ARTICLE 14: SUMMARY AND CONCLUSIONS

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(ABSTRACT)

This final article is intended to provide an overview of the field and laboratory researches of the Proyecto Prehistórico Arenal during 1984. Much has been achieved, yet so much more needs to be done volcanologically, archaeologically, and in terms of soils and exploited species. Comparisons of our findings with other projects are made to improve our understanding of prehistoric settlement and resource use in northwestern Costa Rica. The final section includes some speculations about cultural and environmental processes.

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INTRODUCTION

In reviewing the accomplishments of the field and laboratory work of the Proyecto Prehistórico Arenal during 1984, a number of things stand out. First, I am impressed with the determination of the Ticos and the Gringos on the project, in spite of a multitude of unanticipated vicissitudes. Those included a serious automobile accident with seven people injured, customs seizing our computer for a month, serious illnesses of project members and their families requiring extended absences from the project, and other micro–disasters. Second, it is pleasing to see the variety and quality of data that have been collected from sites ranging from Archaic and the earliest ceramic horizons up to the centuries immediately before the Conquest. Detailed analyses have been done on the artifacts, and there have been some important and intriguing conclusions. Third, a large number of significant directions for future research have been identified.

OVERVIEW OF CHAPTERS

The first article was intended to introduce the reader to the Tilarán – Arenal environment, and to the objectives and methods used by the Proyecto Prehistórico Arenal during its 1984 season of field and laboratory investigations. Certainly, the environment is a very moist one, with most areas averaging well above 2000 mm of annual precipitation. It is a very windy environment, particularly in the somewhat less–rainy months. The natural environment would have been a high–biomass mature tropical rainforest. The degree to which aboriginal populations modified that environment is yet unknown, but aboriginal modification must have been vastly less than the present deforestation for grazing and agriculture.

In the second article, Roberta Klausing-Bradley describes data acquisition, cataloguing, data analysis and processing, text writing and editing, and the central role played

by the computer with software for text and data.

William Melson presents a very useful summary of his research on present and past activity of Arenal Volcano. He began studying Arenal shortly after it began erupting explosively in 1968. He and George Metcalf excavated the small Volcano Observatory site near La Palma. In 1977 bulldozers collecting fill for enlargement of the ICE earthfill dam encountered a site at El Tajo. Melson and Carlos Aguilar excavated the artifacts, and studied the strata at this huge 21 m–deep cut located 7 km west of Arenal's summit. This is the most complete record of Arenal's eruptions yet studied.

As Melson notes, sites downwind from Arenal have much deeper deposits of ash than ones to the north, east, or south. For instance, El Tajo is more downwind than the Volcano Observatory site, and has much deeper tephra deposits. Based on meteorological data collected by ICE and by the Instituto Meteorológico, the dominant wind direction in all months is from the northeast, meaning that there is a strong tendency for tephra deposits to be biased toward the southwest of Arenal. This does not mean that the wind never blows in other directions, because it occasionally does blow other directions. As Melson notes, road cut exposures indicate a maximum thickness of tephra near Quebrada Grande, giving a direction of about 8 degrees south of west. It would be worthwhile to examine exposures between Tilarán and Monteverde to further explore past wind directions and biases of the eruptive plumes.

It is clear from Melson's article that Arenal's eruptions during the past 3000 years have been characterized by long periods of repose punctuated by explosive outbursts that have deposited tephra west and southwest of the cone. The eruptions vary from dacite to basalt, from fine to relatively course grain size, in bed thickness and volume of ejecta, and in the maturity of soil development at the point of the succeeding eruption. His descriptions of the El Tajo sequence establish a volcanological framework. We now need to correlate that sequence with the strata in the Tilarán, Silencio, and Tronadora areas to establish a single, well–understood regional sequence.

The survey of the present shoreline of Lake Arenal, under the field direction of Marilynn Mueller, generated very important data. Because of the hydroelectric reservoir impounded by the ICE dam, the present lake level is about 30 m above the previous lake. A problem in doing survey in volcanically active areas is tephra burying sites; where sites are small, and lacking monumental construction, they are often difficult to discover under their volcanic ash blankets. Geophysical research may help, but it is difficult in areas lacking significant human impact on the prehistoric environment. Thus, the "window" through the tephra provided by wave action along the new shore was much appreciated by the project. A few sites were found by following leads provided by local residents, but most of the 22 sites recorded in and around Lake Arenal were found by pedestrian survey. Two of the sites are graveyards, one an island graveyard and the other upon a ridgetop overlooking the lake. One of the sites is not strictly on the shore, but is located a short distance south of the lake.

Site frequencies per period or phase can be taken as crude indicators of population densities in the Cuenca de Arenal. Archaic sites are very infrequent, particulaly when compared with the abundance of Archaic sites in nearby Panama (Cooke 1984). Although a number of sites were found with some Middle Formative Tronadora Phase artifacts, only one site was found with a preponderance of artifacts from that phase. The number of sites with a preponderance of artifacts dating to the Arenal Phase increases dramatically to 15, clearly indicating a peak in population in the five centuries before and

after Christ. Only two sites had the bulk of their artifacts dating to the Silencio Phase, and three were predominantly Tilarán Phase. It appears that the Arenal area population in the millenium prior to the Spanish Conquest had declined to a level almost as low as during the Tronadora Phase. It suffered a further decline in early historic times, as diseases introduced by the Spanish ravished Middle American native populations. It was not significantly repopulated until almost a century ago with the inmigration of Costa Ricans to exploit gold, soils, and other resources.

In Article 5 John Bradley, John Hoopes, and Payson Sheets describe the test excavations conducted at five sites on or near the present lakeshore of the Laguna de Arenal. The Cañeras site, G–156, was the most disappointing, as the surface collections indicated a site which had been occupied during all four ceramic phases. Unfortunately, the strata were thin and much disturbed by cultural activity during the past few decades. The site did yield some very interesting artifacts, including metates, and ground and chipped stone celts.

G–161 is an intriguing site, in that it contains all of the ceramic phases, and may have some preceramic Archaic material as well. Of the entire collection of identified ceramics, 3°/o are Tronadora Phase, 5°/o are Arenal Phase, 11°/o are Silencio Phase, and 69°/o are Tilarán Phase, with the remainder unidentified. It is unusual to see a site with a regular increase in percentage of identified ceramics through its occupation. Three test units were excavated, Operations B, C, and D. The deepest ceramics in B and D were pure Tronadora Phase and the deepest ceramics in C were pure Arenal Phase. A hearth and some chipped stone artifacts may precede the ceramic deposition. Early maize was found, along with a mano. The strata are better preserved here and less disturbed than at G–156, although not markedly so. Earthquake cracks were encountered in the Unit 30 soil. They evidently resulted from violent tectonic activity that immediately preceded the eruption that deposited Unit 20. The lack of erosion of their sharp edges in this rainy environment indicates to me that they occurred probably no more than a few days before the Unit 20 deposition. The fact that the Unit 20 lapilli do not trickle down in the cracks also indicates the tephra had not fallen when the large earthquake occurred. Thus, the earthquake is fixed in time to a few days, or perhaps only a few hours, prior to the Unit 20 emplacement.

The Tronadora Vieja site (G–163) was of considerable interest, because of the apparently Archaic biface found there, and the fact that it is the only site with a preponderance of its ceramics dating to the Tronadora Phase. Because of the erosion of most of the uppermost tephra and soil layers by wave action, the excavations could begin from relatively "low" or early levels. A disturbed hearth with carbonized maize nearly was found with Tronadora Phase artifacts. The radiocarbon sample was too small to be useful, because the resulting two–sigma range was much too long.

G–169 is not on the present or past lakeshore, but is located on a ridge overlooking the cuenca. The total ceramic inventory indicates an increase in use through time: Tronadora and Arenal Phases are represented by only 1°/o of the ceramics, but the Silencio and Tilarán Phases represent 38 and 39°/o of the ceramics respectively. Operations B, C, D, F, G, and H are in mixed Silencio and Tilarán Phase materials, with much of that mixing coming from mound construction, apparently. The function of the mound construction is unknown. Operation E delved down into earlier horizons, with the Tronadora and Arenal Phases being equally represented. A possible early hearth was found, and a carbonized bean contributed dietary information. The chipped and the groundstone industries were amply represented.

John Hoopes describes the excavations at G–175, Viboriana, the easternmost site excavated in 1984. Both surface collections and excavations indicated that the site was occupied primarily during Arenal Phase times. One of the radiocarbon dates is not surprising (Tx–5082, with A.D. 490 as the central date), but the other, from the intrusive pit, seems much too recent (Tx–5083, with A.D. 1270 as its central date). Being the site closest to the volcano excavated in 1984, it had some relatively thick volcanic ash layers, particularly Units 20, 40, and 41. Why the Unit 50 Complex was not better preserved is unknown, but it may be because of the thinner nature of the tephra layers and the fact that the site was occupied before and after their deposition, adding human disturbance to natural processes of bioturbation and soil formation.

In Article 6 John Bradley describes the excavations at the high status Silencio graveyard site (G–150). It dates to the Middle Polychrome Period, or the Silencio Phase, estimated at A.D. 700 to 1100. That it was a high status graveyard is evidenced by the gold, the Cabuyal Polychrome vessels, the elaborate and thin metates, the impressive earthmoving efforts with their stone fill–retaining walls, and the amount of time people spent visiting the graveyard for post–interment activities. It is not clear if this elevated status derives from a social distinction or from sexual status. If it is social, then the individuals buried at G–150 were chiefs or their families who received preferential treatment because they were at the top of a ranked society. On the other hand, all individuals for whom any evidence of sex was preserved were male. This opens the possibility that males received preferential treatment, and that females and children were buried elsewhere, likely closer to home.

The Silencio graveyard had been looted for many decades. It is located in a topographically prominant place, on top of the first high ridge to the east of the low pass between Tilarán and the lake. The pass would have formed a natural corridor for travel, transportation, and communication between peoples living on the Pacific and the Atlantic sides of the Cordillera de Tilarán, and the ridge is the single most prominant topographic feature within a 6 km radius of the pass.

Excavations divulged two times of graveyard use, one prior to the fall of the Unit 40 and 41 tephra layers, and one after those eruptions. It is interesting that the coarse Unit 40 tephra was used, in some cases in the later stage of graveyard use, as a "bed" upon which the body was placed. The tephra had a preservative effect, by draining away water, but whether that was intended is unknown. Equally unknown is whether the tephra deposit had symbolic and/or ritual implications.

Large amounts of domestic trash are interpreted as not indicating a habitation site, but rather as indicating frequent and probably extended visits by relatives and/or townspeople. The domestic residues initially look much like the midden debris from habitation sites, but there are differences. For instance, habitation sites are characterized by significant percentages of chalcedony chipped stone artifacts, but the Silencio collection is notable for a paucity of chalcedony.

Two excavations were placed in what is interpreted as a higher status area of the graveyard; these are operations B and D. This is in the flat, upper portion, and graves generally have more laja, polychrome vessels, more decorated metates, and occasional fine bifacially–flaked implements and gold pendants. In contrast, Operation C is in the lower portion of the cemetery, and on the edge of the ridge. Graves are not constructed with the same solidity, offerings are less, and quite a lot of domestic trash from graveyard

cleaning was deposited in the area. Thus, we have a funerary midden. Considerable effort was put into stabilizing the sloping surface from erosion by placing large river rocks on the surface. They probably also mark particular graves.

A large–scale effort was made to flatten and extend the ridge top by hauling tons of laja and building a fill–retaining wall. The closest known source of laja is 3 km east of Tilarán, which is 9.5 km east of the graveyard in a direct line. That the effort was successful is evidenced by the tephra layers; they sloped steeply prior to its construction, but the layers deposited in that locality after its construction are flat.

Based on Bradley's estimates of the possible number of human burials in the mapped area of the site, and the fact that the graveyard extends on the other side of the ridge, there could have been 3000 people buried there. The associated habitation areas for the graveyard are unknown. Considerable survey and testing efforts were undertaken within an approximately 2 km radius of the graveyard to locate associated habitation, and none were found. We are confident that the habitation site(s) were farther away. In which direction we are not certain. However, a probable road or path leads westward from the graveyard, makes an obtuse angle bend around site G–152, and heads toward site G–151. That is in the direction of the closest known laja outcrop. Thus, on admittedly gossamer evidence, I suggest that at least some of the graveyard occupants lived to the west of the graveyard.

Bradley also describes the Peraza graveyard, site G–155, and its Tilarán Phase burials. Although there was no skeletal material left, apparently due to a lack of laja or volcanic tephra used in construction, they clearly were burials. The intrusive pits and the funerary vessels indicate burials.

The results of Irving Friedman's analyses of bone samples from the G–150 cemetery are of considerable significance, particularly given the consistency of results: most results are close to the average of –19.6 per mil C13. It would be exceedingly convenient if one could take that figure, consult a chart such as that in van der Merwe's article (1982:603), and derive a figure for percentage of maize in the diet. Given the above figure, and that chart, one would derive a figure of about 12% maize in the diet. However, things are not quite that simple. First, we are not certain that maize was the sole cultigen that uses a C4 photosynthetic pathway available to prehistoric Costa Ricans, although that does seem likely. Numerous edible wild species of plants that use C4 photosynthetic pathways are known in Guanacaste, and these include bromeliads (e.g *Bromelia penguing* and *Bromilia keratas)* and various grasses (Daniel Janzen, personal communication 1984). And, of course, these can be obtained directly, or indirectly by eating animals that have consumed those plants.

On the other hand, fortunately, tropical forests have very few or no C4 plants (van der Merwe 1982). Tropical savanna environments apparently are environments with abundant C4 plants. It also is fortunate that bone collagen is very stable, even under harsh weathering regimes.

Van der Merwe (1982) claims to have detected the shift from non–maize to maize–based subsistence in the northeastern North American woodlands with figures of –21 per mil changing as far as –12 per mil. It is likely that the bulk of that shift *is* due to maize, but not all of it can automatically be ascribed to corn. Comparatively, skeletons from Parmana, in the Amazon area, prior to maize, had exceptionally negative values of –26 per mil, owing to high carbon dioxide recycling among plants under a dense closed forest canopy. Maize–growing populations in the same area, but later in time, had values of

−10.3 per mil, indicating maize may have supplied up to 80°/o of their diet (van der Merwe 1982).

Using the above to interpret Friedman's results, and considering all the caveats and operating assumptions built into the method, I would conclude that maize clearly was a minor fraction of the diet of the people buried in the Silencio Phase high status graveyard. It probably was less than a tenth of their diet. This is important, given the strong reliance on maize by contemporary populations to the northwest in Mesoamerica, and probably to the southeast as well. And, it is important in that the graveyard was for high status burials; it is possible that individuals of lesser status consumed even less maize in their diets. Needed are samples from more contexts, more periods, and a wider sampling of contemporary social segments.

In article 7 Mark Chenault describes the two problematic large stone features located short distances to the northwest of the high status graveyard. At least the closer G–152 site is linked to the graveyard by a long linear feature that exits the graveyard, travels straight to G–152, makes a sharp bend around the site, and heads straight downhill in the direction of G–151. As mentioned above, it probably is a road or pathway. It is being studied on NASA remote sensing imagery.

The two sites share certain features. Both were built on the Unit 50 soil, and therefore are contemporary with the earlier Middle Polychrome stage of the G–150 graveyard. The fact that they are "sealed" by Unit 50 below and Unit 41 above places them clearly in time. This is a case of the advantages of working in volcanically active areas, as stone features with little or no ceramics are notoriously difficult to date. The tephra sandwich here unequivocally establishes their age and their contemporaniety with the high status graveyard. Further, the tephra had worked its way in between many stones, in addition to capping them, which indicates they were exposed and loose at the time of Unit 41 deposition, with air spaces between the piled rocks. Both features had no groundstone artifacts whatsoever, and notably few potsherds. On the other hand, both had comparatively abundant chipped stone artifacts, largely waste flakes. Chipped stone celts were occasionally made there, as well as some flakes for cutting purposes. Some flakes probably derived from shaping laja for use in the graveyard, and some surely were inadvertent, as a thin edge accidentally contacted another stone during construction of the feature.

The tephra also was essential in establishing the features as cultural, not natural. In that they were found above numerous tephra and soil levels, they must have been brought in by people and placed deliberately. The largest size of airfall volcanic material that could be in Unit 50 by natural means is only a few millimeters in diameter. Had these features been discovered in a nonvolcanic area, they could have been misinterpreted in a of ways. First, they look like a mass graveyard, with all the flat–lying laja. However, there are no graves under the stones. Second, the lack of ceramics in most areas of the features might lead one to reason they are aceramic, and thus they could be preceramic. Similar features probably exist in other areas of Costa Rica, but none have previously been identified as laja repositories for cemetery use.

At the Neblina site, G–151, as many as three courses of carefully laid stone were found. In at least two places, right angle bends of the masonry were found. This is the most careful construction at either of the two sites. Most of the stone is laja, but some river rocks and some elongated stones that would serve well as head markers were found. In addition, a huge elongated stone with fine incisions on one side was found. The incisions cannot be confirmed as prehistoric, as a looter's pit extended around three sides of

the large stone. However, there are three indications that it *may have been* incised prehistorically: (1) undisturbed pumice of Unit 20 was found on the fourth, incised side of the stone; (2) the incision patterns match panelled haching on ceramic vessels; and (3) the people who dug the pit claimed they had not moved the stone, and they were surprised to hear that the side they had not exposed had incisions. Thus, I feel the incisions probably are prehistoric, but they cannot be considered certainly to have been prehistoric. They are very similar to incisions on a few normal–sized laja found at the G–150 cemetery.

The Las Piedras site, G–152, is only 250 m from the high status graveyard. The stones were less carefully placed, or, they had been more disturbed by people looking for suitable stone for expedient tool manufacture. In most places the rocks were stacked three deep. One place had a number of elongated stones, suitable for head marker use, lined up and placed vertically. There was no burial under or near them. The chipped stone assemblage is notable for its greater diversity than at G–151, and for its greater abundance. I suggest that both of these are explained by G–152 being located closer to the graveyard. The assemblage includes a chipped stone celt, and even some thermally fractured debitage that is evidence of at least some cooking having been done there. The feature is approximately 4 meters in diameter.

Article 8 briefly describes excavations at two late habitation sites on the Finca El Silencio, on the Pacific side of the divide, and close to the high status graveyard. They were found as part of the survey for habitations associated with the use of that graveyard; only G–153 was contemporary with graveyard use, but it yielded very little. G–154 yielded quite a lot of domestic artifacts, but it was occupied after the cemetery had fallen into disuse.

The Dos Armadillos site (G–154) yielded considerable ceramic and lithic artifacts, with workshop concentrations of fine bifacial debitage on one side of the site. The artifacts included a lot of charcoal, mostly wood, but also including carbonized macrofossils identified as maize, jícaro, avocado, and other fruits. A radiocarbon date yielded the not–surprising result of A.D. 1362, with a range from A.D. 1304 to 1420. Unfortunately no evidence of aboriginal construction or of an inside–dwelling activity area or feature was found. The most prominent feature was a trash–strewn living surface, with numerous pieces of pottery that were broken *in situ*, presumably by the residents stepping on them.

John Hoopes conducted a preliminary ceramic analysis, focusing on almost 5000 diagnostic ceramics from survey and excavations. His assessments of similarities and differences among the Arenal area ceramics, the Greater Nicoya ceramics to the west, and the Atlantic and Meseta Central ceramics to the east and south, are very important. Notable at all times, from about 1000 B.C. to the Conquest, is the Arenal area residents' maintenance of their own identity, as seen in the pottery. The Arenal area is not merely an extension or attenuation of either, and it is not merely a blending of both, but it is a region with its own vitality and tradition. Certainly, it shared characteristics with both areas, in varying intensities at various times, and those sharings are indicative of cultural contacts.

The earliest ceramics are associated with the weathering and formation of a tephra–enriched soil on the earliest volcanic.ash level from Arenal Volcano, as far as we can tell from 1984 research. They are from the Middle Formative Tronadora Phase, and they share resemblances with widespread Middle Formative sites in many areas of Costa Rica

and Middle America. More specifically, Chaparrón and La Montaña in the east and Vidor in the west have quite similar ceramics on this earliest of Costa Rican ceramic horizons. Tecomates and thick bowls abound in our collections. For some reason, ash temper is rather rare, in contrast with all later phases in the Arenal area. Certainly, there was no scarcity of volcanic ash as a natural resource in the area, but it appears that the earliest residents were not taking full advantage of the superior qualities of volcanic ash as a tempering material.

It is during the succeeding Arenal Phase that population reached a peak in the area, as judged by the number of sites found. The actual peak of population apparently was reached before the time of Christ, and continued to decline, with perhaps some ups and downs, until the time of the Spanish Conquest. The Arenal ceramics share some hallmark characteristics of the Greater Nicoya Zoned Bichrome, but others are absent or rare, including black painting and trichrome painting. There is much continuity from the Tronadora Phase, indicating an evolutionary relationship between the phases, rather than a population replacement or site–unit intrusion. Much stamping, with a variety of instruments, was done for ceramic decoration. Red multiple–brushed lines were popular, along with a plethora of solid triangles. Complex–silhouette bowls were the most common vessel shape. In terms of specific types, Los Hermanos Beige was the single most common type. I think it is significant that this is a phase that lasted a millenium. Or, rather, that artifactual changes over a thousand years were insufficient given present data to subdivide into smaller units. Notable for their absence were Tola and Zelaya Trichromes. The population shifts that Lange (1980) noted seem to be substantiated by our data.

It is curious that we have so little data on the transition from Late Zoned Bichrome into Early Polychrome. It is possible that the data are there, but we simply are not recognizing populations from that time because of a lack of key indicators as identified from other sites in Guanacaste or elsewhere in Costa Rica. Alternatively, the area could have been abandoned for a century or longer. If it were an abandonment, a candidate for consideration as a causal agent would be Arenal Volcano, of course. However, that time seems to have been a time of relatively slight volcanism, compared with the deposition of Units 40 and 41 later in the sequence. Yet, those relatively major deposits had strikingly little impact on the ceramics and other artifacts deposited in the high status Silencio graveyard –– comparing artifacts before and after those eruptions. It is possible that the people using the Silencio graveyard were residing farther from the tephra blanket and thus were minimally affected. At any rate, it is clear that demographic recovery from the Zoned Bichrome peak never occurred.

The Silencio Phase, including some Early and Middle Polychrome characteristics, has as its hallmark in the Arenal area the type known as Jiménez Polychrome. Jiménez Polychrome includes some Greater Nicoya Early Polychrome modes. It is very similar to Cabuyal Polychrome, and it is an indicator that Arenal area peoples at this time maintained closer connections with Greater Nicoya than with the Atlantic area. Many other polychrome types are found, including Mora and Papagayo. The high status graveyard contained many Cabuyal Polychrome miniature vessels with burials, which may indicate people using the graveyard came from farther west rather than from the Atlantic side of the divide. They probably were not locally made. It is interesting that Arenal and Silencio Phases have almost identical paste and decorative modes, yet rim forms are different. The paste and decoration, as with the red–rimmed pottery tradition, indicate a notable cultural continuity over some 1500 years in the Arenal area.

The Tilarán Phase marks the most dramatic break with that tradition, but the intensity of that change, as well as its explanation, are not well understood. Actually, the beginnings of a break in connections between the Arenal area and Greater Nicoya are detectable in the upper Silencio Phase. This culminates during the Tilarán Phase, when there are very few similarities with Nicoya. The connections are strongly with the Atlantic Drainage and with the Meseta Central, and the intrusion into Chira Island. This might have meant actual population incursions into the Arenal and Chira areas, but it also could have come from the acculturative effects of trade and social relationships shifting to another direction. At any rate, ceramics are unslipped, often hastily made and decorated, and decoration is by plastic, applique techniques. Many duck–tail shaped thick strap handles with stylized faces were made.

The chipped stone analysis, by Payson Sheets, attempted to describe and interpret some 2300 artifacts. Certainly the most notable characteristic of the entire assemblage is its conservatism. It is dominated by core–flake technology to create the basic cutting edges for household use from the earliest phase to the latest. The use of boiling stones, core–flake technology, and bifacial manufacture, has its roots in the Archaic and earlier. The persistence of stone boiling during many centuries of ceramic manufacture is striking. The Arenal area residents' needs for lithic edges were met by local materials and by local residents. Thus, the instabilities and high costs of relying on outside expertise and/or outside raw materials were avoided. In terms of lithics, then, they avoided an economy of dependency, in marked contrast with their Central American neighbors to the northwest.

The domestic core–flake industry is notable for a relatively low hinge fracture rate. It is informal, with few unidirectional or well–preformed cores. Dacite was the favored material, followed by chalcedony and jasper.

Bifacial manufacture was found in all phases, and in the Archaic. It was not a major component of the lithic inventory of any phase, but it was somewhat more common in the later two phases. Some effort went into chipped stone celt manufacture, but not nearly as much effort as went into the chipped–and–groundstone celts. The chipped stone celts are interpreted as more expedient tools than the groundstone celts, i. e. they were easier to manufacture, but they were more easily damaged in use, and thus they received much less curational time and effort. A few chipped stone workshops were excavated, from the last two phases. Curiously, some flakes from bifacial manufacture were rather highly polished. It is possible that they were polished by wave action on the Arenal lakeshore, but it seems somewhat more likely that they were intentionally polished. For what reason, and by what technique, remain unknown. Both ventral and dorsal surfaces were equally polished. Unifacially flaked artifacts, probably accurately termed "scrapers," were relatively rare, and were found exclusively at habitation sites, not surprisingly.

The general level of lithic skill, as judged by the frequency of hinge fractures, was quite good at all times. It was the best at the high status Silencio graveyard, which could be interpreted as at least a part–time occupational specialization. However, a partial specialization is not the only explanation, and an alternative is that greater care in manufacture was taken because of the sacred nature of the locality and because materials had to be hauled long distances from outcrops or village–household stores, resulting in decreased error rates.

In Article 11 Mark Chenault thoroughly describes the rather extensive collection of of

groundstone and ground–and–polished stone artifacts. The collection is dominated by manos, metates, and celts. A total of 39 metates and 12 manos was recovered. It is important that all were used for grinding, and it is virtually certain that the principal substance ground was maize. However, many of the metates were not made to sustain extended maize grinding use, as many were very thin. The collection, viewed by Mesoamerican standards, seems intended for occasional maize grinding rather than daily processing of large amounts of a dietary staple. Thus, I suggest that they may be both utilitarian, i.e. for maize grinding, and symbolic, i. e. they may identify an individual with high status, with significant connections with the supernatural realm, and they may symbolize fertility, productivity, and societal stability.

It is curious that metates so outnumber manos in this collection and in other private collections in the area. It may be that other materials were used at times instead of stone for manos; might Chonta palm wood have been usable as a mano, without introducing too much fiber into the diet?

The frequency of celts in the Arenal area indicates a considerable amount of effort in woodworking. The chipped stone analysis also indicated woodworking activities, probably involved with some forest clearance, wooden artifact manufacture, construction and maintenance of housing, canoe manufacture, and other items. It is interesting that Chenault found a chronological differentiation, with flaring–bit celts in the earlier two phases, and rounded bits later.

Chenault and Mueller, in Article 12, describe the finer ground and polished stone artifacts and a gold artifact, lumped under the term jewelry. Fortunately, the gold bird pendant was excavated under extremely close controls, with a maximum of contextual data, as it was from an intact tomb, sealed above and below by volcanic ash layers, and it was associated with samples taken for radiocarbon dating and for analyses of pollen, phytoliths, and soil. Its style is an interesting combination of Atlantic–Meseta characteristics and south–Central Panamanian characteristics. It is similar to a much later specimen found by Creamer (1983) in the Gulf of Nicoya. It clearly is a high status artifact. It may be symbolic of chiefly status in a ranked society, or it could be indicative of male status.

The serpentinite pendant found at site G–164 might date to Zoned Bichrome times. It is winged, and probably is a fragment of a bat–form pendant, a form not uncommon in Costa Rica.

Three greenstone beads were found at the high status graveyard (G–150), and three beads of a soft black stone were found at the later habitation site G–154.

In all cases of jewelry, the raw materials were from a considerable distance from their location of discovery, and do indicate wide–ranging trade and social relationships. However, their paucity does not indicate regularized long–distance trade relationships. There is a possibility that the gold could have been locally produced, as gold is still mined at the Rio Chiquito source. The radiocarbon date for the gold pendant, A.D. 235 (range: A.D. 20–445), does seem early by Guanacaste standards, but Bray (1981: 154) mentions the liklihood of gold in a number of areas of Costa Rica during the first millenium of the Christian Era, and some in the earlier half of that era.

A key part of the research design is botanical analyses to determine the wild and domesticated plant species that were utilized. Thus, Meredith Matthews' chapter on macrobotanical finds from the excavations is an important contribution. The adaptation at all times, apparently, was diversified. There seems to have been no time in the prehistoric

past when a single staple dominated the diet. Domesticated crops which have been identified include maize, beans, and avocado. Corn was the most commonly recovered cultigen, probably more owing to its greater probability of carbonization and preservation rather than it having been the major food crop. A variety of root crops probably were utilized, but they do not preserve well and we have no direct evidence of them. Jicaro was found; it probably was not domesticated, but probably it was used as a container similar to the bottle gourd. A variety of nuts and fruits from trees were utilized; presumably no genetic changes from selection were involved, and they remained wild utilized species.

COMPARISONS WITH OTHER NEARBY PROJECTS

Of the variety of projects within a 50 km radius of Tilarán, Lynette Norr (1982/3) conducted the most thorough prehistoric research project to date. She spent a total of 10 months in the field, focused primarily upon the low passes or valleys between Tenorio and Miravalles Volcanoes, 25 km northnorthwest of Tilarán. Most sites were found by noting funerary architecture: stone mounds were 20–40 m in diameter, and 1/2 to 2 m in height, being constructed of river stones and laja. She found very few habitation sites, as they rarely are visible in such an environment. Natural vegetation and pasture dominated the landscape, and plowed fields were rare. In fact, vegetation cover was so thick that she notes difficulty in estimating the percentage of her quadrats that she was able to survey. Examination of a given area in such an environment unfortunately does not often permit mapping the distinction of site:non–site areas.

Three sites received most of her attention: Ramirez, Rio Naranjo, and Mendez. Each has 6 or more stone burial mounds, with numerous graves in each mound, and all were from the Zoned Bichrome Period. Tombs were a mixture of river cobble and laja construction. Well over half of the tombs excavated had no visible bone preservation; some had only "decomposition shadows" of bone left. Some were secondary, some were primary extended, and some were primary flexed burials. She dates the major occupation to between 300 B.C. and A.D. 300, with the period from A.D. 600 to 1000 "approaching abandonment." Many of the graveyards were accompanied by pictographs.

Aguilar (1984) recently reported on two months of fieldwork conducted in 1977–78, between Volcan Arenal and the old Lake Arenal, in areas now largely flooded by water impounded behind the earthfill dam of the Arenal Hydroelectric Project of ICE. A total of 10 sites was recorded. He found evidence of human occupation from before 1000 B.C. to the Conquest. The earliest artifact is a scraper from Unit 10 at El Tajo, which Aguilar estimates dates to 1500 B.C. It probably does date to 1000 B.C. or earlier, but until better radiometric and stratigraphic data are generated, more accurate dating is not possible. El Tajo and El Castillo are the earliest ceramic–bearing sites, and C14 dates are available: 220 $\pm$65 B.C. and A.D. 120 $\pm$80. The artifacts derive from the top of Unit 8 of the El Tajo sequence. Aguilar sees similarities with the Pavas phase and the El Bosque Complex from the Atlantic Watershed. The Asdrubal and Carmelo sites are Late Zoned Bichrome, with artifacts found in the Unit 6 (El Tajo sequence) soil. The Rio Chiquito site ranges from Late Zoned Bichrome into Early and Middle Polychrome periods. The Cuñuñunga site is Early–Middle Polychrome, and the Venado site is Middle–Late Polychrome. Aguilar concludes that the Arenal area offered optimal ecological conditions of temperature, rainfall, and soils. He concludes that the area's intermediate geographic posi-

tion is reflected in its intermediate cultural composition. The early periods are more closely related to the Atlantic, whereas the middle and later periods show strong influence from the north Pacific, or lowland Guanacaste area.

There are some site overlaps: both Aguilar and we recorded La Isla (his No.198, our G–166) and Rio Chiquito (his No. 196, our G–176). Our site names are Isla Chiquita, and Sitio Chiquito, respectively. Their times are predominantly Arenal and Tilarán Phases for the Island Site, and largely Arenal Phase for the G–176 site. Thus, there are some differences in how the two projects date these two sites.

We cannot fully agree with the statement of optimal conditions, as the area's soils range from good to poor, much of the area receives excessive rainfall, the very strong winds are detrimental to structures and agriculture, and temperatures are not suitable for some cultivars such as pejibaye. Our data do not fully agree with Aguilar's assessments of external affiliations. Inhabitants of the area at all times maintained a strong local tradition. The strongest connections with lowland Guanacaste, according to our data, were during the Middle Polychrome Period, and the strongest connections with the Atlantic area were during the final prehistoric occupation.

FINAL COMMENTS, CONCLUSIONS, AND SPECULATIONS

One means of assessing the impact on volcanism on Arenal area societies is to compare volcanic events and processes with the record of settlement within the tephra apron. During the Archaic Period populations were minimal. Hunter–gatherers exploited wild species and maintained a mobile life style. The soils were clay–laden and high in iron and aluminum oxides; these are referred to at the Aguacate Formation. Although the soils were not particularly fertile, they did not need to be markedly fertile for such a dispersed adaptation that had minimal environmental impact. These soils are very mature, and did not have the advantage of periodic tephra enrichment that characterizes later soils developed on Arenal volcanic products.

PHASE	1 + SHERDS	5 + SHERDS	10% OR MORE
Tilarán	17	11	8
Silencio	22	18	13
Arenal	24	19	20
Tronadora	18	9	4

Table 1. Numbers of Sites per Phase By Different Criteria. Left column is number of sites per phase with one or more sherds. Middle column is five or more, and the right column is number of sites with 10% or more. The right column probably is the better indicator of overall populations at different times.

Arenal Volcano first erupted sometime around 1000 B.C., and this apparently was followed by a considerable population increase and notable changes in artifacts and adaptations. Sedentary settlements are the rule, with ceramics, different chipped stone, groundstone implements for grinding food, and celts for cutting trees and making wooden implements. A total of 18 sites have ceramics classifiable as Tronadora Phase, and of those sites, 4 have more than 10% of their ceramics datable to the Tronadora Phase (Table 1). That is quite an increase from the sole Archaic site from our research, to which

one could add the Archaic material from Aguilar's research. However, many other areas of Costa Rica experienced an apparent population increase at about this time, as Middle Formative ceramics have been recognized at a number of sites (Lange 1984b). Therefore, it is important to know if the Arenal area increase was proportionally larger than the country–wide increase. If the Arenal increase was greater, then tephra enrichment of the soils and the resultant advantages could be possible explanations. The soil is very black, with a high organic content, and is quite fertile. Unfortunately, comparable survey data with early phase sites do not exist, so making such a calculation is not possible at this time.

The effects of the Unit 55A deposit are unknown, but it does not appear to have been thick enough in the Silencio area to have caused major problems for a long period of time. The Unit 50 Complex is a series of tephra layers and soils that correlate with the long Arenal Phase. Excavated sites often divulge weak or disturbed stratigraphy, probably mixed by bioturbation and anthroturbation. It is during this time period that the area witnessed its largest population density, and this apparently applies to other areas in the Cordillera, including Rio Naranjo. Thus, it is during this time that the strongest argument could be made for periodic enrichment of soils by relatively thin tephra deposits as an underlying encouragement for greater population densities. Again, such an argument is weak without a controlled sample from an area outside the tephra apron, but with a similar elevation, precipitation, and temperature regime.

Based on ceramics, it appears that population began dropping sometime around the time of Christ. It is possible that the large eruption that emplaced Unit 7 of the El Tajo sequence in the area was sufficiently damaging to flora, fauna, and human life that it facilitated the population decline. However, the loss of population during, or just after, the Zoned Bichrome Period has been noted from inland locations in Guanacaste. Thus, again, we are not able to filter out a possible volcanological impact from trends occurring more generally.

Occupation was markedly reduced during the Silencio Phase from its preceding high (Table 1). And, it apparently continued to decline during the subsequent Tilarán Phase. The deposition of the Unit 41 and 40 tephra layers must have had a considerable impact on flora and fauna, initially deleterious. They are thick in the Silencio area, and little time elapsed between their deposition. In fact, the finding of a soil, even a slight soil, developed on Unit 41 is rare in the area. The Unit 20 tephra is the back cover to the prehistoric book, as it was emplaced almost precisely on the prehistoric–historic boundary. Thus, it is very useful to the archaeologist in judging site disturbance as well as recognizing that key interface.

An important issue is the relationship of the Arenal area societies with their neighbors to the west and to the east. Were they simply peripheral to, and derivative from, Greater Nicoya culture? Or were they a dilution of cultures in the Atlantic Watershed or Meseta Central? Or, were they merely a blend of characteristics from both directions? Or were they actively charting their own course, selectively accepting and integrating innovations from both areas when those ideas were deemed useful and appropriate? I favor the latter approach, and thus would define a Cordilleran culture area constituting a wedge between the Greater Nicoya area to the west and the Atlantic–Meseta Central area to the east and southeast. It would include Rio Naranjo, Hacienda Jericho, Monteverde, and the Arenal area sites. Its maximal extent to the northwest is unknown, but it could include Miravalles and Rincón de la Vieja volcanic complexes. Likewise, its south-

eastward extent is unknown, but it could extend as far as Cerro Cedral, perhaps ending near San Ramón and Zarcero. Future research in this Cordilleran region should examine the possibility of a separate culture in that area.

I would not, however, define it as a separate culture area on the same analytic level as the two adjoining culture areas: Greater Nicoya and the Atlantic–Meseta Central, because the Cordillera does not contain sufficiently unique assemblages of artifacts, features, and customs from these two large areas. Thus, the question then becomes, if it should be subsumed by one of the two large areas, with which is it most closely affiliated? The ceramics, the chipped stone and groundstone artifacts, and other artifacts all show a stronger affiliation with the Greater Nicoya area, in spite of occasional exceptions. And, it should be pointed out, that the affiliations become stronger at the end, during the final few centuries prior to the Conquest, when the population was declining. At any rate, I feel that the Cordilleran zone should be recognized as a sub–region of Greater Nicoya, based on what presently is known about artifacts in the zone and in adjoining areas. One must also bear in mind that vastly more archaeology has been done in the Greater Nicoya than in the Atlantic; thus it is probable that closer Cordilleran-Atlantic relationships will be definable in the future, when the Atlantic data base increases. Also, the characteristic of stone cist tombs shows Atlantic rather than Nicoyan affinities.

The Arenal area does seem to have been independent from outside control during prehistory. Politically, there is no evidence of control or coercion, and given the relatively low level of political evolution throughout the Nicoya and Atlantic/Meseta sequence, one would not expect efforts at conquest and domination of this area.

Economically, they seem to have been almost completely independent. In terms of subsistence, it is highly unlikely that significant foodstuffs had to be imported. Their complex of cultigens and wild food sources must have provided dietary and caloric self–sufficiency in all but extraordinarily bad times. Perhaps only under unusual stresses, such as following a particularly large eruption of Arenal Volcano or severe climatic conditions, would adjustments be necessary that would involve outside groups. Certainly, they were self–sufficient in stone resources that they used for cutting edges, scraping tools, forest cutting and wedging/splitting tools, and grinding implements. Ceramically, they were very close to self–sufficiency, with only an occasional import. And those imports may signify socially–embedded exchange or kin relationships as much as economically–based trade systems. Materials for construction of housing and for a variety of wooden implements were locally available. The chipped stone and the groundstone analyses indicate a lot of woodworking activity. It is unfortunate that we have virtually no information on what probably was a very sophisticated manufacturing and use system for wooden artifacts.

Socially and culturally the Arenal area peoples probably were largely independent. They may have occasionally adopted a characteristic of design, of manufacture, of dress, or of other custom, from adjoining or distant peoples. However, the picture I derive from our data is a series of villages that are largely resolving their cultural and adaptive problems by recourse to internal solutions.

The grinding stone complex does point toward closer connections with Greater Nicoya. The grinding surfaces are not rimmed, as is common in the Atlantic–Meseta Central area (Snarskis 1984).

Burial customs show a mix of affiliations within Costa Rica, yet they maintain their own identity. The burial practice in the Cordillera area, seen at Rio Naranjo, Guayabo de

Bagaces, Hacienda Jericho, and the Arenal area (e.g. G–164) of mounding up soil and large rounded river cobbles with the burial below (Lange 1984b) may be characteristic of the area. The El Bosque use of river cobbles in burials is more quadrangular (Snarskis 1984). The use of river cobbles appears to have dwindled as stone cist construction using laja became more common in Periods V and VI. Again, this seems more closely related to the Atlantic, but with its own uniqueness: the Silencio tombs generally are partial enclosures, with the head end receiving more careful construction than the lower body. By comparison, the stone cist construction at La Isabel (c. 1000 A.D.), Barrial de Heredia, and Agua Caliente in the Meseta Central is comparable but more completely entombs the body.

Given the paucity of Archaic materials from Costa Rica (Lange 1984b, Snarskis 1984), the finding of an apparent Archaic biface at G–163, the occasional discovery of aceramic lithic deposits at the base of test pits, and the finding of probable Archaic materials by Aguilar at the east end of Lake Arenal all indicate some habitation of the area during that period. Of the artifacts that Zeitlin (1984) illustrates in his summary of the Belize Archaic, the greatest similarity is with small bifaces from the Melinda Phase, dated to 4000–3000 B.C.

It is clear that the prehistoric population in the Arenal area at no time approached the population in the lakes area of Nicaragua, and at no time came anywhere near the population density found in similar areas of Mesoamerica. For example, the population in the Zapotitán Valley (surrounding the Lake Zapotitán at about 500 meters in elevation and with mean precipitation figures near 2000 mm and volcanically–derived soils) exceeded Arenal populations by the Late Preclassic, if not earlier. High population density, with the demands placed on access to productive and extractive resources, to needed distant resources, to requirements for economic and political centralization, is a key factor in the emergence of complex societies.

The other side of the issue, population limitation can avoid the needs and problems inherent in chronic or acute demographic stresses. Population control can be achieved by a number of mechanisms, including inadvertent (e.g. prolonged lactation, diet, body fat) and deliberate (e.g. reproductive rituals, birth spacing, infanticide) means. And, of course, there is a plethora of exogenous factors that can be very effective population suppressors, including human and plant diseases. An example of a plant disease that is particularly prevalent in the tropics is the Maize Mosaic Virus (Brewbaker 1979) which severely stunts maize maturation. Certainly, a society with such a problem would be wise to maintain maize as a minor component of the diet, and maintain a wide variety of other cultivated and wild sources of food.

Perhaps the avoidance of the intensifiable staple is a key here. Most societies that underwent the evolutionary sequence from egalitarian agricultural villages through chiefdoms to large and powerful states also based their subsistence on an intensifiable staple. As population increased per unit area, so did food production per unit area, as more and more effort was expended on transforming a natural to a cultural landscape. Generally, this is concomitant with a decline in productivity per unit effort, and it always is concomitant with an increase in economic and political centralization. The loss of village and of family autonomy in both decision making and in terms of resource use is proportional to the degree of centralized authority that emerges. For the Arenal area, I suggest that one of their major accomplishments during 2500 years of settled life is that they avoided the extremes of population increase that affected their bretheren to the

northwest. Thus, they avoided the complex chiefdom and the state levels of political evolution, and maintained internal control of economics, politics, and society. Another way of stating this is that their degree of political centralization was quite modest at all times, achieving simple chiefdom status at most. Even that is not clearly indicated by our data, as even the cultural events at the high status graveyard do not unequivocally indicate a chiefdom. It is possible that the individuals buried there were of chiefly rank, but it is also possible that the status is intra–familial, and thus is still egalitarian. That is, status may be by sex and maturity, and not by familial superiority. All burials examined so far from that graveyard are male, so it is possible that the individuals buried there achieved that status merely by gender. But is there too much earthmoving and laja hauling for an egalitarian society? Here there are no absolute answers, but again I would suggest that there is not a sufficient magnitude of effort to argue clearly for large work gangs ordered by chiefly authority. The effort could have been relatively modest, if it was spread over a few hundred years.

I suggest that one of the accomplishments of Arenal area societies is the avoidance of economies of dependency. They were able to maintain soverign authority over their resource base, which includes access to resources as well as the movement of resources between families and between settlements. This is in marked contrast with villages in Mesoamerica, most of which had become incorporated into an elite–dominated redistributive economy sometime during the first millenium B.C. Mesoamerican villages and families surrendered economic as well as political autonomy, as the tentacles of centralized authority reached deeper and deeper into everyday life. The long–distance trade networks supplied needed commodities including salt, obsidian, basalt, quartzite, cotton garments, and a host of other items. The occupational specialists as well as the elite and administrative sector required more and more surplus production beyond immediate family needs, pushing the agrarian family and community farther from self–sufficiency. Thus, the agrarian sector becomes more dependent on a variety of exogenous forces over which it has little knowledge and no control, making it more vulnerable to maladministration and potential collapse. It is to the credit of most Costa Rican prehistoric societies that they avoided, by whatever means, such dependency on foreign trade, foreign manufacturing, foreign politics, and foreign social domination.

An important issue throughout most of Precolumbian Latin America is the importance of maize cultivation to subsistence. Clearly in most of Mesoamerica since the Formative Period maize supplied the bulk of the protein and caloric needs. However, the maize model should not be automatically extrapolated onto Intermediate Area prehistoric societies, nor should alternative models be automatically extrapolated. In Mesoamerica maize was a very secondary or tertiary source of protein and carbohydrates prior to major genetic changes and adaptive shifts, all of which finally led to it becoming the staple. It is beginning to appear that it may never have become a staple crop in parts of Costa Rica, the Cordillera region being an example. It appears to have accounted for no more than 10% of the diet, at least during the Silencio Phase for the people buried in the G–150 graveyard. It likely was even less of a dietary component for earlier populations around the lakeshore, although testing this must await excavation and analysis of skeletal material. If in fact maize was such a small component of the diet, this could be a partial explanation for the curious pattern of settlement along the Arenal lake shore. Settlements are not clustered in the more agriculturally suitable areas because agriculture was a relatively small component of their adaptation. Areas may have been favored which received more

precipitation and therefore offered a greater density or variety of wild plant species for collecting, and yet did not have greatly excessive precipitation regimes that would be limiting for root or tree crops.

Maize cultivation, based solely on macrobotanical evidence, appears to be very late, i. e. during the last half of the first millenium B. C. (Karen Clary, personal communication 1984). We have recovered earlier macrobotanical evidence of maize, dating to the first half of that millenium, from site G–163. However, the pollen evidence from Panama places maize throughout the millenia from 5000 to 1000 B. C. (ibid). It is of interest that Lippi, Bird and Stemper (1984) are questioning the claims of very early maize in Ecuador. They note the paucity of reliable data prior to the first millenium B.C. They do note the indisputable evidence for maize by the Machalilla Phase, c. 1200 B.C., in the form of numerous charred fragments. It probably is 10- or 12-rowed corn.

A major question of this research is the effects of volcanism on human settlement in the Arenal area. A very important difference between the Arenal area and Mesoamerica is population density and socio–political development of groups surrounding the impact area. In Mesoamerica the surrounding societies, at least from the Late Formative to the Conquest, are complex, with quite densely settled surrounding territories. Large eruptions, such as Xitle in the Basin of Mexico, or Ilopango in the southeast Maya highlands, can have devastating impacts on societies, yet smaller eruptions can have negligible effects on societies in the long run. The pressures of people needing arable land can result in premature recolonization of devastated zones. The vulnerability of societies to volcanic hazards apparently increases proportionally to the population density in the risk zone as well as to the degree of sedentism, the intensity of the adaptation, and the degree to which a cultural landscape has been created out of a natural landscape. This prehistoric trend matches the trend of increasing hazard vulnerability and disaster losses among 20th Century nations as populations multiply and fixed facilities increase dramatically (White 1974).

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VINCULOS (EJEMPLARES PARA LA VENTA)
Volumen 2, Número 1. Año 1976
Volumen 2, Número 2. Año 1977
Volumen 4, Número 1. Año 1978
Volumen 4, Número 2. Año 1978
Volumen 5, Número 1 y 2. Año 1979
Volumen 6, Número 1 y 2. Año 1980
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Esta revista se terminó de imprimir en los talleres de la Imprenta Nacional en el mes de junio de 1986 y consta de 1.000 ejemplares en papel bond de 75 gramos con forro de cartulina barnizable.