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Prehistoric Footpaths in Costa Rica: Remote Sensing and Field Verification

INTRODUCTION

Remotely sensed imagery has revealed a network of prehistoric footpaths in the Arenal region. In this chapter we will examine how the footpaths were formed, and how they were detected, and interpret how they were used by the prehistoric inhabitants of the region.

Footpaths can be utilized as a window to a culture's religious, economic, political, and social organization. Human geographers have long analyzed paths, roads, and highways as networks of transport and communication (Haggett 1965), and archaeologists have studied systems of constructed roads, but they have discovered little evidence of prehistoric erosional footpaths. People use paths for a variety of reasons, including transportation, communication, and ritual; they leave a record of their presence and routes in the form of erosional footpaths. The study of the path networks and their integration of sites and resources is an application of behavioral archaeology, the use of prehistoric features to understand human behavior and activities. This research is primarily methodological, focusing on the recognition and confirmation of features as footpaths. Future research will attempt to expand the network, increase our knowledge of the processes involved in the formation of the footpaths, and improve our understanding of the uses and purposes of the paths.

Our focus is regional, extending from the very moist, nonseasonal eastern end of the research area, over the Continental Divide at 700 m to 1,000 m, to the more seasonal and drier Pacific

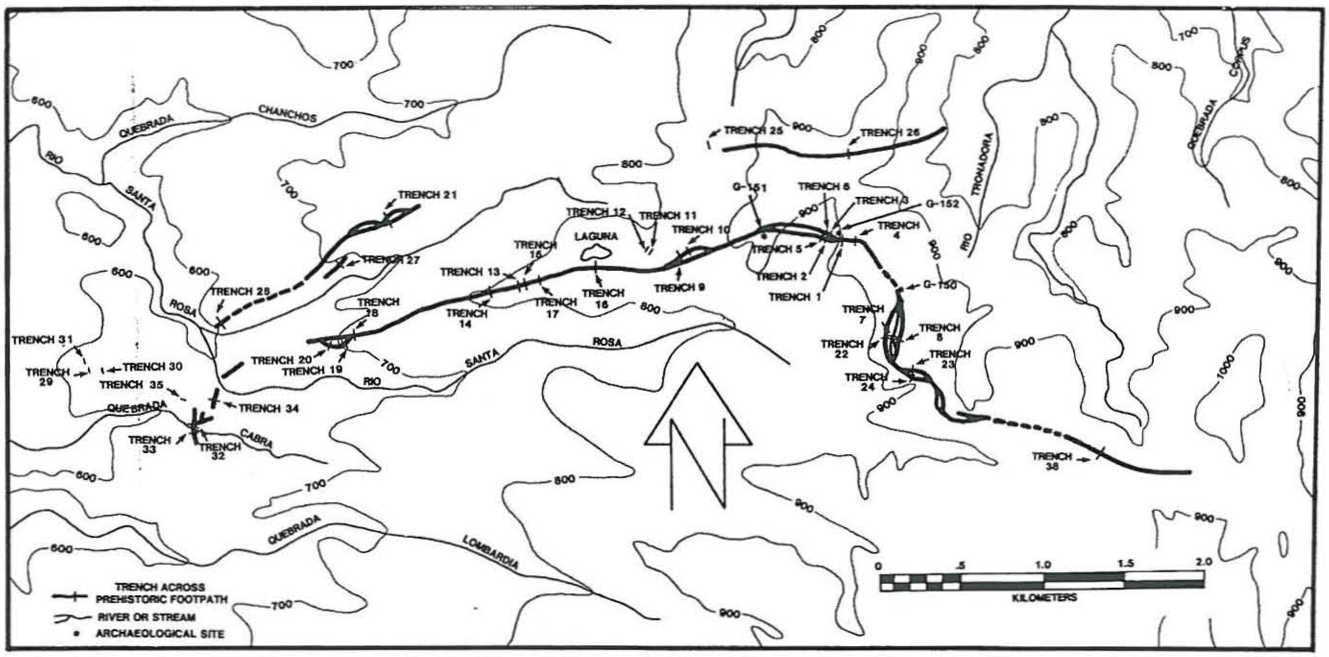


Figure 9-1.
Map of Silencio Phase footpaths in the Silencio/Tilarán area. Location of trenches across confirmed footpaths are shown. Numerous other anomalies have yet to be investigated; many may be prehistoric footpaths. Contour interval 100 m. Map by Brian McKee.

side (Chap. 1). We have detected linear anomalies and subsequently identified them as footpaths in all three areas. We have also detected footpaths and confirmed them in areas buried beneath up to 3 m of volcanic ash.

FOOTPATH DETECTION IN IMAGERY AND IN THE FIELD

During analysis of color-infrared prints in 1985, we observed a linear feature leading westward from the Silencio cemetery (G-150, Chap. 6). The feature made an obtuse bend around a repository of stone used in construction at the cemetery (G-152, Chap. 7), extended to a second stone repository (G-151, Chap. 7) on another ridge top, and continued westward from there.

The lines were considered to be probable footpaths or roads because of their relation to known loci of cultural activity and the crossing of several distinct geomorphic features. Three exploratory trenches excavated across the features demonstrated that they had existed prior to the fall of the Unit 20 tephra (i.e., they were formed before ca. 1500 AD), showing that they formed before European contact and were of prehistoric origin.

The most effective imagery in the detection of the footpaths has been the low-altitude color-infrared photography. The true color aerial photography and the conventional black and white photography have also been helpful (Chap. 8). The large-format black and white negatives provided

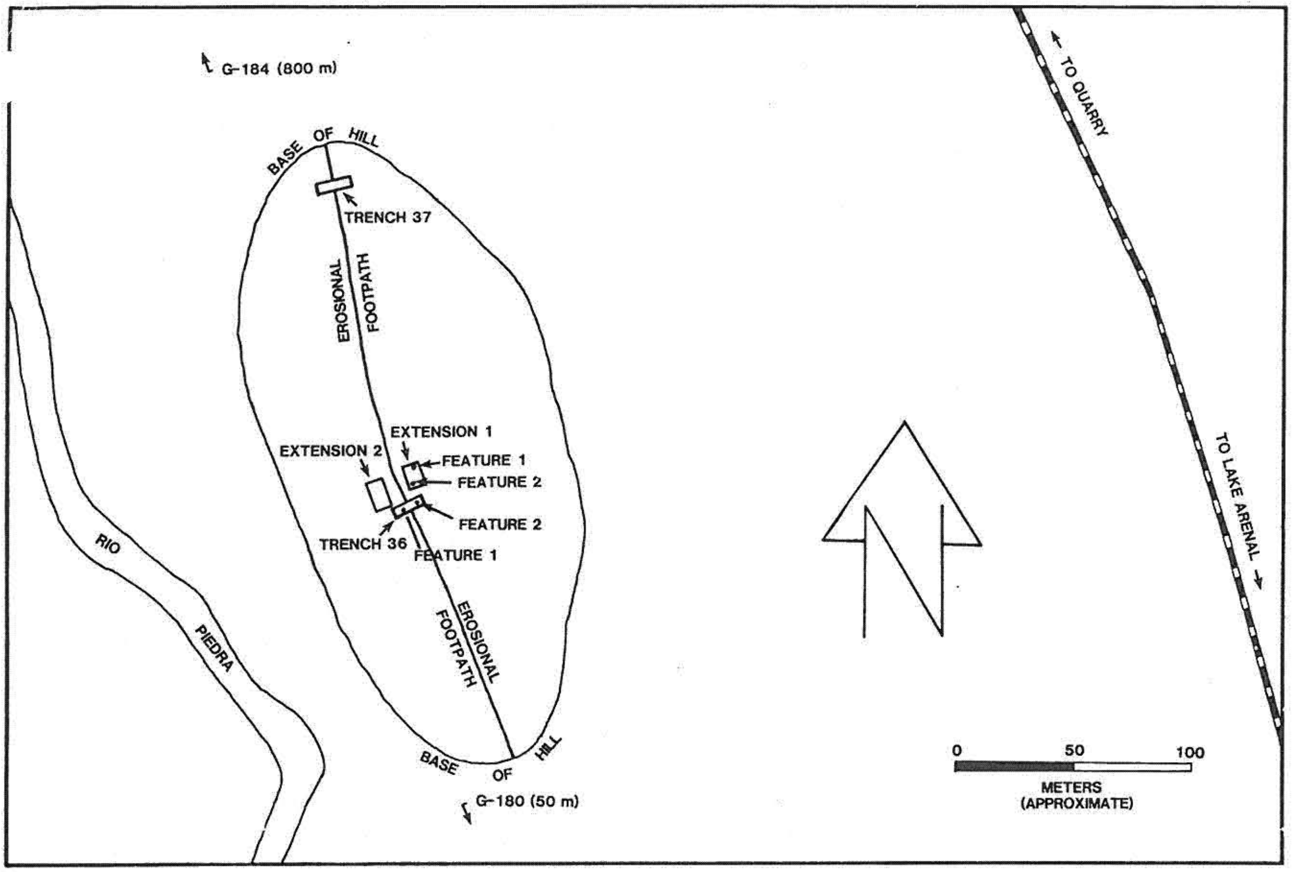


Figure 9-2.
Map of short Arenal Phase footpath crossing a hill northwest of Lake Arenal. Extent of hill, Trenches 36 and 37, and extensions 1 and 2 are illustrated. Map by Brian McKee.

by Costa Rica's Instituto Geográfico were especially useful when a quarter of a frame was enlarged to an approximately 1 m² print. The paths are visible as positive crop marks, where grasses grow better, in the photographs. This may be due to improved root matrix or to moisture retention in areas of the paths. The TIMS imagery clearly shows some known segments of footpaths, as well as other linear anomalies outside the area of known footpaths, but systematic analysis and ground-truthing of these data have yet to occur. We have had little success with radar or Lidar data (Chap. 8). Segments of linear anomalies that have been confirmed to be prehistoric footpaths are shown in Figure 9-1.

CONFIRMATION OF LINEAR FEATURES AS FOOTPATHS

Before examining in detail the processes responsible for the formation of the features, we must evaluate the evidence that they are prehistoric footpaths. Two possible alternatives exist: they are natural features, caused by erosion or faulting; or they are modern cultural features. Before they can be identified positively as prehistoric cultural features, these alternatives must be rejected.

The evidence comes from remote sensing, ground inspection, and excavation. This includes their topographic position, their relationships to sites and resources the prehistoric inhabitants of the region utilized, associated artifacts, and depositional and erosional phenomena recorded in the stratigraphy.

The topographic position of the footpaths can help distinguish them from modern roads. The paths tend to stay high, often along ridge tops, and follow relatively straight lines, frequently running directly across topographic highs and lows, rather than contouring around them, as do most modern roads. In one case (Fig. 9-2), a path between a village and a cemetery went directly over the top of a small hill, rather than around it. The paths' location on high ground may be explained by the extremely wet climate of the area; paths along topographically high routes are better drained than those along lower routes.

The topographic setting of the features also provides evidence for cultural origin. Ridge tops are areas of minimal water erosion, as there is a very limited catchment area upslope from which to draw water (Horton 1945). All water that causes erosion along ridge lines must come from immediately upslope, along the ridge line, or fall directly on the area that is eroded. Natural features caused by water erosion tend to be oriented along the steepest slope of the landform that they are draining, that is, perpendicular to the topographic contours, because this is the orientation along which water exerts the maximum erosional force (Ritter 1986). This direction is usually perpendicular to the trend of a ridge line.

The morphology of the features distinguishes them from faults. There are no scarps, and the geometry is not what would result from faulting. Other indicators of faulting, such as slickensides and alteration minerals, are absent, as is evidence of structural deformation in the area immediately surrounding the features.

The location of these features relative to archaeological sites and resources utilized by the prehistoric inhabitants of the region also indicates that they are footpaths. The first recognized path segments occur between a previously known cemetery (G-150) and a repository for stone (G-152) used at the cemetery, and between the cemetery and a spring. The locations led to their recognition as cultural features. The locations of the paths also help show that the features are not due to faulting. Faults generally do not connect villages with cemeteries, or sites with springs, stone sources, and stone repositories.

The association of artifacts with the features also indicates that they are prehistoric footpaths. We found ceramic and lithic artifacts in most trenches across features where other evidence indicated that they were footpaths. These artifacts were usually found along the path surface, or within the stratum of the first "infilling" after path abandonment. One footpath (Fig. 9-2) between a habitation site and a cemetery was associated with a large concentration of river cobbles and potsherds. The cobbles were transported to the top of a ridge and placed on the ground surface on either side of the footpath (Fig. 9-3). We found numerous potsherds, as well as several broken, but nearly complete, pots scattered over and among these rocks. This feature may be the remains of a pot-smashing ritual similar to those deduced from evidence at other sites during the project (Chap. 5). Snarskis (1981a) has interpreted smashed tripods found at Atlantic Watershed cemeteries as the remnants of *chichadas* (rowdy, drunken festivals), and the broken stones and pots may be reminiscent of similar rituals.

The final body of evidence to support the identification of these features as prehistoric footpaths uses the volcanic stratigraphy of the area (Fig. 9-4). Arenal Volcano, located about 20 km east of the study area, has erupted numerous times over the last 4,000 years, leaving a stratigraphic record of airfall deposits downwind (Chap. 2). Pedogenic processes have operated on the tephra, forming soils on most units. In general, the time for soil development was short, and only A horizons were distinguishable in the field. The soils were then buried by the next eruptive episode of the volcano. This process was repeated at least ten times. The only cases in which a dark soil layer would not be present above a tephra layer would occur when insufficient time elapsed between eruptive episodes for soil formation, or when erosion occurred between episodes. We have no evidence for the latter. The result of these processes is a series of alternating dark (A horizons) and light (unweathered tephra) "zebra stripe" strata.

In undisturbed areas, these layers are relatively flat and uniform (Fig. 9-5*a*). Where erosion occurs, however, some or all of the layers are removed. The paths formed as a result of natural erosional processes initiated by human behavior, rather than solely by natural means. Humans,

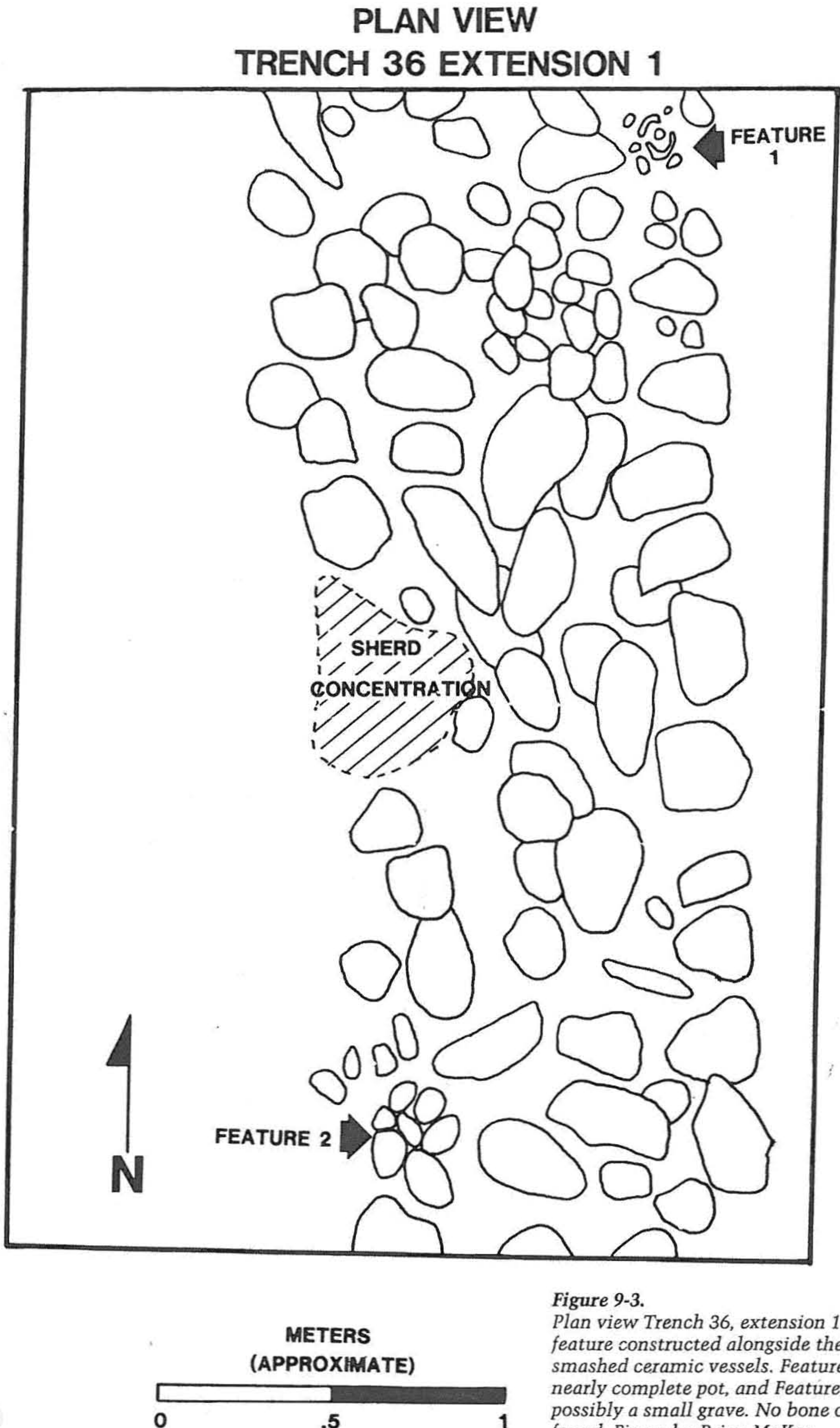


Figure 9-3.
Plan view Trench 36, extension 1, showing large rock feature constructed alongside the footpath, with smashed ceramic vessels. Feature 1 was a broken but nearly complete pot, and Feature 2 was a shallow pit, possibly a small grave. No bone or burial goods were found. Figure by Brian McKee.

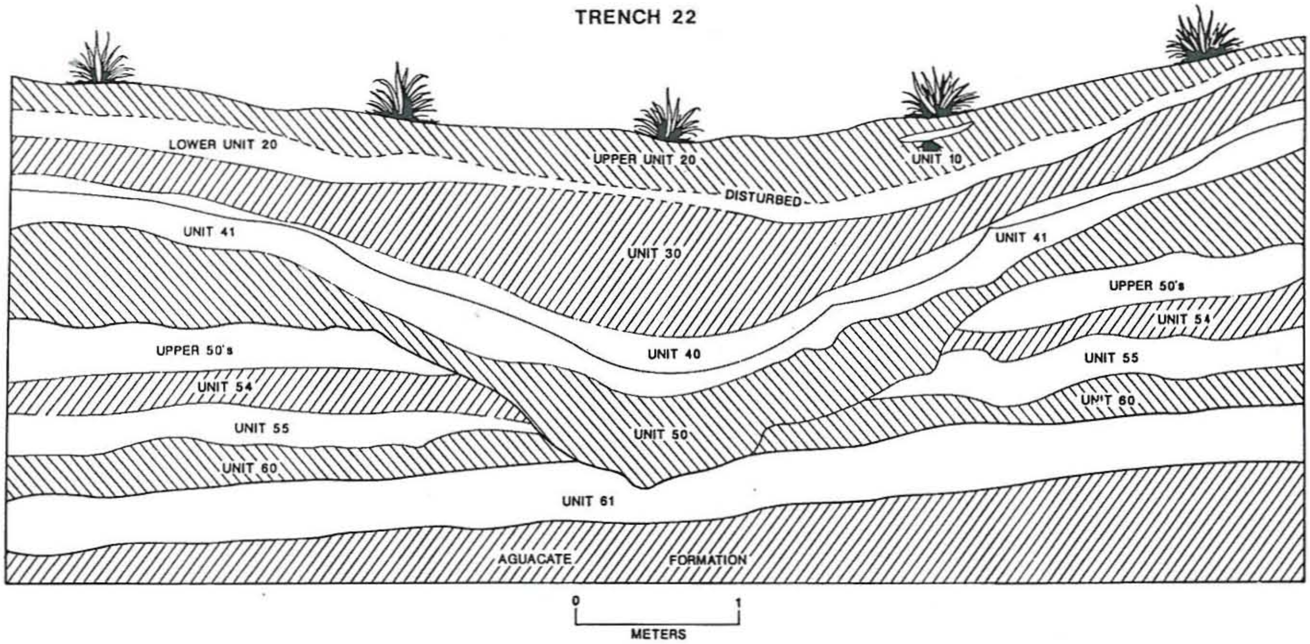


Figure 9-4.
Profile of Trench 22, 200 m south of the G-150 cemetery, on the path to the spring. The trench is located in the center of Figure 9-10. Note the uneroded stratigraphy at far right and left. The footpath eroded strata in the center of the drawing from the top of the Upper 50's layer. Use ceased during the time of Unit 50 soil formation; the eruption of Arenal Volcano that deposited Unit 41 postdates use of the path. The path at this location almost eroded down to the Aguacate Formation, the clay-rich soil that antedates the eruptions of Arenal Volcano. Drawing by Charlotte Timmons.

by walking over the ground surface and clearing vegetation, compacted the soil, retarded or killed vegetation, and initiated erosion. After the initial channel was established, natural processes continued the erosion. The original erosional cut associated with the footpath incision was probably narrow and U-shaped in cross section, and 30 cm to 70 cm wide, based on the widths of the bottoms of the paths. As erosion continued, the sides of the path also eroded, resulting in a several-meter-wide V-shaped erosional trace (Fig. 9-5*b*). The ground surface at the end of the footpath was the upper surface of this V. The next volcanic eruption following the abandonment of the path would then drape a layer of tephra across the path. Often, some infilling by eroding sediments from upslope would occur after abandonment, before tephra burial. The ground surface after the eruption would be roughly parallel to that before the eruption (Fig. 9-5*c*), with some slight topographic smoothing.

The burial process was repeated during subsequent eruptions. Some paths that were not deeply incised have been completely filled in and are thus invisible on the modern ground surface. More deeply incised paths have not been so obscured and can be traced on the present surface. Many of the paths can be seen in the remotely sensed imagery. The present ground surface is approximately parallel to that of the time of the footpath use, although in some cases as much as 2 m higher (Figs. 9-6 and 9-7).

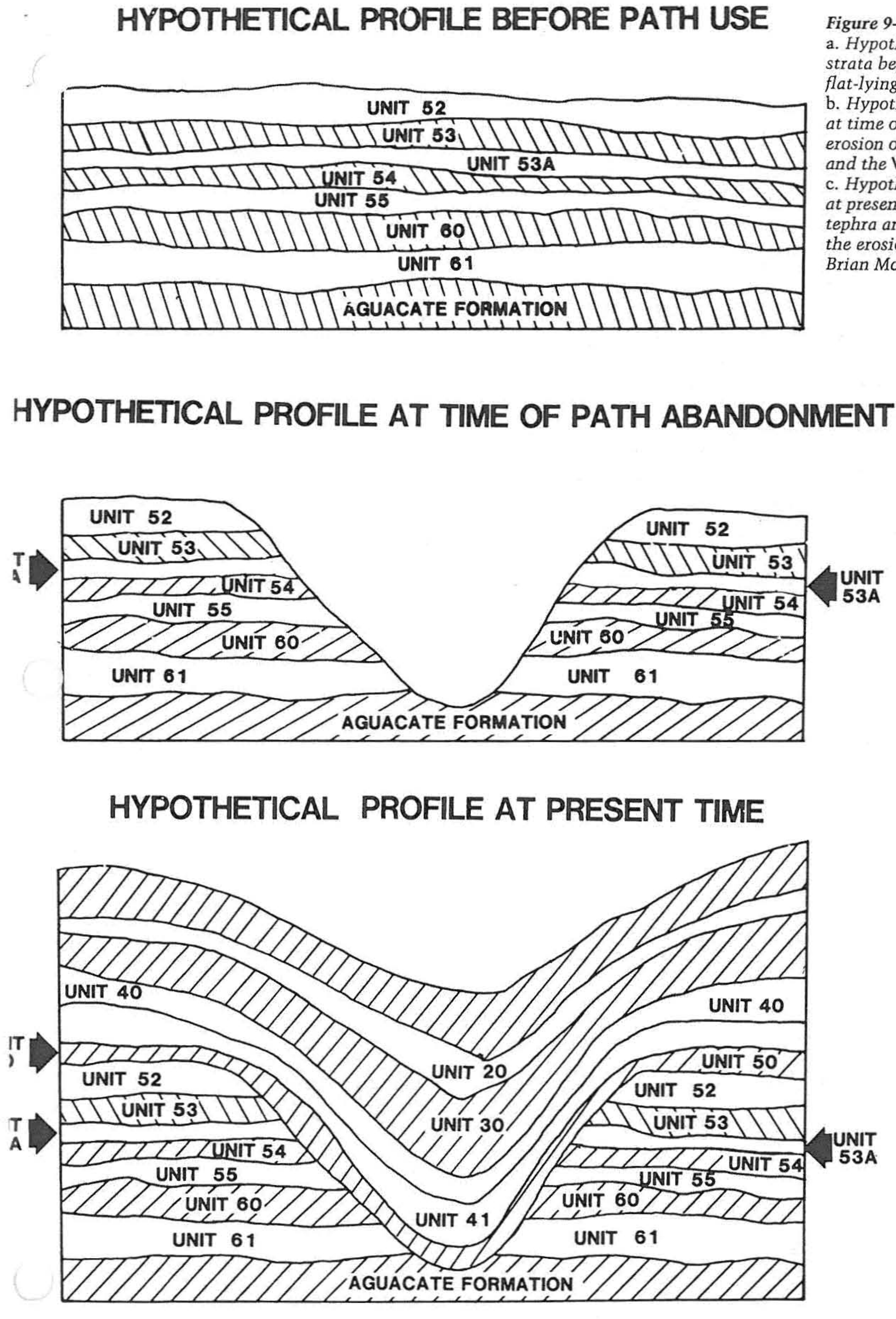


Figure 9-5.
a. *Hypothetical profile of volcanic strata before path use. Note the flat-lying, undisturbed strata.*
b. *Hypothetical profile of footpath at time of abandonment. Note the erosion of soil and tephra layers, and the V-shaped profile.*
c. *Hypothetical profile of footpath at present time. Note layers of tephra and soils draped across the erosional V. Drawings by Brian McKee.*

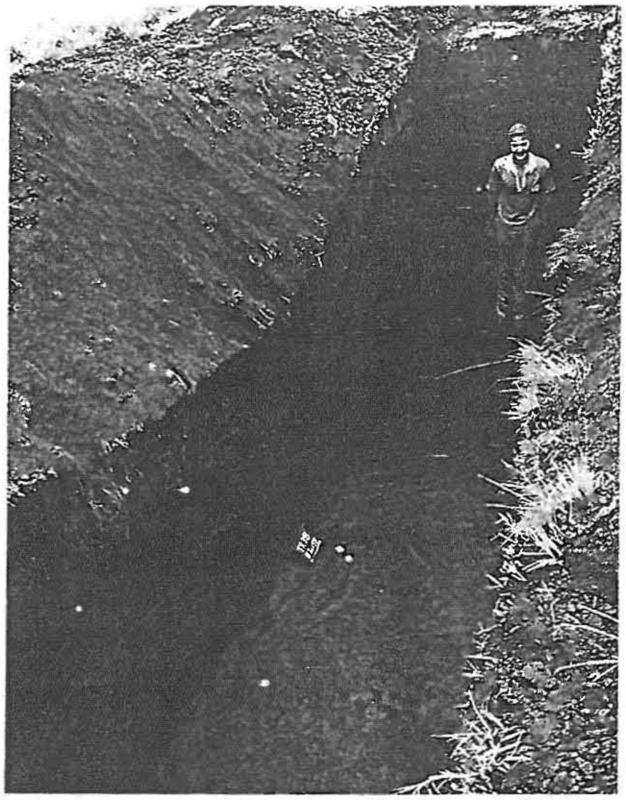
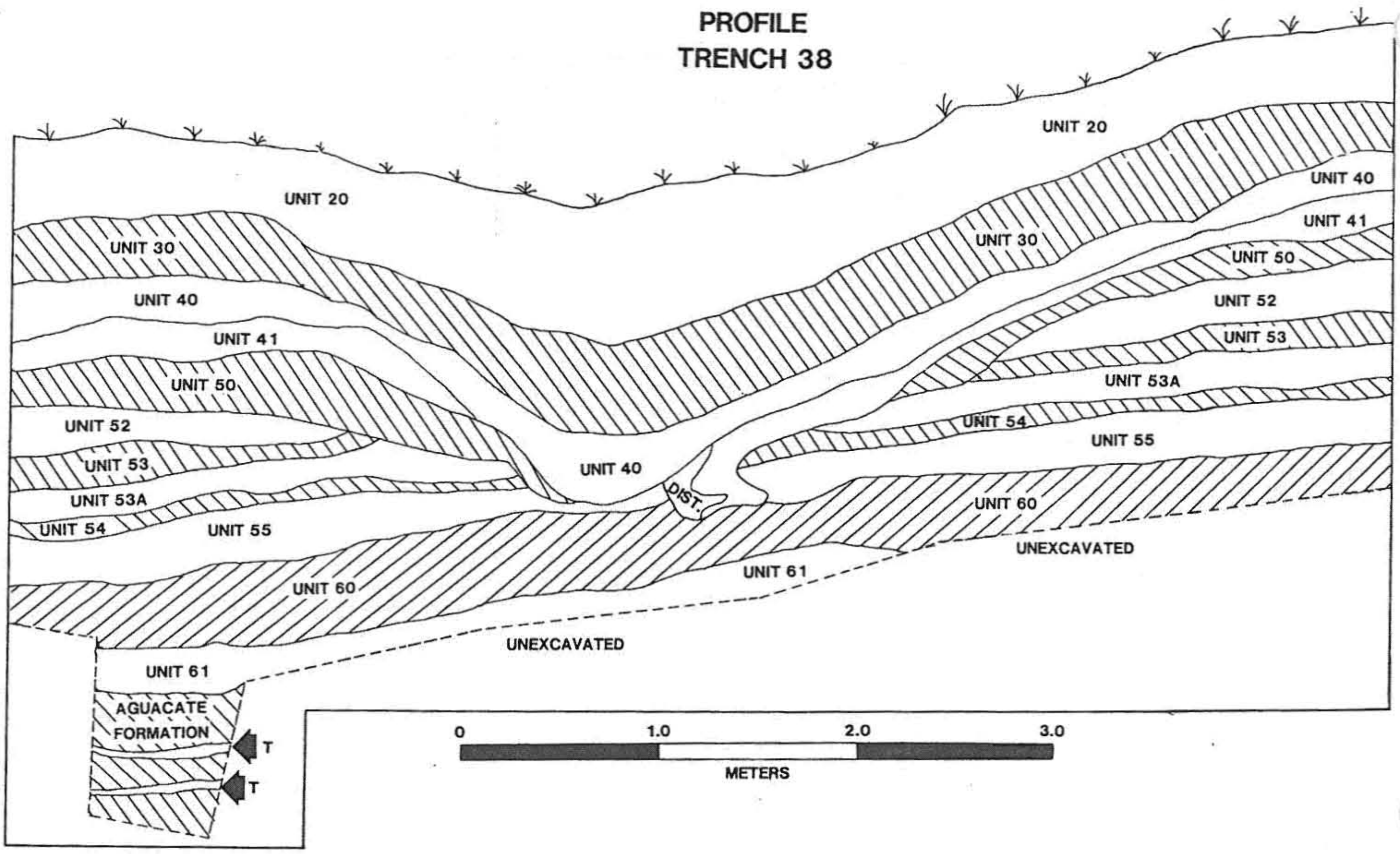


Figure 9-6.
Trench 38, showing the deep tephra burial in the area near the Chiquito River. Photograph by Payson Sheets.

Figure 9-7.
Profile of Trench 38. Note alternating soil and tephra layers and depth of burial in areas nearer the volcano. Figure by Brian McKee.



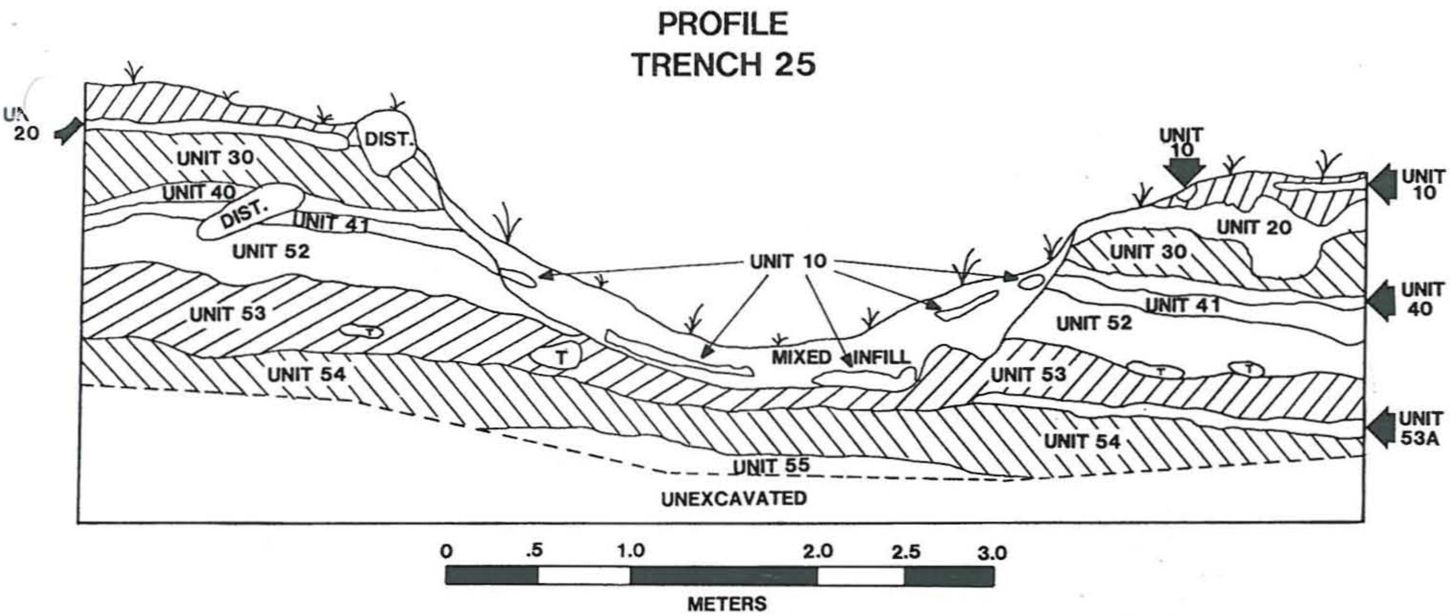


Figure 9-8.
Profile of Trench 25. Note that Unit 20 has been eroded away near the center of the profile, and that Unit 10 is relatively continuous across the full width. This trench was excavated across what proved to be the remnants of a historic road. Figure by Brian McKee.

Absolute dating of the eruptions allows us to use the stratigraphy as a chronological tool for dating footpath use. A lower bracketing date for the initiation of footpath use is provided by the date of the uppermost flat-lying tephra layer from which erosion began. An upper bracketing date for the end of path use is provided by the date of the first uneroded tephra layer draped across the footpath.

In three cases, the stratigraphy indicates that features are historic, rather than prehistoric. Trench 25 in particular is notable (Fig. 9-8). Erosion visible in cross section in the trench cut through stratigraphic Unit 20, which serves as a dividing line between prehistoric and historic times (Chap. 2). After excavation of the trench, informants stated that this feature had been a wagon road in the early decades of this century. The trench correlated Stratigraphic Unit 10 with the 1968 eruption of Arenal. The source of this unit was controversial (Borgia et al. 1988; Chaps. 1 and 2). Unit 10 draped across the erosional trace of the road, and because the 1968 Arenal eruption is the only eruption since the abandonment of this road, the hypothesis that this eruption was the source of the Unit 10 tephra is confirmed.

Two other trenches excavated in another area produced similar results. We observed two parallel linear features closely resembling confirmed footpaths in the CIR imagery at a location 1.4 km west of the G-150 graveyard. Excavations (Tr. 11 and 12) indicate that both features postdate the fall of the Unit 20 pumice, and thus must be historic. Interviews with local landowners divulged that it was a small road in use in the 1930s and 1940s, connecting Tilarán with the Finca El Silencio farmhouse.

PROCESSES OF FOOTPATH FORMATION

The erosional traces of the footpaths have formed because of different rates of erosion between the footpaths and adjacent areas, with surface water as the primary agent of erosion. Erosional processes are complex and will be summarized only briefly.

PROCESSES OF EROSION

Most of the theory utilized in this section comes from Horton's pioneering work (1945). Infiltration theory of surface runoff postulates that soil can absorb water at only a limited rate; this rate is its infiltration capacity. When the infiltration capacity of a soil is surpassed by the intensity of rainfall, overland flow occurs. Infiltration capacity depends on soil texture and structure, vegetal cover, biological structures, temperature, the initial moisture content of the soil, and the condition of the soil surface (ibid. 1945). Because of the variability of these factors, infiltration capacity can change widely across small distances, over time for a single area, and even during a single storm. Erosion of sediment particles too large to be carried downward through the soil profile can occur only during overland flow. In this study, we utilize four broad categories of variables involved in the erosion of the footpaths: climate, slope, soil properties, and vegetation cover.

Climatic variables are relatively independent and include the mean annual rainfall, the temporal distribution of rainfall, and the intensity of rainfall in a given storm. The mean annual rainfall of the region is exceptionally high, between 2,500 mm and 3,500 mm a year (Tosi 1980). Rainfall is lowest in the western portion of the study area and increases dramatically to the east. Only about half of the total precipitation is accounted for by evapotranspiration (ibid.); the rest must travel through the system underground (as throughflow), or on the surface (as overland flow or runoff). Temporal variation in rainfall is more important than is the total annual rainfall. The intensity of rainfall during a storm determines the amount of water that moves as throughflow and the amount that moves as overland flow. Because the rainfall in this region is seasonal, the quantity of water supplied at a given time varies from the amount expected based on the mean annual figure. The intensity of a storm also influences how much soil is detached by the direct impact of raindrops (rainsplash), which plays a major role in erosion of bare soil (Kirkby 1969). Rainfall in the Arenal region is intense and distributed unevenly in time, causing greater erosion than would otherwise be the case.

Slope also plays a role in the intensity of erosion. In a perfectly flat area, water does not flow, and thus erosion by overland flow cannot occur. Young and Mutcher (1969), in a study conducted in South Dakota, relate slope to erosion with the following equation:

$$E = -15.38 + .26R + 1.31S,$$

where E = sediment loss in tons/acre, R = runoff in ft^3, and S = % slope. Although the equation cannot be translated directly to an area with a different environment and soils, it does show that erosion is positively correlated to slope, and that in areas where other variables are equal, steeper slopes cause greater erosion.

Soil and sediment properties are important to both the infiltration capacity and the erodibility of sediments. Texture is probably the most easily understood variable. Coarser sediments have higher infiltration rates than finer ones (Carson and Kirkby 1972), largely because of their higher porosity. Coarse particles are less cohesive than are finer ones, however, because of lower total surface area and electrostatic properties, and are thus more easily detached by rainsplash. Therefore, although overland flow is less likely to occur in coarser-grained soils, when it does occur, erosion is more likely. The tephra-laden soils of the Arenal region consist primarily of sand-sized particles with high infiltration capacities and high erodibility. These soils rest on the Aguacate Formation, a clay-rich soil formed on Tertiary and Quaternary volcanic materials (Tosi 1980). The Aguacate Formation is highly impermeable, but it is also quite cohesive, because of the strong electrostatic bonds between clay particles. Overland flow is common on the Aguacate Formation, but the cohesiveness of the clay keeps total erosion lower than in tephra-derived soils.

There is a regional gradient in tephra particle size and depth. To the east, near the volcano, the particles are larger and the depth is greater. The greater tephra depth provides more easily erodible sediments near the volcano, and erosion should be deeper in this area. The grain size gradient also favors greater erosion near the volcano, as the coarser grains are less cohesive than the finer ones farther away; however, infiltration capacity is greater with increased grain size, indicating lower erosion.

Soil development also influences the erodibility of sediments. Open A horizons with a high organic content have a high infiltration capacity, while B horizons with concentrations of clays or carbonates have much lower infiltration capacities. Structural cracks along ped faces in soils also can increase infiltration capacity and lower the likelihood of erosion. The limited soil development in the Arenal area reduces the significance of this variable.

Vegetation plays a key role in both infiltration and erosion. According to Horton (1945:318), "Vegetal cover is the most important factor in relation to initial resistance to soil erosion." Kirkby (1969) states that overland flow is extremely rare in humid climates except where vegetation has been stripped. Vegetation increases infiltration in several ways. First, it keeps the soil open and increases porosity. Second, it increases the effective roughness of the ground surface and slows the flow of water, allowing more time for infiltration to occur. Vegetation also intercepts raindrops, and thus reduces their impact and rainsplash erosion. Increased infiltration capacity caused by vegetation also lowers overland flow by increasing the amount of water that moves as throughflow. Finally, the mat of organic debris and roots can bind soil together and further reduce erosion.

RELATIVE IMPORTANCE OF VARIABLES IN DEPTH OF FOOTPATH INCISION

A goal of the study is to determine the relative use of the different segments of footpaths. Several variables listed earlier are of particular relevance to this question. Precipitation varies throughout the study area and is conducive to high rates of erosion in areas stripped of vegetation. Depths of footpath incision are slightly higher in eastern portions of the study area, but other variables may play a greater role than precipitation.

Slope is more variable than climate. In theory, a footpath will be incised more deeply in steeper areas than in areas of less slope. Sediment properties also vary. The greater depth of the tephra blanket and the coarser particle size near the volcano should permit deeper erosion in portions of the paths near the volcano.

Statistical analyses were conducted, using SPSS-PC, to explore relationships between variables involved in footpath formation. We looked especially for correlation between the variables and the degree of erosion for each trench excavated. A goal of these tests was to determine the relative roles of the different variables in the depth of incision and if possible, to determine the relative use of the various portions of the paths. A Pearson product-moment correlation coefficient matrix was constructed, using slope, rainfall, and the depth of tephra present above the Aguacate Formation at each trench location, and the degree of erosion present at the same location. Correlations were low between all the variables and the width, depth, and eroded cross-sectional area.

There are a variety of possible explanations for this lack of correlation. First, we were able to control for only some of the variables involved in the erosional processes. We did not control many properties of the sediments, including texture, thickness of the A horizon, organic content, and soil permeability. We were also unable to take microenvironmental variation into account. Rainfall varies more than is recorded in Tosi's (1980) maps, and localized heavy storms, for which we have no record, probably played a major role in variations in erosion. Vegetation differences also may account for some differences in erosion. Some vegetation types are more resistant to trampling than are others. We have also assumed that the variables have remained constant through time. Although major changes are unlikely, it is possible that changes have occurred that could account for the lack of correlation. Finally, we were unable to control for the relative intensity and duration of path use. If a sufficiently large sample of trenches was examined from a segment of a path that received constant use, then we might be able to control for some of the environmental variables and extrapolate to other areas to examine the degree of use of the various footpath segments.

Unfortunately, we cannot yet separate the amount of footpath use from the other variables in our path analysis. There are clearly some variables that we have not controlled in examining the relative use of the different footpaths. According to Schiffer (1987:303), "the importance of identifying formation processes *before* behavioral or environmental inferences are attempted cannot be overemphasized. In far too many cases, the evidence used by an archaeologist owes many of its properties not to the past phenomena of interest, but to various formation processes." Until we have a greater understanding of the environmental factors involved in the formation of these paths, we cannot justify further inferences regarding the intensity and duration of path use.

BEHAVIOR INVOLVED IN FOOTPATH USE

The central questions of this study are behavioral. They include the identity of the people using the paths and the loads that they were transporting. We have some answers to these questions. We know that many live people and some dead people were moving along the paths, with the former carrying the latter for interment. People also carried large quantities of laja, flat-fracturing andesite used in construction of tombs and retaining walls at the cemetery. We have excavated two laja repositories (G-151 and G-152; see Chap. 7) between the cemetery and outcrops of andesite located farther to the west. Laja may have been transported most of the way to the cemetery as a secondary task while traveling to the cemetery for other purposes. The laja repositories were at least slightly organized internally. There was a tendency to separate flatter, larger slabs from smaller and more irregular slabs in both G-151 and G-152. Site G-152 had one section devoted solely to the elongated headstones, which were placed upright in a line. The headstones are long and cylindrical in shape, in contrast to the flat laja slabs, and were used for marking the heads of graves.

COMMENTS, SUMMARY, AND CONCLUSIONS

We have detected prehistoric footpaths as linear anomalies in a volcanically active tropical rain forest environment in northwestern Costa Rica. They were detected most successfully, to date, in the color, color-infrared (Fig. 9-9), and conventional black and white aerial photographs (Fig. 9-10), as well as in the TIMS imagery (Fig. 9-11). These media were most effective when enlarged to a scale such that features approximately 1 m wide could be seen. A variety of means have allowed the features to be confirmed as footpaths. The topographic positions, locations relative to known loci of prehistoric activity, associated artifacts, and stratigraphic profiles across the paths have all provided independent lines of evidence that these are indeed prehistoric footpaths. The ash layers from the eruptions of Arenal Volcano have been particularly useful in confirming their identification as footpaths and have assisted in dating path use and in determining the modes of path entrenchment and preservation. The combination of several lines of evidence provides a much stronger confirmation of the hypothesis that these features are prehistoric footpaths than any single line of evidence could produce.

Until recently, archaeologists have spent little time looking for ancient paths in imagery and on the ground. In spite of the obstacles presented by low population densities, a tropical moist environment, and frequent ashfalls, however, linear anomalies have been detected and confirmed as footpaths in the Arenal area of Costa Rica. Thus, the prospects of finding paths in other moist areas of the occupied New and Old worlds are good. We suggest that aerial photography, of a scale of approximately 1:10,000 to 1:30,000, be examined for any linear features linking known sites. This will need to be followed by on-the-ground inspection and testing to determine the processes of formation and preservation. Methods to separate prehistoric from modern and historic phenomena will need to be developed based on the formation processes involved in each region.

One of the previously unanswered questions of the project is how settlements were integrated during the Silencio Phase, a time when settlements were relatively large, but widely separated. The footpaths provide a partial answer to this question. Integration appears to have been based on ritual or ceremonial behavior. Multiple paths lead from the Silencio cemetery toward villages that buried their dead in that cemetery. The heavily used paths that lead to the spring, as well as the voluminous occupational trash left in the cemetery, argue strongly for long-duration ceremonies in the cemetery, likely directed toward ancestral and other spirits.

An unanticipated result of the footpath study was a direct contribution of data to help resolve one of the important research topics of the project, the degree of forest clearance in prehistoric times. We have made efforts to interpret the pollen, phytolith, and carbonized plant macrofossil record to understand the natural and cultural vegetation (Chaps. 14, 15, and 16). There are difficulties in interpreting these data sets, however, particularly when they are from samples taken from archaeological sites, which are by definition

Figure 9-9.
ck and white print of low-altitude color-infrared ial photograph showing a footpath near the Silencio cemetery. The straight line crossing the center of the photograph is a fence line, which the footpath intersects in the left-central portion of the photograph. As the footpath makes the bend, it divides in two as it heads downhill to cross a stream. The path with the sharper angle bend is earlier; later travelers used the path with the more obtuse angle bend. Photograph courtesy Thomas Sever and NASA.

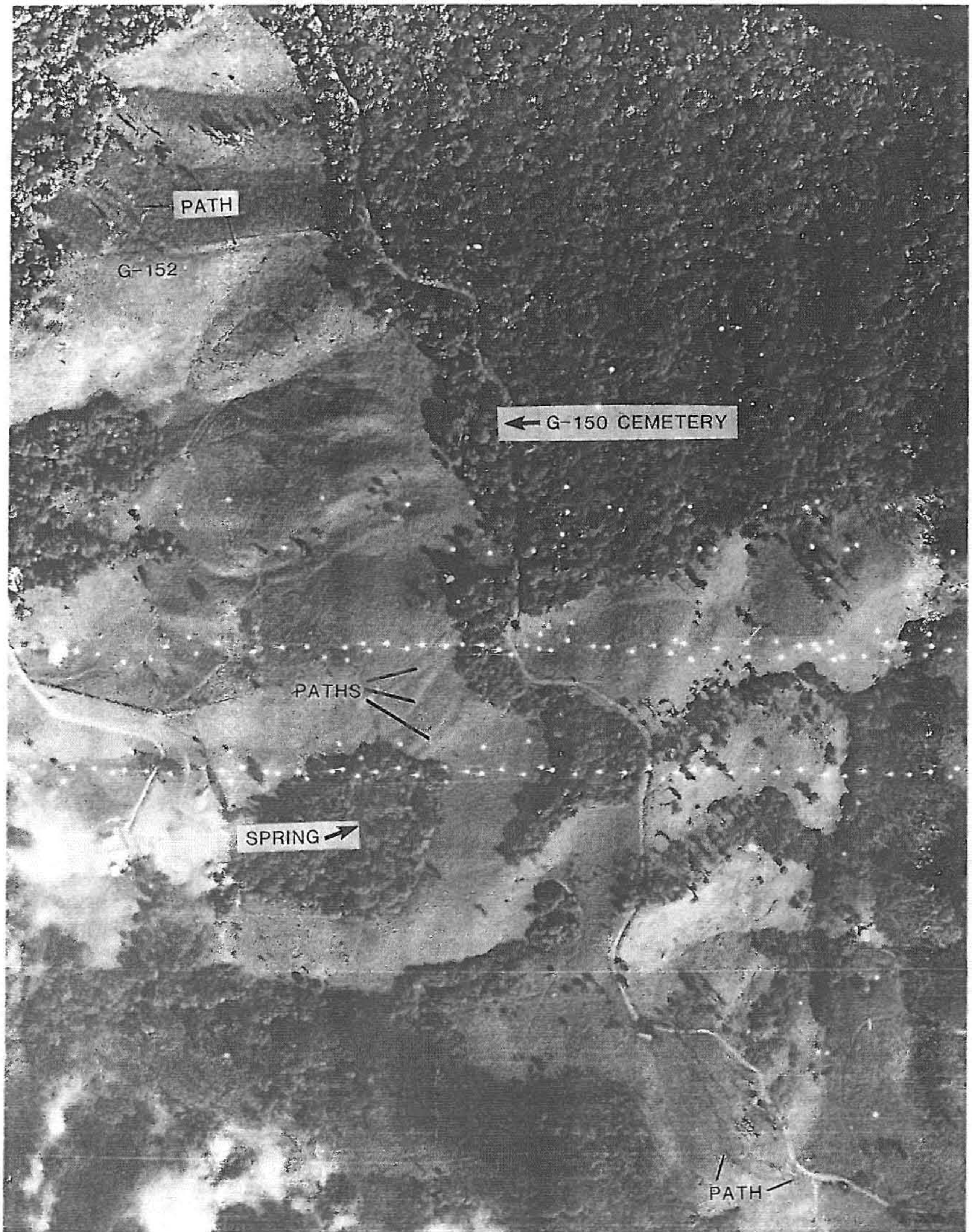


Figure 9-10.
Black and white aerial photograph obtained from Costa Rica's Instituto Geografico showing areas near the Silencio cemetery. Note three lines indicating footpaths connecting the cemetery with a spring.

Figure 9-11.
Unprocessed TIMS imagery (Channel 4) of area surrounding Silencio cemetery. Note three parallel lines indicating footpaths between cemetery and spring. These are the same footpaths shown in Figure 9-10. All were confirmed with trenches. Photograph courtesy Thomas Sever and NASA.

disturbed localities. The contribution made by the path studies is based on the fact that the volcanic ash layers, particularly the Unit 55 tephra, will oxidize when exposed to significant solar radiation. Only one trench—Trench 7, between the graveyard and the spring—out of thirty-eight excavated so far, has encountered an oxidized tephra level. In all other cases, the forest canopy was sufficiently closed to inhibit oxidation of the tephra layers exposed by path use and erosion; this indicates a predominantly forested natural environment between sites. Within the village and the habitation sites, tephra layers are often oxidized, sometimes intensely. The most oxidized area found to date is the lower area of the G-150 cemetery, which must have been devoid of vegetation and exposed to direct solar radiation for a significant period.

It appears that the G-150 Silencio cemetery was more than a place to bury the dead (Chap. 6). There is extensive evidence of cooking, in the form of pottery vessels and especially cooking stones, in the cemetery. Stone tools, particularly expedient stone tools, were manufactured, used, and discarded in the graveyard. Palynological evidence indicates that some maize was grown near the graveyard. The forest was cut, particularly in the lower-status area. The footpaths leading in and out of the graveyard provide further evidence of extensive use of that graveyard. Based on the degree of erosion, it is likely that the traffic to and from the spring to the south of the cemetery was relatively heavy, indicating long stays in the graveyard, rather than rapid visits.

Similar footpath networks have been found in various parts of the world, linking settlements, agricultural fields, sources of water, and other resources. Jessup (1981) describes Apo Kayan settlements and fields in tropical Borneo. Jessup (personal communication, 1987) describes similar erosion and incision of major paths connecting those settlements and fields. There, erosion is accelerated by the efforts to keep the paths free of vegetation for a 2 m to 3 m wide swath, primarily so snakes can be seen from a distance. Sheets has seen numerous Guaymi Indian paths in western Panama, which are similarly incised into the tropical clay soils from 1/2 m to 1 1/2 m. The Guaymi also make an effort to keep the central path clear of grass and other weeds by machete swipes as they walk along the paths. Gross (personal communication, 1987) has observed similar footpath erosion and incision in moist tropical areas of the Brazilian Amazon. He has seen the process and the result in the Kayapó area in central Brazil, described by Posey (1983). Posey describes the deliberate siting of villages in ecological transition zones to maximize access to varied resources, and he describes their "vast network (thousands of kilometers) of trails interlacing villages, hunting grounds, gardens, old fields, and natural resource islands" (ibid. 241). Wendt (personal communication, 1986) has observed deeply eroded footpaths in tephra/soil strata on Mount Fuji, in some cases more than 3 m deep.

Footpath networks can provide a direct window on human transportation and communication in prehistory. Their discovery and interpretation in the Arenal area has been facilitated by the volcanic ash layers; efforts will be made over the next few years to modify the field and laboratory methodology to detect and confirm linear features as prehistoric footpaths outside of volcanically active areas, and in less-moist climates.

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