Underwater ritual offerings in the Island of the Sun and the formation of the Tiwanaku state

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Considerable debate surrounds the economic, political, and ideological systems that constitute primary state formation. Theoretical and empirical research emphasize the role of religion as a significant institution for promoting the consolidation and reproduction of archaic states. The Tiwanaku state developed in the Lake Titicaca Basin between the 5th and 12th centuries CE and extended its influence over much of the south-central Andes of South America. We report on recent discoveries from the first systematic underwater archaeological excavations in the Khoa Reef near the Island of the Sun, Bolivia. The depositional context and compositional properties of offerings consisting of ceramic feline incense burners, killed juvenile llamas, and sumptuary metal, shell, and lapidary ornaments allow us to reconstruct the structure and significance of cyclically repeated state rituals. Using new theoretical tools, we explain the role of these rituals in promoting the consolidation of the Tiwanaku polity.

Andes | collective action | religion | state formation | underwater archaeology

The Lake Titicaca Basin covers ~8,560 km^2 and is among the few regions in the world that experienced primary state formation (1, 2). Shaped by a geological fault that separates Andean mountains in two cordilleras, this "inland sea" favored human settlement by creating a unique ecosystem in the middle of a semiarid territory (3–5). The Inca (1400–1532 CE) acknowledged Lake Titicaca as their place of origin, and at the time of the Spanish conquest, settlements on its shores sustained one of the largest population densities in the Andes (6). Colonial Spanish chroniclers documented the vast Inca pilgrimage ceremonial complex built between Copacabana and the Island of the Sun and compiled several legends of underwater deities and offerings (7–10).

Archaeological research conducted over the last century has helped further explore the deeper history of this region and examine key periods of cultural change, including the emergence of agricultural villages (~1500 BCE), development of regional polities (200 BCE–500 CE), and formation of the Tiwanaku state (500–1100 CE) (11–13). A prominent research question that has framed much of this scholarship is how the archaic state of Tiwanaku emerged and expanded across the basin during the first millennium CE (14–17). Although archaeological research has facilitated a better understanding of the evolution of settlement patterns, social complexity, technology, and human–environment interactions over time, the lake level has fluctuated considerably over time, and a rich archaeological landscape lies hidden below the water's surface (18–20).

In this paper, we report recent archaeological research from the Khoa Reef, a submerged offering location that contains evidence of Tiwanaku (500–1100 CE) ceremonies (21). We use the evidence from the Khoa Reef to infer the structure of religious ceremonies related to Lake Titicaca and discuss the roles of ritual and religion in integrating and reproducing this primary state formation.

Religion, Collective Action, and the Evolutionary Significance of Ritual

A substantial body of research identifies repetitive rituals in emergent states as a key factor in the evolution of political complexity (22–24). The role of religion (belief systems) and ritual (behaviors) is seen as largely related to controlling and manipulating supernatural forces, as well as facilitating group cohesion and solidarity (25, 26). It has been postulated that the greater the power, the greater the social control by an elite. However, more recent theoretical and empirical research into the evolution of religion suggests a subtler and more critical role played by emergent norms and values institutionalized by rituals (27, 28). Specifically, religious-mediated prosociality emerged in the context of increasing population size and social complexity, when decisions about collective action and opportunities for freeloading behavior became common. Religious deities that acted as "supernatural punishers" provided incentives for individuals to engage in cooperation and follow specific moral codes. Similarly, those same supernatural forces could reward individuals who behaved for the benefit of the community. Costly ritual behavior would effectively signal intragroup trust. Therefore, religious beliefs manifested in repetitive rituals play a critical role in ensuring intragroup cooperation, particularly in the absence of more effective secular norm-enforcing institutions.

Rituals should have a direct role in signaling cooperative intent among group members (29). The cost of the ritual should be proportional to the effectiveness of norms of trust among group members. This is particularly significant for group members with weak or no kinship ties. Ethnographic and experimental cross-cultural research suggests that the larger the population, the greater the importance of moralizing deities and, consequently, the need for costly rituals. Therefore, archaeological evidence of rituals provides empirical evidence of this process of how religion

Significance

Ritual and religion are significant factors in primary or archaic state formation. These beliefs and practices not only legitimize these new political organizations in their ability to control supernatural forces, but also incentivize intragroup cooperation by punishing freeloading and rewarding cooperative behavior. Recent archaeological excavations from an underwater ceremonial location near the Island of the Sun in Lake Titicaca have revealed the remarkable constituent elements of repetitive rituals practiced by the Tiwanaku state between the 8th and 10th centuries CE. Evidence of animal sacrifice and high-value offerings of vessels, gold, shells, and lapidary stones on a strategically located reef illustrates how power was consolidated in one of the earliest Andean states.

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evolved and became a prominent feature of archaic states, facilitating intragroup cooperation in tasks ranging from organized intergroup violence to monumental construction (29, 30).

In the south-central Andes, the origins of the Tiwanaku state are related to the expansion of a religious complex that featured distinctive art and architectural styles (31). The state iconography included a rayed front-faced deity holding staffs, often bearing sharp teeth and fangs and escorted by a series of attendants bearing either zoomorphic heads or appendages, as well as trophy heads. At the same time, many monumental pyramids and temples in the Tiwanaku capital and other regional centers featured wide-open terraces where multitudes could have participated in large-scale ceremonies (32). Smaller structures within these larger buildings suggest that specialized rituals also occurred in closed settings, possibly for and by an emerging clergy elite.

While Tiwanaku's iconography could support the notion of a supernatural punisher, and its architecture the importance of collective ceremonies and pilgrimage, well-documented evidence of rituals for making inferences about the content and meaning of the religious behavior is scarce. Therefore, the evidence represented in the Khoa Reef reported here provides a singular example of how in a context of increasing population size and political complexity, rituals would have emphasized the reproduction of a pan-regional moral code signaling appropriate civic and economic behavior.

The Khoa Reef

The Tiwanaku capital is located in a valley in the southeastern portion of the basin. As the state grew, it eventually controlled the entire Lake Titicaca drainage and beyond (33, 34). The Khoa Reef is part of an archipelago of small islands on the northwestern end of the Island of the Sun and as such, has an unobstructed view of a large portion of Lake Titicaca's shoreline and surrounding mountains (Fig. 1*A*) (35, 36). In September 1977, amateur Japanese divers discovered the reef and retrieved fragments of ceramic feline incense burners and andesite offering boxes containing miniature figurines fashioned from shell of the thorny oyster (*Spondylus* sp.) (Fig. 1*B*). A follow-up Bolivian-Japanese expedition in 1988 found more artifacts, as did a subsequent 1989–1992 expedition sponsored by the National Geographic Society and directed by Johan Reinhard (36). In total, 385 archaeological offerings consisting of camelid bone, ceramic, stone, gold, and silver figurines were recovered from the Khoa Reef (37). Whereas the offerings presented in stone boxes are of clear Inca origin, many offerings correspond to Tiwanaku, but the specific association of each was problematic. Moreover, because of sediment accumulation and stone collapse, the reef potentially contained more offerings deeper within the sediment. In 2013, we conducted a new phase of underwater explorations reported here (38).

Results

The distribution of archaeological materials in the Khoa Reef covers an area of ~2,400 m^2. In addition to a new topographic survey of the reef, we conducted three excavations positioned in relation to the reef's topography and previous findings. We emphasized areas that were protected from erosion and thus potentially containing well-preserved stratigraphy and cultural contexts (Table 1).

Unit 1 (8 m^2) was situated at 5–7 m below the surface in the largest fault, located in the eastern sector of the site (Fig. 2). We completely excavated this unit up to bedrock, and it represents a relatively undisturbed cultural context associated with Tiwanaku offerings. The sedimentary accumulation proved to be very dense and was characterized by a compact agglomerate of collapsing stones within which the artifacts lay. With the exception of a few materials, the taphonomy and stratigraphy suggested that the original offering deposits were structurally affected by cryoclastic stone collapse and subaquatic erosion but otherwise remained submerged. Indeed, it seems like the offerings were intentionally made underwater. With the exception of five modern *vasijas* found near the surface, all of the ceramic fragments belonged to the same vessel type, a Tiwanaku feline (puma) incense burner

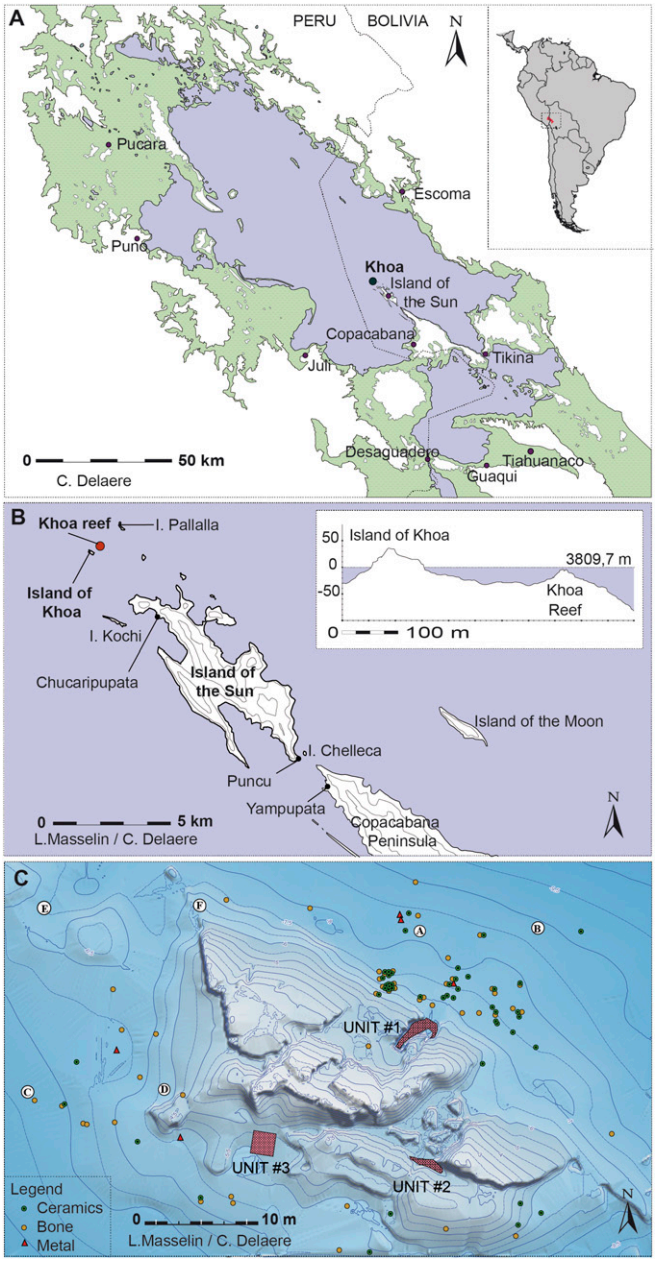

Fig. 1. (*A*) Location of the Khoa Reef within Lake Titicaca. (*B*) Profile of the reef in relation to Khoa Island. (*C*) Khoa Reef, including underwater excavations and location of ceramic findings from previous explorations.

(39). At least 13 incense burners were recovered, including a few semicomplete burners that were too eroded to preserve paint, slips, or traces of soot on their surfaces. Nevertheless, fragments of charcoal were present within the excavated deposits.

In these same deposits, we found 10 gold ornaments, including a pectoral with a Tiwanaku-style ichthyomorphic engraving, a "massive" square pectoral, a 30-cm-long band, and numerous small, perforated gold leaves (*SI Appendix*, Fig. S1*A*). Some of these items were found in good contextual association, such as at the bottom of Unit 1, where underneath a stone collapse lay a perforated corrugated gold leaf still attached to a leather fragment, fragments of incense burners with well-preserved slip, polished green-colored glacier moraine stones, and well-preserved camelid bones, including a possible polished instrument.

The recovered bone specimens included those of camelids, teal, cormorant, anurans (including Lake Titicaca water frogs),

Table 1. Tiwanaku and Inca offerings recovered from Khoa

Artifacts	1977–1992	Unit 1	Unit 2	Unit 3	Total
Tiwanaku					
Ceramic vessels	131	560	0	472	1,163
Camelid bones	184	268	1	115	568
Shell artifacts	6	1	0	5	12
Gold artifacts	4	10	0	19	33
Lapidary artifacts	0	17	0	16	33
Stone anchors	2	1	0	0	3
Subtotal	327	857	1	627	1,812
Inca					
Andesite boxes	28	0	0	0	28
Box covers	7	0	0	0	7
Gold artifacts	10	0	1	1	12
Silver artifacts	8	0	0	1	9
Shell artifacts	5	0	0	0	5
Subtotal	58	0	1	2	61
Grand total	385	857	2	629	1,873

killifish, and catfish (*SI Appendix*, Table S1) Camelids are the only species alien to the reef ecosystem. Osteometric analysis and the presence of diagnostic incisors suggests most of these correspond to anatomically complete (as most bones were represented) domesticated llamas (*Lama glama*), which were likely killed during deposition. We estimate the presence of at least one infantile (age ∼6 mo), and three juvenile (age <15 mo) llamas in the assemblage. Most fish, amphibian, and bird bones were likely deposited naturally within this submerged ecosystem.

Unit 2 (4 m^2) was positioned 5.5 m below the surface in a fault located on the southeastern part of the site, at the junction between the main massif and the secondary massif. This excavation proved to be culturally sterile except for a small gold leaf and a few camelid and frog bones.

Unit 3 (4 m^2) was located 5.5 m below the surface in the western flank of the reef, near the base of a steep natural wall that forms a sedimentary plateau (Fig. 3*A*). This unit included two stratigraphically distinct levels separated by ∼30 cm of mostly sterile sediment. Whereas the upper level contained Inca materials disturbed by previous divers, the lower level included mostly Tiwanaku materials located below a stone collapse. These deposits lay within a plateau at the base of the vertical wall of the western side of the reef, where a small ditch was formed. Recurrent stone collapses and loose sediment trapped many archaeological materials in this ditch, including numerous small metal, shell, and lapidary ornamental artifacts (*SI Appendix*, Fig. S2).

All of the ceramic fragments ($n = 472$) correspond to Tiwanaku feline incense burners, with the exception of two possibly Late Formative fragments, and suggest the presence of at least eight distinct vessels. In addition to camelids, aquatic birds, amphibians, and fish, a possible feline canine was recovered. As in units 1 and 2, most nonmammalian bones were deposited as part of natural taphonomic processes, but some fish bones were burned, suggesting that they might have been consumed as food. Based on element siding and aging, we estimate that at least three juvenile llamas were present. The representation of most skeletal elements suggests that these animals were complete and possibly killed at the time of deposition.

In total, we recovered 19 metal ornaments, including nine zoomorphic llama-puma plaques (commonly referred to as *wariwillkas*), a gold medallion, an L-shaped plaque, two thin bands, and several perforated gold leaves (*SI Appendix*, Fig. S1*B*). The medallion is strikingly similar to another medallion recovered by Reinhard in the reef (37), and both represent the typical Tiwanaku-style rayed-face deity (Fig. 3*B*). The L-shaped plaque, although fragmentary, contains geometric stepped motifs that end in alternating puma and condor silhouettes. Five *Spondylus* shell items, including a small remarkable camelid figurine and a complete but scraped thorny oyster clam, were also recovered with these materials. Finally, we recovered a few semiprecious stone artifacts, including a green turquoise stone pendant, a small lapis lazuli puma figurine, and a batch of small green-colored glacier moraine stones.

Eight AMS radiocarbon dates were analyzed from the Khoa Reef excavations, including four from Unit 1 and four from Unit 3 (Table 2). Four of these dates were on charcoal (which was relatively common in the deposits), and four were on bone collagen. With the exception of an uncertain date from Unit 1 that dates a camelid bone to the Late Formative, the overlapping dates between the two areas verifies that the offerings found in different parts of the reef were roughly contemporary. More specifically, Bayesian modeling of the seven dates as part of a single phase in Oxcal 4.3 (40) using the SHCal13 calibration curve (41) suggests that the offerings were deposited between 794 ± 63 and 964 ± 50 CE, a relatively narrow temporal frame (*SI Appendix*, Fig. S3). This time frame is consistent with the expansion of the state during the Tiwanaku IV and V phases, as well as with the temporal distribution of feline incense burners in the Tiwanaku capital itself (38, 39).

Discussion

Structure of the Offerings at Khoa. The extraordinarily rich contextual associations of the archaeological materials recovered at Khoa allow us to reconstruct the nature and significance of these Tiwanaku rituals in relation to state emergence and consolidation. The rayed-face motif on two gold medallions indicates that the offerings explicitly addressed the main mythical figure in the religious iconography of Tiwanaku (Fig. 3*B*). The sumptuary gold, shell, and lapidary ornaments also highlight the costly display and disposal of wealth during the ceremonies, because these materials were among the most prestigious available in the Andes. For instance, the *Spondylus* shells had to be obtained by trade from the warm ocean waters of the Ecuadorian coast, nearly 2,000 km away. It is likely that these items were attached to organic textiles, feathers, or leather components as part of ritual bundles, which were common in burial and other Tiwanaku ritual contexts (42–44). In fact, leather fragments and dark-color staining on metals were recovered from the reef, and some of the perforated gold sheets might have been attached to the llamas themselves as ear tassels and ritual regalia. Indeed, the bones of at least seven immature llamas complement the remains of approximately 10 animals recovered from previous explorations. The stratigraphic and radiocarbon data from these

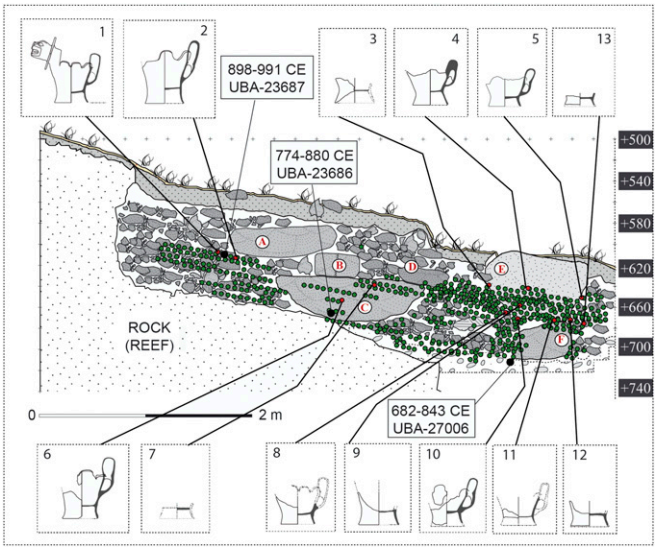

Fig. 2. Unit 1 showing the distribution of Tiwanaku incense burner specimens.

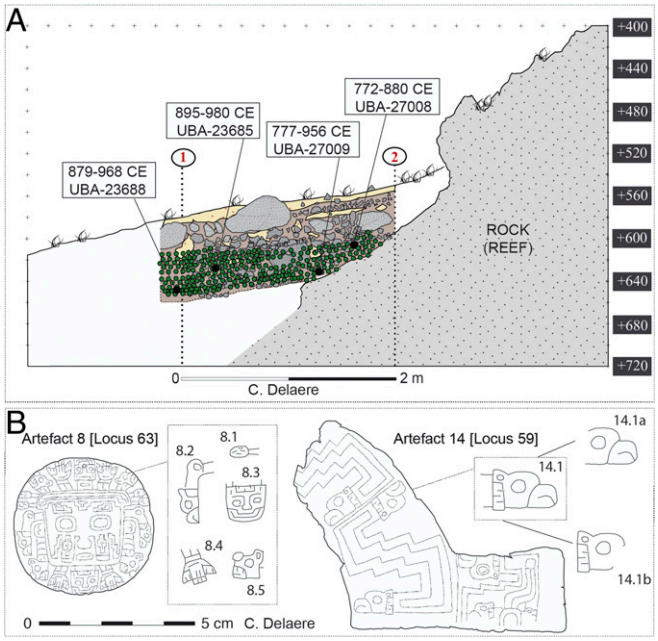

Fig. 3. (*A*) Profile of Unit 3. (*B*) Metal objects with Tiwanaku iconography.

remains verify that most, if not all, of the llamas were deposited during Tiwanaku times.

Similarly, we retrieved more than 1,000 ceramic fragments that, along with the 131 (15 kg) whole and fragmented remains discovered in previous explorations, account for approximately 37 feline modeled incense burners, which together make Khoa the site with the highest frequency of these vessels in the entire basin. Previous scholars have argued that unlike the ceramic *keru* cup, which is frequently found in burial sites marking expansion of the Tiwanaku state across a very wide area, the presence of puma incense burners is one of the most diagnostic traits for the presence of Tiwanaku within the Lake Titicaca Basin (45–47). The high frequency along with the restricted technological and stylistic variability of the paste, temper, and form of the vessels found at Khoa suggest that they might have originated from different workshops within the same broad region, verifying that the puma incense burners are diagnostic of Tiwanaku-related ritual contexts and direct territorial control within the Titicaca Basin itself (34, 48, 49).

By comparing Units 1 (well-preserved but heterogeneous assembly) and 3 (fragmentary artifacts but homogeneous assembly) with the superficial findings (heterogeneous fragmentation and assembly), we can reconstruct repeated offerings performed at Khoa during the Tiwanaku period (Fig. 4). The sacrifice of an immature and possibly decorated llama joined 4 ± 1 puma ceramic incense burners and a bundle of small miniature offerings (*SI Appendix*, Fig. S4). The quantity ($n = 9$) of *wariwillka* zoomorphic gold sheets in the excavations is consistent with the number of identified incense burners and juvenile llamas. The finding of many semicomplete vessels suggests that the ceremonies at Khoa occurred above the waterline, followed by ritual underwater interment. The ritual sacrifice of llamas along with their ritual interment with high-status goods, such as finely crafted vessels and miniatures made on exotic materials, were frequent practices carried out by Tiwanaku and its neighboring rival state Wari (50–52). In the case of Khoa, officiating authorities likely deposited the offerings during rituals held from boats, as suggested by the presence of andesite anchors, such as the one discovered in Unit 1 and four others discovered during previous explorations. The proximity of all of the components of the offerings suggests an intention to keep the assemblage as integrated as much as possible. In this restricted ceremony, there was no "ritual destruction" of vessels, and the ubiquitous presence of charcoal in the excavated contexts confirms that the ceremonies involved burning.

The Meaning of the Offerings: Tiwanaku at the Island of the Sun. Khoa preserves evidence of activities carried out in relation to other submerged as well as nonsubmerged spaces. The finding of contemporary submerged Tiwanaku sites such as Punku, a port situated in the southeastern shore of the Island of the Sun, suggests that when the offerings were made, a portion of the Khoa Reef might have been above water (21). Indeed, the Tiwanaku's presence in the Island of the Sun was substantial and included more than a dozen sites, including Chucaripupata, a puma-shaped ceremonial complex situated near the northwestern shore (53). On a broader scale, the Island of the Sun and especially the Khoa Reef are positioned near the geographic center of the lake, and thus it is not surprising that the emerging Tiwanaku elite appropriated this space for costly and highly charged ceremonies. While access to the ceremonies performed at the reef must have been difficult and reserved for a selected elite group (given the site's small, rugged, and probably sacred nature), residents of surrounding villages might have witnessed the ceremonies from afar. The construction of buildings in the Tiwanaku capital and its regional centers resembles this sacred/profane and public/reserved structuralist dialectic.

The emergence of institutionalized religion in a context of an expanding state polity often involves the appearance of specialized architecture, material culture, iconography, and full-time religious specialists. Priests controlled the esoteric knowledge of the meaning of the iconography, the organization of material culture, and how ceremonies should be officiated (54). The Khoa offerings are associated with the central figure of the iconographic repertoire, as well as with the attributes of prestige and power represented in the public spaces and the monumental complexes of Tiwanaku's main sites. The process of "sacralizing" certain components of these spaces is one among many strategies by which religious authorities orchestrated and legitimized institutional change. By the time the Tiwanaku state emerged, the entire shore around Lake Titicaca was densely populated. The lake was not a border, but rather a vector of communication between the different parts of the basin. Indeed, people were

Table 2. Accelerator mass spectrometry radiocarbon dates of Khoa

Lab code	^{14}C BP	Error	Material	Provenience	Age cal CE (68.2%)	Age cal CE (95.4%)
UBA-23687	1138	26	Charcoal	Unit 1, locus 53	898–991	891–1014
UBA-23685	1161	26	Charcoal	Unit 3, locus 43	895–980	887–989
UBA-23688	1197	25	Charcoal	Unit 3, locus 71	879–968	779–983
UBA-27009	1218	33	Camelid bone (collagen)	Unit 3, locus 51	777–956	771–970
UBA-23686	1251	32	Charcoal	Unit 1, locus 44	774–880	689–950
UBA-27008	1256	41	Camelid bone (collagen)	Unit 3, locus 29	772–880	682–959
UBA-27006	1301	40	*Orestias* bone (collagen)	Unit 1, locus 72	682–843	679–876
UBA-27005	2212	40	Camelid bone (collagen)	Unit 1, locus 31	355–148 BCE	367–108 BCE

Note: All dates calibrated using Oxcal 4.3 (40) and the SHCAL13 (41).

Fig. 4. General composition of offerings at Khoa Reef. Image courtesy of Teddy Seguin (photographer).

boating to the Island of the Sun as early as 2150 BCE and probably much earlier (55). Within this landscape, certain points of attraction, such as Khoa in the northwestern extreme of the Island of the Sun and near the geographic center of the lake, held strategic positions, acquired sacred roles, and became the perfect loci for costly religious practices.

Conclusions

Religion and its associated rituals are keystones of emerging complex societies, providing the moral and institutional structure for enforcing trust, promoting cooperation, and punishing free-loading. The emergence and consolidation of the Tiwanaku state was strongly related to the growth and expansion of a religion manifested in a specific iconography and architecture and the rituals that bound them together. More than a mere cult in an extreme location, the ceremonies at Khoa reflect a complex interaction of being situated at the center of the lake while being carried out by a small elite group. Given its difficult accessibility but widespread visibility, it was a privileged and exclusive space of interaction controlled by a specialized elite class. The quality and quantity of offerings made at the submerged site placed the reef at the center of the Tiwanaku people's beliefs and ritual landscape. They also emphasize the display of powerful forces, as the dissemination of rituals focused on the representation of a rayed-faced deity and smoke-gusting pumas, the sacrifice of juvenile llamas, and the conspicuous disposal of wealth. Much like wealth acquisition and transmission, these activities are profitably understood to represent increasingly institutionalized hierarchical relationships that coopted the supernatural authority to punish while simultaneously encouraging pan-regional cooperation.

Materials and Methods

Our research at Khoa consisted of 19 days of research between June 26 and July 27, 2013. This work introduced the first excavations in the lake sediment itself (38). Fieldwork included sonar scanning and underwater 3D photogrammetric mapping of the reef and excavations. The location of Reinhard's (36) reference datum (metal stakes: A–F) allowed us to relocate earlier findings in a geographic information system, as well as to place our three new excavation units in relation to the materials recovered by previous research (Fig. 1*C*). At the operational level, the various dives in 2013 were devoted to determining the morphology of the reef (topography) and the sedimentary accumulation in relation to the artifacts (stratigraphy). During the excavations, archaeologists operated a water dredge powered by an engine pump to excavate the sediment and documented stratigraphic discontinuities in deposition. Depths were determined with reference to elevation 3,809.7 m (lake level). Archaeological materials (e.g., bone, ceramics, lithics, metal, charcoal), were recorded in situ or retrieved in 1-cm screens and sorted from natural sediment using a provenience (locus) recording system.

We measured and weighed each archaeological specimen recovered during excavations. We identified every bone specimen to its most specific taxonomic and anatomic category and also inspected it for natural and nonnatural modifications (56, 57). We reconstituted the minimum number of individuals for camelids based on skeletal element side, size, and epiphyseal fusion. We also determined the minimum number of ceramic vessels by relying on diagnostic fragments and weight. The incense burners have hyperboloid shapes, annular bases, and modeled feline zoomorphic heads and tails joined by six scalloped rim edges. Based on the intact specimens discovered, we estimated the average weight of a feline incense burner as ∼1,300 g. To refine the chronology of deposits, we analyzed both charcoal and bone samples at the KIK/IRPA (Koninklijk Instituut voor het Kunstpatrimonium–Institut Royal du Patrimoine Artistique) accelerator mass spectrometry radiocarbon dating facility.

In this project, the notion of space and time is inseparable from the concept of cultural context. Stratigraphic excavations were aimed at distinguishing the Tiwanaku, Inca, and other offerings that the site might have received over

time; therefore, it was essential to isolate the Tiwanaku sacred space from that documented by subsequent offering practices and to analyze the deposits from both the horizontal spatial distribution and vertical stratigraphic deposition of the remains (21). Here we focus on the Tiwanaku offerings because these were recovered within the stratigraphic deposits, whereas the Inca offerings consisted of an assembly of sealed stone boxes containing miniature figurines, none of which were recovered during the excavations. The variability of offerings between these two traditions indicates differences not only in the temporal and stratigraphic dimensions, but also in the rituals and belief systems associated with these practices.

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