of a big stone is cropping out. It is in line with the third wall, but its top surface is about 85 cm below the top surface of the first wall. If, as we suspect, that stone is a big upright and that it belongs to the first, or base wall, it would suggest that the base of Akapana's east face had re-entering corners as shown in Posnansky's first plan.

South Side

In 1995–1996, Rivera Sundt excavated at the foot of Akapana, at the eastern end of its south side. There he uncovered the remains of the base wall, and above it, some 5.68 m in from its edge, a second wall (Figure 2.15). The base wall is executed in the same way as the base wall on the east side, but unlike the latter, the wall here no longer reaches its full height; many courses of ashlars are missing, and some uprights are truncated. What remains of the base wall, however is in an excellent state of preservation (Figure 2.16). The faces of the stones, ashlars and uprights alike, are perfectly even and planar, providing for a very smooth surface (Figure 2.17). The wall has a batter of two degrees.

The second wall is built in a quasi-coursed masonry, very similar to the lower half of the third wall on the east side (Figure 2.18). The wall was crowned with a shaped cornice, of which a few stones remain in situ and reaches a height of about 1.96 m. Whether the wall continued above the cornice, as does its counterpart on the east side, is not known. Here too, one finds the remnants of "buttresses," carefully keyed into the wall at more or less regular intervals of 1.5 to 2 m (Figure 2.19). The wall today shows a negative batter of about one degree. Extensive repairs made to the wall indicate that it may have collapsed in places, and was crudely rebuilt at some unknown time before the excavation.

Was there another wall (between the base wall and the second wall on the south side) that would correspond to the second wall on the east side? The excavation does not show any obvious outline of such a wall. But in one section, there is a cut stone with a flat top, which could be a foundation stone, positioned exactly where we would expect to find this "second" wall. We concede that a single stone is scant evidence, but nevertheless think it to be a suggestive indicator that such a wall may have existed in this location.

We believe that the wall shown in Posnansky (1945:Vol. 1, Plate 10, Figure a), unearthed by Courty (as he hacked his way through it in search for the "Cloaca Maxima") is in fact the western continuation of the second wall uncovered by Rivera Sundt. Clearly visible in this photograph are tenons sticking out of the face of the wall, suggesting this wall also had "buttresses." But it is impossible to confirm that there were any "buttresses" from just the photograph.

It was one of Rivera Sundt's excavation objectives to locate the southeastern corner of at least the second wall (Oswaldo Rivera Sundt, personal communication 1996). He did not find it where he expected it to be according to the second plan of Akapana. The wall apparently did not extend that far to the east, thus lending further support to Posnansky's first plan. Only further excavations here, and at the corresponding northwestern corner will eventually settle the issue.

West Side

As noted before, the western-most re-entrant corner on the north side of Akapana and its west facing

Figure 2.15. Basewall and second wall of Akapana's south side.

Figure 2.16. Base wall of Akapana's south side.

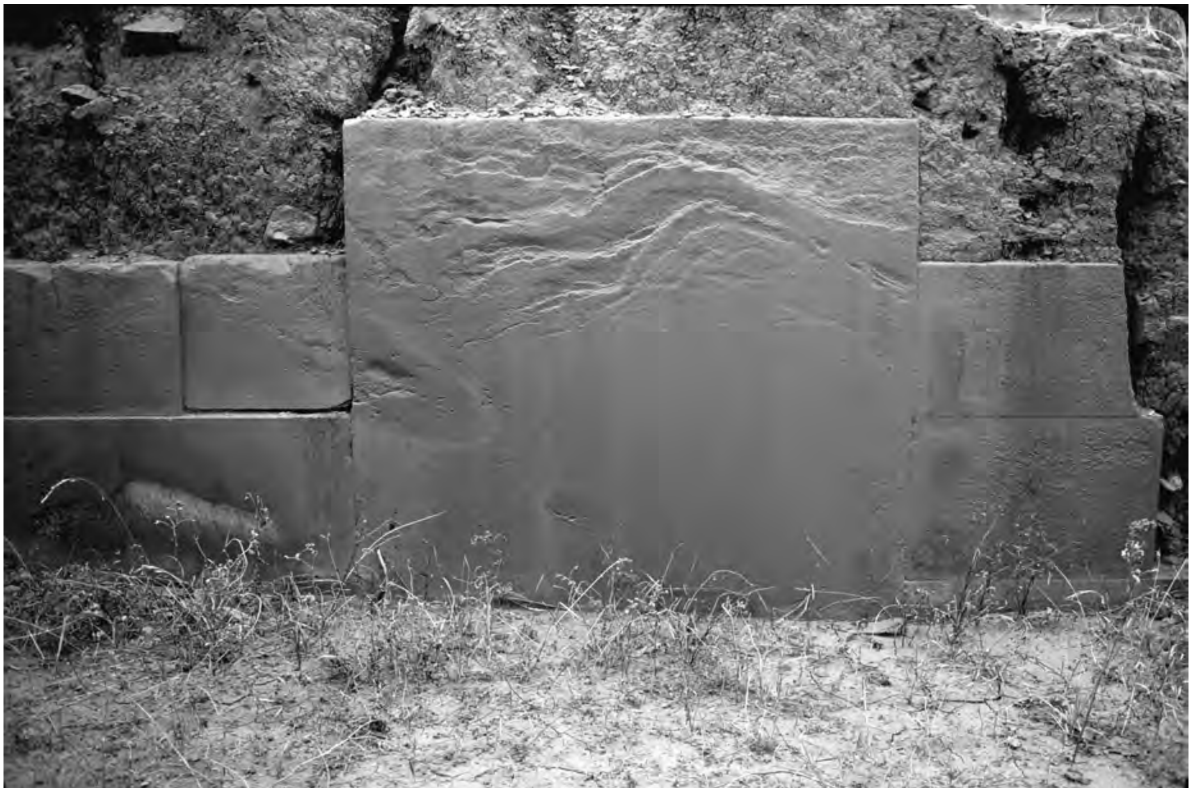


Figure 2.17. Detail of base wall on Akapana's south side.

Figure 2.18. Quasi-coursed masonry of second wall on Akapana's south side.

Figure 2.19. Second wall on Akapana's south side with buttresses.

northern extensions were excavated by Manzanilla in 1988, under the auspices of the International Seminar for Archaeological Excavations at Tiwanaku. She uncovered the base wall, which was excavated to its full length from the re-entrant to the salient corner to the north (Figure 2.20). It is in execution exactly like its counterpart on the east side: upright stones set at more or less regular intervals filled in between with coursed masonry and capped by large slabs laid flat. The stones here are not as heavily exfoliated and better preserved. Like its counterparts on the east and south, the wall was very smooth and built of sandstone. It is perhaps significant that on the west side, the base wall contains an occasional andesite ashlar. The wall has a batter of four degrees. Near the re-entrant corner, Manzanilla uncovered the outlet of a canal that looks very much like the spillway of the "Cloaca Maxima" noted above (Figure 2.21). The entrance to the canal is covered by what has variously been described as an arched lintel (e.g., Manzanilla 1992:37). But the "arch" was not part of the original design. Instead it is only the result of erosion on the outside. Looking inside the opening, one can see that the back part of the lintel stone is not curved but flat, just as the lintel stone over the spillway of the "Cloaca Maxima" was.

Above the base wall, and about 5.6 m inside from its north-south edge, is a second wall of a very different masonry: large, reused stones of irregular sizes and shapes, set horizontally on a base course of ashlars, and spaced apart by gaps 15 to 40 cm wide, filled in with small scale *opus quadratum* and random range work (Figure 2.22). The whole is capped by a cornice and reaches a height of about 1.56 m above the level of the crown of the base wall. The large stones are of andesite, the infill masonry is mixed, andesite and sandstone, but mostly sandstone, and the cornice is of sandstone. Today, the wall has a strong negative batter of up to minus five degrees. Built into the wall and carved out of one of the large stones is a waterspout. Where the wall turns the inside corner and faces north, the bond pattern changes to what may be a small-scale *opus quadratum*, or a quasi-coursed masonry—not enough of this masonry is preserved to make a proper determination. The same bond pattern seems to have continued the west-facing portion of the second wall at what now is its northern end. In other words, the large stones with infill masonry represent

Figure 2.20. Overview of corner with second and third walls on Akapana's west side.

Figure 2.21. Base wall with canal outlet (Type "e") and second wall, on Akapana's west side.

Figure 2.22. Second wall with spout (Type “d”) Akapana’s west side.

only a segment of this wall, and not its continuous pattern. It is possible that this segment represent either a repair or an attempt at remodeling the second wall. The small-scale opus quadratum at either end of the second wall and the carefully fitted foundation course of this wall suggest that this wall may once have had the same appearance as the second wall on the south side and the lower half of the third wall on the east side. Also to be noted is that about 1.40 m in front of the second wall facing west and parallel to it, are the remnants of another, crudely built wall of reused stones.[4]

Above the second wall are the remains of a third. It is about 2.73 m in from the base of the second and rises to about 1.48 m above the cornice of the second wall. The short section of its west face reveals a rather mixed kind of masonry. All together it looks more like random range work, but within which is a clearly reused andesite slab. This wall, too, is capped with a cornice and has a negative batter of minus two degrees. Around the corner and facing north, the wall continues like the second wall in what may be a small-scale *opus quadratum* or quasi-coursed masonry. Curious and unique is a stone set diagonally across the inside corner in the third course (Figure 2.23).

Manzanilla reports that there is evidence of four more retaining walls above the third. Of the fourth and sixth walls, she found only traces in the floors; and of the fifth, the lower courses of a corner. Of the seventh, she said that it probably was higher than the others and had upright stones (Manzanilla 1992:38).

North Side

A later clearing (1999) by the Dirección Nacional de Arqueología y Antropología (DINAAR) brought to light a wall segment on Akapana’s north side (Figure 2.24). In appearance, this segment matches the second wall on the south side and the lower half of the third wall on the east side. It is built of quasi coursed masonry of relatively small stones and at its highest it is preserved to 1.59 m. About every 2 m, at various heights, a stone juts out, but there are no other signs that this wall would have had “buttresses” similar to the third wall on the east side (Figure 2.25). At the visible western end, there is a change in masonry: the courses are only about half the height of the adjoining

Figure 2.23. Third wall with reused stones and a stone set diagonally across the inside corner.

Figure 2.24. Third wall on Akapana's north side, overview.

Figure 2.25. Third wall masonry detail and tenon, Akapana's north side.

courses to the east (Figure 2.26). The way the narrower courses are keyed into the wider ones suggests a construction break and a later modification. Also to the west, there appears a second row of stones about 51 cm behind the face of the wall, suggesting perhaps that the wall was built at least two stones deep. Our rough measurements show the base of this wall to be at the level of the first terrace on the east side. Since there are no signs of the base or first wall in this area of the north side, there is also no telling how wide the first terrace may have been. Did this wall have a cornice like the second wall on the south side, or was it topped by yet another wall with uprights like the third wall on the east side? There are no clues left to tell us how this wall was capped. Yet, a photograph by Stübel of Akapana's north side shows a row of toppled and still standing uprights—all of which have since disappeared— about where the above wall is situated (1892: Part I, Plate 4, Figure1). It is thus quite likely that this wall, which we interpret as the second wall on the north side, was topped with uprights and opus quadratum infill just like the third wall on the east side.

Some 33 m to the west of the wall segment just discussed and roughly at the height of its highest preserved portion, there is a course of stones about 6 m long, the face of which is 2.7 m behind (or south) of the wall segment. Is this course of stones the remains of yet another terrace wall? It would seem so, however, without further excavations one cannot be sure.

How Do the Three Sides Fit Together?

All the idealized reconstruction drawings of Akapana we have seen, assume that the mound had the same appearance all around. But, a comparison and juxtaposition of the profiles of the three sides, east, south, and west, challenge this assumption (Figure 2.27). Taking the top level of the base wall and its edge as bench marks, the three profiles show significant variations, both in the width of the steps or terraces ("vertical" alignment of retaining walls) as well as in height of the retaining or terrace walls ("horizontal" alignment of terraces). The most striking discrepancies are the levels of the second and third terraces on the west that are without correspondence to any levels on the east or south, and that the alignment of the

Figure 2.26. Third wall with change in masonry type on Akapana's north side.

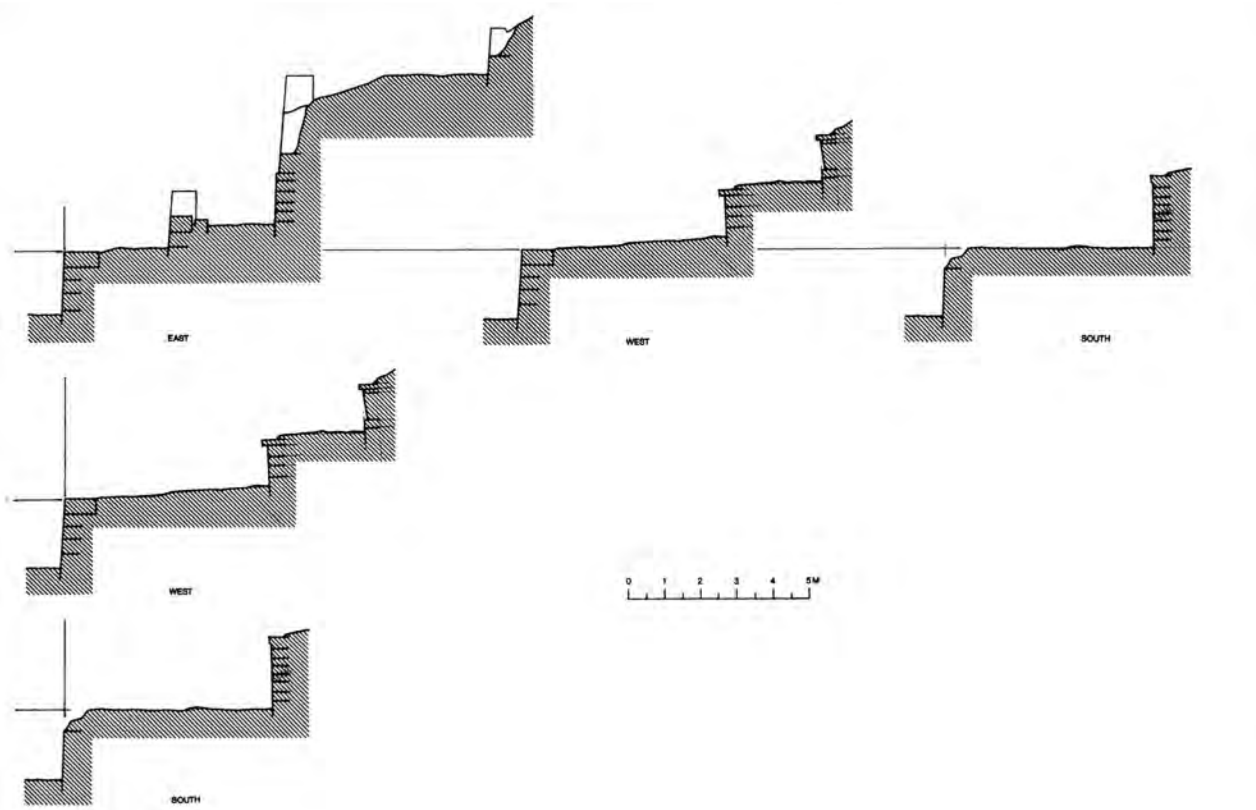


Figure 2.27. Comparison of Akapana's eastern, southern, and western profiles (drawing by Jean-Pierre Protzen, first published in *Journal of the Society of Architectural Historians*).

third terrace on the west has no counterpart on the east, and probably none on the south. Apart from the height of the base wall, similarities between all three sides appear in the width of the first terrace, *if* we are willing to ignore the second wall on the east, and *if* we are willing to equate the rough approximation of heights between the second wall on the south and the lower half of the third wall on the east. But even with these conditional similarities, it is difficult to see coherence in design among the three sides.

A possible interpretation of the abovementioned discrepancies is that Akapana was designed to have different appearances in different sections. If so, how the divergent designs came together at the corners remains an open question. Another interpretation is, of course, that Akapana underwent remodeling over time, and that the divergent designs represent different construction episodes. We tend toward the latter explanation. The incorporation of used building stones, the noticeable differences in bond patterns observed on the west and north side, and the incongruencies between the second and third walls on the east speak to a remodeling of the mound over time. We here propose that what we have called the second wall on the south, west (in its original state) and north side, and the lower part of the third wall on the east side, each with their "buttresses" may represent an earlier construction period. All these walls are at about the same distance from the base, or first wall—that is, about 5.6 m. Considering that all these walls today have a negative batter suggests that indeed they were in need of buttresses. Their own mass was not enough to withstand the pressure of the fill behind them.

Contemplating a frontal view of the four walls on the east side, there is no denying that the second wall seems to signal an intention of "hiding" the lower half of the third wall in an attempt to bring it in line with the masonry of uprights with *opus quadratum* infill of the base wall, the upper half of the third wall and the fourth wall (Figure 2.28). To date it is not known what lies behind the base, or first wall on any side of Akapana. What we then propose—and here we are clearly speculating—is that over time the Akapana has been enlarged and augmented. The masonry with uprights and *opus quadratum* infill represents the latest construction phase, and the walls with buttresses date from an earlier phase. The discrepancies we note

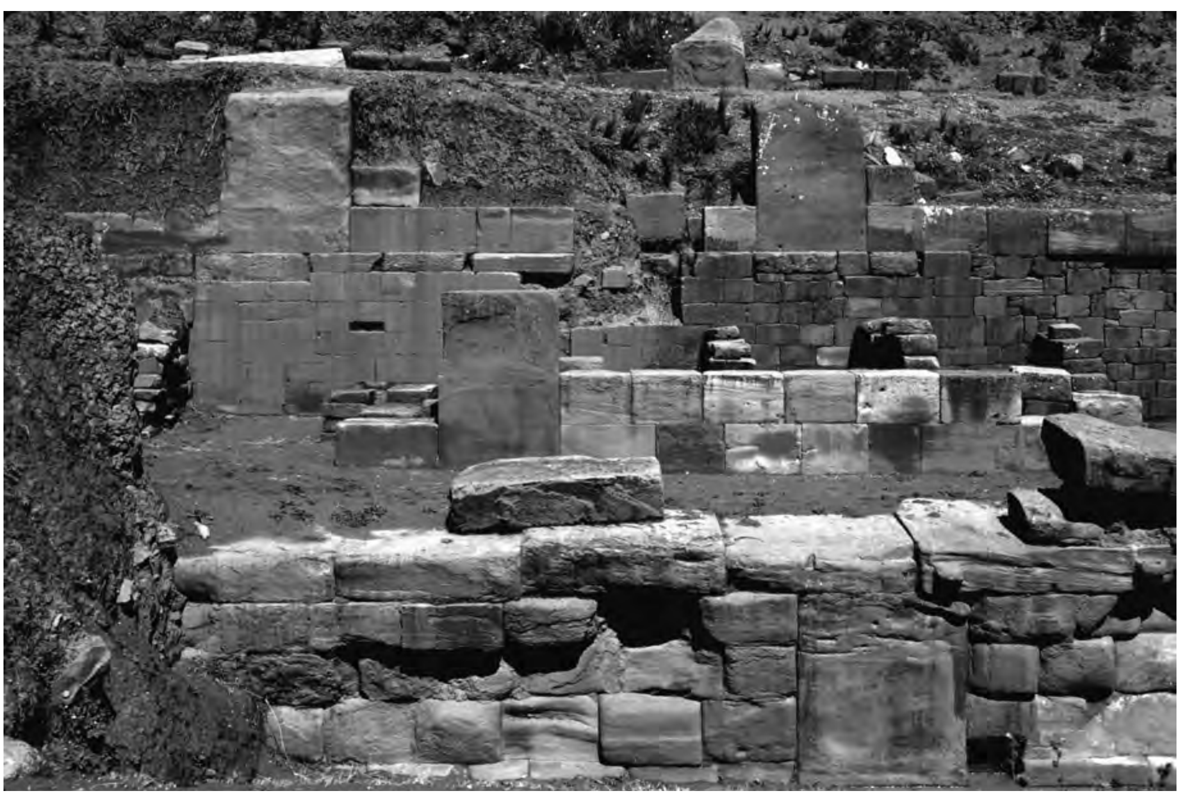


Figure 2.28. Frontal view of Akapana's east side.

today in the configurations of the four sides of Akapana could possibly be explained by the fact that it was remodeled and reshaped over time without ever reaching a state of completion in a single vision. What the remains of Akapana may reveal is a historic process of one vision replacing another, that is, a continued process of cultural transformations.

Canals

Courty's excavations of a major canalization on Akapana were the first signs of Tiahuanaco's sophisticated canal system. Créqui-Montfort described the canal on Akapana as having had three steps, starting in the great excavation at the summit of the hill (Akapana) running down a vertical shaft and then forming a right angle turning north and other successive angles to arrive at the bottom of the hill near the southeast corner of "la Grande Enceinte," or Kalasasaya (1906:533). This description places the canal on Akapana's north side. Créqui-Montfort must have been mistaken, for Posnansky places the canal on the south side of the mound, and the photographs he shows of the French excavation certainly confirm it.[5] Furthermore, the trench made by Courty is very clearly visible in aerial photographs[6] on the mound's south side. Manzanilla et al. (1990:89–90), who repeat Créqui-Montfort almost verbatim, goes on to say that they corroborated the existence of the canal on the south side of the summit.

It is not entirely clear what the function of this canalization was. Posnansky wrote that the canal did not start *in* the Spanish excavation, but just 1 m below the rim of the excavation. He described it as an overflow, thus assuming that water was to collect in the center of the mound, but not to exceed a given level. With a cross-section of 47 by 70 cm (Créqui-Montfort 1906:533), the canal could have evacuated enormous amounts of water.

Manzanilla and her team discovered a few more pieces of Akapana's canal system. Apart from the outlet in the base wall, which penetrates about 2.20 m into the mound and ends in a vertical shaft which must have emerged in the middle of the first terrace, and the spout in the second wall which may have drained into this shaft, she excavated another canal near the summit of Akapana, at its western edge and running parallel to it. This canal has an inclination of roughly seven degrees or 12%, falling from south to north, and a cross-section of 45 by 120 cm.[7] At the south end it led into a square receptacle (Manzanilla et al. 1990:90). Manzanilla tried to make sense of the canal system and proposed a hierarchical organization of reservoirs and canals (labeled a through e). At the center of the hill there was a catchment basin (a) in form of a sunken court, which at its eastern edge had a spillway.[8] From this catchment basin emerged other canals (b) to control the water level, draining out to the edges of the summit. The "Cloaca Maxima" may have been such a canal. Other canals (c) on the summit, like the one excavated by Manzanilla and colleagues, may have been branches of the canals labeled (b). Canals (c) drained onto spouts (d) that conducted the water from terrace to terrace, finally to end in large canals (e) at the base of the structure to be carried to the river by yet other canals like, for example, the one under Putuni (Manzanilla et al. 1990:89–91).

This is a tempting hypothesis, but there is not enough evidence to confirm it. All that is known about the canal system of Akapana are disjointed bits and pieces, with no evidence of how they fit together, nor of what their function was. What could a substantial canal, very near the top and parallel to the mound's edge, have drained? It simply defies one's imagination. That such a canal should have emptied out onto a small spout, the capacity of which, by conservative estimates, is 40 times less than that of the canal that feeds it, is not plausible. Everyone who has experienced a rainy season at Tiahuanaco understands the importance of drainage, as sudden and violent downpours can drench the terrain in a very short time. Remember Courty's experience excavating the Semi-Subterranean Temple! Nevertheless, many of the canals appear oversized, if their sole purpose was drainage. Kolata (2003:185) thought that "[t]here is clearly a dimension to this elaborate drainage network that transcends simple utility…" He saw that dimension in a "profound mimesis between Akapana and the natural mountains of the Quimsachata Range…" (Kolata 2003:186). This mimesis plays on the notion that for the people of Tiahuanaco "the mountains were sacred because they were the source of water that nourished the people and their fields" (Kolata 2003:186). There is a certain poetry to Kolata's interpretation of the canal network, but as we noted above there is not yet sufficient information available of just how this network hung together.

Other Observations

On the top of the mound, or on its last platform, there were several structures and possibly a sunken court. The latter is suggested by a substantial depression in the center of the summit platform. This depression, however, could simply be the result of that first Spanish treasure hunting enterprise, the dirt of which has been dumped over the hill's east side and is now obscuring the mound's configuration on that side. While plausible, the existence of a sunken court here has not yet been demonstrated beyond a reasonable doubt.[9] As to the structures, there is first, a row of evenly spaced and still standing andesite "pillars," running east to west, indicating that a wall similar in construction to the base wall once stood there (Figure 2.29). Second, there are numerous large stones littering the top platform and the slopes of the central depression, fragments of a monumental gateway among them, which suggest that a few substantial structures once occupied this platform. And third, there are the foundations of small scale architecture on both the north and the south sides of the mound, as they have been revealed by Manzanilla's excavation.

Figure 2.29. Pillars on top of Akapana.

There is no immediately evident relationship between the latter and the big stones. Further work will be needed to elucidate the connection between the structures Manzanilla excavated and the ones suggested by the large stones, and to discover where the now dispersed large stones once stood.

Kalasasaya

As impressive as the Akapana is, another major structure also looms over the Semi-Subterranean Temple—the Kalasasaya. While lower in elevation then the Akapana, the Kalasasaya has a larger footprint, one that is rectangular in plan. Today, the Kalasasaya is an enclosed compound, made up of a masonry wall of midsize stones, interspersed with large stone pillars. There is one major entrance that opens out to the Semi-Subterranean Temple. However, its present-day appearance may be very different than what it looked like centuries ago.

The Kalasasaya is a most imposing structure (Figure 2.30). In built area, roughly 135 by 120 m, it is comparable to, for example, the inner temple complex of Angkor Wat, and within its confines one could easily have erected the Chartres cathedral. From 1957 to 1960, the CIAT excavated within the structure and cleared its entire perimeter. It subsequently reconstructed Kalasasaya's retaining walls on all four sides, the entrance gateway and parts of the walls delimiting the interior court from the surrounding terreplein. Thus, what the visitors to Tiahuanaco see of Kalasasaya today is CIAT's imaginary vision of the structure, with very little of the "archaeological" Kalasasaya left.

General Configuration

Judging from Cobo's description of the ruins of Tiahuanaco, the Kalasasaya of the nineteenth century must not have looked much different from the seventeenth-century setting. Most depictions of Kalasasaya from the nineteenth century are rather bucolic scenes: a quadrangular mound fenced in by stone pillars much wasted by time, cultivated fields within, populated by grazing animals, laboring farmers in native costumes, and idling spectators. It is perhaps a similarly romantic vision that led the otherwise sober Squier to call the row of better-preserved and well-shaped andesite pillars on the west side the "American

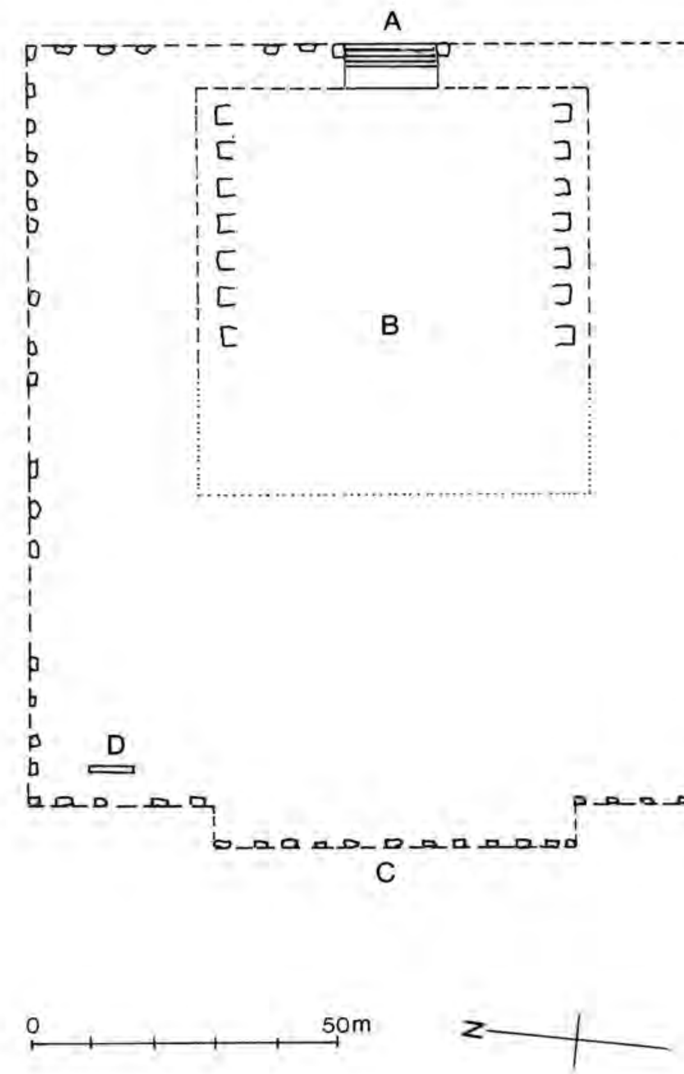


Figure 2.30. Schematic plan of Kalasasaya. (a) Main entrance. (b) Interior court. (c) Balcony Wall. (d) Gateway of the Sun (drawing by Jean-Pierre Protzen, first published in *Journal of the Society of Architectural Historians*).

Stonehenge" (Figure 2.31). Angrand, Squier, Stübel, Middendorf, and Bandelier were well aware that this particular row of pillars, today called the "Balcony Wall," is about 6 m farther west than the corners of the northern and southern walls of the Kalasasaya, and formed a sort of apron or balcony jutting out of the western façade. Curiously, only Squier's plan does not reflect this particular configuration. The plans by all the above authors show a rectangular depression, the outlines of a sunken court, adjoining the eastern edge of Kalasasaya. The walls, delimiting this court from the higher platform surrounding it on three sides, presumably were all in ruins (Squier 1877:278). Neither Angrand nor Squier, depict or mention the statue known as "El Fraile" standing in the southwest corner of Kalasasaya, or a big flat stone, sometimes called the "Altar Stone," near the center of the Balcony Wall. "El Fraile" most likely was still buried when Squier visited the site. Stübel mentions that he found it on January 3, 1877 but that he covered it up again (Stübel and Uhle 1892: Part I, Plate 2).[10] Who erected it and when we do not know, but 10 years later it was there for Middendorf to see. The big flat stone is mentioned by Stübel and Uhle, Middendorf

Figure 2.31. Drawing by Léonce Angrand of Kalasasya from the northwest with Akapana in the background. Balcony Wall is to the right (Bibliothèque nationale de France).

and Bandelier. It may be that it simply did not attract the attention of either Angrand or Squier. Apart from the Gateway of the Sun, to be discussed in great detail in Chapter 3, no other feature of Kalasasaya seems to have attracted the attention of these scholars.

It was left to Courty to uncover the monumental stairway on the east side, leading from the surrounding plain up and into the sunken court within the Kalasasaya (Figure 2.32). This stairway is very similar to the one descending into the Semi-Subterranean Temple, only wider. It is flanked by two big upright stones and has seven steps, with the last two carved from an enormous sandstone slab that is part of the landing platform. On this platform was the outline, or footprint, of a structure forming a narrow entryway. The gateway that is standing here today, built by CIAT, is as Gasparini and Margolies wrote, "pure fantasy," for the marks apart from suggesting a floor plan, furnished "no further indication of the original appearance of the entrance and, hence, no justification for erecting it" (Gasparini and Margolies 1980:17). Indeed, Ponce Sanginés's reconstruction, as we will see in later chapters, completely misrepresents Tiahuanaco construction and tectonics. The gateway is rendered in thin sandstone slabs held together with mortar. The impression is of massive cores clad in a veneer. Mortared stones and veneers are antithetical to Tiahuanaco architecture; there are no known examples of such. As to the shape of the opening, the outline suggested that it was double-jambed. Indications form other examples at Tiahuanaco suggest that the doorway head should not have been just a flat lintel, but should also have been "doubled." Now it could be argued that Ponce Sanginés deliberately tried to set the reconstruction apart as not to confuse it with the original, but that is not what he did with the rest of the reconstruction. His own reactions to criticism of his gateway do suggest otherwise.

Some Questions

The Interior Court

Courty pursued his excavations of the Kalasasaya with a trench cut clear across the structure from east to west, from the landing platform to the "Balcony Wall." Unless Courty actually took notes and these notes will someday be located, what was encountered in this trench will never be known. And so, Squier's question, whether the "sunken area communicated in any way with the more elevated interior parts of the structure" will have to go unanswered for the time being, because even CIAT's excavations did not provide a clear response. Ponce Sanginés, who directed these excavations, wrote:

> El recinto se halla separado en dos segmentos, un patio rectangular más pequeño y que se lo ha llamado interior, pero con el piso al mismo nivel que todo el terraplén, con acceso por la portada principal y la escalinata de siete peldaños, separado por un muro de un otro patio en forma de C [Ponce Sanguinés 1995:229].

Figure 2.32. Stairway to Kalasasaya east before reconstruction (photo anonymous).

> The enclosure is separated into two segments, a smaller, rectangular, smaller patio and which is called interior, but with the floor on the *same level* [added emphasis] as the entire terreplein, with access through the main gateway and the stairway of seven steps, separated by a wall from another patio in the shape of a C [translation by authors].

This statement is in obvious contradiction with the observation that the level of the landing of the stairway and the main gateway leading into the interior patio lie considerably below the level of the C-shaped patio. The excavations within the interior patio did yield the discovery of a beautifully carved statue, some 3 m tall, later named "Ponce" after its discoverer. Unfortunately, this is about all the information that has been published about the finds within, and the make-up of the interior court. Here, as with the statue and stelae of the Semi-Subterranean Temple, it is assumed that the "Ponce" originally stood where it was found, but nothing is said about its foundation or base, the statue's relation to the floor, or the nature of the floor. Where there other structures within the court? The north and south sides of the interior court are bordered each by seven small, roughly square cubicles. The exact character, their relationship to the court, and purpose of these cubicles is not known, for as Escalante wrote (1993:188), they "have not yet been carefully excavated and thus neither have they been studied."

Gargoyles and Drains

When excavating the outside perimeter of the Kalasasaya, the CIAT discovered open channels arranged perpendicular to the south wall and placed at more or less regular intervals, falling away from the wall and draining into a collector channel running parallel to the wall at a distance of roughly 7.5 m.

In its enterprise of reconstructing the perimeter walls of Kalasasaya, the CIAT placed a spout, or gargoyle, above each of the channels draining away from the south wall (Figures 2.33 and 2.34). The assumption, that the drains served some definitive purpose is perfectly legitimate, but, from what we have seen in the old photographs, there was no indication that there were any gargoyles, much less of the height at which they have been placed in the reconstruction. Considering the care generally applied to drainage at

Figure 2.33. South wall after excavation showing drains.

Figure 2.34. Gargoyles on Kalasasaya.

Tiahuanaco, it is not unreasonable to assume that the gargoyles, if there were any, would have been connected to a drainage system inside the Kalasasaya. No such system is to be seen there today, and none has been reported by CIAT. In the reconstruction, gargoyles were also placed in all the other walls. If there has been evidence for corresponding drains at the foot of these walls, it is no longer visible.

STAIRWAYS

The excavation of the south wall also uncovered a stairway:

> Se localizó también los restos de una escalinata que no accedía a Kasasasaya (sic) directamente sino a un muro que había desaparecido y del que quedaban algunos silares pero cuyo piso se hallaba a unos 20 cms. encima del piso correspondiente al muro sur original. Se podía entenderle como un muro tosco colocado en una etapa tardía de Tiwanaku para proteger al muro original [Ponce Sanginés 1995:228].

> Also identified were the remains of a stairway that did not accede to Kasasasaya [sic] directly, but to a wall that has disappeared and of which there remained but a few ashlars, the floor of which was about 20 cm above the corresponding floor of the original south wall. It could be understood as a rough wall built in a late phase of Tiwanaku to protect the original wall [translation by authors].

What Ponce Sanginés was writing about is probably what can be seen in a photograph taken after the excavation, but before the reconstruction of the south wall (Ponce Sanginés 1961:11, lower photograph). It may be that this was the very same access to Kalasasaya noted by Bandelier on his plan dated September 29, 1894, and marked "g"[11] on the south wall, at about one-third of the wall's length from its western end. Today, nothing betrays the former existence of this entrance. And there are still more questions of stairways: "Se ha colegido que en las grandes ceremonias la masa espectaba desde éste, con acceso por dos escalinatas a los lados de la pared balconera. . ." (Ponce Sanginés 1995:229). (One has deduced that during the great ceremonies the masses observed them from this [the C-shaped patio], with access by *two stairways* [added emphasis] at the sides of the balcony wall. . . [translation by authors].)

If there were stairways on the south side of the Balcony Wall leading into the Kalasasaya, and there are some steps there, the CIAT thoroughly ignored this entrance in its reconstruction. The few steps left do not match the stairway on the north side. The former are fairly wide, very similar to the steps into the Semi-Subterranean Temple, and start almost in the same plane as the west face of the Balcony Wall (Figure 2.35). In contrast, the stairway on the north side is very narrow and set back into the re-entrant corner formed by the projection of the Balcony Wall and the main corpus of the Kalasasaya.

Five steps to nowhere are to be seen in front of the southern section of the east wall. These stairways presumably "led onto a later reinforcing wall, of which only a few vestiges were left" (Ponce Sanginés 1995:228).

Most puzzling is a photograph published by Ponce Sanginés (1961:15, lower photograph) of the restored eastern section of the north wall. In it appears yet another stairway of which today there is no trace whatsoever. The stairway is attached to a body of masonry—a sort of apron—that clearly runs in front of the north wall. This body too has since disappeared; three or four stones may be all that is left of it. It is known that in 1959, the CIAT rebuilt a third of the north wall as an experiment (Ponce Sanginés 1961:26). We have recently been given a slide taken in 1961 of that experimental reconstruction[12] (Figure 2.36). Comparing this reconstruction with today's state of affairs, one notes that not only was the apron removed and gargoyles added, but also that some of the uprights used in the experiment were replaced by others in the current version (Figure 2.37). None of today's uprights stick out as much above the crown of the wall as some do in the experimental reconstruction. One would like to know what evidence prompted the shape of the experimental reconstruction, and what reasoning led to its subsequent dismantling and replacement by a different design.

THE "BALCONY" WALL

The perimeter walls of the Kalasasaya were built of irregularly spaced uprights of greatly varying height. On the west, north, and south, the uprights are of sandstone, and on the east of andesite, and all are filled in between with random-range work. In contrast, the Balcony Wall appears to have been built differently: regularly spaced andesite uprights filled in between, not with random-range work, but regularly coursed ashlar masonry that attached to the uprights with rabbet joints (Figure 2.38). The difference in

Figure 2.35. Stairs on south side of Balcony Wall.

Figure 2.36. First reconstruction of Kalasasaya north (photo anonymous).

Figure 2.37. Second reconstruction.

Figure 2.38. Balcony Wall (from southwest).

construction, plus the facts that the Balcony Wall juts out of the main corpus of the Kalasasaya and is considerably higher—about 1.2 to 1.5 m—than the other walls suggest that it may have been an addition and not an integral part of the original structure. Given the drastic reconstruction of the Kalasasaya, one cannot be sure of this. There are no indications in the published records on how the Balcony Wall attached to, or met, the west wall that was there before. To where may the stairs on the south end of the Balcony Wall have led? How was the Balcony Wall incorporated in the design of the interior of the Kalasasaya, the C-shaped patio in particular?

East Wall

There are indications that the east wall may have been built in a technique similar to that of the Balcony Wall. A photograph from around 1904 of a small section of the east wall shows two large, finely dressed ashlars meeting a badly eroded andesite upright with a rabbet joint (Posnansky 1945:Vol. 2, Figure 13a).

Excavating the east wall, the CIAT discovered that this wall, built mostly of andesite, covered up another, presumably older wall, detached from the former and built of sandstone in a fabric very similar to that of the south and north wall (Ponce Sanginés 1995:228). No evidence of this older wall can be seen today. One would have liked to know what its relationship to the main stairway and the gateway had been. The addition of the andesite wall most certainly implied a redesign and remodeling of the whole entrance to the Kalasasaya. Was the addition of the Balcony Wall part of one and the same redesign of the Kalasasaya? Was the redesign an implication of a change of use or meaning of the Kalasasaya? The five steps to nowhere mentioned above, are quite a distance from the actual east wall, about 4 m. Presumably they led to a later reinforcing wall. What did this wall reinforce, and did it cover up the andesite wall in turn? What other changes may that structure have undergone over time?

Putuni

On the west side of the Kalasasaya (opposite the Semi-Subterranean Temple) lies Putuni. Although it is not impressive in size like the Akapana or the Kalasasaya, this low lying structure is deceptively modest. Like the Kalasasaya, it is rectangular in plan, and appears to have had a series of structures along its four walls that formed a large courtyard. Nestled in the shadows of the Kalasasaya, Putuni has revealed several tantalizing clues which suggest that it once was far more magnificent. The outlines of Putuni had been noted by and figured in the plans of several nineteenth-century explorers. If d'Orbigny's etching, which shows a vague square in front (west side) of the Kalasasaya, is any indication, we suspect that the appearance of Putuni at that time was not very different from Kantatayita's today: the top faces of large rectangular stones emerging barely above the surface of the ground, set at more or less regular intervals and outlining a rectangle. Once again, it was Courty who uncovered the entrance to this courtyard on the structure's east side, and the CIAT that in the 1960s completely cleared the structure.

General Configuration

Today, Putuni is a rectangular court of about 48 by 40 m, with the long axis oriented roughly east-west (Figure 2.39). The court is defined on its four sides by walls that formed a raised platform with Putuni's exterior wall, about 6.5 m on the east, north, and south, and 12.5 m on the west side, all roughly 1.2 m high. Presumably, at the center of the court there stood a statue, found decapitated by Cordero Miranda in the abovementioned excavation of Putuni.

On the outside, the walls were built in a masonry of large blocks, mostly laid horizontally and spaced apart, with the gaps between filled in with random range work. There is a notable difference in the quality of the workmanship between the outside east wall and the others. In the former, some of the large stones are set vertically, others horizontally, and all are very well squared. The infill masonry is precisely fitted with barely noticeable joints (Figure 2.40). The whole wall, or what is left of it, is built exclusively of andesite and is smoothly finished in one perfect plane. In contrast, the outside north and west walls are built mostly of reused stones of andesite and sandstone, that are neither very well finished nor accurately fitted (Figure 2.41). Not enough masonry is preserved on the outside south wall to judge its execution. The inside walls are still outlined by large, mostly horizontal blocks set at roughly equal intervals. The masonry that closed the gaps between the large stones has mostly vanished; what remains are only indentations on the sides of the large blocks from

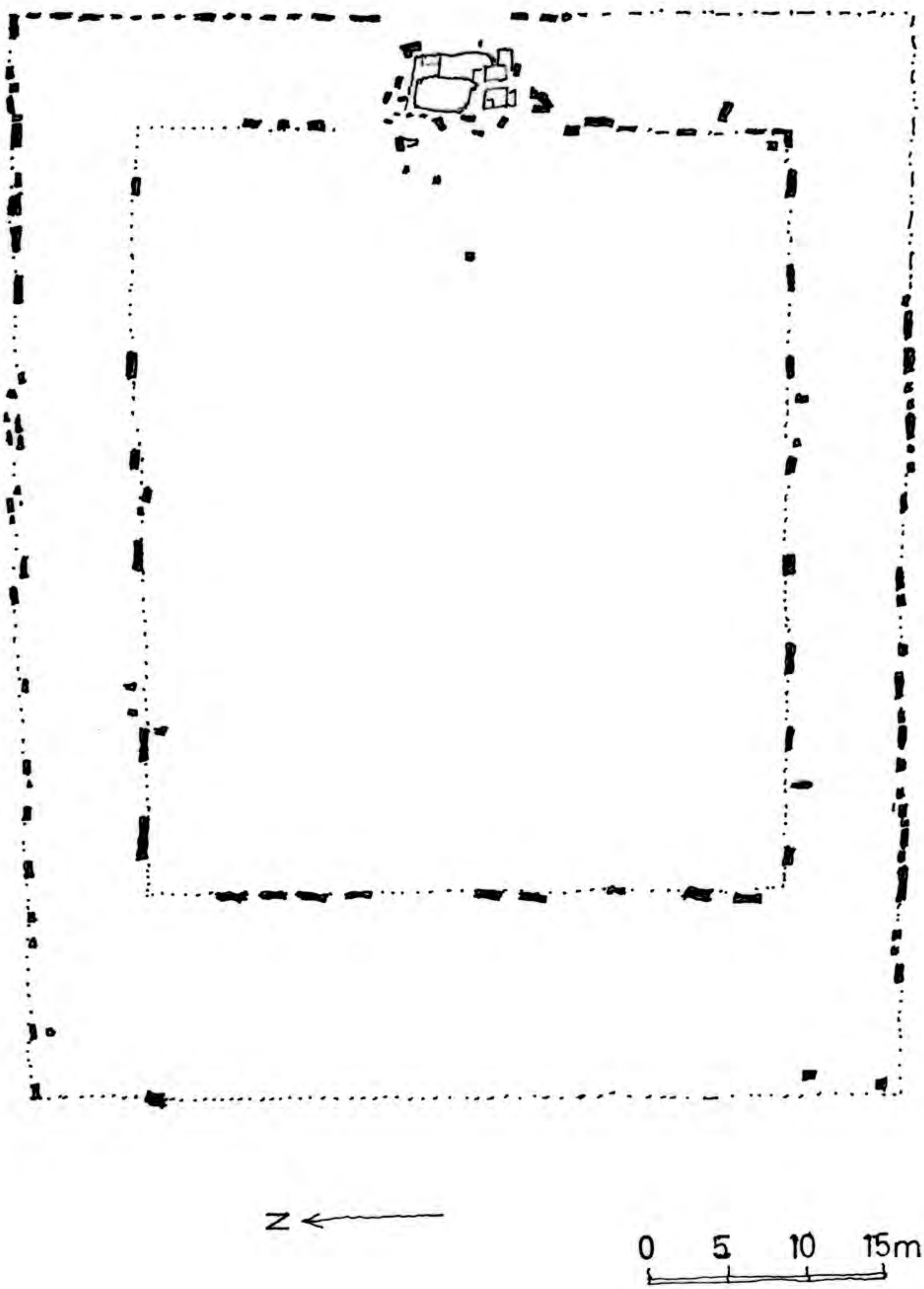


Figure 2.39. Plan of Putuni (Jean-Pierre Protzen redrawn from Escalante).

Figure 2.40. Masonry on east wall of Putuni.

Figure 2.41. Masonry on north wall.

which one can infer the height and depth of the infill masonry courses.

Max Portugal Ortíz (1992:31–32) established that the floor of the court is a compacted mixture of sand and clay, and that it was laid down over three older floors of roughly the same construction. The lowest of these floors he attributed to the original settlement of the site. Unfortunately, Portugal did not say what the relationship of these various floors to the structure of Putuni is, nor did he specify whether he found the base for the decapitated statue excavated by Cordero Miranda. Kolata, whose team has also excavated at Putuni, is very clear about the temple platform having been built "over earlier, domestic structures that were purposely razed to accommodate the new building scheme" (Kolata 1993:153).

The Gateway

The courtyard of Putuni was entered on the structure's east side, a few meters from the Balcony Wall. As noted above, the entrance was first excavated in 1903 by Georges Courty. In front, or east of the entrance itself, he brought to light a stairway of three steps leading down from an apron in front of the Balcony Wall to a pavement of what may have been a forecourt to Putuni. Posnansky published photographs taken shortly after the excavation showing the stairway (1945:Vol. 2, Figures 35 and 36),[13] which he described as having been tricolored without specifying what the color scheme was (1945:Vol. 2, 108). On the other hand, Créqui-Montfort, reporting on Courty's excavation, mentions that "[l]es pierres de l'entrée portaient encore les traces d'une couleur verte cuivreuse dont elles avaient été enduites intentionnellement" (the stones of the entrance still showed traces of a coppery green color with which they were intentionally coated [translation by authors]) (Créqui-Montfort 1906:541). Given the context, "[l]es pierres de l'entrée" likely refers to the stones of the steps, but could also designate other stones forming the entrance to Putuni. What exactly was colored, and with how many colors will remain a mystery. The stairway either fell prey to looters shortly after their excavation or were shipped to Paris, and the level difference that once existed between the forecourt and the apron disappeared in the reconstruction of the Kalasasaya.

When unearthed, the gateway was already reduced to one or two courses of masonry, and it has been tampered with ever since. First, stones from and around the gateway started to disappear. A plan made probably in 1984 and published by Arellano (1991:266, Figure 14) shows many fewer stones than can be seen in the above mentioned photographs, but it also reveals that the state of 1984 is not congruent with today's situation. Since then, some stones have been added and others appear to have been re-erected (Figure 2.42). As a consequence, one cannot be entirely sure of the original configuration and design of the gateway. What transpires from a comparison of the various documents and current conditions, is a double gateway, an outer and an inner separated by a space about 70 cm wide. The outer gateway had a wide central opening of about 1.2 m flanked by two very narrow openings, an impractical 50 cm wide, one on either side. What is left today of the outer gateway are the piers framing the central opening, and a jamb defining its left, or southern narrow passage. Of the inner gateway there remains only the southern pier and the outline of the northern pier carved out of the foundation slabs defining its central opening, also about 1.20 m wide. Whether this opening was flanked by narrower passages, as argued by Ponce Sanginés (1995:236), is not obvious. Two upright stones, one to the south and one to the north of the still existing pier, and aligned with it, rather suggest wide lateral openings of about 1.4 m in width.

The actual stones of the central opening of the outer, or eastern gateway, indicate that it was double-jambed. Yet, the outlines, or slightly recessed areas carved from the floor paving and into which the piers are set, belie the double-jamb: the areas are frankly square, and not indented. A stone recently added to the southern pier of the inner gateway suggest that it too was double-jambed. The added stone was not there at the time of the first excavation and is also in contrast to the clearly square recess. That the piers still in situ are set into the recessed areas suggests, indeed, that outlines were used to position walls or piers, but it is also evident that the areas' shape does not necessarily fit the stones set into them. In other words, simply "extruding" the outlines to recreate the structures above, as Ponce Sanginés did with the gateway to Kalasasaya and proposed to do at Putuni (Ponce Sanginés 1976:Figure 60), may lead one to misconstrue completely what once was, or was intended to be, there. Furthermore, the piers set into the outlines at Putuni have on their upper faces all kinds of cut-outs, recesses, and pockets which

Figure 2.42. Entrance to Putuni.

alter the basic outline considerably, so that it is by no means obvious what the configuration of the gateway was above the base stones. Posnansky (1945:Vol. 2, 109–110) mentions in connection with the piers that thin stone slabs on top of the piers having formed small chambers. From his rather vague description it is difficult to imagine the configuration of the stones he saw. Our own observations suggest that stones other than thin slabs were once fitted to the piers. Furthermore, unfinished sections between some of the outlines to be seen let one believe that work on these piers may not have been completed.

Given what little remains of the gateway to Putuni, the scant information about its configuration at the time of the first excavation, and our own uncertainties, it would be preposterous to offer even an approximate reconstruction. All that can possibly be said about it is that it was not a simple gateway. The access to Putuni's interior court was not immediate, but carefully structured into a sequence: first came the stairway leading down and into a paved forecourt, followed by an outer, solemn, possibly double-jamb gateway, a narrow space, and then, perhaps a simpler, inner gateway, before one would emerge onto the patio. One is reminded of Goldstein's remark about "doorways and stairways that channeled access to a ceremonial core."

The Platform

The platform (created by the parallel walls and infill materials) surrounding the courtyard is accessible from the outside over two narrow stairways built into the north wall. Whether there had been other stairways is not known. What was there on the platform? Ponce Sanginés believed that there were adobe superstructures containing rooms built on the platform for the nobility. He based his argument on the amount of clay found in the interior court (1995:235). Kolata envisioned the platform to be a kind of gallery from which people would observe whatever activity was carried out within the courtyard (1993:152).

Built into the platform walls and facing the courtyard were a number of small chambers of cut stones that had been sacked long before the excavations took place (Portugal 1992:32–33). What the purpose of these chambers was is not known, but they have been variously described as funeral chambers (Escalante 1993:233–236, Kolata 1993:162), or spaces to keep ritual paraphernalia (Kolata 1993:161–162). Built against the outside of the platform wall to the north, are the outlines of a room, as well as the remains of a carefully paved floor that may have run the length of the platform wall. It is possible that there were yet more rooms adjoining the north wall. Along the northern section of the west outside platform wall, Kolata and his team excavated what they called the Palace of the Multicolored Rooms, an elite dwelling built against the platform (Kolata 1993:149–155). Whether similar structures were built against the outside south platform wall is not known, but the fact that the platform was surrounded by at least some buildings must have changed Putuni's appearance considerably. If today we see a courtyard enclosed by a neat platform, at the time of Putuni's peak occupation, the platform was obscured by the surrounding structures.

Pumapunku

While all the structures we have discussed so far have been nestled together at the heart of Tiahuanaco, one impressive structure lay outside this core, Pumapunku. This seems surprising at first, because, by almost everybody's reckoning, Pumapunku is the next most important structure at Tiahuanaco, after the Akapana. But, its apparent isolation from the core of the ruins only seems to underscore its importance as a special structure. As we have seen earlier, it is the only other spot at Tiahuanaco, apart from Akapana, from which to catch a glimpse of both, the three peaks of Illimani *and* Lake Titicaca.

Pumapunku is a low lying structure, made up of several raised platforms. It is rectangle in plan with two small projecting arms. Pumapunku, like so many of the structures at Tiahuanaco that we have seen so far, has been badly damaged over the years, thus, trying to understand its prior appearance has been a challenging task. But scholars have continued to focus on this unique structure because of the quality of its stone carvings. Although these blocks now lie in heaps, many broken, around the footprint of the structure, these blocks are so finely carved and worked, that we can still appreciate the great mastery of their craftsmanship. They also provide tantalizing insights into how magnificent Pumapunku must have once been. Largely geometric in nature, these carvings capture the long shadows that move across the treeless high desert and must have given Pumapunku a most captivating and dynamic appearance.

Cobo's Description

Fortunately, Cobo left us an extensive and detailed description of Pumapunku, including specific measurements. A comparison of his account with today's state of Pumapunku is important for two reasons. First, the account can perhaps tell us what of Pumapunku has been irretrievably lost in the waves of vandalism the site endured after Cobo, and second, it may give the archaeologist clues of what to look for in future excavations. Here is what Cobo had to say:

> Lo principal de la fábrica se llama Pumapuncu, que es tanto como "puerta de león"; es un terrapleno o mogote hecho a mano, de altura de dos estados, fundado sobre grandes y bien labradas piedras, que tienen forma de losas que nosotros ponemos sobre las sepulturas. Está el terrapleno puesto en cuadro, con los quatro lienzos iguales, que cada uno tiene cien pasos de esquina a esquina; remátase en dos andenes de grandes losas, muy parejas y llanas; entre el primero y secundo andén hay un espacio como una grande grada de seis pies de ancho, y eso tiene menos el secundo cuerpo que el primero. La haz o frente deste edificio es el lienzo que mira al oriente y otras grandes ruinas que luego diré. Deste lienzo delantero sale la obra con misma altura y paredes de piedra, veinticuatro pies de ancho y sesenta de largo, formando a los lados dos ángulos; y este pedazo que sobresale del cuadro parece haber sido alguna pieza o sala puesta en medio de la frente del edificio. Algo más adentro de aquella parte que está sobresaliente, se ve entero el suelo enlosado de una muy capaz y suntuosa pieza, que debió ser el templo o la parte principal dél. Tiene de largo este enlosado ciento y cinquenta y cuatro pies, y de ancho cuarenta y seis; las losas son todas de extraña grandeza; yo las medí, y tiene la mayor treinta y dos pies de largo, diez y seis de ancho, y de grueso o canto seis; las otras son algo menores, unas de treinta pies y otras de menos, pero todas de rara grandeza; están tan lisas y llanas como una tabla bien acepillada, y con muchas labores y molduras por los lados. No hay al presente paredes levantadas sobre este enlosado; pero de las muchas piedras bien labradas que hay caídas al redondel, en que se ven pedazos de puertas y ventanas, se colige haber estado cercado de paredes muy curiosas. . .
>
> Por la frente deste edificio se descubren los cimientos de una cerca de piedra labrada, que, naciendo de las esquinas deste lienzo delantero, ocupa otro tanto

espacio cuadrado como tiene el terrapleno y cimiento de toda la fábrica. Dentro desta cerca, como treinta pies de la frontera del edificio, hacia la esquina del sur se ven los cimientos de dos piezas pequeñas cuadradas que se levantan del suelo tres pies, de piedras sillares muy polidas, las quales tienen talle de ser estanques o baños o cimientos de algunas torres o sepulturas. Por medio del edificio terraplenado, a nivel del suelo de fuera dél, atraviasa un acueducto de caños y tajeas de piedra de maravillosa labor. . . [Cobo 1964:Book 2, 195].

The principal structure (of Tiahuanaco) is called Pumapuncu, which means the "lion gateway"; it is a man-made terreplein or hillock, two *estados*[14] in height, set on big and well-worked stones, which have the shape of slabs that we put on top of graves. This terreplein is square, with its four sides equal, each of them a hundred paces from corner to corner; and it culminates in two terraces of large slabs, smooth and flat; between the first and second terrace is a space, as in a great step, six feet wide, and so the second corpus is smaller than the first. The façade or front of this edifice is the wall that faces east, and toward other great ruins of which I will speak later. Out of this face, the building extends with the same height and walls of stone, twenty-four feet deep and sixty wide, forming at the sides two corners; and this piece that juts out from the square, seems to have been a kind of room or hall set into the middle of the front of the building. Somewhat inside of this part that juts out, one can see the entire paved floor of a most ample and sumptuous room that must have been the temple or the principal part of it. This paved floor is a hundred and fifty-four feet long, and forty-six wide; the slabs are all of extraordinary size; I measured them, and the largest one is thirty-two feet long, sixteen wide, and six in thickness or on edge; the others are a bit smaller, some thirty feet and others less, but all are of exceptional size; they are as smooth and flat as a well-planed table, and with much details and moldings on the sides. There are presently no standing walls on these slabs; but from the many well wrought stones fallen all around, among which one sees pieces of doorways and windows, one gathers (that the slabs) have been surrounded by very neat walls. . .

On the front of this building one discovers the foundations of an enclosure of cut stones, which, originating from the corners of the front façade occupies another square space as large as that of the terreplein and the foundation of the whole structure. Inside this enclosure, about thirty feet from the façade of the building, towards the south corner, one sees the foundations of two small square rooms, raising to three feet above the ground, made of highly polished ashlars, which (the foundations) have the shape of ponds or baths or of foundations of some kind of towers or tombs. Through the middle of the terrepleined building, at the level of the surrounding ground, runs an aqueduct of conduits and channels made of marvelously wrought stones. . . [translation by authors].

General Configuration

There are three major discrepancies between Cobo's description and what can be observed today. First, the structure is not square in plan, but rather T-shaped. Two wings, one to the north, and one to the south extend the structure's east side beyond the main corpus. This T-shape was first recognized by Angrand whose plan clearly shows it in about the right proportions (Prümers 1993:Figure 2) (Figure 2.43). Second, Cobo makes no mention of the depression, or court sunk into the top level of the mound toward the east and abutting the platform area, or his "suelo enlosado." And third, the mound had not two, but most likely four terraces. At least three, possibly four, were mapped by Angrand, suggesting that three terrace walls were reasonably well preserved on the north, west, and south sides by the mid eighteen hundreds. How are these differences to be explained? Cobo may simply have made a mistake, or the building did look different in his time. He wrote of how the Incas appropriated Pumapunku and how they modified it: "[T]uvieron por templo el sobredicho edificio de Pumapuncu, y lo ilustraron y enriquecieron, acrecentando su ornato . . . y edificaron junto a él palacios reales. . . (Cobo 1964:Book 2, 198). (They [the Inca] used the abovementioned edifice of Pumapuncu as a temple, and they enlightened and enriched it, augmenting its ornamentation . . . and next to it, they built royal palaces [translated by authors].)

Excavations carried out by the Instituto Nacional de Arqueología in 1989[15] have, in fact, revealed a number of smaller structures built along the base and atop the terraces of Pumapunku's north and west sides. Although Inca artifacts were found in this area earlier (Arellano 1991:271), these structures apparently are not Inca, but date to the opening days of the colonial era (Portugal 1992:33–34). It is thus possible that the colonial structures were already there when Cobo visited the site; they may have obscured Pumapunku's original appearance and hence misled him in his

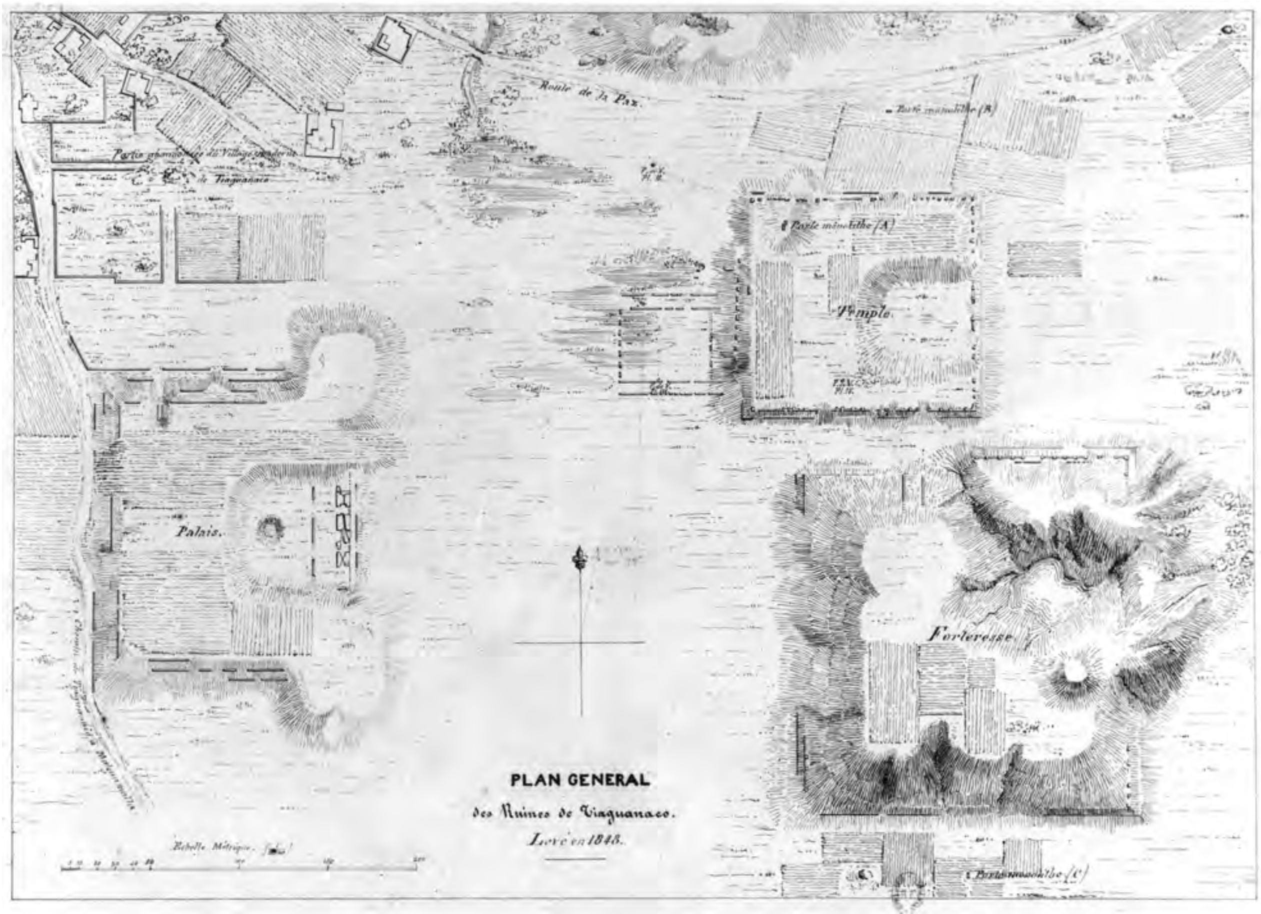


Figure 2.43. Angrand's plan of Tiahuanaco with Pumapunku on the left.

appreciation. There may be yet another explanation that we will discuss below.

In continuation of the work of Cordero Miranda, who had uncovered the south wing and sections of the south side in 1979 (Escalante 1993:200), the objective of the above mentioned excavations was to clear the entire perimeter of Pumapunku on the north, west, and south side. Before these excavations, there existed only a general idea of Pumapunku's basic shape, but nothing was known of its construction. The Bolivian archaeologists involved established that the mound was built up in four terraces. The base wall, or first terrace is well preserved on the north and south sides. The second terrace is quite intact on the south side, but only traces thereof remain on the north side. Of the third terrace only foundation stones are found in spots, here and there, on the north, west, and south sides; and of the fourth only on the west side. The west side is the worst pilfered of the three, yet it is here that the archaeologists unearthed, in its central axis, a stairway and a landing (Figure 2.44, 2.45). Further access to the mound was provided by two stairways tucked into the reentrant corners formed by the main corpus and the wings, one on the north and one on the south. Whether the structure had an entrance on the east side, which Cobo called the main façade, and the location of the huge slabs of sandstone he described, are not known.

The clearing of the sides of the mound and its base, brought to light a most intriguing construction detail: the ground around the mound and the fill behind and below the terraces are of compacted dirt in which are embedded oblong stones, planted vertically at more or less regular intervals of about 40 to 70 cm (Figure 2.47). We call these stones "soil nails" and will explain their possible function in Chapter 6. The other two significant discoveries were a red clay floor very near the U-shaped summit (wrapping around the sunken court) of the mound, and two sizable, covered canals running diagonally down the

Figure 2.44. View of stairs on Pumapunku's west side.

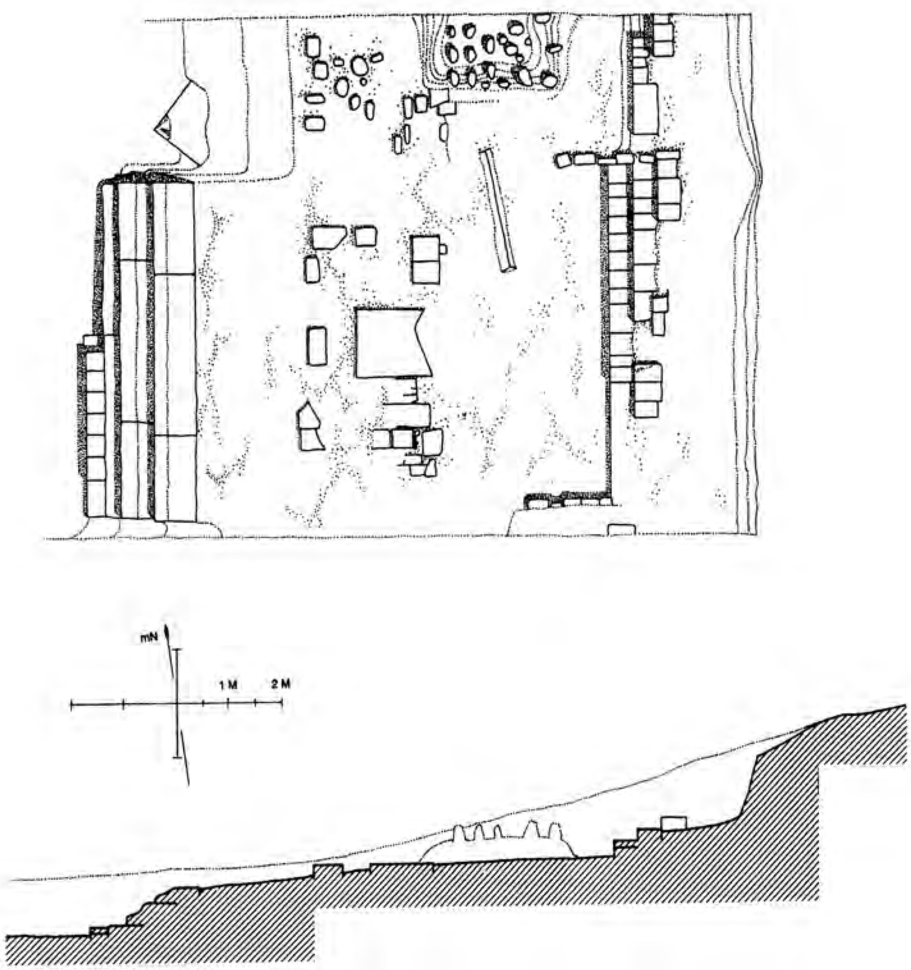


Figure 2.45. Plan and section of stairs on Pumapunku's west side (drawing by Jean-Pierre Protzen).

Figure 2.46. Stereobate and second terrace wall on Pumapunku's south side with soil nails at the base.

Figure 2.47. Canal on Pumapunku's north side.

sides of the mound, one each on the southwest and northwest corner (Escalante 1993:196–230, Portugal 1992:33–38) (Figure 2.48).

The Terrace Walls

Our Bolivian colleagues' work allowed us to examine very closely the various terrace walls and to draw some of our own conclusion about their configuration and construction.

First Wall

What is commonly called the "first wall" is the lowest, outermost terrace wall at Pumapunku. It is entirely built of sandstone and is of a special design. Upon two courses of regular ashlar masonry, follow three steps, of which the first is narrow and high, the third wide and low, with the second in between (Figure 2.49). The three steps have the effect of visually reducing the height of the already low wall, such that it appears more like a base with an elaborate plinth course. This first wall would thus better be described as a stereobate, that is, "a substructure, foundation, or solid platform upon which a building is erected" (Harris 1983:506).

On the south side, the last step of the plinth course, which is carved out of a single block, shows work still in progress. In various places the step has not yet been fully carved out, and all along, the top faces of the stones forming the platform level are uncut. Where observable, the corresponding parts on the north side are well finished. The south side also reveals a curious change of mind on behalf of the builders. The carefully carved out top step was, in places, filled in again with andesite blocks, thus changing the appearance of the stereobate (Figure 2.48). The andesite blocks seem not to have been entirely finished either, for, although they are well squared and finished, they are of uneven heights and widths not fitting exactly into their intended position.

There is a question of how high the visible part of the stereobate really was. From the foundation stones, or bottom of the first course, to the top level it measures on average 1.06 m, but it is likely that the first course was in part hidden by the floor surrounding the entire structure. The profile about midway of Pumapunku's south side shows a suspect whitish thin stratum at about half the height of the first course.

Figure 2.48. Stereobate on Pumapunku's south side with not fully carved top step (center) and infill with andesite blocks (right).

Was that the level above which the structure rose? One cannot be entirely sure, for further to the west, the terrain surrounding the structure is built up in compacted dirt interspersed with soil nails rising to the level of the top surface of the stereobate. Here again, we might be witnessing a change of mind or a later modification in which the stereobate was buried to its top level. This may explain Cobo's description in which the structure rose above a paved floor, this paved floor being the top level of the stereobate, thus leaving three terraces, instead of the two he reported. It should be remembered that Cobo visited Tiahuanaco the first time some 70 years after Pizarro rode into Cuzco in 1533. It is, then, quite possible that the destruction of Pumapunku had progressed to the point where the top, or fourth terrace had already been dismantled for the construction of the church and the houses in town. There may in fact have been only two terraces for Cobo to see. We do not know, however, how to reconcile Cobo's description with Angrand's observations more than 200 years later, other than to think that one or the other, perhaps both, were mistaken.

Second Wall

Between the stereobate, and the second wall is a level space 2.31 m wide. The surface of the floor in between seems to have been of compacted earth consolidated with soil nails and unpaved. The second wall is built in an ashlar masonry with courses of almost even heights varying between 24.5 and 26 cm (Figure 2.49). On the south side, the second wall still stands five courses high in a few places. Where we could ascertain it, the first three courses are at least three, possibly four stones deep. The fourth and fifth courses were only two stones deep. There is evidence in the form of bedding joints on the fifth course that the wall had at least one more course. Remarkable about this masonry is that all stones are perfect parallelepipeds and therefore meet with exact right angles in all three Euclidean dimensions. The face of the wall, however, is not in a single plane, for some courses jut in or out of the wall's general plane, as do individual stones. Elsewhere

Figure 2.49. Second wall with buttresses on Pumapunku's south side.

we have described this masonry as near-isodomic with an in-and-out bond (Protzen and Nair 1997:153). The convenient shape and size of the stones in this masonry made them the preferred prey of the colonial builders. That is perhaps why Pumapunku's west and north sides, which are the closest to the town, are the most depredated.

The wall's general plane is interrupted by buttresses arranged perpendicular to the wall and carefully keyed into it every 2.94 m on average. It is difficult to judge the buttresses's original design from what is left of them. They extend some 90 to 95 cm from the wall at the base and appear to have been stepped back course by course as they rise. Given the massive construction of the wall, with the lower courses at least 1.8 to 2.0 m and the upper courses 1.4 to 1.6 m thick, and a height not exceeding 1.9 m (see below), the buttresses seem to have played more of an aesthetic than a structural function.

Third Wall

On the south side, we could observe of the third wall only foundation stones and one isolated stone of the first course. We cannot be entirely sure that this last stone is in its original position, but we assume it to be. Further supposing the second terrace to have been as wide as the first, and its top level with the base of the third wall, we infer that the second wall may have had as many as eight courses, and that the first course of the third wall may have been four stones deep. Whether the third wall also had buttresses probably can no longer be verified.

Fourth Wall

Escalante proposed that the big slab-like stones found mainly on the north, but also on the west and south sides, may have been set upright to form the fourth terrace wall. He further argued that these stones did not belong to any of the lower platforms, and that the position in which they are found let one suppose that the slabs had slid down from the top of the mound (Escalante 1993:217). If Escalante is correct, then the fourth terrace wall would have had a very different appearance from the second and third, an appearance more like Cobo described "of large slabs, smooth and flat."

As mentioned before, of the fourth wall only foundation stones are left. We, thus, have no indication of how this wall was built. A priori, there is no reason to believe it was built differently from the others, and there is no objective ground to believe that the slabs had no connection to the lower terrace walls. To our knowledge, none of the slabs has been found in situ. The mound has been so severely disturbed, that the slabs' current positions hardly imply any specific use or provenience. The slabs have notches—some have four, two and two on opposite sides, while others have three, one and two on opposite sides. We interpret these notches as purchases for levers used to nudge the slabs into place, rather than sockets for some kind of key to hold them together as Escalante suggested (1993:217). Such notches can in fact be observed on the large sandstone slabs that form the last step of the stereobate. If our hypothesis holds, the slabs would have lain flat with the notches facing down. In this position, the slabs could have served as a crowning course, or even a cornice, on the terrace walls, similar to the crowning of the first terrace wall at Akapana.

Western Stairway

The observable layout of the stairway on Pumapunku's west side today consists of the base stairway, a broad landing, and the remains of a few steps that presumably led to the top of the mound (Figure 2.45). The base stairway probably climbed to the top level of the stereobate. The base stairway is reminiscent of the stairways into the Semi-Subterranean Temple and those on the East side of Kalasasaya. They are carved from large sandstone slabs, some thick enough to have two steps. Curiously, the southern half of the bottom step is widened by small cut stones, two courses high.

The landing very gently slopes down toward the west and shows signs of having been paved. The paving seems to have been yet a step higher than the top step of the base stairway. Cut-off soil nails, or leveling stones, visible here and there may indicate the extent of the paving. At the northern end of the excavation, an elevated area with uncut soil nails, some standing up to 60 cm above the paved surface, is protruding into the landing. At the back of the landing—its east side—are the remains of three steps built of small cut stones. The first step is two courses high and is preserved over almost the entire length of the excavation. Small cut stones, forming a small wall, disposed perpendicularly to the steps, intercept the stairway about 3 m form the northern edge of the excavation. The first step seems to have been removed beyond that wall, whereas the upper two steps seem to continue to the excavation's edge. The construction of the three steps recalls the stairway into Putuni excavated by Courty (see Posnansky 1945:Vol. 2, Figure 35, opposite page 132).

Escalante and *National Geographic* place gateways at the western access to Pumapunku in their respective reconstruction of the mound (Escalante 1993:230, Figure 188, *National Geographic* [en español], junio de 2002). Given what we have seen and recorded, there is little evidence for such a reconstruction. Furthermore, it is very unlikely that one can still establish with any degree of certitude how the stairway and landing were related to the various terrace walls and the stereobate. The walls and the stereobate on this side of Pumapunku, as mentioned above, have been dismantled long ago, and there are no visible traces of either in the immediate vicinity of the stairway. A plausible reconstruction of the western access would have to account for what looks like a modification of the back stairway, the protrusion with the soil nails, as well as the possible modification of the first step of the base stairway.

Platform Area

In the center of the mound's eastern edge and closing off the sunken inner court is the Platform Area, so named for the huge sandstone slabs to be seen here (Figure 2.50). This area is about 2 m below the flanking "arms" of the mound's U-shaped summit, and measures roughly 55 m north to south and 18 m east to west. It is by all means the most enigmatic part of Tiahuanaco. The sheer size of the sandstone slabs—the largest can be inscribed in a parallelepiped 8.12 by 3.86 by 1.2 m, or 37.6 m^3 in volume, weighing approximately 83 MT—is stupefying, and the innumerable fragments of finely wrought building stones, some lined up in rows, others strewn about the area, challenge one's imagination. The account we offer below of this intriguing scene describes the Platform Area as we found it, that is, before it was entirely rearranged in yet another, utterly ill-fated attempt at reconstructing Tiahuanaco architecture. In this sense, our account is anachronistic—it should now be read in the past tense—but it has the merit of describing a scene that

Figure 2.50. View of platform area from north.

had endured essentially untouched for at least the last 200 years as judged by the reports of early explorers such as d'Orbigny, Castelnau, Angrand, or Stübel.

The Platforms

The enormous red sandstone slabs, irregularly shaped were once pieced together with very large cramps (Figure 2.51) to form rectangular bases, or platforms, presumably the foundations for buildings. There are three such platforms in an apparent symmetrical arrangement: two smaller platforms, Platform I to the north and Platform III to the south, and a large double platform, composed of Platforms IIa and IIb, in the middle, as mapped by Angrand (Figure 2.52) and later by Posnanski (Figure 2,53). The southern half of the middle platform, or Platform IIb, has been destroyed, possibly by treasure hunters who dug a trench through and under this area. All that is visible of this half platform are two substantial slabs now stuck part-way in the ground at steep angles.[16] On their eastern edge, the platforms have seat-like carvings raised about 18 cm above the general plane of the platform. It is these "seats" that possibly gave earlier researchers the idea to call Pumapunku the "Hall of Justice"; presuming that judges once sat there to mete out justice. Although the platforms have shifted apart somewhat over time, they most likely were aligned along their eastern edge somewhere around 6.5 degrees west of magnetic north.

Extension of Platforms

The three platforms with their seats appear as isolated islands, but there is evidence that once they were connected, or meant to form a single platform, and that this larger platform extended beyond the current layout to the north, the west, and perhaps to the south. The northern extension of Platform I is indicated by slab 4 attached to slab 2, and jutting out to the north (Figure 2.54). Ledges on slab 2 to the west and on slab 5 to the south suggest that further slabs were supported on these ledges. This we infer from smaller pieces in situ that are supported in that way and attached to other slabs.

Similarly, there is a slab (slab 3) attached to Platform IIa to the north and projecting into the space between Platform IIa and Platform I (Figure 2.55). A ledge on the west side of slab 2 is still supporting a

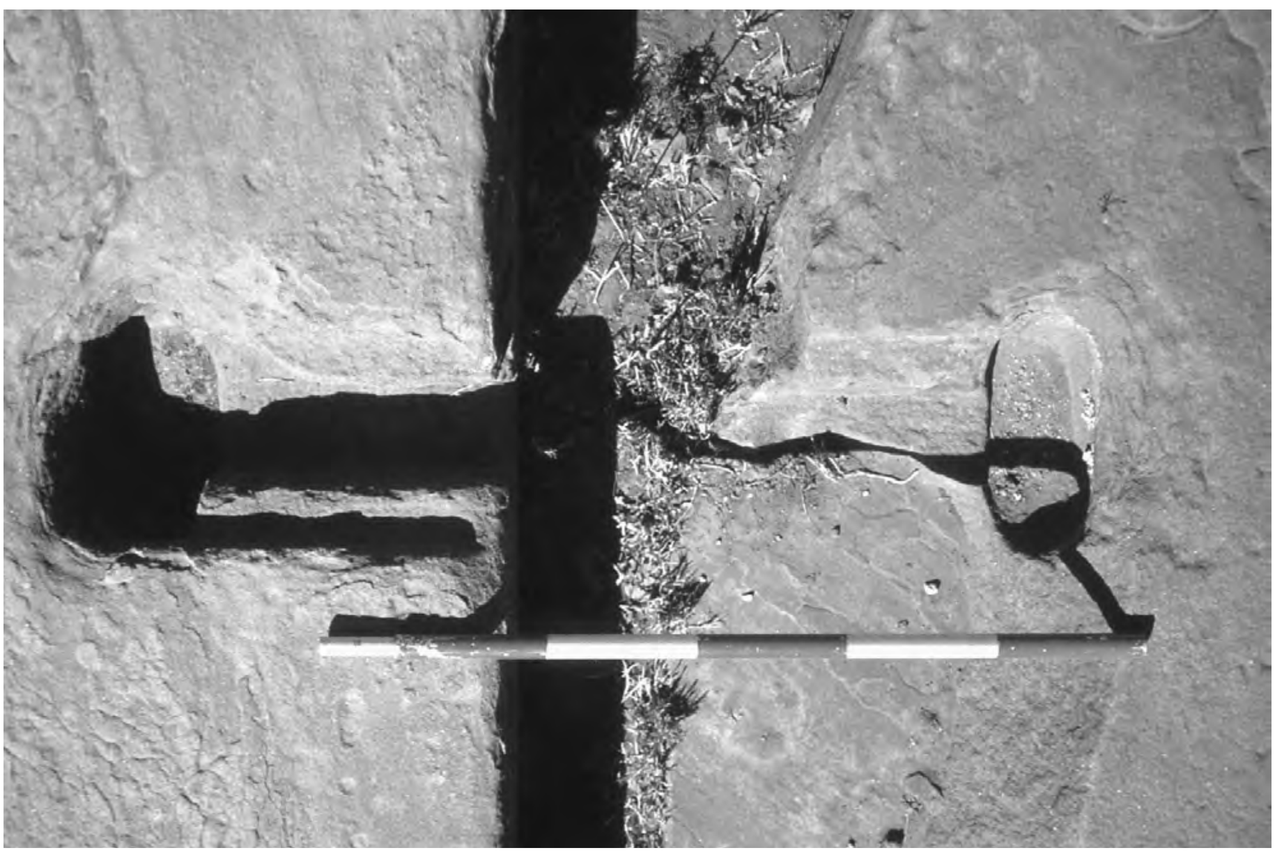


Figure 2.51. Large cramp sockets.

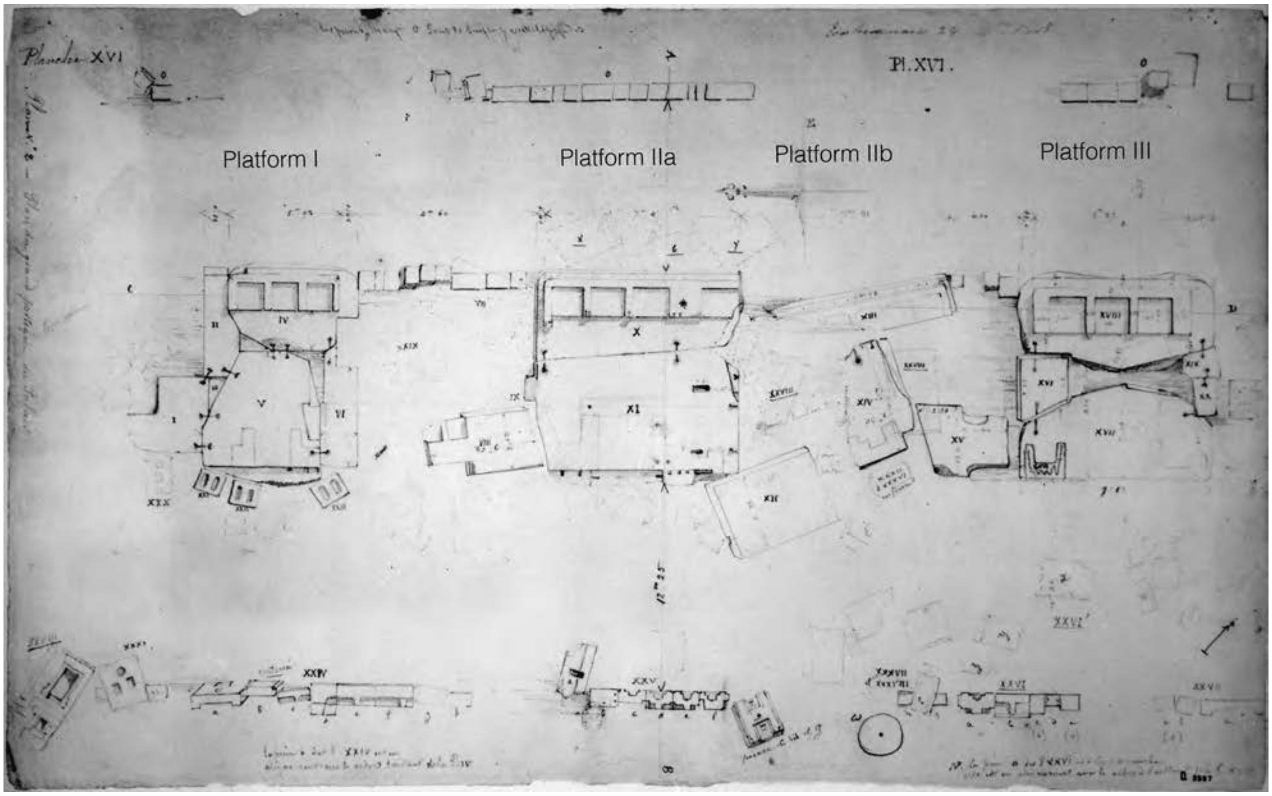


Figure 2.52. Léonce Angrand's plan of the Platform Area with our numbering of the platforms (Bibliothèque nationale de France).

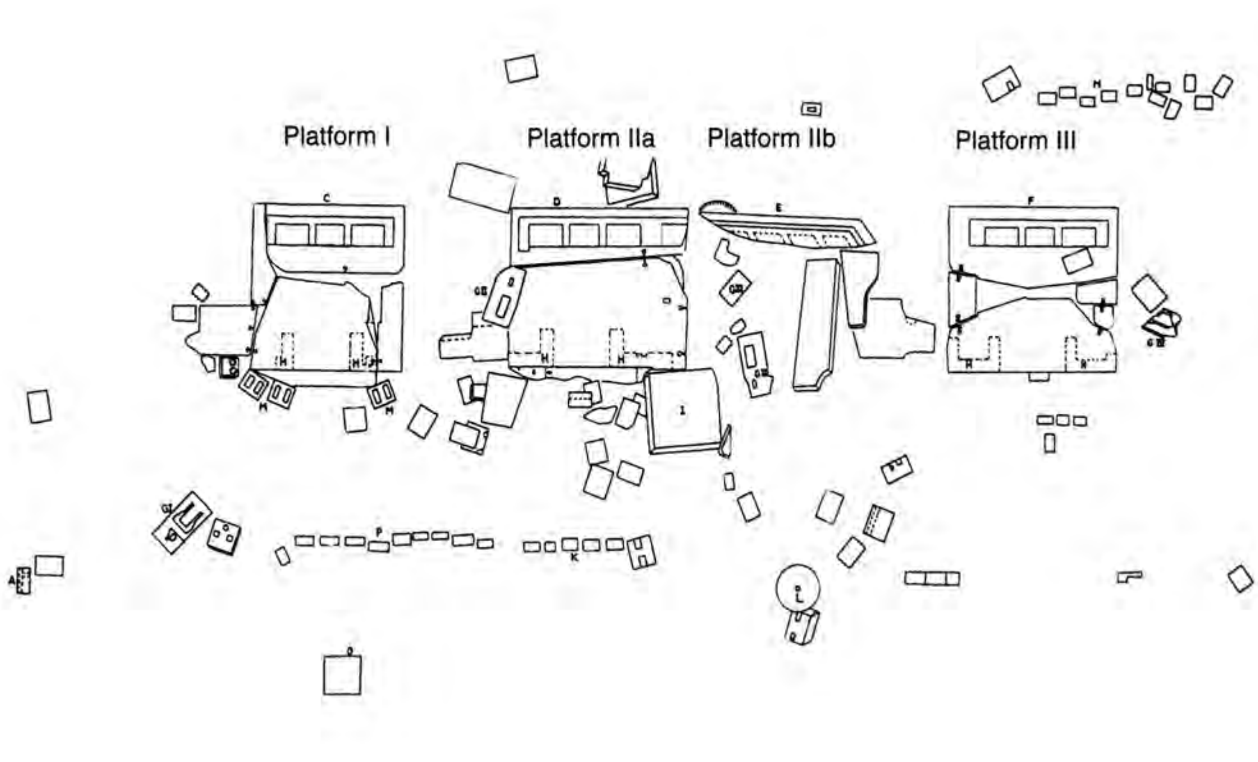


Figure 2.53. Platform Area after Posnansky with our numbering of the platforms. Note difference compared to Figure 2.52.

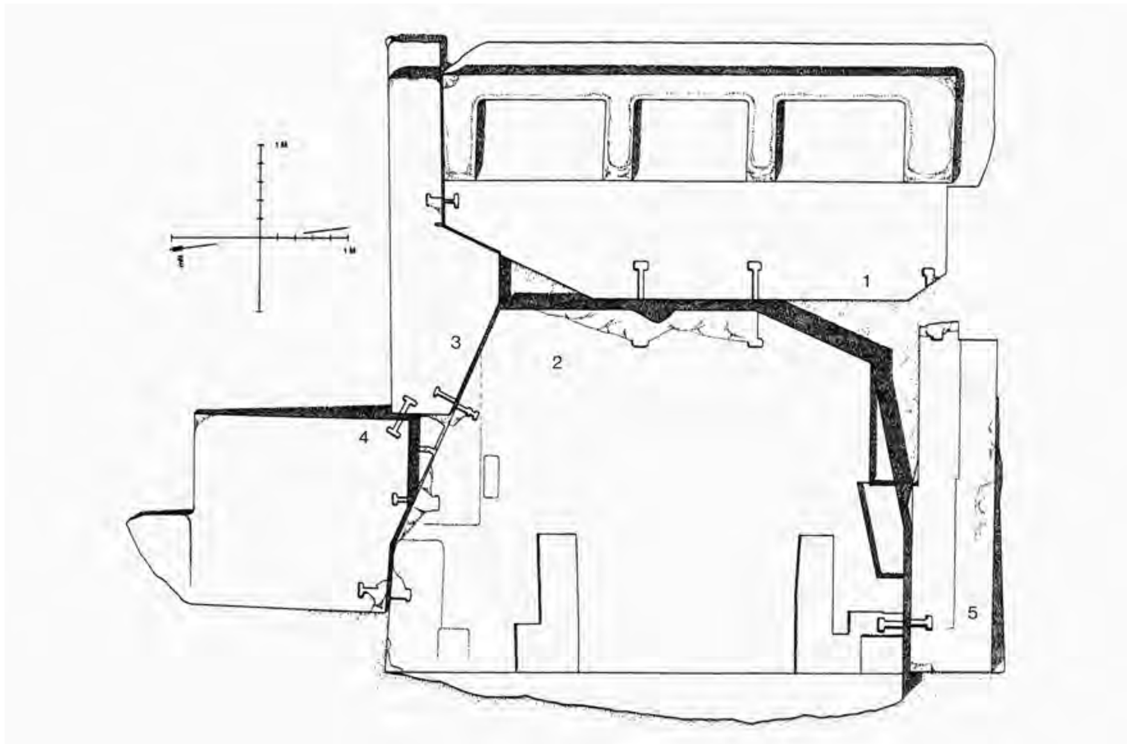


Figure 2.54. Plan of Platform I (drawing by Jean-Pierre Protzen).

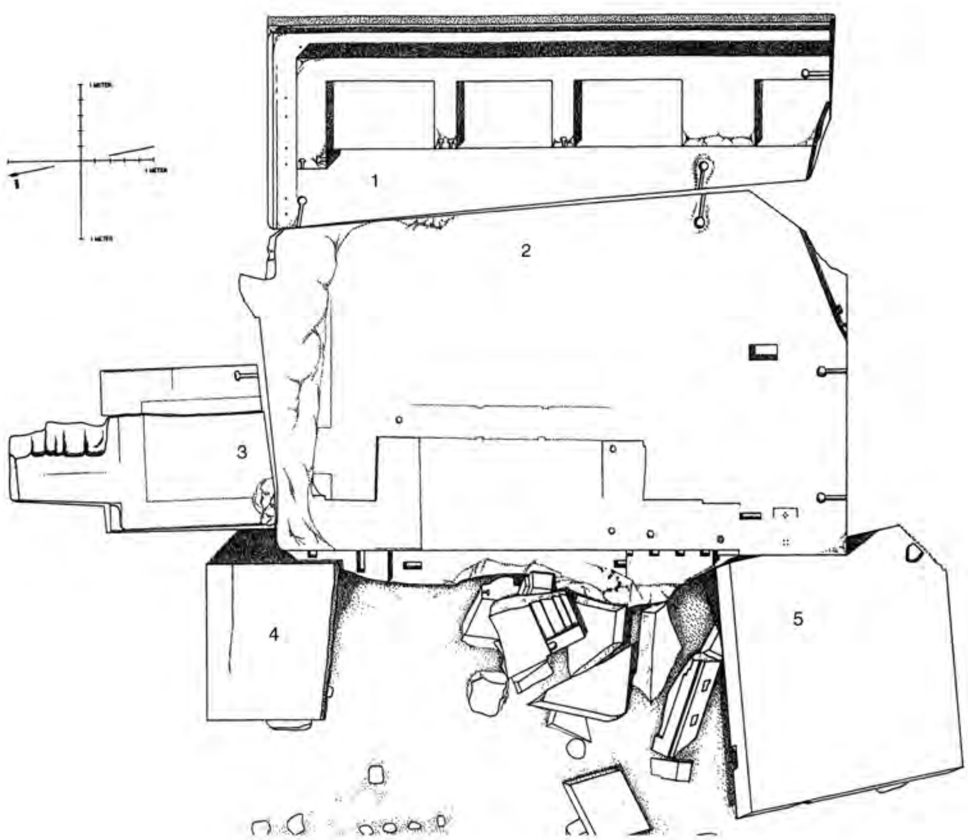


Figure 2.55. Plan of Platform IIa (drawing by Jean-Pierre Protzen).

broken andesite block, slab 4, which in turn still rests on original foundation stones on the side opposite to the ledge. Another huge andesite block, slab 5, now at a very steep slant, was also fitted onto the same ledge, and it too is still lying on an original foundation stone on the west side. These andesite slabs, and numerous foundation stones embedded in the ground between the two, are clear confirmation that the platform area once extended much further west than it does today, perhaps as much as 4 m or more (Figure 2.56). Such foundation stones may well be what Stübel and Uhle (1892:Part 1, Plate 24) interpreted as pavers in their plan of the Platform Area. A further sign of the intent to connect the platforms is slab 3 between Platforms IIb and III (Figure 2.57). We suspect that Platform III extended further to the south than its current boundaries, but cannot be certain. Excavations would be needed to verify our guess.

It is clear that the Platform Area was never completed; there are many signs that work was still in progress when it was abandoned. Slab 4 of Platform IIa shows incomplete sections with the typical "cups," "pans," and "troughs" from pounding with hammer stones (Protzen 1993:170–172) (Figure 2.58). To a lesser extent, the same holds for slab 4 of Platform I and slab 2 of Platform IIb. Other significant signs of incomplete work are the outlined but not yet carved "seats" on Platform IIb (Figure 2.59).

"Seat" Configuration

Platforms I and III feature three seats each, with the middle seat somewhat narrower than the two outer ones. The respective measurements are approximately 1.3 and 1.47 m. On neither platform are the seats precisely carved, they are only roughly square and vary in dimensions in width and depth by as much as 3 cm. The arrangement of the seats on the middle platform is not quite obvious. On Platform IIa one finds the same arrangement of three seats as above, plus what looks like half a seat separated from the other three by a wider partition, or armrest to stay with the metaphor of seats. For reasons of symmetry one would expect Platform IIb to have had a similar configuration, however, of this one cannot be entirely sure. As mentioned above, this platform is partially buried and only a part of its configuration can be seen. Furthermore, because

Figure 2.56. Foundation stones west of Platform IIa.

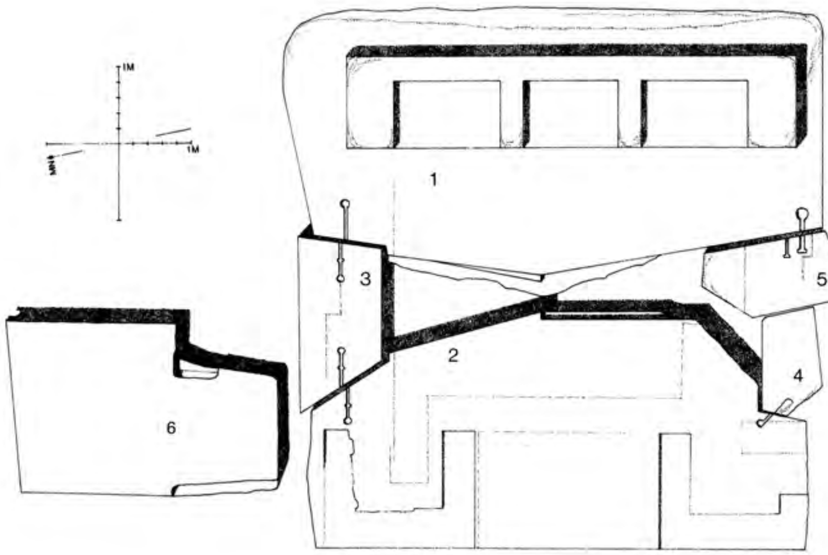


Figure 2.57. Plan of Platform III (drawing by Jean-Pierre Protzen).

Figure 2.58. Marks of work in progress on Platform IIa, slab 3

Figure 2.59. Platform IIb, incomplete seats.

the seats were not yet carved, but just outlined, what is visible are only faint lines. Much of the platform's surface has wasted away from exposure, particularly near the ground, such that no traces are left of the surmised half seat and the armrest separating it from the other three. Using the measurements of Platform IIb (Figure 2.60) that we could secure, and assuming the distance between the seats of Platforms IIb and III to have been the same as between the seats of Platforms I and IIa, we reconstruct the middle platform to have had seven seats, with the central seat measuring about 2.13 m in width (Figure 2.61).

T-shaped cramp sockets at the front of the armrests of the seats of the middle platform, suggest that other building stones were to be added to the current configuration. The intended configuration most likely was far from seat-like. The northern-most armrest on Platform IIa extends beyond the front of the seat and has two cramp sockets, one pointing west, the other south. This suggests, first, that the armrest may have extended further west. In fact, there is a faint outline on slab 2 of the same platform that lines up with this armrest and may give an indication of how far it projected out. Second, the south pointing cramp indicates that a stone at least as high as the armrest was running along the front of the seat, perpendicular to the armrest, and thus closing off the seat and turning the seat area into a cubicle. The sockets on the other armrests suggest that a line of stones closed off all the seats. An outline similar to the one on slab 2 of Platform IIa exists on slab 2 of Platform IIb, showing that the southern most armrest of that platform, too, was meant to extend further west.

Special Features

Beside the outlines just mentioned, there are other areas, some clearly recessed by as much as 2.5 cm and roughly U- or L-shaped on slabs 2 of all platforms. These U- or L-shaped areas show a certain similarity from platform to platform. Pairs of U's or L's appear to be mirrored around the axis of the three-seat groups on each platform. A surprising consistency governs the distance between mirrored pairs of U's or L's—it measures 249 plus-or-minus 1 cm. Other areas slightly raised or shallowly recessed by as little as 5 mm can

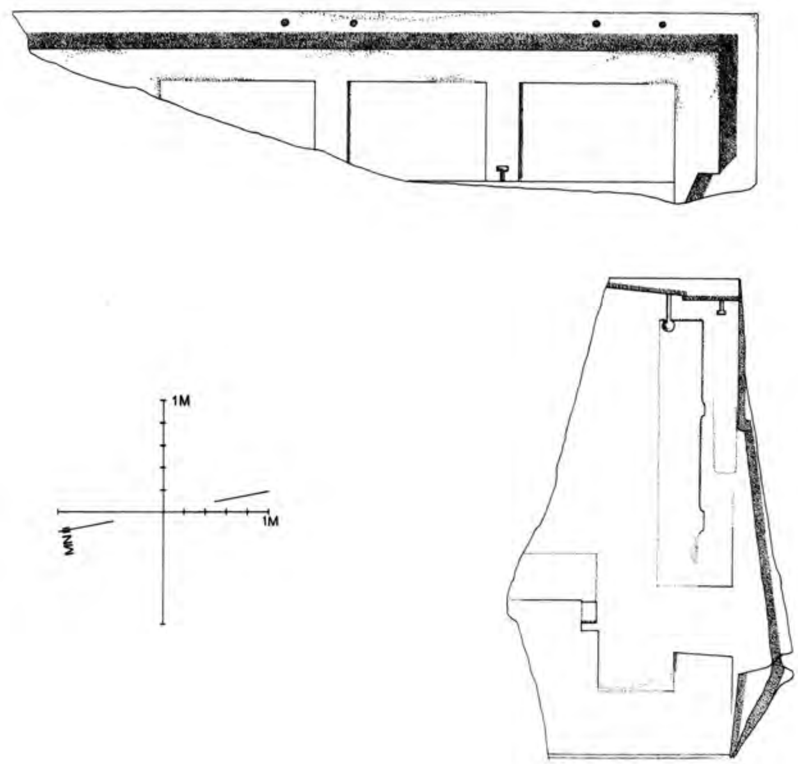


Figure 2.60. Platform IIb (stone slabs rectified/leveled) (drawing by Jean-Pierre Protzen).

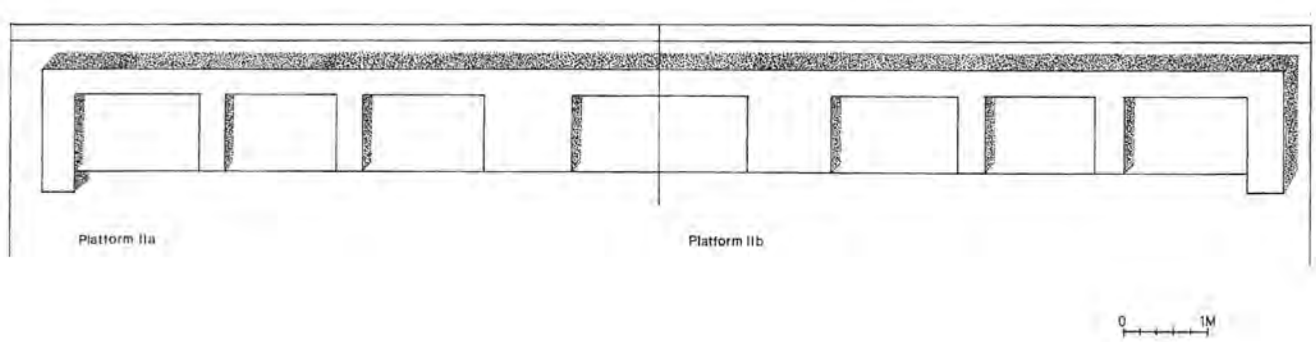


Figure 2.61. Seats of Platform II (a and b) reconstructed (drawing by Jean-Pierre Protzen).

be detected on many slabs, but seem not to form any discernable pattern. We will return to these outlines in Chapter 4.

On the surface of slab 2, Platform IIa, there are round holes and rectangular sockets, the latter also occurring on the ledges, the purposes of which we have not elucidated. Even more puzzling are three round depressions with four pinholes in them. Equally unexplained are the many pairs of pinholes along the ledge in back of the seats and on the north side of Platform IIa.

Eastern Edge

If the platforms were extended north, west, and south, what was their configuration to the east? Cobo, who said that the east side was the main façade of Pumapunku, mentioned a room or hall jutting out of the center of the front. Nothing of such a structure can be detected today, nor are there any clues that the platforms extended further east. The only exposed eastern face is that of slab 1 of Platform IIa. This face, which is at least 2.13 m high—the thickness of the slab—has a batter of six degrees and a row of roughly rectangular recesses. Although we do not know the purpose of these recesses, we are quite certain that they are not structural; they did not serve to attach or support other building stones. If other stones were extending the platform they could only have rested on one or the other ledge at the top of the slab, and if such stones existed, there is no clue left of them. Excavation made, we believe, by Cordero Miranda[17] just east of the Platform Area revealed nothing more than scattered fragments of building blocks. The blocks that we could investigate all prove to have served very specific functions, none of which we could identify with extensions to the platforms.

The short section of the mound's east face, visible near the end of its south wing, fails to provide any information of the relationship of the Platform Area to the mound's east face. The visible section, also excavated by Cordero Miranda, is thrown up in a rough masonry of discarded stones of all sizes bound together with lots of argillaceous mortar. The wall bears no resemblance to the finely crafted terrace walls encountered elsewhere on the mound, but is reminiscent of the colonial walls found on Pumapunku's north side. Further excavations may some day bring to light original parts of Pumapunku's east side. At that time, Cobo's description may be a useful guide, for his words are the only clue we have about that side's appearance.

THE WROUGHT STONES

Cobo saw among the wrought stones and stone fragments scattered around the Platform Area pieces of gateways and windows. In addition to these, there are numerous other building blocks, ornamented with a variety of motifs, the function of which is not immediately obvious. Many stones reveal a distinct kinship, both in design and dimensions, raising the possibility that the Tiahuanacan builders made use of a kit of parts in the edification of their architecture. In Chapter 3 we offer an extensive catalog of building stone types, and propose possible uses for, and connections among the stone types, as well as reflect on the various gateway fragments. Suffice it to mention here that many, if not most, of these stones show signs of work in progress, that is they are unfinished and thus do not come from dismantled buildings.

Most stones are randomly dispersed over the area, but there is a curious alignment of a substantial number of stones a few meters west of the platforms (Figure 2.50, right side). This row of stones has been there ever since they were first recorded by d'Orbigny, and Castelnau. They were then mapped by Angrand, and Stübel and Uhle among others. Comparing the various plans of these authors to each other and to the current situation, however, reveals that some stones have been moved around and the rows rearranged in the intervening times. Some researchers mistook the rows for an original Tiahuanaco wall and thought it to be part of the buildings on the platform (Posnansky 1945:Vol. 2, 130). If this view does not make sense—the row is made up of many disparate stones, some of them in incongruous positions and unfinished—the questions remain about who lined up the stones, when, and why. One possibility is that the Tiahuanacan builders used this row as a kind of staging area in which finished building blocks were stored until used in the construction. Angrand's plan is so detailed that we could identify individual stones within this row that are still where he showed them to be, but we also found some incongruities. For example, where today there are two stones with cross motifs, Angrand's shows three neatly lined up: stones d, e and f, of group 24 on his plan of the Platform Area (Prümers 1993:452, Figure 31). Angrand sketched, measured, and drew these stones (Prümers 1993:460,

Abb. 46, 461, Abb. 48). Even if one of his stones had been moved since he recorded them, the remaining two would not be in the position they are today. The actual stones bear some resemblance to Angrand's, yet they are not identical with them: Angrand shows the cross motifs to be centered on the face of the stones, while on the actual stones the motifs are eccentrically arranged. Another neat row of stones is shown by Angrand on the east side of the platform (Prümers 1993:452, Abb. 31). He did not make any sketches of these stones. Thus, we do not know whether the few stones still in a row just east of Platform III were part of Angrand's row, or whether the remaining stones are just accidentally where they are today. By whom and for what purposes the rows were made will have to go unanswered, at least for now.

Sculptures

In his description of Pumapunku, Cieza de León (1986:283–284) mentions a small sanctum, or alcove (*retrete*), somewhat removed from the platforms, in which stood a big "idol." His description is too cryptic to know where that "idol" was located, but a possibility is that Cieza's *retrete* refers to the sunken court and that the "idol" stood in it. Further excavation of this area may one day shed light on this question. Posnansky wrote of, and published a photograph of two *chachapuma*, effigies of a squatting puma, presumably in their original location, immediately north of Platform I (Posnansky 1945:Vol. 2, 205 and Figure 125). It is curious that these chachapuma, which are no longer there, do not figure in Angrand's detailed plan of the Platform Area, nor in the photographs of Stübel and Uhle, or Middendorf. Even more mystifying is, that the chachapuma are not accounted for on any of Posnansky's own sketches and plans of the Platform Area, are not mentioned in his guide to Tiahuanaco, and do not appear on the photograph in this same guide (1912:Figure 20, opposite page 18). Since Posnansky gives no illustration credits, we do not know the dates of the photographs published by him. We must assume that the chachapuma were placed where Posnansky's photograph shows it after Middendorf's passage at Tiahuanaco in 1887, and were removed again we do not know when, nor by whom sometime after 1904 when Posnansky came to Tiahuanaco. The only other indication of statuary at Pumapunku is, once more, due to Posnansky. He published a photograph of a statue he called "Cochamama" very similar to "El Fraile," buried to its waist, standing about 40 m to the west of Pumapunku's west face and marked "F" on his survey (1945:Vol. 2, Figure 111 and Plate 6). Whether that was its original location, or whether it was moved there from somewhere within the Pumapunku complex is not known.

Canals

The beautifully crafted canals uncovered by the Bolivian archaeologists are perplexing. The canals run obliquely down the mound with a slope of between 11 and 12 degrees, or 24 to 26%, and form an angle of nine degrees with the normal to the respective south and north sides. The canal on the southwest corner cuts through the second terrace wall and spills out onto the stereobate with no clue of the water's final destination (Figure 2.62). The canal on the northwest side is well preserved and shows work in progress (Figure 2.63). In both canals, the stone slabs forming the canals' sidewalls were held together with I shaped copper cramps, a few of which were found in situ on the south side (Figure 2.64). Although the bottom part of this canal is destroyed, our survey shows that it would have followed a similar course to spill out onto the stereobate there. Portugal, who excavated Pumapunku's north side, discovered the spillway of a canal built into the stereobate. Exploring inside, Portugal glimpsed a shaft (*caja*) that he thought might have connected to the canal above. By his own reckoning, however, the area was destroyed in colonial times and the presumed connection could not be verified (1992:36–38). At the upper ends both canals show work in progress. In other words, the canals were never finished, and it is thus unknown where they were supposed to lead and what they were to drain, if drainage was their purpose at all. Assuming the canals were to maintain their course and slope, they would have led to the summit of the mound. As with the canals on Akapana, one is left wondering what the Pumapunku canals could possibly have drained, again assuming that that was their function. These canals, with a clear cross-section of 42 cm in width and 69.5 cm in height, would have had an enormous capacity.

Careful as the Tiahuanacans were in draining water away from structures and controlling its course, we find the termination on the stereobate of the southwest corner canal highly unsatisfactory. The canal looks like an afterthought or a change of plan, perhaps related to the above suggested burying of the

Figure 2.62. Canal ending on Pumapunku's south side.

Figure 2.63. Canal on Pumapunku's north side.

Figure 2.64. Cramps in situ in canal on Pumapunku's south side.

stereobate. We investigated the lower ending of the canal and the area where it cuts through the second terrace wall in search of clues of construction breaks and modifications. The results are ambiguous. It appears that the top step of the stereobate had been modified to accommodate the bottom of the canal, but that does not mean that the two are not contemporaneous. More telling would be if the second wall had been partially dismantled to make room for the canal, but that we could not ascertain with certainty. Assuming as before, that the second terrace was as wide as the first, or stereobate, the canal would not have cut through the third terrace, but passed under its bottom level (Figure 2.65). In other words, had the canal been built after the terrace walls, substantial trenching of the mound would have been necessary to install it. A disturbance of this magnitude should have left traces detectable in an excavation. The other possibility is, of course, that the canals came first, and that the terraces were then built around them. The unsatisfactory lower ending of the southwest canal may thus only represent work in progress. More work is needed before a convincing story of the canals' construction history and function can be written.

Construction Phases

Canals aside, there is other, unequivocal evidence of different construction phases at Pumapunku. During excavations carried out, and in part witnessed by us, in 1994-95, Oswaldo Rivera Sundt, at the time director of the Instituto Nacional de Arqueología (INAR), made several significant discoveries. The first and most stunning find of these excavations is a malachite (greenish) colored plaster floor on the southern slope of the mound, buried about 1.85 m below the level of the red clay floor mentioned before (Figure 2.65). The plaster floor, some 6.5 cm thick, has a clear, upturned edge parallel to the second terrace wall and about 12 m north of that wall's face. It probably was bordered by a row of small stones, of which one with some malachite color remained. This plaster floor is very smooth and extends into the mound far beyond the edge of the red clay floor above, thus making the former anterior to the latter. The second important discovery was that the plaster floor, some time subsequent to its construction, had been deliberately buried under seven or more carefully laid down layers, each about 20 cm thick, of a fine argillaceous material that at first sight is devoid of any cultural material. The

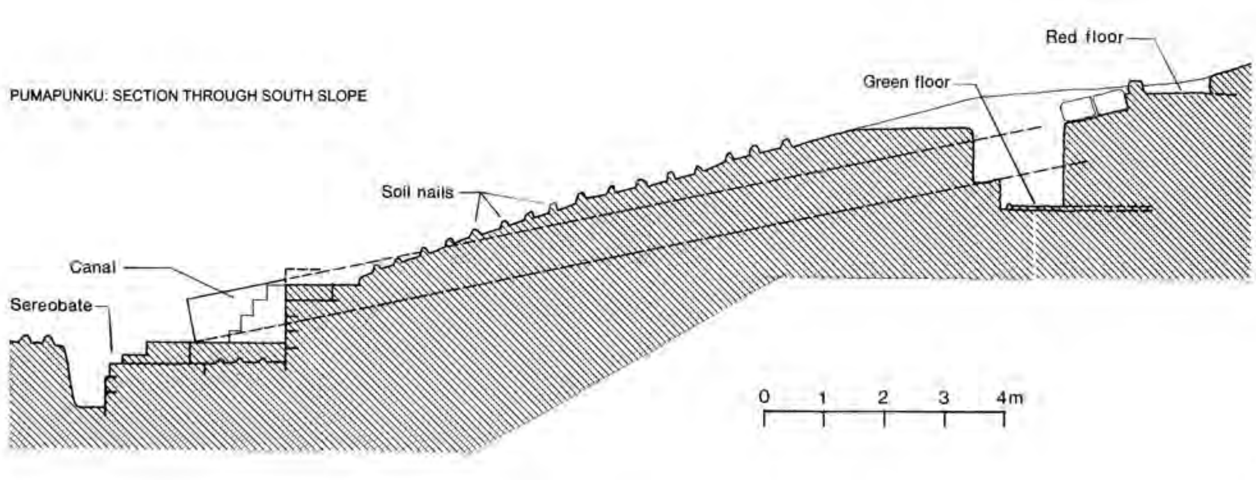


Figure 2.65. Profile of Pumapunku's south side showing position of the canal and the green and red floors (drawing by Jean-Pierre Protzen).

third find was a paved floor in the interior of the sunken courtyard.

These finds raise the question about the relationship between the two colored floors, the terraces, and the courtyard. From our own rough survey at the time of the excavation we determined the malachite plaster floor to be about 2.25 m above the top level of the stereobate or about 55 cm above the base level of the third terrace. This, and the wide distance between the floor and the terraces seem to indicate that there was no connection between the floor and the terraces. As seen above, the terraces were built on a foundation of compacted earth consolidated with soil nails. Rivera's excavation shows that the soil nails do not penetrate into the mound, but form only a surface layer. It appears that this layer was put down over the several layers of carefully laid fill that buried the malachite floor. Rivera expected to find a terrace wall bordering the red clay floor. In stead, he found only a row of rough, irregular stones laid on the surface. This floor, which is covered by another, unidentified layer of about 1 m thickness, alas, appears to have had no connection to the terraces. Subsequently, Alexei Vranich (2006) re-excavated parts of Pumapunku and added new trenches. His excavations essentially confirm earlier finds and added new information relating to the inner court, especially regarding a possible entrance on the west side. The excavations in the inner court also brought to light additional building stones, in particular a very large lintel stone (Figure 2.66). Thus, if the finds to date bespeak several construction phases, and different configurations of the mound at different times, more archaeological research will be needed to establish exactly how the various phases are related, temporally as well as architecturally.

Reconstructions

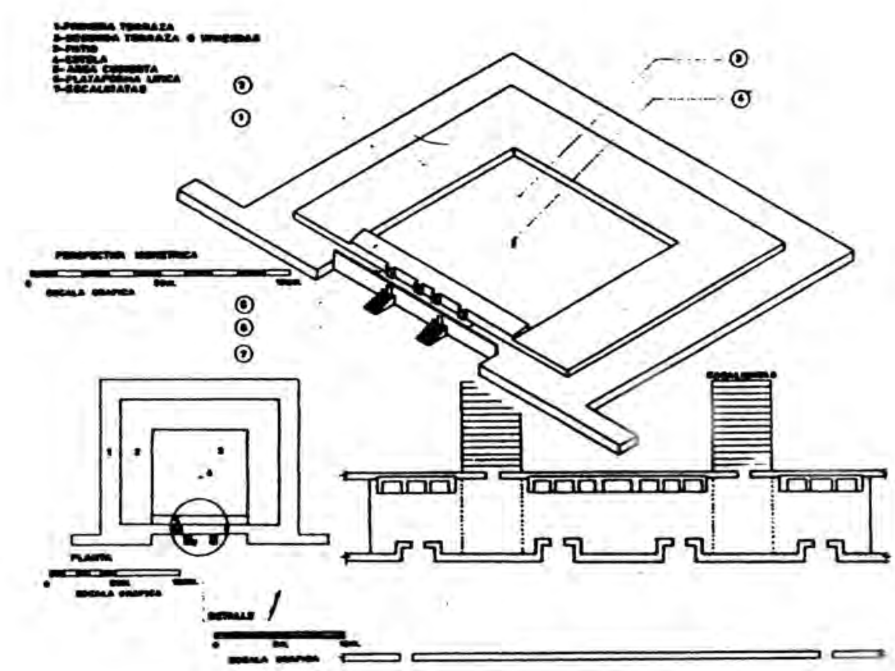
Tempted by the jumble of building stones and its puzzle-like nature, several researchers have proposed reconstructions of the platform area: d'Orbigny, Kiss, Ibarra Grasso with Mesa and Gisbert, Torres de Kuljis, Ponce Sanginés, and Escalante among others. The architect Marta Torres de Kuljis's (Escalante 1993:208, Figure 173a) and Ponce Sanginés's (Escalante 1993:209, Figure 173c) schemes are similar in that both show a building at the western edge of the platforms, leaving the "seat" area to open air (Figure 2.67). Both recess the area east of the "seats" into the corpus of the mound and add stairways. D'Orbigny, Kiss, and Ibarra Grasso with Mesa and Gisbert, all enclosed the entire platform area in a building. In imagination and flamboyance, none have surpassed the inventiveness of Edmund Kiss, a German building official (*Baurat*). His reconstruction is truly fantastic. If all the other schemes are sober, proposing no more than possible outlines, Kiss (1937) went into great detail, offering a full set of architectural drawings, with plans, sections, façades, details of windows and cornices, perspective drawings, and even cut-away views.

Figure 2.66. Large lintel piece in Pumapunku's central court.

With models and perspective drawings, architects visualize for their clients the otherwise abstract and codified information embodied in plans. Similarly, hypothetical reconstructions of archaeological features are imaging the often difficult to interpret archaeological record. To be helpful, however, reconstructions need to be rooted in the observable world, or they become confusing and deceptive. For example, the proposal by Ibarra Grasso with Mesa and Gisbert (Escalante 1993:208, Figure 173b) completely ignores Pumapunku's sunken court, and instead piles another mound on top, thus totally distorting what is there for everyone to see (Figure 2.68). Escalante overlooked, among other things, the fact that the Platform Area is much lower than the summit of the mound, but nevertheless places a building there level with the summit (Escalante 1993:230, Figure 188). Kiss's proposal at least has the merit of having incorporated many of the stones and ornamental motifs found at the site, even if the proper position of several stones is incorrect. But the extreme detail to which it is developed deludes one into believing that the author indeed possessed the corresponding specific information (Figure 2.69). The reconstruction by *National Geographic* mentioned above, which makes the Gate of the Sun the western entrance to Pumapunku, belongs to the same category of delusional thinking. Clearly, such reconstructions are not only useless but also damaging; they mislead the public and are a disservice to serious investigation.

The proposition by Torres de Kuljis and Ponce Sanginés, that the east façade near the Platform Area was recessed rather than projecting out of the main corpus as described by Cobo, is, at least in principle, testable in the field and may serve as a practical hypothesis. To be truly useful, hypothetical reconstructions should not only account for the actual archaeological remains, but also take into consideration the repeated features of other structures at the site. On this ground, Gasparini and Margolies (1980:20) rightly took issue with Ponce Sanginés's reconstruction: "[T]he two axes of the stairways have no continuity and run into a transverse wall," when at other monuments at Tiahuanaco, "the Kalasasaya for example, the stairway, the doorway, and the monolith in the interior courtyard form a sequence governed by the symmetrical axis."

Since, as we have shown, the construction at the Platform Area ceased while still in progress, attempts



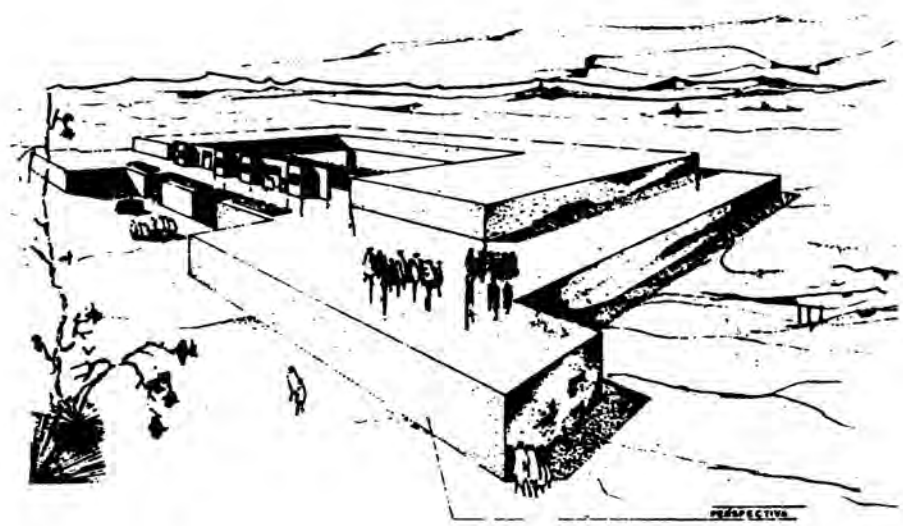


Figure 2.67. Reconstruction of Pumapunku by Marta Torres de Kulljis (bottom) and by Carlos Ponce Sanginés (top) (from Escalante).

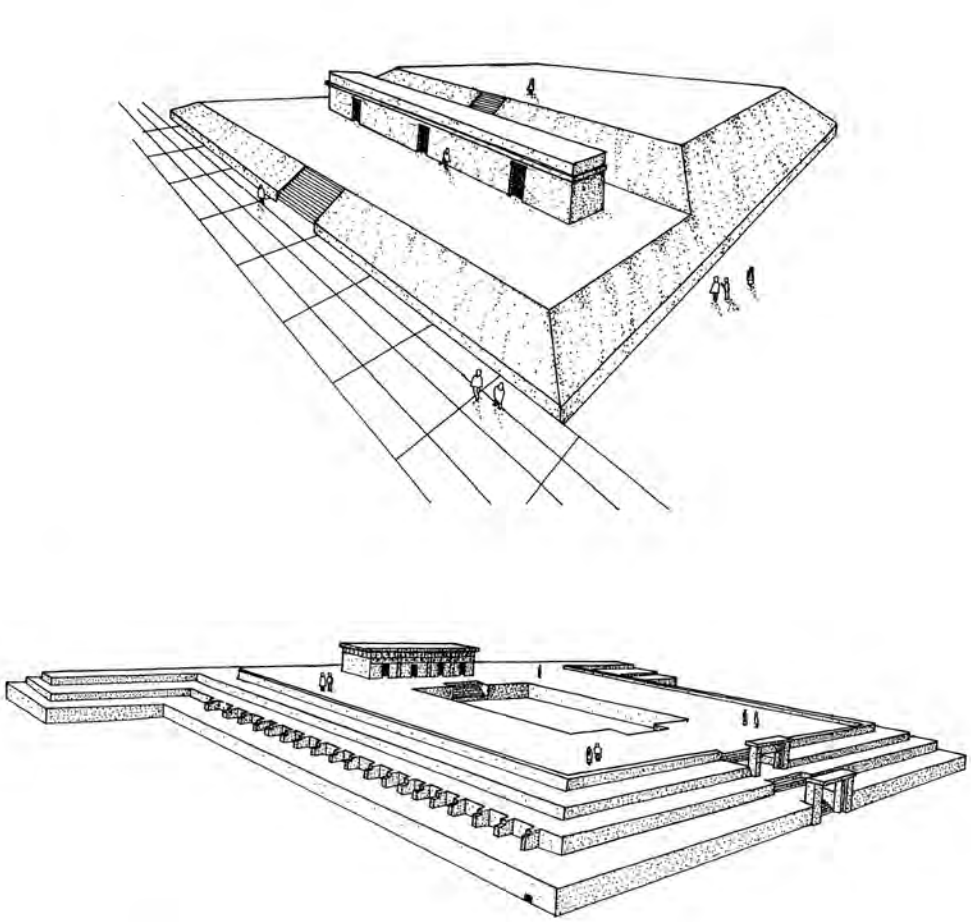


Figure 2.68. Reconstructions of Pumapunku redrawn from Escalante by Ibarra Grasso with Mesa and Gisbert (top) and by Javier Escalante (bottom) (drawing by Stella Nair, first published in the *Journal for the Society of Architectural Historians*).

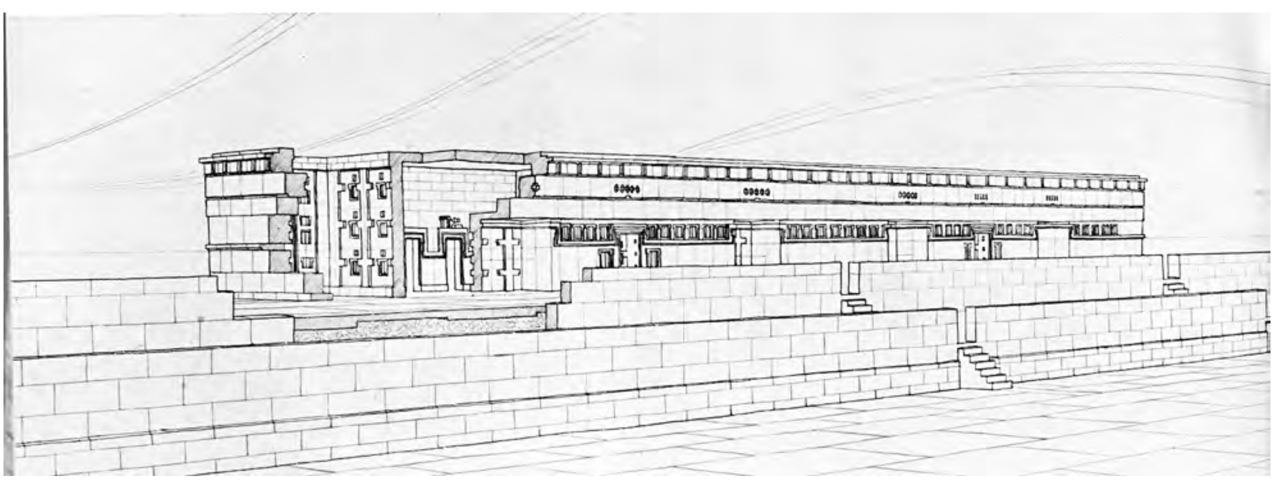


Figure 2.69. Reconstruction of Pumapunku by Edmund Kiss (Escalante 1993, 204).

at imagining what a structure would have looked like had it ever been finished face the formidable task of out-guessing the minds of its long gone designers. This task, if it is at all feasible, depends on a thorough understanding of the design principles and construction practices the designers abided by. And even with that knowledge, there is always the possibility that the designers were on the verge of innovation, challenging the established canons, thus nullifying one's speculations.

The Monuments Compared

A comparison of the monuments does not reveal any obvious and uniting design principle. Apart from the already noted orthogonality and bilateral symmetry, there seem to be few commonalties among the various monuments: they differ significantly in plan, overall organization, appearance, and detail.

Morphology

Morphologically, Akapana and Pumapunku belong together: both are terraced platform mounds with (presumably) a sunken court in the uppermost platform. On approach, however, the two structures are experienced differently, not only because of their difference in volume and height, but also for reasons of design. The low stereobate, or plinth, with its receding steps of Pumapunku is considerably more inviting than the intimidating massive and high base wall of Akapana. The relative small size of the ashlars in the masonry of Pumapunku further reduce its apparent scale, while that of Akapana is heightened by the large and pronounced uprights that structure most of its terrace walls.

Admittedly, not enough is known about the configuration of buildings on the summit of either mound for a proper comparison, but the apparent concentration of construction elements on the east side of Pumapunku contrasts sharply with the symmetrical arrangement of structures found by Manzanilla and colleagues on the north and south sides of Akapana. And while the plans of the two structures show salient and re-entrant corners, that similarity is only superficial. The steps in the plan of Akapana visibly structure the mound into three interlocking corpuses; the steps in Pumapunku's plan are only faintly noticeable in the experience of the mound.

To enter Putuni or the Semi-Subterranean Temple one had to descend some steps, but all resemblance ends here. First, the court of Putuni, unlike that of the Semi-Subterranean Temple, is not below grade; second, the entrance to Putuni was through a forecourt and a formal gateway; that of the Semi-Subterranean Temple was immediate and marked only by two uprights on either side of the stairway. Little is known about the function of either court, but from the known configurations alone we would guess that the Semi-Subterranean Temple had a more sacred character than Putuni, with perhaps a single purpose to Putuni's multiple uses.

Kalasasaya is in a category of its own. It is a raised platform, but not a terraced, mound. It had a sunken court, but unlike that of Pumapunku (or Akapana), it is not centered in the platform. Although the exact configuration of Pumapunku's court is not yet known, its current state suggests that to enter the court from the west or the east, one first had to climb the mound before descending into the court. Kalasasaya's court was directly accessible over the stairway to the east. As seen above, how the platform surrounding the court on three sides was reached, from either the court or the outside, is not known or in doubt, as is the actual configuration of the court. With roughly 66 m in width (north–south) and perhaps as many as 80 m in length, the court was considerably larger than any other at the site, and consequently may have served very different functions. Torres de Kulljis took the so-called "Model Stone" of Kantatayita as a referent for his reconstruction of Kalasasaya (Escalante 1993:133, Figure 1.7). Indeed, the Model Stone is not a bad fit: it has an eccentric court with a direct access to the east (provided its current orientation is original), the court is surrounded on three sides by a higher platform that can be reached over several stairways from the sunken court. Unfortunately, the entrance to the model court is severely mutilated, yet the remains suggest that it may have had a formal double-jambed gateway. The court of Kalasasaya, in distinction to the model court and all other courts at Tiahuanaco, harbored free-standing small structures.

The comparison of the described structures, apart from the variously noted bilateral symmetry and orthogonality, does not reveal any clear set of repeated design features. Not even the predominant east–west orientation is without exception. The knowledge gained from one structure would be of little help in the design of the next one. Gasparini and

Margolies (1980:20), taking their clues from the Semi-Subterranean Temple and Kalasasaya, thought that the typical Tiahuanaco stairway was "set into the earthen platform rather than abutting the retaining wall. That is, the continuity of the retaining wall is interrupted to leave space for the stairway." Of that we cannot be sure. On the Model Stone it is true that the little stairways left and right of the entrance to the sunken court are inset, but the three stairways at the back of the court are abutting the retaining wall, as are the stairways in the re-entrant corners of Pumapunku. Here again, there is no principle that applies without exceptions.

Masonry

The generic nature of the structures at Tiahuanaco, their apparent heterogeneity and the lack of readily identifiable design principles do not necessarily imply that the structures are not uniquely Tiahuanaco. Differences between the structures at Tiahuanaco and others of the same type elsewhere, as well as similarities between the structures at the site, become more pronounced when we consider their masonry. The Semi-Subterranean Temple and most of Kalasasaya share the random-range work of smallish sand stones between orthostats of different heights and set at irregular intervals. The stones in this masonry are only roughly cut and do not fit together with great precision. Kalasasaya's Balcony Wall (at least its original remains) and the base wall of Akapana and its third and fourth wall on the east, all are constructed in regularly coursed ashlar masonry (*opus quadratum*) between large vertical blocks set at roughly equal intervals. In this masonry, all stones are finely cut and fitted, leaving only barely visible joints, and the face of the walls is made smooth and absolutely planar. There are two noteworthy differences within this masonry: that of Akapana is almost exclusively of sand stone, and that of Kalasasaya's Balcony Wall of andesite; the uprights of Akapana are squat, almost square, and those of Kalasasaya slender and elongated.

Affinities of pattern, but not execution, exist between the second wall on the west side of Akapana and the east outside wall of Putuni. It is a masonry of large blocks spaced at narrow intervals filled in with small stones in either random-range or coursed masonry. The execution at Putuni is of the highest quality: precisely fitted stones of andesite with a very smooth finish. At Akapana's second wall the masonry is of lesser quality and is constructed of reused stones in a mixture of sand stone and andesite.

Quasi-coursed masonry seems to have been limited to Akapana, as the near-isodomic is to Pumapunku. The latter, however, may have had a more widespread use. The photographs of the three small chambers excavated by Courty at Chunchukala show that they too were constructed of neatly cut rectangular parallelepipeds (Posnansky 1945:Vol. 2, Figures 37 and 38). Several loose stones with the same cut found inside Kalasasaya suggest that there too may have been buildings erected with a quasi-isodomic masonry.

The many masonry patterns reveal the diverse innovations of the Tiahuanacan builders. At first sight, the random-range work observed in the Semi-Subterranean Temple and Kalasasaya has an uncanny parallel in the semi-subterranean court of the Moraduchayuq Zone at Huari, near Ayacucho in Peru (Isbell 1991). But there is a critical difference: at Tiahuanaco this masonry is set between orthostats. The profuse use of orthostats to structure and anchor walls does not have a precedent in the Andes, nor has the technique been carried forward. As Gasparini and Margolies (1980:13) argued, whatever it is the Incas may have borrowed from Tiahuanaco, "the technique the Incas later developed to contain earthen platforms employed different solutions from that of Tiahuanaco, with its great vertical monoliths sunk into the ground." Quasi-coursed masonry was practiced by the Inca, but unlike the Tiahuanacans, the Incas did not smooth out and flatten the faces of the stones and the walls; their walls, even the finest, are always characterized by "pillowed" stones and the attendant sunken joints.[18] Elsewhere we have shown that the finely fitted coursed ashlar (*opus quadratum*) and near-isodomic masonry are unique to Tiahuanaco and represent major inventions that later were lost (Protzen and Nair, 1997). Obviously, neatly coursed stone masonry was constructed before and after Tiahuanaco, but with significant differences. The best coursed masonry of the Castillo at Chavín de Huántar, for example, is not properly fitted on course; rather each stone of a new course is adapted and adjusted with chips of very small stones (Figure 2.70). In contrast, the fit of Inca coursed masonry is legendary: not even a razor blade can be inserted into the joints. In Inca coursed masonry each stone is fitted individually to its immediate neighbors. Its horizontal, or bedding, joints are never quite planar, nor are the rising joints planar and vertical or perpendicular to the bedding joints (Figure 2.71). Each stone leaves an imprint that no other stone can occupy

Figure 2.70. Chinked cut-stone masonry at Chavín de Huántar.

Figure 2.71. Wavy horizontal joints in Inca ashlar masonry.

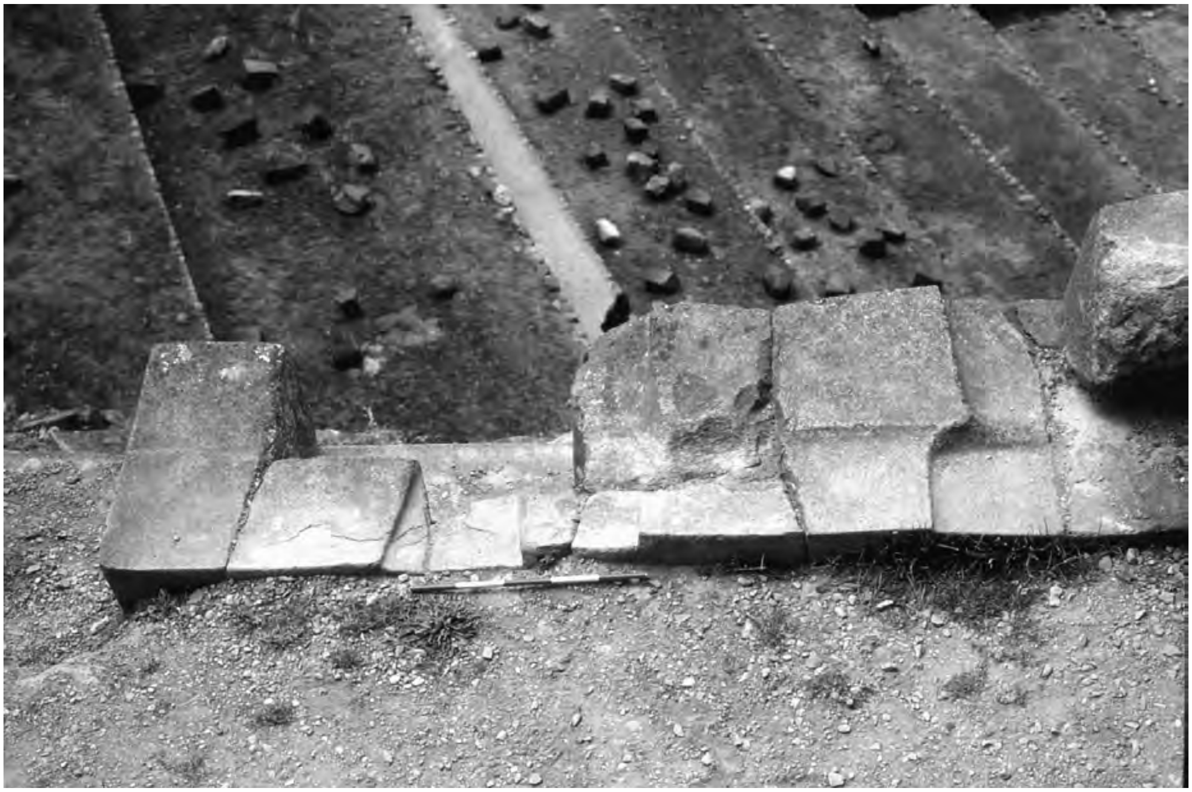


Figure 2.72. Imprints left by removed stones in Inca masonry.

(Figure 2.72). Not so in Tiahuanaco coursed masonry. Here, the bedding joints are perfect horizontal planes, the stones in a course meet at right angles, and the rising joints are perpendicular to the bedding joint. In other words, stones meet stones at right angles in all three dimensions; no stone occupies a privileged place; stones in a course are interchangeable. The interchangeability carries over into the near-isodomic masonry, where all stones are perfect rectangular parallelepipeds of equal height. Interchangeability means that the masons could cut stones without knowing what their final destination was; the stones could be prefabricated, mass-produced even, away from the building, in some stone-cutter's yard in the quarry, for example. Whether the Tiahuanacan builders in fact practiced prefabrication we will consider in a subsequent chapter. Carefully wrought stone slabs were assembled with precision into some subterranean chambers in the Cheqo Wasi Sector of Huari, but well-jointed masonry was not widely practiced there. The fine coursed stone-masonry of the burial towers, or *chullpa*, at Sillustani near Puno in Peru, shows all the hallmarks of Inca coursed masonry, and thus differs in the same way from such masonry at Tiahuanaco.

We argue that the distinctions that set apart Tiahuanaco masonry patterns from seemingly similar masonry elsewhere are unmistakable, if not sufficient identifiers of Tiahuanaco architecture. Are the various masonry patterns at Tiahuanaco also indicators of chronology? Posnansky and others have proposed that sandstone structures precede the structures using andesite. But as Arellano noted the stone type is not enough of an indicator:

> the sandstone walls of the semisubterranean temple and Kalasasaya have finishes that contrast with Akapana, even though the same stone was used in all three. More different still are Putuni, Kerikala, and Puma Puncu, where andesite was employed along with sandstone [Arellano 1991:271].

The idea of using masonry types and materials as indicators of chronology is tempting, but there are at least two difficulties with this suggestion:

1. Without particular dates associated with specific masonry types—which, to our knowledge, as of yet do not exist—or clear-cut evidence of construction sequences using different masonry, the question will have to go unanswered for now.

2. Different masonry types are not always indicative of chronology, they could be coeval and signify different types of buildings or different status.

All the masonry types we have reviewed here describe masonry from retaining and terrace walls on mounds and platform structures. We do not yet know what kind of masonry the Tiahuanacan builders may have used in the erection of actual buildings. The many building stones scattered throughout the site may hold other clues to Tiahuanaco architecture. It is with this in mind that we now turn to the study of such stones.

NOTES

1. Note that the dimensions given here differ from those of the restored temple as given on Plate 17 of the same publication.

2. "Akapana" is an historical name, and was reported by Bernabé Cobo. However, which structure it designated—if it designated a single structure at all—is by no means clear. Some later authors, Stübel and Uhle, for example, apply the name to Kalasasaya. For a discussion of the various names of structures, see Appendix 1.

3. When piled up, loose materials will form a cone, the angle of which is a property of the particular material.

4. During her excavations of the second wall, Manzanilla came upon a major offering of intentionally broken ceramic pieces covering an area of about 9 by 5 meters, in front of this wall, and about 70 cm above its base (Manzanilla 1990:88). This offering, which according to radiocarbon dating was made around 610±210 C.E. (Alconini Mujica 1995:100), suggests that the original construction activities in this area and the crudely built wall, as well as the possible subsequent remodelings came before the offering was placed.

5. Courty likely began his excavations sometime after September 25 and before December 15 (Créqui-Montfort)—that is, a period when the sun at Tiahuanaco's latitude is shifting to the southern sky. Now, the photographs in Posnansky's book show the vertical faces of the canal and associated walls to be illuminated (1945:Vol. 1, Plate XII, c and d, Plate XIII, a). Had they been facing north, they would not have received any sunlight at that time. Note that the same holds true of every photograph of the French excavation shown by Posnansky.

6. See, for example, the aerial photograph by Marilyn Bridges (1991:22).

7. It is possible that 120 cm may not be the height of the interior of the canal, but rather the overall height of the canal.

8. Manzanilla proposes the existence of this spillway based on an electrical survey. We do not know whether this survey was a geoelectric or an electromagnetic survey.

9. Manzanilla (1992:22) argued in favor of the court on the basis of the electric soundings.

10. On Plate 2, the plan of Tiahuanaco, "d" marks the spot where Stübel found what he called a "grosse Bildsäule" (large statue). In parentheses, he added "Aufgefunden am 3. Januar 1877 und wieder mit Erde zugedeckt" (found on 3 January 1877 and covered up again with earth). This statue is depicted on Plate 31, Figure 1; it is a reasonable likeness to the statue that now stands at this very spot and is known as "El Fraile." In their work, Stübel and Uhle mention another stela found to the southeast of Akapana, "r" on the plan, which they call "El Fraile." It is depicted on Plate 32, Figure 7. This stela is rather abstract and clearly has no relation to today's "Fraile."

11. Note that Bandelier used "g" to label two entrances to Kalasasaya, one the main access on the east and the one under consideration here on the south side.

12. Dennis Ogburn of the Department of Anthropology at the University of North Carolina-Charlotte, was fortunate to find in a shop of used building materials a tray of slides from Peru and Bolivia taken by an anonymous traveler. The slide of the Kalasasaya we refer to was among them.

13. Posnansky said he photographed the area shortly after the excavation was done (1945:II, Figures 35,36) and complained that in the time between the excavation and his taking the photographs numerous stones had already been scavenged and that much of the area had been destroyed "by that miserable folk" (1945:II, 106–110). There is, however, some question with regard to the authorship of the photographs. Many of the photographs shown by Posnansky in his books were actually taken by a photographer hired by the French mission. Since Posnansky did not give credit where credit was due, it is thus not really known which photographs were actually his and which were taken by somebody else.

14. One *estado* corresponds to ca. 1.7 meters.

15. The excavations referred to here represent a major effort by the Instituto Nacional de Arquelogía (INAR), carried out between May and July 1989, under the direction of Carlos Urquizo Sossa. Several members of INAR and the Department of Archaeology of the Universidad Mayor de San Andrés participated in this task force (Escalante 1993:207).

16. Note that this platform has now been raised and leveled, as have the others.

17. We could not find a proper reference for these excavations.

18. Katharina Schreiber has pointed out that the Huari also had pillowed stone and sunken joints and some of these may predate the Tiahuanaco masonry. Hence, it is possible that Inca masonry was inspired by elements of Wari masonry practices (Schreiber, personal communication)

PART II

Design and Construction

Chapter 3

Design

"Ce caractère de l'extrême complication des détails forme le trait principal d'après lequel on peut reconnaître les monuments aymaras de ceux des Incas" [Castelnau 1850–1859:Part1, Book 3, 392]. (This character of extreme complication of details is the principal trait by which the Aymara monuments can be distinguished from those of the Inca [translation by authors].)

From the tour of Tiahuanaco and the monumental structures described in preceding chapters the reader will have noted that there are no standing buildings; none have survived, only their foundations are still visible here and there. The only possible clues to what the buildings may have looked like are the hundreds of loose building stones whole and broken, large and small, partially or fully worked, scattered on, between, and around the monumental structures. The highest concentration of such stones is at Pumapunku. The stones there are also the most intriguing; they are not simple ashlars, but stones with very elaborate shapes and, as Castelnau remarked, with extremely complicated details (see epigraph). What do the stones of Pumapunku reveal about Tiahuanaco architecture? What can the design elements and construction details tell us about a stone's position and its relationship to other stones? Can the stones be combined to create meaningful architectural configurations?

Design Elements

Among the many building stones and fragments of stones strewn about Pumapunku Cobo saw pieces of doorways and windows. He did not mention the elaborate cuts of recurrent geometric patterns or motifs, and figurative or representational ornamentation carved in *champlevé* or simply incised, found on many stones and stone fragments at Pumapunku and elsewhere on the site. These motifs, and other design details to be discussed below, provide important clues to the stones' orientation, possible function and relationship to other stones in ancient Tiahuanaco times. The study of these motifs and of various construction details constitutes the basis for a reconstruction of Tiahuanaco's architecture.

Ornamental Motifs

Some of the recurrent motifs are rabbets, both straight and stepped, step moldings, dentils, crosses, "arrows," circles, lozenges, niches, and niche icons. Among the figurative motifs are stylized puma faces, anthropomorphic faces, raptorial bird heads, and a stylized reed design. This inventory of motifs is limited to what can still be observed at Tiahuanaco itself, and to what we have seen in various museums. It is certainly not exhaustive, for other motifs appear on old photographs, but the stones on which they were carved have since disappeared and we could not investigate them.

Rabbets are longitudinal grooves cut along one or more edges of a stone (Figure 3.1). Some rabbets are straight, others are stepped at one or the other of their ends (Figure 3.2). Step moldings are L-shaped rectilinear moldings adding variety to plain surfaces (Figure 3.3). Dentils are small projecting rectangular blocks[1] (Figure 3.4).

Figure 3.1. Straight rabbet.

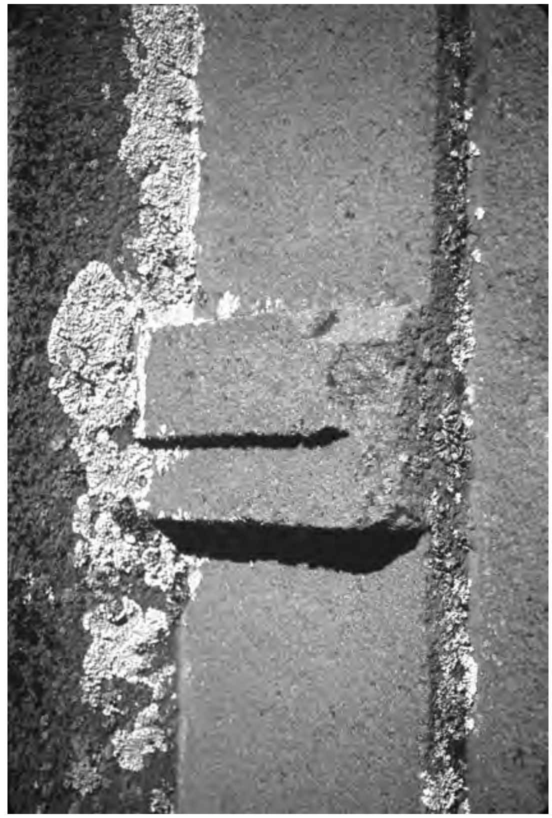


Figure 3.3. Step molding.

Figure 3.2. Stepped rabbet.

Figure 3.4. Dentil at upper right.

There are two basic cross designs: the simple cross, and the stepped, or so-called Andean cross (Figures 3.5 and 3.6). The simple cross motif always appears as a small recessed cross within a larger, recessed cross. These crosses are cut with utmost precision; their dimensions from cross to cross, and from stone to stone, are at most within 1 mm of each other, and all their angles, interior or exterior are prefect right angles. In all examples but one, the inner crosses are exactly inscribed in the central square of the outer crosses. On one stone, the arms of the inner cross extend slightly beyond the central square of the outer cross. All the stones with the stepped cross motif at the Kantatayita, Kerikala, and the storage yard near the museum are unfinished. It is thus not known what their completed form would have looked.

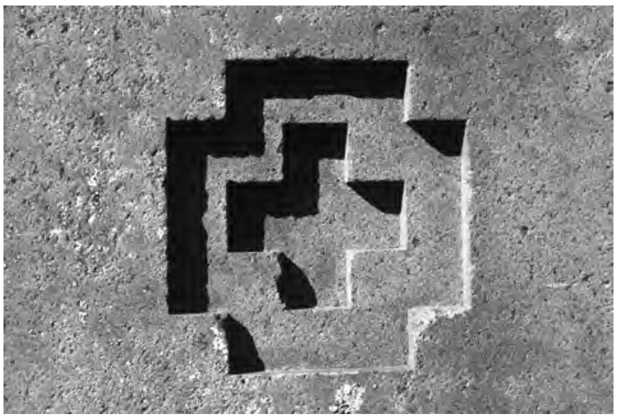


Figure 3.5. Simple cross.

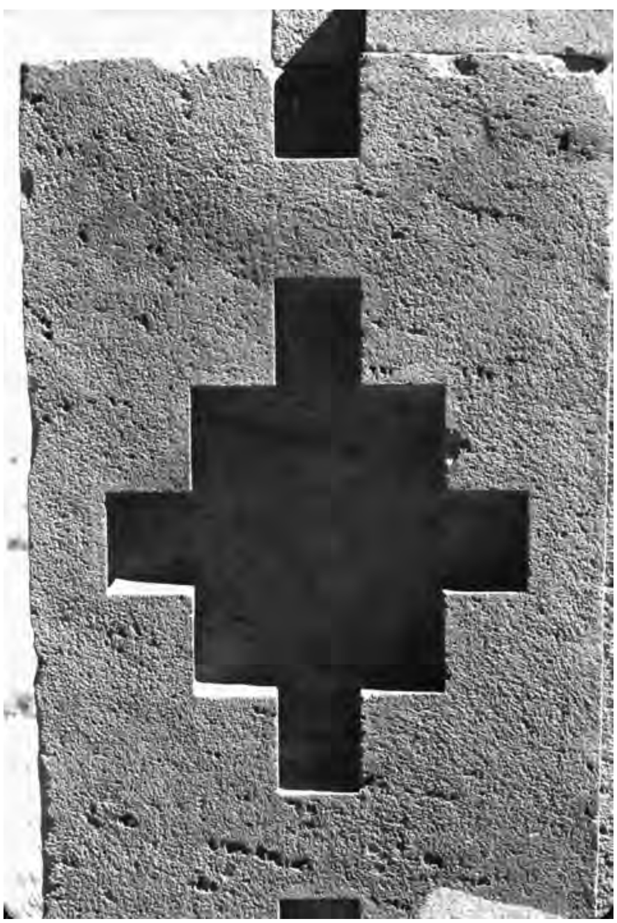


Figure 3.6. "Andean cross"

The arrow motif shows subtleties that bespeak the stone carver's incredible prowess. The surface triangle defining the arrow has truncated apexes at its base, with a rectangular shaft added. The recessed triangles, both the inner and the outer, are complete isosceles triangles with their bases ending in pointed apexes carved out from under the top surface of the stone (Figures 3.7 and 3.8). The circle motif consists of two

Figure 3.7. Arrow motif.

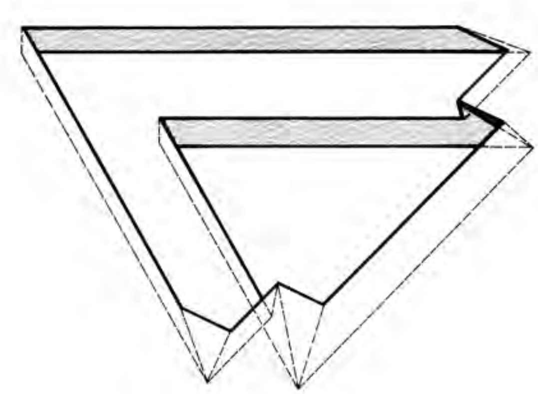


Figure 3.8. Arrow motif drawing (drawing by Jean-Pierre Protzen).

recessed concentric circles, the outer circle recessed against the surface of the stone, the inner recessed against the outer (Figure 3.9). The lozenge motif is best described by an illustration (Figure 3.10).

The niches are generally set into a recessed frame or *chambranle*, that is, an ornamental feature "enclosing the sides and top of a doorway, window, fireplace or similar opening. The top piece or lintel is called the *transverse* and the sides or jambs the *ascendants*" (Harris 1983:104). The niches, and their icons, come in two types (Figure 3.11). Type 1 has the shape of an isosceles, inverse trapezoid set into a chambranle of the same form. Type 2 is rectangular in shape and set in a recessed chambranle whose ascendants are double stepped at the top where they meet the transverse. Both types of niches have the reveals of their jambs and heads, or lintels, beveled and flaring open toward the back. Type 2 niches further assume two distinct shapes: Type 2a is squat or nearly square, and Type 2b is elongated or pronounced rectangular (Figure 3.12).

Figure 3.9. Circle motif.

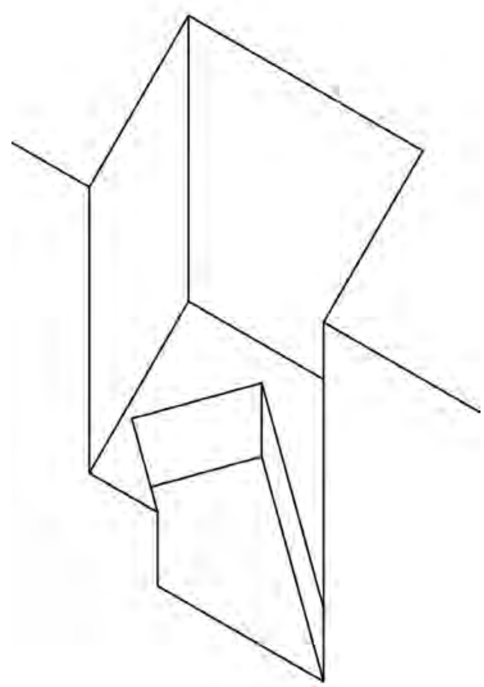


Figure 3.10. Lozenge motif (drawing by Eduardo Guerrero).

Parts and Combinations of Motifs

The motifs were not always carved from a single block, but often assembled puzzle-like from two or more blocks, each having a part of the motif. Good examples thereof are the three quarter crosses at the edge of the stone that is commonly known as the "Escritorio del Inca" (Desk of the Inca)[2] (Figure 3.13). These crosses were to be completed by adding another stone with the missing parts of the crosses. Similarly, the stepped rabbets are part of the ascendants of chambranles to be completed with an appropriate transverse, of which there are several examples, as we shall show.

The "Escritorio del Inca" reveals that when two or more motifs are used in combination, or if the same motif is repeated, there is consistency in their arrangements. For example, if the two niche types, or their respective icons, are present, then Type 2 is always placed above Type 1. Simple crosses repeated, are organized vertically, one above the other. Niches of a particular type, when repeated, form horizontal rows. In some Type 2 niche rows, dentils are separating niches (Figure 3.14). When niche icons are carved into the back walls of niches, the icons match the niche type in which they occur (Figure 3.15). We suspect that there may be other typical arrangements

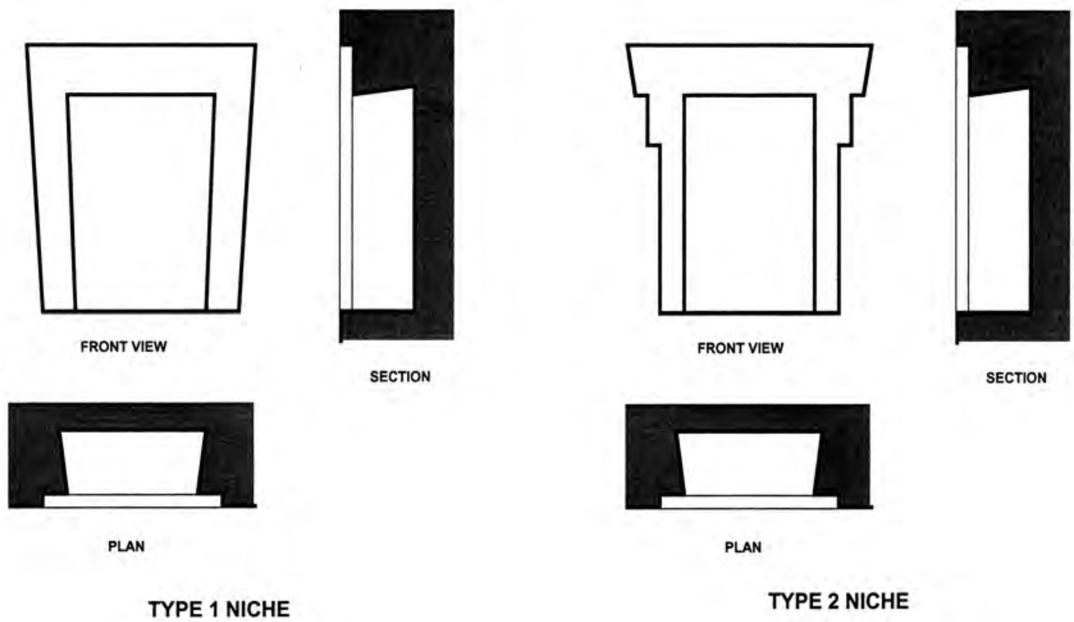


Figure 3.11. Types 1 and 2 niches (drawing by Jean-Pierre Protzen, first published in *Journal of the Society of Architectural Historians*).

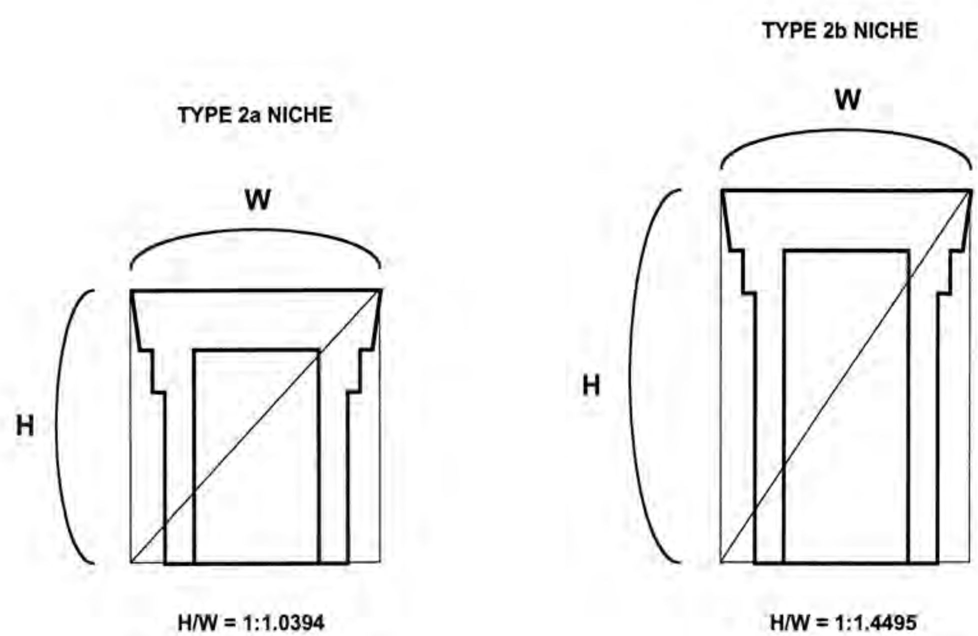


Figure 3.12. Types 2a and 2b (drawing by Jean-Pierre Protzen).

of motifs, but to date we lack the proper evidence to assert their configurations.

Figurative Ornamentation

Several architectural pieces were decorated with figurative, albeit highly codified representations. These ornamentations were simply incised, or rendered in a *champlevé* technique, that is, parts of the designs were pecked out to leave others in relief (Figure 3.16). As the central and main figure on the Gateway of the Sun shows, some ornamentation was also rendered in high relief, with the details of the headdress or the clothing indicated by incision (Figure 3.17).

Figure 3.13. Escritorio del Inca showing crosses and general composition. Bottom of stone is to the left.

Figure 3.14. Niche stones with dentils.

Figure 3.15. Niche Icon within niche.

Figure 3.16. Champlevé carvings.

Figure 3.17. Central figure on Sun Gate.

The Use of Color and Precious Metals

As seen in Chapter 2, colors were applied to several architectural features. The first clue of the use of color in Tiahuanaco architecture came from Courty's discovery of traces of a coppery green (*vert cuivreu*) coating on the stairway into Putuni, and of red and white paints applied to the walls of the small, cubicle-like structures of Chunchukala just west of the Gateway of the Sun. (Créqui-Montfort 1906:541). Colors were used on two floors at Pumapunku: one green, probably much like the coppery green, the other an orangey red. A "malachite green," together with a "deep cobalt blue, and an electric red-orange" were used on adobe walls at Putuni (Kolata 1993:153). Were there geometric patterns, or figurative representations, or both? The fragments of paint found were too small for such a determination. It is not known what patterns were formed when more than one color was applied to a wall. Fragments of a polychrome wall painting with zoomorphic figures found at La Karaña, just north of Kalasasaya, have been described by Portugal Ortíz (1992:16–50). Minute traces of color persist on at least some architectural stones with carvings in the Ethnologisches Museum in Berlin,[3] suggesting that the carvings were highlighted with paint.[4] We have found only scant residue of paint on very few stones of the many we have investigated, but that does not mean that color may not have been used extensively to enhance, or accentuate some of the motifs.

Some of the more figurative motifs are believed to have been augmented by precious metals, gold in particular. We have been told, as have other people, by members of INAR that golden nails have been encountered in some of the pinholes found in the recesses of friezes like those on the curved architrave at the Kantatayita and on the architrave of Gate III at Pumapunku. The pinholes on the former have led William Conklin to propose that

> the recessed background with its associated drilled holes and the raised and carved surface—suggest that the purpose of this recessed zone, which surrounds the painted raised surface, was to hold a metal inlay that would have surrounded and outlined the painted surface [Conklin 1991:283].

Stones and Stone Fragments

The numerous building stones and stone fragments that litter the site have attracted the attention and admiration of travelers and scholars alike since recorded history. Only two, however, have actually studied them: Léonce Angrand and Alphons Stübel. Posnansky, in his passion for Tiahuanaco, has photographically recorded numerous stones, quite a few of which have since been lost. In our own research we have investigated many of the same stones that have been documented by our illustrious predecessors, not in an attempt to duplicate their work, but with an eye on the stone cutting and construction techniques.

Many of the stones scattered around Pumapunku and other parts of the site show a striking similarity to one another, both in design and in dimensions. Stübel and Uhle already speculated that the Tiahuanacans had a kit of standard building blocks from which they assembled the structures at Pumapunku (Stübel and Uhle 1892:Part 2, 38). We are tempted to agree. Our measurements, indeed, confirm that many stones are perfect replicas of each other. But, there are also some building blocks apparently identical in design that show significant dimensional variations. Such blocks could obviously not be exchanged one for another, as is the case in a true kit of building blocks. Yet, the strong similarities do indicate that there were repetitive features in the architecture, and that certain design principles and composition schemes prevailed. Other stones with identical dimensions and the same motifs but mirrored, show that some stones were executed in a left-handed and a right-handed version; for example, on some stones the "arrow" motif points to the left and on others to the right. This suggests that symmetry in architectural composition was important to the Tiahuanacan builders.

Standard Building Blocks

The following inventory gives a partial overview of the standard types of building blocks found mainly at Pumapunku. Some names of the stone types we derived from the motif found on them, their shape, or the stones' function.[5]

Type	1	H-stones (Figure 3.18)
	1.1	With plain back (Figure 3.19)
	1.2	With crossed bar on back (Figure 3.20)
Type	2	Sawtooth stones, left- and right-handed (Figure 3.21)
Type	3	Jamb stones
	3.1	Plain, without step molding, left- and right-handed (Figure 3.22)
	3.2	Plain, with step molding, left- and right-handed (Figure 3.23)
	3.3	With simple cross, without step molding, left- and right-handed (Figure 3.24)
	3.4	With simple cross and step molding, left- and right-handed (Figure 3.25)
Type	4	Lintel stones
	4.1	Plain, for gateway-like structures
	4.2	Plain, for niches, without dentils (Figure 3.26)
	4.3	For niches, with dentils (Figure 3.27)
	4.4	With recessed panel, plain (Figure 3.28)
	4.5	With recessed panel and simple cross (Figure 3.29)
	4.6	"Curved," with or without frieze (Figure 3.30)
	4.7	"Anticephaloid" (Figure 3.31)
Type	5	Niche jamb stones
	5.1	Simple, left- and right-handed (Figure 3.32)
	5.2	Double (Figure 3.33)
Type	6	Niche stones
	6.1	Single (Figure 3.34)
	6.2	Double, without dentils (Figure 3.35)
	6.3	Double, with dentils (Figure 3.14)
Type	7	Arrow stones, left- and right-handed (Figure 3.36)
Type	8	Lozenge stones, left- and right-handed (Figure 3.37)
Type	9	Circle stones, left- and right-handed (Figure 3.38)
Type	10	Slab with niche (Figure 3.39)
Type	11	"Escritorio" (Figure 3.13)
Type	12	"Bisected" stones (Figure 3.40)
Type	13	Niche icon stones
	13.1	Simple (Figure 3.41)
	13.2	Relief framed (Figure 3.42)
Type	14	Ornamental panels, left and right handed (Figure 3.43)
Type	15	"Reed" stones (Figure 3.44)

The list of types presented here is not exhaustive. There are, for example, innumerable conduit stones and plain ashlars strewn about everywhere at Tiahuanaco. We did not make a systematic record of the conduit stones because Tiahuanaco's elaborate canal system is so extensive that it calls for a separate research project. Furthermore, it is not possible to study this system without systematic excavation. The simple ashlars we left out because there was not much more information to be gained beyond what we gathered from studying them in the context of still remaining walls and structures. We also recorded a variety of either unfinished or odd-shaped, broken stones the uses and connections to other stones of which we could not identify, because they bear no clues, or the clues supplied are insufficient to make a determination. Among these are the

Figure 3.18. H-stone, front.

Figure 3.19. H-stone, plain back.

Figure 3.20. H-stone, cross on back.

Figure 3.22. Jamb stone, plain.

Figure 3.21. Sawtooth stone, left side is bottom of stone.

Figure 3.23. Jamb stone with step molding.

Figure 3.24. Jamb stone with cross, without step molding, upside down.

Figure 3.26. Lintel stone, plain for niches.

Figure 3.25. Jamb stone with cross and step molding (by Jean-Pierre Protzen).

Figure 3.27. Lintel stone, for niches with dentils.

Figure 3.28. Lintel stone with recessed panel.

Figure 3.29. Lintel stone with recessed panel and simple cross.

Figure 3.30. Curved lintel stone.

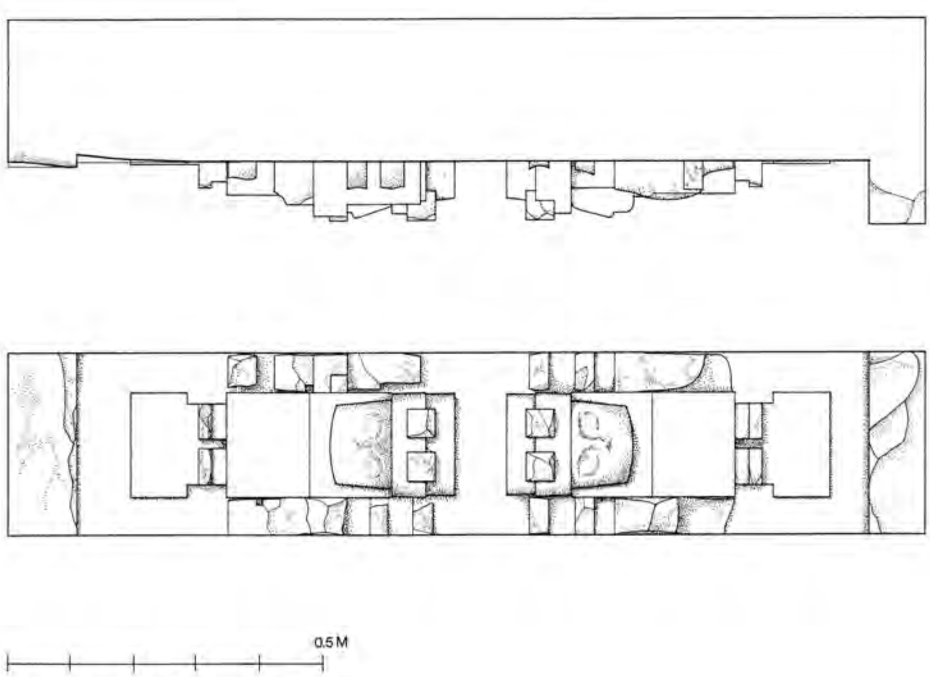


Figure 3.31. "Anticephaloid" lintel (drawing by Mireille Rodier).

Figure 3.32. Niche jamb stone, simple.

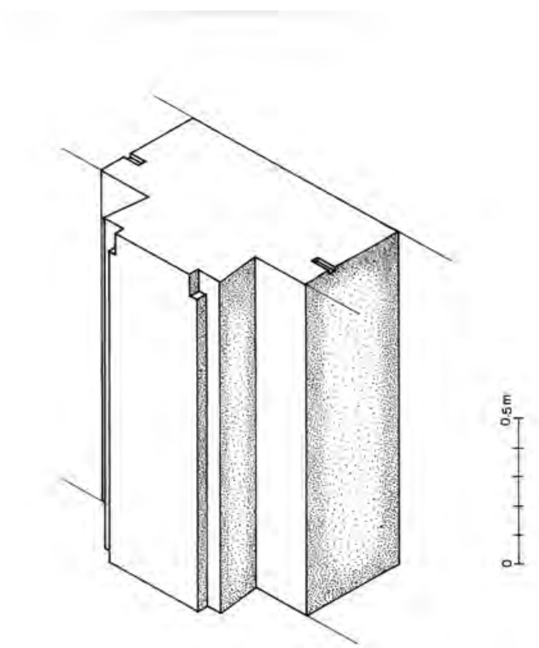


Figure 3.33. Niche jamb stone, double. (drawing by Jean-Pierre Protzen)

Figure 3.34. Niche stone, simple.

Figure 3.35. Niche stone, double without dentils. Niche stone, double with dentils (see Figure 3.14).

Figure 3.36. Arrow stone.

Figure 3.37. Lozenge stone.

Figure 3.38. Circle stone.

Figure 3.40. Bisected stone with rectangular niches.

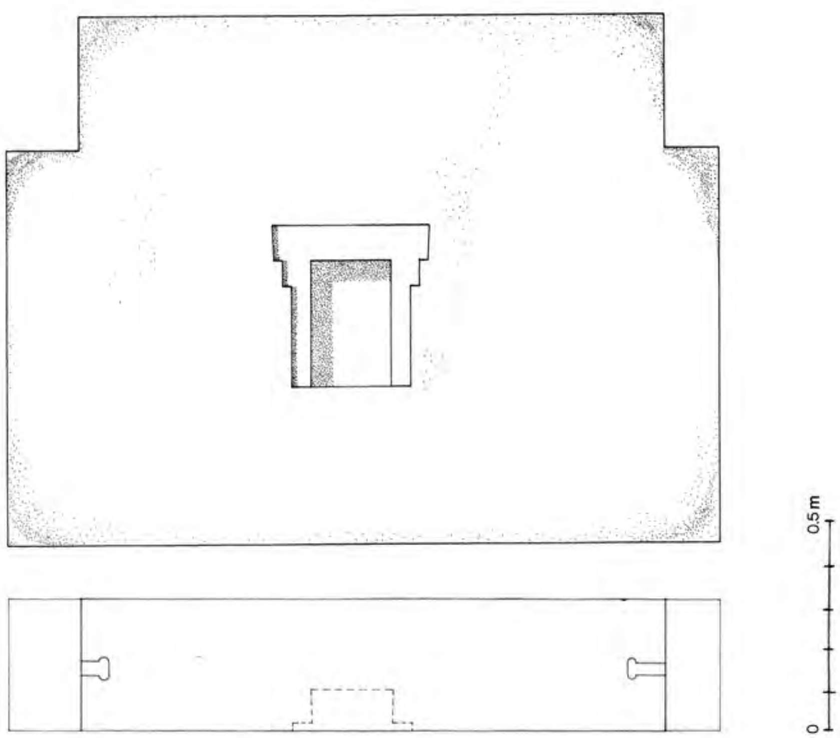


Figure 3.39. Type 10 stone: slab with Niche Icon (drawing by Eduardo Guerrero)

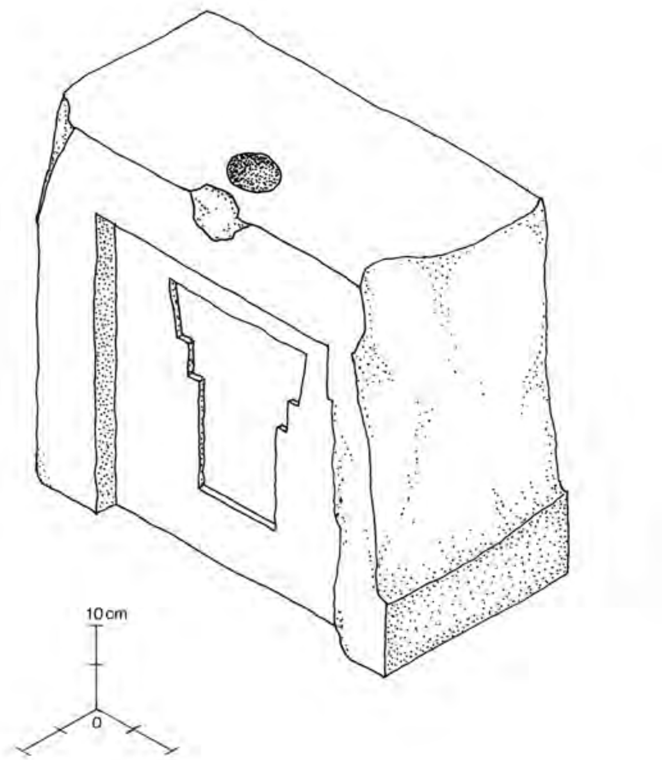


Figure 3.41. Niche Icon stone, simple (drawing by Jean-Pierre Protzen).

Figure 3.42. Niche Icon stone, relief framed.

Figure 3.43. Ornamental panels.

Figure 3.44. "Reed" stone.

Figure 3.45. Tub stones.

stones we dubbed "Tub Stones" (Figure 3.45). These stones, possibly, could represent double niche stones in the making; however, their dimensions do not fit the finished niche stones we have measured. The "Tub" stones and the undefinable stone fragments we also left out. The canal stones and simple ashlars, however, will receive some attention in Chapter 6 on construction, as will the "Reed," or Type 15, stones. All other types are illustrated and discussed below.

Other Stones and Stone Fragments

We measured yet many other stones of which we found only a single exemplar. Whether or not they, too, are representative of a type will remain unknown for now; further excavations may shed new light on that subject. Among the most significant of these solitary stones are a monolithic, blind miniature gateway, and two monolithic, open miniature gateways of different designs, the so-called "Little Pumapunku"[6] and what we have termed Gateway A, all at Pumapunku.

MONOLITHIC MINIATURE GATEWAYS

We identified two fragments that once formed a monolithic, blind miniature gateway, 48 cm wide and 95 cm high (Figures 3.46 and 3.47). From the front, these fragments have the appearance of a gateway set into the typical double stepped chambranle. Just inside the gateway there is a shallow space, 17.4 cm deep, the sides of which are adorned with a step molding at about a quarter of the space's height. A plain wall some 8 cm thick forms the back of the space. One might argue that blind gateways are not really gateways, but more closely represent niches. But niches are unlike gateways in their basic form. Cross-sections in plan and elevation reveal the

Figure 3.46. Right-hand fragment of Blind Miniature gateway.

difference: in the case of niches there is a smooth beveled transition from the opening to the back of the niche, whereas in the blind gateway there is a deliberate ceiling in the form of a recessed panel, giving a distinct hint of a room into which the opening leads that is absent in the niche.

Another two fragments form a small gateway, dubbed "small Puma Door" by Posnansky (1945 Vol. 2:137–139) (Figure 3.48). Apparently, both Angrand and Stübel found the Little Pumapunku still intact, measured, and drew it. Their respective drawings agree fairly well, with one exception: they differ significantly in the representation of the small window above the gateway. Angrand shows the window to be mushroom-shaped, flush with the outside of the gateway, and set into a rectangular recess on the inside (Prümers 1993:460, Figure 45). Stübel and Uhle show a detail drawing, as well as axonometric views of the inside and outside (1892:Part 1, Plate 36, drawing in text, and Figures 2 and 2a). When we

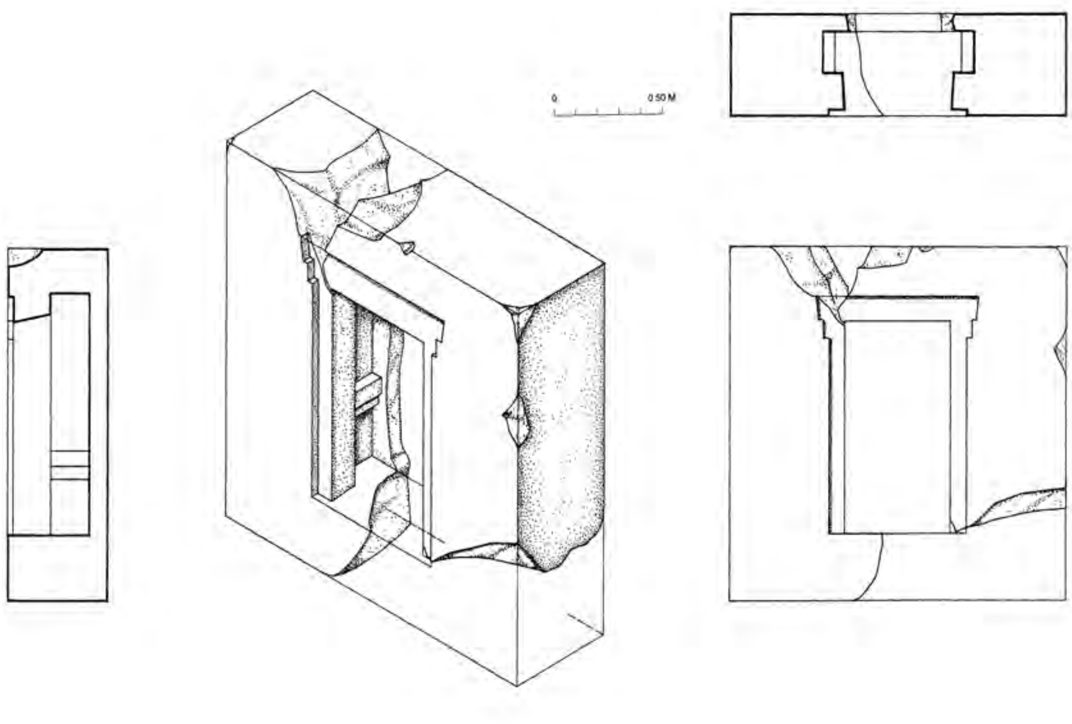


Figure 3.47. Blind Miniature Gateway, reconstituted with plan, section (drawing by Jean-Pierre Protzen, first published in *Journal of the Society of Architectural Historians*).

Figure 3.48. Little Pumapunku.

tried to reconstruct the window from these drawings we were not able to make the two sides agree; the window could not be built as drawn. Posnansky, who had the two pieces leveled and aligned, proposed a solution similar to Angrand's, with the exception that the stem of the mushroom is not simple, but stepped (Posnansky 1945:Vol. 2, 138). Key elements of the window are missing, such that we cannot reconstruct it with absolute certainty. However, based on the clues that are left, we come to the same conclusion as Posnansky (Figure 3.49). There is no evidence whatsoever for the "platelets" shown on the inside by Stübel, nor for the tympanum on the outside. Given the accuracy of Stübel's other work, we can only guess that the sketches of this particular detail got garbled between his initial field visit and the final publication of the work 15 years later.

Of another miniature gateway, Gateway A, there remain the right jamb and a fragment of the left jamb (Figure 3.50). As we will show later, there is a marked similarity between this gateway and the larger, full-sized gateways.

Assemblies

Many standard stones can be reconstructed into meaningful assemblies. As noted in the list of stone types above, many stones were executed in left and right-handed versions. This handedness, design details, and the puzzle-like partitioning of motifs, discussed above, and construction details, such as the cramp sockets, mortises, leverage notches, rope channels, and hoisting grips to be discussed in Chapter

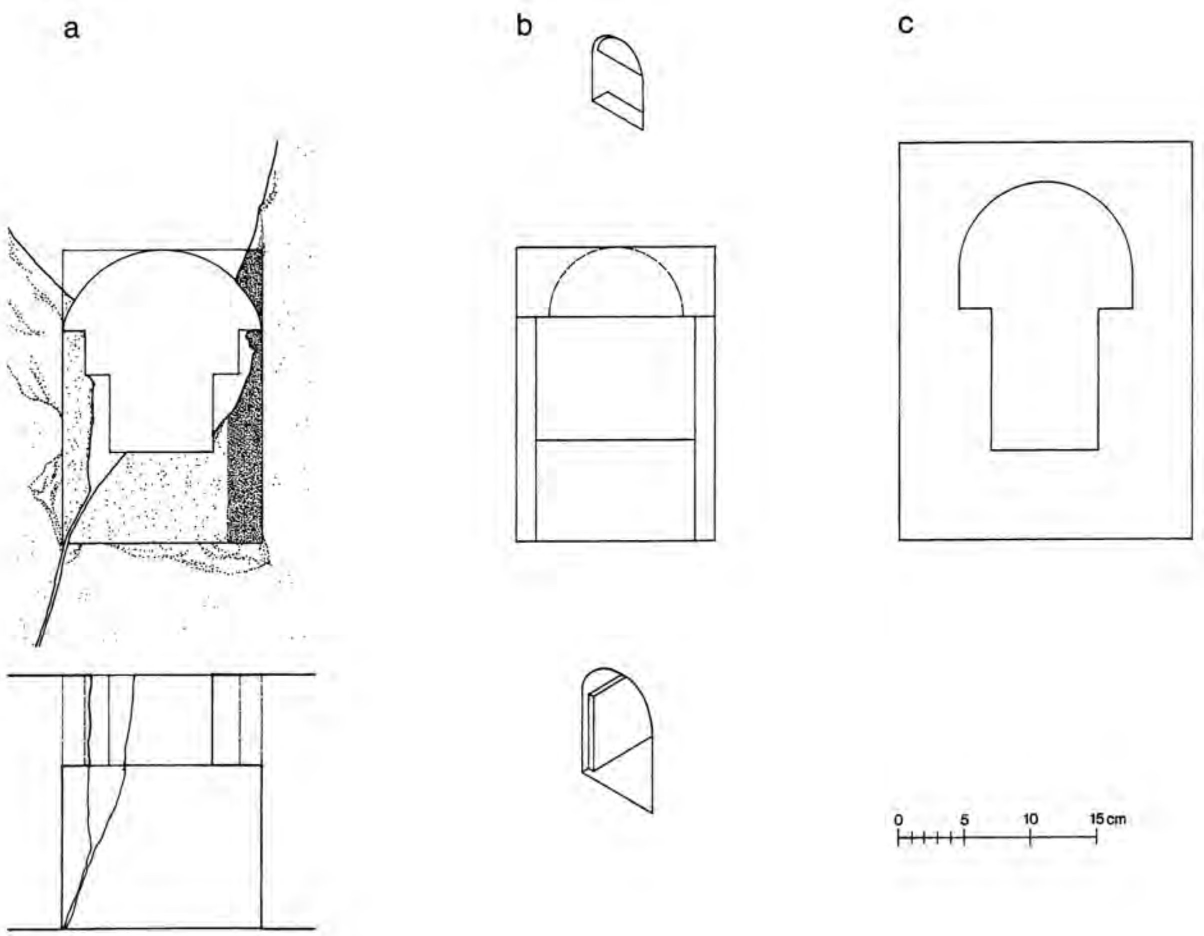


Figure 3.49. Our reconstruction of the Little Pumapunku's window: drawing by Jean-Pierre Protzen (a), compared to Stübel's (b), and Angrand's (c).

Figure 3.50. Miniature Gateway A.

6, provide clues to a block's orientation and position in an assembly, and to the shape and dimensions of immediately adjacent stones. In analogy to the ascendants of chambranles, stepped rabbets are oriented vertically, with the step at the top of the stone, and as gleaned from gateways, step moldings are oriented horizontally with the wider step above the narrower one. Cramp sockets of any shape, and mortises, are, as a general rule, carved out of horizontal planes, typically the top faces of stones. Leverage notches are found at the bottom edges of stones, rope channels are cut into the bottom and ascendant faces of stones, but never into their top face, and hoisting grips are always found at the shorter, lateral edges at the top of stones.

Type 7, or arrow stones are easily oriented because of their niche; the arrow is "flying" horizontally, and hoisting grips, cramp sockets and a mortise are found on the top face. Type 8, or lozenge stones, are trickier to position. There is only a single clue, a U-shaped cramp socket, which would indicate that the lozenge motif was facing up (Figure 3.51). Type 2, or sawtooth stones, are equally difficult to orient. Only one of the three exemplars has a T-shaped cramp socket from

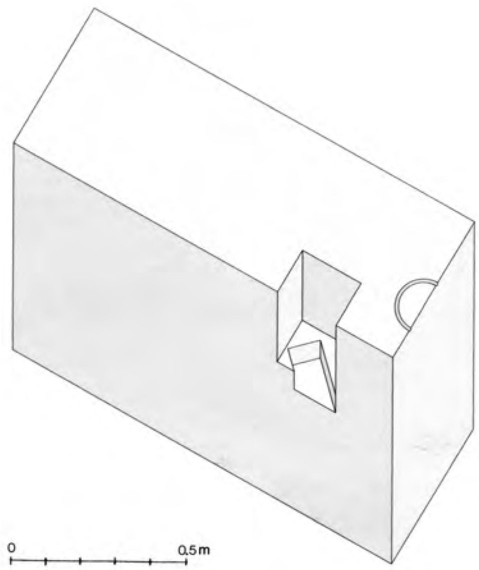


Figure 3.51. Lozenge stone (drawing by Heshang Liang).

which we infer that the stones were positioned with the prominent edges of the teeth laying horizontally and on the upper side.

Arrow and Niche Stones

The arrow stones most likely fit together with niche stones of Type 6.1 and 6.2. Several of these niche stones have exactly the same height as the arrow stones, and all their niches, which are of Type 2a, have the exact same measurements, and are open at the bottom (Figure 3.52). Either type, arrow or niche stones, exhibits the appropriate lateral cramp socket, suggesting that it was connected to other stones in the same plane as its face. Because the niches are open at the bottom, we surmise that the stones were set atop some other stones that would provide a base for the niches. In the case of the arrow stones we do not know how the triangular recess under the arrow would have been completed on the stones below. It is possible that the completed recess would have formed yet another Tiahuanaco motif. If we are right in our assumption that arrow stones were connected to niche stones, we can also contend, on the basis of the handedness of arrow stones, that the combination of arrow and niche stones must have formed symmetric compositions.

Niche Assemblies

Type 6 stones are relatively abundant. We recorded 13 within the ruins, but know of many more in the town of Tiahuanaco having caught glimpses of them in courtyards and people's houses. By analogy to the Gateway of the Sun and Type 11 stones, we infer that niches were sometimes arranged in horizontal rows. The various niche stones we have recorded all show cramp sockets appropriately placed to be connected to each other. Two particular niche stones attest that in some niche rows the niches were separated by dentils placed above the level of the transverse of their chambranles (Figure 3.53).

Niche jamb stones (Type 5), both simple, left- and right-handed (Type 5.1), and double-sided ones (Type 5.2), suggest that there had also been rows of larger niches (of Type 2b as discussed below). To complete the niches formed by these jamb stones there were niche lintel stones with or without dentils (Types 4.2 and 4.3). We found several such lintel stones, most of them broken into pieces. The lintel stones are easily identified by the transverse of the chambranle and the beveled recess, trapezoidal in shape, carved into them. The beveled recess forms the niche's "roof" (Figure 3.54).

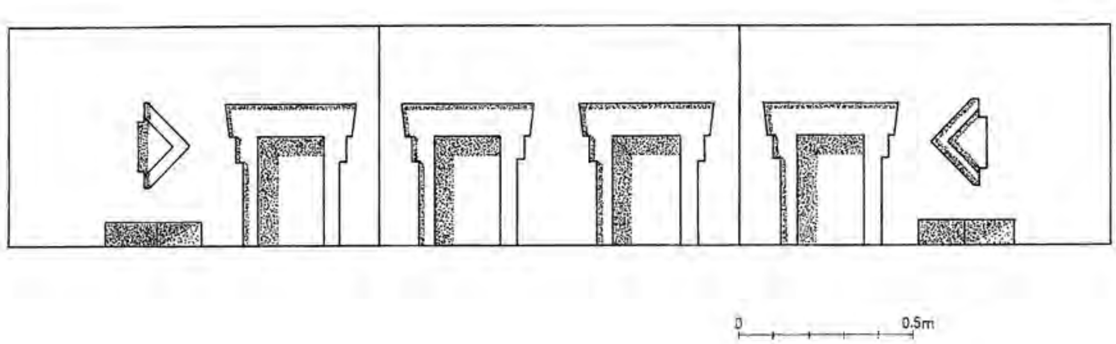


Figure 3.52. Hypothetical reconstruction of a combination of arrow and niche stones (drawing by Jean-Pierre Protzen).

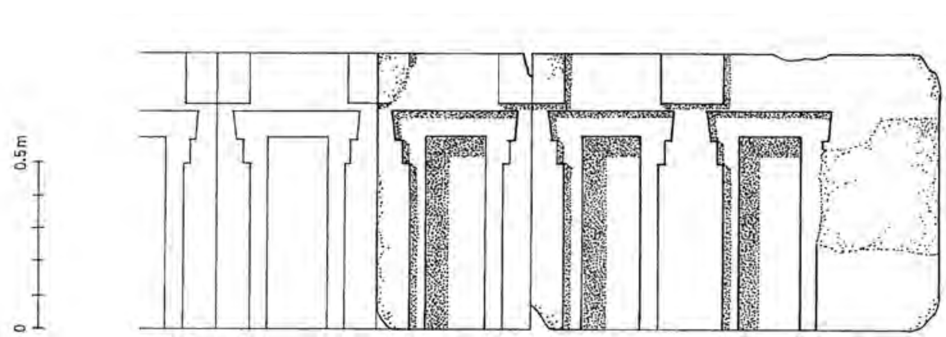


Figure 3.53. Niche row with dentils (drawing by Jean-Pierre Protzen).

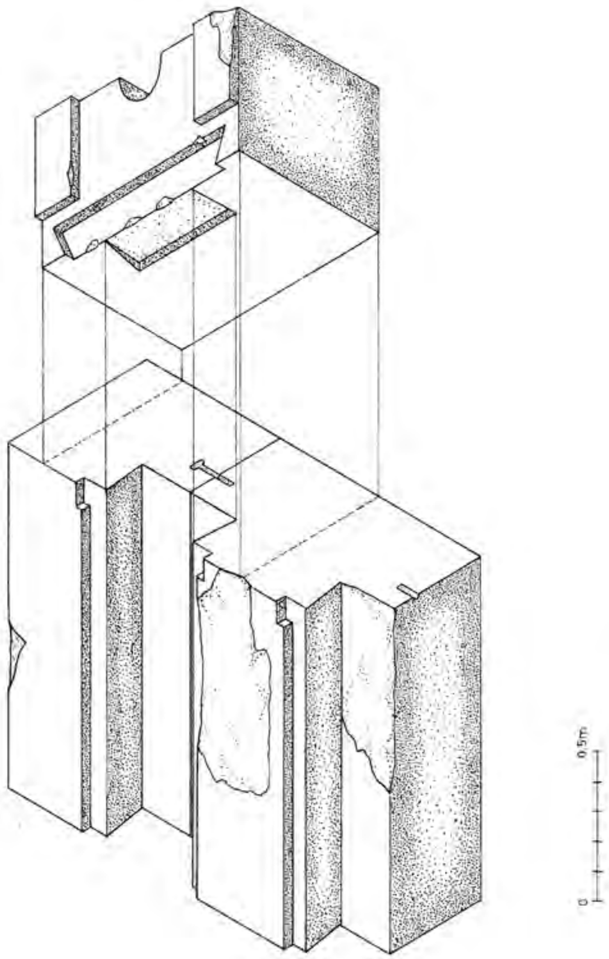


Figure 3.54. Niche jamb stones completed with lintel and dentils (drawing by Jean-Pierre Protzen).

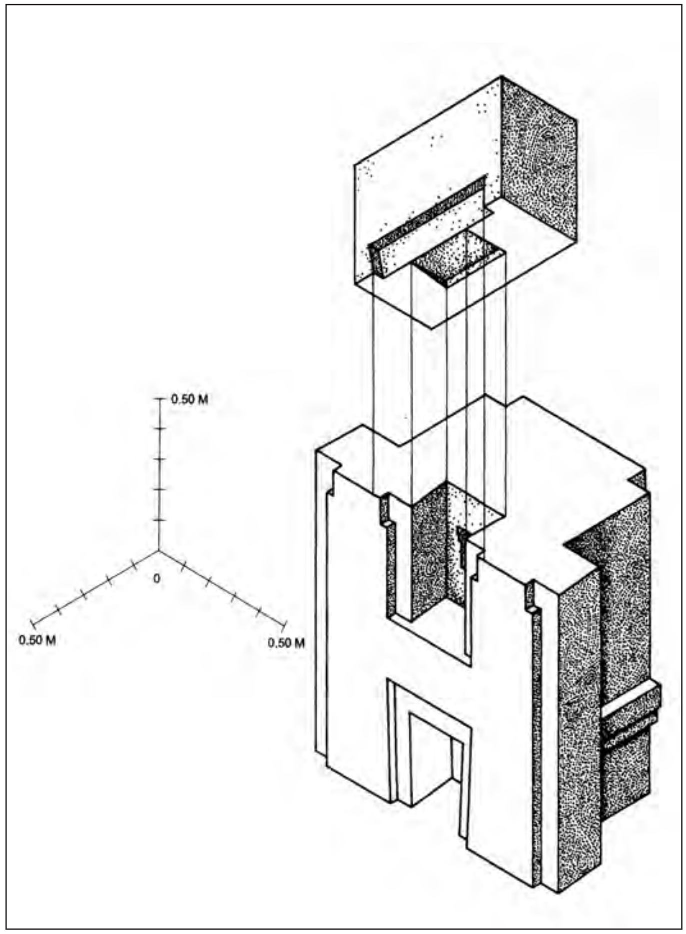


Figure 3.55. Niche lintel on H-stones (drawing Jean-Pierre Protzen, first published in *Journal of the Society of Architectural Historians*).

Similar lintel stones without dentils neatly complete the niches of Type 2a on H-stones of either Type 1.1 or Type 1.2 (Figure 3.55).

COMPOSITE MINIATURE GATEWAYS

Our "discovery" of the monolithic blind miniature gateway discussed above was crucial for our understanding and interpretation of other stones at Pumapunku. It made clear the use of stones with a recessed panel (Types 4.4 and 4.5)—the panel is the ceiling of the small space. It also gave us clues to the positioning of the step molding found on so many stones. For example, stone Types 3.2 and 3.4, executed in a right and left-handed version, feature a stepped rabbet on one side, beveled reveals, a step molding at about a quarter of their height, and a straight rabbet on the opposite side with the traces of T-shaped cramp sockets set at an angle. We figured these stones to be the jamb stones of blind miniature gateways. A plain stone slab fitted into the straight rabbets on the "back" side and anchored to the left and right-sided jamb stones with cramps, crowned with a suitably shaped lintel stone, with recessed panels, of Type 4.4 and 4.5, respectively, indeed combine to form composite blind miniature gateways, plain or decorated with simple crosses (Figures 3.56 and 3.57). A particularly impressive Type 4.4 lintel stone is used as a bench in the center of Tiwanaku's Plaza de Armas. On its front, this stone shows the complete transverse of the chambranle, including the upper step of the ascendants (Figure 3.58).

Stones of Type 1.1 with Type 1 and 2a niches, within which are carved the corresponding niche icons, completed with lintel stones of Type 4.2 and 4.4 appear to have composed a whole row of blind miniature gateways. All the details on the H-stones match such a reconstruction: beveled jamb reveals, step moldings, and rabbets with the appropriate T-shaped cramp sockets for the attachment of a stone backing (Figure 3.59). It should be noted that Stübel and Uhle had anticipated this very same configuration (1892:Part 2, 38), although they had not recorded any lintel stones. Another version of this reconstruction will be described below.

From Types 3.1, 3.3, and 4.1 stones and stone fragments, we infer that there were also composite open miniature gateways of both designs, plain and decorated with crosses. The corresponding jamb stones are thinner than in the above examples, have stepped rabbets on both sides, and typically lack both the step-molding and the straight rabbet to receive a backing. Correspondingly, the lintel stones show a bevel on their underside instead of the recessed panel of the blind miniature gateways (Figure 3.60).

Type 11 Stones

Two stone fragments, Fragment A (Figure 3.61) and the Five Niches Stone (Figure 3.62), bear similarities to the "Escritorio del Inca" (Figure 3.13), suggesting that there were more than one Type 11 stones. Cramp sockets on the upper faces of both, the Escritorio del Inca and the Five Niches, indicate that these stones once were connected to other stones. The partial crosses on the "Escritorio del Inca" call for completion, and indeed, on the top face of the stone there is a T-shaped cramp socket appropriately placed

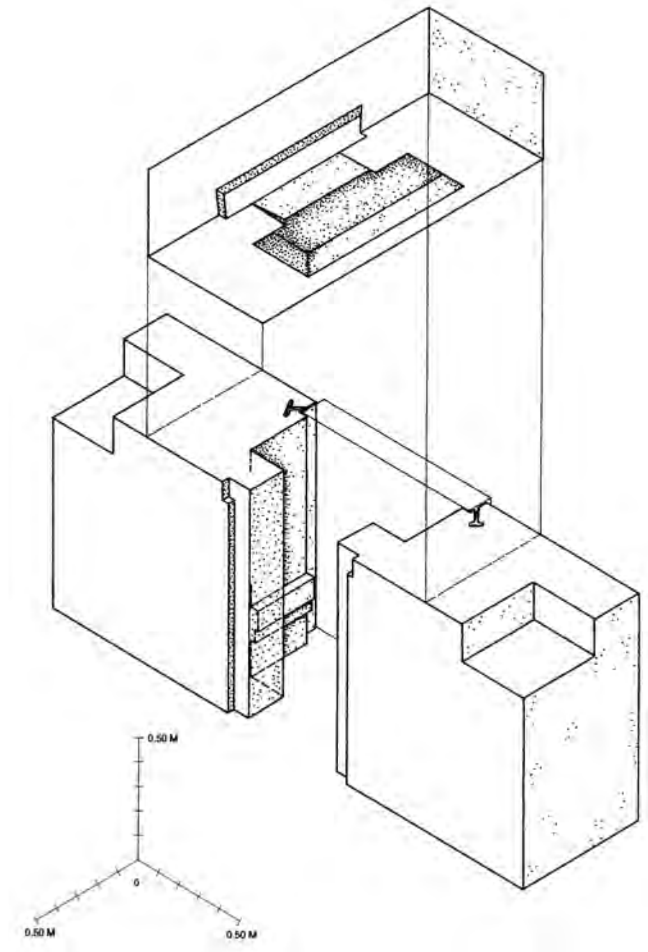


Figure 3.56. Plain Blind Miniature Gateway (drawing by Jean-Pierre Protzen).

confirming the addition of a stone. On the opposite end there is another T-shaped cramp socket oriented perpendicular to the stone's face. On the Five Niches stone, a U-shaped cramp socket suggests that another stone was attached perpendicular to its back side.

Circle Stones

Type 9, or circle stones are among the most complicated stones at Pumapunku. At first, we had only one exemplar that is so badly mutilated that we had no clue about its shape, orientation, or use. It was not until a second, better-preserved, exemplar was located, that we were able to reconstruct the circle stones' general appearance (Figure 3.63). The stepped rabbets clearly orient the stones with the step up, yet the U-shaped cramp socket belies this position. The rabbets, beveled reveals, and the stones' left- and right-handed versions

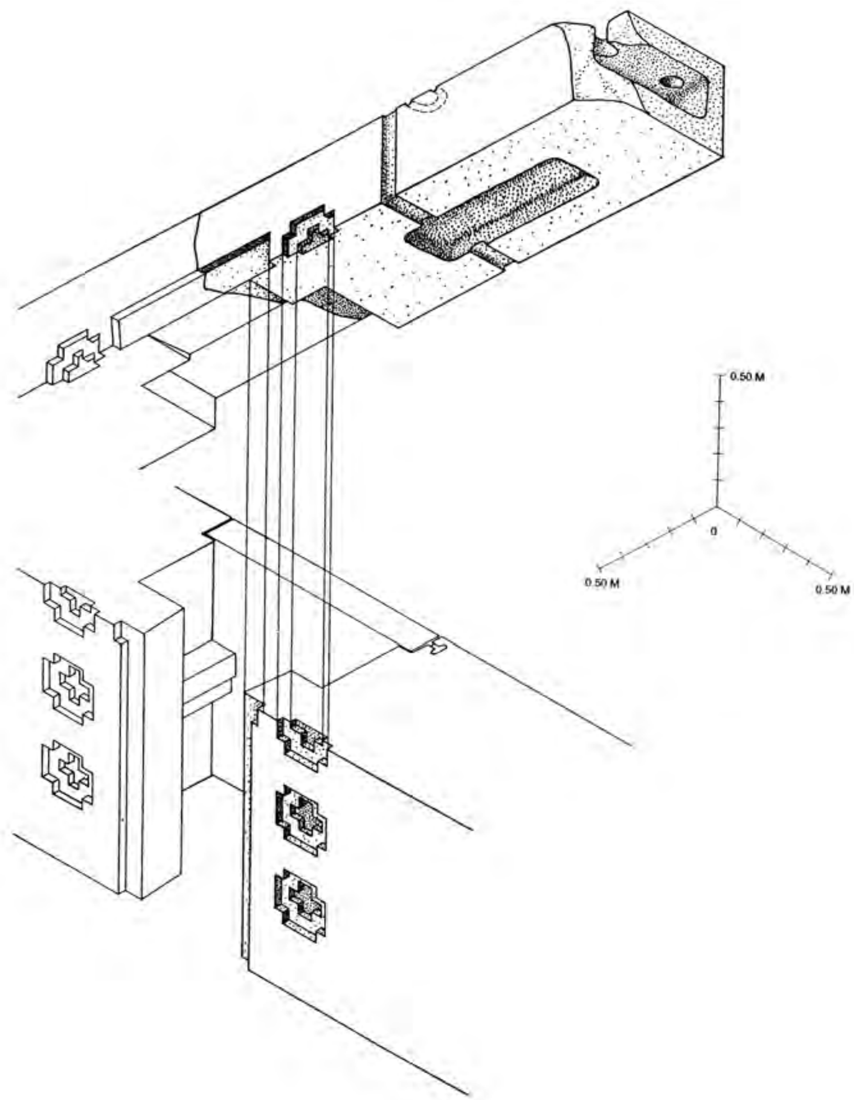


Figure 3.57. Blind Miniature Gateway with crosses (drawing by Jean-Pierre Protzen).

Figure 3.58. Lintel in town.

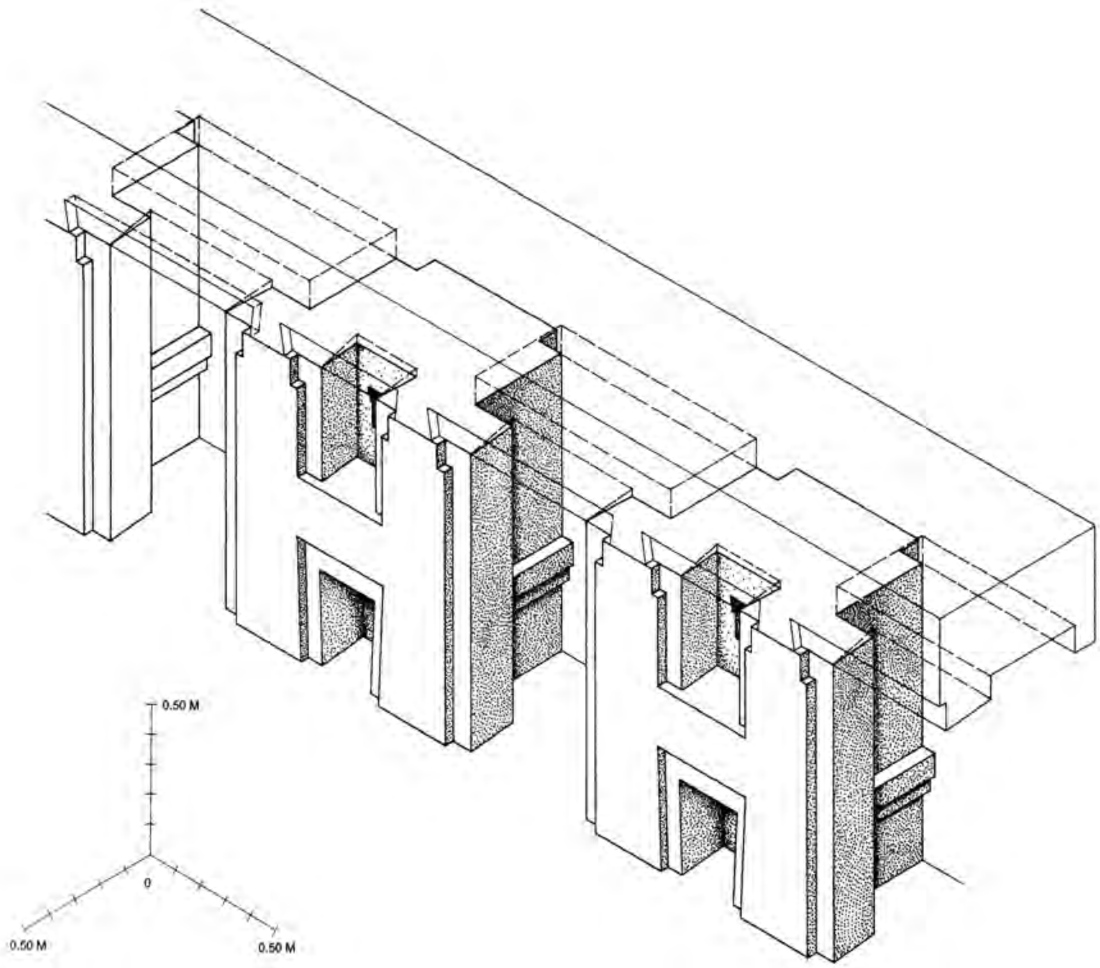


Figure 3.59. Row of H-stones (drawing by Jean-Pierre Protzen).

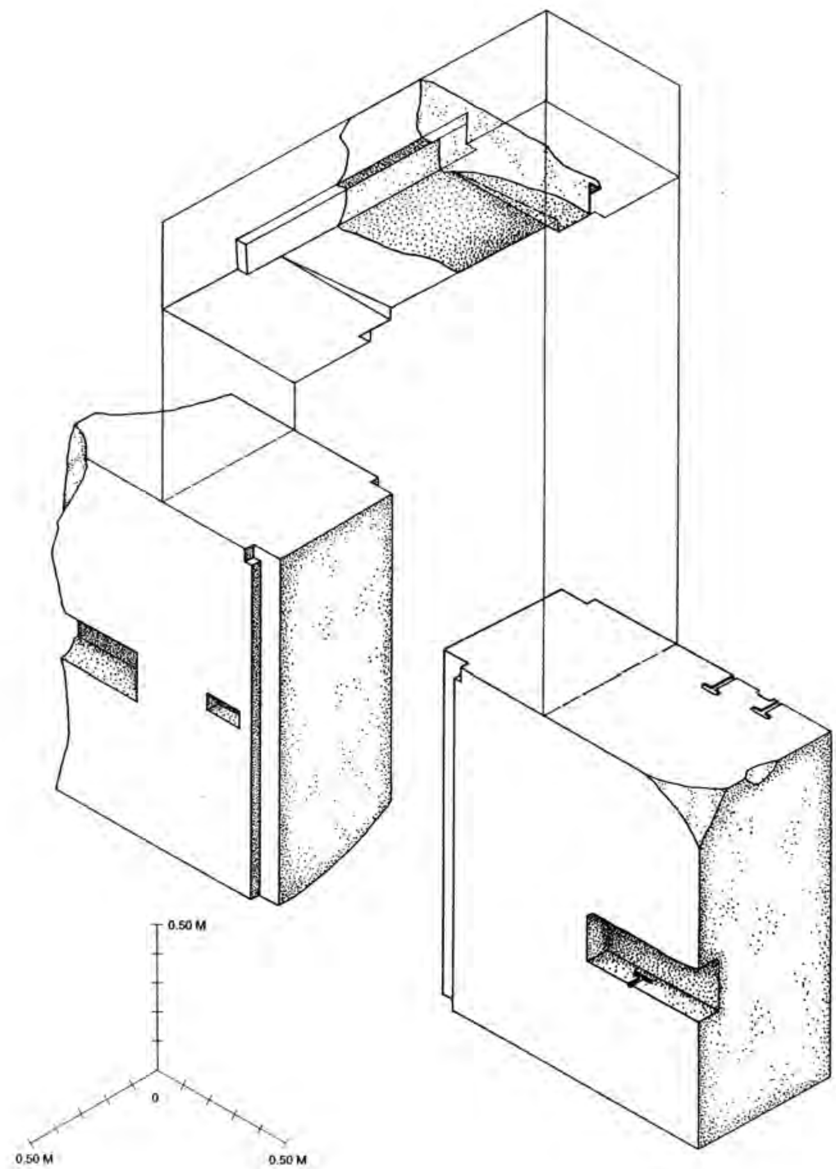


Figure 3.60. Open Miniature Gateway (drawing by Jean-Pierre Protzen).

Figure 3.61. Fragment A.

Figure 3.62. Five Niches stone.

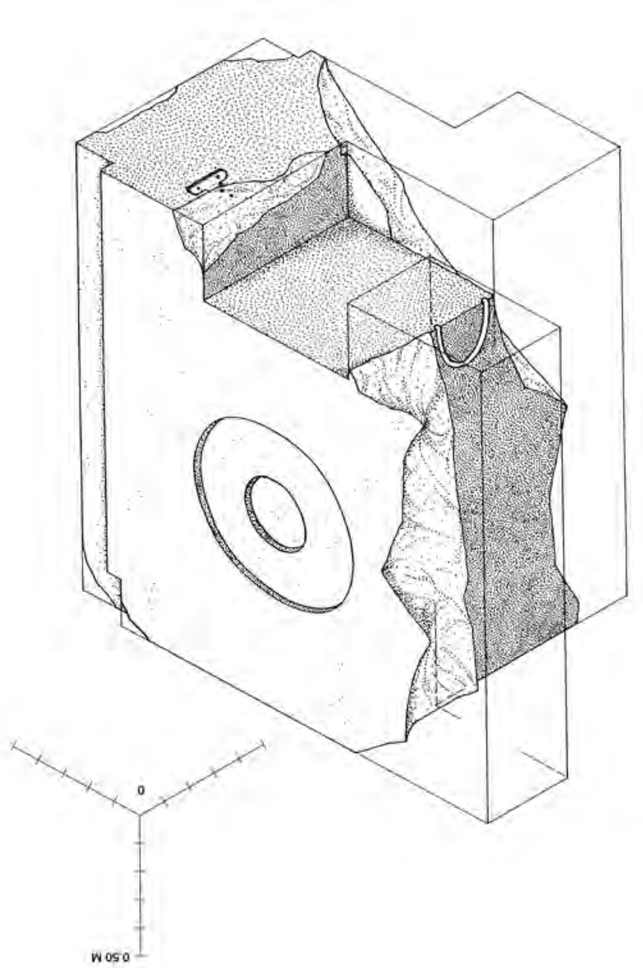


Figure 3.63. Circle stone (drawing by Jean-Pierre Protzen).

would identify them as jamb stones. We have created a separate type for them because we are unsure of their identity. The cut-outs and numerous cramp sockets with anchor pins at or near the bottom challenge one's imagination. The stones' use and immediate context still elude us.

Type 10 Stones

The slabs with niches and niche icons within, have shoulders cut out at the top at both ends. T-shaped cramp sockets indicate that other stones were resting on these shoulders and attached to the slabs (Figure 3.39). It is difficult to figure out how these stones were used. Were they lined up and joined to form a wall, or were there gaps between the stones bridged by stones of unknown shape but resting on the shoulders? Unless more stones of this kind are found, or stones that could be fitted to them, these questions will have to go unanswered.

Type 12 Stones

The two bisected stones (Figure 3.40) we found are very similar to two stones in a photograph by Posnansky of a portal built with reused stones in the town of Tiahuanaco (1945:Vol. 2, Figure 81). On our stones the bisecting bar at the center is rectangular, whereas on the stones in the photograph the bar ends in a point at the top. One of our stones has a T-shaped cramp socket oriented in the same direction as the stone's main plane, suggesting that it was part of a row of perhaps similar stones forming a band, or frieze. What relationship such a band or frieze may have had with the rest of the architecture we do not know.

Type 13 Stones

On the two simple niche icon stones (Type 13.1) brought to light in the 1996 excavation by Alexei Vranich, both of which are of sandstone, roughly cut, much eroded and mutilated, the icon consists only of the stepped outline, without the representation of the niche itself. We know very little about these stones, but based on another, isolated stone, we suspect that some niche icons had formed horizontal rows that turned corners. We know even less about Type 13.2, or relief-framed niche icon stones, of which we recorded two. One of these stones has two niche icons vertically aligned. The top icon is the typical double stepped Tiahuanaco niche outline, the lower is a simple rectangle. Both icons are surrounded by a double frame rendered in high relief. The other stone has only one niche icon with the same design and almost identical dimensions as the lower icon on the first stone. Stones exactly like the second are shown in the same photograph by Posnansky mentioned above (1945:Vol. 2, Figure 81). There one can appreciate that these stones were executed in a left and right-handed version. All three stones, ours and Posnansky's two, have the frames pushed right up to one edge, either left or right, of the stone. Because the same is true of the lower frame on our first stone, we believe that this stone must at one time have had its mirror image.

In that same photograph one finds still more simple niche icon stones. One, used as a lintel over the doorway, has two niche icons carved into it. Two more stones are flanking the "lintel" on either side. All these niche icons have the typical double stepped recessed chambranle. The portal Posnansky originally photographed was later dismantled and reassembled in a different configuration, which he also photographed (1945:Vol. 2, Figure 82). In this second photograph one can appreciate another niche icon stone sitting on the threshold of the doorway. We recorded a stone very similar, albeit much smaller, to the one in the picture. Both have rectangular niches within plain rectangular recessed chambranles.

Type 14 Stones

The most impressive ornamental panel features a beautiful, stylized puma face, delicately carved, as the center piece of an elegantly balanced composition of an abstract, slightly asymmetric geometric pattern (Figure 3.64).[7] This stone, found in 1933 "a few steps to the west of the building" by Rodas Eguino (Posnansky 1945:Vol. 2, 107, 225) was built into a wall at the Miraflores museum in La Paz when we last saw it. According to Posnansky, this stone once had its mirror image as a companion (Posnansky 1945:Vol. 2, Figures 143 and 145).[8] The latter, he wrote, was still in perfect condition and built into a house in Tiahuanaco in 1904, but had since been destroyed (1945:Vol. 2, caption to Figure 143). Yet we wonder, for there stands in the museum yard at Tiahuanaco today a rather eroded left-handed panel like Posnansky illustrated (Figure 3.65). We cannot

Figure 3.64. Puma Face from Miraflores.

Figure 3.65. Puma Face from museum yard.

be entirely certain, but it appears that this piece may be the one Posnansky thought destroyed. The eroded piece has several deep scars. Posnansky's photo is not very sharp, but we seem to detect two such scars on the museum yard piece in the very same spots.

Another panel with a geometric pattern similar to the "Puma Face" and carved with the utmost precision has as its centerpiece a squished oval ring ornamented with an incised meander and a sort of "head-dress" on top (Figure 3.66). John H. Rowe (personal communication 1997) suggested that the oval might have been inlaid to form a face similar to the faces found in the lowest register on the frieze of the Gateway of the Sun. Because of a slight asymmetry of this panel, similar to the asymmetry on the "Puma Face," we surmise that it, too, once had its mirror image. This panel of unknown origin was housed in an office of the museum complex at Tiahuanaco. In the same complex are the right- and left-handed pieces of yet another ornamental panel design. Only the right-handed piece is complete (Figure 3.67), the left one has been broken. Whence these two pieces came is not known. Neither piece represents a whole composition; both show at the top the bases of two niche icons that would have had to be completed on another stone. The symbol at the center of the panels is generally interpreted as a tail and is very common in Tiahuanaco iconography. The geometric configuration just below may be understood as part of the body to which the tail belongs. Because of the narrow border framing the lower part of the composition on the side of the complete niche icon, we do not believe that the two stones were joined directly; some other stone or stones probably came in between to complete what must have been a symmetric composition. We call these stones "panels" because they are relatively thin, 20 cm or less, and thus may have been used veneer-like on walls.

Figure 3.66. Squished Oval.

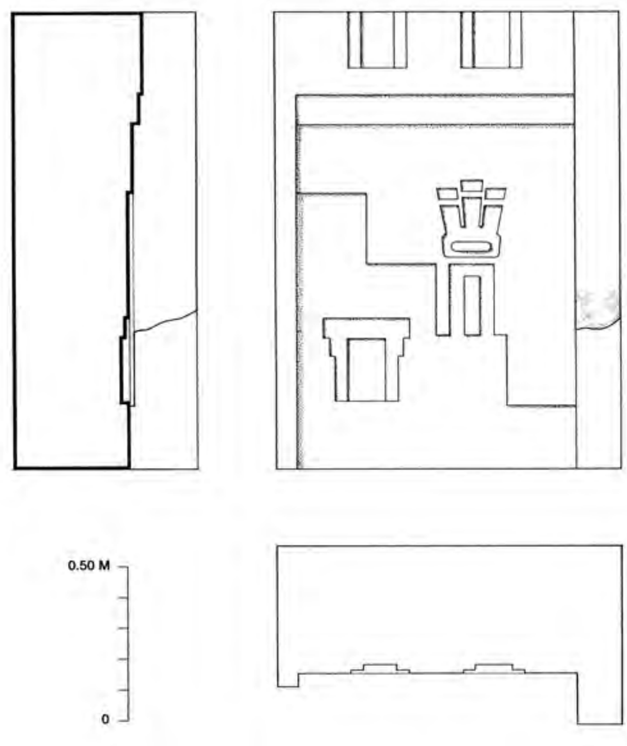


Figure 3.67. Ornamental Panel 2 (drawing by Jean-Pierre Protzen).

Full-Sized Gateways and Gateway Fragments

The known large gateways at Tiahuanaco are the Gateway of the Sun, the Gateway of the Moon, and the Sandstone Gateway. In addition to these gates there are fragments of several more gateways at Pumapunku. Most of these gateways and the fragments at Pumapunku have been previously documented by Angrand, Stübel and Uhle, and Posnansky. From the measured and drawn fragments of Pumapunku, Stübel and Uhle concluded that the fragments came from three distinct gateways (1892:Plate 29, Figures 29c and 29d). Posnansky thought that the fragments came from four gateways (1945:Vol. 2, 143–146). The piece that Posnansky believed to belong to the fourth gateway, Stübel and Uhle suspected to belong to Gateway I.[9] From the fragments, all of which are found clustered around the enormous sandstone slabs at Pumapunku, we reconstruct the same three gateways as Stübel and Uhle, Gateway I, II, and III, with confidence. Yet, as we will show, we found evidence of a possible fourth gateway.

All the above mentioned gateways have in common that they are (or were) monolithic, that is, cut from a single slab of stone, including the threshold, that the actual doorway openings are set into a double-stepped recessed chambranle on both sides, and that the reveals of the jambs and the door head are beveled, that is, they flare open to one side such that the opening of the actual doorway is larger on one side and smaller on the other. From this, and by analogy to niches, we infer that the side with the smaller opening is indeed the front or outside of the gateways, whereas the side with the larger opening is their back or inside. These communalities apart, each gateway has its own distinguishing features.

Gateway of the Sun

The Gateway of the Sun (Figure 1.68) is not only the best known of the gateways at Tiahuanaco, it is also the largest. The stone slab from which it was cut measures 3.82 m in width and more than 2.85 m in height. On the front side the gateway is crowned by a beautiful frieze, to be discussed below. The doorway is flanked on either side by a rectangular recess, or pocket—the function of which will be explained below (Figure I.01). Otherwise the front is plain.

The back side is divided by a step molding at about two-thirds of its height and which wraps around, or “roofs,” the doorway head (Figure 3.69), thus defining six distinct fields: one each on either side of the doorway below the step molding (LL—lower left—and LR—lower right), one each above it (UL—upper left— and UR—upper right), a field in the middle, the “wrap-round” area (C), and another just above

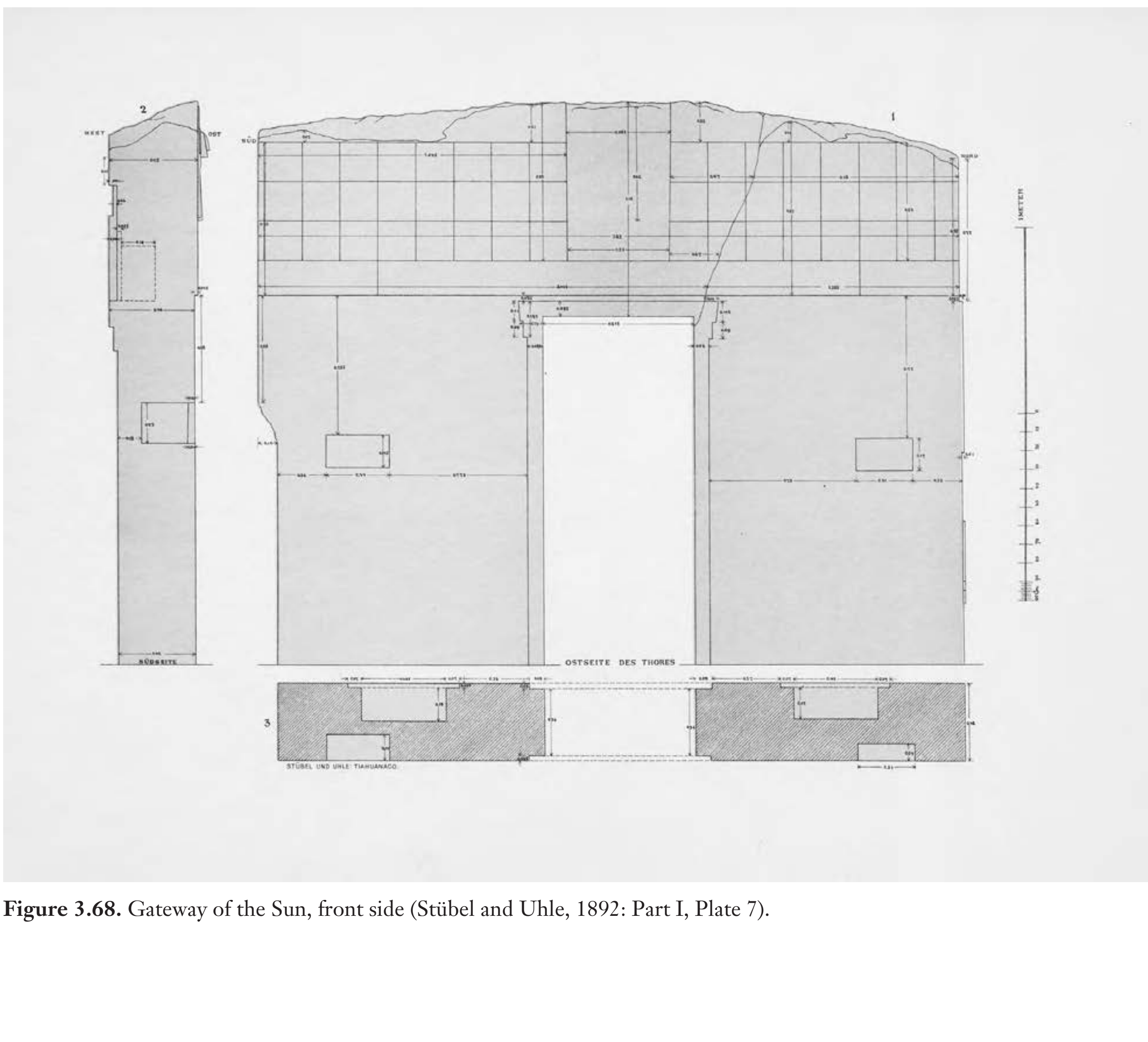


Figure 3.68. Gateway of the Sun, front side (Stübel and Uhle, 1892: Part I, Plate 7).

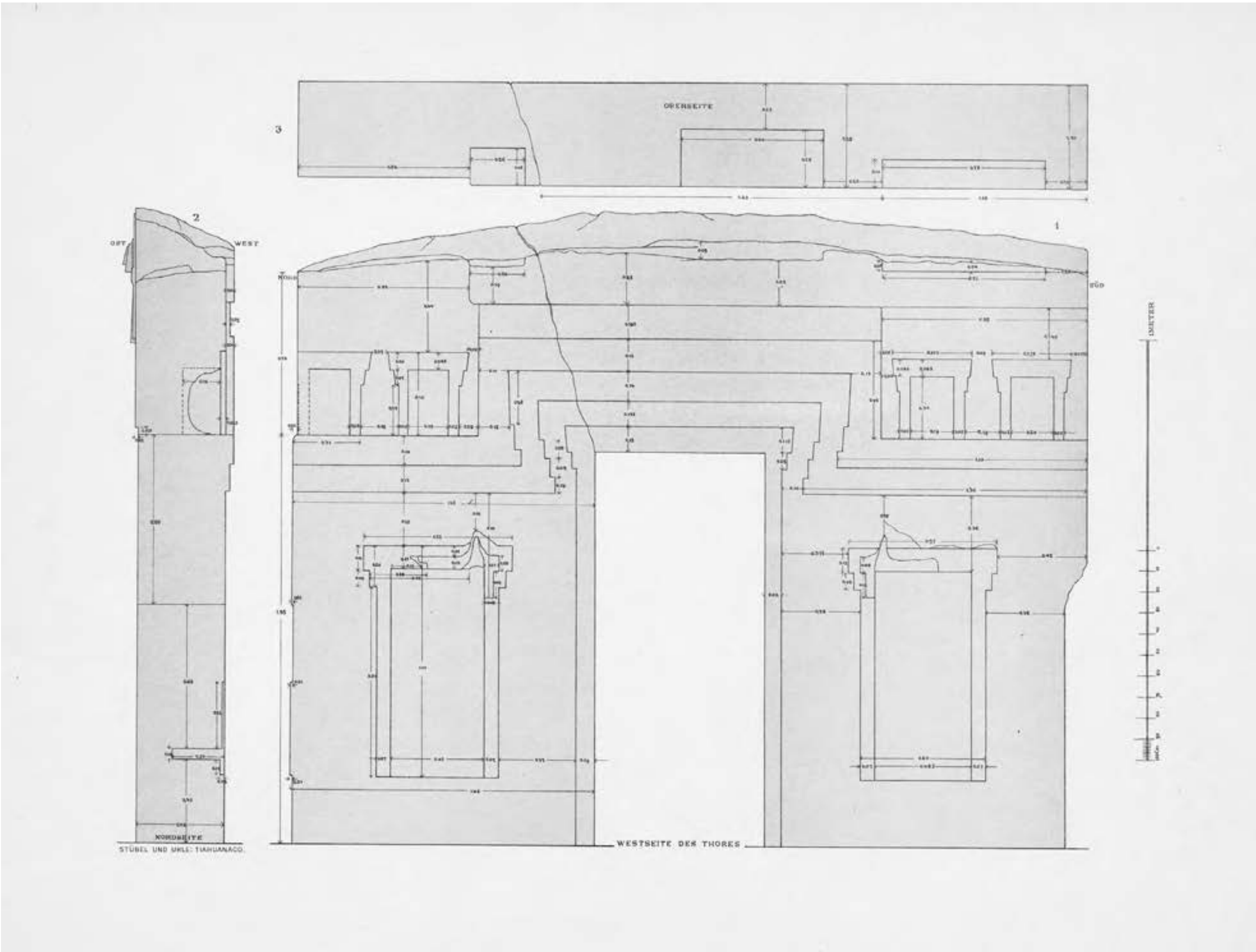


Figure 3.69. Gateway of the Sun, back side (Stübel and Uhle, 1892: Part I, Plate 6).

it (D) (Figure 3.70). The fields UL and UR contain two niches of Type 2a each, the fields LL and LR one niche each of Type 2b,[10] although the chambranle of the one to the far left is not complete; it would have to be complemented with another stone. The step molding wraps around the doorhead in a two-and-three-stepped fashion. One curiosity of this gateway is the asymmetry of its crown on the back side, for which we have no sensible explanation.

The Gateway of the Sun was never finished. One finds work in progress particularly at the top where one can observe roughly carved cut-outs. The two narrow sides of the gateway, too, show work in progress. This latter fact suggests that no stones were yet fitted to extend the Gateway's main plane in either direction and that the outermost Type 2a niche in the UL field was never completed. In other words, the Gateway of the Sun was not yet incorporated into any wall, building or structure, which leaves us guessing what its final destination and use would have been. Furthermore, the Gateway shows signs of later modification to be discussed in detail below.

What makes the Gateway of the Sun truly stand out is the elaborate and beautifully frieze on its front focused on a central figure holding a staff in either hand (Figure 3.71). Yet, as Stübel and Uhle already observed there are discrepancies in the execution of the of the frieze. The central portion with its fifteen fields in three rows and five columns to the left and right of the central figure, and the meander just below, are expertly carved with the utmost care and precision. The nine fields on the left, and the six and three half fields on the right end with their corresponding meander, are rather crudely cut: "Alle Theile des Reliefs, welche links und rechts darüber hinaus liegen … sind nicht allein unvollendet, sondern—und dies

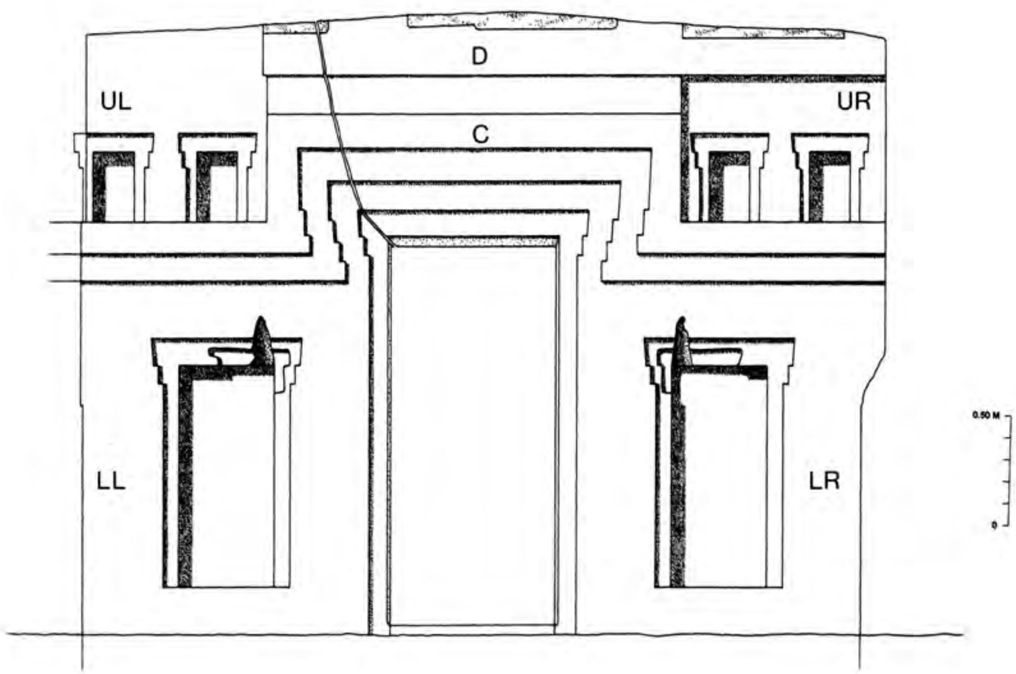


Figure 3.70. Gateway of the Sun, back side with fields (drawing by Jean-Pierre Protzen).

Figure 3.71. Frieze of Gateway of the Sun.

ist das Wichtigste—technisch mangelhaft und den vollendeten Theilen nicht entsprechend" (Stübel and Uhle, 1892:Part 2, 26). (All parts of the relief, which reach beyond [the central part] to the left and right … are not only unfinished, but—and this is of utmost importance—technically flawed and not comparable to the completed part [translated by authors].)

In their remarkably thorough and detailed analysis of the frieze's many different motifs and parts Stübel and Uhle made a convincing case that the peripheral sections are not the outlines of finer work yet to be done, but rather represent the work of epigones who had neither the technical skills nor the aesthetic talent of their predecessors (1892a:Vol. 1, Part 2, Plates 8–20). In particular, Stübel and Uhle have shown that the figures and ornaments in the peripheral sections show "errors" that could not possibly be repaired in a presumed final carving stage. Of the meander bands at the bottom of the frieze (Figures 3.72 and 3.73) Uhle wrote:

> Während die Verzierungen des mittleren Mäanders die schönste Ebenmässigkeit, die genauste Geradigkeit und den saubersten rechtwinkligen Zusammenstoss der geometrischen Linien zeigen, ist bei den Wiederholungen überall das Gegentheil zu bemerken. Schiefe Winkel, krumme Linien und Ungleichmässigkeit der Verhältnisse machen sich überall geltend. Der technische Abstand zwischen dem mittleren Mäander und der Seitenstücken ist ein so beträchtlicher, dass es unmöglich scheint, den Verfertigern des erstern auch die Wiederholungen desselben zuzuschreiben [Stübel and Uhle, 1892:Part 1, Plate 17].
>
> While the ornaments of the central meander exhibit the most beautifully balanced proportions, the most precise straightness and the cleanest right angle connections of the geometric lines, one notes the opposite everywhere in the repetitions. Oblique angles, crooked lines, and unevenness of proportion are predominant everywhere. The technical distance between the central meander and the lateral pieces is so considerable that it seems impossible to attribute the repetitions to the makers of the former [translated by authors].

Posnansky, who considered the peripheral sections to be original work in progress, took issue with Stübel and Uhle's *Die Ruinenstätte von Tiahuanaco*…, and in particular dismissed all that Uhle wrote:

Figure 3.72. Good carving (Robert Batson).

Figure 3.73. Bad carving (Robert Batson).

> Repleto de errores como los capítulos que acabo de criticar, está toda la obra de Uhle, así es que en cada página puede uno llevar ad absurdum al incalificable criticón de Uhle (Posnansky 1913: Page IV). (As replete with errors as the chapters that I just finished critiquing is the entire work of Uhle, such that on every page one can reduce ad absurdum the reprehensible faultfinder Uhle [translated by authors]).

Posnansky's arguments and the whole controversy could safely be ignored, if it were not for the fact that his ideas have influenced many scholars. Yet understanding whether the low relief images on the Gateway of the Sun were meant to be a single design or an original with a later addition is crucial in understanding how to interpret the iconography. If the images were created as Posnansky believed them to be, such that a single, original design was meant to cover the entire upper face of the monolith and that design had been executed in phases (such that the last phase was interrupted before its completion) one must examine all the iconography together. But, if the images were carved as Stubel and Uhle argued, then only the central portion of the design was original, and the side elements were added later. Hence one must read the central portion as a distinct composition that first functioned as a contained unit and later as the central portion of a larger design. Which assumption one makes dramatically changes the interpretations of the iconography, as most of these arguments are based on the number of elements and their calendrical associations.

In our own re-examination of the frieze we noted that not only are there differences in the quality of execution, but also significant differences in the carving technique, which further support Stübel and Uhle's findings. We will return to this topic in more details in Chapter 5. We also noted formal incongruities in the composition of the frieze. It is clear from the evidence that the middle section of the frieze was conceived as a whole, complete in itself. This is indicated by the meander in the lowest register with its obvious endings on either side, which underline the central section's symmetry already indicated by the figures in the upper registers converging on the central figure. The additional meanders, left and right, with their new beginnings, and the rough figures facing away from what should be a new axis of symmetry, upset the logic of the design and the balance of the middle section. Or as Uhle wrote: "Die unvollendeten endigenden Theile des Reliefs vermehren in keiner Weise den inhaltlichen Wert deselben. Man möchte sagen:—sie beuten ihn aus" (Stübel and Uhle, 1892:Part 2, 26). (The unfinished end parts of the relief in no way augment the value of the content of the latter [i.e., the central part]. One is tempted to say that they exploit it [translated by authors].)

It should be noted that the peripheral, or so-called unfinished parts, are in themselves incomplete, which is particularly obvious on the right side with the half figures. The authors of the peripheral sections understood that the Gateway of the Sun was originally intended to be part of an extended wall as suggested by the incomplete niche on the far left of its back side and thus tried to maintain at least part of the mindset that first conceived the gateway. One only wonders how far the new meanders would have been extended, how many figures they would have embraced and what kind of new symmetry was intended. The formal closure of the central part of the frieze does not yield any clues to these questions, which may be a further indication of a discontinuity between the original design and the later additions.

On the Gateway of the Sun's back-side one observes an attempt at modifying the stepped chambranle around the Type 2b niches in the LL and LR fields (Figure 3.74). These modifications also exhibit a distinctly different craftsmanship, which prompted Stübel and Uhle to attribute them to the same inexperienced hands that carved the peripheral sections of the frieze. What the intention of this modification may have been is difficult to imagine.

Figure 3.74. Modification of chambranle on back side of Gate of the Sun.

The Pumapunku Gateways

Among the myriad of stones and stone fragments scattered around the vicinity of Pumapuku's Platform Area there are several fragments, equally scattered, that testify to the former existence of other gateways. Stübel identified the fragments of three additional gateways; Posnansky thought there were four. These gateways at Pumapunku show a distinct affinity with the Gateway of the Sun in their general appearance. They have a step molding wrapping around the door head and dividing the back side into four fields (LL, LR, UL, and UR) with their respective niches. On the front they show the same pockets on either side of the doorway, but they either lack the frieze or else it is a much more modest one. They also were cut from somewhat smaller slabs, about 3.3 m in width and 2.45 m in height. Like the Gateway of the Sun, the Pumapunku Gates were unfinished; they all show work in progress.

GATEWAY III

Of Gateway III Stübel[11] recorded its left jamb (seen from the front) with most of the doorhead still attached (Stübel and Uhle 1892:Plate 29, Figure 1). This stone has since been broken into two pieces. Yet, more fragments of this gate are found scattered around the Platform Area. Apart from its threshold, it is the broken gateway that most accurately can be reconstructed. The width of its doorway can be precisely calculated to 77.4 cm on the outside thanks to the incised meander frieze it features on the front above the doorway (Figure 3.75). The constituent

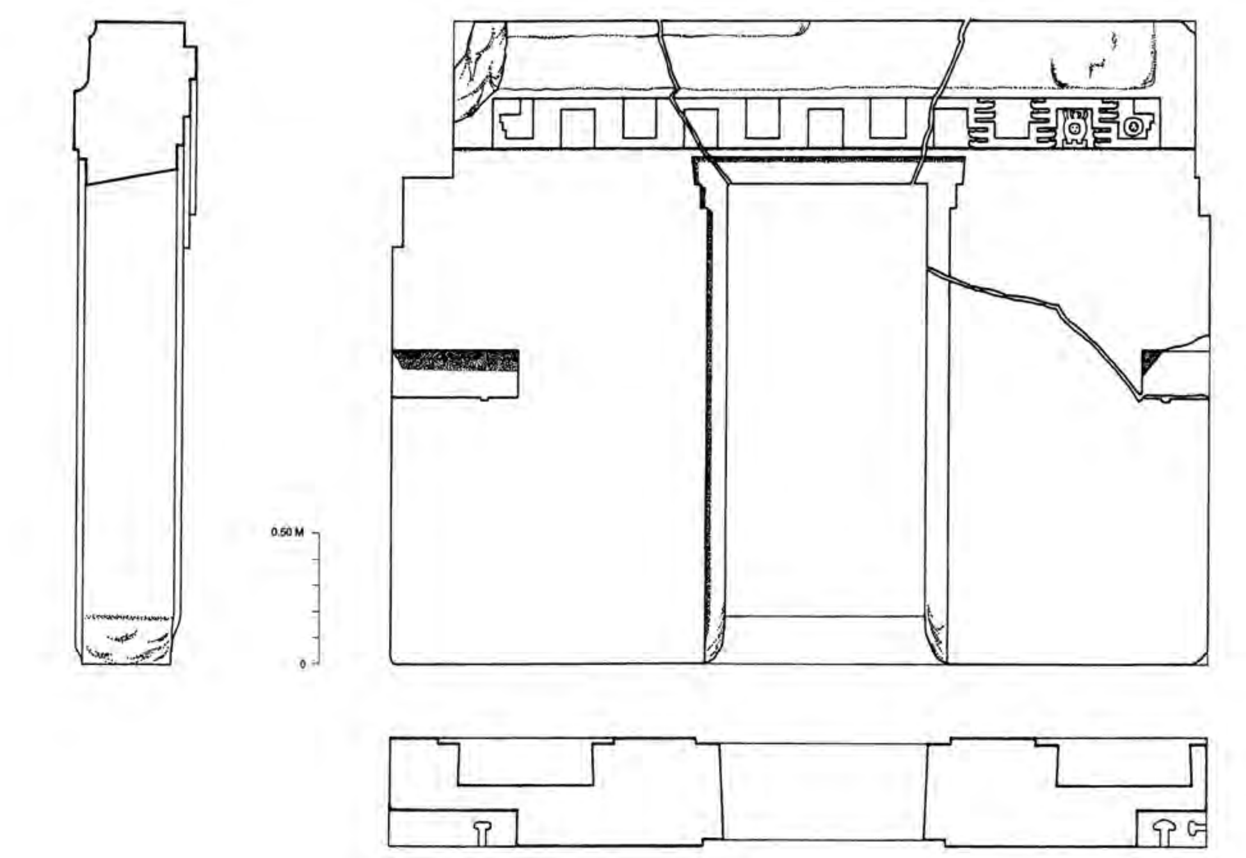


Figure 3.75. Gateway III, front (drawing by Jean-Pierre Protzen, first published in *Journal of the Society of Architectural Historians*).

parts of the frieze are repeated with such regularity, that it is easy to reassemble it with great accuracy in spite of obliterated or shattered sections. The height of the doorway opening can be directly measured on the remaining jamb pieces, from the door head to the traces of the broken off threshold.

On the back side, the step-molding roofs the head of the doorway in triple-stepped fashion (Figure 3.76). The gate's back-side indicates that gateways, although monolithic, were not whole compositions in themselves, for the chambranle of the Type 2b niche in field LL is *not* complete. This chambranle would have had to be complemented by another building stone attached to the gateway. Several recessed and plain T-shaped cramp sockets on the narrow sides of the stone slab do in fact suggest that other building stones were meant to be attached to the gateway, thus prolonging the monolith in the plane of the gateway. The rectangular recessed pockets on the gateway's front side also have T-shaped sockets arranged perpendicular to the main plane of the gateway, indicating that more building blocks were added to the gateway perpendicular to it and flanking the doorway on either side.

Gateway III was not quite finished. The long recess above the frieze has only been roughed out and shows signs of work in progress.

Gateway II

Stübel recorded two pieces of this gateway the left jamb, again with part of the doorhead, or lintel, intact and a fragment of the right jamb (Stübel and Uhle 1892:Plate 28, Figures 1, 1a, 1b, and 1c). The part of the doorhead on the left jamb has since been broken off. However, we identified at least three more pieces for Gateway II than have been recorded by Stübel. This gateway is nearly complete, all that is missing is a piece of its lintel. A stone fragment at Pumapunku that came from a door head raised our hopes that we may have found the missing piece. While it matched Gateway II in overall dimensions and configuration, there is a small, but significant, detail that is missing:

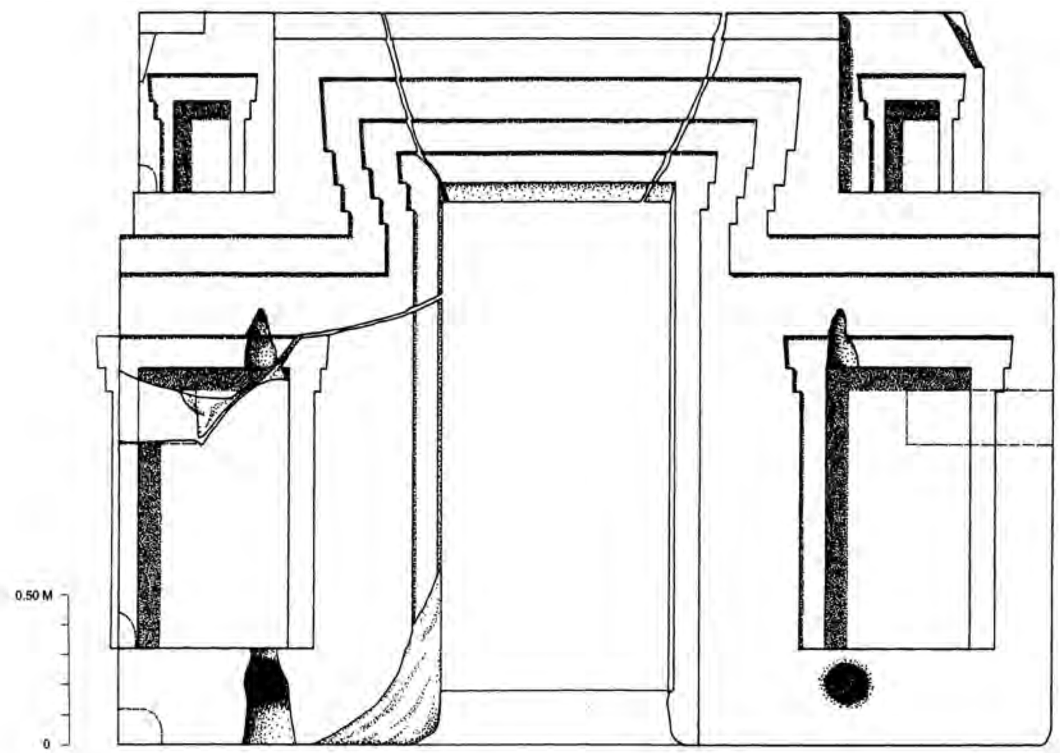


Figure 3.76. Gateway III, back (drawing by Jean-Pierre Protzen, first published in *Journal of the Society of Architectural Historians*).

the intact fragment of Gateway II's lintel shows that on its front, right above the chambranle's transverse and defining it, there is a narrow molding, 3.6 cm high, and 3 cm deep—the depth of the recessed chambranle —, that does not appear on the surmised lintel piece. Because this piece does not fit any known gateway we postulate the previous existence of a fourth gateway, of a different design, at Pumapunku.

Gateway II is very similar to Gateway III in general appearance; it differs from the latter in two aspects. First, it has niche icons on the jamb reveals, a feature that is unique to this gateway (Figure 3.77). Second, it does not have a meander frieze. Instead, where the frieze is on Gateway III, Gateway II has three narrow ledges stepping back (Figure 3.78). On these ledges one finds tiny T-shaped cramp sockets regularly spaced, suggesting perhaps that some ornamentation was attached there in lieu of an incised frieze (Figure 3.79). Incidentally, such tiny cramps are also found on the ledges of the surmised fourth gateway lintel fragment. Like on Gateway III, the inside door-head of Gateway II is roofed with a triple-stepped step-molding, and like Gateway III, Gateway II has T-shaped cramp sockets of all kinds in similar places as Gateway III, and thus may have been meant to be set into a similar context (Figure 3.80).

GATEWAY I

Two stones, the right jamb and a fragment of the left jamb—the same pieces as recorded by Stübel (Stübel and Uhle 1892:Plate 29, Figures 2, 2a, 2b, 2c, and 2d)—define this gateway. The left jamb fragment that Posnansky believed to be a part of a fourth gateway, and Stübel and Uhle suspected belonged to Gateway I, we positively identified as the left[12] jamb of Gateway I, or at least of one exactly like it (Figure 3.81). On this gateway's back side, the step molding roofs the doorway in two steps, not three as on the previous two gateways. As a consequence, the various fields on this gate's back side have slightly different dimensions and so do its Type 2b niches. It is this slight variation in the Type 2b niche that lets us associate

Figure 3.77. Gateway II niche icons on jambs.

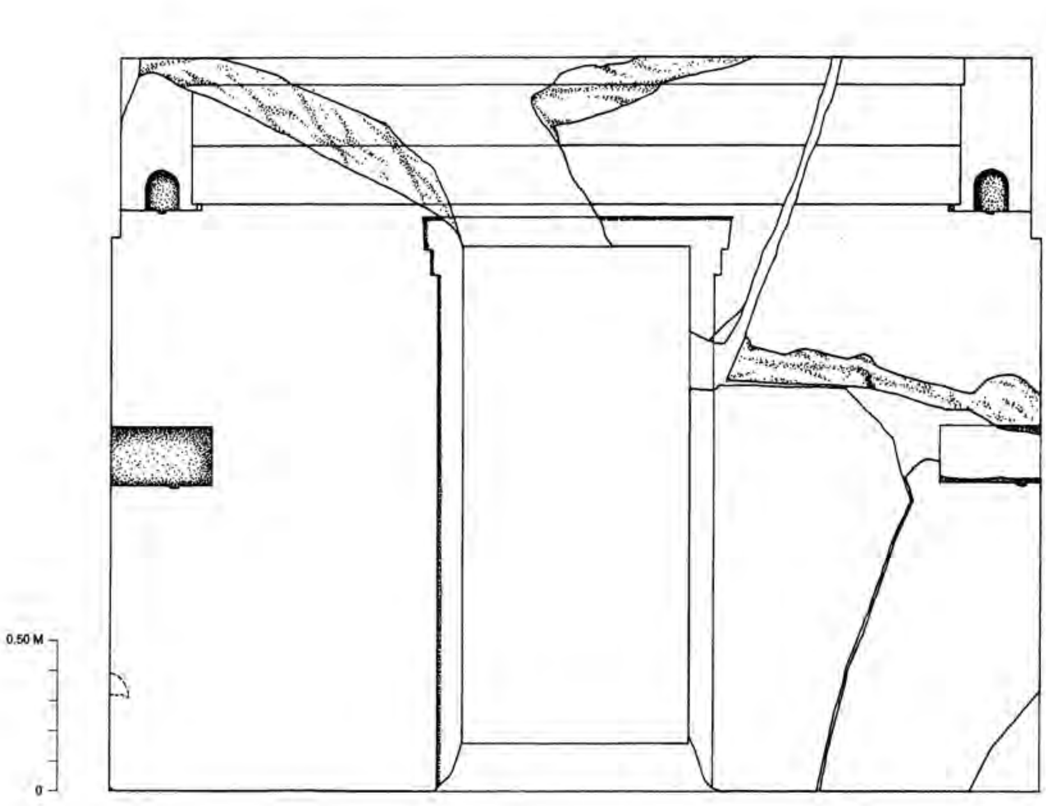


Figure 3.78. Gateway II, front (drawing by Jean-Pierre Protzen, first published in *Journal of the Society of Architectural Historians*).

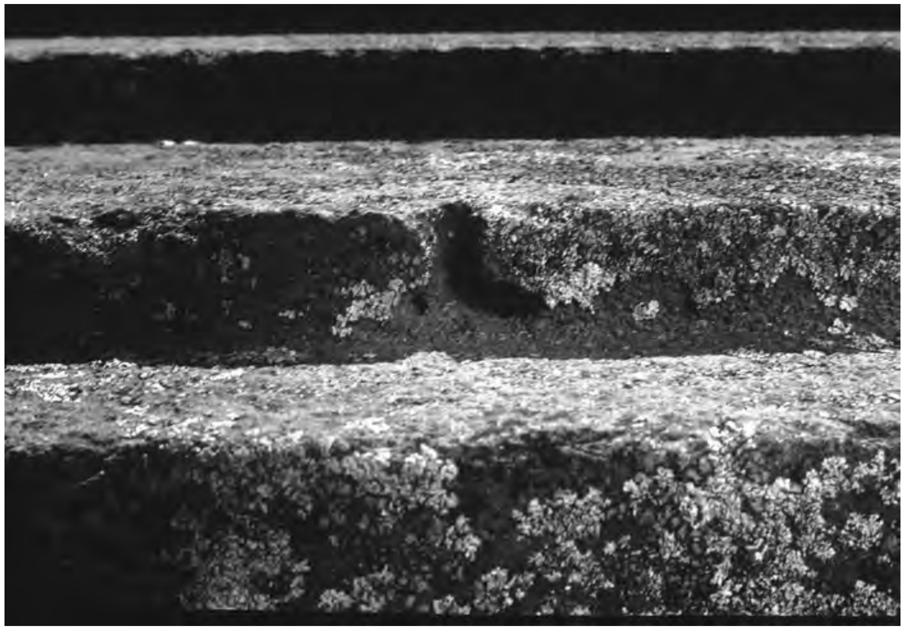


Figure 3.79. Gateway II, tiny cramp sockets.

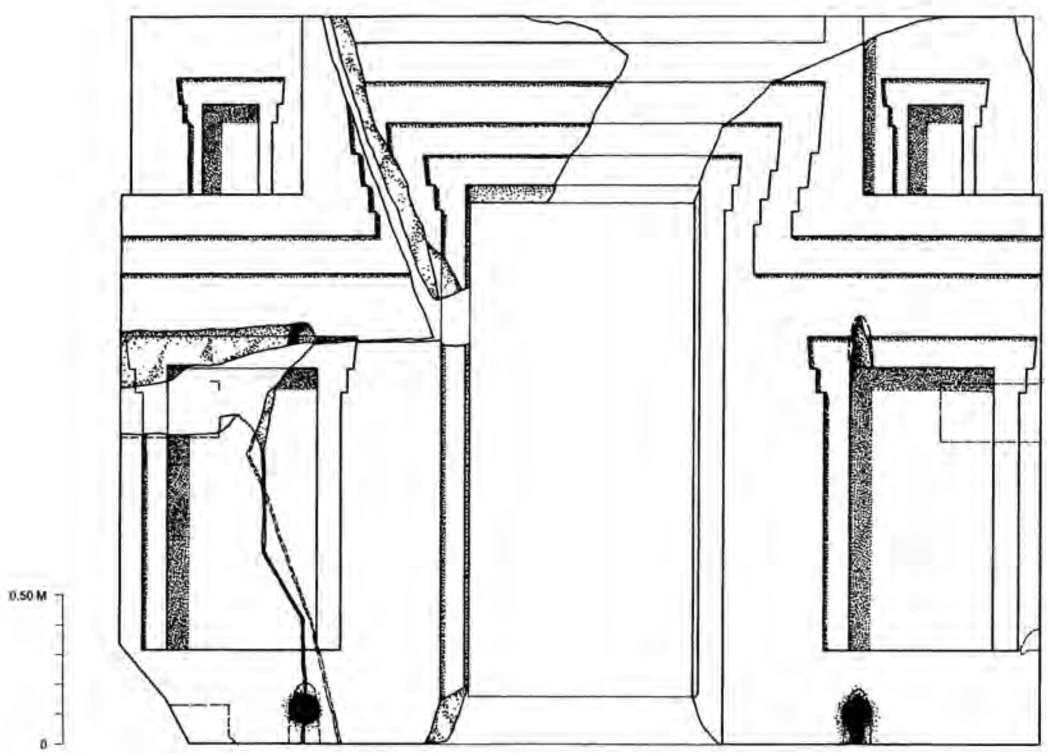


Figure 3.80. Gateway II, back side (drawing by Jean-Pierre Protzen, first published in *Journal of the Society of Architectural Historians*).

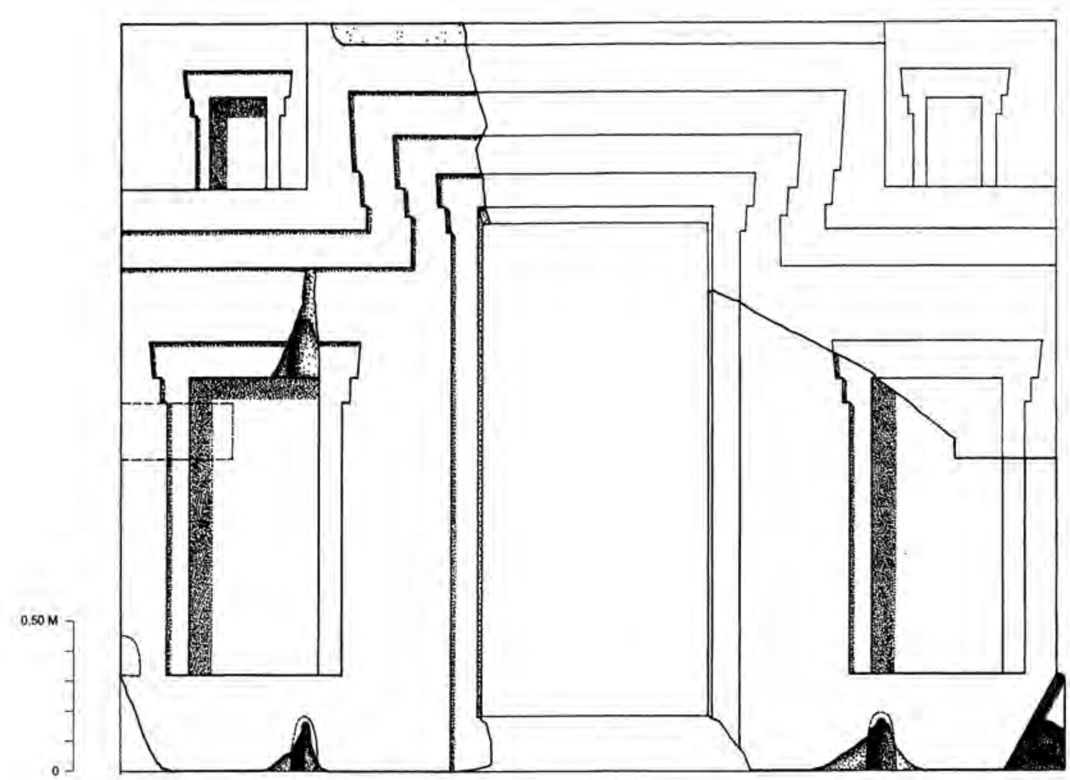


Figure 3.81. Gateway I, back side (drawing by Jean-Pierre Protzen, first published in *Journal of the Society of Architectural Historians*).

the fragmentary left jamb piece with Gateway I, for its Type 2b niche matches the exact measurements of that on the right jamb. We will address this variation in more detail in the next chapter. Little of the gate's lintel has survived, but what is left is enough to affirm that on its front side, like Gateway II, it had no incised frieze (Figure 3.82). Instead, where the frieze would be, there is a large recessed area into which, again, some equivalent ornamentation could have been set. As on Gateway III, this recess is only roughed out. Work in progress is also found on the gateway's back side above the step molding over the doorway head.

Like Gateways II and III, Gateway I features recesses on the narrow side of the right jamb piece and has rectangular pockets of its front, but no cramp sockets were yet been carved in either the recesses or the pockets.

Akapana Gateway

We recorded the remains of yet another gateway on the summit of Akapana; we call it the Akapana Gateway. Some of the pieces of this gateway were known to the attendants at the site, but, to our knowledge, they have never been documented. Stübel and Uhle did mention the remnants of a gateway on the mound's plateau (1892:Part 2, 27, no. 7). Whether those remnants are identical to the pieces we recorded will probably never be known. The Akapana Gateway differs from the aforementioned gateways in that it was not cut from a monolith, but is a trilithon, that is, a gateway assembled from three stones: an enormous lintel and two jamb stones (Figure 3.83). Only fragments of the lintel (Figure 3.84), and a candidate for the left jamb stone remain. The stone illustrated by Stübel and Uhle (1892: Part 2, Plate 38, Figure 22), no longer existing, may have been a candidate for the right jamb stone. It should be noted that Bernabé Cobo, who visited Tiahuanaco in 1610, and likely again in 1620, described just such a gateway: "[C]inquenta pies al oriente dél (Acapana) ha quedado en pie una portada grande de solas tres piedras bien labradas, a cada lado la suya, y otra encima de ambas" (Cobo Book 13, Chapter 19; 1964:Vol. 2, 196). ([F]ifty feet to the east of it (Acapana) a large gateway

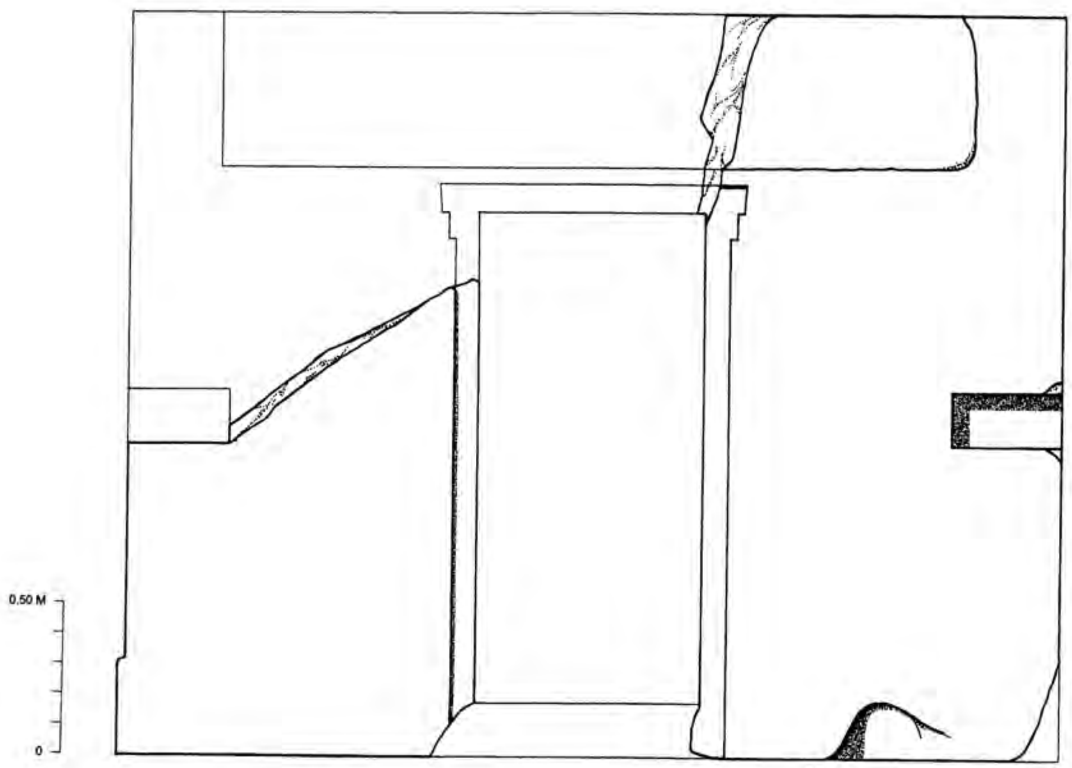


Figure 3.82. Gateway I, front side (drawing by Jean-Pierre Protzen, first published in *Journal of the Society of Architectural Historians*).

remained standing, of three well-wrought stones only, one to each side and another on top of both [translation by authors].)

Stübel and Uhle also reported remains of a gateway on the east side of Akapana (Berg), but placed them on the slope of the mound (1892:Part 2, 27, no. 8). Could these have been the remains of Cobo's gateway?

The Akapana Gateway shows a very unusual construction technique. The underside of the lintel is cut at an angle, the exact angle of the door head's bevel flaring open to the inside. The top of the jamb is cut at the same angle to receive the lintel (Figure 3.85). With this configuration, the stonemasons saved themselves a lot of work, but they also ran the risk of the lintel sliding off the jamb stones. Furthermore, all was not labor saving, for, with this configuration, the bottom of the Type 2a niche above the jamb had to be carved out of the beveled surface of the jamb. It is noteworthy that the short extension of the height of the niche so created is exactly what is needed to bring the niche's dimensions in line with the established proportions.[13] These details bespeak a remarkable sophistication in stereotomy, or the art of stone-cutting, presuming an understanding, if not knowledge, of descriptive geometry.

The reader will have noticed that the jamb stone lacks the Type 2b niche in the LR field (Figure 3.86). We are not sure that this jamb stone really was connected with the lintel pieces. While the position and dimensions of the Type 2a niche bottom in the UR field, and of the stepped step molding on the jamb align precisely with the corresponding parts on the lintel, the depth of the jamb stone is 3 cm less than that of the lintel. It is thus possible that the jamb stone belonged yet to another gateway with the same features as the ones we proposed above, but somewhat thinner. Squier, too, illustrated a left jamb stone similar to ours (1877:280). His engraving, however, is too schematic for us to determine whether it is the same stone. Furthermore, the engraving appears to be a composite of several views, for none of the stones depicted in the foreground were ever reported in the vicinity of the north side of Akapana, the background of said illustration.

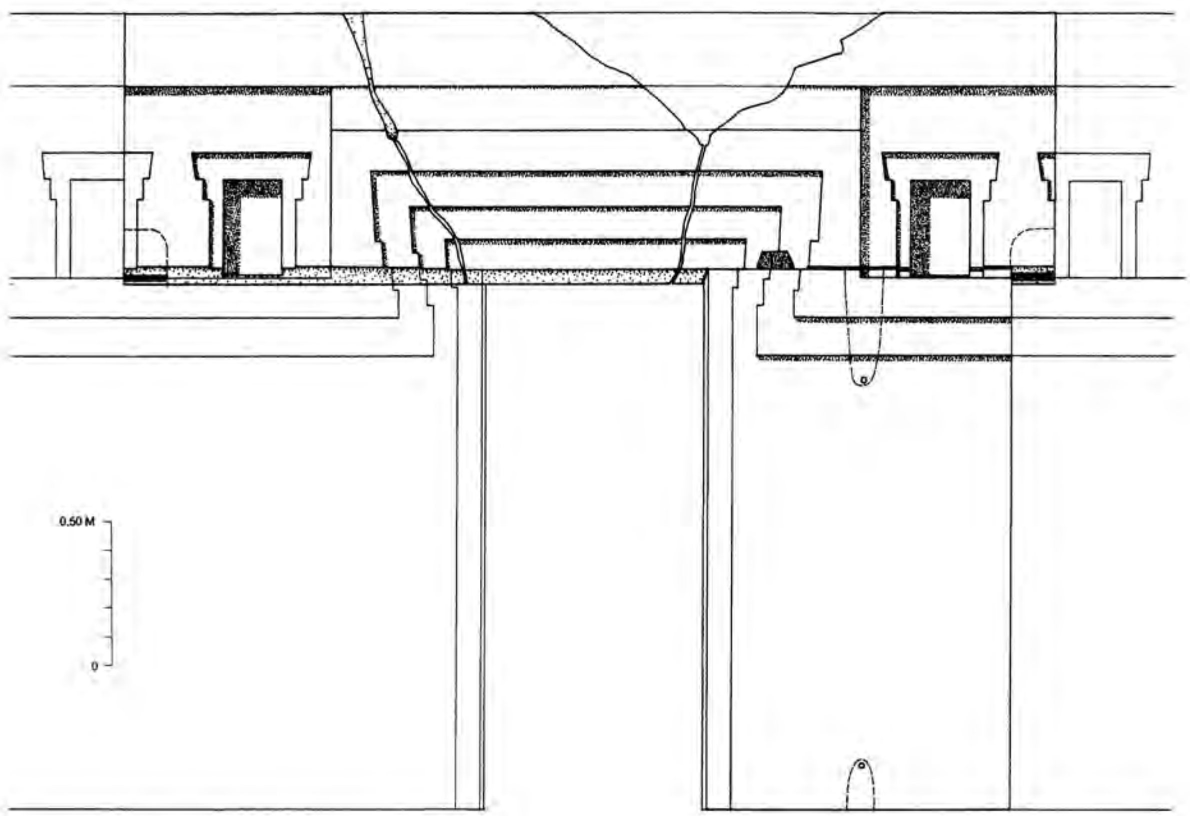


Figure 3.83. Akapana Gateway, front side (drawing by Jean-Pierre Protzen, first published in *Journal of the Society of Architectural Historians*).

Figure 3.84. Pieces of Akapana Gateway.

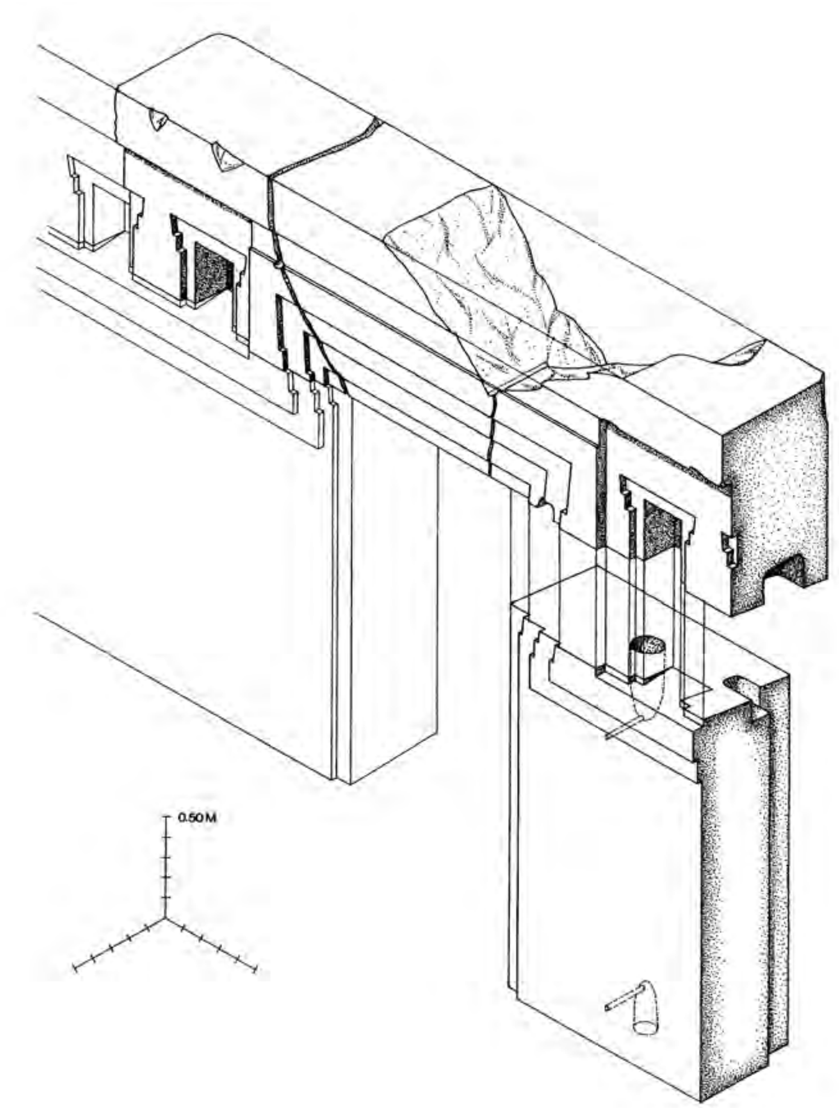


Figure 3.85. Construction of Akapana Gateway (drawing by Jean-Pierre Protzen).

Figure 3.86. Possible jamb stone of Akapana Gate.

A particularly well-preserved and somewhat mystifying feature of the Akapana Gateway are conical recesses carved into the bottom and the top of the jamb stone with a small hole drilled into their apexes (Figure 3.85). Such recesses are found on all the above discussed gateways, only there they have mostly been broken open. We will address the possible function of these conical recesses in Chapter 6.

Gateway of the Moon

The Gateway of the Moon, atop of a mound north of the Kerikala, does not fit any of the above designs: it has not a step, but a simple molding, and no indication of niches of either Type 2a or 2b (Figure 3.87). The inverse stepped rabbet and the plinth at the bottom are not repeated in any other design. Curious too, is the fact that the doorway is narrower at the bottom than the top. From photographs of this gateway published by Posnansky it appears, that unlike the other monolithic gateways, the Gateway of the Moon is unbroken at the bottom and that it was cut without a threshold (1945:II, Figures 78 and 79) (Figure 3.88).

The meander frieze on the Gateway of the Moon, whose iconography is identical with that on the Gateway of the Sun, appears to have been carved in the same inexperienced hand we find on the latter's additions. The figures and ornaments are far from precise, horizontal lines are only approximately so and are quite irregular (Figure 3.89). And looking at the reveals of the jamb we noticed that their finish is rather bumpy, and far from the perfectly even planes we have become accustomed to seeing on the stones of Pumapunku. The Gateway of the Moon's divergent design and its less than prefect execution let us argue that this gateway may represent a later attempt at creating a gateway similar to the gateways discussed above.

Sandstone Gateway

The Sandstone Gateway is found on the south side of Akapana, adjacent to the railroad tracks. Squier illustrated (1877:283), and Middendorf photographed it (1895; vol.III:391). In both renderings the gateway is buried to half its height and has a big stone slab leaning against it. That slab has since disappeared. In 1996 the gateway was excavated so that its full height can be appreciated (Figure 3.90). It was cut from a single slab of reddish sandstone. The opening has the common features of being framed on both sides by a double stepped recessed frame, and beveled reveals. The threshold, which here is still intact, is 31.5 cm high, and shows that the recessed chambranle also went around the bottom of the opening (Figure 3.91). Since no threshold has survived on any other

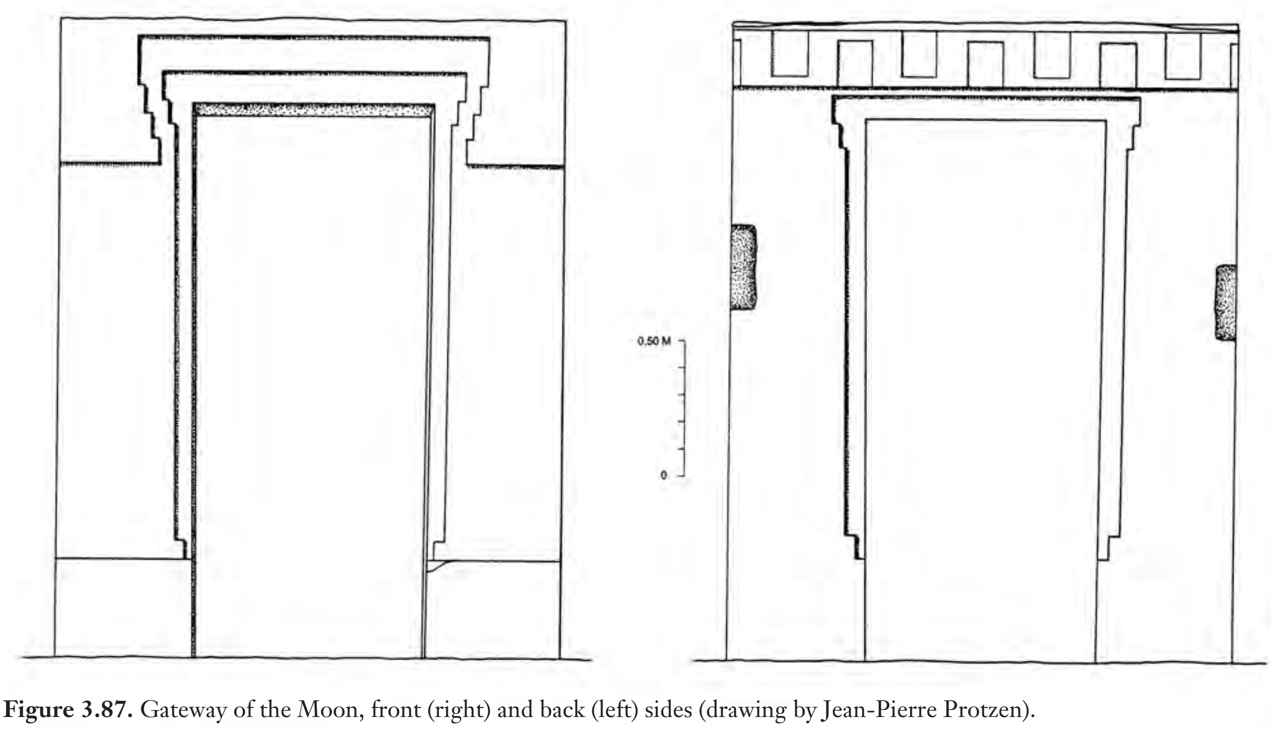


Figure 3.87. Gateway of the Moon, front (right) and back (left) sides (drawing by Jean-Pierre Protzen).

Figure 3.88. Gateway of the Moon, front side.

Figure 3.89. Frieze of Moon Gateway.

Figure 3.90. Sandstone Gateway, view of east (or front) side.

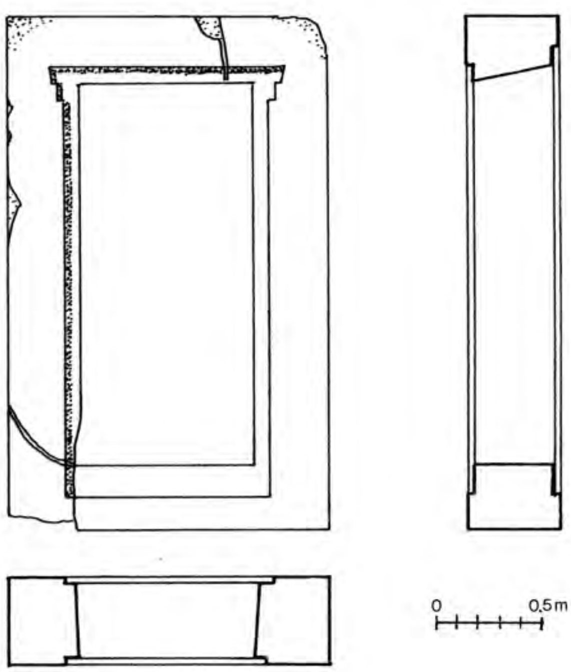


Figure 3.91. Sandstone Gateway, front view and sections (drawing by Jean-Pierre Protzen).

gateway, we do not know whether returning the frame at the bottom was a standard design feature of Tiahuanaco gateways.

Architraves

A number of isolated architraves,[14] or lintels, at the site testify to the former existence of still more gateways at Tiahuanaco. These architraves bespeak two distinct designs, the doubly curved (stone Type 4.6), and the "anticephaloid" (stone Type 4.7).

Curved Architraves

The doubly curved lintels, seen in elevation, are cut in a shallow elliptical arch (Figure 3.92); in cross-section their back side recedes in a steep parabolic curve (Figure 3.93). The combined curvatures produce an

Figure 3.92. Curved lintel at Kantatayita, front side.

Figure 3.93. Beautiful parabolic curve on back side.

incredibly beautiful, but complicated surface the creation of which would tax any stonemason's skills today. One such architrave of andesite was uncovered at the Kantatayita in a test excavation by Cordero Miranda in 1976. Its front was adorned with an arch-shaped frieze of "flying" figures holding staffs, and was probably inlaid with gold leaves (Conklin 1991:283) (Figure 3.92). Another curved architrave of sandstone, broken into several pieces, is found near the southernmost platform at Pumapunku (Figure 3.94). This architrave was unadorned and probably unfinished. One fragment each of two more such lintels are built into a crude retaining wall of unknown date on the southeast side of the same mound.

How the curved lintels were supported, and what the corresponding gateway looked like, is not known. All we can say about their appearance is that the actual doorway was much wider than any of the gateways discussed above. Whereas the typical doorway width of the monolithic gateways is between 75 and 85 cm, the curved lintels indicate doorway widths of monumental dimensions, ranging from 168 cm (Kantatayita) to 266 cm (Pumapunku). No jamb pieces matching to the curved lintels have yet been identified, nor is anything known about the context, to which gateways with curved lintels may have belonged.

Figure 3.94. Curved lintel at Pumapunku.

Anti-Cephaloid Architraves

Museums from Berlin to La Paz and Tiahuanaco hold in their collections of Tiahuanaco materials prismatic stones with two opposing human figures standing head to head sculpted in high relief on one of their long faces (Figure 3.31).[15] These stones are invariably set upright, and commonly thought to be a kind of stelae. Conklin was first to suggest that the stones might have been architraves with the figures looking down from the head of the doorway (1991:282–283). In this position none of the figures is standing on its head, and the whole composition makes better sense. An investigation of the still intact pieces reveals that each one has clearly elaborated seatings, or support surfaces, at either end. Although, to our knowledge, none of the pieces has a documented provenience or known context, we find Conklin's suggestion persuasive, in spite of some reservations. On some pieces the support surfaces, or turned-down ends, are very small, sometimes less than 6 cm in width. On stones that measure 1.4 m or more in length these supports appear very fragile. Furthermore, some of the pieces are quite asymmetric, that is, the two figures are eccentric relative to the short axis of the stone, and would thus not have been centered over the respective doorways. But, if they were lintels, then each "anticephaloid" architrave stands for yet another gateway at Tiahuanaco. Here, as is the case with the doubly curved lintels, nothing is known about the construction and context of gateways with anticephaloid architraves, except that the doorways must have between 125 and 145 cm in width.

Beam-Like Architraves

Aside from the architraves just discussed, there is an intimation that the Tiahuanacans also used straight, or beam-like, architraves. Conklin illustrates as an example of a decorated beam architrave, a stone photographed by Posnansky (1945:Vol. 2, Figures 140 and 140a). This stone, presumably a flat slab with a decorated band on one of its narrow sides, was found serving as a lintel in a house in La Paz. Posnansky said that he "saved" it in the Miraflores Museum; however, we have not seen it there. He gave no dimensions for the stone, which leaves one guessing what kind of stone it was. Conklin shows yet another example of a decorated beam-like architrave, a stone now in the Museum für Völkerkunde in Berlin (catalog number VA 10883), that is very similar to another stone illustrated by Posnansky (1945:Vol. 2, Figures 138, 139, 139a) and now in the museum at Tiahuanaco. Both these stones are unbroken and measure 57.5 and 66 cm in length, respectively. If they served as lintels over doorways, these doorways must have been quite narrow. Another possibility, suggested to us by Katharina Schreiber, is that these architraves may have been set into the recesses above the doorways, say of Gateways II or III, to from the missing frieze.

Figure 3.95. Stepped chambranle at Pilco Kayma (Island of the Sun).

More Diagnostic Features

Castelnau had it right: the principal trait that sets Tiahuanaco architecture apart from Inca architecture—and we will say from other Andean architecture—is the extreme complication of its details (see epigraph to this chapter). The motifs, the intricacies of their carving and finishes, the puzzle-like assemblies of motifs, the standardization of building stones, and the configurations of the niches and doorways, are truly unique to Tiahuanaco.

Motifs

The stepped chambranle surrounding niches and gateways has long been seen as a diagnostic feature of Tiahuanaco architecture, and it is. The stepped chambranle, albeit in trapezoidal form and more in the shape of a double jamb, was later adopted by the Incas at Pilco Kayma on the Island of the Sun (Figure 3.95) as was the stepped, or Andean cross motif at Iñacuyo on the Island of the Moon. Both of these examples deviate markedly in dimensions and proportions from their Tiahuanaco counterpart and lack the latter's fine execution. The Tiahuanaco chambranle is highly refined, almost an abstraction or stylization of the more elementary double jamb doorway. Crosses within crosses, "arrows," lozenges, concentric circles, step-molding, and other motifs discussed above are, to our knowledge, not found elsewhere. Furthermore, the combination and arrangements of motifs, and in particular the use of a step-molding to subdivide a surface and separate different motifs, are without precedent in the Andes.

Flaring Reveals

The flaring of the jamb and head reveals of niches and gateways at Tiahuanaco is so subtle that it escaped the attentive eyes of both Léonce Angrand and Alphons Stübel. Posnansky may have been the first to observe that the opening of the Gateway of the Sun was wider on one side than the other (Posnansky 1945:Vol. 2, 39), but he did not carry this observation to other gates or niches. The flaring of at least the jamb reveals open to the back of niches and inside of doorways has a precedent: it can be found in the remains of Enclosure 2 at Pucara (mapped and excavated by Alfred Kidder). Another example of flaring niche jambs was shown to the authors by Gordon McEwan at Pikillaqta, a Huari site near Cuzco. At neither site are the heads of doorways or niches preserved, thus it is not possible to determine their shape. At Pucara the flaring of the doorjambs is rather extreme; one of the authors (Protzen) measured differences in the width of the openings on the out and inside of at least 10 cm as compared to differences of at most 2.8 cm at Tiahuanaco. Like the chambranle above, the flaring of jamb and head reveals acquires Tiahuanaco identity in the subtleties of its application and finesse of execution.

Puzzle-Like Assembly of Motifs and Compositions

Greek builders, as a rule, roughed out moldings on their building stones before they were assembled, but the finishing work, the last centimeter of excess stone, was removed in situ. The drums of columns were stacked before the fluting was cut (Müller-Wiener

1988: 90-92). Ornamental themes and scenes developed over entire walls, buildings even, made up of hundreds of building stones are a common aspect of the temple complexes of Angkor, the great hieroglyphic stairway at Copán, and the temple of Ammon at Karnak, to give just a few examples. In all these cases, however, the themes or scenes were carved *after* the building stones were in situ. Here, again, Tiahuanaco stands out: the carving of different sections of a motif on different stones *before* they were assembled to compose a whole configuration, is, to our knowledge, unique in the annals of construction history.

Some Questions of Style

"Style" is a complicated concept, loaded with manifold meanings and connotations. We have no intentions of joining the debate about the merits or demerits of its many definitions, nor of proposing our own.[16] Here, we adopt a purely descriptive definition of style as a convenient means of classifying objects: polythetic objects, that is, objects that share a number of common attributes, none of which is necessarily essential for membership, form a class or define a style. Styles thus defined are arbitrary in the sense that they are relative to the chosen set of attributes and have no explanatory power; they tell us nothing about why the artifacts share the attributes, or how they were made, nor about the artifacts' function or history. As a working hypothesis, we will assume, however, that different styles may *possibly* result from different building practices.

The majority of building stones that we have recorded appear to have come from the same or a very similar context. The gates (Gate of the Sun, Akapana Gate, and Gates I, II, and III) and the stones share similar dimensions, designs and details, take part in similar compositions and assemblages, and generally exhibit the same outstanding craftsmanship of smooth planar faces, sharp straight edges, and perfect right angles. Because most of these stones and gates that share these attributes are found at Pumapunku, we subsume them under what we call the Pumapunku Style.

There are, however, even at Pumapunku, some stones whose stylistic characteristics seem to differ. The niche icons on two niche icon stones (Type 13.1) and a niche icon corner stone brought to light in the 1996 excavation by Alexei Vranich depart from all the other niche icons in that they feature only a recessed stepped chambranle without the recessed rectangular niche inside. Since the stones seem to be otherwise finished, it is unlikely that they represent only work in progress. It is perhaps also significant that these stones, unlike most others we have investigated, are of sandstone and not andesite, and show a workmanship of lesser quality. The layout of the motifs is rather imprecise and their corners and edges lack the crispness one encounters otherwise. Similarly, stones of Type 12 (Figure 3.40) seem not to fit the Pumapunku style. These stones, some made of sandstone, have simple rectangular recesses or niches. Two other stones in the museum at the site have rectangular niches within rectangular chambranles (Figure 3.96). Rectangular niches doubly framed by rectangular chambranles appear on an unfinished, now broken, stone near the Kantatayita. Another characteristic of the above stones is their size: with maximum dimensions of 50 by 40 by 28 cm, these stones are all much smaller than most other stones we have investigated. We suspect these sandstone stones to belong to another style, to come from structures very different in design and possibly from another time than the stones exemplifying the Pumapunku style.

Three stones of Type 13.2 (niche icon stones), one in the Museum courtyard, the other at Pumapunku (WR 8) (Figure 3.42 and a third, also at Pumapunku (IR 8) (Figure 3.97), that appears to be a fragment of another open miniature gateway, show unusual features. The usual, recessed niche icons are surrounded by a raised, stepped frame. The opening of

Figure 3.96. Niche icon stone with rectangular chambranles.

Figure 3.97. Fragment of Miniature Gateway with raised frames.

the gateway, framed by two recessed chambranles, the inner two-stepped, the outer three-stepped, is surrounded by an unusual four-stepped, raised frame. All three stones are cut from a very porous andesite and rather inaccurately carved. On stone WR 8 the niche icons are odd; in the upper design the icon is reduced to the stepped frame without the rectangle marking the niche opening, in the lower design the rectangle is floating in the center of the stepped frame instead of abutting the lower edge of the frame, as it does in all the Pumapunku Style icons. Furthermore, the steps in the frame are square, rather than flaring open to the top. The same holds for the stone from the Museum.

Posnansky found a stone—he called it the "True Pumapunku"—a few steps from the Platform Area (1945:Vol. 2, 146–148). He later illustrated and exhibited it in the Miraflores Museum (1945:Vol. 2, Figure 71). The stone is another miniature gateway surmounted by a four-stepped, raised chambranle just like our fragment IR 8, albeit in the "True Pumapunku" the steps are not square but flared, as it befits the Pumapunku Style. Towards the bottom of the gate, the raised frame turns into a horizontal step molding very similar to the step moldings on the large Pumapunku Style gateways. Cramp sockets in rectangular pockets on the sides of the stone suggest that the step molding was continued perpendicular to the stone's principal plane and flanking the opening. The design elements of the "True Pumapunku" are recognizably in the Pumapunku Style. The stone is rendered in a fine-grained andesite and executed with the corresponding precision. What sets the stones of Type 13.2, WR 8, and IR 8 apart, is thus not the raised chambranle per se, since it can be found on at least one Pumapunku Style stone, but its form and execution, and the other details discussed above.

The stepped or Andean cross motif, and the stones on which it appears in the Kantatayita and Kerikala, too, may belong to yet another style (Figure 3.98).

Figure 3.98. Andean cross at the Kerikala.

As mentioned before, this motif is unfinished on all stones on which it is found, and thus its intended final form is not known. Nevertheless, the motif is cut very deep, from 70 to 72 mm, more than three times as deep than any of the other motifs, the average depth of which is between 20 and 22 mm. Thus, even motifs recessed within motifs reach a maximum depth of only 44 mm. As a consequence, the Andean cross motif casts much deeper shadows and projects a tenser image, less modulated than the layered, simple cross motifs of the Pumapunku Style, suggesting a different aesthetic. Unlike most other motifs that are associated with standardized stones in the Pumapunku style, the Andean cross motif appears on widely differing building blocks. At the Kantatayita, the stones are relatively large rectangular parallelepipeds that, judging from the badly eroded rabbet on one long edge, may have been jamb stones. At Kerikala, the stone is a large, pillar-like upright, with the cross motif showing on two opposite faces, two elongated crosses and half a cross arranged vertically. The two stones in the courtyard of the Museum are small, each bearing only half of a motif. On the latter three stones the dimensions of the motifs are fairly consistent and reveal an oblong design, that is, the crosses are higher than they are wide. In contrast, the crosses on the Kantatayita stones are roughly square. One cross on one of the two Kantatayita stones shows an irregularity, which may betray an error by the stone cutter.

What do these deviations from the Pumapunku style mean? Were there buildings built in different styles? And were different styles applied to buildings with different functions, for different occupants, of different status, or indicators of chronology? We simply do not have enough information. The stones that deviate from the Pumapunku style are so few and we know practically nothing about the context from which they came or belonged to that we cannot provide even some speculative answers.

In this chapter we showed how the many features, from motifs to construction details, let us determine a stone's position and its relationship to other stones, and how certain stones can be combined to create meaningful architectural elements, such as doorways, both large and small, niches, and windows. Whether these elements can be used to form even larger architectural units, entire walls or even buildings, we will explore in the next chapter.

NOTES

1. Strictly speaking "dentil" refers to one of many rectangular blocks forming a band characteristic of some Greek orders. Today, however, the term seems to have acquired a wider connotation so that we find its use acceptable in our context.

2. Most visitors to Tiahuanaco are familiar with the stone referred to as the Escritorio del Inca. It was drawn and illustrated by several nineteenth-century explorers, including d'Orbigny, Wiener, and Rivero y Ustáriz and Tschudi among them.

3. Formerly the Museum für Völkerkunde.

4. Catalog numbers 268, 269, and 270.

5. Note that the typology given here differs significantly from the one we published earlier (Protzen and Nair 1997), precisely because in the meantime we have established the uses, or functions, of many more stones than we were aware of previously.

6. So named by Posnansky (1945:Vol. 2, 138).

7. It should be noted that the motif of this stone has been drastically re-worked. We do not know by whom and when. The reason may have been to "enhance" the design.

8. Where exactly the "Puma Face" stones came from is not clear. "These two finely carved blocks . . . we considered . . . when we discussed the place commonly called 'of the Sarcophagi' by whose external southeast side they were found. . . . [O]ne had been brought to this village more than forty years ago. . . . With regard to its companion, this was found . . . on the abovementioned site (Posnansky 1945:Vol. 2, 225). This site appears to be Putuni, but in his "Survey of the Ruins of Tihuanacu," Plate 1, Posnansky marks the location of the find at the western end of today's Kerikala, some 150 meters to the west of Putuni.

9. From Stübel and Uhle, Part I, Plate 29, Figures 2c and 2d. The numbering of the gates follows that of Posnansky.

10. In another paper we described the three basic niche types found at Tiahuanaco: Type 1 and Types 2a and 2b. We have also established that niches of Types 2a and 2b can be inscribed in rectangles with very specific proportions: 1:1.03. . . for Type 2a, and 1:1.44. . . for Type 2b. See Protzen and Nair (1997).

11. Note that our numbering of the gateways differs from that in Stübel and Uhle. Our Gateway III is their Thor 2, our Gateway II their Thor 1, and our Gateway I their Thor 3.

12. Left and right jambs are defined as seen from the front or outside of a gate.

13. These proportions are discussed in Chapter 4.

14. "Architrave" is a term borrowed from Greek architecture referring to "the beam that spans from column to column, resting directly upon their capitals" (Harris 1975:29). We feel justified in applying the term to Tiahuanaco architectural parts, because the enormous lintel over the Akapana Gate and the elaborate curved lintels to be discussed below appear to be more than just simple beams, and because "the word *architrave* carries with it symbolic frontal entrance-way connotations that the technical words *lintel* and *beam* do not" (Conklin 1991:282).

15. For some of these stones, such as those in the Museum für Völkerkunde in Berlin (VA 10881 and 10882), only fragments with just a single figure remain.

16. For a discussion of "style," see, for example, Conkey et al. (1990).

CHAPTER 4

ARCHITECTURAL CONFIGURATIONS

> Eine Commission, welche mit der systematischen Erforschung der Ruinenstätte beaufrtragt wäre, müsste es sich auch zur besonderen Aufgabe machen, diejenigen der bearbeiteten Steine, welche ursprünglich zusammengehört haben, jetzt aber getrennt liegen—soweit dies ohne störenden Eingriff in die fundamentale Anlage des ganzen geschehen könnte—wieder zu vereinigen [Stübel and Uhle 1892:Part 1].
>
> A commission charged with the systematic investigation of the ruins should make it a special task to reassemble the worked stones that once belonged together, but today lay separated—as long as this can be done without a disturbing intervention into the fundamental configuration of the overall site [translation by authors].

THE ASSEMBLIES OF STONES SHOWN IN THE previous chapter are conceptual in the sense that we established the use or function of certain types of stones and then propose ways in which they were used in combination with other stones. For stones to actually fit together they must share at least some critical measurements. When measuring the stones at Pumapunku, we were truly impressed with the apparent regularity of like elements. Like many researchers before us, we suspect that the Tiahuanacans used a system of preferred measurements, possibly a system of proportions.

DIMENSIONS, PROPORTIONS, AND COMPOSITIONS

Posnansky, taking the Balcony Wall of the Kalasasaya as his reference, noted:

> From the center from each of the pillars of this wall ... to that of the next, there is an almost exact distance of four meters, eighty-four and one-half centimeters which, divided by three, gives 161.51 [centimeters] or the unit which was to the people of that period, what the meter is to us today. Thus, from the center of the first pillar to that of the tenth and last there is a distance of thirty "lokas", as they call this measurement now[1] [Posnansky 1945:Vol. 1, 89].

Posnansky claimed that this unit of measurement was "repeated in almost all the buildings of the second period at Tihuanacu" (1945:Vol. 1, 89). In the course of our research we were not able to corroborate Posnansky's claim. Ponce Sanginés proposed that the Semi-Subterranean Temple was designed with a unit of measurement of 40 cm: "Apparently, the measurement used was the cubit, or the distance that measures from the elbow to the extremity of the hand. The denizens of the Altiplano today call it in Aymara the 'mujlli'" (Ponce Sanginés 1969:58).[2] Taking Ponce Sanginés's measurements of the Semi-Subterranean Temple before the reconstruction, we find the unit of measurement to be closer to 42 cm.[3] Remarkably, 42 cm is the thickness of the Gateways of the Sun, I, II, and III, of H-stones with crossed bars (Type 1.2), cross stones (Types 3.3 and 3.4), circle stones (Type 9), and some niche stones (Type 6). Nevertheless, it is by no means a ubiquitously recurrent measurement, nor could we determine it as either a fraction or multiple of others.

The Quechua equivalent of the Aymara *luqa* is the *rikra*, and of *mukhlli* it is *khococ*. Rowe gave the metric equivalent of 1.62 m for the *rikra*, and 45 cm for the *khococ* (Rowe 1946:323) . These measurements are obviously of the same order of magnitude as those given by Posnansky and Ponce Sanginés. For example, when applied to the Kalasasaya's east wall, which according to Escalante measures 119.06m (1993:174, Figure 143), dimensions given for the *luqa* (or *rikra)*, 1.615 and 1.62 meters, result in 73.72 and 70.86 *luqa*, respectively. While neither measure provides a perfect fit, they are good approximations. As an alternative, Escalante proposed that the Tiahuanacans used not a *luqa*, but what he calls a "chica luk'a," that is an arm's length or 60 cm (Escalante 1993:392–393).[4] He finds this measure to apply to the Kalasasaya, the Semi-Subterranean Temple, and Akapana. On the former two structures, the measure again applies only approximately. Of Akapana Escalante gives a highly idealized picture with whole numbers. Since the exact outline of Akapana has yet to be determined (Chapter 2), this proposal has to be considered an approximation. It is, of course, quite possible that the *luqa*, or the "chica luk'a," of the Tiahuanacans was *not* a standardized measure and that, therefore, one should expect a certain variability in all measurements. We will come back to this question below.

Conklin suggested that the Tiahuanacans used, at Pumapunku, a system of proportion akin to a logarithmic scale (1991:289–290). He did not elaborate how that system worked, but the spacing of the "set of flowing parallel lines" on the Gateway of the Sun and others, indeed seem to vary according to some progression, arithmetic, geometric, or logarithmic. Escalante, using the "chica luk'a," argued that he had found evidence of the use of this measure and of Pythagorean triangles in both, the Gateway of the Sun and Gateway III (Escalante 1993:392–400). Taking the slabs from which the gateways were carved, he thought that he could inscribe them in rectangles, the diagonal, width, and height of which were in the relationship of 5:4:3. However, in the case of the Gateway of the Sun, Escalante uses a diagonal other than that of the circumscribing rectangle, and in the case of Gateway III, diagonal, height, and width of the rectangle are considerably off the ideal proportions. Even if Escalante's arguments were correct, there is an issue. As noted above, neither the slab of the Gateway of the Sun nor that of Gateway III could accommodate the full composition; further stones had to be added to complete some of the niches. It seems utterly illogical to assume that the slabs, the dimensions of which are accidental, dictated by what was available, rather than the deliberate design of the whole composition, should provide the basis for a proportional system. With respect to the actual measurements corresponding only approximately to multiples of the "chica luk'a," Escalante explains that it was not a standardized measure, but that the masons used their own arms as a reference and therefore one would have to expect variability. As mentioned previously, this is a cogent argument, and may well reflect the practices of many ancient builders. However, the great accuracy and regularity with which motifs are repeated on many stones, the precision with which stones and motifs had to be fitted to one another, and the predictability of sets of dimensions belie the use of the arm's length of whichever stonemason happens to be around; instead they suggest the application of an agreed-upon, standardized system of measurements with very precise units.

Systems of measurement in construction serve a variety of purposes: they assist the designer in designing a building and judging its appearance before it is built, in laying it out, in planning and coordinating the construction activities, and in communicating the plans to others involved in their realization. There are two basic ways of building a measurement system. First, one may choose a basic module from which the dimensions of all architectural elements, from the dimensions of the building to its smallest detail, are expressed in either multiples or fractions of the module. Second, one may choose a set of rules of proportions, which relate the dimensions of one element to those of its immediate neighbors. Rules of proportions need not be tied to a particular module, and thus may be independent of scale. The two systems are not exclusive of each other; they may be combined into a single system. What kind of system did the Tiahuanacans use, if any?

To elucidate this question, we were very careful to measure the building stones and their details with a precision of plus or minus 1 mm (thus allowing a maximum error of 2 mm) by taking overall dimensions and then having the parts add up to it, give or take 1 mm. The 1 mm missing may be lost because not all arises are crisp and clean, or because the point to be measured does not fall exactly on a millimeter mark. Errors may also be due to unfavorable lighting conditions, difficulties in reaching the point to be measured, etc.

In our research to date we have not succeeded in detecting a convincing unit of measurement, or module, nor were we able to verify the existence of a progression of measurements as postulated by Conklin, whatever the progression's nature. Earlier in the project we were reasonably sure we had evidence for a proportional system governing the dimensions of niches (Protzen and Nair 1997:155–156). Further investigations and additional measurements revealed subtleties that we did not recognize at first and that complicate matters further.

The Niches

Since the aforementioned publication we have been able to augment our various data sets and make new observations that lead us to revise our earlier conclusions. Type 2a niches are now inscribed in rectangles with an average width-to-height ratio of 1:10376. The new sample of 29 niches yields a standard deviation of 0.0147, a slight improvement over our previous results. As before, the Type 2a niches are divided into two clusters corresponding to two distinct sizes, or scales. Scrutinizing our data, we found two Type 2a niches whose proportions of 1:1.0743 (Escritorio I, 6) and 1:1.074 (Escritorio II, 1 fall significantly above the established average proportion of all such niches. By removing these two niches from the full set, the average proportion becomes 1:1.0345, with a somewhat improved standard deviation of 0.0119 (see Appendix 2, Table 2.1). We feel justified in isolating the two particular niches because both appear on Type 11, or "Escritorio" stones, below the step molding. In this location, the Type 2a niches are placed above Type 1 niches, and together the two types have to match the height of Type 2b niches. In other words, here the Type 2a niches are responding to a specific composition of several niche types, rather than standing alone or in a horizontal row, as are all the others in the set. The conclusion is that, while there were specific proportions set for individual elements or motifs, these proportions were not stubbornly applied, but made dependent on an overall composition.

As we described in Chapter 3, the Type 2b niches on Gateway I differ slightly in dimensions from those on Gateways II and III. With this in mind, we also took a fresh look at the specific data set. In our earlier investigation we lumped together all niches of this type in one set, obtaining an average width-to-height ratio of 1:1.5311, with a standard deviation of 0.0 822 (see Appendix 2, Table 2.2). Although this set is essentially the same as our earlier set, at close inspection we detect three distinct subsets, each of which, as we will show below, seems to respond to very specific conditions. The three sets, which we now call Type $2b_1$, $2b_2$, and $2b_3$, have average proportions of 1:1.5474, 1:1.3431, and 1:1.4520, and much lower standard deviations, 0.007, 0.009, and 0.015, respectively (see Appendix 2, Table 2.3). The $2b_3$ niches appear on several Type 6 niche stones with or without dentils (Figure 3.14). Like our original set, these three sets are divided into two clusters corresponding to two distinct sizes or scales.

The basic data set for Type 1 niches suffers a similar partitioning. The full set has an average width-to-height ratio of 1:1.2135, with a standard deviation of 0.0525. Separated into Type 1a and 1b, the sets have average proportions of 1:1.1837, and 1:1.2807, with standard deviations of 0.0145 and 0.0280, respectively (see Appendix 2, Table 2.4). Niches of Type 1a correspond to niches on stones of Type 1.1, and Type 1b niches to stones of Type 1.2, and Type 11.

We are painfully aware that the sample sizes of all our basic data sets are quite small, and that the statistical analysis of these sets is therefore not very powerful. By partitioning the sets, we make the sample sizes even smaller, thus further weakening the analysis. However scant the statistics, it would be a mistake to gloss over the nuances and to have them disappear behind overall statistics, for it would ignore the specific situations in which the differences occur.

The Full-Sized Gateways Compared

Leaving the Gateway of the Moon and the Sandstone Gateway aside for the moment, the other full-sized gateways, in spite of their apparent similarities, follow two different vertical composition schemes. The difference, as mentioned in our description of Gateway I, appears to stem from the number of steps in the molding that wraps around the head of the doorway.

A three-stepped wrapping pushes the step-molding down further, relative to the head of the doorway, than a two-stepped wrapping, thus making fields on the left and right of the doorway shorter in one case and taller in the other. Consequently, the respective Type 2b niches are proportioned differently: Type $2b_1$ are associated with two-stepped wrappings, and Type $2b_2$ with three-stepped wrappings. Accordingly, the gateways fall into two different vertical compositions schemes: the Gateway of the Sun and Gateway I follow vertical composition Scheme 1, while Gateways II, III, and the Akapana Gateway follow Scheme 2 (Figure 4.1). Note that the position and dimensions of the actual doorway opening remain the same in either scheme.

Miniature Gateways and Full-Sized Gateways Compared

Miniature Gateway A with its triple-stepped wrapping appears to be a perfect miniature replica of the full-sized gateways of Scheme 2 in almost all its details. The front of Gateway A shows the gateway in its double-stepped, recessed chambranle, as well as the two "pockets" with T-cramp sockets so typical of the larger gateways (Figure 4.2). On its back side, the gateway is roofed with a triple-stepped molding similar to Gateways II and III; it has the corresponding Type $2b_2$ niches below the step molding, but is lacking the Type 2a niches above it (Figure 4.3). Instead, there is a sizable recess that could have received a stone with a niche or some other element.

The apparent close affinity between the diminutive and the full-sized gateways, strongly suggest that the Tiahuanacans had some scaling factor that allowed them to maintain the relative proportions of similar elements independent of scale (Figure 4.4). We searched for a linear or nonlinear, monotonic function that would provide the desired transformation. Trying first to derive the specific dimension of an element in one scale from the corresponding element in the other scale, we did not fare very well. No matter how we manipulated the numbers we always ended up with margins of error as extreme as 18%, and with average errors of 9% or more. When we turned our attention to the cumulative values of element sequences, the results became more convincing. The function

$$x' = tg30°x$$

(where tg stands for tangent), predicts corresponding values within a margin of error of plus or minus 1% or less, with one exception. Figure 4.5 illustrates this relationship and its exception at the base of the gateways. Note that the value of tg 30 degrees is 0.5774, making the smaller architecture slightly larger than half-scale.[5]

Through our investigation of dimensions and proportions we had hoped to find rules that apply generally; instead we get a picture of infinite sensibilities to specific conditions. This situation is not unlike that described by J. J. Coulton for the early Greek architects, who probably "used a system similar to the

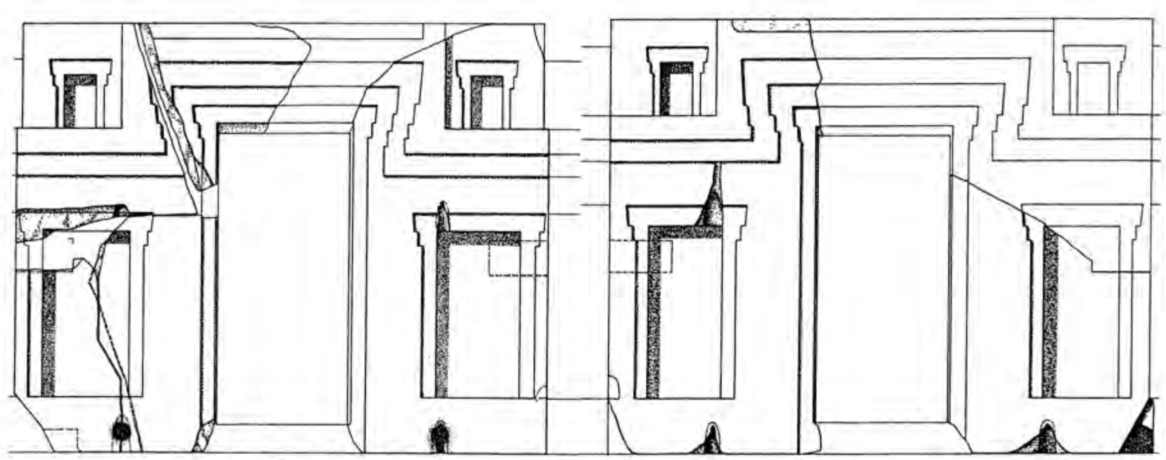


Figure 4.1. The Gateways fit into schemes 1 (to the left) and 2 (to the right) (drawing by Jean-Pierre Protzen, first published in *Journal of the Society of Architectural Historians*).

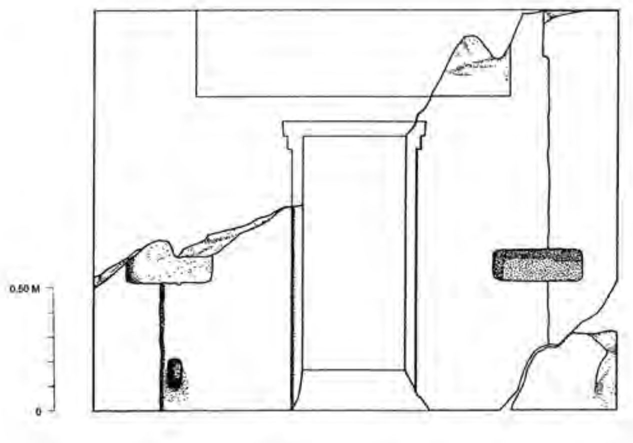


Figure 4.2. Miniature Gateway A, front side (drawing by Jean-Pierre Protzen, first published in *Journal of the Society of Architectural Historians)*.

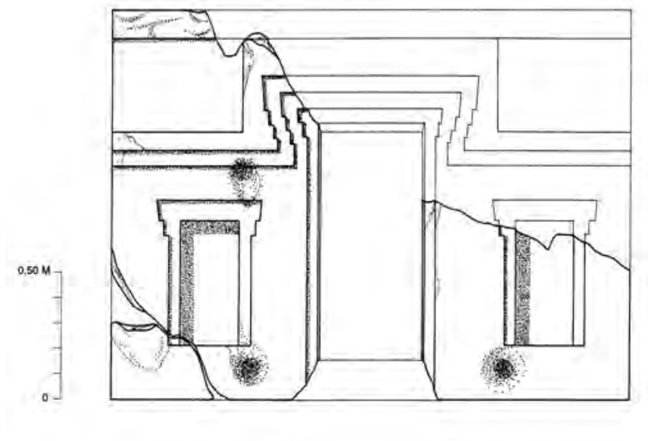


Figure 4.3. Miniature Gateway A, back side (drawing by Jean-Pierre Protzen, first published in *Journal of the Society of Architectural Historians*).

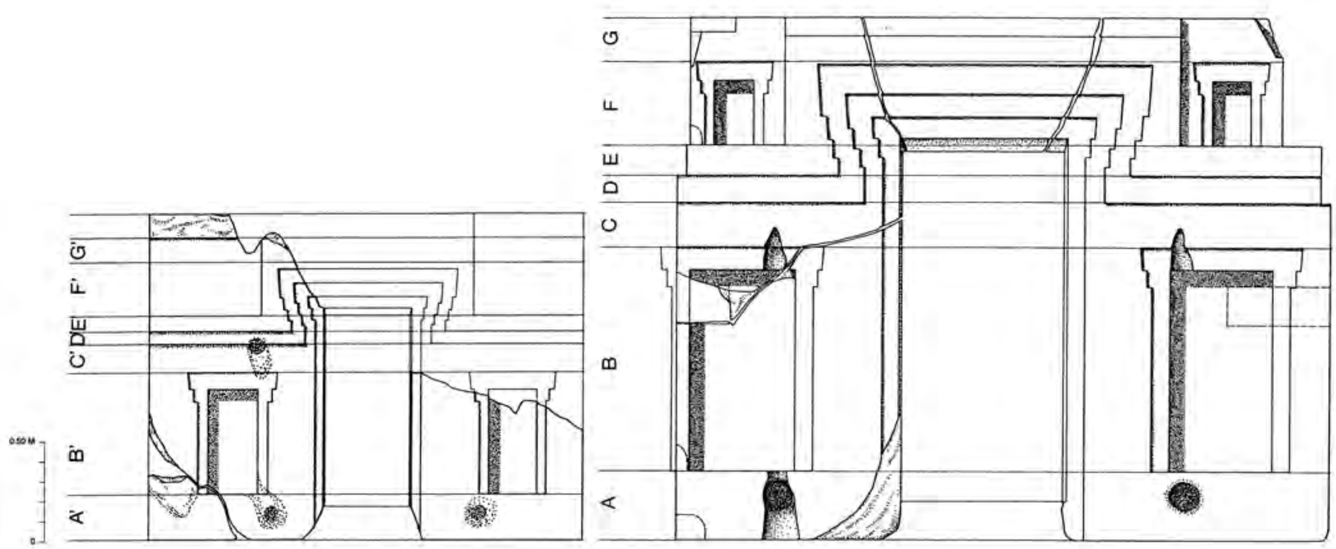


Figure 4.4. Miniature and Large Gateways compared (drawing by Jean-Pierre Protzen, first published in *Journal of the Society of Architectural Historians*).

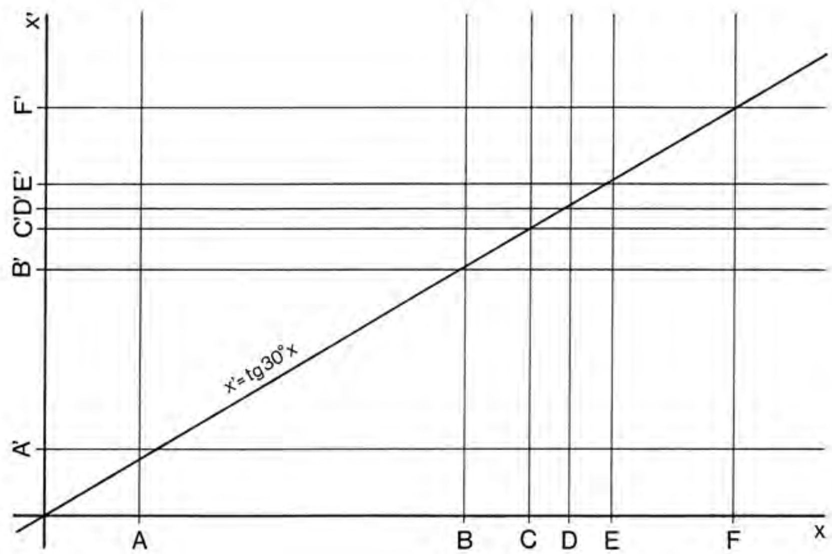


Figure 4.5. Graph showing the relationship of proportions between the Miniature and Large Gateways (drawing by Jean-Pierre Protzen).

one set out by Vitruvius for the Ionic order" (Coulton 1977:66). Coulton explains this system:

> In this the rules do not relate each element to a single common module, but form a sort of chain, so that each element is derived successively from the preceding one, usually the immediately preceding one. The ratios between successive parts are also more complex than in the modular system, and ratios between widely separated parts may be very hard to calculate. Because of this structure, such a system gives more scope for experimentation and variation... [Coulton 1977:66].

Architectural Configurations

Encouraged by insights gained about design details and stone assemblies (Chapter 3), and by our analysis of dimensions, proportions, and scales, we investigated the possibilities of larger architectural configurations involving many stones of different designs.

The Miniature Gateways in Context

The various dimensions and proportions of the three Type 11 stones—"Escritorio del Inca," "Escritorio II," and "Five Niches"—show that they can be inscribed in the same vertical composition of elements (Figure 4.6). A comparison of these stones with Gateway A reveals that the latter also fits into this same vertical composition of elements (Figure 4.7). As seen above, Gateway A is a roughly half-scale replica of Scheme 2 of the full-scale gateways. The dimensions of the remaining transverses of the chambranles of the large, or Type 2b niches, on the "Five Niches" stone indicate that these niches were somewhat wider than those on the "Escritorio del Inca." As we reconstruct these niches by giving the "Five Niches" stone the same height as the "Escritorio del Inca" and Gateway A, they become perfectly congruent with the Type $2b_2$ niches on Gateway A. The Type 2b niches on the "Escritorio del Inca," on the other hand, have proportions of the Type $2b_1$ niches of Scheme 1. Assuming that our reconstruction is correct, it follows that the miniature architecture reflects the differences in niche proportions of the full-scale architecture, but unlike in the full-scale architecture, these differences occur within the same vertical layering of elements.

On the reverse side of the Five Niches stone, we find another remarkable fit: the outlines of step moldings (Figure 4.8), and the distance between them, perfectly match the corresponding parts on the back side of the "Little Pumapunku." Even the clamp sockets on top of either stone are in the proper position. Whether the Little Pumapunku was connected to the Five Niches stone or a similar one, and in what ways, we do not know.

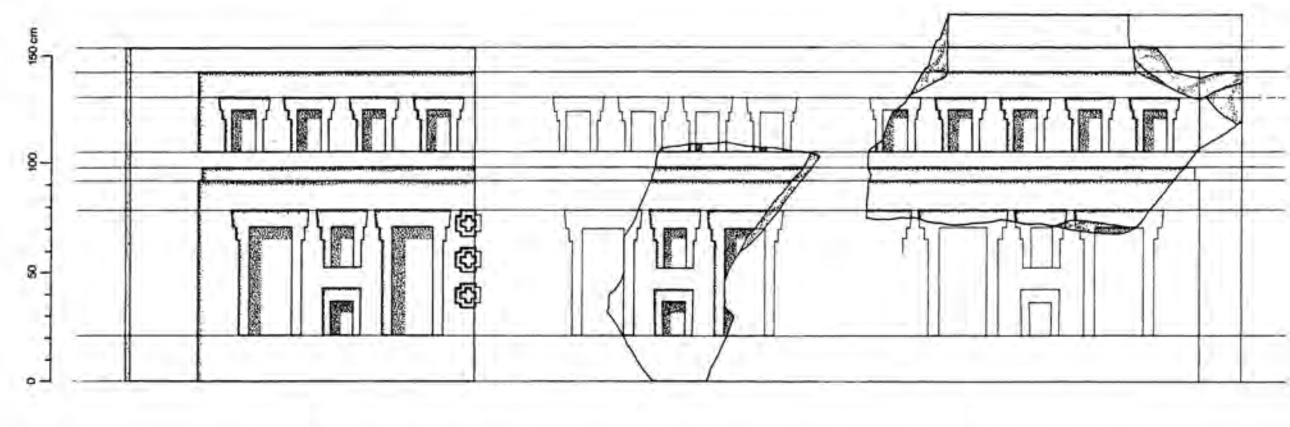


Figure 4.6. "Escritorio" type stones fit together (drawing by Jean-Pierre Protzen, first published in *Journal of the Society of Architectural Historians*).

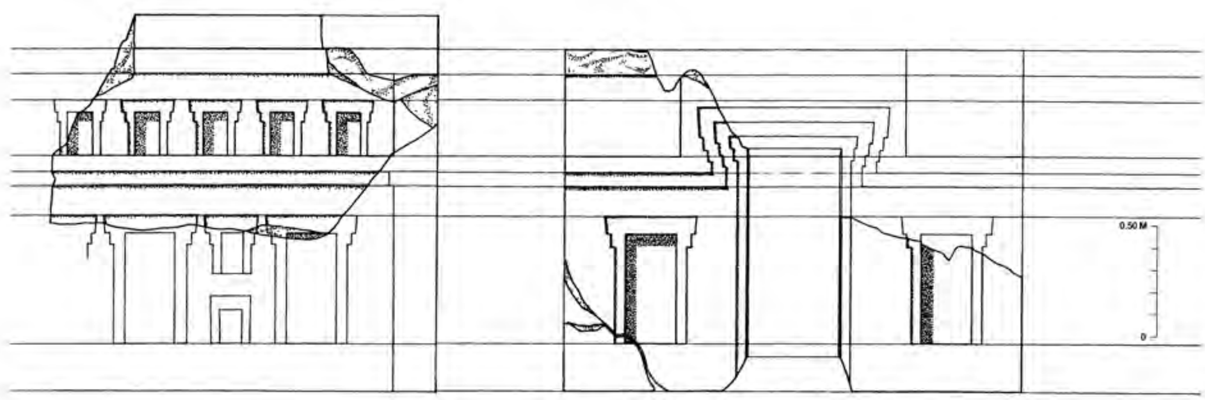


Figure 4.7. Miniature Gateway A matches "Escritorio" type stones (drawing by Jean-Pierre Protzen, first published in *Journal of the Society of Architectural Historians*).

Figure 4.8. Outline of a step molding on the back side of Five Niches Stone.

By reconstructing Little Pumapunku to match the height of the Five Niche stone (Figure 4.9) and the other two in the same context, we achieve another surprising result: the proportions of the gateway's opening conform to those of the openings of the big gateways. We grant that this may be just a coincidence.

We also wondered about the context of the "Escritorio del Inca." Clamp sockets in its top face clearly indicate that other stones were meant to be connected to it (Figure 4.10). We did not find any matching stones, but one stone in the same plane as the "Escritorio del Inca" would have had to complete the cross motifs. The other stone, as suggested by the clamp socket at the other end, was attached perpendicular to the "Escritorio del Inca's" face. This makes the Escritorio del Inca a left-handed stone placed in the left corner of an interior space. As will be seen in the Epilog, our "Escritorio II" stone is a fragment of what once was a right-handed equivalent to the Escritorio del Inca (Figure E.02), thus, once again, underlining the importance of symmetry in Tiahuanaco architecture.

Full-Sized Gateways in Context

Repeatedly we have mentioned that the full-sized gateways were not whole compositions in their own right, but that other stones were meant to be connected to them not only to complete the composition, but also to extend the gateways' context. Although we have not found any stones that we can link directly to any gateway, the numerous cramp sockets, hidden or simple, on the gateways themselves provide clues from which to reconstruct the context, if not in detail, at least in general terms. The three Pumapunku gateways have on their narrow sides hidden cramp sockets that are level with the bottom of the Type 2b niches (Figure 4.11). This suggests that a base was meant to extend out on either side of the gateways within their main plane. On that base, another stone would have reached the height of the rectangular pockets to be connected there with another cramp. Gateway III has one more hidden cramp socket flush with the top of the step molding, suggesting that the step molding would have extended beyond the gateway stone itself. On Gateway II the corresponding hidden cramps are not level with, but above the step molding, yet the implication is the same: the step molding was meant to extend beyond the gateway stone itself. Furthermore, Gateways II and III have cramp sockets at the very top, meaning that the walls extending the main plane of the gateways would have reached the height of the gateway stones.

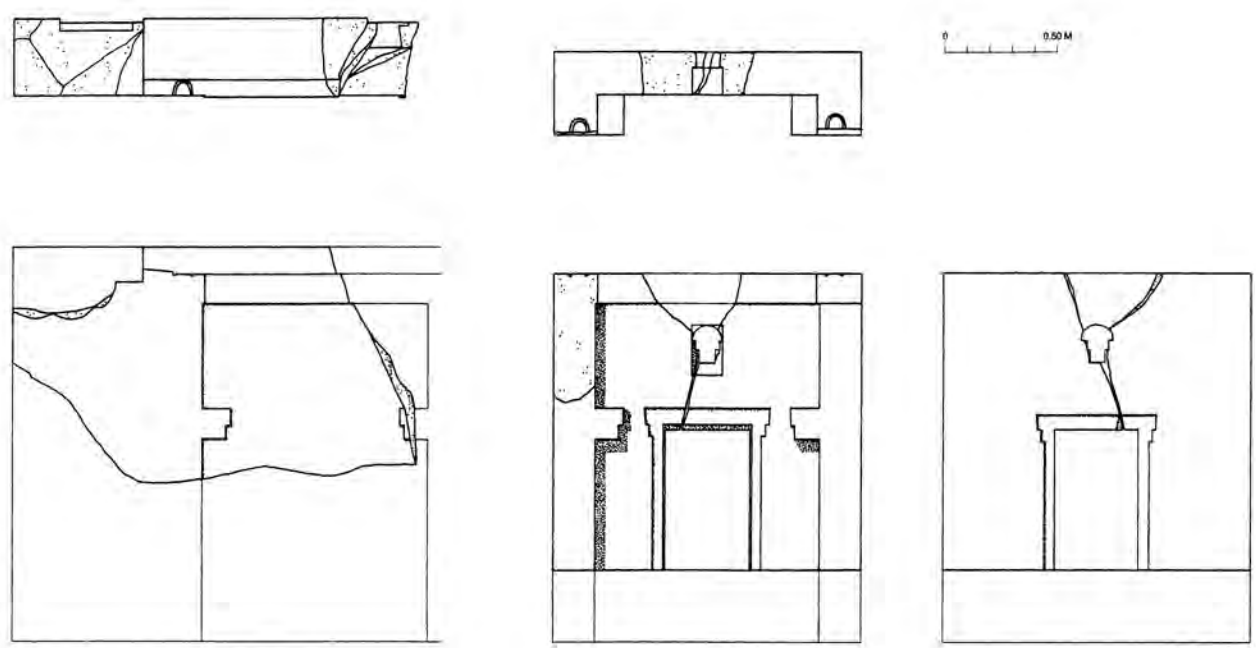


Figure 4.9. Back sides of Five Niches stone (left) and of Little Puma (center) (drawing by Jean-Pierre Protzen, first published in *Journal of the Society of Architectural Historians*).

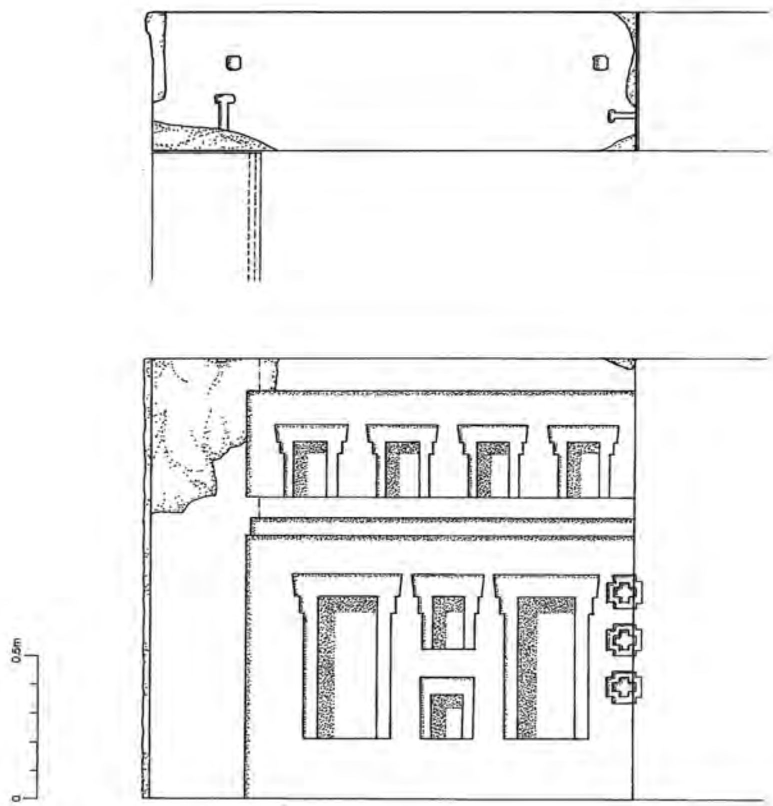


Figure 4.10. The niche face of the Escritorio del Inca forms an interior corner of a space (drawing by Jean-Pierre Protzen).

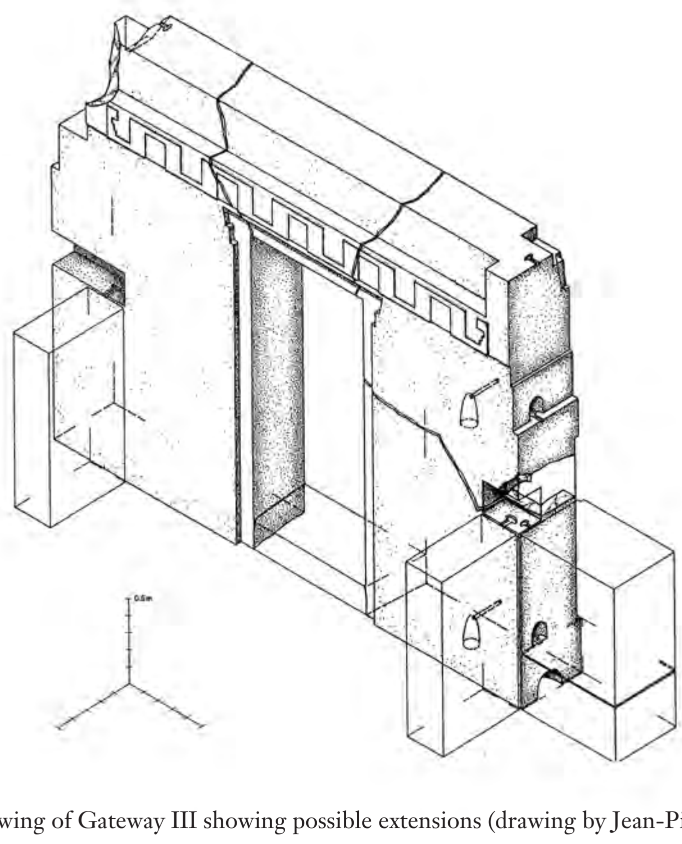


Figure 4.11. Axonometric drawing of Gateway III showing possible extensions (drawing by Jean-Pierre Protzen).

Although the Gateway of the Sun and the Akapana Gateway lack cramp sockets on their narrow sides, their incomplete niches of Type 2a above the step molding are a clear indication that these gateways too were not meant to be free standing, but to be incorporated into a more extended wall. If all the above gateways were meant to be embedded in some extended wall, they could not all have been part of the same wall. Because the gateways do not belong to the same scheme of vertical composition, the step molding and the row of Type 2a niches of gateways of Scheme 1 would not have aligned with the corresponding parts of gateways of Scheme 2.

Posnansky, Escalante, Buck, and others have suggested that the Gateway of the Moon may have been in the same wall as the Gateway of the Sun, either directly adjacent or at some distance from it (Posnansky 1945:Vol. 2, 159; Escalante 1993:192–193, Figures 162a–d; Buck 1936:159, Figure 56). The argument is that the two gateways share a similar meander frieze. We have shown in Chapter 3 that the frieze on the Gateway of the Moon is only a poor imitation of the one on the Gateway of the Sun, carved by an inexperienced hand and with a different technique. We have also shown that on its reverse side, the Gateway of the Moon has only a simple chambranle, but not a stepped chambranle. Furthermore, the dimensions of the doorway opening of the Gateway of the Moon do not match those on the Gateway of the Sun; the height of the former measures at least 190.5 cm, on the latter it is 168 cm on the front side. Also, the opening on the Gateway of the Moon is framed with a chambranle of a design that differs from that of the Gateway of the Sun. With all these distinctions, it should be obvious that the Gateway of the Moon simply would not fit into the same vertical composition scheme with the Gateway of the Sun, nor that of any of the other full-sized gateways discussed above.

Cramp sockets within the rectangular pockets of Gateways II and III oriented perpendicular to the main plane further suggest walls parallel to the gateways' axes and flanking the gateways on their front on either side at least to the level of the rectangular pocket (Figure 4.11). Hidden cramp sockets in the front plane and directly above the rectangular pockets set at the level of the top of the chambranle of Gateway II indicate that the flanking walls, in this case, reached that least to this height.

On the Gateway of the Sun, although the rectangular pockets do not have cramp sockets carved into them—because the gateway is unfinished—the pockets suggest that the opening of this gateway was also meant to be flanked by walls perpendicular to its principle plane. How high these flanking walls would have been and how far out they would have reached we cannot tell, again because the gateway was, as we noted in Chapter 3, not yet incorporated into any wall, building, or structure. Yet, the evidence of flanking walls means that the gateway was not originally conceived to be viewed as a freestanding monolith such as it is today. Instead, one would have approached the gateway through a distinctly delimited space, which would likely have framed and enclosed only the finely carved central section of the frieze above the opening. This lends further support to Stübel and Uhle's argument that the lateral, unfinished extensions of the frieze were later additions whose makers were unaware of, or disregarded, the original concept.

The narrow approaches to the gateways created by the flanking walls suggest that access through them may have been restricted to the privileged few, a subject that we will reconsider in the Conclusion.

Conjectured Configuration

Taking our clues from the "Escritorio del Inca" (Figure 3.13), we speculate that the Type 1, or H-stones might fit into a similar full-sized composition. The front of the H-stones, with their Type 2a niche above a Type 1 niche, are, indeed, similar to the central section of Type 11 stones.[6] Furthermore, the height of the ascendants of the chambranle on the left and right sides of the Type 1.2 stones matches the height of the corresponding ascendants of the Type $2b_1$ niches of Scheme 1 within 1 or 2 mm. The same holds true of some of the Type 3.4, or cross-stones with step moldings.

Using Type 1.2, or H-stones (WR 24 and WR 27)[7] with crossed bars on their backs, and a Type 3.4, or jamb stone with crosses (WR 14) and step moldings, it is possible to create a full-sized composition recalling the "Escritorio del Inca." Instead of the Type 2b niches of the latter, this configuration has open miniature gateways with chambranles on both front and back sides, leading into small cubicles with step moldings on the sides (Figure 4.12). A small fragment of a lintel (PF 2-C) for an open miniature gateway, a step molding stone (PF 4-D), and a Type

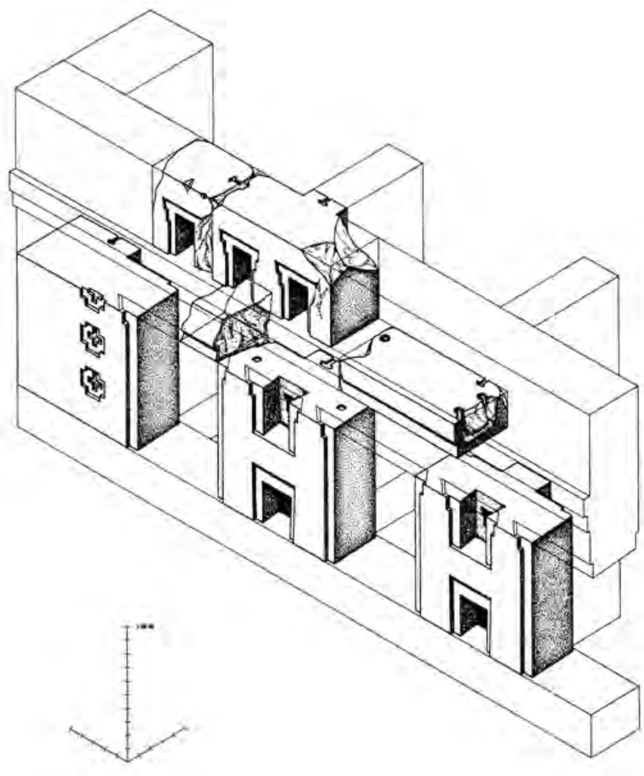


Figure 4.12. Hypothetical configuration, back side (drawing by Jean-Pierre Protzen, first published in *Journal of the Society of Architectural Historians*).

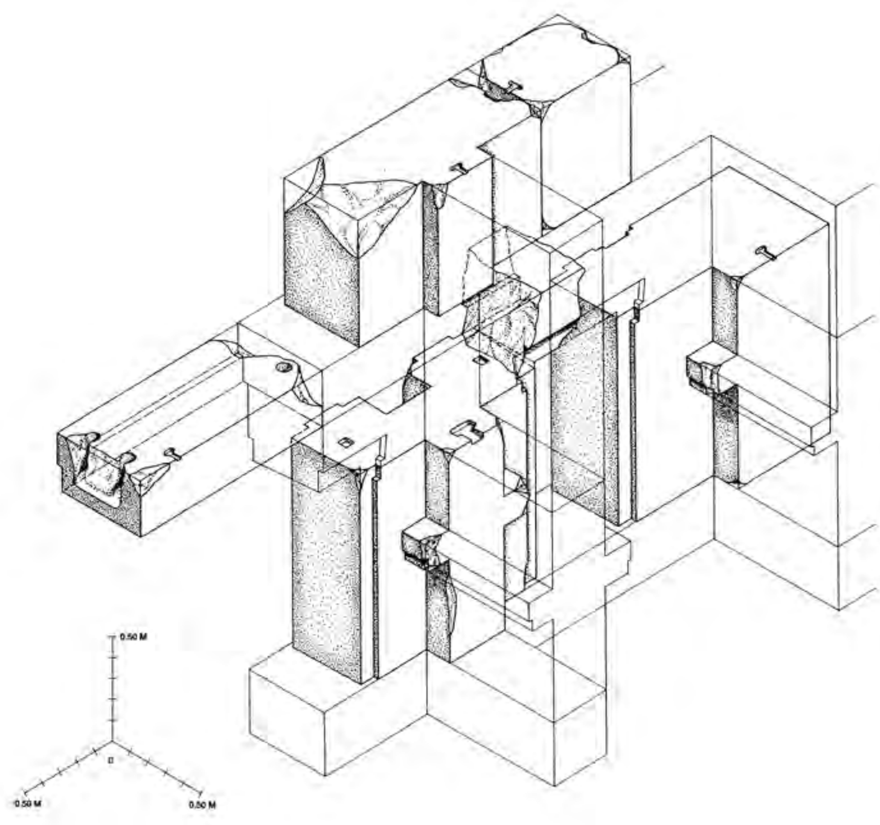


Figure 4.13. Hypothetical configuration, front side (drawing by Jean-Pierre Protzen, first published in *Journal of the Society of Architectural Historians*).

6.2 stone (ER 15) with two Type 2a niches nicely complete the configuration. Several more Type 6.1, or niche stones have the exact same height as ER 15, and could be combined with it to form a row of niches. One of these (PF 3-D) is shown. The dimensions of the conjectured coping cornice we derived from the corresponding cornice on the "Five Niches Stone." All the actual stones used to reconstruct this configuration have the required dimensions and T-shaped cramp sockets in the appropriate locations, supporting the proposed reconstruction (Figure 4.12). The configuration resolves both sides of the assemblage; the stones used align perfectly in the planes of both, the obverse and the reverse sides, and the resulting vertical composition of the obverse side does indeed fit in with Scheme 1 (Figure 4.13). Yet, this reconstruction is entirely speculative since we have no evidence that such a configuration ever existed. We do not know how the configuration would have continued or ended on either the left or right side, nor do we know how deep the cubicles on the reverse side would have been, or if there had been cubicles at all, nor do we know whether jamb stones with crosses would in fact have been combined with H-stones.

If entirely speculative, this configuration suggests other possibilities. For example, we noted earlier that the gateways were not meant to be free standing, but part of a longer wall, and that walls probably were suppose to be flanking the opening on the front side. In the reconstruction's front side, too, there are walls projecting out.

More Questions of Style

Two stone slabs near the Kantatayita with Type 2a niche icons are structured in a vertical composition scheme for which there is no correspondence at Pumapunku (Figure 4.14). A recessed band at the top of the stones, containing the niche icons, seems to have continued on other, similar stones. The band thus formed is reminiscent of the band that presumably ran around the Semi-Subterranean Temple at Lukurmata (Ponce 1989:Figures 44, 49, and 50). Also, the chambranle of the niche icons on these stones and the ones at Lukurmata show a different outline to that of the Pumapunku style. In the former the steps at the top of the chambranle are all at right angles (Figure 4.15), whereas in the latter the top step forms an acute angle with the transverse of the chambranle.

With regard to the gateways of Tiahuanaco, Conklin proposed a sequence of styles based on a comparison of the iconography found on the architraves with the iconography on Tiahuanaco tapestry (1991:285–286). He starts out the sequence with the decorated beam-like architraves followed by the curvilinear architraves, and concludes the sequence with the monolithic Gateway of the Sun. The anticephaloid architraves, which are not shown in his seriation table, Conklin places between the Gateway of the Sun and the curvilinear architraves (William Conklin, personal communication 1997). As we have shown above, the Akapana Gateway, Gateways I, II, and III, and all the miniature gateways are stylistically related to the Gateway of the Sun, and should thus fit into Conklin's scheme at the same place.

Conklin's stylistic seriation of textiles is also chronological, spanning from Pucara and early to late Tiahuanaco (1991). If his parallel between the iconography on textiles and on the architectural elements holds, our findings would indicate that the width of doorways diminishes steadily over time from gateways with curved lintels to the Gateway of the Sun. From that viewpoint, the Gateway of the Moon and the Sandstone gateway would both fit in with the Gateway of the Sun; they are monolithic and have narrow openings. But as discussed before, we are not prepared to associate these two gateways with that of the Sun because of their otherwise radically divergent design features.

There is, of course, a technical reason for the narrow openings in monolithic gateways: it would have been extremely difficult, if not outright impossible, to cut a wide opening in to a single slab of stone. Not only would it have required a much bigger slab, but the stresses at the corners of the large opening would have become such that it would have been near impossible to manipulate the slab without breaking it into pieces. Technical reasons aside, the changes in width of the openings have a direct bearing on the nature and importance of passage, of which we have written above. Through the large opening of the curved lintel gateways, four people abreast could have moved with ease, two could have done so through anticephaloid gateways, but only one person at the time could pass through a monolithic gateway. Assuming, still, that the change from wide to narrow

Figure 4.14. Stone with niche icon from Kantatayita.

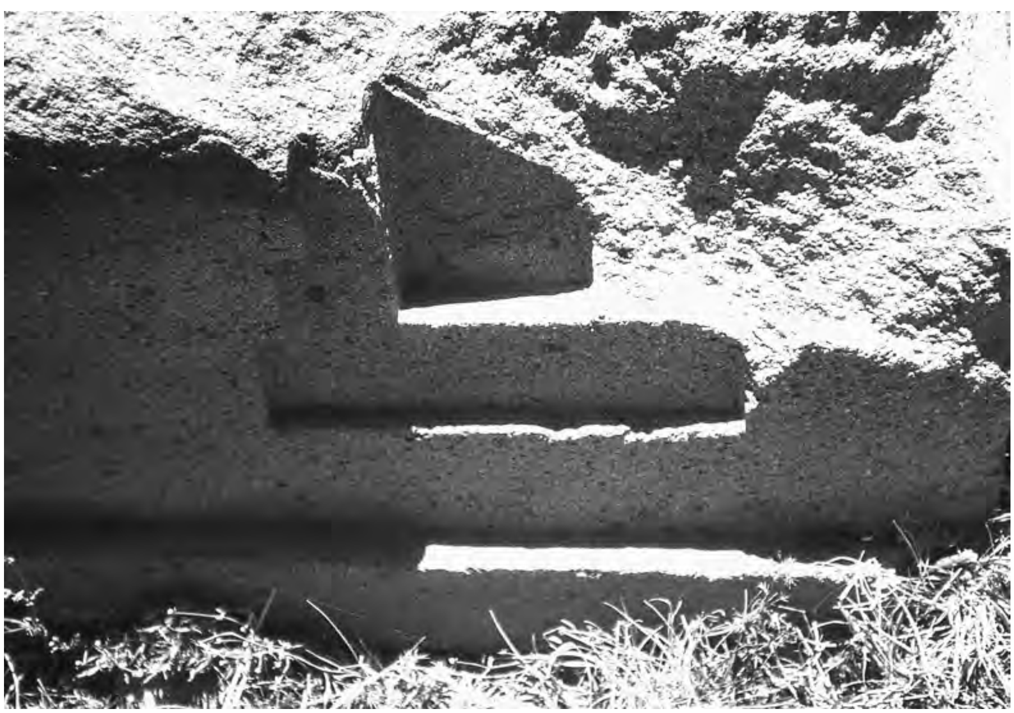


Figure 4.15. Niche Icon stone at Lukurmata.

openings is chronological, could that signal a change in ritual practices from processions with many participants to exclusive access for the chosen few? Or does it indicate a change of function of the spaces from open and public to highly guarded and private or sacred? The flanking walls on monolithic gateways, creating a sort of anteroom or corridor, would have enhanced the sense of control and privacy or sanctity by narrowing and focusing the approach. At the same time, the flanking wall would have altered the perception of the gateways considerably. We are used to see the Gateway of the Sun in its full splendor and monumentality. It would have been a very different experience to have its façade narrowly restricted. Other lines of inquiry like the above could be developed, but it is the archaeological record that ultimately will decide their viability.

Tiahuanaco Architecture: Some Unresolved Issues

The knowledge we have gained of Tiahuanaco architecture thus far is either at the very large scale of site organization and building footprints, or at the level of construction details, design elements, and stone and wall assemblies. While we have important and compelling architectural evidence from all the buildings that give us important insights into each of those structures, the surviving evidence does not provide a complete picture of each structure. Instead we still lack enough information to give us a full picture of their volume and scale, "final" appearance and spatial configurations, or the types and shapes of rooms they may have harbored; nor do we know where the many gateways stood, what spaces they led into, and what relationship the gateways had to each other and other elements of the architecture, in particular the half-scale architecture. As noted before, Stübel and Uhle already wondered about the abundance of gateways and the scarcity of buildings (1892:Part 2, 26–27). Indeed, not a single building has survived beyond its foundations. In part, our ability to reconstruct Tiahuanaco architecture in full depends on our ability to find out where the above described architectural configurations stood and to determine how they related to each other and the large structures at the site. For this purpose we will survey what is known, in particular, about the location of the various gateways and the half-scale architecture.

Gateway of the Sun

The Gateway of the Sun, now standing in the northwest corner of the Kalasasaya, was erected there by Posnansky in 1908 (Posnansky 1945:Vol. 1, caption to Plate 65), approximately where d'Orbigny saw it in 1833. Although d'Orbigny said it was lying on the ground, this is unlikely, for in his accounts he shows drawings of the gateway's two sides. He could not have drawn both sides had it been prostrate (D'Orbigny 1835–1847:Vol. 8, Plate 6). D'Orbigny probably found it in exactly the same state as subsequent explorers saw, depicted, or photographed it, broken into two pieces, upright but reclining, and buried in the ground to about a quarter of its height.

Whether the present location of the gateway is its original one is open to debate. It stands there eccentrically placed and incongruously isolated, with no obvious relationship to its immediate surroundings. Historical documentation claims that Marshall José Antonio Sucre, who was impressed by the ruins of Tiahuanaco and later became president of Bolivia, ordered the local authorities on February 6, 1825 to re-erect the Gateway of the Sun (Ponce Sanginés 1995:15). This order, however, is silent about the gateway's original location and the place of its resurrected glory, if indeed the order was heeded. D'Orbigny's observations eight years later rather cast doubt on the execution of that order.

Most observers, ourselves included, are agreed that the Gateway of the Sun's current location is not its original one, and believe that it had been carried there from elsewhere. Squier, for example, said, "I very much question if this remarkable stone occupies its original position" (1877:295). He surmised that it may have stood in the courtyard of the Kalasasaya in a structure similar to Pumapunku, or that it came from the Kantatayita.[8] Ernst W. Middendorf questioned the gateway's location: "[Da] ist ein Baudenkmal, welches eigentlich nicht hierher gehört hat, und gewiss nicht für den Platz bestimmt war, auf welchem es steht, wiewohl es denselben nun schon seit Menschengedenken einnimmt" (Middendorf 1895:383). ([There] is a monument that did not really belong here, and which certainly was not destined for the place in which it now stands, even though it has occupied it in living memory" [translated by authors]).

Middendorf did not speculate about whence the gateway came. Conklin argued on stylistic grounds that it—as well as the Gateway of the Moon—had to come from Pumapunku (1991:285). Our own view today is agnostic: we do not know where it came from. If there indeed have been gateways on the summit of Akapana with pronounced stylistic, dimensional, and proportional affinities with the presumed gateways of Pumapunku, it is quite possible that this style was not limited to the site of Pumapunku, but that it was characteristic of other parts of Tiahuanaco as well.

Gateway of the Moon

Middendorf reported that the Gateway of the Moon, which marked the entrance to a children's cemetery laid out on the summit of an ancient mound—the same mound the gateway is on today —was brought there some 50 years before his visit in 1887 by the corregidor Marcelino Huachalla (Middendorf 1895:380). Whence the gateway came he did not say. Castelnau, who visited the site in 1845, observed:

> Près d'un des angles du carré (Kalasasaya), sont deux portails d'une exécution remarquable, dont l'un, le plus petit, est renversé et a environs 2 mètres 1/2 de hauteur; l'autre est encore debout: c'est un beau monolithe qui a été fendu à l'un de ces angles; il a environs 3 mètres 1/2 de haut [Castelnau 1850–1859:Part 1, Vol. 3, 391–392].

> Near one of the square's (Kalasasaya) corners, are two gateways of remarkable execution, of which the smaller one is thrown down and is about 2-1/2 meters high; the other is still standing, a beautiful monolith, which has been split in one of its corners, about 3-1/2 meters high [translated by authors].

There is no doubt that the larger gateway Castelnau is describing is the Gateway of the Sun; but is the smaller one the Gateway of the Moon? It is a possibility, for Rivero and Tschudi illustrated the Gateway of the Sun with a prostrate smaller gateway next to it. Admittedly, the drawing is not of great accuracy, but anybody who has seen the Gateway of the Moon will not fail to recognize it. Tschudi did not visit Tiahuanaco until 1858, but de Rivero Ustáriz may have been there as early as 1842 (Ponce Sanginés 1995:21), which is some three years before Castelnau. Angrand sketched at Tiahuanaco in December 1848 (Prümers 1993:387). He drew the Gateway of the Moon standing upright and called it "Porte monolithe (B)," which, on his general plan of the ruins, he placed beside the road from La Paz to Tiahuanaco, roughly where it stands today. If the gateway mentioned by Castelnau and illustrated in Rivero and Tschudi, is indeed the Gateway of the Moon, it must have been moved to its present location between 1845 and 1848—that is, roughly 40 years before Middendorf visited the site. His account of the moving of the gateway would thus seem corroborated. Tschudi, who visited Tiahuanaco on October 19 and 20, 1858, wrote that there was a second, smaller gateway next to the Gateway of the Sun,[9] but that it was moved to the nearby cemetery in 1857, that is, the year before his visit (Tschudi 1971:Vol. 5, 294). This is not possible, but perhaps Tschudi meant to write 1847, which would fit perfectly with the above reckoning.

Pumapunku: The Gateways and the Platforms

Both Cobo's and Cieza de León's descriptions of Pumapunku leave the distinct impression that at least one gateway was still standing on one of the platforms.

> Solamente está en pie sobre la losa mayor una parte [sic for puerta][10] que mira al oriente cavada en una gran piedra muy labrada, la cual piedra tiene de alto nueve pies y otros tanto de ancho, y el hueco de la puerta es de siete pies de largo, y el ancho en proporción [Cobo Book 13, Chapter 19, 1964:Book 2, 195].

> There remains standing on the major slab only one part [sic for doorway] that faces east and is carved in a large stone well wrought, this stone is nine feet tall and another so many wide, and the opening of the door is seven feet long [high?] and the width in proportion [translated by authors].

Cieza de León reported:

> [A]y muchas portadas grandes con sus quicios, unbrales, y portaletes, todo de vna sola piedra. Lo que yo más noté, quando anduue mirando y escriuiendo estas cosas, fue que destas portadas tan grandes salían otras mayores piedras sobre que estauan formadas.... Y esto y la portada y sus quicios y umbrales era una sola piedra... [Cieza de León 1984:Part 1, Chapter 105, 283].

> [T]here are many large gateways with their jambs,[11] lintels, and doorways, all of a single stone. What I most noted, when I went looking [at] and writing [of] these things, was that from (under) these large gateways projected other major stones on which they were arranged.… And this [the platform] and the doorway

> [with] its jambs and lintel were of a single stone… [translated by authors].

Cieza's account is ambiguous. He first talks about many gateways standing on big platform stones, but later mentions a single gateway cut from a single stone. Cobo is more straightforward, as he speaks of a single standing doorway. The dimensions he gives for it describe a square slab from which the doorway was carved. All three remaining gateways—Gateways I, II, and III—are cut from roughly square slabs about eight feet on the sides, a bit less than Cobo's nine feet. We find it suggestive that Cobo's description seems to rule out that the one standing gateway was the Gateway of the Sun, the slab of which measures about 2.74 m (nine feet) in height and 3.81 m (12.5 feet) in width.

It is generally thought that the faint, and slightly recessed or raised areas to be found on the platforms at Pumapunku are where the gateways stood, or were to be erected. Some of the U and L-shaped outlines look suspiciously similar to those first documented by Posnansky on the landing of the eastern stairway of the Kalasasaya (1945:Vol. 1, Plate 26) and that led Ponce to his unwarranted reconstruction of the gateway to that structure. Do these areas in fact represent outlines of structures? If they do, they pose a kind of figure-ground problem: what represents the solid part of the architecture, and what represents the void, or the space through which people move? In other words, what was built on, the recessed or the raised parts?

Taking our clues from the gateway of Putuni, it appears that the outlines did indeed serve as a kind of floor plan of the structures above and that it is the recessed areas that were built upon. Our detailed study of the outlines at Pumapunku during the summer of 1995 has failed to enlighten us about the structures that stood or were to be constructed on the platforms. As mentioned in Chapter 2, we found some regularities, but we could not match the measurements of any gateway with the measurements of the outlines.

Half-Scale Architecture

Another puzzle concerns the half-scale architecture: where was it standing, or meant to stand, what was its relationship to the full-scale architecture, and what was its function? Cobo, when writing about the one standing gateway at Pumapunku, added: "Cerca desta puerta está también en pie una ventana que mira al sur, toda de una sola piedra" (Cobo 1964:Book 2, 195). (Near that doorway also stands a window that looks to the south, all made from a single stone [translation by authors].)

If that window was one of the monolithic half-scale gateways, such as Gateway A, the Little Pumapunku, or the True Pumapunku, then Cobo's description suggests a very close relationship between the full-scale and half-scale architecture. But as it stands, we do not know what kind of a window Cobo saw.

Some people refer to a stone at Kantatayita with a sunken rectangle and little stairs leading into it as an architectural model of a Semi-Subterranean Temple (Figures 4.16 and 4.17). Models have at least two very distinct functions. First, models can be prototypes, representations of things not yet built or realized. Architects typically use models, usually at a much-reduced scale, to visualize, test, and communicate their ideas before they are set into the real world. Second, models can be replicas, representations of actual things. Tourists typically will buy a model of the Gateway of the Sun as a souvenir of their visit to Tiahuanaco, or people will keep and display replicas of sacred objects in places of worship or at home for veneration, protection, or good fortune.

It is unlikely that the "Model Stone" at Kantatayita and all the half-scale architecture we have recorded are models in the first sense. The fact that many stones were executed in multiple exemplars is not congruent with the idea of a prototype, but rather bespeaks mass production. The Tiahuanaco architects had means other than exact replicas at half-scale to represent and convey their visions. The kit of parts and the rules of proportion and composition that we have discussed are powerful means of communication. If they needed models nevertheless, they did not have to be carved at half-scale from hard materials, models at much smaller scale and made from malleable materials like clay would have served the same purpose just as well. Thus, the half-scale architecture must have had another function. Stübel and Uhle proposed that this architecture was ideally suited for altars (1892; part 2, 38). The idea is intriguing, for we find examples in our own history and culture, such as Gothic altars with their arches, spires, rose windows, and so on, carved from wood or stone that are miniature reflections of the larger architecture without. Nevertheless, our own view today is that we do not know enough about the context of this half-scale architecture to offer

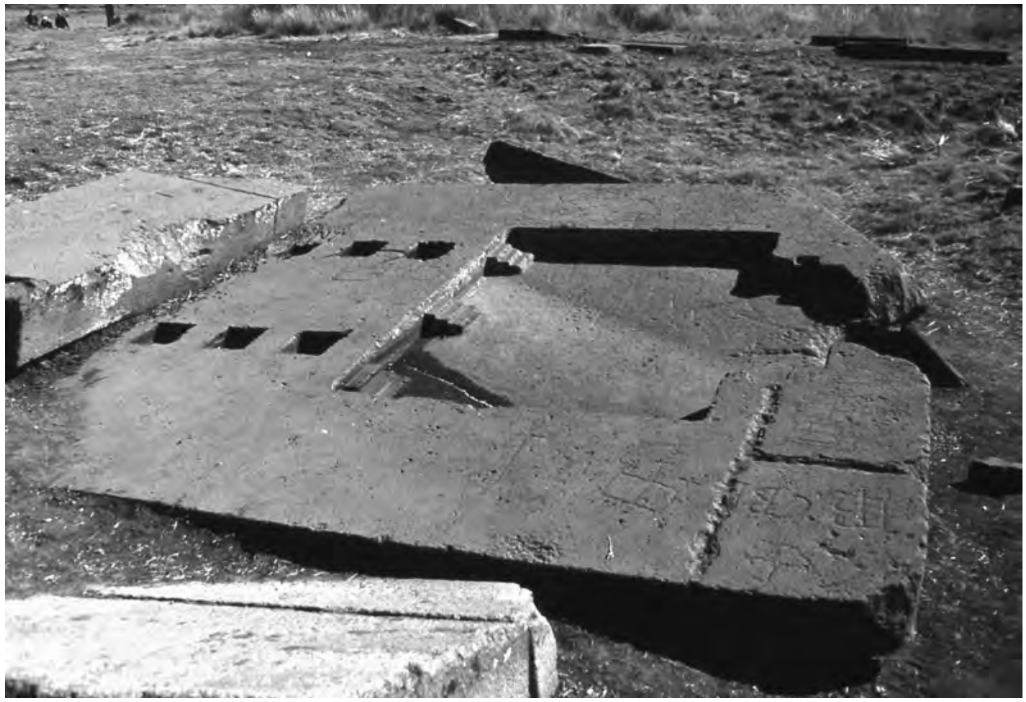


Figure 4.16. So-called "Model Stone" at Kantatayita.

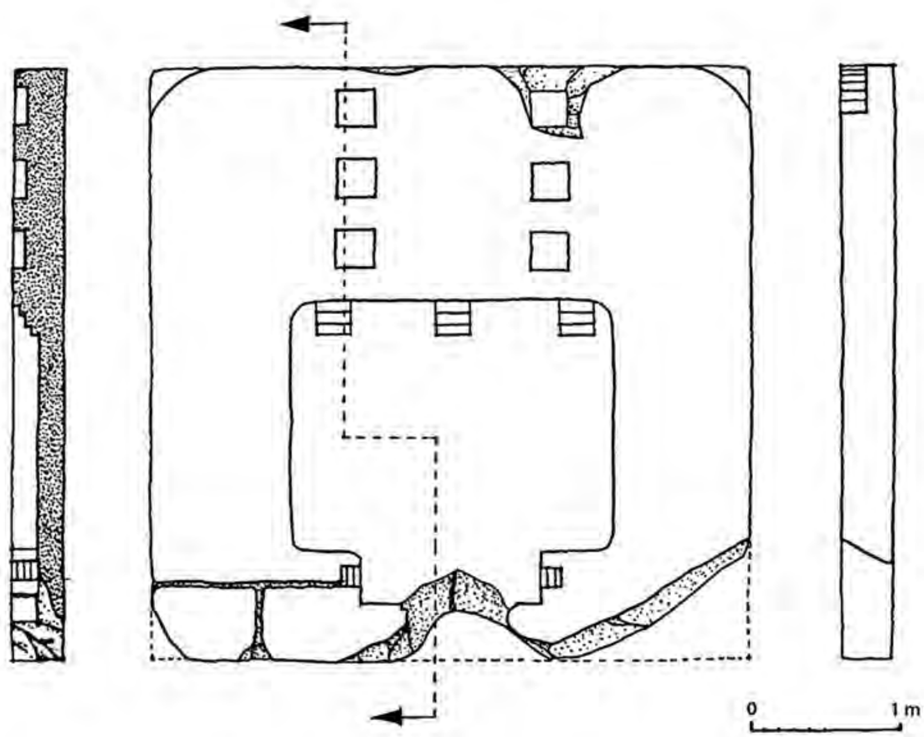


Figure 4.17. Kantatayita model stone drawing (drawing by Heshang Liang).

hypotheses with respect to its possible use or function or its location.

Whether these unresolved issues can one day be answered through further investigations and excavations is uncertain and, in our view, much in doubt. We are afraid that too much has been lost to the ravages of time and the wanton destruction we have commented on earlier. On a more optimistic note we now turn to what we have learned from our observations and experiments about the skills and practices of the stonemasons of Tiahuanaco.

Notes

1. In his dictionary of the Aymara language of 1612, Ludovico Bertonio translates "loca" as "una braça, medida," that is, the measurement between the outstretched arms or a fathom (1984).

2. Bertonio renders "mukhlli" as "codo del braço," that is, the elbow. Of "codo," the cubit, he wrote "no la usan los indios." That the *mukhlli* was not used by indigenous people in the fifteenth and sixteenth centuries does not mean it was not used in some earlier time, but it does suggest that it was not a very common measure.

3. The dimensions of the sides of the Semi-Subterranean Temple were given clockwise from north as 26.00, 28.57, 26.05, and 28.47 meters (Chapter 2), which correspond to 61.90, 68.02, 62.02, and 67.79 *mukhlli* of 42 cm, respectively. With these minor deviations from whole numbers, it is not unreasonable to think that the Semi-Subterranean Temple was laid out with dimensions 62 by 68 *mukhlli*, if that is a measure actually used by the Tiahuanacans.

4. We could not find any reference to the arm's length as a measure in any of the Aymara dictionaries we consulted.

5. Angles of 30 degrees are easy to construct, even without the help of a compass. With three sticks of equal length one can construct an equilateral triangle, all angles of which are 60 degrees. Marking the mid point on one of the sides and joining that point to the apex of the angle opposite that side, one bisects this angle into two angles of 30 degrees.

6. Protzen is indebted to Stephen G. Miller, Department of Classics, who, in a course they taught together, remarked on this similarity.

7. Labels such as WR 24, or later ERxx or PFyy, refer to our inventory of stones.

8. Note that Squier's Temple is today's Kalasasaya, his Hall of Justice, Pumapunku, and the structure he "ventured to call symbolical," Kantatayita.

9. Tschudi probably remembered the second, smaller gate from his earlier work with Rivero on the *Antiguedades peruanas* in which they published the abovementioned drawing (Rivero y Ustáriz 1851).

10. The word "parte" is a typographical error introduced into the typeset version. Cobo's manuscript clearly contains the word "puerta."

11. "Quicios" literally translates to "hinges." But since there are no hinges to be seen, we interpret "quicio" to mean "jamb."

CHAPTER 5

THE ART OF STONECUTTING

Apart from the architectural, the nature of most of the worked stones at these ruins also raises a technical problem. It seems that the technological means available to the old Peruvians, in as much as we know them, are in no relation to the excellence of their achievements [Stübel and Uhle 1892:Part 2, 44] [translation by authors].

STUDYING TIAHUANACO CONSTRUCTION, like other aspects of Tiahuanaco architecture, has been hampered by the vast destruction of the site, which has made it difficult to investigate. Yet, despite this destruction, the surviving pieces are so exquisitely carved and composed that they have fascinated visitors for centuries as to their method of construction. In the sixteenth century Cieza de León mused, "[W]hat I cannot grasp nor understand is with what instruments and tools [the stones] were wrought" (1986:283), and as reported before, Squier did not even want to speculate on the subject. It was not until the late nineteenth century when we get our first concise definition of Tiahuanaco construction. Alphons Stübel and Max Uhle performed a careful analysis of the remains, highlighting three characteristics of Tiahuanaco masonry. Without providing an answer, Stübel and Uhle, argued that:

1. The Tiahuanaco stonecutters had a means to produce right angles with consistency.
2. The stonecutters knew of several techniques to grind (*schleifen*) and smooth (*glätten*) stones.
3. The perfectly executed interior corners required the use of sharp instruments (Stübel and Uhle 1892:Part 2, 44).

To these observations we add:

4. The Tiahuanaco stonemasons had means of controlling the planarity of extended, smoothed, or ground surfaces.

The questions arise, what processes and tools the stonemasons used in their work? To our knowledge, no tools have ever been excavated or identified that are positively associated with construction at Tiahuanaco. Iron tools were unknown in the Andes before the arrival of the Spanish. The few Tiahuanaco copper or bronze chisels in the American Museum of Natural History[1] in New York and in the Museum Tiahuanaco in La Paz seem too small for construction work. Furthermore, preliminary tests we made with modern bronze showed the material to be rather ineffectual on hard stone. Our tests are in agreement with those made by Denys Stocks, who experimented with copper and bronze tools on hard limestone, various granites, and grano-diorite in an attempt to replicate the carving of Egyptian hieroglyphs (Stocks 1986). Stocks found that even modern, high technology steel chisels were severely damaged when used on hard stone and needed frequent and considerable sharpening. Turning to stone tools, flint chisels in particular, Stocks eventually was able to carve a good facsimile of the glyph for “nb” into coarse-grained granite. Could the Tiahuanaco stonemasons have used similar stone tools?

First Clues

Our close inspection of numerous building stones yielded some first clues to the stonecutting process and, if not to the actual tools used, at least to their shape, dimension, and action. Several large blocks of andesite, still raw from the quarries, are testimony to the partitioning and rough shaping of stone. One such block near the north gate of the site was about to be quartered into four smaller blocks; another just north of the museum was being parted into two slabs, yet another near the northeast corner of the Kalasasaya shows signs of being reduced (Figure 5.1). All these stones feature pit scars and patterns of cups, pans, and troughs that are diagnostic of work with hammer stones (Protzen 1993:170–172).[2] However, we have found one hammer stone of hematite that shows wear marks and that the stone was found out of context.[3] The valley floor around Tiahuanaco is strewn with quartzite cobbles, which would make excellent hammer stones, but their use as such has still to be established. Although we have yet to identify the actual hammer stones, the marks nevertheless suggest that the Tiahuanaco stonemasons used a technique quite similar to that described elsewhere by Protzen (1983; 1986) to do the coarse work. Other building stones bear evidence that rough and finishing work was done simultaneously on one and the same work piece. The roughing out of stones was done by pounding with hammer stones, the fine work, however, is still in need of an explication.

Figure 5.1. Large block that is in the process of being cut into smaller blocks by pounding with hammer stones.

We observed consistently a small groove at the apex of interior angles (Figure 5.2a). The grooves appear to have been incised or made by a chisel-like tool and not with pounders. Pounders, no matter how pointed they are, always leave rounded corners (Figure 5.2b). In interior corners formed by more then three planes, such as in the case of the arrow motifs (where four planes come together in a single point), evidence suggests that a punch-like tool was used (Figure 5.2c). Because of existing point-like marks, we inferred that such a tool was also used in chiseling out cramp sockets in deep recesses (Figure 5.2d). The disposition of these cramp sockets and the recesses into which they are carved give us some idea about the minimum length of the tool and its angles of attack.

An Experiment

The above observations prompted us to devise an experiment as an attempt to reproduce Tiahuanaco-style stonecutting techniques and to gain an understanding of the particular intricacies and difficulties associated with the making of perfectly planar surfaces, exact right angles, and sharp edges and corners—exterior as well as interior. Encouraged by Stocks’s findings and armed with the knowledge that bronze tools were probably not used, we decided that the experiment must be performed with stone implements alone.

Nair carried out the design, development, and execution of the experiment. For reasons of logistics and time, the experiment was done in Berkeley, rather than in the field (Nair 1997).

Choice of Task and Material

The most exacting stone carving at Tiahuanaco is found on andesite. The andesite at Tiahuanaco measures from 5.5 to 6 on Moh’s scale of hardness, and

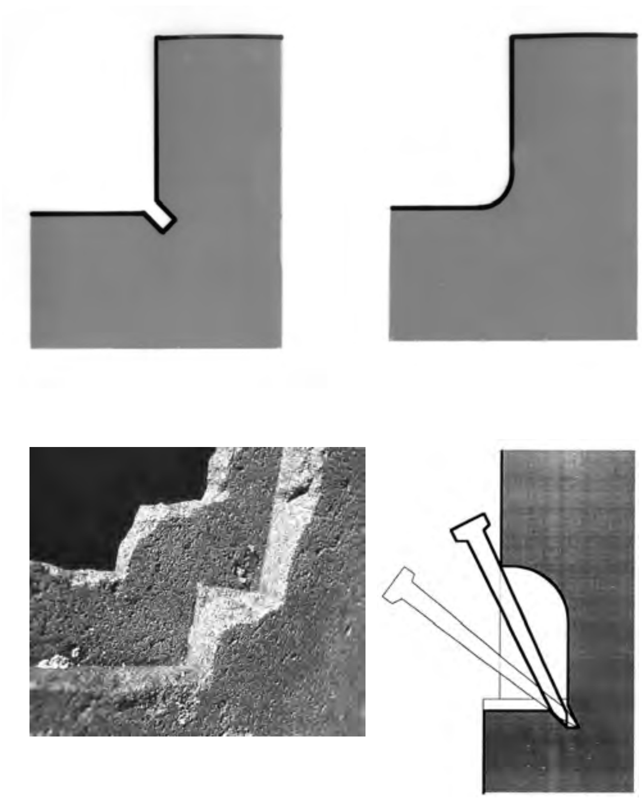


Figure 5.2. (a) Small groove at the apex of the interior angle carved stones, result of incisor.
Figure (b) Rounded corners in interior angles, result of pounders.
Figure (c) The precise interior corners suggest the use of a sharp thin blade (punch or chisel) and incisor tool.
Figure (d) How a long thin chisel or punch tool was used to carve deep recessed pockets (drawings Jean-Pierre Protzen, first published in *Journal of the Society of Architectural Historians*).

comes in various qualities from dense, fine, and even-grained, to very porous with uneven-sized phenocrists. The most intricate and precise carvings are generally found on the best quality stone. Ideally, the experiment should have been executed on actual Tiahuanaco andesite, but without this, the stone to be carved had to at least approximate the hardness and quality of the Tiahuanaco andesite. We found a suitable rhyolite similar in composition and grain size, albeit slightly more porous than the Tiahuanaco andesite.[4] The proposed carving, in turn, had to have all the characteristics of those at Tiahuanaco: perfectly planar surfaces, dimensional precision, exact right angles, and sharp exterior and interior edges and corners. Nair chose to cut half of a simple cross motif as seen, for example, at the top of Types 3.3 and 3.4 stones, keeping the same dimensions of the actual crosses.

Choice of Tools

What types of stones should be used as tools? Since we were not aware of any detailed petrographic study of the Tiahuanaco area, we did not know what, besides quartzite, was immediately available to the stonemasons. The same way as the Tiahuanaco builders went out of their way to find suitable construction stone; they are known to have imported exotic raw materials for their artifacts such as basalt, obsidian, and hematite. Thus, it seemed to us that we had a certain liberty in our choice of raw materials and that we were not bound to the particular local conditions. We let our selection of raw materials be guided by previous experience with stone tools, and by the availability in Berkeley. As Protzen has discussed elsewhere, the tools do not necessarily have to be harder, only tougher (i.e., more resistance to cracking) than the work piece on which they are used (1993:172–173). Nevertheless, we expected that to do the fine work, we would need a set of hard, sharp, and pointed tools. The stones chosen for our tool kit included several chalcedonies (flint, agate, and jasper), obsidian, greywacke, quartzite, and hematite.

Preparing the Surface

As mentioned before, surviving building blocks demonstrate that rough work and finishing touches were often made simultaneously on the same block. However motifs, whether finished or not, always appear to have been carved into a flattened, smooth and finished surface. For obvious reasons, a surface that is smooth and flat is ideal for laying out a motif that is exact to the millimeter. Otherwise any bumps or dips in the surface would cause serious errors. To obtain an even surface, Nair first used hammer stones to wear down one side of the work piece to a roughly even surface. Grinding and polishing with a flat stone (a fire brick) and sand she obtained a reasonably flat and smooth surface, which, however, fell short of the Tiahuanaco prototype (Figure 5.3). Indeed, Nair found in her experiment that surfaces that visibly appeared flat were tactically unveiled as incredibly uneven.

Stonemasons today use a straightedge, preferably two, to check the planarity of a surface. They use the first straight-edge set on a building block's clean edge to take a sighting at the second located anywhere on the surface to be cut. The ancient Egyptian stonemasons used a device called "boning rods," which

Figure 5.3. Polishing device (fire brick) with polishing matrix (sand containing silicates).

consisted of three rods and a string. Two rods of equal length are connected to each other at their tops by a string (Figure 5.4). The third rod, also of the same length, is used to move over the surface against the taut string (Clarke and Engelbach 1990:105–106; Arnold 1991:256–257).

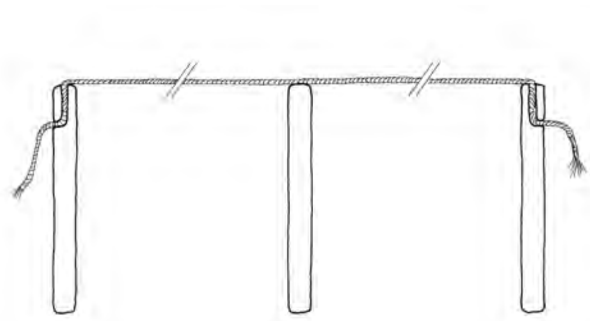


Figure 5.4. Boning rod as used by the Egyptians (drawing by Jean-Pierre Protzen).

Intrigued by this possibility, Protzen conducted an experiment to see if he could devise a method to obtain planarity on a large stone surface. Armed with a straightedge and perseverance Protzen was able to carve a good facsimile of a planar, hammered Tiahuanaco surface. He found that with the repeated and systematic use of the straight edge, such that he repeatedly moved the straight edge in concentric circles around several fixed points, he could obtain a flat, planar surface while hammering. Hence, it is quiet possible this was the technique used by the Tiahuanaco masons to level large surfaces.

While we cannot say conclusively what the Tiahuanaco masons used to flatten surfaces, the experiment undoubtedly demonstrated that a tool similar to a straightedge is necessary to control a surface's planarity. The human eye is not good enough a judge. As we found in our own experiments, what appears flat to the eye may still be bumpy to the touch. But if touch can detect unevenness, it cannot necessarily discover planarity: a smooth but shallowly convex or concave surface may appear planar to the touch. Such fine deviations from planarity are also not easily detected by the unaided eye. In the absence of a straightedge, pouring water on the surface does reveal concave and convex areas, provided that the work surface can be set to be more or less horizontal.

Technically, perfectly planar surfaces can be obtained without a tool or water, simply by grinding three, approximately flat stones, S_1, S_2, and S_3, against each other: first S_1 against S_2, then S_3 against S_1, and finally S_3 against S_2. Repeating the sequence until all three stones fit snugly unto each other, one ends up with three perfectly planar surfaces. Three are necessary, for two stones alone when ground against each other may hug perfectly, but the connecting plane could be warped. With three they will be planar: if S_1 were convex, S_2 would have to be concave to fit tightly against it. Now S_3, if it were to hug both S_2 and S_1 would have to be both convex and concave at the same time. This is impossible (Gonseth 1946:106–107). In practice, one of the three stones is the work piece, and the two others are grinding stones that are alternately applied to the work piece, and periodically ground against each other for correction.

The Greek builders used a technique very similar to this method to adjust the bedding joints, or seatings, of the column drums, as well as other blocks. A pair of "surface plates"—large stone slabs attached to a wooden lifting grid—was ground against each other for a perfect match (Figure 5.5). The two plates (A and B) may not have been perfectly planar, yet they complemented each other; the concavity of one would be matched by a convexity of the other. Checking the smoothness of, say, the top of a column with surface plate A, and the underside of the column drum to be set on top with surface plate B, the two column drums will fit perfectly onto each other. The surface plates were coated with some paint, thus in repeated checking for smoothness, the masons had only to grind down those spots on the column drums that were marked with paint until the whole surface was marked and the final fit achieved (Korres

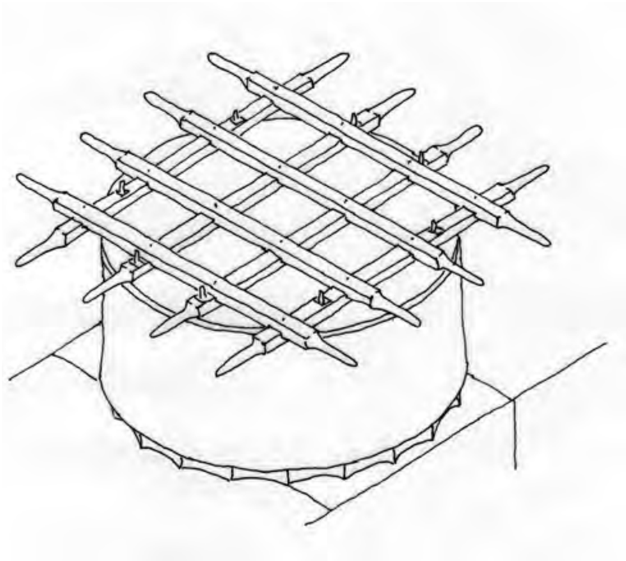


Figure 5.5. Greek "surface plate" technique (redrawn by Jean-Pierre Protzen after Korres).

1995:106–109). This process helped to visualize the uneven areas and direct the tooling process directly on the raised areas.

However, even if a technique with surface plates is able to flatten large outer surfaces, it would not be applicable to recessed surfaces or planes. For example, it would not be able to flatten the interior planes of a cross motif because there is no room for the grinding action. Therefore, Tiahuanaco stonemasons must have used some other technique, unknown to us, for this purpose.

Laying Out the Motif

Once the surface is prepared, the questions become, where on the surface is the motif to be placed and how is it transferred to the stone face? A system of proportions and rules of composition (as discussed in Chapter 4) would help to determine where on a stone a particular motif was to be placed. However, since most building stones were only pieces of an overall composition, some sort of measuring device would have been needed to precisely position an isolated motif by measuring its location from some reference edge or corner. This issue was of no concern in the experiment at hand, since the location of the motif was arbitrary.

Once the location was set, did the masons simply start cutting, or did they layout the motif on the stone first? It is theoretically possible that the Tiahuanaco masons simply carved their motif "freehand" without the assistance of measuring devices. Considering the precision of the motifs and the unforgiving nature of stone, this is, however, highly unlikely. Even the most skilled masons would have had difficulty visualizing the motif, locating it exactly to the millimeter upon the stone slab, and cutting it precisely without making a single mistake. To minimize errors, it is probable, then, that the masons laid out their design on a prepared surface before starting to carve.[5] As the experiment showed, a template provided a solution to the problem. With a template, the motif was easily traced and transferred (with a medium such as paint) to the stone surface (Figure 5.6). Considering the numerous repetitions of motifs at Tiahuanaco, such a reusable template would have greatly aided the work.[6]

Figure 5.6. Wooden motif template placed on stone surface. The painted motif is in the process of being hammered away.

Postulating the use of templates by the Tiahuanaco is not too far fetched. There are various examples of template use in the Andes. Early Chavín-style rolling templates, made of ceramics, have been found along the north coast of Peru (Rowe, Chavín template, personal communication, 1996), and a Tiahuanaco-style rolling template, made of llama bone, was found in present-day Chile. Although these rolling templates are smaller than any motif on Tiahuanaco building stones, such templates could have been made on a larger scale.

Cutting the Motif

Once the motif was laid out, the problem arose of how and where to begin to cut the motif. Using various sizes of rounded granite and quartzite hammer stones, Nair was able to pound out much of the interior of the

Figure 5.7. Round hammer stones used in the experiment. Note the smooth sizeable body to hold and the subtle variation in tool head size.

Figure 5.8. Long, narrow hammer tool (grey wacke) used extensively after rounded hammer tools proved to have a too-wide working head. The long body also allowed for better directional control in the hammering process.

cross motif (Figure 5.7). A minimum of 4 to 5 mm of excess stone was left around the outline to avoid over-hitting and leaving an irreparable mistake in the stone. The outline of the motif provides clear guidance to the extent of the motif; however, no such direction is given for the depth to which the motif is to be carved. Here, the mason has to interrupt the pounding every so often to measure the depth to avoid carving out too much of the stone. With the stone surface around the motif as a reference plane, controlling the depth of the working area is easy, provided again that the stone surface surrounding the motif is perfectly planar and smooth. Any unevenness of the surface around the motif introduces errors in the depth measurement.

Hammers to Chisels

After a few hours of Nair's pounding, a rough bowl-shaped depression marked the interior of the motif, with the greatest depth roughly at the center. The next step was to clear away the material in the corners. The round hammer stones, useful in the initial stages, became too clumsy. A long hammer tool with a thin head to get into the narrowing areas was needed. A long, thin greywacke tool worked best. Its narrow but durable head was able to work the corners, while its thin and curved body allowed for easy handling (Figure 5.8).[7]

To remove material efficiently, it is important that the mason strikes the stone along cleavage planes, or, as the parlance goes, that she work "with the meat"[8]. To find the cleavage planes the mason not only shifts the angles of attack, but also the direction of the strikes. In the experiment, Nair often moved around the stone and alternated hammering the block at angles between 30 and 70 degrees. It should be noted that it is easier to carve half a motif than a complete one. In half a motif, the mason has two sides at right angles to each other from which to attack the stone. Working from two sides makes it easier to create ridges or edges in the stone, which then can be broken off with little effort. In contrast, working from just one side, the mason always works "against" the stone. The result is that the stone surface is slowly pulverized (with much effort) rather than rapidly broken off (with relative ease).

As work progressed, even the heads of the long, thin greywacke and agate hammer stones became too large for the increasingly narrower corners. Furthermore, pounding made it difficult to strike a precise point, because the length of travel necessary for the hammer to impart a blow with sufficient force lets the mason only roughly estimate where the hammer will land. At this stage of the work, it becomes important that the mason be able to place the cutting edge of the tool in the exact spot *before* the work piece is struck (Stocks 1986:Part 3, 28). A shift from hammering to chisel-like tools seemed desirable to reach the ever-narrower areas of interior corners as well as to strike the ever-thinner bands around the exterior edges.

But what could be used as chisels? The tool needs to be long enough to be held with at least two or three fingers, and must have a sharp point or very thin blade on one end and a striking platform on the other. By breaking up nodules of flint, jasper, and obsidian Nair obtained suitable tools with which she could carve fine

Figure 5.9. Motif in the early stages of being carved. The area to the back and left has been worked with various hammer tools, while the area to the right has also been worked with medium-sized chisels, such as the one shown on top of the stone.

Figure 5.10. Motif in process. Note the large scars in the area to the far left, which has been hammered compared to the smaller scars in the walls to the middle and right. These latter areas have also been worked with chisels and punch tools. Note also the line in the interior corner of the middle wall. This has been made by a fine chisel tool and has been sharpened by an incisor blade.

and straight grooves (Figure 5.9). It was not necessary to shape the tools by knapping because of the exceedingly high turnover rate of the chisels. No tool could be used for more than three to four blows with a stone hammer before the working end was crushed or the tool shattered into pieces. Wooden mallets, absorbing some of the force of the blows, extended the life of the blades only minimally.

Working away at the corners and edges, it became apparent that the different corners, those defined by *two* intersecting planes, exterior and interior, and those formed by the intersection of *three* planes, again interior and exterior, each presented unique problems and, therefore, required specific tooling procedures. To work down the 4 to 5 mm left around the exterior edges (two planes) after hammering, experience showed that with chiseling, one could not get much closer than about 2 mm to what is to be the final edge. With two receding planes, the exterior corner is extremely fragile. Trying to get any closer with the chisels resulted in permanent damage to the edge. In contrast, working interior edges (two planes) posed no such problem. With jasper, and then finer flint and obsidian blades Nair was able to work within half a millimeter of the final line (Figure 5.10).

Punches

Interior corners at the junction of three planes were much more difficult to work. To reach into the corners, the chisel had to have a very fine point and have a long enough body that it could be held and then struck beyond the fragile exposed edges of the motif. What was needed was a 'punch' or pointed chisel. Obsidian delivered the best punches, but they were so frail as to last an average of only one or two blows. Exterior corners at the junction of three planes, on the other hand, could not be worked close to the surface without risk of damaging the edges, even with a fine point.

Beveled Walls

Because interior corners of either type (an area between either two or three planes) could be worked to within a half a millimeter of their final depth, while exterior corners could only be cut to within a few millimeters, (almost) visibly imperceptible beveled sidewalls resulted all around the motif (such that the exterior edge overhangs the interior corner). Protzen suggested that the beveling might be part of the carving sequence. Indeed, an undercut, or protruding edge should be easier to cut off with precision than one in full stone, as there are more exposed surfaces to enable quick removal. Nair tested a version of this approach to level off the final walls. Marking the final edge on the surface of the stone with an incised line about 1 mm deep, the projecting 2 mm or so could be chipped off cleanly at the incised line by very gently and carefully tapping the area with a small chisel. While successful for the removal of a small area, this process was not possible on the large scale, such as seen at Kantatayita beveling. Beveled walls (albeit extreme and clearly visible) are commonplace in the unfinished stepped crosses at the Kantatayita. When Nair tried to hammer off such a large overhang, the stone broke off in uncontrollable chunks, creating disastrous permanent damage. This exercise highlights the fact that each stage of the carving process has very distinct conditions that necessitate specific working processes and that those processes are not easily transferred.

Incision

Incising was also used to finish the interior edge. Fine cuts could be made with flint and obsidian microliths. Most of the blades used were nothing more than byproducts of making chisels; no effort was needed to cut new blades (Figure 5.11). The blades were used for about two to three minutes of constant scraping. Incising required a large supply of new blades because it is a slow process.[9] In the end, all the interior corners could be sharpened and worked to their correct measurements with incising.

Polish

After all the hammering, chiseling and incising had been done, and the motif had taken on its intended shape, the stone still had a rough appearance. It did not yet have the smooth, clean look that distinguishes Tiahuanaco masonry. To remove the remaining tool marks the stone had to be polished. The traditional method of grinding a large, flat stone and a loose abrasive material over a surface did not seem practical. The small interior surfaces with their many boundaries did not allow enough maneuvering room for this kind of tooling, nor did it seem possible to keep the loose abrasive in place on vertical surfaces. What was needed was a light, small polisher with a sharp, abrasive material embedded within it, something akin to a file.

Nair was perplexed, at first, as to what material could work here. Sandstone is an effective grinder, but it is a poor polisher. No matter how fine the sand grains, they are too coarse to bring about a polish. Several materials, including quartz and pumice, were tested with equally poor results. Then came a hint: Carolyn Loss Winter mentioned that obsidian, when aging, tends to become hydrated, giving its surface a vesicular and pumice-like appearance (Winters, personal communication, 1996). Nair decided to see how this change in the stone could affect tool use. Pieces of old flow obsidian were obtained in Berkeley and tested on the rhyolite (Figure 5.12). The results were dramatic. The rough surface of the obsidian worked like sandpaper on wood. The obsidian gently but effectively smoothed the rough stone surface. The obsidian pieces endured about 10 to 15 minutes of constant use before losing their abrasive qualities.

Polishing with old flow obsidian required specific patterns of movement. At first, Nair obtained only curved surfaces. This was, in part, due to the rounded surfaces of the obsidian and in part, to the single movement in which she rubbed the hydrated cortex across the stone. After experimenting with tool shapes, small flat obsidian blades proved to be the best. They were easy to control even in tight areas, and permitted to vary the patterns of movement even in small areas. The small size of the obsidian also meant that the mason had direct tactile contact with the surface she was working on. As mentioned above, the ability of the mason to see the bumps on the stone surface gradually disappears as the lumps become smaller, and

Figure 5.11. Incisor blade in use.

Figure 5.12. Obsidian tool used as polisher.

therefore, the mason must rely more and more on the feel of the stone surface to locate irregularities.

Working with obsidian polishers, Nair made another discovery. While polishing with the hydrated face of the blades, she learned that it is possible to use the sharp edges of the obsidian to incise the interior lines in the same operation (Figure 5.13). Yet, polishing is a slow process. For example, Nair took six hours to finish the exterior corner of the third wall. Polishing also fails to remove all the tool marks; subsurface breakage from hammering remains. The evidence is subtle, but it is possible to see the difference between the surface that was picked (before the experiment began) and hammered. Areas that had not been hammered, such as the fragile exterior corners, showed less subsurface damage.

With a correctly dimensioned, polished motif, the only stage left was to flatten out the remaining bumps on all the interior planes. This task was left to the end as it was seen as no more than a finishing touch, but that assumption proved to be a serious miscalculation. Trying to flatten the entire interior surface turned out to be a very difficult task that was never accomplished.[10] It became obvious that surface flattening must be taken care of in an earlier stage, simultaneously with other carving tasks. Protzen's later experiment suggests how large exterior stone surfaces could have achieved planarity. Further experimentation will have to be conduct to discover the appropriate technique for planning small interior surfaces.

Without a doubt, the experiment showed that motifs, like those found at Tiahuanaco, could be carved with simple stone tools (Figure 5.14). No fancy theory is needed to explain Tiahuanaco stone carving. Using these stone tools, Nair was able to closely reproduce what the Tiahuanaco accomplished: dimensional precision, right angles, and sharp edges and corners on both the interior and exterior of the motifs. Only the perfect planarity of surfaces developed by the Tiahuanaco was not reproduced. It took Nair approximately forty hours to complete three of the five walls of the half cross motif. Much time, of course, was spent in a trial-and-error mode. With some prior knowledge, we estimate that this amount of work could be accomplished in about 25 hours. Armed with what we had learned from the experiment, we returned to the field to compare our insights with the actual field data and to look for observable tool types, tool marks, and stonecutting processes which would either corroborate or refute Nair's results.

Figure 5.13. Obsidian being used as polisher and incisor.

Figure 5.14. Close-up of finished corner in the motif, revealing the precision obtained in the form of a perfect right angle. Note also the damaged surface of the interior angle where Nair learned how fragile this area is, and hence, the need to preserve this area until the very final stages in the carving.

The Experiment Compared to Field Observations

Lithic Materials and Tools

One of the first things we did upon returning to Tiahuanaco was to look for tool evidence. It was clear that the Tiahuanaco masons, like those of the Incas, used hammer stones in their stone working process. For the Inca, hammer stones constituted their main tool, but for the Tiahuanaco, pounders would have only begun the complex process of shaping the stone. Although we did hold out much hope that tools would be lying readily on the surface, we did scan the area around Pumapunka again to look for any evidence of tools, such as hammer stones. We came upon a few rough, odd-shaped river cobbles of quartzite that looked more like rock debris, but they showed wear as if they had been used to pound stone. If these stones were indeed hammers, they are not like any of the hundreds of hammer stones Protzen has seen in the ancient quarries and on construction sites in Peru, Egypt, or other places. Most of these hammer stones have two or more planes of symmetry, which make them easy to handle and well balanced. We doubt that the ill-shaped stones we found at Pumapunku were the hammer stones of the Tiahuanaco, but will withhold judgment for now.

We also searched the surface of Pumapunku for any stone types that could serve as successful stone carving tools. Among the many stone types littering the surface we found an abundance of green basalt. Initial tests with the basalt indicate that it is very durable and tends to break into relatively long, straight flakes. This stone performs better then jasper when used to chisel andesite. Our lack of finding tool evidence on the site surface is not surprising given the almost 800 years since the site's abandonment. If any tools for the stone carving process are to be found, it will likely be in excavations. Indeed, it is in excavations that we get our first mention of evidence that could be related to the stone carving process.

In the early twentieth century, Bennett wrote about having found stone tools and flakes in his excavations. Among the tools were several basalt axes and a number of hammer stones made of granite. He described them as "cylindrical, with rounded edges, and straight sides. A typical hammer measures 4.5 centimeters in length and 3.5 centimeters in diameter" (Bennett 1934:246). Whether the tools showed signs of wear, Bennett did not say. He found flint, quartz, and obsidian in many of his pits and noted that most of these stones were unworked (Bennett 1934:246). That, of course, is congruent with Nair's findings that flakes from nodules could be used without further shaping, and that shaping would only have been a waste of time.

Bennett did not say whether the flakes bore wear marks, but even if he had noted that the flakes had been used, questions would remain. On what would the flakes have been used and for what purposes? The wear marks left on the many tools used by Nair in various processes need first to be analyzed, before they can be used in comparison and identification of use. However, what is important here is that unlike the easily recognizable intact tools like the hammer stones and the chisels, most of the tools would have looked much like tool debris rather than tools themselves, such as the fractured remains of the chisels, punches, and incisors. These unshaped and broken fragments would be found in dense patterning, but would not otherwise be readily recognizable as tools to someone not familiar with the stone tooling process. Hence, in future excavations, stone flakes must be carefully examined to determine whether they could be the remnants of stone carving tools.

Clues and More Clues

While we could do nothing further with the material that may still be buried, the stone blocks above the surface proved to hold a treasure trove of clues that we had previously missed. By reexamining building stones we had recorded before but with an eye for what we learned in the experiments, we found many additional clues to the carving techniques of the Tiahuanaco. Several of the Type 1, or H-stones, and the Type 2, or Sawtooth stones, show sections at different stages of the carving process "frozen" in time. These sections hold clues to a variety of carving tasks, and, as we will show, suggest that the Tiahuanaco stonecutters had standard techniques to execute recurrent tasks.

Preparation of Surfaces

Our experiment has shown that the preparation of a planar surface is quite a challenge, but it also revealed exactly what the problems are. Armed with this knowledge we took another look at the smooth surfaces in the field.

Pounding

Much to Nair's chagrin, our subsequent field analysis revealed that the Tiahuanaco stone carvers made perfectly flat surfaces throughout the carving process. Indeed, the stonemasons made flat surfaces with such apparent ease that they created these surfaces not only for the finished motif, but also throughout the carving process. Hence, a flat surface was made to define a motif in one stage of the process, only to be subsequently destroyed and then remade again later, a few millimeters deeper into the stone block. Flat surfaces were made first with larger hammer tools and were redone further down in the stone with successively smaller hammer tools, ending with a surface that was also polished.

Planing by Layers and by Drafts

The field evidence from Pumapunku reveals that a consistent hammering-based process was used to create flat surfaces on all the fine carvings. The evidence indicates that through all stages of the carving process, no matter what tool was being used, Tiahuanaco stone masons approached the desired final surface gradually by removing one layer of excess stone after another, with ever more care the closer they came to the target surface. To control the depth to which lithic material had to be removed, the Tiahuanaco stonemasons cut drafts into the stone and, very early in the process, created carefully leveled sections of the finished surface to serve as references to the final surface. This is consistent with the earlier reported observations that rough work and finishing touches were made simultaneously on one and the same stone.

Quality of Surfaces for Motif Layout

If we examine all the motifs made at Pumapunku, there is little evidence for understanding what surface they were initially laid out on. This is because all of the cross motifs at Pumapunku are largely finished.[11] While we cannot learn from the evidence of the cross motifs in terms of surface preparation, we can gain insight from the stone carving process at Pumapunku, in particular, we can observe how other motifs and arrangements were carved out in the stone by looking at other examples. At Pumapunku, we discovered an abundance of evidence that shows overwhelming consistency in pattern and execution, from the beginning of the carving process to the final touches.

LAYING AND ROUGHING OUT MOTIFS

As demonstrated in Nair's experiment, the first issue is how to layout and begin carving the stone. One of the determining factions regarding the degree of surface preparation for motif layout depends on whether the motif is to be carved out of the "full flesh" of the stone, or whether it is at the stone's edge. Considering that all the motifs in the field begin with carving that lies well within the boundaries of the final outline of the motif, it is likely that a template, whether painted, drawn, or placed on the stone, was used to mark the final outline.

In addition, at Pumapunku, motifs that reached the edge of a stone block appear to have been roughed out starting from the edge. As noted in the experiment, this allows for an easier or more controlled carving process. It also allows one worked stone face to "move" to an adjacent plane on another side of the stone. Once motifs and design elements are laid out on one part of a stone's face, the mason can then use this new plane to move around the stone, whether on the same face, or to a worked plane on another side of the stone. We found repeatedly among the surviving stones of Pumapunku that a flattened surface was made and then carried across to an adjacent façade, no doubt allowing the mason to monitor and control the surface in preparation of the final, precise motif (Figures 5.15 and 5.16).

CARVING INTERIOR EDGES AND CORNERS

The next stage, after laying out and beginning to carve the motif with hammer tools, is to work more closely toward the final edges, creating the interior corners and walls. In the experiment, this results in a series of progressively more delicate operations, with smaller tools and more careful movement and techniques. In the field, we found abundant evidence supporting this sequence. Perhaps the most striking example was found on stone WR 41,[12] a Type 2, or Sawtooth stone (Figure 5.17). In the stone, the exterior surfaces have all been hammered to a well-defined outline of the final stone type. The larger planes are hammered flat and are planar.

The next stage of work is in carving out the still very rough interior corners and neighboring portions of the walls. As one can see in the photograph, the interior edge at the intersection of two planes forming an acute dihedral angle is roughed out at the top, almost finished in the middle, and partially cleared at the bottom (Figure 5.18).[13] Hence, the most advanced

Figure 5.15. Note how a flattened, planar surface (one that has been worked with large and then very small hammer tools) is moved along a single plane (where only large hammer tools are being used).

Figure 5.17. Unfinished Sawtooth stone, Type 2. The interior corner to the far right has three stages of carving in process, running what is now vertically down the corner. The interior corner to the left is largely complete, lacking only the final finishing work.

Figure 5.16. Note how a flattened, planar surface is transferred to an adjacent face of a stone block.

Figure 5.18. Close-up of right-hand corner of Sawtooth stone, showing three carving stages in the process of making the interior corner.

work occurs in the middle of the motif (the Sawtooth stone's interior corner). This concurs with what Nair discovered by trail and error, namely that exterior areas are the last to be worked as one begins to get close to the final surface. This is due to the exterior (two planed) areas being the most fragile (unintended overhitting can create irreparable damage). Thus, while exterior edges are the best to begin (rough shaping a partial motif) due to their ease of carving, this same malleability makes them the most delicate toward the end of the carving process. Hence, the edges then become the last areas to be carved.

In this section of the Sawtooth stone, we also see the transition from hammer tools to successively smaller chisel tools. The roughed-out section has the typical pockmarks of a surface that has been hammered. As the corner gets tighter and tighter, a tool with a narrow, rounded head appears to have been used. One can imagine the round hammer tools used by both of us in our own experiments being used first. Then, as the carving surface became closer to the final target layer and more delicate detailing was needed, one can imagine the mason beginning to use the narrower hammer tool (such as the long, narrow one with the smaller head used by Nair). The markings (on this portion of the Sawtooth stone) indicate this transition in tool type. In addition, as the marks in the corner of the Sawtooth stone become even smaller, it seems that a type of chisel must have been used in order to obtain such small and precise corner marks, again matching with another stage in Nair's experiment (Figure 5.19). On the Sawtooth stone, the chisel tool left marks that were longer, thinner and more precise than those left by the hammer tool. These marks are visible in the lower, partially cleared section.

It is also at this point in the carving process that we see the importance of creating flat, planar surfaces, as well as the various degrees of flatness and smoothness that the Tiahuanaco carvers were able to obtain so frequently. In the Sawtooth stone, the left surface (next to the corner) has already been flattened and smoothed in order to serve as a guide to the final interior edge. By contrast, the right surface is only roughly shaped (Figure 5.20). On that surface, faint chisel

Figure 5.19. Close-up of Sawtooth stone. Note change from the pock marks typical of hammer tools to smaller, deeper marks in the more acute angles of the corner, indicating the transition to a chisel tool.

Figure 5.20. Note that the corner is made ever tighter toward the bottom. The round tool marks are replaced by sloping lines. These chisel marks show the transition to an ever smaller and more easily controlled tool head. Note also that the plane to the left of the corner is smooth (pock marks of a small hammer tool), while the plane to the right of the corner is rough (pock marks of large- and medium-sized hammer tool).

marks used to work down the corner and adjacent face can be seen descending from left to right. Also visible is a distinct line demarcating the intersection of the still rounded corner and the right-hand plane. That line continues to be visible in the middle where the corner has already been cleared. Where the corner has been cleared, very fine chisel marks appear between the actual corner and the demarcation line, indicating that, after the use of a small hammer tool, a chisel has been introduced to work down the surface adjacent to the corner. Note how this work ends as the edge of the stone approaches, in order to protect this delicate area (Figure 5.21).

In this example, with the important exception of successive planar surfaces, the sequence of carving interior corners developed by Nair is borne out. First, hammer stones are used to remove the bulk of the material. Second, flat, planer surfaces are continually made and remade to control depth and motif outlines. Third, as the corners gets tighter, the mason shifts from larger to smaller hammer tools, and eventually from rounded chisel heads to small linear ones, in order to cut away the remaining material. All of these stages in the carving process can be seen on the surviving stones in the platform area of Pumapunku. Wherever we inspected interior edges, we recognized the same patterns: carving out a sharp interior corner followed a standard procedure.

The evidence on the Sawtooth stone highlights an important element in the Pumapunku carving process that was absent from Nair's experiment, namely the frequent creation of flat surfaces. Throughout Pumapunku today, one finds again and again flat surfaces ranging from those worked with larger hammer tools to those worked to a fine polish. In addition, one also finds the juxtaposition of hammered flat surfaces and smoother flat ones, where the finished surfaces are used as reference planes for the work still to be done (Figure 5.22).

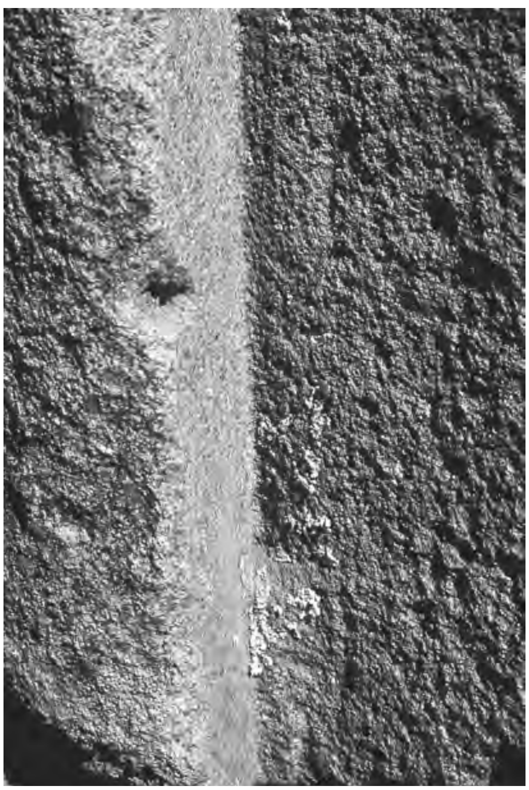


Figure 5.21. Transition from finely worked area to the excess stone left near the edge of the stone.

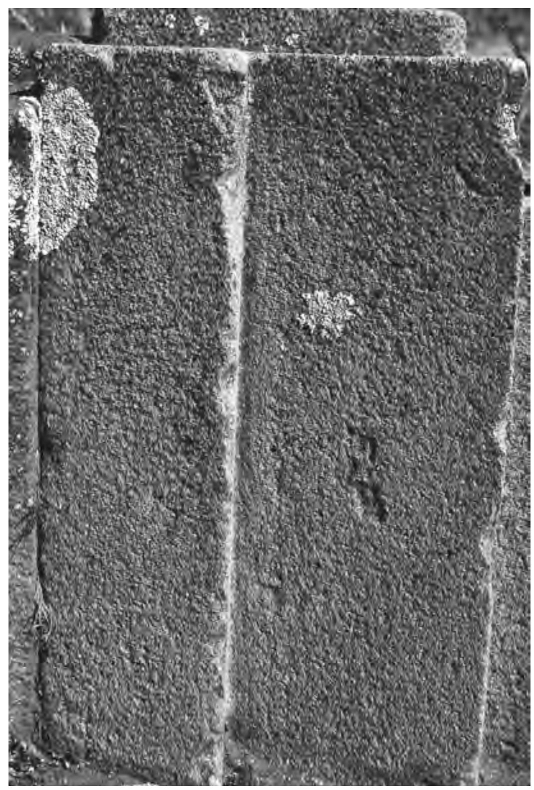


Figure 5.22. On the same Sawtooth stone, this corner is farther along in the carving process. Note the survival of the demarcation line, revealing where excess material had been in the interior corner. Note also the change in working pattern. The area nearest the corner has been worked with small hammer tools and chisels, leaving smaller, shallower pits in the stone, compared to the large, deep marks to the right of the line, where sizable hammer tools have been used.

Finishing Touches

The next operation in the above example, according to Nair's sequence would have been the incising and polishing of the remaining surfaces. As noted by Nair, incising and polishing can be done in one and the same operation with an obsidian flake. The highly hydrated face of an obsidian flake is doing the polishing and its sharp edge the incision. Evidence for this operation, whether done with an obsidian flake or some other tool, can be found on several stones. With a microscopic lens, one can find striations due to abrasion on the upper plane, and a fine groove, the result of incision, in the apex of the corner. The striations tend to run parallel to the interior edge (Figure 5.23). In the narrow areas near an interior edge, Nair found that there is no room for rotary movements with a grinding stone; only to and fro motion is possible. The observed parallel striation on surviving stone blocks shows that the Tiahuanaco stonecutter was constrained by the same difficulties.

At Tiahuanaco, incising can be seen most clearly in the delicate work needed to carve the motifs found in the friezes of the Gateways at Pumapunku and in the central section of the Gateway of the Sun. To hollow out more delicate parts of a motif, such as the area between the meanders or between figures in the friezes, the stone carver used very fine tool heads (Figure 5.24). A small chisel and then an incisor blade could have made the observable tool marks in the interior corner. Judging from the regularity and sharpness with which the elements of the frieze and the figures above have been carved, we surmise that a template or stencil was used to layout out the motif. Then the interior areas were worked, slowly approaching the edges of the motif, at which point chiseling and incising was employed to create precise, delicate lines. The very straight incisions and smoothly curved lines to be seen in the frieze suggest that some sort of ruler or the edge of a template supported the incisor blade. The very minor variations existing between figures we attribute to the specific qualities of the stone. Hard crystals or phenocrists embedded in the stone cause the blade of the chisel or incisor to deviate from its intended course or spot. A clear view of an

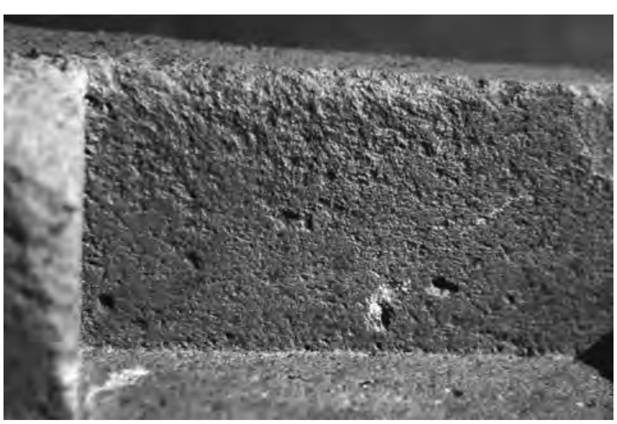


Figure 5.23. Faint striations due to abrasion on the wall surface, running left to right, parallel to the long interior corner.

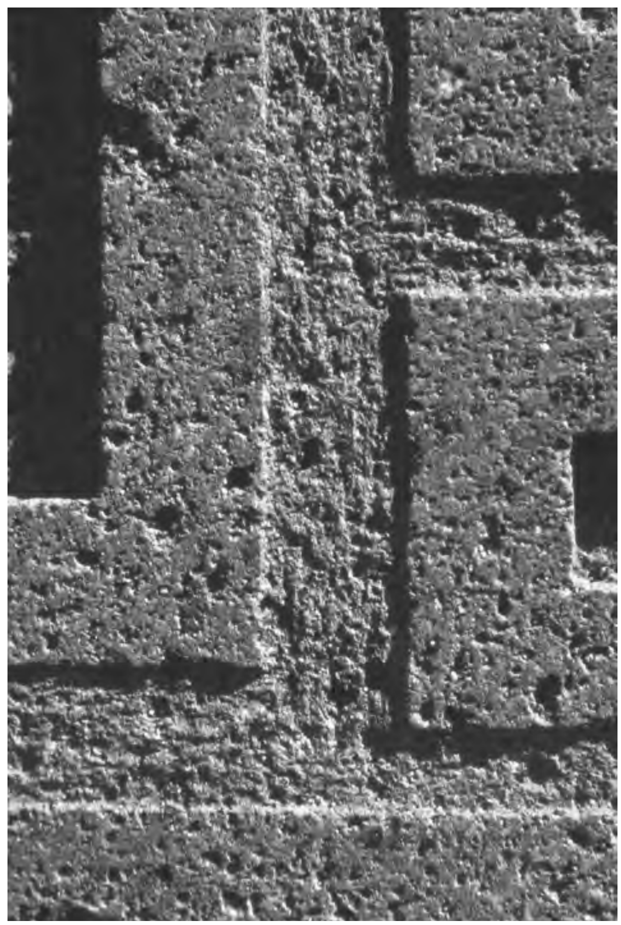


Figure 5.24. Close-up of finely worked area in the frieze of the Gateway of the Sun. Note the sharp exterior and interior corners and the different flat surfaces. The interior areas have been left chiseled, revealing a small chisel blade had been used parallel to the raised areas. This would have provided protection for the raised edges, such that the edges of the tool would have always been pointed away from the delicate raised areas of the frieze, and thus, the sharp blade would not accidentally hit and break the raised frieze. The lower areas were not polished, but the raised ones were. As the Tiahuanaco masons had the technology to polish both planes, this appears to have been an aesthetic choice. The two surface types enforce the contrast of the two planes, allowing them to be read in distinct contrast to one another. This technique of differentiating the planes is typical in the carving of friezes all over the world.

incision line can be seen in a small stone fragment at Pumapunku, which reveals a rare mistake by a Tiahuanaco stone mason. Here we see how an incisor blade has overrun the interior corner, providing us with an unobstructed view of a Tiahuanaco incisor mark (Figure 5.25).

Polishing

Nair had found out that the pumice-like surface of old flow obsidian works extremely well as an abrasive, and a version of this was likely used to polish the interior surfaces of the motifs, leaving scars such as those already discussed. But it is not likely that large surfaces could have been polished with small, rounded abrasive tools. The surfaces on most stones and gateways are finished to a smooth appearance, with most of the marks from the stone hammers or chisels removed. The smoothing or grinding of the large surfaces hardly left any marks; only on occasion are very fine striations to be observed. How the grinding of extended surfaces was done, we can only speculate. A technique similar to the one Protzen experimented with at Ollantaytambo to replicate Inca polished surfaces may have been used (1993:194). Protzen rubbed a flat stone, about 30 by 25 cm, over the work piece with a slurry of clay and water to obtain a smooth, glossy finish (Figure 5.26).

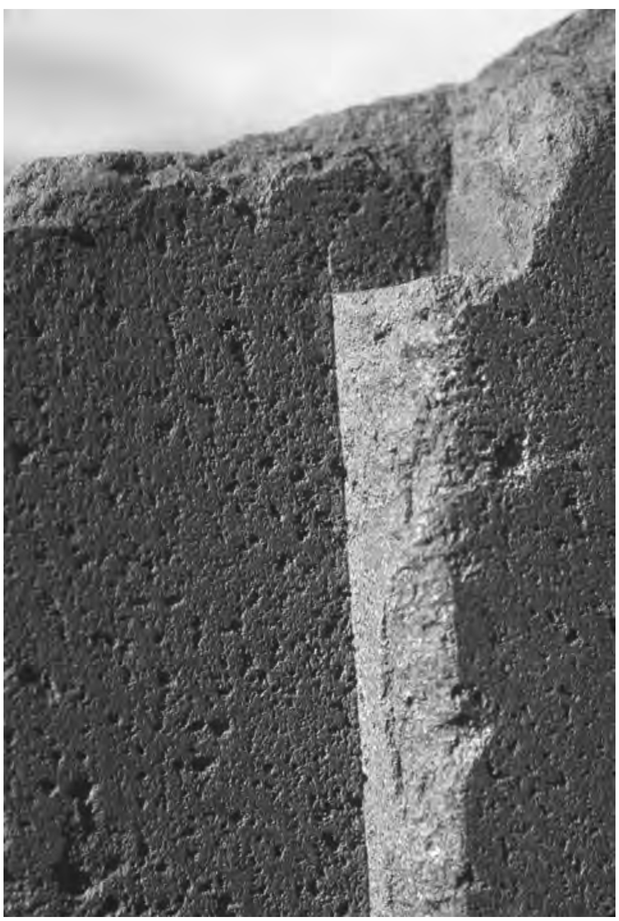


Figure 5.25. An example from Pumapunku that reveals a rare mistake by a Tiahuanaco stonemason. Here we see how an incisor blade has overrun the interior corner, providing us with an unobstructed view of an Tiahuanaco incisor mark.

Variations in Stonecutting Techniques

The experiments provided key insights into the making of the fine stone carvings that have stood exposed at Pumapunku for centuries. In particular, they demonstrated the extreme skill that was needed to execute the precise stone carvings and how consistently those skills had been employed. In revealing the systematic ways in which these stones were carved, the experiments and related field observations also highlighted variations in the tooling methods found in other parts of Tiahuanaco. In some cases, these differences are subtle, suggesting choices among masons or possibly experimentations in carving practices. In other cases, the differences are dramatic in both process and tool kit, revealing a significant change in stone carving technology that has important implications for the occupation history of Tiahuanaco. In the following section, we will examine some of the variations in stone carving at Tiahuanaco.

Figure 5.26. Polishing experiment with mud and sand as an abrasive.

Pumapunku

While in the field, Protzen noticed an intriguing clue into the flattening process not noted on other stones in the Pumapunku area. On a lintel stone with dentils (Type 4.3), Protzen found unmistakable chisel marks about 2 to 4 cm long, all oriented in the same direction in some areas and criss-crossing each other in others (Figure 5.27). Because the marks are uneven in width, we infer that the tool was a point chisel and the direction of strike caused the direction of the marks (Figure 5.28). The blade of a flat chisel would have left marks of more or less uniform width, and the orientation of the marks left by the blade would be at right angle to the direction of strike. The observable slight curve in some of the streaks or marks is inconsistent with the use of a flat chisel.

At first we were unsure how to interpret this chisel evidence. Was this stone an anomaly or does it represent larger practices we had overlooked at the site (i.e. why do the marks appear only on one stone)? If the stone did reflect larger practices, were chisels used to remove the last millimeters left after pounding the large surface area flat, or were chisels sometimes used instead of hammer stones? One clue lies in the stone itself. Where this particular stone is polished, the marks are partially obliterated. Thus, we may have overlooked evidence because it is barely visible. Going back over the stones, we did find faint chisel marks in a few cases. These examples all have high protruding sections, nearly leveled parts, and finished portions. The chisel marks are only found on the nearly leveled surfaces, suggesting that chisels were not the main tool for flattening raw or roughly hammered areas, but instead had been used for finer work left after the first stages of pounding.

The fact that we found evidence of this process on only a select number of stones had us puzzled: if this was an effective technique, why do we find traces of it only on a few stones? There are several possible explanations. First and as noted above, the chisel marks may have been obliterated in the final polishing work such that we can only observe it on partially unfinished stones. As plausible as this explanation may sound, it is not satisfactory. There are so many blocks at Pumapunku that show work in progress that, had chiseling been widely applied, we should have found more evidence thereof. Second, one could argue that chiseling was introduced and added to the standardized process at a later period, and therefore one finds it only on a few stones. Conversely, one could also argue that chiseling was found to be ineffective and thus was abandoned. Hence only a few stones reveal its use. Third, chiseling may have been the preferred technique of some masons, and thus it was an optional tooling process that could be added to the standardized process of working the stones. This explanation opens the possibility that the masons at work at Pumapunku may have come from different schools. The use of chisels in the flattening stage is the only distinction in the stonecutting process that we found in the Pumapunku area, which otherwise testifies to a highly standardized process. However, its existence reveals the masons' continued search to further refine an already high-quality carving process.

Figure 5.27. Stone Type 4.3 in the Akapana, showing chisel marks.

Figure 5.28. Detail of above-mentioned chisel marks.

Gateway of the Sun

The Gateway of the Sun offers evidence of another significant change in carving practices (Figure 5.29). On the whole, the Gateway of the Sun exhibits the same precision and quality of the Pumapunku stone-cutting. Yet, as mentioned in Chapter 3, the peripheral low-relief carvings of the frieze on its front side reveal a change in tool kit and carving practices. Under close scrutiny, it is clear that the central part of the frieze has been created with the same stages of production as the expertly carved friezes on the Gateways in Pumapunku (and the rest of the finely carved stones in Pumapunku). But the lateral sections to the right and left of the central part, however, while similar in iconography, differ dramatically in execution (Figures 5.30-5.31).

Of the central part of the frieze Stübel and Uhle noted that "one cannot avoid the impression that the original outline was placed on the stone with the aid of stencils or templates," just as Nair's experiment suggested (Stübel and Uhle 1892:Part 1, Plate 16). To replicate so exactly the placements of the motifs and their details would not be possible without a template or some similar aid. Postulating the use of templates by the Tiahuanaco is not too far fetched. As noted earlier in this chapter, there are various examples of template use in the Andes.

This is one of many differences between the central and peripheral portions of the friezes. The latter reveal that the placement of the individual elements ranges from somewhat irregular to strikingly different, suggesting that the motifs were laid out by eye rather than by template. Regarding the lateral unfinished parts, Stübel and Uhle argued that

> [t]here can be no doubt that the unfinished figures were not outlined with the same carefully elaborated stencils or templates as the others. The lack of congruency is such that it could not have been evened out through further elaboration.… The unfinished figures represent nothing more than a plagiarism of the earlier ones [Stübel and Uhle 1892:Part 1, Plate 16] [translation by authors].

As proof of their argument, Stübel and Uhle overlaid tracings of the outlines of various low-relief carvings from the center part and compared them with the corresponding tracings of the peripheral parts (Figure 5.32). As these images clearly reveal, there is amazing consistency among the motifs of the central frieze and great variation among the peripheral motifs.

Our examination of the central part of the frieze suggests that, once the stone had been properly prepared and the design was transferred onto the stone,

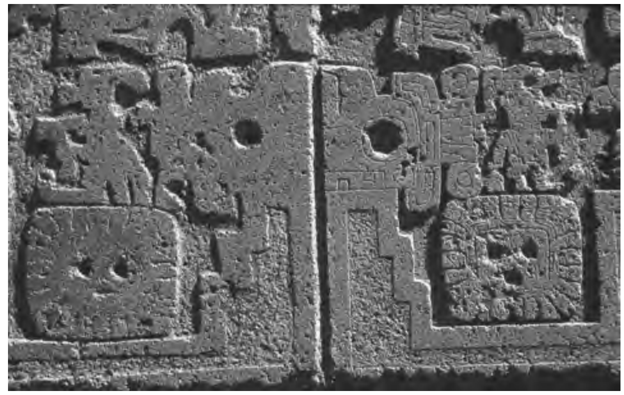


Figure 5.29. Detail of Gateway of the Sun frieze. To the right is the end of the central portion, which is finely carved. To the left is its "mirror image" executed with less precision.

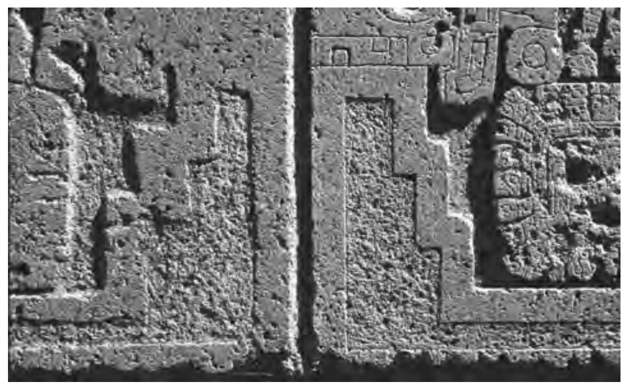


Figure 5.30. Detail of Figure 5.29 showing the difference between the two carvings.

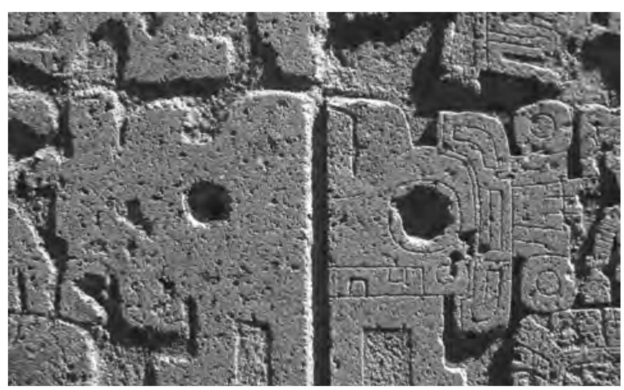


Figure 5.31. Detail of Figure 5.29 showing overcutting and lack of incising.

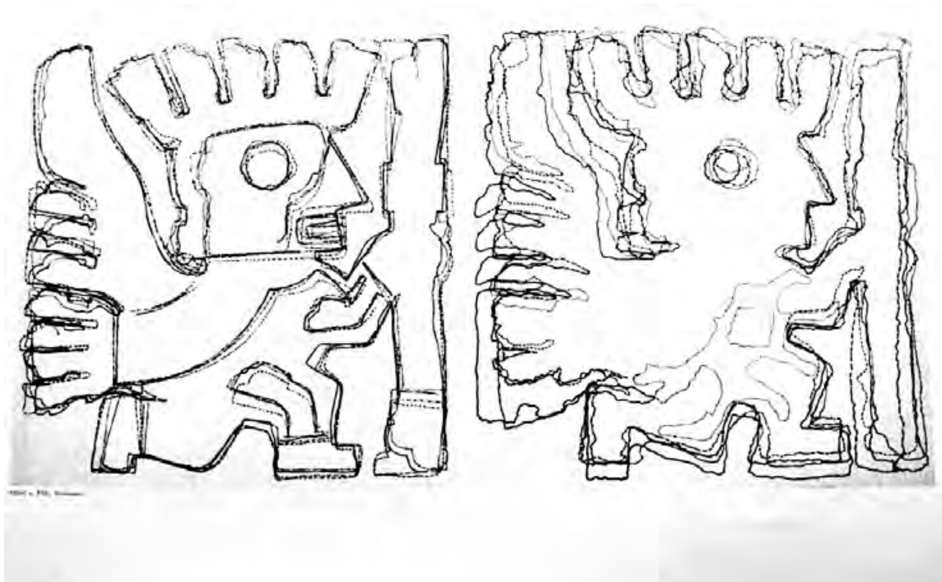


Figure 5.32. Comparison of trace overlaps of the central and peripheral figures by Stübel and Uhle.

the outlines of the figures and other motifs have been worked with hammer stones and hammer chisels, preventing any overcutting of the motif outlines. In narrower areas, only a hammer chisel was used to deepen and flatten the interiors areas (Figure 5.33). In addition, all the motifs were finely cut and incised. The ability to incise clean and precise interior lines was an important feature of the central frieze motifs, which distinguished them from the poorly executed peripheral figures (Figure 5.34).

The original central frieze was a complex design that required additional procedures beyond the

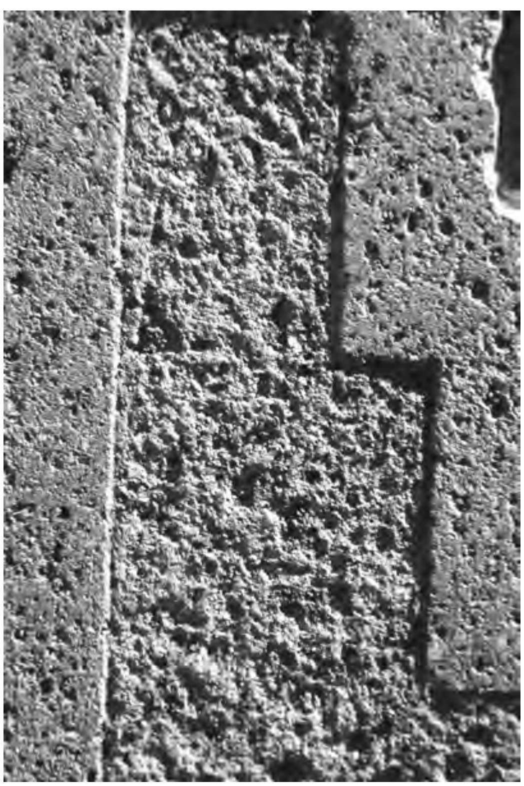


Figure 5.33. Detail of Figure 5.29, right figure showing straight interior edges.

Figure 5.34. Detail of Figure 5.29, left figure showing hammered and poorly chiseled interiors.

cutting of a large motif. For example, thin decorative lines within a raised portion of the motif could be incised directly upon the prepared surface. These precise incised lines are evident throughout the central motifs. Incising was also used in the shallowest relief areas within a motif. Protzen has noted that the interior incision line is at the same level as hammer-chiseled areas. If incising was used first, the masons would have had to been exacting in their process, such that no edges show damage by a hammer chisel. This would not have been possible in a larger, deeper cut which required excessive hammering and chiseling, but, as the relief here is so shallow, the minimal hammer chisel process may have allowed such precise workmanship. However, it is possible that the hammer chisel work was done first, and the incising afterwards, as was done in the rest of the carving process. More experiments will have to be done to shed light on this particular detail of carving the decorative elements of the frieze.

The precision that is so evident on the central elements of the frieze is completely absent from the peripheral motifs (Figure 5.34). An examination of the peripheral sections reveals only an occasional incision mark, and even these may be the result of a small chisel tool. Here, all the outlines appear to have been pecked out with pounders. Judging from the size of the pecking marks, the pounders were slightly bigger than the ones used in the central part. Almost everywhere one looks, the motifs have been grossly over-cut, that is, too much stone has been removed for the motifs to be rectified later no matter by what technique. Just as Stübel and Uhle noted, the carving technique used in the unfinished section results in crooked lines, oblique angles, and inconsistent proportions of the various motifs.

The striking differences in carving technique and toolkit applied between the central and the peripheral sections of the frieze lends further support to Stübel and Uhle's proposition that the peripheral sections are the works of some later generation who did not possess the skills and tools of their predecessor. Unlike their predecessors, they did not know—or did not care—how to lay out motifs with precision in multiple exemplars, to carve perfectly straight and controlled curved lines, or to create sharp interior and exterior edges and right angles.

The Skill and Art of the Tiahuanaco Stonecutters

Our experiments, along with our detailed investigations of stone surfaces and tool marks at Tiahuanaco have yielded valuable information on Tiahuanaco stonecutting practices and insights into the many challenges this stonecutting raises. Our investigations reveal the careful, measured process involved in creating the impressive stone works of Pumapunku, while also highlighting the intense training and skill of the masons. The stonemasons at Pumapunku were not untrained labor brought in to do tasks that required a few simple instructions to complete. The masons at Tiahuanaco had to have had a long period of training and practice to achieve the high quality workmanship. It is almost impossible to find mistakes in the carving process in the stones of the platform area. And when one does find a rare error, it is a very minor one (Figure 5.25). This is striking considering the difficulty and unforgiving nature of the carving process. But it also provides a clue into why the Tiahuanaco masons did seemingly risky practices such as carry parts of one motif over to another stone, rather than carve one in its entirety in a single block. For these skilled masons, this was a task they could master, and one must wonder if they did not also enjoy the challenge of it. Perhaps the Tiahuanaco stone masons may have thought about their own masterpieces in the same way that the skilled weavers of Paracas, who labored for thousands of hours on finely embroidered textiles, thought about theirs. The fine detailing of the Pumapunku carvings, the skill and difficulty of which would not have been readily appreciated by the average viewer, must have been of great importance to these artisans. Their skill and labor also highlights the importance of making the stones of Pumapunku, suggesting that the process of carving itself was as important, if not more so, than the end product.

An example of this can be seen in the arrowhead stones at Tiahuanaco. This finely cut motif, as mentioned previously, is impressive from the outside. However, if one puts a finger inside the carving, one finds that the interior planes meet precisely and sharply in a perfect point. This aspect of the stone carving would have been oblivious to any observer, even one trying to peak inside the motif. So why did the mason not just round off the interior and move on to her next assignment? One must infer from this and other similar examples, that such details were important to the mason, whether as a matter of professional pride or perhaps because stones were often seen as sacred elements in the Andes. Hence carving them in such a fine way may have been an act of religious devotion. It is perhaps here, in the details of Pumapunku's finely carved stones, that we can begin to appreciate, not only the richness of their construction tradition, but also the importance of the art of making architecture. Architecture, as a process, is often overlooked in our fixation on the final product. Yet both are interconnected and are deeply informed by the desires and achievements of their makers. Stonecutting is a fascinating operation in the construction and erection of Tiahuanaco buildings, but it is not the only one. We will now turn to some of the other important activities, such as the quarrying, transporting, and lifting of stones, as well as other construction operations such as the laying of foundations.

NOTES

1. Chisels in the collection brought back by Adolph Bandelier.
2. Stübel and Uhle thought the troughs and pans to have resulted from fire (1892:45).
3. It was found near the railroad tracks a couple of hundred meters west of the train station.
4. Andesite and rhyolite are both fine-grained igneous extrusive rocks. Andesite is the extrusive equivalent of the intrusive igneous diorite and rhyolite is the extrusive equivalent of the intrusive igneous granite. Rhyolite generally has a significant component of quartz (up to 30% or more) while andesite generally contains no quartz. Thus, the rhyolite is a more difficult stone to work, due to its porous nature and inclusion of quartz. Because it is less dense, the rhyolite breaks in a more uncontrolled manner than the andesite that the Tiahuanaco masons used, and because of its porous nature, rhyolite is filled with air pockets; thus it cannot produce the visibly smooth surfaces of the dense andesite.
5. Several attempts were made to lay out the motif directly on the stone with a ruler and a marking medium in the experiment. However, this proved not only to be time consuming and laborious but the somewhat bumpy surface and porous nature of the stone made measuring and drawing difficult. Regardless of the media tested, whether dry or wet, drawing and erasing on the stone surface were frustrating and time consuming.
6. In the experiment, a wooden template, a fine brush, and gesso proved to be effective means to transfer the outline of the cross motif to the stone. The motif outline on the stone was accurate to the millimeter to the template with one exception. Because the surface of the stone was not completely flat in one corner, the gesso tended to bleed out under the wooden template in that area. This error heightened the need for a perfectly flat surface. The rest of the motif was transferred without problems.
7. A long, thin agate worked equally well.
8. We are indebted to George Gonzales, a sculptor and stonemason, for this expression as well as many hints and insights into the secrets of stonecutting.
9. Dust buildup also became a problem and periodic cleaning of the base stone became necessary.
10. The hammer stones kept creating small bumps and pits in the stone's surface. Changing hammer stones did not improve the situation. Instead, it merely left different pit sizes in the andesite. Polishing only created smooth, slightly smaller bumps, rather than eliminating them. Nair experimented with a variety of techniques, alternating among hammering, chiseling, and polishing but, in the end, a flat surface was not obtained. She had reached a point where she could no longer continue to remove material, since the motif had obtained its intended measurements.
11. Or, in one case, perhaps missing. Stone WR 28 of Type 1.1 is missing its niche icons. If they were to be carved, they too would have been cut from perfectly finished surfaces. However, it is also possible that there was never any intent to carve this motif in this stone.
12. The numbering of stones is ours.
13. The references "top," "bottom," "left," and "right" are relative to the photograph. The stone is now standing up, but its intended position was lying horizontally.

CHAPTER 6

CONSTRUCTION

> The stones composing the structures of Tiahuanaco ... are mainly of red sandstone, slate-colored trachyte, and a dark, hard basalt. None of these rocks are found in situ on the plain, but there has been much needless speculations as to whence they were obtained [Squier 1877:298].

QUARRYING

Raw Materials and Provenience

THE TIAHUANACAN BUILDERS USED primarily a reddish sandstone and greenish-gray andesite for the construction of their monuments. On rare occasions limestone and a volcanic tuff were also used. Large formations of sandstone and volcanic tuff are found on the Quimsachata range just south of Tiahuanaco, within a distance of 5 to 12 km from the site. The closest limestone outcrops we know of are near Tambillo, some 20 km east of Tiahuanaco, at the edge of the Pampa Koani; they are currently mined by the cement plant at Viacha. The nearest andesite formations, on the other hand, are found much farther away on Cerro Khapia between Zepita and Yunguyo in Peru, and Cerro Calvario at Copacabana, both across the Lake Titicaca from Tiahuanaco. Petrographic and geological analyses carried out by Mille and Mongrovejo confirm the provenience of both the sandstone and andesite at Tiahuanaco from the respective formations, the Quimsachata range, and Cerro Khapia (Capira) or Cerro Calavario (Mille and Ponce Sanginés 1968; Ponce Sanginés and Mongrovejo Tarrazas 1970; Ponce Sanginés 1971), but the authors fall short of identifying actual quarry sites for either material.

Ponce Sanginés illustrated a potential sandstone quarry (1970:Figure 23), today known by the name of Kaliri (Escalante 1993:418–420) in the eastern part of the Quimsachata Range, which is littered with a great number of roughly squared sandstone blocks. Ponce Sanginés dismissed the site with the comments:

> Resta puntualizar que no falta quien con desconocimiento de la técnica en tiempos pretéritos, confunda los bloques que afectan morfología más o menos geométrica y por ende regular, originados a causa de diaclasamiento por acción de agentes naturales que los separan de la roca aflorante, en especial arenisca con plano de exfoliación apropriado, con aquellos litos exprofesamente cortados por mano humana [Ponce Sanginés 1970:64].
>
> It must be pointed out that there are those ignorant of the techniques of old who confuse blocks with a more or less geometric morphology and therefore regular (in shape), generated and detached from bedrock by the

> action of natural agents splitting them along fracture planes, and in particular sandstone with the appropriate exfoliation planes, with those stones explicitly cut by human hands [translation by authors].

We have visited the Kaliri site on two occasions, and admit that at first sight, it looked more like a natural formation than an ancient quarry. The site is heavily silted in and overgrown, with no immediately visible signs of quarrying activities (Figure 6.1). Upon a closer view, however, one discerns shallow mining pits, and discovers numerous extracted blocks that are deliberately notched on at least two opposing edges of one of their faces (Figure 6.2). The notches most likely served to keep in place a rope used to move the blocks. Furthermore, during our second visit we found numerous fragments of hammer stones, a sure sign of quarrying activities (Figure 6.3). The hammer stones are easily identified by their lithic material and shape; these stones are not naturally found at the site.

The bedrock at this site features three natural fracture planes roughly perpendicular to each other and spaced 40 to 120 cm apart (Figure 6.4). Accordingly, the blocks extracted from this quarry are relatively small, and correspond to the size of the sandstone blocks used in the random range masonry of the Semi-Subterranean Temple and the Kalasasaya. Somewhat larger blocks found on the lower slopes of this quarry site are commensurate with the opus quadratum masonry on Akapana. Where exactly the very large sandstone slabs at Pumapunku were extracted, we do not know yet. Other potential quarry sites we visited at the foot of the Quimsachata range did not seem to have the appropriate characteristics.

Unlike the Inca quarries that Protzen investigated, we did not at first see any obvious ramps or transportation routes within the immediate vicinity of the Kaliri quarry. Only much further down the slope did we discern, under appropriate lighting conditions, the outlines of a gently sloping road, perhaps 8 m wide, heading in the direction of Tiahuanaco. There are no abandoned blocks along this route, however, to substantiate its use. Yet on our second visit, we discovered two branches of a road, one leading to the bottom of the quarry and the other to the top. Farther down the two branches join into a single road that points toward the road we noticed in our first visit.

In their attempt to identify the sources of andesite used at Tiahuanaco, Ponce and his associates

Figure 6.1. Overview of the quarry area of Kaliri.

Figure 6.2. Stone with notches at Kaliri.

Figure 6.3. Hammer stones at Kaliri.

Figure 6.4. Natural fracture planes in the sandstone formation at Kaliri.

engaged in a wild goose chase, for as early as 1858 Tschudi pointed to Cerro Khapia, as did Forbes, Squier, Stübel and Uhle, and Posnansky after them, as the place where the Tiahuanaco mined their andesite. Here is what some authors wrote:

> Die Steine sind Granit ... und im Cerro Ckapia bei Zepita in Peru gebrochen, dort behauen und erst dann nach Pumapuncu transportiert worden [Tschudi 1971:291].

> The stones are of granite [sic] ... and were quarried on Cerro Ckapia near Zepita in Peru, where they were dressed and only then transported to Pumapuncu [translated by authors].

> [T]he quarries are still visible [western side of Lake Titicaca]; and there remains at the edge of the lake an immense block hewn out into a sort of sofa or divan ... which no doubt had been left behind when on its road to Tiahuanaco [Forbes 1870:65].

> We observed also, laying near our path [from Zepita to Yunguyo], many large blocks of basalt and trachyte [sic], some completely, and others only partially hewn, and corresponding exactly in material and workmanship with those of Tiahuanaco. They were evidently obtained from the quarries visible at the foot of the rocky eminence on our left, and had been abandoned midway to the lake [Squier 1877:313].

> Am Wege von Zepita nach Yunguyo trifft der Reisende hier und da grosse und kleine Blöcke andesitischer Lava, welche offenbar von dem Berge herrühren und wenigstens zum Theil als Geröllblöcke angesehen werden müssen. Diese Blöcke sind es, unter welchen die Erbauer von Tiahuanaco die für ihre Werke brauchbaren ausgewählt und nach dem südlichen Ufer zur Einschiffung transportirt haben dürften [Stübel und Uhle 1892:Part 1, Plate 31].

> On the road between Zepita and Yunguyo the traveler encounters here and there large and small blocks of andesitic lava that obviously come from the mountain [Cerro Capira] and must be taken, at least in part, to be loose boulders. It is among these boulders that the builders of Tiahuanaco may have selected those that were useful for their works and transported them to the southern shore for embarkation [translation by authors].

We traveled the road between Zepita and Yunguyo several times, and can only confirm the accounts of these nineteenth-century observers. Many dozens of raw and partially hewn blocks of all sizes are still strewn along four distinct routes leading from the foot of Cerro Khapia to the edges of Lake Titicaca (Figure 6.5), to points directly opposite the Taraco peninsula where dozens of large andesite blocks that had been brought across the lake are still lying. Señor Vilca Maydana, an elderly schoolteacher from Yunguyo, guided us along one of the four routes to what was most likely a quarry site. The area, a low andesitic ridge, is now well covered with silt and vegetation. Traces of the ancient quarrying operation are all but obliterated; only clearly defined depletions in the ridge betray human intervention, as do several large extracted blocks awaiting transportation.

Quarrying Techniques

Of the quarrying techniques used by the ancient Tiahuanaco we cannot be certain. At the sandstone quarries of Kaliri the quarry workers extracted stone from the bedrock by taking advantage of the natural cleavage planes in the bedrock. The bedrock is fractured enough that very little effort is required to detach building stones from it: crowbars or wedges, or both, of wood or bronze would do the job. In a letter to Junius Bird, Harold Osborne, editor of *The British Journal of Aesthetics*, who had visited what we believe to be the same quarries, noted: "There are signs of boring into the hillside itself—I suppose for inserting wood, which they would then soak in order to start a split in the stone."[1] We did not observe any borings, but the site is so large that it would take several weeks to do a complete and detailed survey. In our relatively short visits to the site we could quite possibly have missed other traces of quarrying.

What we suspect to be quarries on Khapia are even more covered with sediments and overgrown than those at Kaliri. To elucidate the quarrying techniques used for the andesite we would have to follow Tschudi's advice: "Nachgrabungen in dem Schutte der Steinbrüche von Zepita könnten vielleicht einige Aufschlüsse geben, denn ohne Zweifel liegen dort unter den Steintrümmern vergraben noch viele Werkzeuge" (Tschudi 1971:292). (Excavations in the debris of the quarries of Zepita could perhaps give some insights, for under the stone rubble, without a doubt, there must still be buried many tools [translation by authors].)

It is noteworthy that Stübel—who, it will be remembered, was a geologist by training—thought that at least some blocks were just loose boulders, and not actually quarried, that is, detached from bedrock by human labor. This is a distinct possibility that suits the particular environment of Khapia and

Figure 6.5. Abandoned andesite blocks from the quarries at the foot of Cerro Khapia.

for which there are other examples. At the quarries of Kachiqhata, near Ollantaytambo in Peru, as in others, the Incas, too, did not practice quarrying in the proper sense, but chose suitable blocks in large rockfalls (Protzen 1983:165).

Transporting

It has always been a subject of fascination how ancient civilizations that did not know the wheel transported stones weighing a hundred metric tons or more over long distances. In most instances, however, the solutions to the problem were deceptively simple. At Ollantaytambo the Incas dragged the large monoliths from the quarry to the construction site (Protzen 1986; 1993:175–183). At Tiahuanaco the problem is complicated by the transportation of the andesite blocks across the lake, where dragging is obviously not an option.

By Land

There is little doubt that on land the Tiahuanaco dragged the stones along the ground as did the Incas; many blocks at Tiahuanaco still have the tell-tale drag marks on at least one of their broad faces (Figure 6.6). Proposals like that of Posnansky, who would have loaded the blocks onto stone balls and then pushed the blocks with poles (1945:Vol. 2, Figure 50a), not only lack all evidence, but also common sense.

The Incas did not drag their stones over the natural surface of the terrain, but prepared carefully constructed roadbeds. An excavation carried out in 1994 by the Instituto Nacional de Cultura under one of the undisturbed abandoned blocks at Ollantaytambo revealed just how the roadbed was constructed. Over a very compact and gravely soil (3), some 25 cm thick, another layer (2), about 20 cm thick, was deposited, in which are embedded stones roughly 15 by 30 cm (Figure 6.7). The interstices between the stones are filled with a gravely soil with a heavy clay component. The block rests on the stones in this layer. At the front of the stone (in the direction of transportation) one observes pushed-up material (1a) similar to the filler material in layer (2).[2]

Given the enormous weight of many stones at Tiahuanaco, it is almost certain that special roadbeds had to be built to support them in their transit from the quarries to the construction site. Except for the

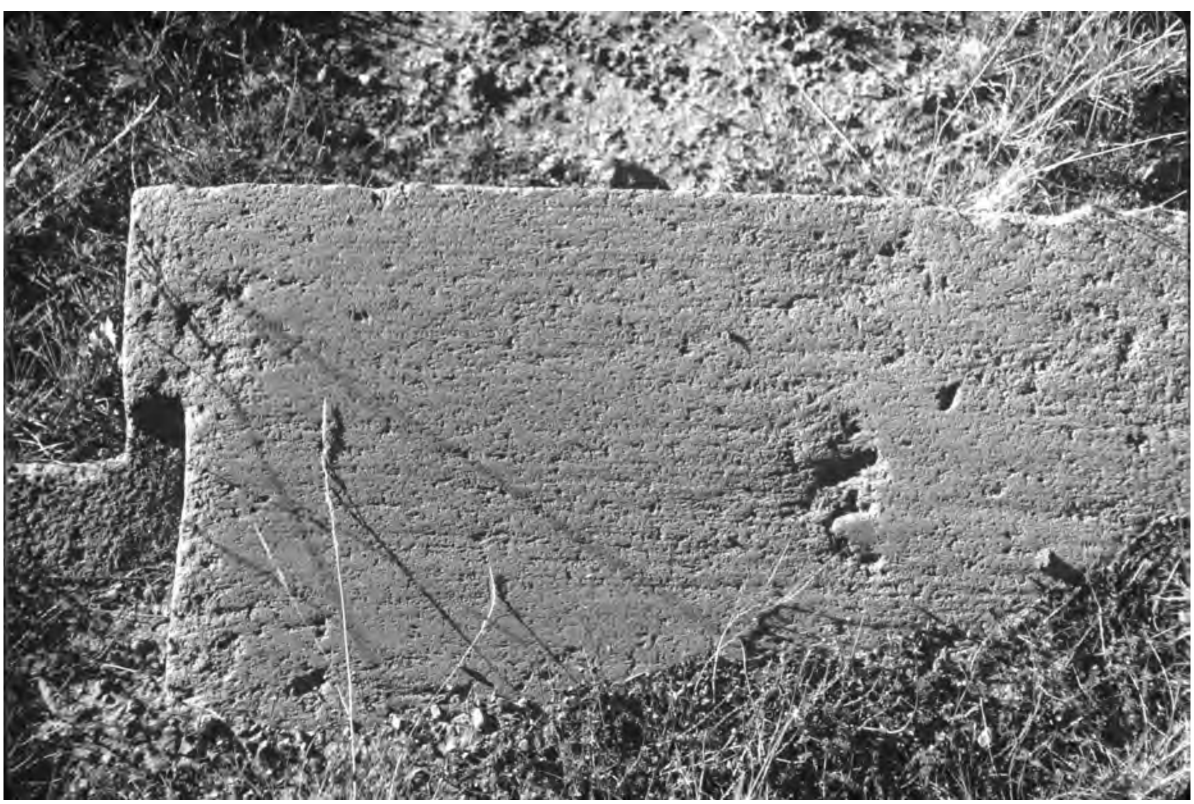


Figure 6.6. Drag marks on a stone in Putuni.

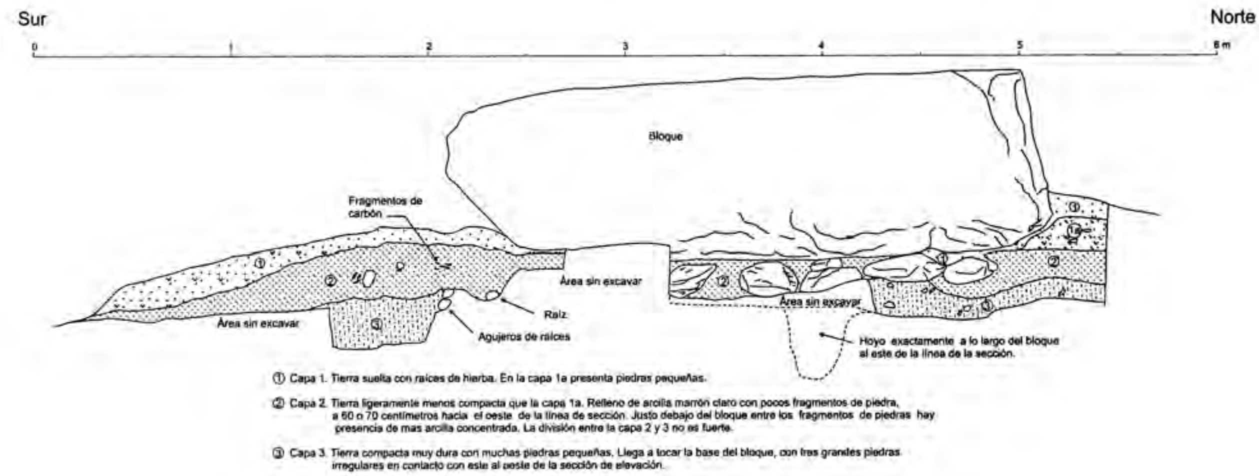


Figure 6.7. Roadbed under abandoned stone at Ollantaytambo, excavation profile (drawing by Mark Lehner).

possible road spotted near the Kaliri quarry, we have not seen other evidence of roads. Excavations under blocks on the flanks of Cerro Khapia, for example, could corroborate, or refute their existence.

By Water

Many researchers have speculated that the blocks were loaded onto *totora* reed boats or rafts (Escalante 1995:420–424). Reed boats and rafts presumably were the crafts used by the pre-Hispanic dwellers along the shores of Lake Titicaca, and such crafts are still in use today.[3] Totora reeds are used in the building and the periodic rebuilding of the famous floating islands of the Urus just offshore Puno. These islands can be considered to be very large rafts. Could similar rafts have been built to carry large stones across Lake Wiñaymarka from Cerro Khapia to Iwawe on the Taraco Peninsula? Sergio Chávez and David Jorgenson presented some calculations that show that a raft about 3 m long, 1 m wide, and 0.5 m thick would support a stela weighing about 9.81 kiloNewtons or 1 MT (Chávez and Jorgenson 1980:76–79). By the same calculations, to transport a slab of stone from which the Gateway of the Sun could have been carved, say a slab of approximately 4 by 3 by 0.8 m and weighing about 25 MT, would have required a raft of approximately 5 by 5 by 1.5 m. That rafts of this size could have been built is certainly demonstrated by the floating islands. How such large rafts would have been maneuvered is another question, as is how a stone of the size and weight of the Gate of the Sun might have been loaded onto crafts of the sort. However, in a recent experiment, Alexei Vranich et al. have successfully demonstrated the essential feasibility of the transport of big stones on traditional reed boats (Vranich et al. 2005). Their stone, measuring 3 by 1.3 by 1 m and weighing about 9 MT, was loaded onto a reed boat in Copacabana and navigated trough the Taquina Strait to Santa Rosa on the Tarraco Peninsula, a roughly 90-kilometer journey.[4]

Stone Fitting, Laying, and Handling

The Incas, when building a wall, typically left the apparent upper faces of already set stones uncut until the next stone was ready for laying. This next stone was first carved on at least two faces, its bedding face and one lateral face. The shapes of these faces were then cut out of the already set stones to receive the new one. Thus, each stone was individually fitted to its immediate neighbors. On dismantled Inca walls one can always find the footprints of stones that once occupied these spots; each footprint is unique, no one is like any other (Protzen 1986) (Figure 6.8).

In Situ Fitting versus Prefabrication

At Tiahuanaco such imprints are not common, but are found on the sides of some upright stones, in particular on the six still standing pillar stones on the summit of Akapana, and on some of the large blocks outlining the courtyard of Putuni (Figure 6.9). The

Figure 6.8. On dismantled Inca walls, one detects the "imprints" of the missing stones.

Figure 6.9. Imprints on the uprights on top of Akapana give clues to the position and size of the infill masonry.

marks on these stones are an indication of the infill masonry that closed the spaces between the large stone, and testify to a one-on-one fitting technique similar to that of the Incas. Footprints, or fitting marks, are, however, noticeably absent from all coursed ashlar and near-isodomic masonry. The fact that stones meet at right angles, have planar faces, and are all of the same height obviates the individual fitting of stone on stone. Fitting could be replaced by the control of dimensions, angles, and planarity, of each stone carried out on the ground or even in a stonecutters' yard or workshop removed from the oeuvre. So prepared, the stones could be delivered to the site and assembled without further fitting work. In other words, building stones could have been prefabricated, even mass-produced. Such a process presupposes the existence of appropriate tools to execute the control functions: a standard unit of measurement, squares, and straight edges, or their equivalents.

While prefabrication and mass production of stones are distinct possibilities, there is evidence that not all coursed ashlar and near-isodomic masonry was built that way. For example, in the second-tier wall of Pumapunku with its in-and-out bond, where one stone was projecting out from under another, one finds residual bulges at the front edge of the stones (Figure 6.10). Such bulges indicate that the top of the stones was left uncut and the courses leveled to their height in situ. As seen before, the last course of the first tier, or stereobate, on the south side provides further evidence, since its entire top surface has been left uncut (Figure 2.45). On the north side, the corresponding course is evened out, suggesting that indeed the south side is unfinished. And on the last step of the first tier, also on the south side, one can actually observe progress made in carving out the step; there are still unfinished sections. It is thus possible, that sometimes the Tiahuanaco leveled an entire course

Figure 6.10. Residual bulges on second tier wall, suggesting in situ fitting.

Figure 6.11. Inca wedge stone.

in situ, and then laid a new course of rectangular, cut stones onto it. On the other hand, the second wall on Pumapunku's south wing, and the second wall on the east side of Akapana show no signs of in situ work. Both walls could very well have been built with prefabricated stones.

"Wedge" Stones

When building a wall, the Incas often had several construction crews working side-by-side. Where two crews met in a course the final gap in the wall was closed with a "wedge" stone introduced into the masonry bond from the front of the wall (Protzen 1993:195–199). Because in the last gap there is not enough room to maneuver the stones for the usual one-on-one fitting, the Inca stonemasons hit on the ingenious idea of the wedge stone that fits to its neighbors only along a very narrow band near the face of the wall (Figure 6.11). Once one knows what to look for, it is relatively easy to spot wedge stones in an Inca cut-stone wall and to determine its construction sequences. Several reports ascertaining the use of wedge stones at Tiahuanaco not withstanding, these seem not to exist; at least we have not found any. The alleged wedges at Putuni (Arellano 1991:265), puny little stones found on a corner of larger stones, are not wedges at all but repairs (Figure 6.12). As seen before, the walls of Putuni were built mostly of reused stones, some of which had notches in the corners. The small stones are simply plugging these notches. The small stones are impressive for their exquisite craftsmanship, but not as a structural innovation. Portugal wrote of the stereobate at Pumapunku, that "su acomodo y encaje era por presión o cuña"—its laying and fitting was by pressure or wedge (1992:35). We were unable to verify Portugal's claim, but even if wedge stones were used in the stereobate's construction, they would not have exerted pressure. Portugal probably thought of the analogy of the keystone in an arch, but an arch is subject to forces very different from those in a

Figure 6.12. So-called wedge stone in Putuni.

simple, horizontal course of stones. Horizontal, or lateral, compression in a wall is neither necessary nor desirable. Imagine a wall made of three stones, one on either end and a "wedge" stone in between. Pushing in the wedge between the two other stones only drives these apart, pushing them beyond the corners of the wall. Furthermore, a stone wedge, unlike a wooden wedge, cannot be driven into an assembly without shattering it in the process. If wedge stones did exist at Pumapunku—and they may not, for in regularly coursed masonry, with perfectly rectangular blocks, there is no need for them—then they had the same function as Inca wedge stones, that is to fill a gap in which there is no room for one-on-one fitting, or to maneuver the stone.

Bosses, Leverage Notches, and Rope Chases

Ancient builders around the world resorted to a variety of strategies to lift, handle, and position stones when laying up a wall of cut-stone masonry. Some of the most common features found on building stones for these purposes are bosses, notches, chases or grooves, and holes of different configurations. The whole gamut of features can be appreciated at Tiahuanaco, although none enjoyed universal application.

In the Old World bosses were used to attach ropes to lift or move stones, or served as purchases for levers. At Tiahuanaco bosses are few, and where they are found most of them are so badly eroded that their original shape is no longer apparent (Figure 6.13). It is thus difficult to judge how exactly they were used. Alternative purchases for levers are notches gouged out of the side or back edges of a cut stone, preferably at its base (Figure 6.14). Levers applied to such notches are useful in nudging a stone into its desired position. Notches, like bosses, are not very frequent at Tiahuanaco, but they are systematically found on large sandstone slabs at Pumapunku (see Chapter 2).

Unique to Tiahuanaco, we believe, are grooves carved out of the bottom and one side of a cut stone (Figure 6.15). We interpret these grooves as rope chases. With a rope fitted into the grooves and pulling on it in seesaw fashion, the stone can be moved and eased into its desired position until it finally rests against its immediate neighbor. Once the stone is set, the rope can be pulled out of its chase and

Figure 6.13. Protuberances or bosses to handle stones.

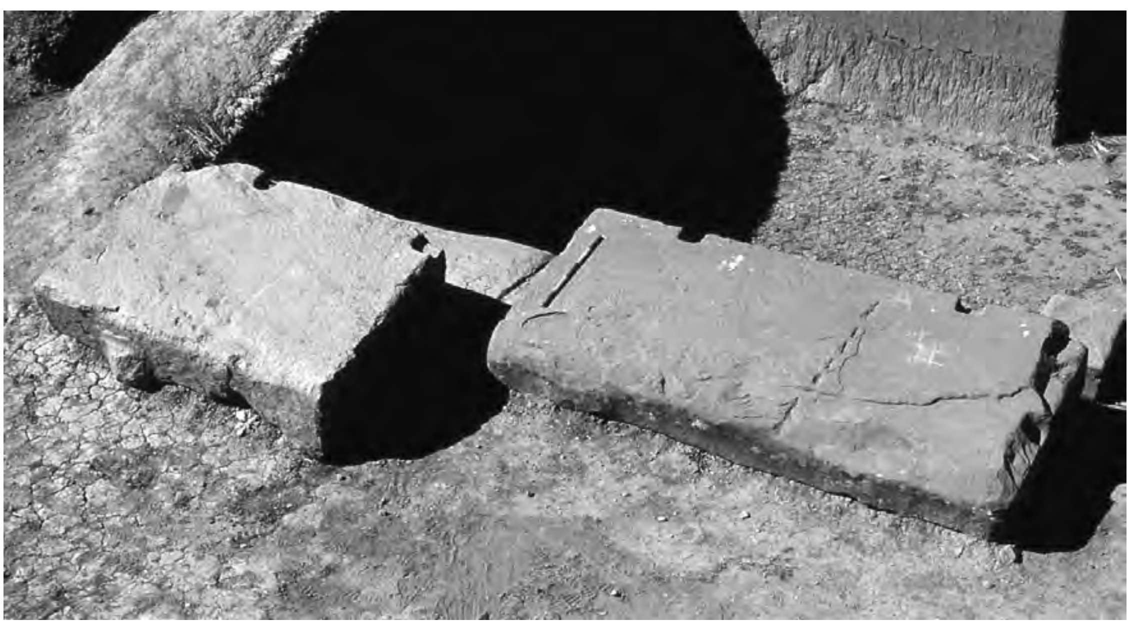


Figure 6.14. Notches providing purchases for levers.

Figure 6.15. Rope chases.

reused on the next stone. We verified the use of rope chases in the *opus quadratum* of at least the second and third wall on Akapana's east side.

Besides rope chases, one finds at Pumapunku a variety of channels of different shapes, some up to 15 to 18 cm wide and deep, the function of which is not obvious and is in need of further investigation. The position of some of these channels diagonally across the corner of large slabs, offer the possibility that logs were slid through them, with which the slabs could be lifted (Figure 6.16). However, calculations we made for the largest block with diagonal channels, weighing about 16 MT, a lot more people would have been necessary to lift the block than could possibly be deployed around it. Unless the Tiahuanaco disposed of some hoisting devices they could apply to the logs just mentioned, these channels are not about to reveal their secrets.

Hoisting Grips

Several blocks at Tiahuanaco feature elaborate cut-outs of grooves and communicating drill-holes (Figure 6.17). For lack of a better term, we call such cut-outs "hoisting grips" because ropes could be threaded through the holes and used to lift blocks (Figure 6.18). These grips are ingenious, for in contrast to bosses that need to be removed when between two stones, hoisting grips allow the tight joining of neighboring stones with the ropes in place. Hoisting grips are akin to lifting techniques observed in the Old World, where grooves and drill-holes for holding ropes were well known (Arnold 1993:75; Müller-Wiener 1988:81). In its form, however, the Tiahuanaco hoisting grip is probably unique in the world. Not too many remaining blocks are equipped with hoisting grips, suggesting that the Tiahuanaco made only sparing use of these grips, but they do ease a difficult construction problem. In his experiments with Inca-style cut-stone masonry, Protzen was repeatedly frustrated when trying to set down, large, finely wrought stones without damaging the delicate edges. The task requires precise control over the stones' movements, something that is, if not impossible, very difficult to achieved with levers alone. Could the blocks have been suspended above and gradually lowered into position, this would have

Figure 6.16. Diagonal channel.

Figure 6.17. Hoisting grip.

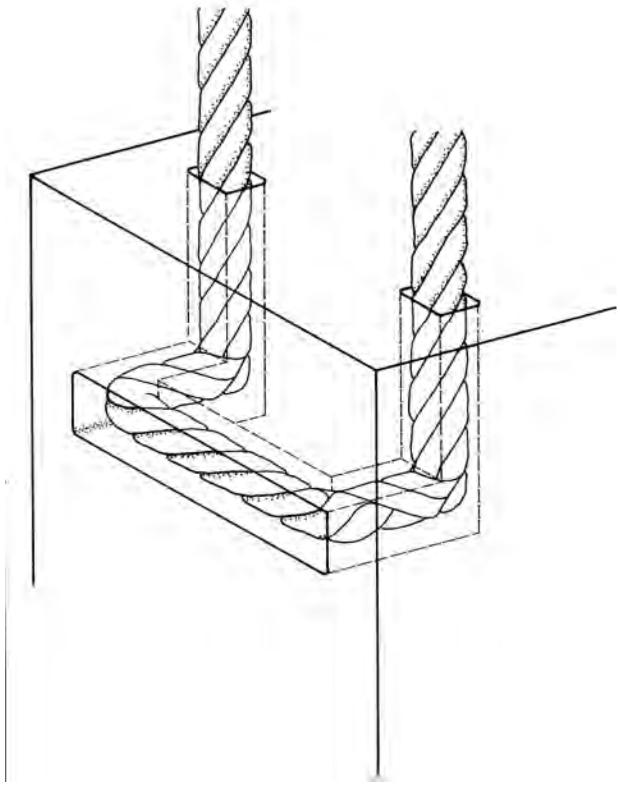


Figure 6.18. Conjectured use of hoisting grips (drawing by Jean-Pierre Protzen, first published in *Journal of the Society of Architectural Historians*).

resolved most of the difficulties encountered in the experiment. If hoisting grips fulfill a very definite function, they raise another question: what kind of device was used to lift and suspend the blocks? Did the Tiahuanaco use some kind of tackle? The grips themselves suggest the existence of some hoisting device, but nothing in the archaeological record to date holds even a clue to the nature of this device.

How Were Large Stones Cut?

Large flat monoliths that are carved on both sides, like the Gateway of the Sun for example, raise the question in what position they were cut: lying down, or standing up? The question will probably never be resolved, but one can reason about it. It is considerably easier and faster to pound at a horizontal than onto a vertical work plane, for on the horizontal work plane the mason can take advantage of gravity. As Protzen has shown elsewhere, the mason drops the hammer stone onto the work piece only guiding it with the hands, without exerting any force, and catches it in its rebound to continue the process (1986:99–100). Applied on a vertical surface, this technique does not work. Here the mason has to uphold the hammer against gravity *and* impart an impulse to it to get any carving action. Differences also exist in the effort required to pound at a vertical surface whether the masons are working below their waist, at chest height, or above their head. Below the waist, it is easiest to work with one's back to the work piece and swinging the hammer between one's legs. The wide forward swing of the arms imparts a good impulse to the hammer, and in its rebound from the work piece the hammer aids the back swing. Furthermore, the downward extending arms and hands make it easy to uphold the hammer. Working at chest height is very awkward. All the force that can be imparted to the hammer stone comes out of bending the arms at the elbows; the swing of the arms therefore is shortened, and much more effort needs to go into pounding than by working below the waist. Working above one's head, one again gains the momentum of the swing of the arms' full length, but here, in the back swing, as the hammer gets behind the mason's head it is pulling down her hands, and the hammer has first to be brought up before any force can be put into the hammer's carving action.

If it seems preferable to carve a stone while it is lying down—less effort is involved and no scaffolding is necessary to reach the upper realms of the work piece—the stone needs to be turned over for the carving of its other side. This operation, besides requiring another non-negligible effort, may put stresses on the stone that could break it and inflict damage to the already carved parts. The same questions and problems apply to the tall statues, such as the "Bennett" or the "Ponce," that were worked on all sides. Unless they were rolled on the ground as the carving progressed around the stone, they had to be carved in the upright position, thus requiring some sort of scaffolding to reach their upper parts. As with flat monoliths, a roughly shaped statue is much less prone to damage in the erection process than is a finished and finely carved one.

CONSTRUCTION AND DETAILS

Foundations

Earlier we reported that the walls of the Semi-Subterranean Temple were built directly upon tamped earth without further precautions. We suspect the walls of Putuni to have been built in the same way. We do not know what kind of foundation is under the retaining walls of Akapana. Kalasasaya's "Balcony Wall" is built upon a course of substantial sandstone blocks (Figure 6.19), which themselves are simply laid on tamped earth. We are not certain about any general principles the Tiahuanaco applied to their foundations, but at Pumapunku they resorted to a rather unusual technique. The ashlars of the base courses of the stereobate and the subsequent retaining walls rest upon the cut-off and leveled tops of oblong cobble stones embedded vertically in a constructed layer of compacted, fine-grained soil (Figure 6.20). In Chapter 2, we named the oblong stones "soil nails," because the technique is vaguely reminiscent of pilings, called soil nails, used today to anchor skyscrapers on loose soil (Pelli et al. 1997:96). The method is not new; ancient cities, for example Amsterdam and Venice, were also built on pilings. Piles of wood, densely packed and driven into the mud produce enough friction to consolidate the mud and provide a supporting platform on which to build a city. Yet, at Tiahuanaco the situation is quite different. To the extent that we could see it, the native ground on which Pumapunku stands is an argillaceous soil mixed with sand and gravel. It is fairly compact and simply cannot be compared with mire; even when saturated with water, this soil remains reasonably firm. Nevertheless, the foundation stones certainly contribute to stabilize the constructed layer of fine soil.

More difficult is the question of how such a foundation was laid down. Were the foundation stones cut first, and then implanted on an even level, or where they implanted first, and then cut and leveled out in situ? The first strategy appears to be by far the more plausible of the two. In this, the constructed layer of soil is put down, compacted, and leveled to create a reference plane. The previously cut and planed foundation stones are then driven into the compacted layer until level with the reference plane. An alternative method to the above is akin to that of constructing a sett paving: the previously cut and flattened stones are all set in loosely deposited soil, with their tops more or less leveled; the spaces between and around the stones are filled with soil, and the whole assembly is then compacted by tamping, possibly with the addition of water, and leveled out to the desired plane.

The task of staking out an even, horizontal plane without modern equipment is not as daunting a task as it may sound. Among the many possibilities, a pole, kept vertical with a plumb line, and with an attachment at a right angle to it, the whole contraption, somewhat simpler than the Roman *groma*, revolving

Figure 6.19. Sandstone blocks as foundation under the Balcony Wall.

Figure 6.20. Bottom of stereobate on Pumapunku's north side resting on cut-off soil nails.

360 degrees around its vertical axis, will provide the necessary sight lines with which to establish a level plane over 100 to 200 m with an accuracy of plus or minus a few cm, the deviations depending on the resolution power of the human eye making the determination.

The next step in the construction process is to lay the first course of stones onto the foundation. Most likely the first course stones were set down, rather than dragged upon the foundation stones. Our experiments show that in dragging them there is a great risk that the stones get snagged on the foundation stones and tear them out, or at least disturb their level position. Except for their cut off tops, leveling or foundation stones are not different from the soil nails embedded in the fill around the stereobate and behind the retaining walls of Pumapunku (see Chapter 2). The latter, like the former, help to consolidate the fill in which they are embedded.

Floors

When constructing floors, the Tiahuanaco builders had recourse to a variety of options. The courts of the Semi-Subterranean Temple and Putuni were finished in well-compacted clayey soils. A similar floor, colored in red, was laid down near the summit of Pumapunku. On the north side of Putuni and in the sunken court of Pumapunku pavings of carefully cut stones in rectangular patterns were used. Similar pavings covered the entry court to Putuni and can still be appreciated in Chunchukala. And finally, as seen in Chapter 2, a substantial plaster floor of a turquoise green color, was built in some intermediate period of Pumapunku's history.

A specific technique corresponds to each floor type. Except for a very small section of the reddish floor near the summit of Pumapunku, we have not ourselves seen other compacted floors at Tiahuanaco. The Pumapunku floor is a mixture of sand and reddish clay, and appeared to be not much more than 2 cm thick. We do not know how the Tiahuanaco builders compacted floors, but it could easily have been done by workers just stomping the mixture of sand and clay with their feet.

The paving in the sunken court of Pumapunku made of rectangular paving stones, 20 to 35 cm long by 20 to 25 cm wide, and 15 to 20 cm thick (Figure 6.21). They are laid with precision in a pattern

Figure 6.21. Paving in central court of Pumapunku.

recalling an *opus quadratum*. The paving on the north side of Putuni is very similar, except that the pattern is not as regular as at Pumapunku but more like what we called quasi-coursed masonry with many interlocking stones.

The plaster floor at Pumapunku was laid down over a leveled and compacted soil. The floor itself is about 6 cm thick, and has a very smooth surface. We are not certain of how the floor was laid down. If some sort of float[5] was used, one should be able to detect the traces of sweeping motions, but we have not seen a large enough section of the floor to confirm the existence of such marks. The material of the floor is a hard mortar of lime and sand, to which ground-up malachite was admixed to give it its greenish color.

The subject of the plaster floor brings up another set of questions: where were the lime-burning kilns, and where did the fuel for burning come from? Tom Schreiner has experimented with a wide array of kiln designs used still today in the Maya region of Mexico and Guatemala. He has found that in the most efficient kilns the ratio of quicklime to wood (desiccated) is roughly 1:4. Since the wood used in kilns is green and contains about 50% water in weight, about 8 kg of wood is needed for every kilogram of quicklime (Schreiner 2002). From Schreiner's work it is possible to derive the amount of energy needed to produce a unit of quicklime. With this information future researchers should be able to search for equivalent fuel sources that might have been available to the Tiahuanaco.

Walls

The Tiahuanaco builders used principally four types of wall constructions: partially cut stone assembled in a rough fit, tightly fitted cut stone, double faced walls of loosely fitted cut stones, and walls of adobe. The first type can only be seen in its reconstructed form in the Semi-Subterranean Temple and the Kalasasaya. The second is limited today to retaining walls on Akapana, Putuni, and Pumapunku, but, as we have shown in conjunction with the various gateways, it must also have been used for free-standing walls. Kerikala and the small structures near the summit of Akapana were built in the third type. Adobe walls have been postulated on the basis of the amount of argillaceous material in various places. As seen before, Ponce speculated from the clay found in the courtyard that superstructures of adobe once stood on the platforms of Putuni, and it has been argued for similar reasons that the stubbles of double-faced masonry may have been only the foundations, or splash-courses of long-gone adobe walls. Because to date we know of no standing remains of original adobe walls, we cannot comment on their construction, nor is there much to say about the scant remains of the double-faced masonry, or the totally reconstructed first type of wall construction.

When assembling walls of well fitted cut stone, the Tiahuanaco masons most commonly relied on gravity and friction to hold the building blocks in place. The tight fit of the stones provides excellent contact between them and leaves no room for individual stones to move. In specific instances, the builders made use of additional devices to assure the structural integrity of walls: rabbets, mortises and tenons, metal cramps, possibly lime mortar, and a somewhat mystifying device: a conical recess.

Rabbets, Mortises, and Tenons

In the *opus quadratum* between upright stones, as exemplified in Akapana's base walls or the Balcony Wall, the ashlars immediately abutting the uprights were carefully keyed into them, either with interlocking rabbets or with tenons. Angrand illustrated a tenon-and-mortise joint between an ashlar and an upright in his drawing of the remains of a wall on Akapana's north side (Figure 2.4). Squier described interlocking rabbets: "[T]he sides or edges of each erect stone are slightly cut away to within six inches of its face, so as to leave a projection of about an inch and a half, as if to retain in place any slab fitted between the stones, and prevent it from falling outwards" (Squier 1877:278).

The wall drawn by Angrand has since disappeared, and we have been unable to locate another mortise-and-tenon joint similar to his. Rabbets in opposite positions, one on the erect stone and one on the abutting ashlar, can be observed in situ on both the second and third terrace walls on the east side of Akapana (Figure 6.22), and rabbets, as described by Squier, are evident on some of the erect stones in the row of six on the mound's summit (Figure 6.9). Rabbets, or projections of the kind that have been documented by Angrand and Rugendas in their sketches of the Balcony Wall, can be seen in photographs of the same wall before its unfortunate reconstruction. These projections varied in depth and width over the height

Figure 6.22. Rabbet joint on upright. Also note the rope chase on the block fitted to upright.

of the erect stones, and were different on either side of them. A careful study of the projections and the shoulders cut out of the upright stones near their top may have held clues to the height and depth of the coursed masonry that filled in the space between the uprights, and the height and crowning of the wall. In another of Angrand's drawings depicting the inside of Kalasasaya's southeast corner, one appreciates similar rabbets on the sides of the erect stones, as well as shoulders carved near the bottom of the stones. These shoulders most likely marked the level of the floor inside the structure, and the rabbets again may have held information regarding the infill masonry and its height. Due to the reconstruction, these features are no longer visible, and thus another clue to Kalasasaya's original configuration is lost.

In addition to rabbets, Squier reported that the ashlar masonry was vertically "held in position by round holes drilled into the bottom and top of each stone at exact corresponding distances, in which, there is reason to believe, were placed pins of bronze" (1877:281). This particular feature we could not verify. There are, however, stones that in their top faces have small square recesses, which we interpret as mortises cut to receive corresponding tenons on the stones to be put on top. Such mortise-and-tenon joints were probably not designed to strengthen the joint, but rather served as a "centering" devices to assure the proper, relative positioning of the blocks.

CRAMPS

As seen in Chapter 3, much more common than mortises and tenons are cramp sockets of a wide range of shapes—L, T, double-T or ‡, U, Y, Z—and dimensions. Cramps in construction serve diverse purposes. The Egyptians, for example, cramped together most of their ashlar masonry. They favored the double dovetail shape and chose the wood from acacias or sycamores to make their cramps (Figure 6.23). Much less frequently, the cramps were of bronze, some of which were cast in situ (Arnold 1991:124–128). Jean-Claude Golvin, the head of the Centre Franco-Egyptien des Temples de Karnak, wondered about the usefulness of wooden cramps in perfectly executed and seated ashlar masonry and was puzzled by the fact that in several monuments the cramp sockets were empty, even in undisturbed masonry. He eventually concluded that the wooden cramps had no structural function, but rather were used during construction. Building blocks were set in place on a thin film of wet clay. The wooden cramps kept the blocks in place and from slithering out of position until the film had dried. The cramps were then removed and reused on

Figure 6.23. Wooden dovetail cramp at the temple of Khnum, Aswan.

the next course (Jean-Claude Golvin, personal communication, 1987).

The ancient Greeks, at first, borrowed the dovetail cramp from the Egyptians. Towards the end of the sixth century B.C.E., however, double-T cramps started to replace the dovetail. In the fourth century B.C.E., the Greeks systematically cramped and doweled together ashlars and other building elements with ∏-shaped iron cramps, that were often packed in lead; the lead protected the iron from rusting and thus prevented rust stains from marring the masonry (Müller-Wiener 1988:82–93). In emulation of the Greeks, the Romans continued the practice of cramping ashlar masonry (Adam 1989:56, 57).

Unlike these Old World examples, at Tiahuanaco cramps were not universally applied; they are noticeably absent from the near-isodomic construction of the tiers at Pumapunku, as well as of the ashlar masonry at Akapana. The Tiahuanaco seem to have used cramps very selectively and for special purposes. At both Akapana and Pumapunku, the sidewalls of the water channels are built with upright stone slabs held together at the top with I-shaped cramps. The apparent function of the cramps here is to hold the slabs in the proper alignment, but the overall construction of the canals made that feature entirely unnecessary. The lid, or capstones engaged with a rabbet into the canal, thus keeping the two sidewalls at the desired distance and properly aligned at the top (Figure 6.24). The main force acting on the sidewalls is the pressure of the fill surrounding the canal. This fill has the tendency of pushing the sidewalls inward. The push is greatest at the bottom of the canal, where the sidewalls are set onto the base in a simple butt-joint, leaving only friction to resist the push. We are somewhat at a loss in trying to explain the purpose of the cramps in the canals. One possibility is that the cramps when cooling off pulled together the stones for a tighter fit to prevent leakages from the canal. However, given its eccentric position relative to the joining plane of the adjacent stones, the cramp could not have prevented the opening of the joint at the bottom of the stones. Perhaps the cramps served not a structural, but only a constructive function similar to the wooden cramps of the Egyptians: the cramps held the side walls together and aligned during their erection. Even if the cramps had a structural function, there is a question. The main forces acting on the canal would have subjected the cramps mainly to shear, and that at the cramps' smallest cross-section. How much shear stress could the cramp resist? We will address this question below.

Figure 6.24. Canal with cover on Pumapunku, south side.

Substantial cramps of various shapes once pieced together the enormous sandstone slabs used in the construction of the Pumapunku platforms (Figure 6.25). Judging from the sockets, one of the largest I-shaped cramp measured 82 cm in overall length, had a cross-section of 13 cm in width and 10 cm in thickness, and flanges 16 cm wide, 8 cm high, and 12 cm deep, and would have weighed over 981 Newtons. Such cramps may very well have kept the platform slabs from drifting apart, but would have done nothing to prevent their uneven settlement. In our estimate, the vertical separation of the slabs due to settlement was a greater threat to the structural integrity of the platform than the horizontal separation, which, to some extent, would have been resisted by friction alone. As discussed in Chapter 4, large monolithic gateways were, or were to be, erected on the platforms. The cramps, then, may have prevented the dislocation of the platform slabs while heavy weights were moved onto and about them.

The lintel fragments of Gateway II at Pumapunku and of an unidentified gateway bear tiny T-shaped sockets with pinholes at both extremes of the crossbars of the T's (Figure 6.26). These sockets, about 3.5 cm on the side, are found on what was the gates' front side, where other gateways at Tiahuanaco are decorated with a frieze. It seems reasonable to

Figure 6.25. Cramp sockets on Platform III at Pumapunku.

Figure 6.26. Recessed cramp socket.

assume that tiny T-cramps were used to attach the ornamental equivalent of a frieze to these lintels.

On occasion, cramps appear to have been used to repair cracked stones, or at least to prevent the progression of incipient cracks. Repair cramps were used both in horizontal and vertical planes. For a better grip, and to prevent the cramps from falling off vertical surfaces, these cramps all had anchor pins at the tips of their flanges penetrating some 5 to 15 mm into the stone. To further enhance the grip, the holes for the pins were drilled not at right angles to the face of the stone, but at varying angles and directions. As seen in Chapter 3, cramps with anchor pins are also found at the bottom of circle stones. What functions these cramps served we have not been able to elucidate.

Recessed, Hidden Cramps

As was discussed in Chapter 3, most monolithic gateways were augmented by building stones connected with cramps. Many of the cramp sockets are carved into recesses, rectangular pockets or small niches, that later would be hidden by additional stones (Figure 6.27). Recessed, hidden cramping in one or even two directions is, to our knowledge, unique in the world and bespeaks an innovative construction technique. As discussed in Chapter 5, some of the recessed cramps would have required a chisel-like tool to reach the deepest part. If the recesses and cramp sockets are found in similar and predictable locations on the gateways, the cramp sockets and the recesses within which they are carved take on a variety of shapes. There does not seem to have been a particular standard for either shape or size of either recesses or sockets. The cramp sockets—mostly T-shaped—and the cramps that once occupied them differ widely in dimensions. Some are as short as 6 cm and 1.5 cm thick, with flanges 2.5 cm wide and 6 cm long, and webs less than 2 cm wide; others are up to 16 cm long and 3.5 cm thick, with webs 5.5 cm wide, and flanges 9.5 cm long and 4.5 cm in width. We presume that the larger the socket, the larger the stone was that was to be joined. We cannot be sure of this, since we have not found, as of now, stones that once were connected to the gateways. Recessed cramping observed on gateway fragments was to permit the connection of stones against a vertical surface. In a wall of several courses in height the masons generally try to avoid continuous vertical joints by overlapping stones from one course to the other to give the wall structural continuity, and in walls that turn a corner the masons interlock the corner with headers and stretchers. But when a wall meets a vertical surface (say the jamb of a gateway) it ends in a continuous vertical butt joint that breaks the continuity between the two. Carving out a recess from the vertical surface allowed the placing of a cramp to bridge the butt joint and to provide some structural continuity approaching the header and stretcher bond. Cramp sockets observed on some other stones suggest that a similar problem was to be solved. Large slabs set upright were to be joined at right angles to each other in butt joints. As above, the cramps provided a solid bond between the stones that otherwise would only loosely lean against each other.

Figure 6.27. Recessed cone in jamb of the Akapana Gate.

The use of cramps in masonry is not an obvious one' especially if there are no precedents as one can sometimes find in wood construction. (The predilection for the dovetail cramp of the early Egyptians and Greeks may be an example of this.) At Tiahuanaco, the copper cramps may possibly have had their precedent in stone cramps or keys. Ponce Sanginés (1961:37) illustrated such a key connecting two blocks, which he is said to have found in the west wall of the Kalasasaya. Where exactly he found it and whether there were more than one such instance, he did not say. We are thus left guessing what the function of this key was and whether it really represents an early example of the use of cramps. The use of cramps presupposes not only some experience with failed structures or unsuccessful construction efforts but also an understanding of the reasons for the failures. The fact, that the Tiahuanaco used cramps the function of which is not entirely clear, may indicate that they were still experimenting with them. Possibly they saw cramps as a replacement for the mortise-and-tenon and interlocking-rabbet joints. To our knowledge, aside from Tiahuanaco, cramp sockets in the Andes are only found on building stones at Huari near Ayacucho, Cuzco, Ollantaytambo, and Vitcos, all in Peru. Was there a diffusion of the cramp technology from Tiahuanaco, to Wari, to the Incas? Today, this question cannot be answered. First, at Tiahuanaco, a number of scattered building stones of unknown provenience, or context, feature cramp sockets. It is, therefore, impossible to determine the temporal relationship of these stones to stones in known contexts such as in the canals at Akapana and Pumapunku, and thus to set a date, even relative, for the introduction of cramps at Tiahuanaco. Second, sockets on Inca sites cannot be observed in their original setting since they are only found on displaced or reused blocks, and no cramps in situ or otherwise have yet been recovered. There is no positive association of cramp sockets with Inca masonry. At Ollantaytambo, it is obvious that blocks featuring cramp sockets came from an older structure and were incorporated into a new building in which the cramp technology was *not* applied (Protzen 1993:258; 2005:371–372). What were horizontal faces, or bedding planes, with cramp sockets on the stones in the older structure are now in the faces of the walls of the new structure in which the old cramp sockets have no function at all. Where the older structure stood is not known, nor is its age. Perhaps future work at Tiahuanaco and Ollantaytambo may one day allow associating the introduction of cramps at both sites with a known time horizon, and illuminate our understanding of the development of Tiahuanaco and Andean construction technology.

Cramp Material

Cramps from Tiahuanaco are well known; samples have been brought back by Bandelier to the American Museum of Natural History in New York, and by Créqui-Montfort to the Musée de L'Homme in Paris. Tiahuanaco copper objects have been analyzed as early as 1870 by David Forbes (1870:69). Erland Nordenskiöld (1921:91) reports that of seven Tiahuanaco cramps, none contained any tin (Sn), all were of plain copper. Ponce Sanginés, who had eight cramps analyzed, essentially confirms Nordenskiöld; none of the eight contained any tin. He reports, however, that some samples had as much as 2% arsenic (As) and showed traces of nickel (Ni). He discusses the possibility that the arsenic content might be high enough to call it an intentional alloy, but does argue that it was a matter of choice of ore rather than an explicit addition of arsenic to the copper (Ponce Sanginés 1994:12–14, 42).

The excavations conducted by the Instituto Nacional de Arqueología (INAR) in 1989 at Pumapunku uncovered cramps in situ in the side walls of two water channels. The walls of the channels and the cramp sockets are at a slope of about 12 degrees, but the cramps are level, indicating that they were cast directly into the sockets. The casting suggests that the masons were moving around the site with crucibles and capable of producing, at will, temperatures high enough to melt the copper or copper alloy.[6] More recently, Heather Lechtman analyzed some of the cramps found in situ, and examined the metal objects in the Museo Tiwanaku at La Paz. Sampling cramps in situ at Pumapunku, and other recovered cramps, her analysis reveals all cramps to be of a ternary alloy of copper-arsenic-nickel with more than just a trace of nickel. The two cramps from Pumapunku prove to have 6.0% As and 5.85% Ni, and 0.27% Sb (antimony), and 2.55% As, 1.75% Ni, and 0.022% Sb by weight, respectively (Lechtman 1998:77–92). These cramps clearly have more than just a trace of nickel.

Lechtman found that the cramps she analyzed were of two types: cast in situ, and rough casts hammered into the sockets. To our knowledge only cast in situ cramps have been observed in their actual context, the hammered cramps all come from museum collections with no known context. If at Tiahuanaco both hammered and cast cramps were used, it would be interesting to know under what circumstances one, rather than the other type of cramp was used, and whether the two types were used in parallel, or whether there are specific time horizons for the introduction of one and the other.

David Parks calculated that the cast *in situ* cramp, in cooling and retracting, develop a tremendous clamping power, pulling the stones together with a force of up to 44 kiloNewtons, that is a force fifteen times the weight of a typical stone in the canal side walls (Lechtman 1998:90). This force would have tightened the joint between stones, a desirable feature in a canal, and thus contributed to the structural integrity of the masonry. However, as noted above, because of the eccentricity with which this clamping force acts on the stones, its exact effect remains to be investigated.

The clamping effect of cast cramps, of course, does not apply to hammered cramps. Nevertheless, Parks calculated the latter could have withstood tensile forces as high as 46 kiloNewtons (Lechtman 1998:91). The knowledge that the As-Cu-Ni alloy from Tiahuanaco has great tensile strength is useful, but it does not quite explain the function of the cramps in construction. Walls are primarily subject to gravity and, apart from earthquakes, are exposed to horizontal forces in the direction of their longitudinal axes only in cases of uneven settlement of foundations, due to weak foundations, poor soils, or both. Uneven settlement can bring about an opening of the joints. Cramps as used at Tiahuanaco could have counteracted the opening of the joints at the top of the stones (caused by a "convex" settlement), but not at the bottom (caused by a "concave" settlement).

Use of Mortar

An alternative or addition to the use of cramps to hold ashlars together is the use of an adhesive, such as mortar. A thin coat of whitish material covering some of the stones on the first and second tier on the south side of Pumapunku was identified as a layer of mortar. The Bolivian archaeologists Pareja and Escalante analyzed the material and concluded that it was composed of clay, lime (*cal*), and fine sand in the proportions of 3:1:1, respectively (Escalante 1995:218). Workers of the Instituto Nacional de Arqueología have informed us that it was extremely hard to remove stones that were bonded with this material. What puzzles us is that even uncut and patently unfinished areas are blanketed with the stuff. What was mortared to these areas? Given the unevenness of these areas, the mortar must have been applied in very thick layers, but only films thereof remain! Even more puzzling is the fact that what looks like the same material is found on bedrock in the Quimsachata Range some 10 km southeast of Tiahuanaco.

We encountered serious difficulties in our attempt at having the material analyzed. The first of these concerns the procurement of a proper sample. The coat is so thin, often less than half a millimeter thick, that it is impossible to separate it from the sandstone without tearing off some of the latter as well. Thus, quartz will inevitably show up in the analysis of such a sample. The same holds for clay: it is either washed or airborne onto the coats on the site or the bedrock. Sand and clay, if found, are therefore not necessarily indicators of a mortar, nor is calcite. Our tests, carried out at the Earth Science Laboratory at the University of California at Berkeley, indeed show a steep peak for the mineral calcite, but here is the second difficulty. Naturally occurring calcite, or calcium carbonate ($CaCO_3$), is indistinguishable from calcite in set lime mortar. The cycle starting with the baking of limestone, to yield quick lime (CaO), that, with the addition of water becomes slaked lime ($Ca(OH)_2$), which, with the addition of sand and more water is made into lime mortar, returns to calcium carbonate during the final air drying and curing stage of the mortar. Our tests to date are inconclusive; they do not let us distinguish the bedrock sample from the construction site sample.

The extensive green plaster floor discussed above is proof enough that the Tiahuanaco builders possessed a lime burning technology, and were entirely capable of making lime mortar. If nevertheless we suspect the thin, white coating to result from natural processes, it is because of the coat's erratic and sometimes unexpected appearance, and because at Pumapunku, where it is mostly found, it serves no structural purpose. The coat is not consistently found on all masonry that should have it, if mortar were applied systematically. There are extended bare surfaces all along the visible bedding joints of, for example, the second wall on the south side of Pumapunku that cannot be explained by erosion. In the same wall, with its in-and-out bond, the white material sometimes is found on the protruding surface of a stone but not on the surface that was in contact with other stones. And then, the white coat is found on the faces of stones that should not have any mortar, such as unfinished faces and faces with motifs. As we have seen, the terrace walls at Pumapunku are so well fitted and so thick that the addition of mortar would have contributed very little to the structural integrity of the walls. Should later analyses prove our suspicions wrong, and confirm that the material was indeed a lime mortar, the above observations would still have to be adequately explained.

Conical Recesses

The Gateway of the Sun, and the jamb fragments of Gateways I, II, and III at Pumapunku exhibit sugarloaf, or cone-shaped recesses (Figure 6.28). The conical recesses have a diameter at the base of 13 cm

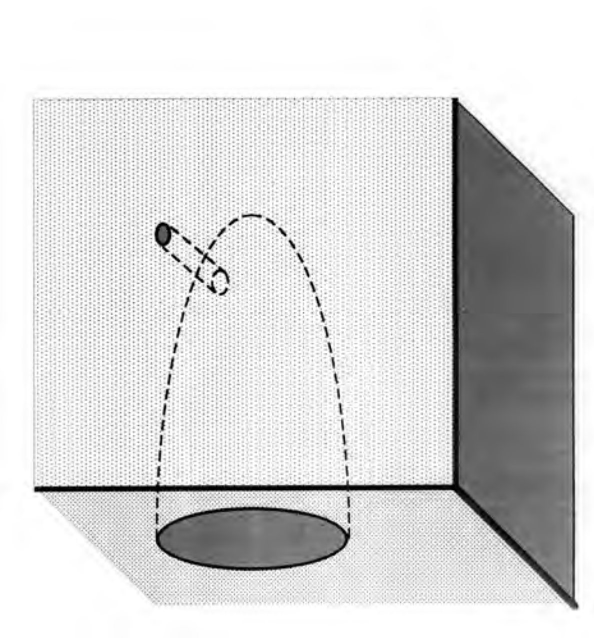


Figure 6.28. Drawing of recessed cone (drawing by Jean-Pierre Protzen).

on average, and measure 18 to 22 cm in height, or depth. They are carved into the bottom of the jambs on either side of the gateways with an additional cone, vertically aligned and similarly oriented, that is, base down and apex up, in the upper, inner corner of the Type 2b niches flanking the gateways. In each case, a small hole, about 2 cm in diameter, is drilled from the face of the gateway into the cone near its apex. Similar cones are found on the jamb stone of the Akapana Gateway, one at the bottom and one at the top, vertically aligned, but on this stone the conical recesses are arranged apex to apex. The conical recesses were pounded out as is revealed by the pit marks inside. Given the depth of the large conical recesses, it appears likely that the pounders, or hammer stones, were hafted.

We have not yet been able to elucidate the purpose these conical recesses fulfilled, except to imagine that some object was inserted into the conical recesses and held in place by a pin pushed through the drill hole. On the gateways, the bottom cone may have served to anchor the gateways to their base in some ways, but what purpose the conical recesses in the corners of the niches had is difficult to fathom. Posnansky believed the upper conical recesses to have been the hinges for a cover of the niches as on a retable: on opening the screen, the image of an idol would appear (1945:Vol. 2, Figure 10). Oh, so much imagination! All the conical recesses in the niches are damaged as if some force had been applied to break them open. The upper cone on the Akapana jamb stone in its inverse position, apex down and base up, may have served to connect and anchor the lintel piece above, but we do not know how. Conical recesses were not limited to the dimensions given above. On a small stone in the Kalasasaya, we found two miniature conical recesses, 2.5 cm in diameter at the base and about 3.5 cm deep, with small holes, 8 mm in diameter, drilled into the conical recesses near their apexes (Figure 6.29). Unfortunately, these miniature conical recesses are no more enlightening than the large ones. However, because their configuration is the same, we assume they had a similar function, whatever it was.

Roofs

Since there are no standing buildings at Tiahuanaco, there are also no roofs to be observed today. Given the scant archaeological information available today, it is difficult to impossible to figure out how roofs were constructed. To our knowledge, the oldest, and only reference to roofs at Tiahuanaco is found in Garcilaso de la Vega's *Comentarios reales*. It is attributed to Diego de Alcobaza, a childhood friend of Garcilaso's: "[E]l techo de la sala, por de fuera, parece de paja, aunque es de piedra, porque, los indios cubren sus casas con paja, porque semejase ésta a las otras, peinaron la piedra y la arrayaron para que pareciese cobija de paja" (Vega Book 3, Chapter 1; 1976:125). ([T]he roof of the hall, on the outside, looks like straw, although it is of stone. Because the Indians cover their houses with straw, and for this [room] to look like the others [houses], they

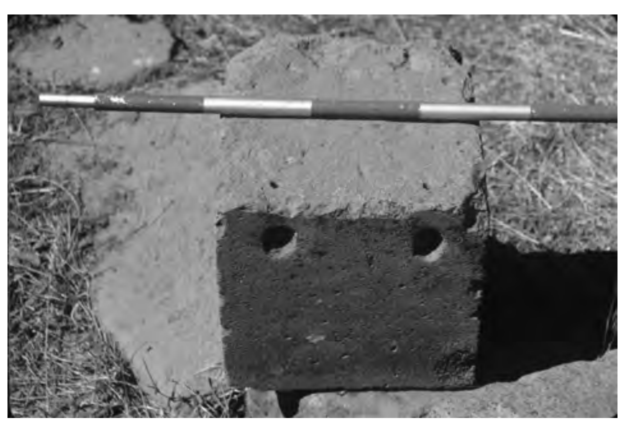


Figure 6.29. Small cones in stone at Kalasasaya.

dressed the stone and incised it so that it would appear like a cover of straw [translation by authors].)

What building or hall Alcobaza was describing cannot be inferred from his summary account of the ruins at Tiahuanaco, but what he said about the roof is corroborated by the archaeological remains. There are indeed several stone slabs with an incised design representing bundles of reeds, if not straw (Figure 3.44). On one such slab the design even turns the corner. We do not really know how these roof slabs were put on a building. Were they laid at a pitch or flat? We suggest that they were used horizontally to form a cornice along the top of the wall, thus simulating the eves of a reed roof. However, how the roofs were actually built, what kind of beams or rafters where used, and so on, we will probably never know.

Tool Kit

Surveying Tools

Posnansky proposed that to establish "lines of sight" the Tiahuanaco builders may have used a "diopter" made of two perforated *tupu* ("Alfiler grueso de oro, plata o cobre que usaban las mujeres para prenderse las vestiduras"), mounted on a movable plate atop of what looks like a massive pedestal (Posnansky 1945:Vol. 2, Figures 16–18). He further suggested that the builders used a simple rectangular box, which they filled with water, as a level (Posnansky 1945:Vol. 2, Figure 15). The use of *tupu* has some merit; a contraption such as his diopter suitably mounted on something less massive than a stone pedestal and more mobile could have been used. The water box is another matter. Unless it could be moved easily over a surface without spilling, such a tool would hardly guarantee the levelness of that surface. A surface may well have several level spots, without itself being level. Even less plausible is Escalante's suggestion that an odd stone found at Tiahuanaco with a curved bottom and a square depression on top could have served as a level (Escalante 1993:400, Figures 333a and b).

The Tiahuanaco builders, as seen before, knew how to survey and lay out a structure, they also were capable of creating perfectly level surfaces large and small. What tools they used in performing these tasks, we simply do not know.

Stonemason's Tools

We mentioned before that the construction tools of the Tiahuanaco, with perhaps the exception of hammer stones, remain essentially unknown and have yet to be discovered. Nair's experiment has shown that rough, unworked flakes of hard stones make excellent stone carving tools (Nair 1997). It is thus possible that construction tools have been excavated but not recognized as such. On the other hand, as Protzen has discussed elsewhere (1993:vi, vii), replicative experiments, at best, demonstrate that a postulated technology was not impossible, but they can never prove that it was actually used. In other words, if Nair's experiment unequivocally shows that Tiahuanaco-style stone work can be done with a simple lithic toolkit, it does not mean that the Tiahuanaco stonemasons actually used such a kit. The Tiahuanaco may have had other options. If one of these options is metal tools, then, as Stübel and Uhle have pointed out long ago, only bronze tools could be considered (1892:Part 2, 45). Normal copper and bronze tools have been shown to be ineffectual in carving andesite as found at Tiahuanaco thus confirming Stocks's finding in Egypt (Stocks 1986). It is not yet not known whether copper alloys with the required hardness to work this stone could have been manufactured by the Tiahuanaco. The ancient chroniclers were rather emphatic about how the Incas used stone tools exclusively to cut and carve their building blocks. Garcilaso de la Vega, for example, wrote that "they had no other tools to work the stones than some black stones they called hihuana [*sic* for hihuaya] with which they dress the stone by crushing rather than cutting" (Book 2, Chapter 27; 1976:Vol. 1, 126 [translation by Patricia Lyon]). Thus, to the extent that the Tiahuanaco roughed out stone like the Incas did, we will assume that the Inca tool kit was at least a proper subset of the Tiahuanaco tool kit. To finish their stones, however, the Tiahuanaco must have had the use of other kinds of tools, for one finds no comparable execution in Inca stonework.

The postulated tools in the Tiahuanaco tool kit not found in the Inca kit are chisel-and punch-like tools, incisors, a square and a straightedge, or their equivalents. Drills were also part of the Tiahuanaco kit as evidenced by the many fine holes drilled into the friezes of Gateway III at Pumapunku, the curved architrave at the Kantatayita, and other stones. The consistency wherewith proportions were maintained over a range of niche sizes, the precision wherewith layouts were following given patterns, and the frequent repetition of certain dimensions, suggests that the Tiahuanaco possessed an accurate measuring device with a standard unit of measurement. Further research and the archaeological record may, one day, reveal the actual Tiahuanaco tool kit.

Handling and Hoisting Tools

When discussing the laying and handling of stones, we implied that these tasks would have been facilitated considerably by the use of some sort of hoisting devices. Such devices are, in fact, suggested by the hoisting grips found on many stones. Unfortunately, like for most other tools used by the Tiahuanaco builders, no evidence of any such devices has yet been found in the archaeological record of the site.

Clearly, our account of Tiahuanaco construction technique leaves many questions unanswered. Besides the gaps already mentioned above, we have no information about the labor force. How large was the labor force? How were the workers recruited, trained, and organized? As noted, the possibility that regular ashlars were mass-produced suggests that stonemasons may have been organized in workshops and other gangs of workers enlisted to haul the blocks to the actual construction site. The very fine and precise carving of details suggest that there may have been among the masons a specialist elite. But then, these are, for now, no more than hypotheses and whether such questions can ever be answered remains itself an open question.

NOTES

1. Letter dated 31 October 1962, a copy of which was made available to us by Barbara Conklin of the American Museum of Natural History.
2. We thank Mark Lehner of the University of Chicago for having recorded this profile.
3. John Rowe suggested that reed boats might not have been used on Lake Titicaca before the Incas. They may have brought the idea from the coast after their conquest of the Chimu on the north coast of Peru (Rowe, personal communication 1994)
4. The reader might remember that after the failure of his papyrus boat Ra I, Thor Heyerdahl made appeal to the skills of the reed boat builders of Lake Titicaca to build Ra II, with which he successfully traversed the Atlantic from Africa to Barbados.
5. A flat tool with a handle on the back.
6. Heather Lechtman, (personal communication, 1997) calculated that the As-Cu-Ni alloy is liquid at a temperature of ≈1,250 °C, starts to freeze at ≈1,045 °C, and is completely solid at ≈810 °C.

Conclusion

> "Por haber carecido de letras los indios, no podemos averiguar muchas de sus cosas, y así en las más vamos a tiento y por conjeturas..." (Cobo 1964:Vol. 2, 196). (Because the Indians lacked writing, we cannot verify many of their things, and so with most of them we proceed carefully and by conjectures… [translation by authors].)

In the Introduction we argued, first, that an understanding of the use, function, and meaning of architecture cannot be derived from a mere contemplation of its artifacts, it also has to be tied to the experience of the architecture. Second, that the ruined state of Tiahuanaco's architecture prevented it from being experienced, and that therefore, our research should attempt to recover as much of Tiahuanaco's architecture as possible, with the hope that perhaps we could re-experience it, at least vicariously, in a virtual reconstruction.

This proved to be a difficult, if not impossible, goal to reach, not only because the site has been devastated and key pieces of the puzzle have been destroyed or lost, but also because Tiahuanaco, like any other site occupied over many centuries, underwent many transformations, with one phase of construction overlapping another, and one vision replacing another. While we tried to look at all (still visible) phases, we concentrated our efforts on what we have called the Pumapunku Style architecture, an architecture so elegantly illustrated by the Gateway of the Sun. But in this effort we also encountered complications. As we noted in Chapter 4, we have yet to reach an understanding of the architecture at the building level. We still do not know much about the buildings, their volume and scale, appearance and spatial configuration, or the types and shapes of rooms they may have harbored; nor do we know the kind of spaces buildings set up between them and their relationship to the larger landscape. If we have been able to establish the immediate context of the main gateways, we still do not know where the many gateways stood, what spaces they led into, and in what relationship the gateways stood to each other and to other elements of the architecture, in particular the half-scale architecture. The main difficulty here, as Cieza de León had already noted, is that Pumapunku was abandoned before it ever was finished: "Y notase por lo que se ve destos edificios, que no se acabaron de hazer..." (Cieza de León Part 1, Chapter 105; 1986:283). (And one notices from what can be seen of these buildings, that they were not completed... [translation by authors].)

Our own investigations confirm Cieza's view. The Gateway of the Sun and all the gateways at Pumapunku show work in progress, as do the canals, the platforms, and many other stones there. If indeed construction was still underway at Pumapunku, attempts at reconstructing its architecture become attempts at outguessing the builders' intentions or reading their minds. In the absence of drawings, sketches, models, or descriptions betraying the builder's ideas, this is a formidable challenge! As we have noted in Chapter 2, fanciful "reconstructions," in particular those of a "complete" Pumapunku, ignore the fact that it was never finished and are a disservice to scholars and the public alike.

While we may never be able to definitely state what the exact significance or symbolism of the gateways at Tiahuanaco were, what hierarchies of spaces the buildings were designed to create, nor the kind of social or political relationships they were intended to establish or embody, our work on Tiahuanaco architecture provides some key insights that move us toward an understanding of these issues.

Throughout the text we have noted features, both technical and architectural, that are unique to Tiahuanaco architecture. Many of these features are in fact remarkable inventions made by the builders of Tiahuanaco, inventions that to our knowledge and to this time have no known antecedents, either in the architectural history of the Andes or in that of the world. In what follows we give a brief recapitulation of the most salient features.

Tiahuanaco Inventions

Technical

Tiahuanaco soil nails, particularly those with the cut-off tops used as foundation or leveling stones, are unique in the annals of architectural history. Even if we do not yet entirely understand their workings, they nevertheless have to be rated an innovation. These stones may have helped solve problems of alignments. It is easier to level a building block if it rests only on a few points rather than on its entire surface.

The construction of retaining walls, as for example in the Akapana, with large uprights planted into the ground and notched to receive smaller stones in between, has no known precedent in the Andes. As Gasparini and Margolies (1980:13) noted: "Those evenly spaced monoliths insure the greater stability of the smaller stones set between them." The myriad of agricultural terrace walls that sculpt the Andean landscape have a very old tradition, one that most certainly antedates Tiahuanaco, but nothing in that tradition seems to have prepared the ground for the new construction technique.

Stones cut into perfectly rectangular parallelepipeds that could be exchanged one for another, and even mass-produced, is certainly another invention without an Andean precedent. This practice may have been inspired by the production of adobes with a mold,[1] yet in stone it had not been tried anywhere else in the Andes.

The puzzle-like assembly of motifs from several stones, each of which has only a part of the completed motif, and the development of a kit of parts, are novelties, which in turn may have driven two other inventions: a precise method of measurement and construction cramps. To accurately and repeatedly place the fragmentary motifs on many stones and to cut them with the required precision to fit them together, it was essential to have a standardized method of measuring, or at least of comparing, distances to the accuracy of a millimeter. How the Tiahuanaco did this we do not know, but we are confident that in the Andes no other artifact or activity before ever required this high a resolution of measurement. Measurement, the staking out of large structures with strictly parallel sides and numerous corners at perfect right angles, and the precise proportioning and scaling of elements presuppose, as Middendorf already suspected, knowledge of mathematics and geometry. For example, when we argued that it was easy to construct 30-degree angles (Chapter 4, note 7), we assumed, or presupposed, knowledge of equilateral triangles and their properties. The carving of two parts of a motif from two stones that join at a bevel rather than at a right angle (see Akapana Gate section in Chapter 3) where respective parts get foreshortened, presupposes some knowledge of similarity transformation. We do not know the form of the Tiahuanaco builders' knowledge of geometry and mathematics, except that we find it materialized in their built world.

In the assembly of motifs and stones at the level of perfection at which the builders of the Pumapunku style architecture worked, errors of only a few millimeters would have been immediately perceived. Thus, the uneven alignment of the motifs, or of stones in a planar wall, would have spoiled the intended effect. It is perhaps to prevent misalignments during and after construction that the Tiahuanaco builders conceived of construction cramps hitherto unknown in the Andean world. As we argued in Chapter 6, cramps are an ingenious, yet far-fetched invention.

Big stones had been moved and erected or assembled in the Andes before Tiahuanaco, as well as at Tiahuanaco itself, without apparent devices to lift them. The introduction of hoisting grips and rope chases must thus be seen as another notable innovation. The limited number of stones outfitted with such devices and the relatively small size of these stones, suggests that the Tiahuanaco builders may still have been experimenting with these contrivances.

Architectural

The builders of Tiahuanaco, at least those who created the architecture that we call the Pumapunku Style, had an extraordinary sense of architectural order. The strict treatment of perfectly planar surfaces, modulated by sharp geometric figures and moldings in prescribed arrangements, betrays an aesthetic that is preoccupied with the precise relationship of elements to each other and an overall canon to which every detail had to conform.

No architecture is without order. We recognize and distinguish the architecture of a different culture and a different age by its redundant, or repetitive features, or its rules; we do not confuse Moche with Chávin, or Chimú with Huari. But the Pumapunku style architecture at Tiahuanaco differs from any of these in its rigor, which has no precedent in the Andes. With its system of rules, it more resembles a Greek order with its standardized details, and it is reminiscent of Renaissance architecture with its well-structured facades, balancing the vertical and horizontal elements in a reinterpretation of classical antiquity. By evoking European examples, we wish to underline the sophisticated uniqueness of the Pumapunku style in the Andes.

Significance

John Hemming argued that "[a]rchitecture anywhere in the world evolves from precursors" (1982:26), and Ernst H. Gombrich, in his *The Sense of Order*, stated bluntly that "[n]othing comes out of nothing" (1984:210). Similarly, George Kubler holds that "[t]he human situation admits invention only as a very difficult tour de force" (quoted in Gombrich 1984:210).

What, then, are we to think of the many Tiahuanaco inventions that apparently do not have any precursors? An argument could be made that Tiahuanaco architecture and construction practices had ample time, perhaps a millennium or more, to develop and evolve, and that, in some sense, Tiahuanaco had become its own precedent. One could then perhaps see a progression from the cruder, random-range work of the Semi-Subterranean Temple, to the well-fitted and very smooth masonry of the base walls of Akapana, or the east wall of Putuni, to the sophistication of the "Pumapunku" style architecture. Even then, there is a gap, or a missing link, between the random range work and the fully fitted, smooth masonry with planar bedding and right-angle vertical joints. Furthermore, at this time and as we see it, there is no chronology of the various construction episodes at Tiahuanaco sufficiently reliable to establish an evolutionary trend. And, as we noted in Chapter 2, at any time there is the possibility that the builders of Tiahuanaco came upon an invention challenging the established canons, and thus defying any sort of evolutionary thinking.

At the beginning of this text we noted that Tiahuanaco stonemasonry is often taken to be the precedent for the wonderful stonemasonry of the Incas. In contrast, we have argued elsewhere that there "existed at least a strong prima facie case in favor of the hypothesis that Inca architecture and stonemasonry are authentic inventions and not Tiahuanaco derivatives" (Protzen and Nair 1997:166). We do not deny that the Incas may have been impressed and inspired by what they saw at Tiahuanaco; we only argue that whatever the Incas saw, whatever inspired them, they completely reinterpreted it and made it their own. It may thus be fruitful to compare the Tiahuanaco inventions in construction techniques and architecture with the accomplishments of the Inca stonemasons.

DIFFERENT TECHNIQUES AND CONSTRUCTION PRACTICES

Whatever it is that the Incas supposedly learned from their Tiahuanaco predecessors, it is *not*, as Hemming said, "tight *polygonal* joints and *beveling* of junctions" (1982:26, emphasis added), two of the hallmarks of Inca masonry, for those simply are not found at Tiahuanaco. The beveling of joints is, at least in part, a consequence of Inca stone cutting techniques (Protzen 1985; 1986), which, as we have shown, differs from that of the Tiahuanaco in a variety of ways. The technique that allowed the Tiahuanaco to cut perfectly rectangular building stones with perfectly planar faces that could be exchanged one for another, and to carve perfectly square and sharp exterior and interior angles, was not adopted by the Incas. Either the skills and the tools to produce such blocks and angles had already been lost, or perhaps, as we tend to believe, the technique did not suit the Inca temperament.

The Incas were, as a rule, very careful to erect their buildings on sound foundations, either directly on bedrock, or otherwise on fieldstone masonry, generally wider than the footprint of the wall above, buried in trenches (Protzen 1993:219). This practice seems to have been unknown to the Tiahuanaco, who erected their structures either directly on tamped earth or on soil nails. The two practices, Inca and Tiahuanaco, apparently have nothing in common and may illustrate different perceptions of how loads are distributed and transferred to the ground.

We still do not have a good grasp on how, in fact, the Incas lifted and set building blocks into place with only bosses on the front face of the blocks. In Protzen's several attempts to replicate this operation he ended up with damaged edges. The Incas obviously had developed their own technique—unknown to us—since they either overlooked, or otherwise did not understand the ingenious rope chases and hoisting grips of the Tiahuanaco, which allowed a gentle handling of the stones.

As noted in Chapter 6, cramp sockets are not unknown in the Inca heartland. Sockets of various shapes are found on blocks uncovered at the Qorikancha, and T-shaped sockets are well documented at Ollantaytambo. However, unlike at Tiahuanaco, sockets at Inca sites cannot be observed in their original setting since they are only found on displaced or reused blocks, sometimes in incongruous positions like the face of a wall. Furthermore no cramps have ever been found in situ. It is thus unclear whether the Incas had adopted the cramping technique from Tiahuanaco. It is our view that the Incas did not use cramps in their masonry, at least it was not their common practice: to our knowledge *no* intact Inca masonry bears evidence of its application! But then, who did use it in the Cuzco region? That question is vexing, and the answer eludes us to this date. At Ollantaytambo, for example, earlier excavations by either Llanos or Gibaja de Valencia have failed to bring to light any Tiahuanaco material, thus, apparently, ruling out any earlier Tiahuanaco occupation of the site (Llanos 1936; Gibaja de Valencia 1984). Yet, there are the remains of a wall—Protzen named it the Llanos Wall (Figure C.1)—on the Temple Hill at Ollantaytambo that bear a striking similarity to

Figure C.1. Llanos wall at Ollantyatmbo with Tiahuanaco-like masonry.

Tiahuanaco masonry (Protzen 1993:89, 90). Two courses of nine stones show planar bedding joints and a face without traces of sunken or beveled joints. Could they be of Tiahuanaco origin? Without excavation and further investigation, this question cannot be addressed.

Different Discipline

The Tiahuanaco practice of constructing walls with precisely placed motifs and their puzzle-like assembly over several building stones must have required a strict coordination of the stonemasons. In this masonry there is no room for improvisation, every detail is subordinate to a larger order. Plain and immaculate planar surfaces, sharp and precise straight edges are ruthlessly unforgiving; the slightest imperfection jumps out and mars the intended design and effect. Under such exacting constraints, the Tiahuanaco stonemasons must have been subjected to a stringent discipline.

In contrast, the individual Inca stonemason enjoyed considerable freedom.[2] Once the basic layout of a building was determined, the masons could let their own imagination soar and flaunt the mastery of their individual skills. The Inca stonemasons were certainly no less precise in their work than their Tiahuanaco ancestors, yet if they should have made a mistake it would hardly be noticeable or they could have corrected it with relative ease and without consequences for the overall design.

It is not really known how the Incas organized their labor force, but it is not unreasonable to assume that they adopted the same decimal system they used to raise tribute in form of a labor service, the *mit'a* (Protzen 1993:12). In the physical realm, however, a trained eye may discern in the bond patterns of Inca walls signs of Inca construction practices as well as the use of the labor force. Certain joint shapes, such as L-shaped joints, bespeak the sequence in which blocks were erected, as well as the particular technique of carving out bedding joints from already placed stones (Figure C.2). The placement and distribution of wedge stones reveal the workforce organization (Protzen 1985:193–195), and the diminishing stone sizes toward the tops of the walls are reflective of the effort required in lifting stones to increasing heights.

Figure C.2. L-shaped joints at Saqsawaman.

We know, of course, even less how the Tiahuanaco labor force was organized, yet the possible mass production of stones and the use of a kit of parts do suggest that groups of masons were assigned to the manufacture of certain types of building blocks. Other workers could have been assigned the task of assembling the building blocks into walls and buildings, with perhaps another specialized group in charge of casting the construction cramps.

Today's architects make extensive use of drawings—plans, elevations, sections, details, and sometimes models—to convey their ideas about a building's looks, configuration, and assembly to clients and contractors alike. What means did the ancient builders use? Here again, we do not know the answers, but we can conjecture.

Inca architecture, with some notable exceptions, consists mainly of simple, one-room rectangular buildings with only a few elements: doorways, niches, windows, and sometimes pegs. Roofs were either gable (two-sided) or hip roofs (four-sided), or occasionally shed roofs (Protzen 1992:199–202). The arrangement of the elements was quite standardized. Once the basic dimensions and layout of a building had been determined, and the number of doorways, niches, and windows fixed—decisions that could easily be communicated orally by the master builder to the masons—the masons familiar with the standards could proceed without further information or instructions.[3]

Could a similar practice have worked at Tiahuanaco? Structures like the Semi-Subterranean Temple or the Kalasasaya could certainly have been conceived in, and built from, mere oral descriptions. Even Akapana could have been constructed without visual aids, although it has to be admitted that even a rough sketch of its large ground plan with its many salient and re-entering corners, its many tiers, the supposed sunken court on top, and the location of the many underground drains would have been helpful not only for the conception of the structure, but also for the communication of the idea, for the actual layout of the mound, and the subsequent construction of it. It would have helped in estimating the volume of construction materials to be procured, and the size of the workforce to be marshaled.

In contrast, how one could conceive and build an architecture in the Pumapunku Style without a visual representation of some sort is difficult to fathom. How would one communicate to a mason the shape and dimensions, and the intricacies of details of, say, an H-stone without what we today call a shop drawing? How would one communicate to a work crew where to place a particular stone type without a visual representation of the overall composition? Or conversely, how would one subdivide an overall composition into constituent parts, that is, specific building blocks, without such a representation? As mentioned in Chapter 4, the use of a standard unit of measurement, a system of proportions, and rules of composition are useful tools in the communication of design ideas. However, they are no substitute for a visual representation, for very rarely are sets of rules of composition complete or closed as to leave only one solution. Designers who think they have deciphered Palladio's rules of composition can generate Palladio-like buildings that Palladio never built or designed (Mitchell 1990).

The abovementioned advanced knowledge of mathematics and geometry of the Tiahuanaco goes hand in hand with the problem of representation, for accurate representation at reduced scale implies that knowledge. If the Tiahuanaco did not use drawings, laying out structures directly on the ground or motifs on the stones necessitated a set of tools embodying that knowledge of mathematics and geometry, and substituting for representation. What the nature of such tools would be, we do not know.

The layout of some Inca terraces and street patterns suggest that the Incas, too, had some knowledge of geometry and must have had some surveying tools (Protzen 1993:49). However, nothing in their architecture or construction suggests a level of accuracy and sophistication in measurement and proportion comparable to that of the Tiahuanaco.

Different Aesthetics and Values

The Incas' play with endless variations in bond patterns, and the mostly irregularly shaped stones with pillowed faces are in sharp contrast to the Tiahuanaco's severe symmetrical arrangements of standardized geometric patterns and elements, and the planarity and orthogonality of their building stones. Where the Incas accentuated and enhanced the unique features of every single stone, the Tiahuanaco effectively erased that singularity. The two aesthetics, exquisite as each is, belong to very different orders. We argue that the difference is not just a question of taste, but that it may have deeper roots. While we don't know about Tiahuanaco, we suggest that to the Inca stonemason the carving of an individual stone meant more than a simple act of construction; it had ritual connotations embedded in Inca cosmology. Each stone probably was understood as a piece of Pachamama, the all-powerful Mother Earth that had to be treated with respect and reverence. In comparison, it would seem that the Tiahuanaco treated stone primarily as a good construction material. Here, meaning is not found in the stone and its treatment, but in the compositional geometry of entire walls and the symbolism of the motifs and iconography. Perhaps, as Nair suggests, the Tiahuanaco stonemasons not only took pride in precision, but precision carving in itself may have had ritual connotations. Hence, it may have been the process (or act of making) rather than the material itself that was meaningful to the people of Tiahuanaco.

The veneration of Pachamama may also be the reason for the Inca's propensity to juxtapose and blend natural features with the human-made: buildings literally grow out of the bedrock on which they stand, natural boulders are enshrined, windows are oriented to chosen features—peaks, waterfalls, boulders—in the landscape, bedrock is contrasted with precisely cut stonemasonry to form an integrated whole, and where judged deficient bedrock is "repaired" to look natural. At the scale of whole sites, it is true that the Incas often practiced enormous earth movements, for example, when building terraces or sites such as Machu Picchu, but the end result, rather than a scar in the landscape, is a harmonious integration with it, an intervention that reveals and enhances the existing topography. For the Incas, the art of building had, in some ways, also become the art of landscaping. In contrast, the Tiahuanaco builders seem to have emphasized the human-made over the natural world; there are no examples of the conjunction of the hewn with the unhewn, of buildings integrating natural features. The existing structures at Tiahuanaco are markers in the landscape, markers that stand out against, and in contradistinction to, the background of the natural world. Akapana stands out in its opposition to the only natural mound in the valley, some kilometers away and to the east. Because the valley floor on which Tiahuanaco stands is otherwise relatively featureless, it was perhaps more important to the Tiahuanaco to signal their presence with their artifices rather than their ties to the soil. And more important still may have been the expression of the connections to the cosmos: the underground, the Earth surface, and the sky, as perhaps exemplified, respectively, by sunken courts like the Semi-Subterranean Temple and underground canals, the ground into which the courts are dug and on which mounds are erected, and the mounds like Akapana that reach toward the sky. Further connections to the cosmos may perhaps be found in the alignment and orientation of the various structures that perhaps correspond to specific observations of celestial phenomena. As we noted earlier, the east-west orientation of many structures may be related to the path of the sun.

The Incas used a bowing out, or entasis,[4] of the walls and door jambs to give a feel of weightiness to their stonemasonry. A particular good example is the "apse" wall of the Qorikancha in Cuzco, but entasis can be observed in many other Inca buildings and it bespeaks the Incas' particular aesthetic sensibilities. The expression of weightiness or the correction of optical illusions does not seem to have concerned the Tiahuanaco. Yet, one finds similar aesthetic subtleties in the flaring of gateway openings and niches, which gives one the illusion of depth. At a larger scale, and if we follow Conklin (1991), the Tiahuanaco were perhaps more preoccupied with horizontality. The flowing parallel horizontal lines on the Gateway of the Sun and on some of the curved architraves may have provided a "permeating matrix [that] gave the architecture a special harmonic relationship with the horizon" (Conklin 1991:290).

The relatively small dimensions of Inca architecture, combined with the above described adaptations to, and integration with the natural landscape give the Inca sites a sense of intimacy. Even Saqsawaman with its cyclopean building stones, doubtless the largest single Inca structure, impressive and monumental as it is, has an undeniable human scale. One is more awed by the size of the stones than by that of the structure itself. This may be due to the structure's informality, the fact that it cannot be grasped in its entirety, except from far away, its receding three tiers and the smaller spaces created by the many salient and reentrant corners, and the seeming randomness of the bond patterns in the walls. This is not to say that the Incas never built at a monumental scale. The enormous plaza at Huánuco Pampa with the impressive platform structure, or *'usnu*, at its center is certainly imposing, if not intimidating. However, the rest of the site's fabric again takes on a more human scale.

We have argued many times that Tiahuanaco architecture is not preserved well enough to experience it in the way that Inca architecture still can be. Yet, the sheer extension of the site, and the large size and formality of its main structures suggest more of an experience of monumentality than a design for intimacy. In Chapter 1 we noted that the individual structures seemed to be in isolation, each oriented unto itself and not intended to form an urban ensemble, thus implying an experience of exclusion for people navigating between structures. The few places where, with some imagination, one can still catch a glimpse of the spaces between structures, the experience is not particularly inviting. Picture the corridor between Kalasasaya and Akapana flanked by sheer walls without openings or access, visualize the space between Kalasasaya and Putuni with the forbidding Balcony Wall (it must have been so in its original configuration, not only in its current crude reconstruction) on one side and the single entrance gate to Putuni on the other. Neither of these spaces must have been very attractive. Was there a vast plaza to the west of Akapana from which to view the structure? If so, the experience, again, may have been of overwhelming monumentality not unlike what one experiences facing the Pyramid of the Moon at Teotihuacan, which is comparable in footprint if not in height to Akapana. A more pleasing experience by our standards of today is afforded by the Semi-Subterranean Temple from where one enjoys some handsome perspectives, one of Akapana, the other of the east entrance of Kalasasaya (even if it is now distorted by an unwarranted reconstruction). Were there other such spaces within the site? How did the many stelae and statues fit into the architecture? How did they modify the experience of monumentality? We simply do not know.

The perceived experiences of monumentality and exclusion at Tiahuanaco may well have been intentionally designed as displays of power or as expressions of the site's sacredness. If, as we argued, Inca sites are more intimate, we do not imply that they were, therefore, also inviting. Many Inca sites and structures were indeed designed and built for the exclusive use of the Inca ruler and his entourage, or of the high priests. The exclusion of unauthorized persons was clearly signaled by walls with a single entrance that surrounded most important residential and religious compounds (Protzen and Rowe 1994:237).

Design, Technology, and Culture

To design and to build is to make choices, choices about what to build and where, and choices about structure, construction, and tectonics.[5] The field of choices open to the designer and builder is, in principle, without boundaries. This field of infinite choices is a manifestation of what Horst Rittel once called the "awesome epistemic freedom" of the designer: "*Nothing has to be or remain as it is or appears to be;* there are no limits to the conceivable" (Rittel 1987:5; emphasis in original).

There are no limits to the choices designers can make, but in practice the choices made are not entirely arbitrary; they are embedded in cultural and technological fields of possibilities, fields that are in turn modified by the choices made. If we disagree with Hemming and argue that innovations in architecture do not always require a precedent, we also hold with Kubler that innovations tend to be resisted and are not easily embraced. For an innovation to take hold, it has to have at least some relationship to existing, broader cultural and technological patterns, or in Ian Hodder's (1993) terms, to some general "way of doing."

Architectural Types

Sunken courts, circular or rectangular, and platform structures or mounds, have permeated Andean architecture from preceramic to Tiahuanaco times, from the coast to the highlands, from Caral to Chavín de Huántar. Within the Titicaca Basin and preceding Tiahuanaco, sunken courts and platform structures are found at Pukara and Chiripa. Sunken courts, or semi-subterranean temples, also dot the Copacabana Peninsula (Sergio Chávez and Karen Mohr Chávez, personal communication 1995). The Kalasasaya does not fit the previous types, although it borrows elements of both the platform and the sunken court. Nor do we know of a direct precedent for Akapana, which stands out by its sheer size, its footprint, and elaborate "drainage" system.

Stone Working

Working stone with stone has a long tradition. It found an early architectural expression in the Andes at Cerro Sechín in the carvings of the megalithic mosaic wall, and at Chavín de Huántar in the cut building stones of the later phases, in sculptures like the Lanzón, and in the ornamental plaques of the Circular Plaza or the Black and White Portal. Stone carving and cutting was practiced in the Titicaca Basin on stelae of the Yaya-Mama religious tradition, and in the construction at Pukara. Some building stones at Pukara presage the even and planar surfaces of Tiahuanaco, as some stones at Chavín do.

Construction Practices

Fieldstone masonry with partially cut stones to form corners or to frame openings is found throughout the Andes, and the practice probably goes far back in time. Fully cut-stone masonry does not seem to appear until the later phases at Chavín de Huántar. This masonry, however, is not of fitted, but rather of stacked cut stones. Where necessary, the stacked blocks were chinked with stone chips for fit and stability. Truly fitted cut-stone masonry does not emerge until Tiahuanaco and it is doubtful whether this masonry owes much to that at Chavín. Richard Burger noted that "[t]here is increasing evidence that during the Early Horizon an independent process of sociocultural transformation was occurring among the groups living around Lake Titicaca" and that it is "the Yaya Mama Religious Tradition, rather than Chavín civilisation" that "provided the cultural matrix out of which these later altiplano cultures (Pucara and Tiahuanaco) developed" (Burger 1992:220).

Motifs and Architectural Elements

The stepped chambranle, one of the hallmarks of Tiahuanaco architecture, has an antecedent at Chiripa and possibly at Pukara. The structuring of façades into layered fields and registers for iconographic friezes may have its parallel in the decoration of ceramics and the patterns of textiles. Some of the architectural geometric motifs, such as circles and "arrows" are found on Pukara and Tiahuanaco pottery, as is their organization in registers. Many Pukara and Tiahuanaco textiles betray a similar spirit for arranging geometric motifs or iconographic representations in bands akin to the layering of abstract motifs and friezes in the architecture.

The above matrix of general "ways of doing," including the ways of Tiahuanaco, becomes the background for Inca architecture, but the Inca builders chose to go different routes, to make different choices. They were not in the habit of building semi-subterranean courts. Large platform structures, such as the *'usnu* at Vilcashuaman or Huánuco Pampa, are the exceptions rather than the norm in Inca architecture. The Incas did not carve stelae or sculpt free-standing figurative statues; with a few exceptions they did not decorate their buildings with geometric or iconographic figures, nor did they structure their façades into layered fields.[6] As Tom Cummins noted, the Inca did not

> integrate architecture with pictorialized mythical history of sculpture and painting so as to create stages for political/religious theater. The few architectural sculptures at sites such as Huánuco Pampa only serve by their presence to underscore their general absence in Inka centers [Cummins 2007:267].

In an Inca wall, the bond or joint pattern becomes its own ornamentation.

Although the Incas did build miniature walls—witness the stones at Saihuite or the diminutive cut-stone wall at Cuper Bajo (Nair 2003) near Chinchero (Figure C.3)—and did carve small effigies of animals at various shrines, these miniatures, unlike the half-scale elements at Tiahuanaco, were not an integral part of the architecture itself.

Figure C.3. Miniature wall at Cuper Bajo near Chinchero.

One of the few common threads in Tiahuanaco and Inca architecture is the tight fitting stonemasonry, a way of doing that we believe to be of Tiahuanaco origin. But, as we have seen above, the stone-cutting techniques and the expression, or tectonics, of the respective masonry diverge radically.

Why are some choices made rather than others, why do some innovations prevail and others remain without consequences? Why is it that different eras and peoples develop such different architectures and have such different ways of building them?[7] The matrix of general "ways of doing" may provide a background for the choices made by the builders, but it can neither predict nor explain them.

In the epigraph to this chapter, Cobo speaks of the challenges of understanding an ancient culture that was without the written word. These challenges are heightened when we try to understand a culture exclusively through its selected physical manifestations that, by chance, have endured the ravages of time. What we can learn about such a culture has to be extracted from these remains. We have tried to make the stones of Pumapunku "speak" to us. And they have told us a story, a story about the builders of Tiahuanaco, their conception of architecture, their knowledge and preferences, and their construction practices. Although the story is still fragmentary, we believe that it has opened up new windows on Tiahuanaco's material culture and its production. We hope that others will be encouraged to pursue and expand on our research.

Notes

1. We do not know when exactly the use of molds for the production of standardized adobes was first introduced in the Andes, and thus do not know whether that practice actually predates the standardized stones at Tiahuanaco.

2. We are not arguing here that the Inca stonemason was a free agent. The skilled labor enjoyed the status of *kamayoq*, or professional, and, although exempt from the *mit'a*, the labor tax, was in the full-time and exclusive service to the Inca ruler.

3. Vince Lee suggests that the attendant information could easily have been encoded on a *qhipu* (Lee, personal communication).

4. "The intentional slight convex curving of the vertical profile of a tapered column ... [was] used to overcome the optical illusion of concavity that characterizes straight-sided columns" (Harris 1977:197).

5. For the terms "structure," "construction," and "tectonics," see the Introduction.

6. Exceptions to the decoration of Inca facades are the reported gold plates hanging off the Qorikancha, the black band running along the walls and through the niches in one of structures in the Qorickancha, and the painting of walls and niches as found, for example, at Tambo Colorado. Another exception is the pair of pumas in bas-relief in a doorway at Huánuco Pampa.

7. This question parallels the question that Gombrich raised in his *Art and Illusion* (2000:3): "Why is it that different ages and different nations have represented the visible world in such different ways?"

Epilogue

As we were putting the final touches to our manuscript, Liz Rozelle, who had visited Tiahuanaco in 2008, sent us images of recent alterations made at Pumapunku. The pictures both excited and disturbed us. We were elated to see some new stones that recently had come to light. Several of these finds support what we had projected, while others shed light on new discoveries at Pumapunku. Among the former is the base fragment of the Monolithic Blind Miniature Gate (Figure E.1), thus confirming our anticipated reconstruction. Another is a fragment that complements what we called the Fragment A stone (Figure E.2). With this addition, the Fragment A becomes a right-handed complement to the left-handed Escritorio del Inca, thus further emphasizing the importance of symmetry in Tiahuanaco architecture.

Among the recent discoveries are two "new" gateway lintel pieces. At first glance we thought that the first lintel (Figure E.3) may be the missing part of our Gateway I as it also reveals the top part of the Type 2b niche that is missing from Gateway I on the right side. But after a closer look we concluded that it is a lintel from another gate. Its two-three steps in the step molding wrapping around the doorway does not conform to the two-two steps in the preserved wrap-around on the left side (Figure 3.81). The second lintel (Figure E.4) is a surprise. Judging from the uprights that it rests on—the dimensions of which we know—the width of the doorway to which that lintel belonged is of the same order as the other Pumapunku Gateways. Unlike these gateways, the gateway to which this lintel belonged was not cut from a single stone slab, but like the Akapana Gateway was a trilithon. This stone is another example of the sophisticated puzzle-like assemblage that characterizes Tiahuanaco architecture. The chambranle of the doorway and the wrapping around the door head would have to be completed on the jamb stones—note that the uprights in the picture are not the gateway's actual jamb stones, they are what we have called niche jamb stones (Type 5) and pertain to a very different context. From the lintel piece alone, we cannot determine if the gateway it belonged to was otherwise similar in design to the Pumapunku gateways. Yet, the two lintels confirm the existence of more than the three Pumapunku Gateways, as suggested in Chapter 3. Also, some stones of a type that we have not seen before are now on display; they are fairly sizeable stones with a recessed band at the top in their current position (Figure E.5). We do not know how these stones might have been used, but they definitively suggest that much of Pumapunku's complex architecture still lies below the surface, awaiting discovery.

At the same time that these pictures animated us, they also deeply disturbed us. It appears that the Pumapunku Platform Area has been massively rearranged. The platforms themselves have been leveled out and stones that formerly were lying around or were arranged in rows have now been set up on the platforms in positions that make absolutely no sense (Figure E.6). H-stones on the "armrests" of the platforms? This rearrangement of Pumapunku gives a totally wrong impression of the site's configuration

Figure E.1. Bottom stone completing Blind Miniature Gate. (Courtesy of Liz Rozelle)

Figure E.2. Escritorio II stone with additional piece, making it a right-handed counterpart to the Escritorio del Inca. (Courtesy of Liz Rozelle)

Figure E.3. "New" lintel piece belonging to an unknown gateway of Scheme 1. (Courtesy of Liz Rozelle)

Figure E.4. Monolithic lintel of a gateway of unknown design. (Courtesy of Liz Rozelle)

Figure E.5. New stone types: uprighted with a recessed band near top (third and fourth from right). (Courtesy of Liz Rozelle).

Figure E.6. Stones set on platforms where they never belonged. (Courtesy of Liz Rozelle)

as it has been known for centuries and a completely distorted view of its architecture. Not only does this rearranging greatly mislead visitors to the site, but the moving of these valuable artifacts on top of each other also exposes them to the unnecessary risk of irreparable damage.

We fully understand that in practice, the sustained maintenance, preservation, and long-term conservation of archaeological and historic monuments unquestionably raise difficult questions that go far beyond the mere technical issues. The goals of conservation need to be carefully balanced with the public's right to access and the welfare of the indigenous populations for which the archaeological remains are still part of living traditions. Yet, whoever authorized and implemented the interventions at Pumapunku acted thoughtlessly. They ignored the basic principles of preservation of ancient monuments as outlined, for example, in the text of the International Committee of Archaeological Heritage Management, better known as the Charter of Lausanne of 1989, and its earlier companion, the "International Charter for the Conservation and Restoration of Monuments and Sites" or the so-called Venice Charter of 1964. The latter clearly states that "all reconstruction work should ... *be ruled out 'a priori*." More nuanced, the Charter of Lausanne recognizes the value of reconstructions for experimental research and pedagogical purposes, but explicitly states that they "should ... be carried out with great caution, so as to *avoid disturbing any surviving archaeological evidence*" and admonishes that "*reconstructions should not be built immediately on the archaeological remains*..." (emphases added).

We have seen that the damage inflicted to the Kalasasaya by Ponce Sanginés resulted in misguided reconstructions and the destruction of critical evidence. Is this not enough? Will we ever learn?

APPENDIX I

Notes on the Names of Structures at Tiahuanaco

The names attributed today to the various structures at Tiahuanaco are mostly of recent vintage and thus do not convey any deep etymological meaning, nor do they supply clues to the structures' uses or functions; they only provide a convenient nomenclature for identifying the structures. "Kalasasaya" first appeared in the writings of Bandelier who spelled it "Kalisasaya" (1911:8). He used it to designate what today is known as Kantatayita, and said it was the name given to the site by the Indians. Posnansky introduced "Kalasasaya" and "Kantatayita" as used today in the literature (1945:Vol. 1, 84, and Vol. 2, 123). Before Posnansky, Kalasasaya was generally referred to as The Temple, Akapana as the Great Mound or Fortress, Putuni as the Palace (Squier), Pumapunku as the Hall of Justice, and Kantatayita as the Sanctuary (Squier). Some time after the excavations by the French mission of 1903–1904, Squier's "Palace" was renamed the Palace of the Sarcophagi by Posnansky, before Ponce introduced the name "Putuni." Ponce is also responsible for the names "Kerikala," "Lakakollu," and "Chunchukala."

Of all the names, only "Akapana" and "Pumapunku" have historical significance; both names were reported by Cobo and thus date back to at least 1610. By how much time the names precede Cobo is not known. The meaning of "Pumapunku" poses no difficulties; it translates literally to "Gateway of the Puma." The etymology of "Akapana" is more doubtful. From Cobo's description of Tiahuanaco, there is little doubt that Pumapunku is the structure still referred to by this name today. Which structure was called "Akapana," if indeed it designated a single structure, is not entirely obvious. Cobo's text, in this regard, is open to divergent interpretations; it is clear only about Akapana's general location:

> A la parte oriental deste edificio (Pumapuncu), como cuatrocientos pasos, se ven unas ruinas de otro no menos grande y suntuoso; no se puede averiguar si era distinto del primero o ambos eran uno, y su fábrica se continúa por alguna parte, de que ya no queda rastro; a lo menos los indios lo llaman con distinto nombre, que es *Acapana* [Cobo 1964:Vol. 2,196].

> To the east of this edifice (Pumapuncu), about four hundred paces (away), one can see ruins of another no less great and sumptuous[1]; one cannot figure out whether it was distinct from the first or whether both formed one, and that its fabric continues some where, (but) of which there remains no more trace; at least the Indians call it by a distinct name, that is *Acapana* [translation by authors].

The terraced platform mound, which today is called Akapana, is about 370 m to the northeast of Pumapunku. Thus, Cobo's distance and direction vary somewhat from the actual ones, but nevertheless correspond reasonably well to the general lay of the land. Akapana is separated from Pumapunku by what appears to be a vast empty space. It is this seeming isolation of Pumapunku that led Cobo to wonder whether the two ruins were related or constituted two different sites. When describing Akapana, Cobo writes: "Este es un terrapleno de cuatro o cinco estados en alto, que parece collado, fundado sobre grandes cimientos de piedra; su forma es cuadrada y tiene a trechos como traveses o cubos de fortaleza..." (Cobo 1964:Vol. 2,196). (This is a terreplein four or five fathoms[2] in height, which appears to be a hillock raised on big foundations of stone; its shape is *square* [added emphasis] and it has at intervals traverse works or towers of a fortress... [translation by authors].)

The very first part of this passage parallels Cieza's description of what we believe to be Akapana, although he does not name it: "Cerca de los aposentos principales está un collado hecho a mano armado sobre grandes cimientos de piedra" (Cieza de León Part 1, Chapter 105; 1986:283). (Near the main buildings is a hillock made by hand [and] erected on big foundations of stone [translation by authors].)

Both these passages are a fair description of today's Akapana. It is a hillock with base walls made of well fitted, big stones. That Cobo underestimated the height of this hill—it is about twice as high—is not surprising; judging heights is difficult. More doubtful is Cobo's assertion that the mound is square in plan, which it is not. His mention of "traverse works or towers of a fortress" is puzzling. Unless he is referring to the more or less regularly spaced upright stones in the base walls of Akapana, we do not know what he could have been describing.

Cobo continues:

> [C]inquenta pies al oriente dél ha quedado en pie una portada grande de solas tres piedras bien labradas, a cada lado la suya, y otra encima de ambas. No ha quedado desta fábrica más obra sobre la tierra que el terrapleno y algunas piedras labradas que salen de los cimientos por donde se muestra su forma y planta [Cobo 1964:Vol. 2,196].

> [F]ifty feet to the east of it remains standing a gateway of only three well wrought stones, to each side its own, and one on top of both. Nothing more remains of this structure above ground but the terreplein and some worked stones that stand out from the foundation (and) through which its shape and plan are revealed [translation by authors].

In this part of the quote there seems little doubt that "al oriente dél" means to the east of "un terrapleno de cuatro o cinco estados" of the first part of the quote. What is Cobo then referring to with "desta fábrica"? If he is referring to the structure to which the gateway belonged, he could possibly have meant what today is called Kantatayita. Of this, there is indeed nothing left but "some worked stones that stand out from the foundation." But Kantatayita is located about 160 m from Akapana, not 50 feet. We find it more likely, however, that "desta fábrica" refers again to the terreplein in the first part of the quote. But that is puzzling, because it does not seem congruent with the first part of the quote. If there is nothing left of the structure but the terreplein and a few worked stones, where are the big foundations of stone and the traverse works or towers? In our view, Cobo's description to this point could just as well refer to today's Kalasasaya. In pictures of the nineteenth century, Kalasasaya, too, appears as a terreplein or a hill; its square shape could be inferred from the many upright stones sticking up above ground, and these stones could well be Cobo's "traverse works or towers of a fortress."

In continuation, Cobo wrote:

> Cerca deste terrapleno está otro tambien cuadrado; divídelos una calle de cinquenta pies de ancho, y así parece ser ambos una misma obra. Las paredes deste último edificio eran admirables, dado que ya está por tierra. De un pedazo de muralla que todavía se conserva en pie ... se puede sacar su labor y traza. Es, pues, esta muralla de piedras cuadradas sin mezcla y tan ajustadas unas con otras, como ajustan dos maderos acepillados. Las piedras son de mediana grandeza y puestas a trechos otras muy grandes a modo de rafas; de suerte, que como en nuestros edificios de tapias o adobes se suelen entremeter rafas de ladrillios de alto a bajo, así esta pared y muralla tiene a trechos, en lugar de rafas, unas piedras a manera de columnas cuadradas de tan excesiva grandeza, que sube cada una del cimiento hasta lo alto y remate de la pared, que es de tres o cuatro estado... [Cobo 1964:Vol. 2,196].

> Near this terreplein is another one also square; a street fifty feet wide separates them, and so both appear to be just one oeuvre. The walls of this latter one were admirable, given that it is already thrown down. From a piece of wall that is still conserved standing ... one can infer its construction and outline. This wall, then, is (made of) of squared stones without mortar and so well fitted to one another, as two planed timbers do.

> The stones are of medium size, and others placed at intervals [are] very large and resemble posts[3]; as in our buildings of tapia or adobe, it is customary to intersperse posts of bricks from top to bottom. At intervals, instead of posts, this wall and rampart have some stones in the shape of squared columns of such massive size that each reaches from the foundation to the height and crown of the wall, which is three or four *estados*... [translation by authors].

Kalasasaya and Akapana are indeed separated by a passage about 15.24 m (50 feet) wide, such that there seems little doubt that Cobo's two terrepleins, the first and the one next to it, refer to these two structures. Which is which, however, still remains an open question. Cobo's description of the piece of wall he saw at the second terreplein matches the construction of the retaining walls of today's Akapana quite nicely: beautifully fitted ashlars between big square upright stones. A stretch of such a wall was still visible in the middle of the nineteenth century, as seen in Angrand's sketches. Only the height of the wall does not fit, for the walls of Akapana are at most 2 m high, and not between 5 and 7 m as Cobo estimated his wall to be. If his height estimate was correct, we suspect that the preserved piece of wall he saw was a section of the west wall, the so-called Balcony Wall, of today's Kalasasaya. This wall would in fact have stood some 5 m tall, and from what can still be seen of its original construction, there were carefully fitted ashlars laid between very big upright, column-like stones. Cobo's subsequent passage may actually confirm our latter interpretation:

> "Por los rastros, que desta muralla se descubren, se echa de ver que era una gran cerca que, saliendo deste edificio último, corría hacia el oriente y ocupaba un grande espacio" (Cobo 1964:Vol. 2, 196).
>
> (From the vestiges that one discovers of this wall, one can see that it was a great enclosure which extended from the latter building, ran toward the east, and occupied a large space [translation by authors].)

If "deste edificio último" refers to the piece of preserved wall, then the second terreplein Cobo describes could well be Kalasasaya, for as we have seen, it is a large enclosure and it extends east of the Balcony Wall. The first terreplein, then, should be Akapana. The uncertainties we experience in our interpretation of Cobo's text are reflected in the writings of later authors. Stübel and Uhle attributed the name "Ak-kapana" to today's Kalasasaya, and refer to Akapana as "der Berg" (the Mountain) (1892:Part 1, Plate 2). Middendorf, on the other hand, called "Acapana" a group of ruins that consisted of two sections, a courtyard construction and a hill, that are today's Kalasasaya and Akapana, respectively (Middendorf 1895:381). Courty, in his plan of the site, calls Kalasasaya "La Grande Enceinte d'Ak-kapana" (The Big Enclosure of Ak-kapana), the Semi-Subterranean Temple "La Petite Enceinte d'Ak-kapana" (The Little Enclosure of Ak-kapana), and today's Akapana is "Cerro Ak-kapana" (Ak-kapana Hill) (Créqui-Montfort 1906:535, Figure 1). Thus, it is not impossible that "Akapana" designated an area, rather than a single structure as it does today, for as Cobo said, the two structures today labeled Kalasasaya and Akapana are so close to each other that they appear to be a single structure.

Notes

1. One *paso*, or pace, equals about three feet (Covarrubias 1943) or about 0.92 m.
2. An *estado*, or fathom, corresponds to about 1.67 m.
3. The word "rafa" is generally translated as "buttress." However, in the context here, "post" or perhaps "frame" seem to be more appropriate translations.

APPENDIX 2

ON DIMENSIONS AND PROPORTIONS

Explanation of abbreviations used:

W/H	width to height ratio
IJ	distamce between Inner Jambs
OJ	distance between Outer Jambs
IL	Height of Inner Lintel
OL	Height of Outer Lintel
N	Sample size
SD	Standard Deviation
CI	Confidence Interval

Table 2.1. Dimensions and Proportions of Type 2a Niches

Stone No.	Element	Width	Height	W/H	IJ	OJ	IJ/OJ	IL	OL	IL/OL	IJ/IL	OJ/OL
E.R. 15	left	377	392	0.961735	192	285	0.67	305	392	0.778061	0.63	0.73
	right	377	392	0.961735	192	285	0.67	305	392	0.778061	0.63	0.73
"Escritorio I"	1	239	248	0.963710	113	179	0.63	191	248	0.770161	0.59	0.72
	2	239	248	0.963710	114	178	0.64	191	248	0.770161	0.60	0.72
	3	239	248	0.963710	113	177	0.64	191	248	0.770161	0.59	0.71
	4	239	248	0.963710	114	177	0.64	191	248	0.770161	0.60	0.71
	6	242	260	0.930769	114	190	0.60	180	260	0.692308	0.63	0.73
"Escritorio II"	1	243	261	0.931034	112	190	0.59	180	260	0.692308	0.62	0.73
5 niches stone	far right	242	249	0.971888	112	179	0.63	191	248	0.770161	0.59	0.72
	right	238	248	0.959677	112	176	0.64	191	248	0.770161	0.59	0.71
	left	240	248	0.967742	112	177	0.63	191	248	0.770161	0.59	0.71
	far left	240	248	0.967742	112	178	0.63	191	248	0.770161	0.59	0.72
I.R. 16		371	387	0.958656	192	284	0.68	300	387	0.775194	0.64	0.73
Gate I	left inside	377	395	0.954430	192	284	0.68	305	395	0.772152	0.63	0.72
Gate II	right inside	377	390	0.966667	192	285	0.67	305	390	0.782051	0.63	0.73
	left inside	375	394	0.951777								
Gate III	left inside	370	385	0.961039	190	278	0.68	305	389	0.784062	0.62	0.71
	right side	375	388	0.966495	195	285	0.68	297	388	0.765464	0.66	0.73
W.R. 40		378	385	0.981818	195	289	0.67	300	385	0.779221	0.65	0.75
Arrow stone		377	385	0.979221	196	289	0.68	305	385	0.792208	0.64	0.75
Slab-Niche 1		396	390	1.015385								
Niche stone A		373	389	0.958869								
Niche stone B		378	389	0.971722	197	289	0.68	302	389	0.776350	0.65	0.74
Niche stone C		375	385	0.974026								
Akapana Gate	left	416	434	0.958525	209	319	0.66	310	407	0.761671	0.67	0.78
	right	416	434	0.958525	207	306	0.68	302	400	0.755	0.69	0.77
Sun Gate	2	375	390	0.961538	190	285	0.67	400	485	0.824742	0.48	0.59
	3	375	390	0.961538	190	290	0.66	300	385	0.779221	0.63	0.75
	4	375	390	0.961538	200	300						
			N:	29								
			Median:	**0.961735**			**0.66**			**0.770161**	**0.63**	**0.73**
			Average:	**0.963756**			**0.65**			**0.768723**	**0.62**	**0.73**
			Maximum:	**1.015385**			**0.68**			**0.824742**	**0.69**	**0.78**
			Minimum:	**0.930769**			**0.59**			**0.692308**	**0.48**	**0.59**
			Range:	**0.084615**			**0.09**			**0.132435**	**0.21**	**0.20**
			SD:	**0.014705**			**0.03**			**0.026827**	**0.04**	**0.03**
			90% CI:	**0.004560**								
			Ratio of W/H with W set equals 1:	**1.037607**								
		b	**a**	**r^2; r**								
	Regr. Line H on W:	**0.976465**	**-4.168477**	**0.994690**								
	Regr. Line W on H:	**1.018664**	**6.075427**	**0.997342**								
	Results with niches Escritorio 1-6 and Escritorio II-1 removed											
			SD:	**0.01198**								
			90% CI:	**0.00371**								
			Ratio of W/H with W set equal to 1:	**1.03499**								

Table 2.2. Dimensions and Proportions of Type 2b Niches

Stone No.	Element	Width	Height	W/H	IJ	OJ	IJ/OJ	IL	OL	IL/OL	IJ/IL	OJ/OL
Blind Gate		738	1055	0.699526	480	630	0.761905	950	1055	0.900474	0.51	0.60
"Escritorio" I	5	366	574	0.637631	196	290	0.675862	495	573	0.863874	0.40	0.51
	8	366	573	0.638743	196	290	0.675862	495	574	0.862369	0.40	0.51
W.R. 18	left	420	573	0.732984	233	333	0.699700	498	578	0.861592	0.47	0.58
Gate I	lower l. inside	722	1107	0.652213	450	598	0.752508	989	1107	0.893406	0.46	0.54
	lower r.	722	1107	0.652213	450							
Gate II	lower r. inside	786	1054	0.745731	509	673	0.756315	950	1054	0.901328	0.54	0.64
Gate III	lower r. inside	795	1054	0.754269	506	670	0.755224	950	1056	0.899621	0.53	0.63
	lower l. inside	790	1060	0.745283	520	688	0.755814	948	1053	0.900285	0.55	0.65
Sun Gate	lower l.	718	1110	0.646847	465	605	0.768595					
	lower r.	720	1110	0.648649	450	590	0.762712	1000	1110	0.900901	0.45	0.53
WR 36		373	556	0.670863								
IR 12		423	608	0.695724								
Double Niche	left	325	654	0.496942	192	285	0.673684	305	405	0.753086	0.63	0.70
	right	352	655	0.537405								
Graveyard		325	657	0.494673								

			N:	**16**								
			Median:	**0.652213**			**0.755224**			**0.896513**	**0.486567**	**0.586640**
			Average:	**0.653106**			**0.730744**			**0.873694**	**0.491651**	**0.588641**
			Maximum:	**0.754269**			**0.768595**			**0.901328**	**0.629508**	**0.703704**
			Minimum:	**0.494673**			**0.673684**			**0.753086**	**0.395960**	**0.505226**
			Range:	**0.259597**			**0.094911**			**0.148242**	**0.233549**	**0.198477**
			SD:	**0.082202**			**0.040031**			**0.045833**	**0.073036**	**0.068007**
			90% CI:	**0.043411**								
			Ratio of W/H with W set equal to 1:	**1.531145**								

	b	a
	b	**a**
Regr. Line H on W:	**1.354268**	**60.728441**
Regr. Line W on H:	**0.698947**	**-9.811133**

Table 2.3. Dimensions and Proportions of Type 2b1, 2b2 and 2b3 Niches

Stone No.	Element	Width	Height	W/H		
	Type 2b1					
					N:	6
"Escritorio" I	5	366	574	0.637631	**Median:**	0.64775
	8	366	573	0.638743	**Average:**	0.64625
Sun Gate	lower l.	718	1110	0.646847	**Minimum:**	0.63763
	lower r.	720	1110	0.648649	**Maximum:**	0.65339
Gate I	lower l. inside	722	1107	0.652213	**Range:**	0.01576
	lower r. inside	722	1105	0.653394	**SD**	0.00668
					95% CI:	0.00456
					Ratio of W/H with W set equal to 1:	1.54740
	Type 2b2					
					N:	4
W.R. 18	left	420	573	0.732984	**Median:**	0.74551
Gate III	lower l. inside	790	1060	0.745283	**Average:**	0.74457
Gate II	lower r. inside	786	1054	0.745731	**Minimum:**	0.73298
Gate III	lower r. inside	795	1054	0.754269	**Maximum:**	0.75427
					Range:	0.02129
					SD	0.00876
					95% CI:	0.00731
					Ratio of W/H with W set equal to 1:	1.34306
	Type 2b3					
					N:	3
WR 36		373	556	0.670863	**Median:**	0.69572
IR 12		423	608	0.695724	**Average:**	0.68870
Blind Gate		738	1055	0.699526	**Minimum:**	0.67086
					Maximum:	0.69953
					Range:	0.02866
					SD	0.01557
					95% CI:	0.01501
					Ratio of W/H with W set equal to 1:	1.45200

Table 2.4. Dimensions and Proportions of Type 1a and 1b Niches

Stone No.	Element	Width	Height	W/H		
	Type 1a					
					N:	7
Escritorio		182	217	0.838710	**Median:**	0.84091
Escritorio II		182	217	0.838710	**Average:**	0.84480
Akapana		307	355	0.864789	**Minimum:**	0.82192
WR 24	H w/c	372	431	0.863109	**Maximum:**	0.86479
WR 25	H w/c	372	440	0.845455	**Range:**	0.04287
WR 27	H w/c	370	440	0.840909	**SD**	0.01499
WR 37	H w/c	360	438	0.821918	**95% CI:**	0.00946
					Ratio of W/H with W set equal to 1:	1.18371
	Type 1b					
					N:	4
WR 26	H w/o	342	433	0.789838	**Median:**	0.78253
WR 28	H w/o	338	440	0.768182	**Average:**	0.78077
WR 30	H w/o	340	437	0.778032	**Minimum:**	0.76818
WR 34	H w/o	340	432	0.787037	**Maximum:**	0.78984
					Range:	0.02166
					SD	0.00979
					95% CI:	0.00817
					Ratio of W/H with W set equal to 1:	1.280783

Type 2A Niches w/o Escritorio and Niche Slab

E.R. 15	left	377	392	0.96173	1.04	
	right	377	392	0.96173	1.04	
"Escritorio I"	1	239	248	0.96371	1.04	
	2	239	248	0.96371	1.04	
	3	239	248	0.96371	1.04	
	4	239	248	0.96371	1.04	
5 niches stone	far right	242	249	0.97189	1.03	
	right	238	248	0.95968	1.04	
	left	240	248	0.96774	1.03	
	far left	240	248	0.96774	1.03	
I.R. 16		371	387	0.95866	1.04	
Gate I	left inside	377	395	0.95443	1.05	
Gate II	right inside	377	390	0.96667	1.03	
	left inside	375	394	0.95178	1.05	
Gate III	left inside	370	385	0.96104	1.04	
	right side	375	388	0.96649	1.03	
W.R. 40		378	385	0.98182	1.02	
Arrow stone		377	385	0.97922	1.02	
Slab-Niche 1		396	390			
Niche stone A		373	389	0.958867	1.04	
Niche stone B		378	382	0.98953	1.01	
Niche stone C		375	385	0.97403	1.03	
Akapana Gate	left	416	434	0.95853	1.04	
	right	416	434	0.95853	1.04	
Sun Gate	2	375	390	0.96154	1.04	
	3	375	390	0.96154	1.04	
	4	375	390	0.96154	1.04	
				MEDIAN	0.96	
	0.96153846			**AVERAGE**	0.96	1.04
	0.96			**MINIMUM**	0.95	
	0.96296296			**MAXIMUM**	0.99	
27/28	0.96428571			**RANGE**	0.04	
	0.96551724			**STDEV**	0.01	
				95% CONFIDENCE INTERVAL	0	
				N	26	

References Cited

Adam, Jean-Pierre
1989 *La construction romaine: matériaux et techniques*. Edition A. et J. Picard, Paris.

Albarracín-Jordán, Juan
2003 Tiwanaku: A Pre-Inka, Segmentary State in the Andes. In Kolata 2003, pp. 95–111.

Albarracín-Jordán, Juan, and James E. Mathews
1990 *Asentamientos prehispánicos del valle de Tiwanaku*, Vol. 1. Producciones Cima, La Paz.

Alconini Mujica, Sonia
1995 *Rito, símbolo e historía en la pirámide de Akapana, Tiwanaku: un análisis de cerámica ceremonial prehispánica*. Editorial Acción, La Paz.

Arellano L., Jorge
1991 The New Cultural Context of Tiahuanaco. In *Huari Administrative Structure, Prehistoric Monumental Architecture and State Government*, edited by William H. Isbell and Gordon F. McEwan, pp. 293–316. Dumbarton Oaks Research Library and Collection, Washington, D.C.

Arnold, Dieter
1991 *Building in Egypt: Pharaonic Stone Masonry.* Oxford University Press, New York.

Bandelier, Adolph Francis
1911 *The Ruins at Tiahuanaco.* American Antiquarian Society, Worcester, Massachusetts.

Baptista Gumucio, Mariano
1975 *Tiwanaku.* Plata Histories. Editorial Plata, Chur, Switzerland.

Bennett, Wendell C.
1934 *Excavations at Tiahuanaco.* Anthropological Papers Vol. 36, Pt. 2, pp. 357-494. American Museum of Natural History, New York.

Berry, Brian Joe Lobley, and Allen Pred
1965 *Central Place Studies: A Bibliography of Theory and Applications*. Includes supplement through 1964 by H. G. Barnum, R. Kasperson, and S. Kiuchi. Bibliography Series, No. 1. Regional Science Research Institute, Philadelphia.

Bertonio, Ludovico
1984 [1612] *Vocabulario de la lengua aymara*. Facsimile reproduction. CERES Serie Documentos Históricos No. 1; Museo Nacional de Etnografía y Folklore: Serie Fuentes Primarias No. 2, Instituto Francés de Estudios Andinos: Colección Travaux del l'IFEA Vol. 26. CERES (Centro de Estudios de la Realidad Económica y Social), Cochabamba.

Binford, Michael W., Alan L. Kolata, Mark Brenner, Mark Abbott, John W. Janusek, Matthew T. Seddon, and Jason H. Curtis
1997 Climate Variation and the Rise and Fall of an Andean Civilisation. *Quaternary Research* 47(2):235-248.

Bridges, Marilyn
1991 *Planet Peru: An Aerial Journey through a Timeless Land*. Aperture Foundation, New York.

Buck, Fritz
1936 *El calendario Maya en la cultura de Tiahuanaco.* Lit. e Imp. Unidas, La Paz.

Burger, Richard
1992 *Chavín and the Origins of Andean Civilization.* Thames and Hudson, London.

Castelnau, Francis, Comte de
1850–1859 *Expedition dans les parties centrales de l'Amérique du Sud, de Rio de Janeiro à Lima, et de Lima au Para*. P. Bertrand, Paris.

Castro y del Castillo, Antonio de
1906 *Obispados y audiencias del Cuzco.* Vol. 11. Imprenta por Henrich y Comp. Barcelona.

Chávez, Sergio Jorge
1975 The Arapa and Thunderbolt Stelae: A Case of Stylistic Identity with Implications for Pukara Influences in the Area of Tiahuanaco. *Ñawpa Pacha* (Berkeley) 13:3-26.

Chávez, Sergio Jorge, and David Bruce Jorgenson
1980 Further Inquiries into the Case of the Arapa-Thunderbolt Stela. *Ñawpa Pacha* 18:73-80.

Christaller, Walter
1968 *Die zentralen Orte in Süddeutschland: eine ökonomisch-geographische Untersuchung über die Gesetzmässigkeit der Verbreitung und Entwicklung der Siedlungen mit städtischen Funktionen.* Wissenschaftliche Buchgesellschaft, Darmstadt.

Cieza de León, Pedro de
1984 [1553] *Crónica del Perú, Primera Parte*. Introduction by Franklin Pease G.Y., notes by Miguel Maticorena E. Colección Clásicos Peruanos. Pontificia Universidad Católica del Perú, Lima.

Clarke, Somers, and Reginald Engelbach
1930 *Ancient Egyptian Masonry: The Building Craft*. Oxford University Press, London.

Cobo, Bernabé
1964 [1653] *Historia del Nuevo Mundo. Estudio preliminar y edición del P. Francisco Mateos Biblioteca de Autores Españoles desde la Formación del Lenguaje hasta nuestros Días.* Vols. 91 and 92, works by P. Bernabé Cobo, books 1 and 2. Atlas, Madrid.

Coe, Michael, Dean Snow, and Elizabeth Benson
1989 *Atlas of Ancient America.* Facts on File, New York and Oxford.

Conkey, Margaret, and Christine Hastorf, eds.
1990 *The Uses of Style in Archaeology.* Cambridge University Press.

Conklin, William J.
1991 Tiahuanaco and Huari: Architectural Comparisons and Interpretations. In *Huari Administrative Structure, Prehistoric Monumental Architecture and State Government*, edited by William H. Isbell and Gordon F. McEwan, pp. 281–292. Dumbarton Oaks Research Library and Collection, Washington, D.C.

Coulton, J. J.
1977 *Ancient Greek Architects at Work: Problems of Structure and Design.* Cornell University Press, Ithaca, New York.

Couture, Nicole Claire
2003 Putuni: A History of Palace Architecture at Tiwanaku. In Kolata 2003, pp. 226–263.

Covarrubias Orozco, Sebastián de
1943 *Tesoro de la lengua castellana o española según la impresión de 1611, con las adiciones de Benito Remigio Noydens publicadas en la de 1674*. S.A. Horta, Barcelona.

Créqui-Montfort, Georges de
1906 Fouilles de la mission scientifique française à Tiahuanaco. *Internationaler Amerikanisten-Kongress: vierzehnte Tagung, Stuttgart, 1904*, Vol. 2, pp. 531-551. Stuttgart.

Cummins, Tom
2007 Queros, Aquillas, Uncus, and Chulpas: The Composition of Inka Artistic Expression of Power. In *Variations in the Expression of Inka Power*, edited by Richard L. Burger, Craig Morris, and Ramiro Matos Mendieta, pp. 267–311. Dumbarton Oaks Research Library and Collections, Washington, D.C.

Escalante Moscoso, Javier F.
1993 *Arquitectura prehispánica en los Andes bolivianos.* Producciones Cima, La Paz.

Escalante Moscoso, Javier F.
2003 Residential Architecture in la K'araña. In Kolata 2003, pp. 316–326.

Forbes, David
1870 *On the Aymara Indians of Bolivia and Peru.* Taylor & Francis, London.

Garcilaso de la Vega, "El Inca"
1976 [1609] *Comentarios reales. Prólogo, edición y cronología, Aurelio Miró Quesada.* Vols. 5 and 6. Biblioteca Ayacucho, Caracas.

Gasparini, Graziano, and Luise Margolies
1980 *Inca Architecture.* Translated by Patricia J. Lion. Indiana University Press, Bloomington.

Gibaja de Valencia, Arminda
1984 Secuencia Cronológica de Ollantaytambo. In *Current Archaeological Projects in the Central Andes: Some Approaches and Results*, edited by Ann Kendall. Proceedings, 44th International Congress of Americanists, Manchester, 1982. BAR International Series 210. British Archaeological Reports, Oxford.

Gicklhorn, Renée
1969 Thaddäus Haenke in Tiahuanaco/Thaddäus Haenke en Tiahunaco. *Aconcagua* (Vaduz, Lichtenstein) 5(1):7-28.

Goldstein, Paul
1993 Tiwanaku Temples and State Expansion: A Sunken-Court Temple in Moquega, Peru. *Latin American Antiquity* 4(1):22-48.

Gombrich, Ernst Hans
1984 *The Sense of Order: A Study in the Psychology of Decorative Art.* Cornell University Press, Ithaca, New York.

Gombrich, Ernst Hans
2000 *Art and Illusion: A Study in the Psychology of Pictorial Representation.* Bollingen Series 35, Vol. 5. Princeton University Press, Princeton.

Gonseth, Ferdinand
1946 *La géométrie de l'espace. Part II: Les trois aspects de la géométrie.* Bibliothèque Scientifique La Science Dialectique, No. 6, pp. 69-156. Edition du Griffon, Neuchâtel, Switzerland.

Harris, Cyril M. (editor)
1975 *Dictionary of Architecture and Construction.* McGraw-Hill, New York.

Harris, Cyril M. (editor)
1983 *Illustrated Dictionary of Historic Architecture.* Dover, New York.

Hemming, John, and Edward Ranney
1982 *Monuments of the Incas.* A New York Graphic Society Book. Little, Brown and Company, Boston.

Hodder, Ian
1993 Style as Historical Quality. In *The Uses of Style in Archaeology*, edited by Margaret Conkey and Christine Hastorf, pp. 44-51. New Directions in Archaeology. Cambridge University Press, Cambridge.

Inwards, Richard
1884 *The Temple of the Andes.* Brook, Day & Son, London.

Isbell, William, and Alexei Vranich
2004 Experiencing the Cities of Wari and Tiwanaku. In *Andean Archaeology*, edited by Helaine Silverman, 167–182. Blackwell Studies in Global Archaeology. Blackwell, Malden, Massachusetts.

Isbell, William H., and Gordon F. McEwan (editors)
1991 *Huari Administrative Structure, Prehistoric Monumental Architecture and State Government.* Dumbarton Oaks Research Library and Collection, Washington, D.C.

Janusek, John W.
2003 The Changing Face of Tiwanaku Residential Life: State and Local Identity in an Andean City. In Kolata 2003, pp. 264–295.

Janusek, John W.
2004 *Identity and Power in the Andes: Tiwanaku Cities through Time.* Routledge, New York.

Janusek, John W.
2008 *Ancient Tiwanaku Case Studies in Early Societies.* Cambridge University Press, New York.

Johnson, Gregory A.
1972 A Test of the Utility of Central Place Theory in Archaeology. In *Man, Settlement, and Urbanism*, edited by Peter J. Ucko, Ruth Tringham, and G. W. Dimbleby, pp. 769-785. Duckworth, London.

Johnson, Gregory A.
1977 Aspects of regional analysis in archaeology. *Annual Review of Anthropology* 6:479–508.

Kiss, Edmund
1937 *Das Sonnentor von Tihuanaku und Hörbinger's Welteislehre.* Koehler & Amelang, Leipzig.

Kolata, Alan L.
1993 *The Tiawanaku: A Portrait of an Andean Civilization.* Basil Blackwell, Oxford, England, and Cambridge, Massachusetts.

Kolata, Alan L. (editor)
1996a *Tiwanaku and Its Hinterland: Archaeology and Paleoecology of an Andean Civilization.* Vol. 1, Agroecology. Smithsonian Series in Archaeological Inquiry. Smithsonian Institution Press, Washington, D.C.

Kolata, Alan L.
1996b *Valley of the Spirits. A Journey into the Lost Realm of the Aymara.* John Wiley and Sons, New York.

Kolata, Alan L.
1996c Proyecto Wila Jawira: An Introduction to the History, Problems, and Strategies of Research. In Kolata 1996a, pp. 1–22.

Kolata, Alan L. (editor)
2003 *Tiwanaku and Its Hinterland: Archaeology and Paleoecology of an Andean Civilization.* Vol. 2, Urban and Rural Archaeology.

Smithsonian Series in Archaeological Inquiry. Smithsonian Institution Press, Washington, D.C.

Korres, Manolis
1995 *From Pentelikon to the Parthenon*. Melissa, Athens.

Kostof, Spiro
1985 *A History of Architecture: Settings and Rituals*. Oxford University Press, New York.

Krauskopf, Gunther
1972 Tadeo Haenke y Tiwanaku (1799). *Pumapunku* 5:9–15. Instituto de la Cultura Aymara de la H. Municipalidad de La Paz, La Paz.

Lechtman, Heather
1998 Architectural Cramps at Tiwanaku: Copper-Arsenic-Nickel Bronze (with an appendix by David M. Parks). In *Metallurgica Antiqua, in Honour of Hans-Gertbachmann and Robert Maddin*, edited by Thilo Rehren, Andreas Hauptmann, and James D. Muhly, pp. 77–92. Deutsches Bergbau-Museum, Bochum.

Llanos, Luis A.
1936 Trabajos arqueológicos en el Dep. del Cuzco. *Revista del Museo Nacional* (Lima) 5(2):123–156.

Manzanilla, Linda
1992 *Akapana. Una pirámide en el centro del mundo.* Instituto de Investigaciones Anthropológicas. Universidad Nacional Autónoma de México, México, D.F.

Manzanilla, Linda, Luis Barba, and María Renée Baudoin
1990 Investigaciones en la Pirámide de Akapana, Tiwanaku, Bolivia. *Gazeta Arqueológica Andina* (Lima) 5(20):81–107.

Middendorf, Ernst W,
1890-92 *Die einheimischen Sprachen Perus*. Vols. 1-5, Brockhaus, Leipzig.

Middendorf, Ernst W.
1895 *Peru. Beobachtungen und Studien über seine Bewohner während eines 25-jährigen Aufenthalts.* Vol. 3, Das Hochland von Peru. Robert Oppenheim (Gustav Schmidt), Berlin.

Mille, Max, and Carlos Ponce Sanginés
1968 *Las Andesitas de Tiwanaku. I. Estudio petrográfico. II. Perspectiva arqueológica*. Publicación No. 18. Academia Nacional de Ciencias de Bolivia, La Paz.

Mitchell, William
1990 *The Logic of Architecture*. M.I.T. Press, Cambridge, Massachusetts.

Müller-Wiener, Wolfgang
1988 *Griechisches Bauwesen in der Antike*. C. H. Beck, Munich.

Nair, Stella E.
1997 Stone against Stone: An Investigation into the Use of Stone Tools at Tiahuanaco. Master's thesis, Department of Architecture, University of California, Berkeley.

Nair, Stella E.
2003 Of Remembrance and Forgetting: The Architecture of Chinchero, Peru, from Thupa Inka to the Spanish Occupation. Ph.D. dissertation, Department of Architecture, University of California, Berkeley.

Nordenskiöld, Erland
1921 *The Copper and Bronze Ages in South America*. Comparative Ethnographical Studies No. 4. Elanders, Gothenburg.

Orbigny, Alcide Dessalines, d'
1836 *Voyage pittoresque dans les deux Amériques. Résumé général de tous les voyages.* L. Terné et Henry Dupuis, Paris.

Orbigny, Alcide Dessalines, d'
1835–1847 *Voyage dans l'Amérique Meridionale: executé pendant les années 1826 et 1833.* 9 vols. Pitois-Lerrault, Paris.

Paynter, Robert
1982 *Models of Spatial Inequality: Settlement Patterns in Historical Archaeology*. Studies in Historical Archaeology. Academic Press, New York.

Pelli, Cesar, Charles Thronton, and Leonard Joseph
1997 The World's Tallest Building. *Scientific American* 277(6): 93–101.

Ponce Sanginés, Carlos
1961 *Informe de labores, octubre 1957–febrero 1961.* Publicación no. 1. Centro de Investigaciones Arqueológicas en Tiwanaku, La Paz.

Ponce Sanginés, Carlos
1969 *Descripción sumaria del templete semisubterráneo de Tiwanaku.* Publicación no. 20. Academia Nacional de Ciencias de Bolivia, La Paz.

Ponce Sanginés, Carlos
1971 *Procedencia de las areniscas utilizadas en el templo precolombino de Pumapunku, Tiwanaku.* Publicación no. 22. Academia Nacional de Ciencias de Bolivia, La Paz.

Ponce Sanginés, Carlos
1976 *Tiwanaku: Espacio, tiempo y cultura. Ensayo de síntesis arqueológica.* 3rd edn. Los Amigos del Libro, La Paz.

Ponce Sanginés, Carlos
1989 *Lukurmata: investigaciones arqueológicas en un asentamiento urbano de la cultura Tiwanaku. Ensayo de historiación del avance científico (1895–1988).* Arqueología de Lukurmata, Vol. 1. Proyecto Wilajawira, University of Chicago, Instituto Nacional de Arqueología de Bolivia, La Paz.

Ponce Sanginés, Carlos
1994 Análysis espectográfico y patrón de impurezas en el cobre de las grapas tiwanacotas. *Pumapunku* (La Paz) 3(7):9–64.

Ponce Sanginés, Carlos
1995 *Tiwanaku: 200 años de investigaciones arqueológicas.* Producciones Cima, La Paz.

Ponce Sanginés, Carlos, and Gerardo Mogrovejo Tarrazas
1970 *Acerca de la procedencia del material lítico de los monumentos de Tiwanaku.* Publicación no. 21. Academia Nacional de Ciencias de Bolivia, La Paz.

Portugal Ortíz, Max
1992 Trabajos arqueológicos de Tiwanaku. *Textos Antropológicos* (Revista Semestral de la Carrera de Antropología-Arqueología de la Universidad Mayor de San Andrés) 4:9–50.

Posnansky, Arthur
1912/1913 1. "*Una falsa crítica de Max Uhle.*" II. "*Un par de palabras críticas sobre la obra Tiahuanaco de Stübel y Uhle (parte de Uhle).*" Paul Funk, Berlin.

Posnansky, Arthur
1945 *Tihuanacu: La cuna del hombre americano/Tihuanacu: The Cradle of American Man* (bilingual edition), 4 vols. J.J. Augustin, New York.

Protzen, Jean-Pierre
1983 Inca Quarrying and Stonecutting. *Ñawpa Pacha* 21:183–214.

Protzen, Jean-Pierre
1986 Inca Stonemasonry. *Scientific American* 254(2):94–105.

Protzen, Jean-Pierre
1992 Archittetura Inca. In *I regni preincaici e il mondo Inca*. Corpus Precolombiano, edited by L. Laurencich Minelli, pp. 193–217. Jaca, Milan.

Protzen, Jean-Pierre
1993 *Inca Architecture and Construction at Ollantaytambo*. Oxford University Press, New York.

Protzen, Jean-Pierre
2005 *Arquitectura y Construcción Incas en Ollantaytambo.* Pontificia Universidad Católica del Perú. Fondo Editorial, Lima.

Protzen, Jean-Pierre, and John H. Rowe
1994 Hawkaypata: The Terrace of Leisure. In *Streets: Critical Perspectives on Public Space*, edited by Zeynep Çelik, Diane Favro, and Richard Ingersoll, pp. 235–245. University of California Press, Berkeley.

Protzen, Jean-Pierre, and Stella Nair
1997 Who Taught the Inca Stonemasons Their Skills? A Comparative Study of Tiahuanaco and Inca Cut-Stone Masonry. *Journal of the Society of Architectural Historians* 52(2):142–167.

Prümers, Heiko
1993 Die Ruinen von Tiahuanaco im Jahre 1848. Zeichnungen und Notizen von Léonce Angrand. Offprint of *Beiträge zur allgemeinen und vergleichenden Archäeologie*, Vol. 13 pp. 385–478. Zabern, Mainz.

Rittel, Horst W.J.
2010 The Reasoning of the Designer. In *The Universe of Design: Horst Rittel's Theories of Design and Planning*, edited by Jean-Pierre Protzen and David Harris, pp. 187–196. Routledge, New York.

Rivera Casanova, Claudia
2003 Ch'iji Jawira: A Case of Ceramic Specialization in the Tiwanaku Urban Periphery. In Kolata 2003, pp. 296-315.

Rivero y Ustáriz, Mariano Eduardo de
1851 *Antigüedades peruanas, por Mariano Eduardo de Rivero y Juan Diego de Tschudi.* Impr. Imperial de la Corte y del Estado, Viena.

Rostworowski de Dez Canseco, María
1960 *Pesos y medidas en el Perú pre-hispánico*. Minerva, Lima.

Rowe, John H.
1946 Inca Culture at the Time of the Spanish Conquest. In *Handbook of South American Indians*, Vol. 2, edited by Julian H. Steward, pp. 183–330. Bureau of American Ethnology, Washington, D.C.

Rowe, John H., and Dorothy Menzel
1967 *Peruvian Archaeology*. Peek, Palo Alto, California.

Rugendas, Johann Moritz
1960 *Johann Moritz Rugendas, 1802–1858, Reisestudien aus Südamerika*. Ausstellung in der Staatlichen Graphischen Sammlung München. Prestel, Munich.

Sarmiento de Gamboa, Pedro
1906 [1576]. *Geschichte des Inkareiches von Pedro Sarmiento de Gamboa*. Edited by Richard Pietschmann. Abhandlungen der königlichen Gesellschaft der Wissenschaften zu Göttingen. Philologisch-historische Klasse. Neue Folge, Bd. VI, Nr. 4. Weidmannsche Buchhandlung, Berlin.

Schreiner, Thomas Paul
2002 Traditional Maya Lime Production: Environmental and Cultural Implications of a Native American Technology. Ph.D. dissertation, Department of Architecture, University of California, Berkeley.

Sekler, Eduard F.
1965 Structure, Construction, Tectonics. In *Structure in Art and in Science*, edited by Gyorgy Kepes, pp. 89–95. George Brazillier, New York.

Squier, Ephraim George
1877 *Peru, Incidents of Travel and Exploration in the Land of the Incas.* MacMillan, London.

Stanish, Charles
2003 *Ancient Titicaca: The Evolution of Complex Society in Southern Peru and Northern Bolivia.* University of California Press, Berkeley.

Stanish, Charles, and Amanda B. Cohen
2005 Introduction. In *Advances in Titicaca Basin Archaeology*, vol. 1, edited by Charles Stanish, Amanda B. Cohen, and Mark S. Aldenderfer, pp. 1-11. Cotsen Institute of Archaeology, University of California, Los Angeles.

Stocks, Denys
1986 Sticks and Stones of Egyptian Technology. *Popular Archaeology* April:24–29.

Stübel, Alphons, and Max Uhle
1892 *Die Ruinenstätte von Tiahuanaco im Hochlande des alten Perú: Eine kulturgeschichtliche Studie auf Grund selbstständiger Aufnahmen.* Karl W. Hiersemann, Leipzig.

Tschudi, Johann Jakob, von
1846 *Reiseskizzen aus den Jahren 1838–1842.* 2 vols. Scheitlin und Zollikofer, St. Gall.

Tschudi, Johann Jakob, von
1891 *Culturhistorische und sprachliche Beiträge zur Kenntnis des alten Peru.* Denkschriften der Kaiserlichen Akademie der Wissenschaften, Philosophisch-Historische Classe, Vol. 39. Akademie der Wissenschaften, Vienna.

Tschudi, Johann Jakob, von
1971 [1866–1869] *Reisen durch Südamerika. Unveränderter Neudruck mit einer Einführung von Carl Troll und Hanno Beck.* 5 vols. Quellen und Forschungen zur Geschichte der Geographie und der Reisen. Brockhaus, Stuttgart.

Ubbelohde-Doering, Heinrich
1941 *Auf den Königsstrassen der Inka. Reisen und Forschungen in Peru.* Wasmuth, Berlin.

Upton, Dell
1998 *Architecture in the United States.* Oxford History of Art. Oxford University Press, Oxford.

Vranich, Alexei
2001 La pirámide de Akapana: reconsiderando el centro monumental de Tiwanaku. In *Huari y Tiwanaku: modelos vs. evidencias (segunda parte)*, pp. 295–308. Boletín de Arqueología 5. Fondo Editorial de la Pontificia Universidad Católica del Perú, Lima.

Vranich, Alexei
2006 The Construction and Reconstruction of Ritual Space at Tiwanaku, Bolivia (A.D. 500–1000). *Journal of Field Archaeology* 13(2):121–136.

Vranich, Alexei, Paul Harmon, and Chris Knutson
2005 Reed Boats and Experimental Archaeology on Lake Titicaca. *Expedition* (University of Pennsylvania Museum of Archaeology and Anthropology, Philadelphia) 47(2):20–27.

Wiener, Charles
1880 *Pérou et Bolivie. Récit de voyage suivi d'études archéologiques et ethnographiques et de notes sur l'écriture et les langues des populations indiennes*. Hachette, Paris.

Whiteman, John
1987 Criticism, Representation and Experience in Contemporary Architecture: Architecture and Drawing in an Age of Criticism. *The Harvard Architecture Review* 6:137–147.

Index

Note to index: an *f* following a page number indicates a figure on that page; an *n* following a page number indicates a note on that page; a *t* following a page number indicates a table on that page.

About the Authors

Jean-Pierre Protzen

Jean-Pierre Protzen is professor emeritus of the Department of Architecture at the University of California, Berkeley. He received his diploma of architecture from the Ecole Polytechnique de Université de Lausanne (EPUL), Switzerland. After several years of private practice, he joined the Department of Architecture at the Swiss Institute of Technology in Zurich, where he became interested in the theoretical aspects of architectural design. This interest eventually brought him to Berkeley, where he taught the subject matter until retirement. His interest in pre-Colombian architecture and construction—Inca architecture in particular—was sparked on his return trip from a teaching assignment in Sao Paulo, Brazil. Several years of field work in Peru led to the publication of the book *Inca Architecture and Construction at Ollantaytambo* and many articles. He is currently completing a manuscript on the Inca site of Tambo Colorado on the south-central coast of Peru.

Stella Nair

Stella Nair is assistant professor in the Department of the History of Art and core faculty in the Interdepartmental Archaeology Graduate Program at the University of California, Los Angeles. She received her M.Arch. (Professional design degree) and Ph.D. (History of Architecture) from the Department of Architecture, University of California, Berkeley. Nair's interest in stone architecture was sparked by growing up around the impressive architectural remains of the Roman Empire in Pozzuoli, Italy. She has since conducted fieldwork in Bolivia, Mexico, Peru, and the U.S. Midwest. Nair specializes in the architecture and urbanism of the Andes, with a special focus on Tiahuanaco, Inca, and Spanish colonial construction and design. She is currently completing a manuscript on the art, architecture, and urban form of an Inca royal estate and its transition to an indigenous town under Spanish colonial rule (A.D. 1450 to 1850).

Since Europeans first saw the monumental stone structures at the southern end of Lake Titicaca in Bolivia, they have marveled at the skill of the people who produced them. These constructions have rightfully been called the world's most artful and skillful stone architecture. Its precision rivals that of the Incas to the point that writers from Spanish chroniclers of the sixteenth century to authors of the twentieth century have claimed that Tiahuanaco not only served the Incas as a model for their architecture and stone masonry, but that the Incas even imported stonemasons from the Titicaca Basin to construct their buildings. This careful study refutes this idea and delves into questions of the techniques of the Tiahuanaco stonecutters; their knowledge of geometry; and how they quarried, cut, and assembled the stone. The detailed analyses of building stones yield insights into the architecture of Tiahuanaco, including its appearance, rules of composition, canons, and production.

ISBN 978-1-931745-67-3

9 781931 745673

MONOGRAPH 75

UCLA COTSEN INSTITUTE OF ARCHAEOLOGY PRESS