Implications of the Fluvial History of the Wacheqsa River for Hydrologic Engineering and Water Use at Chavín de Huántar, Peru

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Channeling of water through a variety of architectural features represents a significant engineering investment at the first millennium B.C. ceremonial center of Chavín de Huántar in the Peruvian Central Andes. The site contains extensive evidence of the manipulation of water, apparently for diverse purposes. The present configuration of the two local rivers, however, keeps available water approximately 9 m below the highest level of water-bearing infrastructure in the site. Geomorphic and archaeological investigation of the fluvial history of the Wacheqsa River has revealed evidence that the Chavín-era configuration of the Wacheqsa River was different. A substantially higher water level, likely the result of a local impoundment of river water caused by a landslide dam, made the provision of water for the hydrologic system within the site a more readily practical possibility. We review what is known of that system and argue that the fluvial history of the Wacheqsa River is critical to understanding this aspect of hydrologic engineering and ritual practice at Chavín. This study demonstrates the relative rapidity and archaeological relevance of landscape change in a dynamic environment. © 2009 Wiley Periodicals, Inc.

INTRODUCTION

The geomorphic history of the lower reach of the Wacheqsa River is demonstrably complex and important to archaeological interpretation of the first millennium B.C. site of Chavín de Huántar. The Wacheqsa River is a glacier-fed, perennial, fourth-order stream located high on the eastern slope of the Peruvian Andes, draining a small catchment in the southern Cordillera Blanca. Its headwaters originate at approximately 4500 m asl on the slopes of Nevado Huantsan and neighboring peaks, from whence it drops 1400 m in approximately 15 km. Ultimately, the Wacheqsa feeds into the Mosna River in the upper reaches of the valley known as the Callejón de Conchucos. At the confluence of these two rivers is the archaeological site of Chavín de Huántar, a monumental complex dating primarily to the first millennium B.C. The Callejón de Conchucos is a steep valley characteristic of the eastern slope of the

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Cordillera Blanca. The Wacheqsa and Mosna rivers meet at approximately 3180 m asl, while the surrounding ridges, less than 5 linear km away, reach 4500 m asl.

Exposed stratigraphy on the south bank of the Wacheqsa indicates that the river bed was situated 6–8 m higher in the Chavín period than at present; archaeological features and radiocarbon-dated organic material recovered from the same exposure date this elevated river level to within the last 3000 years. We discuss here the geomorphic evidence for this elevated river level, the chronology and probable cause of the river-bed elevation, and the implications of the fluvial history of the Wacheqsa River for understanding water management at Chavín de Huántar.

The monumental center of Chavín, located on the valley floor, is a complex of stone-faced platform mounds, terraces, and sunken plazas (see Figure 1) dating to approximately 1200–500 B.C. (though the chronology remains debated; see Kembel & Rick, 2004:62; Burger, 2008). One of only a handful of monumental highland sites from this early period, Chavín has been a focus of archaeological research in the Andes since Julio C. Tello’s 1919 visit, and it remains central to the understanding of Peruvian culture history (Burger, 1992; Lumbreras, 1989; Tello, 1943, 1960). Most recently, John Rick has directed a Stanford University–based project at the site, of which this research is part, since 1996 (Kembel & Rick, 2004; Rick, 2005, 2008; Rick et al., 1998). This long research history has produced some disagreements regarding the details of Chavín’s chronology and the sociopolitical mechanisms underlying its rise, but there is broad archaeological consensus that the site served as a ceremonial center (Burger, 1992; Lumbreras, 1989; Rick, 2005, 2008; Tello, 1960).

The platform mounds at Chavín incorporate a complex and interconnected system of subsurface galleries that have been home to some of the most spectacular archaeological finds at the site (see Lumbreras, 1993; Rick, 2008). These galleries have now been mapped in detail and provide valuable information about the site’s construction history (Kembel, 2001, 2008). The architecturally elaborate core containing these galleries, 7 ha in total area, is set in a landscape heavily modified by fills, retaining walls, and megalithic terraces (comprising approximately another 13 ha (Contreras, 2007). In addition, the site and its near periphery are also honeycombed with smaller subsurface constructions: ventilators, drains, and canals. Most of these are yet to be mapped, but they are sufficiently documented that Richard Burger, drawing on the partially published work of two Peruvian hydrologic engineers (Lumberas, Gonzalez, & Lieataer, 1976), was able to cite a figure of nearly 1000 m as a linear measure of known water-bearing channels at the site (Burger, 1992:141). Given the limited accessibility of many of these features, and those documented since, this estimate should be regarded as a minimum.

This water-bearing infrastructure is testament to the significance of water at the site. The two local rivers and reliable seasonal rainfall provided adequate water for agricultural purposes, and water also served as ritual element and practical hazard. As we discuss below, water appears to have played a significant role in ritual practice at Chavín, and high seasonal rainfall provided a significant engineering challenge.

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1 All dates are given in calibrated radiocarbon years.
Figure 1. Chavín de Huántar and its surroundings, including features discussed in the text. Site sectors are labeled in uppercase.
Moreover, the steep local landscape was (and is) prone to landslides when saturated (Tello, 1945; Turner, Knight, & Rick, 1999).

The water-bearing features at Chavín comprise an interpretive problem for two reasons. First, as we discuss below, the water-bearing infrastructure at Chavín evidently outstrips drainage needs—that is, the capacity of the site’s water-bearing channels exceeds any amount of water likely to be naturally introduced into the site. Second, the present configuration of the two rivers that flank the site of Chavín is such that the reaches of river adjacent to the site are significantly below the highest water-bearing infrastructure. The Wacheqsa River, for topographic reasons the only potential source of water that might have been brought into the site by canal, currently flows past the site at a modest grade in a narrow canyon with a bed roughly 9 m below the highest water-bearing channel, implying the prehistoric need for a long and difficult-to-engineer canal unless the river bed in Chavín times was higher than it is at present.

Whereas examples of such canal construction are not uncommon in Andean prehistory, dating from as early as the fifth millennium B.C. (Dillehay, Eling, & Rossen, 2005; for later examples see Farrington, 1980; Kosok, 1965; Kus, 1984; Ortloff, Moseley, & Feldman, 1982; Petersen, 1985, *inter alia*), no evidence of a prehistoric canal diverting water from the Wacheqsa River has been found at Chavín to date, in spite of the long investigative history at the site. In this paper we explore a possible explanation for this situation using geomorphic and stratigraphic evidence for changes in the local elevation and gradient of the Wacheqsa River during the Late Holocene, during which time the ceremonial center was built, utilized, and abandoned.

We detail here evidence suggesting that the Chavín-era configuration of the Wacheqsa River was notably different from the modern one, and discuss the archaeological significance of such an interpretation. After summarizing the evidence for water use at Chavín, we describe the local geomorphology, and then turn to the history of the Wacheqsa River, reviewing the archaeological and geomorphic evidence that suggests the level of the Wacheqsa River was in Chavín times 6–8 m higher. We discuss this data, and suggest that the most probable cause was an impoundment of water on the Wacheqsa River, likely caused by a landslide dam. Such an elevated river level would have made the provision of water for the architecture of the monumental core much easier than it appears today.

**WATER USE IN THE CEREMONIAL CENTER**

As noted above, the ceremonial center of Chavín consists of a core of monumental buildings and a near periphery consisting of a heavily modified landscape. The monumental core is made up of an array of platform mounds faced with large blocks of quartzite, fine-grained sandstone, and granite, and filled with angular rock fragments in a prepared clayey matrix. These platform mounds originally ranged up to 10 m in height and were extensively decorated with finely carved lithic art.

The area contains a profusion of water-bearing features of various sizes, many still unmapped, ranging from enclosed drains as small as 20 × 20 cm to enclosed canals large enough to allow a person to walk upright through them (Burger, 1992;
Kembel, 2001, 2008). We here use the term “gallery” to refer to a subsurface construction not intended to transport water, while “canal” refers to features designed for water movement and “drain” specifically to features intended to remove water from the site or one of its structures. Where the design function of the feature is not clear, we refer to it as a water-bearing channel.

In addition to those features in the structures of the monumental core, water-bearing channels are also present in the site's near periphery, and they have been documented in the West Field, South Area, Wacheqsa, and La Banda sectors (see Figure 1 for the location of site sectors and locations of water features); water-bearing features have in fact been found in nearly every area excavated at Chavín. The landscape in which the ceremonial center is embedded, as discussed in detail by Contreras (2007), was extensively engineered. The landscape modifications included not only construction of megalithic terracing and deposition of massive amounts of leveling fill but also construction of associated water-bearing channels, erection of walls to restrict both local rivers, and rerouting of the channel of the Mosna River (Contreras, 2007; Rick, 2005; Rick & Contreras, 2006). Part of this infrastructure included the evident diversion of river water to provide flow for the elaborate system of sub- and intra-monument canals. The only possible source of this water, given local topography and geomorphology, is a point on the Wacheqsa River approximately 300 m west of the monumental core.

Like other features of the modified landscape, the canals and drains at Chavín appear to have had multiple purposes. Modern conservation problems demonstrate that during the wet season (December–April), seepage of water into the galleries within Chavín’s structures can be a problem, and thus at least some of these water-bearing features were likely designed to drain rainwater from the structures. Burger notes that the drainage system was well constructed and engineered, and was able to “accommodate even the most severe local [rainfall] conditions” (1992:142). However, as discussed below, the local catchment draining directly into the monumental core is small, with a total area of little more than 1 km², and the likely amount of rainwater is not such sufficient to explain the profusion of features—average annual rainfall in Chavín today is only 800–900 mm (Burger, 1982:5; Diessl, 2004:38), and regional paleoclimate records suggest that precipitation amounts in the Central Andes were probably similar 3000 years ago (e.g. Sandweiss et al., 2001; Thompson et al., 1995).

The scale and profusion of the water-bearing features have led to suggestions that in addition to their practical drainage function they served ritual purposes. Lumbreras (Lumbreras, Gonzalez, & Lieataer, 1976) proposed that at least one water-transport feature in the site—the canal that runs under the staircase on the east side of Structure B (see Figure 1)—was designed for acoustic effect, as water running through this small canal would have created a deep roar in the Lanzón Gallery. This multivalence has an obvious parallel in the site’s built landscape, which includes terraces and platforms constructed to specifications that exceed what would be necessary for simple persistence. Rather than erecting casual, utilitarian fieldstone walls to capture slope sediments and manage erosion (as local agriculturalists do today), Chavín’s builders constructed large filled platforms and walls of massive, often partly shaped,
stone blocks. Water management within the monument itself thus seems to have been both practically imperative and ritually significant: While drainage of the sunken plazas and the interior galleries remains a conservation issue today, the intricate network of canals and drains far exceeds what is necessary for simple drainage.

While prior work (Lumbreras, Gonzalez, & Lieataer, 1976; Burger, 1992; Kembel, 2008) has documented nearly 1000 meters of subsurface channels, much of the system of canals and drains at Chavín de Huántar still remains poorly defined due to the logistical difficulties of trying to map the small and enclosed subsurface spaces. Where the system has been explored and documented in detail, the multiple intentions of its construction have been apparent. For example, the Rocas drain, into which many of the site’s smaller drains feed, stretches from immediately off the southeastern quadrant of the Circular Plaza approximately eastward, crossing under the northwestern corner of the Square Plaza and the southeastern corner of the Square Plaza’s North Flanking Mound before eventually emptying into the Mosna River (Figure 1). The Rocas drain has been the subject of two major archaeological investigations: Its upper portion was excavated by Hernán Amat as part of the Lumbreras/Amat project between 1966 and 1973 (Lumbreras & Amat Olazabal, 1966), and more recently the Stanford Project has been excavating, clearing, and conserving the lower portion of the canal (Kembel & Rick, 2004). Like the canal associated with the Lanzón Gallery, the Rocas drain was evidently multifunctional. It is much larger than needed to move any amount of water that might have drained through it (Figure 2) and had at least two formally constructed entryways (Kembel & Rick, 2004).

It is clear, then, that Chavín’s builders were concerned with the movement of water throughout the complex, evidently for multiple reasons. What has been poorly understood is how—given modern topographic constraints—water was diverted into this system of water-bearing features.

**GEOLOGY AND GEOMORPHOLOGY**

The principal elements of the valley geomorphology around the monumental center are steep slopes thinly covered with colluvium, alluvial fans created by small tributary drainages perpendicular to the valley axis, and earth flow complexes extending from high up the valley walls to the valley floor (Figure 3). Bedrock outcrops—generally clearly bedded and heavily folded—are also scattered throughout the valley at all elevations. These consist of Lower Cretaceous deposits of the Oyón Formation (the majority of the lower and mid-valley) and the Goyllarisquizga Group (Chimú, Santa, and Carhuaz formations) higher in the valley. The Oyón Formation consists of siltstones, and sandstones in strata 5–30 cm thick, interbedded with strata of anthracite (Cobbing et al., 1996:74). Ascending toward the ridges, one moves from

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2 This highlights the ways in which the site’s construction blurs the distinction between canal and drain. The Lanzón canal, for instance, serves to drain water from Structure B, but much of the water it transported was apparently deliberately introduced to that structure. The Rocas drain, conversely, served primarily to convey water from the site into the Mosna River, but seems to have served as a ceremonial waterway in addition to a simple drain.
the Oyón Formation into the Chimú, Santa, and Carhuaz formations. These consist, respectively, of white, quartzitic sandstones in massive layers 1–3 m thick (Chimú Formation), blue-gray limestones, 10 cm to 1 m thick (Santa Formation), and cemented silty clays (Carhuaz Formation) (Cobbing et al., 1996:83–90; Turner, Knight, & Rick, 1999:48).

Figure 2. Cleared segment of the Rocas drain, looking roughly northwest, at the northern edge of the Square Plaza. Step visible in foreground at right is the opening of a formally constructed stair (now blocked) that descended from the surface into the Rocas drain.

The large landslides in the valley around Chavín may be separated into two types on the basis of their surficial morphology: relatively shallow earth flow complexes whose movement is primarily translational, and deep-seated rotational slumps. The majority of the landslides are of the former type; a massive landslide at the northern

3 The practical implication of this in archaeological terms is the ready availability of quartzite and sandstone construction material that tended to readily fracture in relatively rectilinear blocks. Conversely, the limestone and granite employed in construction had to be imported from at least 3 and 15 km distant, respectively (see Turner, Knight, & Rick, 1999:54–55).
Figure 3. Geomorphic map of area. Drawn from fieldwork by the authors, with reference to Turner, Knight, and Rick (1999).
extreme of the valley, which dammed the Mosna River before Chavín’s settlement (Contreras, 2007; Turner, Knight, & Rick 1999), provides an example of the latter type. Distinctive morphological characteristics for either type are the main scarp at the landslide’s upper limit, a main body of material displaced downslope (typically longer than it is wide for earth flows and wider than it is long for slumps), a zone of depletion, and a zone of accumulation (for an idealized schematic, see Cruden & Varnes, 1996:Figure 3-3; also Keefer & Johnson, 1983:Figure 4).⁴

These varied large landslides form only part of the valley topography. The geomorphic units identified by surface mapping (Figure 3) include, in addition to the major elements of the large landslides (Qls and Qlsa), the alluvial plain on which the modern town is located (Qoal), talus slopes (Qtl) and bedrock covered by thin

⁴ For a full description of earth flow morphology, see Keefer and Johnson (1983:8–17) and Cruden and Varnes (1996:40–41).
colluvium (b/c). The valley slopes are also dissected by small drainages that form small alluvial fans as they descend into the valley (Qaf). The topography of the valley walls is the result of the activity of the large landslides coupled with the variable resistance of the bedrock—the resistant quartzite forming prominent fins while the more easily eroded rocks of other types form the more moderately inclined colluvial slopes between them. Shallow debris slides, rock falls, and accumulated talus are associated with the steep slopes underlain by well-indurated bedrock.

Chavín lies immediately south of the mouth of the Wacheqsa River, which flows eastward out of the Cordillera Blanca to join the north-flowing Mosna River. The glacier-fed Wacheqsa, whose fluvial history is our focus here, flows reliably even during the dry season, draining a watershed of about 118 km$^2$.

In 1945, a large debris flow originating high in the watershed descended the Wacheqsa valley, burying the archaeological site and part of the adjacent town under as much as 4 m of material (Indacochea G. & Iberico M., 1947). The valley floor in the vicinity of the site is underlain by this deposit (not shown in Figure 3 as it obscures all other geomorphic units in the immediate vicinity of the site) as well as by recent alluvium (Qyal). Also present are remnant alluvial terraces, stranded by the downcutting Mosna River (Qt). As discussed by Contreras (2007), the area surrounding the archaeological site (and probably the area under the modern town, though it remains little investigated) has also been heavily modified by human activity in the last three millennia.

**STRATIGRAPHY AND INTERPRETATIONS**

Our field investigations of stratigraphy were concentrated in the area west of the monumental core of Chavín and immediately south of the Wacheqsa River—here referred to as the West Field (see Figure 1). This area has been recognized since at least Julio C. Tello’s visits to the site (beginning 1919) as containing Chavín-era construction. Two megalithic east–west trending walls (terrace facades in current appearance), constructed of quartzite blocks in a style similar to that of the structures in the monumental core, are currently visible on the surface (A and B in Figure 4), as is one drain feeding northward into the Wacheqsa River (C in Figure 4). Further architecture, as well as the sediment stratigraphy central to the research presented here, is visible in the river cut at the northern limit of the West Field.

Our fieldwork, carried out from 2004 through 2006, served to reconstruct the history of the Wacheqsa channel over the last 4000 years and to define its implications for Chavín’s inhabitants. Turner and colleagues (Turner, Knight, & Rick, 1999:50) and our regional-scale mapping (Figure 3) agree in depicting the West Field area as being underlain by a spatially diverse array of earth flow and alluvial deposits in addition to bedrock thinly covered by colluvium. Additional and more detailed data come from strata exposed by the Wacheqsa River along the northern flank of the West Field (Figures 1, 4, 5). As much as 8 m of stratigraphy are exposed along the south bank of the river there, displaying both natural and archaeological strata (Figure 5). Characterization of this stratigraphy comes from multiple sources. These include documentation and description of visible features, correlation of visible strata with data from a 4 × 4 m excavation unit 5 m south of the river cut (Unit
Figure 5. Stratigraphy of Units CdH-WF-10/10A and CdH-WF-11. See Tables I and II for details. Profiles are to scale and offset to reflect their differing elevations.
### Table I. Stratigraphic descriptions for WF-10/10A.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Texture</th>
<th>Deposit Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Surficial slopewash, primarily derived from the 1945 debris flow. Abundant roots and organic material.</td>
<td>Surficial slopewash</td>
</tr>
<tr>
<td>10–1</td>
<td>Somewhat reworked diamicton of 1945 debris flow. Dark grey matrix with clasts of angular pebbles up to 3 cm on long axes. No sorting or alignment.</td>
<td>Diamicton/debris flow</td>
</tr>
<tr>
<td>10–2</td>
<td>Fine light-brown matrix with abundant clasts of angular gravel, up to 3 cm on long axes. No alignment or sorting of clasts.</td>
<td>Colluvium?</td>
</tr>
<tr>
<td>10–3</td>
<td>Lens of fine-grained grey sediment.</td>
<td>Colluvium?</td>
</tr>
<tr>
<td>10–4</td>
<td>Organic rich matrix with abundant of angular and subangular cobbles, up to 8 cm on long axes. Deposit occasionally but not exclusively clast supported.</td>
<td>Cultural or colluvium?</td>
</tr>
<tr>
<td>10–5</td>
<td>Fairly loose and organic-rich matrix with abundant angular and subangular clasts, up to 20 cm on long axes. No sorting, but some alignment of clasts with long axes horizontal.</td>
<td>Cultural or colluvium?</td>
</tr>
<tr>
<td>10–6</td>
<td>Compact clayey matrix containing clasts of angular large gravel. No sorting or alignment.</td>
<td>Cultural?</td>
</tr>
<tr>
<td>10–7</td>
<td>Compact, clayey matrix with abundant angular clasts up to 20 cm on long axes.</td>
<td>Cultural?</td>
</tr>
<tr>
<td>10–8</td>
<td>Compact clayey matrix with scattered clasts of angular cobbles.</td>
<td>Cultural?</td>
</tr>
<tr>
<td>10–9</td>
<td>Compact fine-grained matrix with scattered angular clasts up to 20 cm on long axes.</td>
<td>Cultural—fill</td>
</tr>
<tr>
<td>10–10</td>
<td>Compact matrix containing scattered clasts of gravel (some angular), up to 3 cm on long axes; a few larger angular clasts up to 30 cm on long axes.</td>
<td>Cultural—fill</td>
</tr>
<tr>
<td>10–11</td>
<td>Loose clayey grey-brown matrix containing matrix-supported subangular and round cobbles, 4–12 cm on long axes; no alignment.</td>
<td>Cultural</td>
</tr>
<tr>
<td>10–12</td>
<td>Compact, clayey matrix with clasts of angular and subangular cobbles up to 20 cm on long axes. Clasts grade in size upward from bottom to top of deposit, with the larger cobbles concentrated in the upper portion and generally aligned with long axes horizontal.</td>
<td>Cultural—fill</td>
</tr>
<tr>
<td>10–13</td>
<td>Silty organic-rich dark-gray matrix with subangular clasts up to 10 cm on long axes; no alignment.</td>
<td>Cultural</td>
</tr>
<tr>
<td>10–14</td>
<td>Matrix-supported deposit with mixed angular and rounded clasts, from large pebbles and cobbles up to 10 cm on long axes, with a few boulders (up to 50 cm on long axes). Some alignment of long axes horizontally.</td>
<td>Cultural—probable cultural fill deposit intended to level ground surface; lower contact is irregular (follows surface of Unit B), while upper is level.</td>
</tr>
<tr>
<td>B</td>
<td>Matrix varying in composition from sandy silt to gravel with abundant matrix-supported clasts of both angular and rounded cobbles and boulders, up to 90 cm on long axes. No sorting or alignment, no cultural material, and no sign of soil formation at upper contact. Same as the basal deposit in WF-11 and WF-12.</td>
<td>Diamicton/debris flow</td>
</tr>
</tbody>
</table>
CdH-WF-07, excavated in 2005; see Figure 4), and a series of cleaned 1-m-wide profiles in the exposed streamcut (investigated in 2006).

As Figure 5 demonstrates, these profiles are both heterogeneous and internally complex. The architectural stratigraphy visible in WF-10/10A and WF-12 correlates well with that excavated approximately 5 m to the south in WF-07/07A, whereas WF-11 does not display any corresponding architectural strata at comparable elevations. We focus here on WF-10/10A and WF-11, as the stratigraphy of WF-11 and the contrast between these two exposures are of most interest. The strata visible in WF-12 are consistent with those in WF-10/10A.

All materials but the lowermost stratum exposed within this streamcut are younger than approximately 2000 B.C., based on archaeological content. Artifacts and/or construction material (wall fragments and exposed artificial fill) appear in, or interbedded with, all strata except the lowest. Given the established archaeological chronology of the valley, such material provides a terminus post quem date of 1800 B.C., if not later (the appearance of ceramics in the valley, though poorly dated, is unlikely to be before 1800 B.C., given the dates of the earliest ceramics at other highland sites).

The lowest visible stratum appears in WF-10, WF-10A, WF-11, and WF-12. The top of this stratum is offset downward approximately 1.5 m between WF-10A and WF-11, a distance of only about 3 m. This basal stratum (B in Figure 5) consists of a fine matrix varying in composition from sandy silt to gravel with abundant angular and rounded clasts. These matrix-supported clasts range up to 45 cm on their long axes, and are not sorted or aligned; no cultural material is present in the deposit. We interpret this deposit as a diamicton resultant from a pre-Chavín period debris flow; lack of sorting and clast size suggest a high-energy event similar to the well-documented 1945 debris flow (Indacochea G. & Iberico M., 1947; Spann, 1947). The base of this stratum is nowhere visible; we are only able to judge it to be 2–7 m thick on the basis of the depth of deposit visible and the elevation of exposed bedrock not far downstream. Following this rapid depositional event the river channel was approximately 114 m asd (meters above site datum), or circa 6 m above the current channel level (Figure 6a).

Above the basal stratum is a divergence in stratigraphy between WF-10/10A (containing archaeological deposits) and WF-11 (lacking archaeological deposits). The strata exposed in WF-11 may be grouped (in ascending order from the basal layer described above) into colluvium (11-11 through 11-8), alluvium (11-7 through 11-5, and 11-1), and a mixture of colluvium and alluvium (11-2 and A) (see Table II and Figures 5 and 7). Units 11-4 and 11-3 may be either colluvium or alluvium.

Strata 11-11 through 11-8 are matrix-supported deposits of fine (clay to fine sand) sediment, with scattered, predominantly small, clasts. No bedding or sorting is visible in any of these strata, and none of the clasts are aligned, leading us to interpret these as colluvial deposits. Stratigraphic units 11-11, 11-10, and 11-9 all include single fragments of Chavín-period ceramics, and charcoal recovered from 11-11 yielded a date of 997–815 cal B.C. (see Table III). While the ceramics are scarce and not

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5 Investigation units of the Stanford Project at Chavín follow a site-sector-unit (e.g. CdH-WF-10 is read as Chavín de Huántar–West Field–Unit 10) naming scheme; hereafter this will be abbreviated to sector-unit.
### Table II. Stratigraphic descriptions for WF-11.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Texture</th>
<th>Deposit Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Surficial slopewash, primarily derived from the 1945 debris flow. Abundant roots and organic material.</td>
<td>Surficial slopewash</td>
</tr>
<tr>
<td>11–1</td>
<td>Clast-free sands and silts. Some bedding visible.</td>
<td>Alluvium</td>
</tr>
<tr>
<td>11–2</td>
<td>Loose, mostly clast-supported layer of angular cobbles; matrix of dark gray sandy silt.</td>
<td>Colluvium</td>
</tr>
<tr>
<td>11–3</td>
<td>Matrix of compact sandy silt, with some clay, supporting clasts of angular and subangular pebbles and cobbles, 4–10 cm on long axes. No bedding, sorting, or alignment of clasts.</td>
<td>Alluvium or colluvium</td>
</tr>
<tr>
<td>11–4</td>
<td>Clast-supported gravel with angular pebbles up to 3 cm on long axes. No bedding or alignment.</td>
<td>Alluvium or colluvium</td>
</tr>
<tr>
<td>11–5</td>
<td>Clast-supported layer of well-sorted angular to subangular pebbles and cobbles, 3–10 cm on long axes. Fine silty gray matrix. Some alignment of clasts with long axes horizontal.</td>
<td>Alluvium</td>
</tr>
<tr>
<td>11–6</td>
<td>Large clasts up to 45 cm on long axes, both angular and rounded, in matrix of gravels with pebbles up to 5 cm on long axes. Matrix is poorly bedded and coarsens upward; clasts are generally aligned with long axes horizontal. Deposit is matrix supported.</td>
<td>Alluvium</td>
</tr>
<tr>
<td>11–7</td>
<td>Large clasts to 45 cm on long axes, both angular and rounded. Densely packed, but matrix supported, in a matrix that is predominantly silt, with some sand and gravel. In some parts of the deposit horizontal bedding of matrix is visible. Some alignment of clasts with long axes horizontal.</td>
<td>Alluvium</td>
</tr>
<tr>
<td>11–8</td>
<td>Fine matrix of sandy silt with moderately abundant angular and subangular clasts, ranging in size from gravel to 10 cm on long axes. Some sorting of clasts with more larger clasts near the top of the unit, but no bedding or alignment. Deposit is matrix supported.</td>
<td>Colluvium</td>
</tr>
<tr>
<td>11–9</td>
<td>Fine grey matrix (gravelly and sandy silt) with unsorted pebble-size clasts up to 3 cm on long axes, both angular and rounded. No bedding. Deposit is matrix supported. One included Chavín-period ceramic fragment.</td>
<td>Colluvium</td>
</tr>
<tr>
<td>11–10</td>
<td>Fine matrix of sandy silt with abundant rounded and angular clasts, ranging from pebble-sized to 40 cm on long axes. Deposit is matrix supported. One included Chavín-period ceramic fragment.</td>
<td>Colluvium</td>
</tr>
<tr>
<td>11–11</td>
<td>Fine gray matrix, varying from clay to fine sand, with occasional clasts up to 4 cm on long axes, mixed angular and subangular to rounded. No bedding, sorting, or alignment. Deposit is matrix supported. One included Chavín-period ceramic fragment. One radiocarbon date of 997–815 B.C. from a charcoal sample [two-sigma range of 2805 ± 37 B.P. (AA 75394; charcoal; δ¹³C = −25.4%)].</td>
<td>Colluvium</td>
</tr>
<tr>
<td>B</td>
<td>Fine matrix varying in composition from sandy silt to gravel with abundant matrix-supported angular and rounded clasts, up to 45 cm on long axes. No sorting or alignment, no cultural material. Same as basal deposit in WF-10/10A and WF-12.</td>
<td>Diamicton/debris flow</td>
</tr>
</tbody>
</table>
Figure 6a. River channel recently filled with the diamicton of a substantial debris flow (B in Figure 4 and Tables I and II), raising river to a level of ~114 m asd (meters above site datum). Basal elevation of diamicton unknown, but not lower than 107 m asd, based on bedrock exposures downstream.

Figure 6b. Diamicton partially displaced by a rotational landslide in the West Field, blocking the river channel. These landslide deposits bear Chavin-period cultural material.
Figure 6c. River makes its way across landslide dam deposit once impoundment is of sufficient depth to raise water level to top of landslide dam.

Figure 6d. With landslide dam in place, the river begins an aggrading phase, and as the channel wanders across the irregular surface of the landslide dam alluvial and possibly colluvial deposits (11-7 through 11-3 in Figure 4 and Table II) begin to collect atop the landslide deposit. The level of these deposits continues to rise as more material is deposited, eventually reaching a level of ~116 m asl.
**Figure 6e.** Colluvium (11-2 in Figure 4 and Table II) is deposited atop the southern alluvial layers; these are capped by a final layer of alluvium (11-1 in Figure 4 and Table II).

**Figure 6f.** River downcuts through the landslide dam, draining pond, establishing a consistent gradient of $\sim2.4\%$ from the mouth of the canyon to the juncture with the Mosna River. In this phase the river reaches its early-20th-century level of $\sim110$ m asd. The river's northerly course relative to the west field at this point is due to a landslide of uncertain age $\sim500$ m upstream of the West Field that diverts the river course as far to the north as the bedrock fins encountered there allow.
diagnostic to a specific temporal phase, they do appear to be Chavín-period (attributable on the basis of one characteristic Chavín neckless jar rim fragment), indicating that deposition is unlikely to have occurred earlier than about 1200 B.C. (a likely “earliest possible” date for Chavín; see Kembel, 2008; Kembel & Rick, 2004; Rick, 2008). As previously mentioned, ceramics are extremely unlikely to have been present in the valley before about 1800 B.C. Thus, the single radiocarbon date and the multiple ceramic fragments provide a *terminus post quem* date between 1200 and 800 B.C. for the deposition of these layers.

Strata 11-7 through 11-3 contrast strongly with the underlying material (Table II). Stratigraphic units 11-7 and 11-6 are matrix-supported and contain large angular and rounded clasts in matrices of finer (silt through gravel), bedded material. Clasts in both deposits are generally aligned with their long axes horizontal. Stratigraphic unit 11-5 is a well-sorted and clast-supported deposit of angular to sub-angular pebbles and cobbles in a silty matrix; a few included clasts are significantly larger (up to 50 cm on long axes), and some horizontal alignment of clasts along long axes is visible. In contrast, 11-4 is a clast-supported deposit of gravel without visible bedding, alignment, or sorting. Unit 11-3 is a matrix-supported deposit similarly lacking in bedding, sorting, or alignment. Whereas stratigraphic units 11-7 through 11-5 are clearly alluvial deposits based on bedding, alignment of clasts, sorting, texture, and fabric, there is some ambiguity in the cases of 11-4 and 11-3, which may be either alluvium or colluvium. The ambiguity stems from the absence of visible bedding, sorting, or alignment;

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**Figure 6g.** Following the 1945 debris flow, upstream of the West Field the river cuts back south through the landslide deposit mentioned in Figure 6f and assumes a more southerly course adjacent to the West Field, cutting the modern agricultural field there and downcutting farther to its modern level of ~108 m asd.
while the matrix and clasts resemble the underlying alluvial strata, the arrangement is distinct. Strata 11-7 through 11-3 lack evidence of disturbance of the stratigraphy, and clearly seem to postdate the underlying colluvial strata.

The uppermost three strata at WF-11 consist of a mixture of colluvium, alluvium, and recent slopewash. Unit 11-2 is a colluvial deposit composed of loose, clast-supported angular cobbles in a matrix of sandy silt, interpreted to be of colluvial origin. Unit 11-1 consists of poorly bedded sands and silts, inferred to be alluvial on the basis of the clear bedding and lack of organic material. This unit is capped by shallow slopewash (Unit A), primarily derived from the 1945 debris flow.

Although only separated by 3 m, stratigraphy above the basal diamicton at WF-10/10A (Table I) is strikingly different from that at WF-11. None of the deposits that we interpret as alluvial at WF-11 are visible in WF-10/10A, placing their western limit just to the west of WF-11. In contrast, the alluvial deposits are visible for a distance of approximately 80 m to the east (see Figure 7).

Above the basal diamicton (Stratum B in Tables I and II and Figure 5) in WF-10/10A are a series of cultural fills (10-14 through 10-9), interpreted as such due to their mixture of angular and rounded clasts, generally fine and compact matrices, and relationship to architectural remains. Architectural style and elevation link these
Table III. Radiocarbon dates referenced in the text.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Unit</th>
<th>Material</th>
<th>Corrected $^{14}$C Age</th>
<th>$\delta^{13}$C (%)</th>
<th>From (B.C.)</th>
<th>To (B.C.)</th>
<th>%</th>
<th>From (B.C.)</th>
<th>To (B.C.)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA 69446</td>
<td>WF-07A F17 L3A</td>
<td>Wood charcoal</td>
<td>2644 ± 45</td>
<td>23.2 ± 0.1</td>
<td>818</td>
<td>596</td>
<td>68.20%</td>
<td>841</td>
<td>540</td>
<td>95.40%</td>
</tr>
<tr>
<td>AA 69447</td>
<td>WF-07A F17 L3B</td>
<td>Wood charcoal</td>
<td>2712 ± 42</td>
<td>23.6 ± 0.1</td>
<td>892</td>
<td>793</td>
<td>68.20%</td>
<td>911</td>
<td>772</td>
<td>95.40%</td>
</tr>
<tr>
<td>AA 75394</td>
<td>WF-11 L11</td>
<td>Wood charcoal</td>
<td>2805 ± 37</td>
<td>25.4 ± 0.1</td>
<td>927</td>
<td>833</td>
<td>68.20%</td>
<td>997</td>
<td>815</td>
<td>95.40%</td>
</tr>
</tbody>
</table>

Calibrated using OxCal 4.0.5 (Bronk Ramsey, 1995, 2001, 2007) and SHCal04 Southern Hemisphere atmospheric curve (McCormac et al., 2004).
cultural features to architecture excavated 5 m to the south in WF-07 that has been positively identified as Chavín-period and dated to pre-750 B.C. Above Unit 10-9 are a series of deposits (10-8 through 10-2) whose identifications are less certain; these units generally consist of a compact matrix containing disordered angular clasts. These may represent either post-Chavín fills or colluvium, but none of their characteristics suggest that they are alluvial in origin. The uppermost deposits (10-1 and A) are the diamicton of the 1945 debris flow and surficial slopewash, respectively.

The stratigraphic sequence in WF-11—particularly the alluvial strata so high above the modern river—and the disjunct in stratigraphy between WF-11 and WF-10/10A—particularly the offset in Stratum B—imply a significantly different past landscape, and require explanation. We interpret the alluvial strata as indicative of a significantly elevated Wacheqsa River, the dating of which we discuss above. The disjunct between WF-11 and WF-10/10A is less clearly interpretable, but we argue that the most probably cause is the occurrence of a rotational landslide following the deposition of the diamicton (Stratum B in WF-10/10A and WF-11). Such a landslide would explain the elevated river level, and is suggested by several pieces of evidence.

The most salient feature, and the first that drew our attention, is the contrast in stratigraphy between WF-11 and WF-10/10A. The two are only approximately 3 m apart, but with the exception of the basal diamicton (B in Tables I and II and Figure 5) and uppermost slopewash (A in Tables I and II and Figure 5), their stratigraphies are distinct. A downward offset of approximately 1.5 m from west to east in Stratum B is particularly notable. This offset, we suggest, marks the western edge of the rotational landslide—posited above—that caused the disjunct between WF-10 and WF-11. The eastern edge of the landslide does not display such clear stratigraphic offset but is visible as a break in slope. In addition to this stratigraphic evidence, a head scarp is visible approximately 60 m upslope (at upper right in Figure 8). Thus, both stratigraphic and topographic evidence are suggestive of a landslide. As Figure 3 demonstrates, landslides generally are common in the area.

Such a landslide (about 100 m wide at its toe and 60 m in length (slope distance) would have disturbed the West Field (Figures 1, 4, 9) and dammed the Wacheqsa River where the river course is constrained by exposed fins of quartzite bedrock to the north (Figure 10). In addition to reworking the diamicton of the earlier debris flow, this landslide in the West Field evidently blocked the river channel, raising the water level to at least 114 m asd (or higher, as evidenced by the elevated alluvial deposits visible in WF-11; Figure 5 and Table II). The deposits of comparable elevation in WF-10 show no evidence of fluvial activity; we hypothesize the absence of alluvial deposits in WF-10 to be the result of lateral shift in the position of the river channel between the time of deposition of the basal diamicton and the fluvial deposition of Units 11-7 and above. There is abundant evidence throughout the area that the local river channels are frequently shifted or completely dammed by landslides. This process is both inferred from topographic evidence—e.g., the Mosna-damming landslide that created the plain north of the modern town of Chavín (see Turner, Knight, & Rick, 1999; Contreras, 2007)—and historically attested (see Tello, 1945:775).

The colluvial deposits visible in WF-11 (11-11 through 11-8 in Figure 5 and Table II), which we infer were displaced by the landslide, contain included cultural material
Figure 8. Hypothesized landslide (outlined in white); note head scarp at upper right. Units WF-10/10A and WF-11 are visible at right.

Figure 9. Schematic cross-section through the West Field, looking roughly ESE, showing the hypothesized landslide. Location of section is indicated in Figures 1 and 3.
and provide a *terminus post quem* date for the initial deposition of those strata of most probably 1200–800 B.C. and 1800 B.C. at the earliest (see above). The excavation of Unit WF-07, approximately 5 m south of Units WF-10/10A and WF-11 (Figure 4), provides a further temporal constraint for the occurrence of this inferred landslide. The unit revealed substantial and wholly intact architecture with a *terminus ante quem* date centered on approximately 800 B.C. (see Table III), based on age determinations from wood charcoal recovered from a central hearth deposit in a well-preserved plastered structure (see Contreras, 2009). As the intact architecture is within the boundaries of the landslide, it demonstrates that the landslide predated this construction episode, which is at the same level as the most substantial construction visible in WF-10/10A (Figure 5). The landslide, thus, evidently occurred between 1800 and 750 B.C. (using the extremes of the date range), and most likely occurred between 1200 and 800 B.C., given the chronology of the pre-landslide colluvial deposits in WF-11 and the post-landslide architecture in WF-07.

The first signs of construction activity after the landslide are of foundational construction fill visible in WF-10/10A, as the surface of the debris flow diamicton was leveled and the first of several walls was constructed on it (Figure 5, Units 10-14.
through 10-12). That fill is visible only to the west of the landslide deposit and does not cross the contact. The colluvial deposits that we suggest were moved by the landslide (visible in WF-11 as Units 11-10 and 11-11) are at the same level as this construction. These deposits in WF-10/10A provide additional chronological information: The lack of evident deposition or soil formation prior to the construction on the diamicton surface suggests that these three events—debris flow (Figure 6a), rotational landslide (Figure 6b), and leveling fill—occurred in a relatively short span of time.

HISTORY OF THE WACHEQSA RIVER

The inferred damming of the Wacheqsa River that occurred around 1000 B.C. and produced the elevated fluvial deposits exposed in WF-11 would have enabled the diversion of water into the ceremonial core of Chavín de Huántar. Evidence discussed in the previous section indicates that that the damming resulted from a landslide. Following its evident damming, the Wacheqsa River made its way across the landslide deposit, locally aggrading in some areas up to thicknesses of about 2 m and maximum elevations of about 116 m asl on what was almost certainly a highly irregular surface.

Downriver, approximately 80 m to the east, the elevated fluvial deposits disappear from the visible stratigraphy. Moreover, the level of the architectural fragments visible in the exposure above the river’s south bank drops to nearly the level of the modern river. This dramatic offset in architecture, combined with the elevated alluvial deposits described above, suggest that the landslide dammed the river where its course is pinched by exposed bedrock fins to the north (Figures 9, 10) and that downriver of this feature the river’s level was close to what it is today. Continued slope-failure and slopewash activity during this period is evidenced by the colluvium (11-2 in Figure 5 and Table II) deposited atop these alluvial layers. The interfingering of alluvium and colluvium evident in the depositional sequence of these upper deposits suggests that colluvial deposition began while the landslide dam was still present.

The persistence of this inferred landslide dam into the post-Chavín period is suggested by the absence of any Chavín-period architecture or material culture in any strata above the fluvial deposits; they are overlain by the same colluvial strata that cap Chavín-period strata to the east and west. Eventually, however, the Wacheqsa River downcut through the landslide dam and established a consistent gradient of 2.4% from the mouth of the canyon to the juncture with the Mosna River. While the absence of archaeological features above the alluvial strata or as low as the modern river level suggests that this downcutting occurred after the end of the Chavín period (i.e., post-500 B.C.), no other evidence is present that would date that event. During this downcutting phase the river reached its early-20th-century level of 110 m asl (Figure 6f). The river’s northerly course relative to the West Field at this point in time is due to another landslide, of uncertain age, about 500 m upstream of the West

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6 Alternative explanations are ruled out because the site is below the altitude of glacial deposits in the region, there is no local geomorphic evidence for tectonic uplift, and there is no evidence for a manmade dam (nor likelihood of such an engineering undertaking at this date).
Field, which diverted the river course as far to the north as the bedrock fins encountered there allow. An abandoned channel north of the current one indicates the continuing shifts in channel position; local oral history testifies to flow in this northern channel as recently as the 1960s.

Colluvial deposition continued following this alluvial downcutting, as evidenced by the series of uppermost deposits that span the disjunction between fluvial deposits to the west and the cultural deposits to the east (visible in WF-10/10A; Unit A in Figure 5 and Tables I and II). Also in this most recent period, the Wacheqsa River cut back south through the landslide deposit upstream of the West Field and assumed a more southerly course adjacent to the West Field, cutting the modern agricultural field there and downcutting farther to its modern level of approximately 108 m asdl (Figure 6g). Those colluvial deposits are capped by the deposit of the 1945 debris flow (known locally as an *aluvión*) that flowed through the West Field and left an approximately 30-cm-thick deposit. Farther east (in the monumental core, for example), where the debris flow was spreading laterally and losing energy, diamicton deposits of up to 5 m have been observed in excavation profiles (Turner, Knight, & Rick 1999:52).

**DISCUSSION**

A combination of stratigraphic, geomorphic, and archaeological data documents the complex history of the Wacheqsa River and has significant implications for water control at Chavín de Huántar. The modern course of the Wacheqsa River would require that a canal be diverted at least 400 m upstream of the monumental core in order to reach the elevation of the highest of the water-bearing features documented in the West Field and the monumental core. As Burger pointed out in his discussion of the function of the entire gallery system: “In order for such a system to operate during the dry season, water would have to be channeled up to the roof of the Old Temple from an intake on the Huacheqsa River” (Burger, 1992:143). There is no evidence that such a canal ever existed. Moreover, the modern canal that supplies Wacheqsa water to the modern town of Chavín de Huántar has its intake about 1 km upstream and is tunneled through bedrock. Owing to the slope steepness and bedrock outcropping in this area, any ancient canal would have required a similar construction, which, based on all available evidence, is highly unlikely to have been undertaken during that era in the Andean region, and in any case would have left visible evidence.

An explanation for how water was provided to the monumental core lies instead in the region’s active geomorphology. As we have described here, geomorphic and archaeological investigations of stratigraphic exposures on the south side of the Wacheqsa River (Figure 1), combined with excavations in the West Field itself, demonstrate that the level of the Wacheqsa River in the West Field area was 6–8 m...
higher during the period of Chavín’s construction and use, as evidenced by alluvial material exposed high above the current river bed, and this evidence suggests that the source of water for the extensive hydrologic system within the monument was the Wacheqsa River. We infer that the elevated river level was due to a landslide dam.

Based on archaeological and radiocarbon age control, we additionally infer that the river remained elevated for at least 1000 years before the river cut through the landslide dam down to its modern level. Such long-lasting behavior is well within the established parameters of landslide dams, as a global survey (Costa & Schuster, 1987:13–14) found that landslide dams may last for as long as several thousand years, depending on many factors.

The fluvial history of the Wacheqsa River described here thus suggests that it would have been possible for Chavín’s engineers to draw water from the Wacheqsa River via a short (approximately 200 m) canal in order to supply the monumental core. While no evidence of an intake canal crossing the West Field has yet been found, most Chavin-period architecture in the area was buried by subsequent cultural and natural deposition, and such a canal could easily remain hidden. This is in contrast to the area west of the West Field, where any canal drawing water from farther up the Wacheqsa River would have had to traverse a steep slope thinly covered with colluvium and/or involved tunneling, and should thus have left visible traces.

The ability to draw water directly from the Wacheqsa River less than 200 m upstream of the monumental core (and below the narrow canyon neck) would have made an abundant supply of water for the water-bearing architectural features of the site available year-round. This adds credence to arguments (Lumbreras, Gonzalez, & Lieataer, 1976; Rick, 2008) that the architecture of water management at the site exceeds what was necessary for drainage of wet-season rainwater.

The evident importance of water in ritual practice at Chavín may thus be deduced from the water-bearing channels within the temple complex as well as inferred from the broader Andean cultural context, in which water was commonly of great religious and ceremonial significance. Elaborate ritual manipulation of water is well documented in sites spanning the geography and chronology of the Central Andes [e.g., Kuntur Wasi (Onuki, 1995), Wari (Isbell & McEwan, 1991), Tiwanaku (Kolata, 1993), and many Inca examples (e.g., MacLean, 1987; Wright, McEwan, & Wright, 2006)]. In the pre-Hispanic Andes generally, the manipulation of water was apparently a significant religious act and its control a powerful statement of ritual power.

CONCLUSIONS

Our findings have identified a significantly higher past elevation of the channel of the Wacheqsa River, evidenced by alluvial deposits exposed high within the cut streamcut on the south side of the river. This elevated channel was likely caused by a landslide dam, and would have provided a source for the provision of water to the Ceremonial Core of Chavín de Huántar. The associated sequence of geomorphic events we describe here is temporally constrained to have occurred before 1945, when the diamicton of the 1945 debris flow was deposited, and after the beginnings
of large-scale Chavín-period construction, unlikely to be earlier than approximately 1200 B.C. (Kembel, 2008). The earliest stratum documented evidently closely preceded the beginnings of monumental construction in the valley, while the uppermost of the Chavín-period strata—approximately 2 m higher—predates 500 B.C. The remainder of the strata—post-Chavín fills, colluvium, the diamicton of the 1945 debris flow, modern soil horizons—fall within the span of the last 2500 years. In other words, the 5 m of stratigraphy visible represents only approximately 3000 years of geologic history. Within that span, there is evidence of at least six significant geomorphic events and three cultural ones. Of particular interest, the West Field landslide that we infer—based on stratigraphy and surface topography—dammed the Wacheqsa River during Chavín’s span as a ceremonial center.

This local, detailed geomorphic case history may, more broadly, serve as an example of the large scale and great frequency of landscape changing events in these high valleys on the eastern slope of the Cordillera Blanca. The study also provides, more locally, evidence that the ceremonial center Chavín was built—and persisted for several centuries—in a dynamic environment. The role that such a setting played in Chavín’s establishment and function as a ceremonial center may have been a significant one (Contreras, 2007; Rick & Contreras, 2006). The Wacheqsa-damming landslide event not only made hydraulic manipulation within the monumental core much more practicable than it would otherwise have been, but also confronted Chavín’s inhabitants with a direct example of the power and unpredictability of their environment.

A growing body of literature (e.g., Bauer, 1998; Glowacki & Malpass, 2003; Goodman-Elgar, 2009; Gose, 1993; Reinhard, 1985) has documented the ways in which landscape features in the prehistoric Andes were foci of ritual activity and construction. Major environmental elements such as mountains, rivers, springs, and rocks were invested with ritual significance, acting as ritual architecture in their own right. These elements were regarded as sources of sacred power throughout Andean prehistory, and proximity to such elements has been used to explain the location of Andean monumental centers (e.g. Reinhard, 1985). The case of Chavín suggests that the incorporation of one such potent element—running water—into an architectural setting was a significant feature of ceremonial elaboration in Formative Period Peru. The discovery of a potential source of water for the hydrologic system of the temple complex, that is, an elevated Wacheqsa River, explains how it would have been possible for this elaborate water-bearing infrastructure to have functioned in prehistory.

The research we report here demonstrates that the relative rapidity of landscape change in Chavín’s geomorphically dynamic environment has obscured an important feature of the relationship between the site and its contemporary environment. The previously elevated level of the Wacheqsa River is not only testament to local geomorphic dynamism, but also explains the means by which water could have been supplied to the site’s ceremonial architecture. This serves as a demonstration that at Chavín, the geomorphic context of the site is necessary for a clear understanding of the engineering activities of Chavín’s builders. Moreover, it establishes that the tempo of geomorphic change at Chavín is sufficiently rapid as to be of key
archaeological relevance. The case of Chavín additionally illustrates that in dynamic geomorphic environments, detailed study of the site's geomorphic history is necessary for accurate archaeological interpretation. Significant differences between present and past landscapes may render interpretations based on modern landscapes difficult if not misleading.

The fieldwork involved in this research was carried out as part of John Rick's ongoing Stanford University research project at Chavín de Huántar, and we thank him for his support and generosity. Funding for the major season of field research in 2005 was provided by a National Science Foundation Doctoral Dissertation Improvement Grant (#0532350), with additional support from a Stanford School of Humanities and Sciences Graduate Research Opportunity Grant, and an Amherst College Memorial Fellowship. The Explorers Club Exploration Fund and a Lewis and Clark Field Scholar Grant from the American Philosophical Society provided funding for follow-up work in 2006. We were also, of course, supported in the field by colleagues, students, and local residents too numerous to name. Particularly deserving of mention for their help are Maria Mendoza, Christian Mesia, Patricia Quiñonez, and Franklin Romero; the excavation itself would have been impossible without the expert work of Zóismo Melgarejo, Álvaro Llanos, and many others. The Stanford Archaeological Project was possible thanks to the approval and support of the national (Lima) and regional (Huaraz) offices of Peru’s Instituto Nacional de Cultura. The text of this article has been much improved thanks to the constructive criticism of Kenneth Lajoie, John Rick, Robert Schuster, three anonymous reviewers, and the editors.

REFERENCES

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