STYLE AND FUNCTION IN INCA AGRICULTURAL WORKS NEAR CUZCO

Susan A. Niles

It is my belief that we can define different kinds of Inca agricultural works based on stylistic differences and on their association with other architectural remains. Ethnohistorical sources can, in turn, suggest the function of different systems. Although all terracing systems near Cuzco stem from the same system of design and the same principles of engineering, there are differences that can only be attributed to their context within the Inca plan of administration and production.

The descriptions are based on my observations and measurements of standing remains of agricultural systems, not on excavation. Detailed analysis of the soils, of the movement of water and of techniques of construction are beyond the scope of this paper. I shall begin by a consideration of different kinds of terraces, then characterize irrigation works and finally shall use ethnohistorical data to suggest reasons for some of the stylistic differences encountered.

Terracing

Many separate systems of irrigation and agricultural terracing are still visible in the area relatively close to Cuzco, in the heart of the ancient empire. The construction of a terracing or irrigation system may reflect both geography and function, which may, in turn, reflect both social and cultural concerns. The mode of construction of a particular system can be defined on the basis of such empirically observable traits as scale, configuration, masonry and location. Function can best be attributed on the basis of association of terracing and irrigation systems with architectural forms which have been better studied in the literature, and by recourse to the chronicles.

One style of terracing system is typical of the agricultural works associated with small farming communities near Cuzco that I have analyzed as ideal communities (Niles, 1980; ms.a). Terraces of this sort are well designed to expand the amount of cultivable land within easy reach of small population centers, and are, perhaps, the most common kind of terrace in Inca imperial construction, a characterization of which is given by Garcilaso (Garcilaso de la Vega, Book 5, ch. 2; 1966, pp. 241-242).

Typical of this sort of production terracing is the system found near the site of Callachaca. This Inca community housed families of low social status and was, perhaps, a tributary community of Cuzco (Niles, 1980, pp. 77 ff.). The terracing associated with Callachaca is part of the system seen in the ravine of the Cachimayo River, on the north side of the Huatanay Valley above the modern community of San Sebastián. A system of terracing extends on both sides of the Cachimayo from its mouth all the way up to the site of Tambo Machay.[1] Terraces cover the slopes from valley bottom to the top of the hills, and are faced with limestone boulders which are not coursed. In comparison to the fieldstone foundations of the buildings in the farming communities, the agricultural terraces use fieldstones which are somewhat larger than building stones and are set in a matrix with less clay than in the associated buildings. One could suggest that terrace facings with relatively little clay might help

the soil to retain water. Additionally, use of little clay in the masonry could reduce the amount of destructive seepage, thus providing greater stability and prolonging the life of the wall. Production terraces of this kind vary in height, but many I have observed near Cuzco are 1-1.5 m. in height. They vary in width from several meters near the valley bottoms, where slope is not a major consideration, to not much more than a meter on steeper slopes.

Location of systems of agricultural terraces such as these seems to be premised on several engineering and social decisions. Many (such as those in the Cachimayo ravine, in the Orquillos canyon above Huayllabamba and beyond Ollantaytambo towards Lares) are located in side valleys so as to benefit from the relatively warm and sheltered microenvironment, or *clima de quebrada* that prevail in such locations. The warm and windless environment that characterizes some of the narrow side valleys permits the cultivation of low altitude crops, such as maize, at a higher elevation than would be possible in the open valley.[2] Ethnohistorical sources would lead us to believe that maize was an especially valued crop, and that expansion of the land where it could be cultivated was an important motivation for Inca terracing (Murra, 1960, p. 400). The fact that other cultivable land in open, but windy, areas is not terraced suggests that this force is an important determinant of the location of terracing systems. The sheltered transverse valleys are usually cut by fast-moving streams which drop rapidly, thus providing potential sources of water which can be used for irrigation. This might provide a further motivation for use of side valleys for extensive systems of terraces.

A second favored location for terraces is in the valley bottom where broad terraces can be constructed to expand the relatively rich and accessible land of the river valleys. This choice of location is seen, for example, in terracing systems associated with the site of Písac, in the Vilcanota Valley, described by Donkin (1979, p. 108), and at Tablapata, near the residential site of Raqay-Raqayniyoq in the Huatanay Valley (Niles, 1980, pp. 40-41). The Tablapata terracing system is a large complex of fields which are several meters wide and step gently from the base of the foothills on the north side of the valley towards the Huatanay River. There is little of the original fieldstone masonry left in the system, and the exact configuration and size of the fields cannot easily be determined.[3]

Production terracing of the sort described is often associated with architectural remains, but not intimately. Inca residential communities are located on hills or tongues of land off the primary zone of cultivation and away from major roads (Niles, 1980). Towns could be windy and exposed (and the remains of Inca ruins frequently are), but the Inca fields are not. The Inca seem to have chosen to sacrifice some degree of personal comfort in the work areas surrounding their homes in favor of sheltering fields and, perhaps, expanding their productivity.[4]

Terracing systems are often linked to communities by "agricultural roads," that is, by relatively wide, smooth roads of easy grade. Some such roads are walled and often follow irrigation canals. Roads of this sort would have provided easy access to fields for farmers burdened with tools, seeds or crops. In my experience, small Inca communities near to Cuzco are within a twenty-minute walk of cultivable, terraced land.

A suggestion that agricultural terraces can be associated with more than simple productivity comes from portions of the site of Callachaca that

include both architecture that shows canons of the prestige tradition, and terraces that are of an extraordinary form. The portion of the site of Callachaca which is known as Choquequirau is located on the eastern edge of the ravine of the Cachimayo, slightly below the zone of most residential architecture, and connected to it, now, by a footpath. For our purposes, the important parts of Choquequirau include several large buildings of cut limestone foundations.[5] The buildings are constructed on terraces of fairly good cut stone masonry, roughly polygonal, and are oriented out across rectangular plazas defined by these high terraces. The zone is also characterized by an elaborate treatment of the limestone bedrock: a rock outcrop has been provided with cut limestone masonry veneer; and a natural cleft in the rock has been carved inside and provided with a doorway, complete with lintel. This zone is likewise littered with enormous carved blocks set in various positions, which look like blocks prepared for some architectural end, although they could just as well represent a religious treatment of rock. The cliff could well have been a quarry originally. In all aspects, the character of Choquequirau is one of sacredness, and of an architecture devoted to a special purpose, one associated with a fairly high prestige. The buildings of Choquequirau could have housed either priests or the administrators of the agricultural communities in the area. The buildings clearly have all the marks of high prestige Inca adobe architecture as defined by Moorehead (1979, pp. 89-90) and a location that would permit the denizens to oversee religious ritual nearby or to guard the roads that enter the site from the agricultural areas and to administer and oversee this produce.

Choquequirau also provides us with two systems of terraces that seem to be related more to symbolic productivity than to actual productivity (fig. 2). Two systems flanking the main agricultural foot road to the Cachimayo are known as Choquequirau Chico and Choquequirau Grande. Both are formed of roughly circular systems of terraces greater in diameter at the bottom than at the top. It is not clear whether the terraces were used to sculpt existing hills, or whether they were filled to form new ones. Choquequirau Chico has three tiers of terraces and Choquequirau Grande has seven. In both cases, the terraces are stylistically very similar to the production terraces on the Cachimayo. That is, they are about one meter in height, and define fields of about one meter in width, at least in the lowest tiers; the topmost terraces define roughly circular fields that may be several meters in diameter. Masonry for the terraces is of roughly cut limestone, and there is no evidence of irrigation canals on the system. In all structural respects, the terraces at Choquequirau would seem to be similar to the production terraces in the upper slopes of the Cachimayo; however, their context, that is their proximity to special architecture and their unique form, suggest a more ritually charged function.

Another portion of the site of Callachaca contains terraces in which, again, both form and architectural association suggest a special function (fig. 1). At this part of the site, separated from the bulk of the residential areas and located midway between them and the site of Rumi Wasi along the vehicular access road to the Huatanay Valley, we see terraces in association with a ceremonial complex (Niles, 1980, pp. 19-20). I am inclined to identify this part of the site with the town of Yacanora mentioned by Cobo. The location of these ruins, which coincides roughly with his placement, and the presence of remains in the area which are like shrines he lists, both suggest this identification. A large nearly spherical rock surrounded by a good Inca wall is located just below this zone on an Inca road. Cobo's shrine of Subaraura is identified as "a round stone" in Yacanora (An-5:3; Rowe, 1980, p. 35).

Pachayacanora is a fountain located higher up (An-5:4; Rowe, 1980, p. 35), and might correspond to some of the waterworks adjacent to the stepped plaza. The actual town of Yacanora might well have been the house stubs that can be seen in aerial photographs of the hill across the road from and immediately above the structure I have described (fig. 1, F). On the photos, these remains seem very similar in size and form to house remains at Callachaca. The fact that an entire ceque is also named Yacanora (An-7; Rowe, 1980, p. 37) suggests the possibility that a templelike structure such as that I describe could have been considered part of Yacanora ritually.

The architectural complex consists of two (and, originally, perhaps three) kallankas constructed so that their rear wall is built into a hill and their front, free-standing wall contained multiple doors which open out onto a plaza. The best preserved measures 34.6 × 12.35 m., and had 3 symmetrically placed doors 1.25 m. in width at the base. The other 2 buildings did not exceed 23 m. in length. Building foundations are of cut and fitted polygonal limestone, with free-standing walls measuring nearly one meter in thickness. The buildings may well have had adobe superstructures in antiquity. The plaza onto which the buildings open can best be described as an asymmetrical stepped design, or thick-stemmed-T shape, with the wide base (approx. 77 m.) formed by the long building façades and the stepped edges defined by terrace walls and the natural bedrock. The smallest step is some 34 m. in width, and is located at the edge of the cliff about 34 m. in front of the buildings (fig. 1, A). The steps of the plaza are themselves flanked by stepped sets of curvilinear terraces, which provide wide, curved fields adjacent to the support walls of the plaza, and situated at a lower level (fig. 1, B). The terrace walls here are of cut limestone blocks, roughly coursed, but by no means as well fitted as the polygonal masonry of the buildings which flank the plaza, or even of the retaining wall which defines the construction zone to the north. The terraces stand about 2 to 2.5 m. above the surface of the ground, and define open areas of irregular shape up to 3 m. in width.

The broad, flat area of the plaza and the subsidiary fields defined by terraces are now under cultivation, although there is no current provision of water to the fields. It is not clear whether the zones were originally intended for cultivation. As in the case of the terrace sets at Choquequirau, these terraces have a form which is unusual, incorporating as they do curvilinear forms that highlight the stepped shape of the plaza, and an association with buildings clearly representing the high prestige architectural tradition. Further, there is no clear provision of water which would indicate an agricultural use. On the basis of conceptual similarities to a nearby reservoir (fig. 1, G), I shall argue that the plaza zone is designed to be provided with water, and that a cultivation function, perhaps associated with special purpose crops, might be attributed to these terraced spaces.

A final sort of terracing deserves particular mention because of its close association with high prestige architecture at some sites (such as Tipón), or because ethnohistorical sources suggest it is associated with royal activity (as at Yucay).[7] In high prestige terracing, stylistic attention to size, scale, masonry and configuration of the system seem to take precedence over the simple expansion of productivity. Terraces at Tipón may be up to 3 m. in height, while Donkin reports terraces up to 9 m. at Yucay (Donkin, 1979, p. 111). The masonry wall facings slope markedly inward from bottom to top. The terraces are faced with worked boulders which are fitted together carefully, approaching the fitting typical of Inca polygonal style in parts of Tipón

(fig. 4). The boulders are shaped and fitted so that in many places, the clay matrix is not visible. The attribution of an agricultural function is clear at Tipón, as the masonry of the wall faces is provided with vertical grooves fed by water channels. These terraces at Tipón are provided with sets of five to seven stone slab peg stairs to give access between terrace levels, and the angles of various terraces are broken in some places by flights of stairs which also facilitate movement within the system (fig. 5). At Yucay, symmetrical arrangements of flights of stairs help to channel traffic (Gasparini and Margolies, 1980, p. 297), in a pattern that not only defines a bifurcate circuit through the system, but also enhances the sensation of the massiveness of the terraces by moving the pedestrian through narrow and steep interstices between the terrace levels. Terraces may enclose fields of varying shapes and sizes, but all are larger than the production terraces I have described. The terrace system as a whole may take advantage of natural features of the topography, such as a high U-shaped valley of Tipón, or the circular terraces that elaborate a natural quebrada or dolines at Moray (Donkin, 1979, p. 118); the individual terraces that compose the system may be constructed into elaborate shapes that are not modeled on nature. Terraces at Tipón, for example, are shaped into zigzags, trapezoids and curves. High prestige terraces may be conceived of as a whole system, designed to fill a relatively small space. The asymmetry of the design of the terraces may be offset by a symmetrical arrangement of sets of peg steps or flights of stairs. These features give relief to the surface of the wall and cast interesting shadows in the sunlight.

Sets of high prestige terraces are often located to take advantage of a location that is desirable because of its microclimate or because it affords a spectacular view. The terraces of Tipón and Yucay, for example, are located in exceptionally warm and pleasant areas, as are the terraces at Ollantaytambo, parts of which were established as a pleasure palace (Rowe, 1968, p. 69, note 23). Unusually pretty views are found from terraces at Chinchero, a country palace of Topa Inca (Rowe, 1968, p. 69, note 23), and Cañaraqay in the Lucre Basin, an area associated with the emperor Huascar (Rowe, 1968, p. 69, note 23). Some of the terraces that seem to be part of the high prestige tradition are built where production terraces might be expected. Such systems as the terraces of Larapa, near San Jerónimo, probably a part of the estate of Inca Roca, and the terraces at the Hacienda Andenes near Zurite on the edge of the Pampa de Anta might be associated with production of crops as part of a royal estate.

Irrigation Works

In considering the expansion of cultivable lands, whether devoted to production of surplus or to cultivation of a special purpose crop, it is necessary to consider the ways in which provision of water helps to modify the environment. In examining irrigation works it is necessary to consider both the way water is moved onto the fields, and the sources from which it is drawn. The modes of irrigation near Cuzco suggest that several kinds of water sources were used by the Incas to serve agricultural ends.

Production terraces are associated in many cases with irrigation works. The canals I have observed in use today are earth-lined and relatively narrow (usually 50-60 cm.), and may be banked with dirt or sod. Such channels generally follow the edges of footroads and fields and are, in some cases, moved onto the fields by means of shallow vertical grooves in the terrace walls. In addition to the channels still in use, there are traces, on or

near to Inca sites, of canals which are not currently in use. The ones which can be observed are stone-lined and are generally about 40-80 cm. in width (if they are sunk into the ground, as at Callachaca and in parts of Raqay-Raqayniyoq), or can be narrow grooves when they are carried above ground on walls 80-120 cm. wide (as in the case of feeder channels at Raqay-Raqayniyoq).

Waters carried in the channels can come from several kinds of sources. Some systems, as in the case of the Cachimayo terraces, are created by channeling water from a stream as it cuts through a side valley. Several tiers of irrigation channels can be drawn from the stream at different heights, usually in pairs of channels which are carried along the wall of the side valley towards the main valley. Channels which have been drawn off much higher in the canyon can continue to water upper tiers of terraces even when the lower channels are carrying water to lower terraces parallel to the higher channels on the same slope. The effect of this arrangement is to have two to four channels visible on the sides of the valleys in many places.

The hydrological value of this construction technique is obvious: engineers can water the greatest number of terraces at different elevations by drawing off water as often as possible. This is particularly important in the Chachimayo canyon, where salt deposits towards the mouth of the river could taint the water in the lower reaches. Inca engineers undoubtedly gauged the altitude at which they drew off canals by the altitude of natural features intervening between the source of the water and its ultimate destination, a consideration that would have been especially important in systems designed to carry water across long distances, as described by Garcilaso (Garcilaso de la Vega, Book 5, ch. 1; 1966, p. 242). A parallel system of canals can also provide a potentially useful backup in case of destruction of one portion of the set. In contemporary canals, paired sets are provided so that the lower channel can collect seepage from the upper one (Mitchell, 1977, p. 46). It is possible that this function was filled by the dual canals in ancient times, as well.

These practical considerations were probably supplemented by social and cosmological ones. Dualism is important in Andean thought, and is reflected in the moiety structure of Inca social organization. Barrio control of water is reported for contemporary communities in the central highlands (Mitchell, 1977; Isbell, 1978), and ayllu control of canals was important in Inca and Colonial Cuzco (Sherbondy, 1980). It is quite likely that sets of canals on two sides of the river and at different levels on the same side of the river were tied to ancient social divisions. Certainly legendary accounts of the construction of these sets often attribute them to competitive engineering tasks as part of a suitor test (Lehmann-Nitsche, 1936; Dumézil and Duviols, 1976), a motif that suggests the regulation of marriage and leadership which may have been a duty of the Inca ayllu.

The symbolic value of canals cannot be denied. In conquered areas, major canals were built to impress natives of the regions as much as to make their land more productive (Garcilaso de la Vega, Book 5, ch. 24; 1966, pp. 295-296). Certainly canals are conspicuous reminders of the Inca presence and their domination of the social world, as well as of the world of nature, in much the same way that roads and administrative centers must have functioned (Thompson, 1968, p. 72).

Perhaps because they are not as extensive as the production terraces,

high prestige terrace systems may draw their water from a more local source. At Tipón, for example, water for most of the high prestige terraces comes from a spring which bubbles from the ground near the top of the terracing system. The spring has been elaborated with polygonal limestone masonry walls, and is run through a series of baths and into a stone-lined channel before being directed across the fields. It should be noted that the manner of moving water so channeled is based on a canal system not unlike that observed in production terracing systems.

Although channels drawn from streams are the most conspicuous way of moving water, other channels move water to towns or to fields from reservoirs which have been constructed higher on hills. To my knowledge, there has been no discussion of Inca reservoirs outside of the Cuzco area, and they may represent a special local development. However, the fact that reservoirs are used in contemporary communities in the central highlands to store water for later distribution (Mitchell, 1977, p. 45) suggests a wider distribution in antiquity. Reservoirs are found in association with terraces from each of the stylistic traditions described. They have in common a location on relatively flat areas at the edges of hills that overlook a valley. In form and in details of construction, there is great variation.

The site of Raqay-Raqayniyoq includes a reservoir which supplied water to the community of farmers and to the production terraces of Tablapata below the site. The reservoir, located some 250 m. above the upper limits of domestic architecture, is roughly rectangular in form, and has interior dimensions of at least 11 x 22 m. The water source for the reservoir would appear to be runoff from the steep hillside above the town, as there is no evidence of feeder channels or natural sources of flowing water. There is evidence of heavy erosion on the hill, however. The rear wall of the reservoir is built into the hill; it is not possible to say whether it was originally higher than ground level. The other 3 walls are free standing, and the front wall is quite thick (1.2 m.) and is noticeably inclined to the interior of the reservoir. Masonry in the reservoir is based on a rough clay and fieldstone construction, using larger stones than are seen in building foundations. There does not seem to be any attention to providing a smooth outer surface of the wall. The southwest corner of the reservoir, closest to the zone of architecture and the ravine that divides it, has traces of a finished edge which suggest that there might have been an opening through the reservoir wall at this point. The form of the opening and the manner in which it could have been used remain obscure due to the poor state of preservation of the reservoir. Beyond this corner of the wall are the remains of a canal system which follows the natural canyon that divides the site into two groups of buildings. At its uppermost part, the canal is about 2.7 m. wide, and is defined by fieldstone walls built into the sides of the narrow valley. There is no trace of stonework lining the bottom of the canal at this point, but the zone has been subject to considerable erosion. As it approaches the zone of architecture, the canal narrows to 0.8 m., always following straight lines, although changing course in an angular fashion as the valley changes course. A series of fieldstone walls at the base of the hill seem to form a decorative way of slowing and collecting the water in a pool before it was carried to the fields of Tablapata. Neither the reservoir nor the canal are currently in use, and the exact course of the channel to Tablapata cannot be traced.

The water system associated with Raqay-Raqayniyoq, like the production terraces associated with the site, represents a "no frills" solution to the

problem of increasing productivity. The reservoir itself probably helped to reduce erosion of the hill above the town by capturing water. It also must have provided water for domestic use by the many residents of the town. Mitchell notes that reservoirs are the preferred source of water for households when water is being released through irrigation channels to the fields (Mitchell, 1977, p. 45), and it is not difficult to imagine this pattern of use of the reservoir and canal complex at Raqay-Raqayniyoq. The canal also served to divide the town physically into two groups, which might well represent a division into moieties, a social division that we might expect to be represented spatially in an ideal farming community (Niles, 1980, pp. 88-89; ms.a, p. 16).

A particularly interesting reservoir appears to be associated with the special purpose terracing described for Callachaca. At the edge of the hill, some 600 m. directly above the T-shaped plaza system, is a T-shaped reservoir, sharing the orientation and general configuration of the plaza (fig. 1, G). The reservoir is not well preserved, and is much more conspicuous on aerial photographs than it is on the ground.[8] It is about the same altitude as the pass to Ch'itapampa, which is visible from the reservoir, and is well above any of the Callachaca terracing systems. Currently the reservoir is a depression about head height, with traces of coursed limestone masonry towards the south, or downhill, side; its rear (long) wall measures approximately 73 m. and the width of the depression about 43 m. The reservoir's narrow base is approximately 51 m. wide, and shows evidence of some concrete, suggesting that it was used until recent times. The front wall seems to define a dam, to contain the water for release into a canal which, on aerial photographs, runs straight out from the center of the dam. There is no trace of a spring or of feeder canals to provide water to the reservoir, but the rear wall is built into the hill, suggesting that runoff might have been its source. Some support for this hypothesis is seen in the aerial photograph series for May, 1962, at the end of the rainy season, which shows standing water in this depression; other aerial photographs do not show standing water. From its location, it is possible for the reservoir to have provided water for any of the terraces on the face of Callachaca hill. The course of the water canal that flows from it suggests the possibility, at least, that the waters were directed towards the special purpose terraces described.

The curious form and orientation of both the special purpose terraces and the reservoir at Callachaca seems to be more than coincidence. I believe that the use of the same form unites the two sets of remains into a single system conceptually, even though the exact course of the canal that might have represented the linkage can no longer be traced. The fact of a special purpose reservoir, defined by an unusual shape and provided with coursed limestone masonry, being tied to the special purpose terraces suggests an agricultural function for them.

Other reservoirs in the immediate vicinity seem to be based on different hydrological principles, and to have served different ends. A large pool of water, still in use, is located about 100 m. to the east of the T-shaped reservoir. Because it is full of water, it is not possible to describe its construction or dimensions, other than to comment that a swampy area extending outward at the edges of the pool covers a greater area than that of the other reservoir. There are no channels feeding the pool, and it would appear to be spring fed. A channel on the east side of the pool directs water towards the terraces below Rumi Wasi, currently farmed by Soqso ayllu and

Awqalli ayllu of San Sebastián. The round reservoir of Moyoqocha, located on a hilltop on the west side of the valley of the Cachimayo, is built at approximately the same altitude as the Callachaca reservoirs, and appears to feed straight channels that drop down the face of the hill toward a set of terraces located at the edge of the valley.[9]

A final reservoir is associated with the high prestige terraces at Tipón, and shows stylistic treatment in keeping with this context. Here, an area roughly rectangular, and measuring approximately 26 x 38 m., is defined by walls approximately 2 m. in height built into the surrounding hillside. Free-standing walls must have been a part of the construction on two sides, but they are now fallen. The walls are faced with limestone blocks which are cut and carefully coursed. Niches facing into the reservoir are visible in one of the walls. There is no trace of the original construction on the downhill side of the reservoir, so the mode of releasing water from it remains obscure. water may have been directed toward a portion of the high-prestige terraces which are below the reservoir and could not otherwise be watered by the spring source described. The water is fed by a canal which ultimately has its source in a spring high on the hill above. The canal itself represents special attention to the idea of moving water, as it includes above-ground channels carried on broad walls in parts, and on a raised aqueduct (fig. 6), in parts; and includes channels excavated into the ground at some places. The channel is fully stone-lined, and is defined in some places by a groove in the masonry of the wall on which it is carried and in other cases by carefully cut and finished channels in blocks of stone. The course of the water and the special treatment of it probably reflect cosmological considerations (Niles, ms.b). The channel that feeds the reservoir is but one branch of a canal, to which it is joined in a Y (fig. 7). Clearly, the reservoir was designed to be filled from time to time by diverting water from the main canal, perhaps using blocks of stone or sod, as described by Mitchell for contemporary waterworks (Mitchell, 1977, pp. 45-46).

Many of the terraces and some of the irrigation channels are still in use. Modern farmers seem to prefer to use the broadest fields, so the narrow terraces are more likely to be in a state of disrepair. I have observed vertical irrigation grooves more often on fields lower down on the slopes. This observation may be an artifact of the differential preservation of the lower fields; however, there are other possible explanations for this distribution. Mitchell's consideration of contemporary irrigation practices near Ayacucho includes the observation that high fields if they require any irrigation at all, require less than do lower fields. He notes that the higher fields are more often in clouds, or in a cooler zone, so that they are less subject to drying heat than the lower fields (Mitchell, 1977, p. 48). In the case of the agricultural terraces near Cuzco, the lower fields are generally in the valley bottoms and hence more subject to wind, a force that would certainly influence the rate of dessication in a field. Further, since the surface area of a broad field is greater, the field would be subject to a quicker evaporation of any ground water naturally available, and lower fields are often broader. Clearly, archaeologists need to walk more terrace systems, both ancient and modern, to see how the size, shape and altitude of the fields are related to the ways in which water moves across them.

Discussion

Stylistically it is possible to identify three kinds of terracing at Inca sites near Cuzco; an agricultural function is suggested clearly in two of them. The production terraces described for the Cachimayo, for Tablapata and for other sites, are massive systems which maximize usable land in desired locations such as sheltered canyons and fertile valley bottoms. Production terraces are characterized by rough fieldstone masonry and walls that are low relative to other kinds of terracing. Perhaps because of their size, they are not necessarily provided with the stone peg stairs which often are a part of systems with higher terraces. In form, the production terraces tend to follow natural contours of slopes. This choice of form must be important in following natural lines of drainage in river canyons. Further, following contours can help to preserve a stability of form that would be less easy to achieve with large systems based on straight lines.

The terraces of the high prestige tradition, such as those at Tipón, Yucay and Chinchero, are markedly different from the production terraces. The system itself may be smaller, restricted to a particular hanging valley or topographic feature, but the component terraces are defined by high walls that outline large fields. Masonry is of cut limestone, and walls may be noticeably slanted to stabilize the wall and to achieve an illusion of even greater massiveness. Sets of peg stairs or inset stairways may be incorporated into the design of the system to facilitate movement and to emphasize the height of the walls and perhaps to define a ritual circuit. Further, the play of light on the stairs may create patterns with the shadows that pleased the Incas. The form of the component fields may be based on straight lines, zigzags, curves and other forms not modeled on natural contours. In addition to their symbolic value, the zigzags and curves, at least, represent forms which help to dissipate the forces of the earth pushing outward on the retaining wall, and might lead to greater stability of the terrace. Many of the same canons of design applied to high-prestige terraces are seen in the high-prestige building tradition in general. For example, greater size, scale, and complexity; the use of cut stone masonry; and freedom from the rectangular constraints of the low-prestige tradition.

Stylistically, the special purpose terraces described for Callachaca and Choquequirau are intermediate between the production terraces and the high-prestige terraces. Their size and the quality of masonry used is intermediate, and their use to sculpt existing hillocks or open areas into new forms is conceptually intermediate between obeying the contours of a valley and imposing a pleasing form on the landscape. There is not a clear association with agriculture in the sites described, but special purpose cultivation cannot be ruled out as a possibility.

Terraces of any style can be watered by any means. There is clear evidence of provision of water from channeled rivers in the production terraces, and from channeled springs in the high-prestige sort. Reservoirs can be used to distribute water to any kind of terracing. The major determinant of the choice of irrigation source would seem to be the location of the terracing system, rather than its style. In general, side valley terraces are located to take advantage of water in streams that cut the valleys; valley bottom terraces may be watered by reservoirs higher on the hills above the terraces. The style of the irrigation works may depend on the function of the system, however, in the same way that the style of terracing seems to

relate to the use of the archaeological site. In the irrigation works associated with the production terraces at Tablapata, walls of the reservoir are of coarse fieldstone masonry, and the water is channeled through the town using a canal of roughly worked and fitted limestone masonry. The irrigation works associated with the high-prestige terraces at Tipón include an elaboration of a spring using finely fitted limestone, provision of a channel and aqueduct arrangement based in part on carved stone blocks and a reservoir faced with finely fitted limestone blocks.

In considering the agricultural works attributed to the Incas, stylistic distinctions only make sense when we distinguish the notions of system and of site. Archaeological sites are zones of concentrated archaeological remains which are spatially separated from other such sites. Site boundaries may be as artificial as the limit of a scatter of sherds, or may equate with conceptual limits imposed by the builders who delimited a site with a wall, as is the case at Tipón. In Inca sites, various kinds of architectural remains may be represented in different sectors. Recognizable forms such as houses, palaces, storehouses, fortresses and kallankas may all be present in a single site (again, this is the case at Tipón), but must be associated with different kinds of human activity. Just as a site can contain different kinds of buildings, it can also contain different kinds of terracing and irrigation works. Their limits can be traced by following natural drainage lines and their elaboration with such cultural forms as canals or reservoirs, and by their bounding by natural or architectural features. It is useful to think of the sets of terraces and their associated irrigation works as systems, in the sense that they preserve some engineering and stylistic integrity that probably relates to a common function. Again using the example of Tipón, the system of high-prestige terracing and waterworks is associated spatially with an architectural complex built in the high-prestige tradition, and constructed on the kancha plan. At another portion of the site, with less well built structures based on the double house plan, are additional terraces which show their greatest affinities to production terraces. This system is watered through a series of canals fed by the spring that also feeds the reservoir. It is the reservoir, and not the spring itself, that waters the high prestige terraces.

Other sites also show evidence of different kinds of terrace systems within the boundaries of the site. Callachaca and Choquequirau special purpose terraces are small systems that are associated with some buildings, and are separated from the bulk of the terraces in the area. The site of Písac in the Vilcanota Valley has flights of neatly constructed and fairly large terraces below the Inti Huatana sector of the site and has "structurally unremarkable" terraces elsewhere (Donkin, 1979, pp. 108-111). Stylistic differences in terraces at Moray have been attributed to temporal differences (Urton, 1981, p. xviii).

In referring to terraces and irrigation works that extend over a large distance that may include several named sites, it is useful to use the concept of system to characterize the unity of the group. The Cachimayo agricultural system covers an enormous distance up the canyon on both sides, and almost certainly was related to a number of residential sites in the area.

The construction of terraces and irrigation works was important to the Incas for a number of reasons. Most importantly, it permitted the cultivation of more land in desired crops than was possible without

modification of the slopes. Increasing production would be important for an administrator who had to feed armies and host bureaucrats, but expanding the resource base was approached with a literally religious zeal. Pachacuti reportedly remodeled the entire Cuzco area, providing it with more efficient farm lands (Sarmiento de Gamboa, cap. 32; 1943, pp. 179-180). Expanding dominion over land and water was perhaps treated with the same enthusiasm as expanding control over new provinces. Certainly it is no coincidence that the man who introduced the worship of a creator god should himself be credited with creating new means of exploiting the land (Niles, ms.b). The production terraces near Cuzco are found in association with residential groups that can best be viewed as ideal communities (Niles, ms.a). In the towns the architecture is used to mark social standing of the residents and to instill Inca notions of the social order just as the terraces must have done. It is not surprising to find so many production terraces in the area of Cuzco; goods consumed in the capital city were brought in from villages within a radius of fifteen or twenty leagues (Garcilaso de la Vega, Book 6, ch. 4; 1966, p. 322), an area that would certainly include the production terraces described. The amount of food used to maintain the nobles and their retainers would have been enormous (Garcilaso de la Vega, Book 6, ch. 4; 1966, p. 320), as would be the amount of goods expended in ritual. The presence of production terraces in association with a royal site such as Tipón is not surprising, as Garcilaso tells us that the Inca's obligation to feed his nobles and retainers followed him wherever he happened to be (Garcilaso de la Vega, Book 6; ch. 4; 1966, p. 320).

The presence of special purpose terraces is also suggested by the chronicles. Some fields were dedicated to the Inca or to the state religion, and there is a suggestion that some of these fields were defined by terraces (Garcilaso de la Vega, Book 5, ch. 1; 1966, pp. 241-242). Support for this idea comes from the case of contemporary Chinchero, where crops designated for the support of the church are specifically those which are harvested from a set of terraces (Núñez del Prado, 1949, p. 200). We are also told that some terraces were devoted to the cultivation of special crops which were ritually planted and harvested by nobles or priests, as reported for the fields of Colcampata in Cuzco (Garcilaso de la Vega, Book 5, ch. 2; 1966, p. 244). Special purpose terraces of the sort described for Callachaca and Choquequirau could easily have been devoted to the kind of symbolic agricultural endeavors described by Garcilaso.

Cultivation of crops for the religion or the Inca is one of the possible uses of the high prestige terraces as well, although at least some of them may have been used for the cultivation of exotic plants. Garcilaso claims that all palaces were provided with baths and gardens "planted with all sorts of gay and beautiful trees, beds of flowers, and fine and sweet-smelling herbs found in Peru" (Garcilaso de la Vega, Book 6, ch. 2; 1966, p. 315), which were for the pleasure and recreation of the Inca. The location of the terraces of Tipón, in particular, in a warm and sheltered area, and their provision with water, would have made possible the cultivation of plants that might not have grown in a less sheltered area. It is easy to suggest that at least some of the high prestige terraces must have been pleasure gardens.

Given the Inca propensity to mark social differences in architecture, it is not surprising to see that terracing and waterworks can also be approached stylistically, and that the differences may relate to the different

social uses of the land and water they provide. What is not clear is whether the range of styles described for Cuzco is representative of works from other parts of the empire. Because Cuzco is so closely associated with royal activity, it is possible that there is more high-prestige terracing and waterworks in that area than would be found in the provinces. Similarly, since farmers in the immediate vicinity of the capital were supplying it with goods, it is possible that there is more simple production terracing in the region than would be found farther away. I would suggest that it is not likely that Inca production terracing will be found outside of regions specifically set up as planned agricultural centers, such as Cusichaca (Kendall, 1974) and the Urubamba Valley sites described by Fejos (1944), and perhaps in association with mitmaq colonies in more distant area. Even in these sites, terraces described are quite different from those seen nearer to Cuzco, and it may be that the symbolic use of architecture to impose a way of life would require the construction of more impressive terraces farther away from the capital.

It is also not clear whether engineering patterns are being tested in the heartland before being attempted elsewhere, or if ideas encountered during the expansion of the empire are incorporated in the Cuzco agricultural works. These and other questions will only be answered as more examination of Inca land use patterns are carried out.

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To all these friends and colleagues, many thanks.

NOTES

[1] The terraces on the east side of the ravine are now disappearing rapidly from a combination of erosion and intentional destruction by residents of the area. When I revisited the site in 1982, the system of irrigation canals in the lower Cachimayo and the terraces on the east side of the canyon had eroded to such a point that the road to the site was impassable. Unless immediate conservation measures are taken, there will be little left of the agricultural complexes of the Cachimayo within a few years.

[2]I have noticed semitropical plants and animals (green parrots) living at a quite high altitude in the sheltered Orquillos canyon above the Hacienda Huayllabamba. I observed maize growing in this canyon in November, 1977, which was about three times the height of maize growing above the canyon, near Chinchero, and was about twice the height of maize growing near Ollantaytambo in the open Urubamba Valley on the same date.

[3]The fields of Tablapata are currently farmed by campesinos from the town of San Jerónimo, and are devoted to purple maize, quinoa and tarwi, which are intercropped. The water from the Inca irrigation system at Tablapata has been diverted to lower fields where carrots, onions and lettuce are grown as cash crops. There are a number of crosses associated with the ruins of Raqay-Raqayniyoq, and several are located at the juncture of water canals. Adjacent terracing systems, similar in style to those of Tablapata, are called Qorikalli, and are now planted in eucalyptus.

[4]Contemporary farming strategy in Yuncaypata, near the pass to Chit'apampa, shows the importance of sheltering desired crops from the wind. An archaeological ruin, probably an Inca storage site, is located on an exposed hilltop near the modern community. Residents have chosen to plant maize inside the standing walls of the ancient buildings where, sheltered from the strong winds, the crop manages to grow. Unprotected lands used by the Yuncaypatans are devoted to European grains and to pasturage.

[5]One of these buildings has been described by Moorehead (1979, p. 68) as San Sebastian Structure 1.

[6]We do know that several ancient shrines were located in this area, among them Chuquiquiraupuquiu (An-4:2; Rowe, 1980, p. 35), and the Callachaca shrines (An-4:3, An-5:6, An-5:8, An-6:2; Rowe, 1980, pp. 35-37).

[7]Tipón is located some 25 km. from Cuzco along the Cuzco-Urcos road, near the Hacienda Quispicanchis. I have argued that, on stylistic grounds, Tipón is best analyzed as being associated with royal activity; it is very likely an Inca country estate (Niles, ms.b). Yucay, in the Vilcanota Valley, near a town of that name, was the country residence of Huayna Capac (Sarmiento de Gamboa, cap. 54; cited in Rowe, 1968, p. 69, note 23).

[8]The reservoir is shown clearly on aerial photograph #8461 from the Instituto Geográfico Militar, 1962 series. Segments of a straight canal are visible on aerial photograph #8485-1345, 1956 series, from the Servicio Aerofotográfico Nacional.

[9]My observations of the channels and terraces associated with Moyoqocha are based on aerial photographs, as modern construction in the area has obliterated any trace of the Inca agricultural works.

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KEY TO FIG. 1

A - Plaza and kallanka complex

B - Zone of terraces

C - Rock outcrop with tombs

D - Canalized spring: possibly Pachayacanora

E - Rock defined by wall: possible shrine

F - Zone of structures: possible town of Yacanora

G - Reservoir

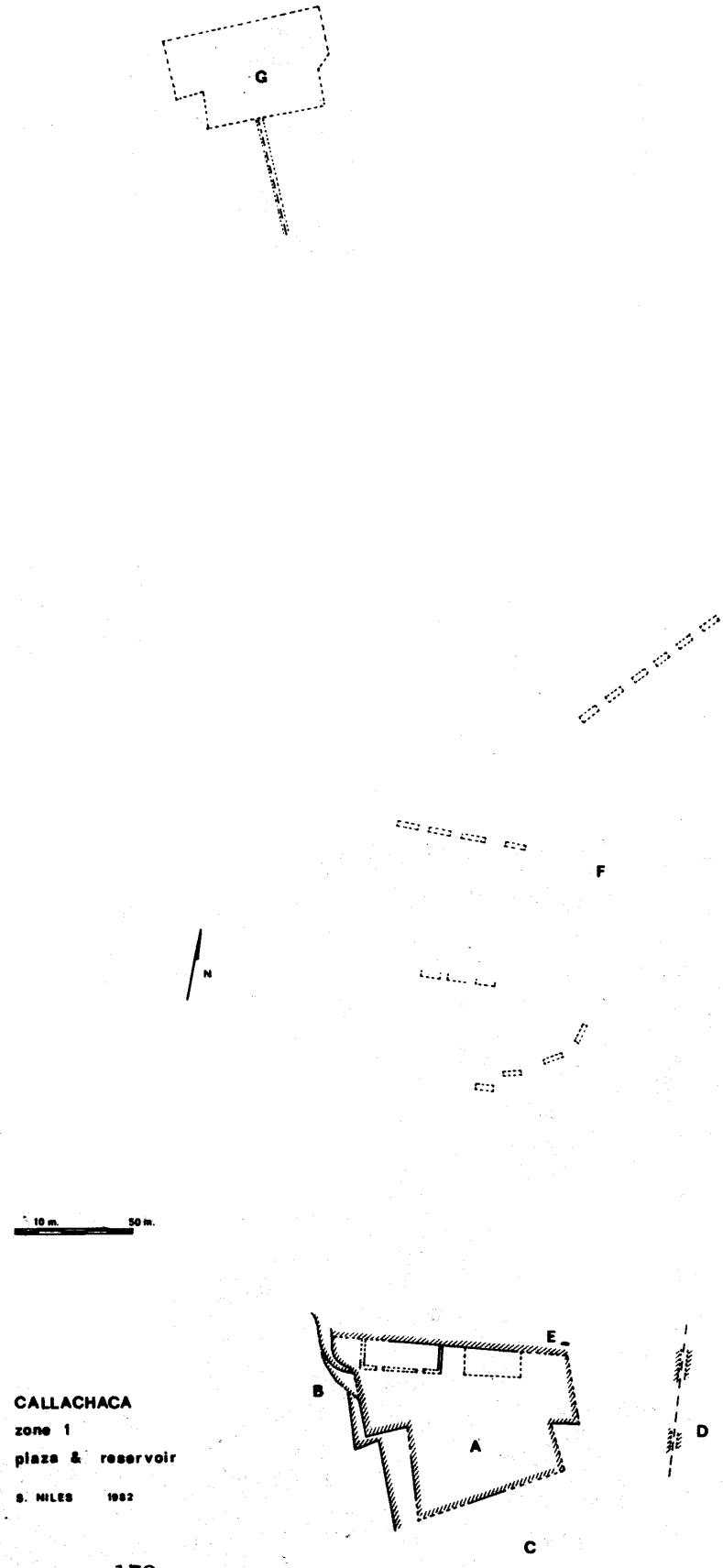

Fig. 1, see Key on p. 178.

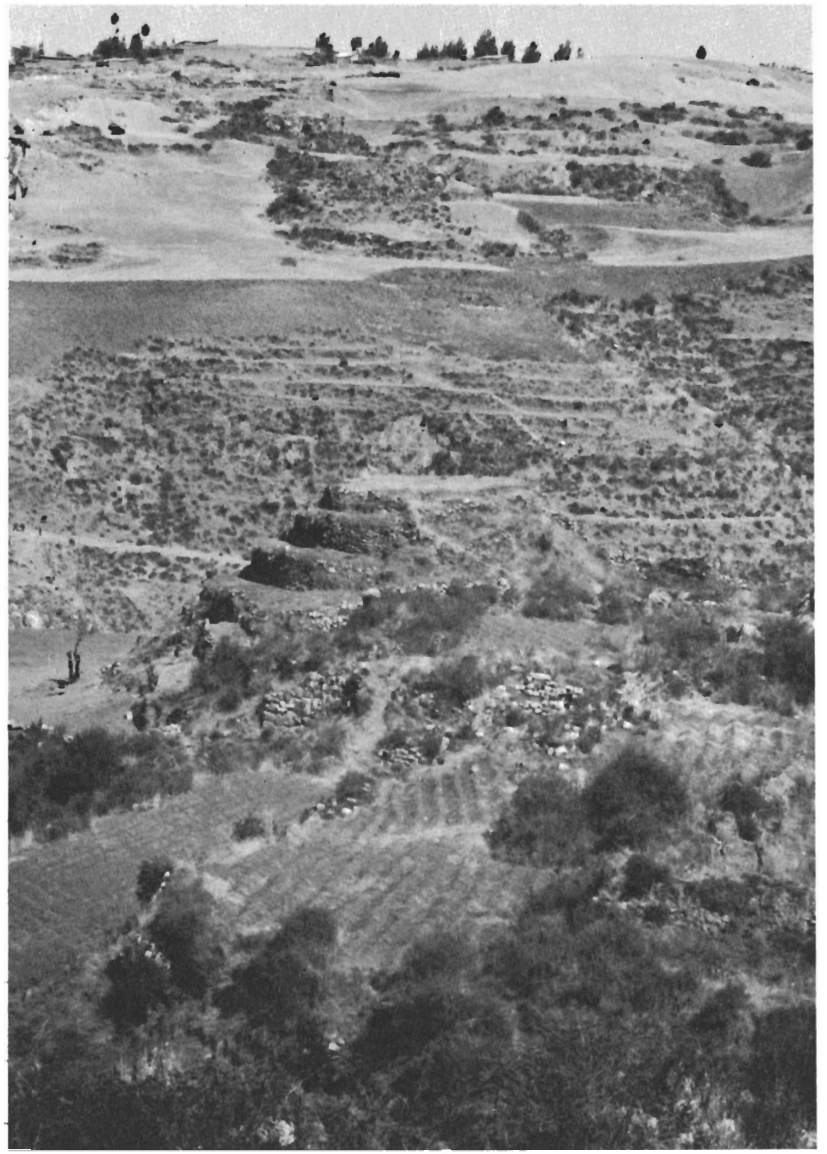

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Fig. 2, terraces of Choquiquirau Grande (middle ground) with production terraces of the Cachimayo ravine in the background; fig. 3, detail of Choquequirau Grande terraces.

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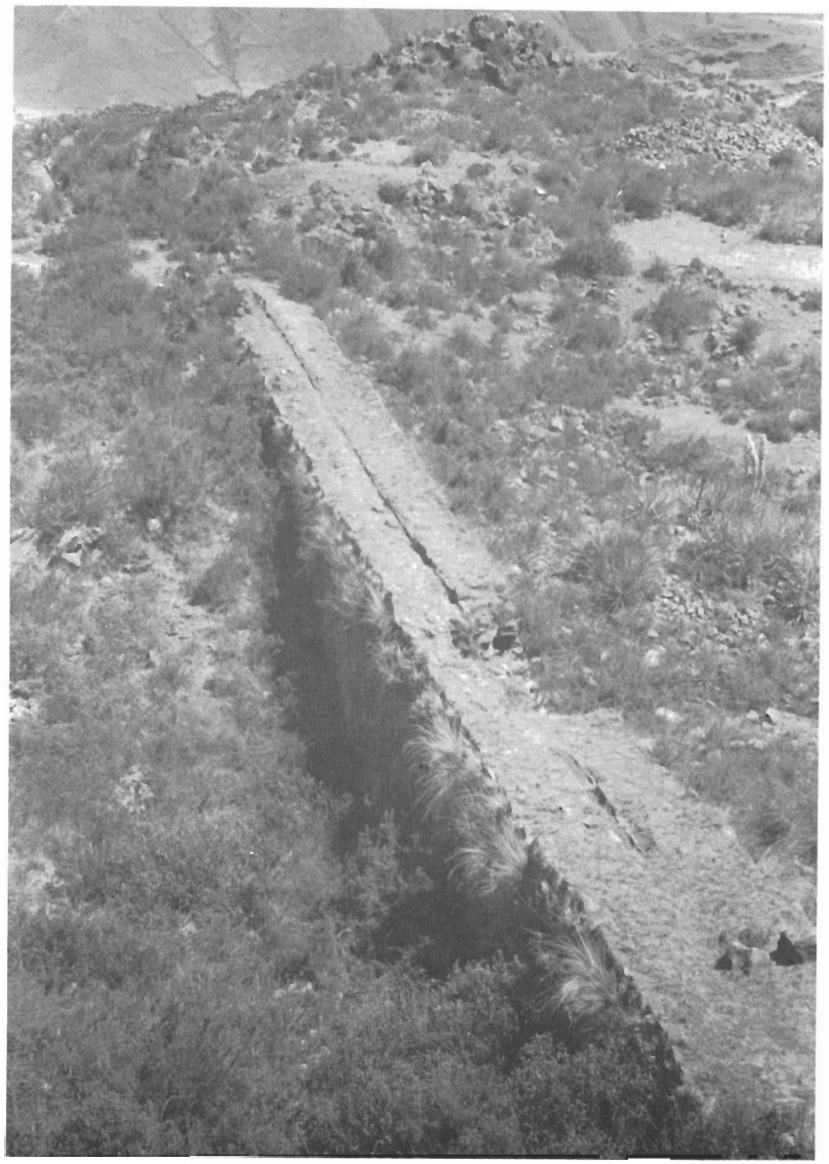
Tipón. Fig. 4, overview of high-prestige terracing system; fig. 5, detail of terrace wall.



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Tipón. Fig. 6, aqueduct; fig. 7, water channel showing Y-shaped branch of main canal to feed reservoir.