ARTICLE 1: THE PROYECTO PREHISTORICO ARENAL: AN INTRODUCTION

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ABSTRACT

Multidisciplinary research, involving archeaeology, volcanology, and botany, was conducted in the Arenal–Tilarán area of northwestern Costa Rica during 1984. Habitation and funerary sites on the eastern and the western side of the continental divide were investigated. Artifacts were found from before the early Zoned Bichrome Period to the Late Polychrome Period, a time span of almost three millenia. This article describes the natural environment, presents the archaeological background for the research, the specific research objectives, and the sequence of project activities during 1984.

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INTRODUCTION

The general theoretical framework within which the following research was conducted is human ecology. Human ecology is the study of the dynamic interrelationships between people, their environments, and their societies. Specifically, the research of the Proyecto Prehistorico Arenal is directed toward understanding aboriginal settlements and adaptations in the Arenal–Tilarán area, as they were affected by the periodic explosive eruptions of Arenal Volcano (Fig. 1). A sudden fall of volcanic ash, or tepnra, can be very detrimental to the natural vegetation, to animals, and to crops of all kinds. However, as the ash is weathered it can become a very fertile soil for intensive or extensive cultivation. Natural vegetation with a very high biomass and high species diversity on fertile soils offers numerous subsistence alternatives to cultivation. Well-weathered volcanic materials can form very good clays for pottery making or for construction. Iron oxides for pigments range from yellow to orange and red to black. Basalts and andesites are excellent materials for making very tough and reasonably sharp cutting edges for stone tools. Thus, there are obvious benefits to living in volcanically active areas. There are detrimental factors as well. Although Arenal only erupts with a huge explosive eruption every few centuries, those eruptions are very hazardous to human, animal, and plant life. On the other hand the short-term benefits to living within the tephra apron of a volcano are numerous. Determining the risks and the benefits of living near Arenal Volcano in prehistoric times is a major project goal.

Tropical areas are often depicted as uniform, redundant environments. The trees spread out as far as the eye can see, and one area looks very much like the others, at least at first glance. However, microenvironmental differences exist, and many of them may have been critical in terms of prehistoric land use and choice for settlement location. This chapter presents information on variation in the natural environment; other chapters explore variation in settlement, artifacts, and other topics.

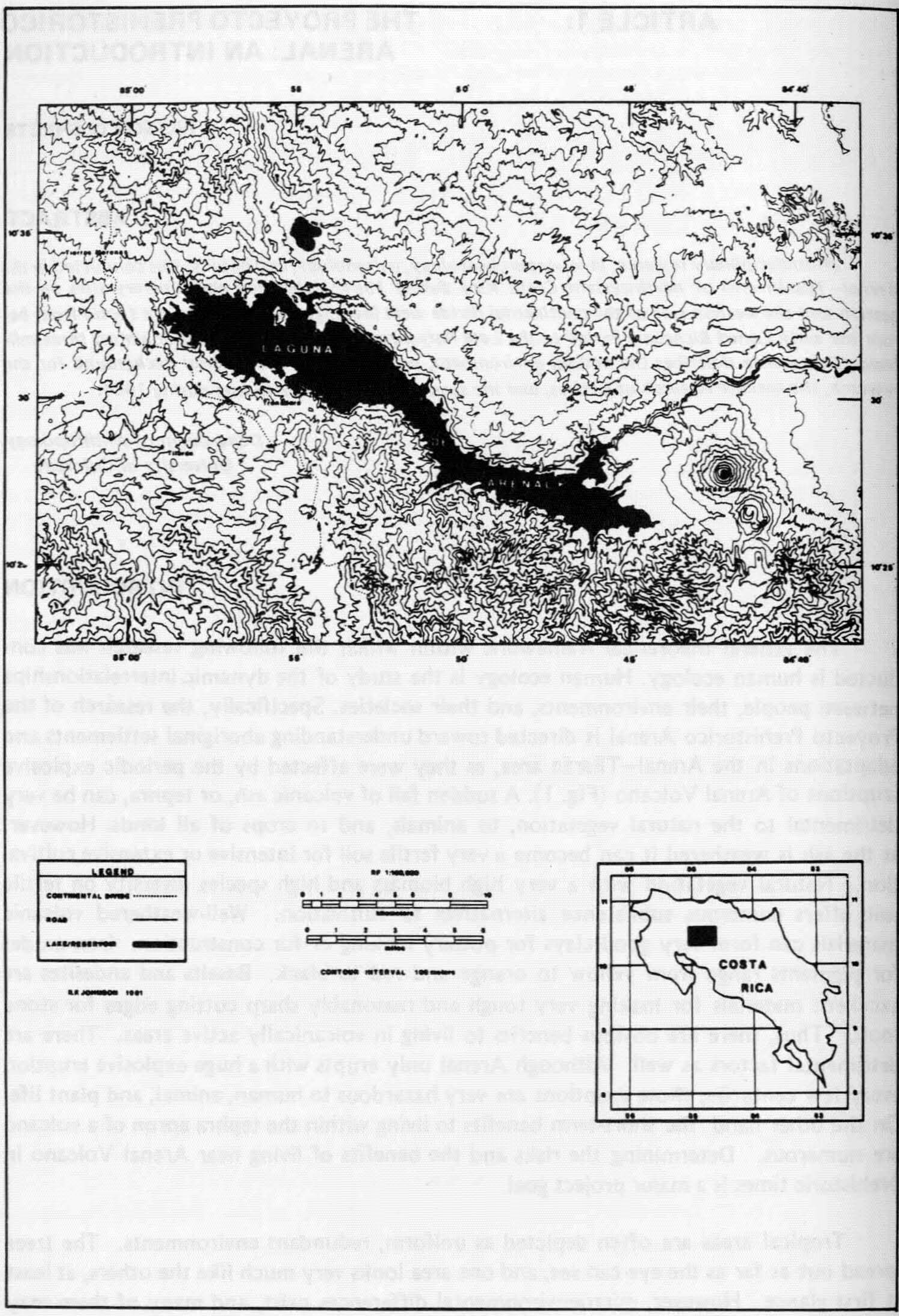

Figure 1. Vicinity of Arenal.

Costa Rica, located between 9 and 11 degrees north latitude, falls well within the latitudinal tropical zone. Tropical seasonality is more pronounced in precipitation than in temperature variation, in contrast with temperate climates (West and Aguelli 1966:35, MacArthur 1972). The annual temperature variation in Tilarán is minimal; the January mean temperature of 22.5 degrees C is only 2.1 degrees cooler than the hottest month, May, with 24.6 degrees C. On the other hand, the daily or diurnal range is relatively great, averaging about 8 degrees C throughout the year.

The Tilarán – Arenal area is very windy. Mean windspeed is 14.5 km/hr at Tilaran, and is consistently from the northeast in all months. Winds are greatest from November through April, with all these months registering 15 km/hr or more. January is the windiest month, with an exceptionally high mean windspeed of 28 km/hr. The rainy season months have windspeeds of 8 to 14 km/hr. Other areas in the cuenca are even windier; La Toma has an average windspeed of 23 km/hr, with a high of over 30 km/hr in January. Chicago, the "windy city" of the U.S., has a relatively low mean annual wind speed of 16 km per hour, according to information supplied by the U.S. National Weather Service. Gusts at La Toma reach 100 km/hr or more. La Toma is not the windiest point in the cuenca; high points exposed toward the northeast receive even higher winds. The wind affects vegetation, agriculture, land use, and construction in the present, and it would have been an equally important factor in the past. Stunted, deformed isolated trees are seen frequently in the area. However, the wind probably affected the stable climax forest less, as it is interlocked at the top with vines, and stabilized at the bottom by the roots. Thus, the wind would have passed over the tops of the trees, little affecting the ground surface. However, forest clearance allows the wind to descend, creating a wind hazard. Some shallow-rooted plants, including maize, are very susceptible to wind throw. Isolated tropical trees with shallow roots and lack of upper level support, also seem very vulnerable. Thus, in the context of the cuenca's vegetation and the wind factor, an appropriate land use would have been tropical forest swidden, making use of small partial clearings on a rotating basis.

Meteorological data are particularly abundant from the Tilarán station, at the 562 m elevation, with 33 years of records. A mean total of 180 days per year have rain, with a minimum of 5 days each in March and April to a maximum of 20 days from June through October. The annual mean precipitation is 2112 mm, with a standard deviation of 496 mm. March is the dryest month, with a mean of 19 mm; the wettest months are May, June, August, and September with means between 105 and 125 mm. The 'dryer' season months do have less precipitation when compared with the wetter months. They are, with their average precipitation figures in mm: January (60), February (28), March (19), and April (34). The fact that the standard deviation exceeds the mean for March and April indicates a less-than-predictable precipitation pattern.

Vivo Escoto (1964:207) classifies the overall Tilarán-Arenal area as having a humid tropical climate with rain in every month (Afw'). However, precipitation varies in the area markedly, due to variation in elevation, topography, and exposure. Highest mean annual precipitation figures are recorded on the Atlantic side of the divide, with stations such as Caño Negro recording 4452 mm (s.d. 718). Rio Cote, at 700 m, receives 6022 mm, and a number of other stations in the cuenca record between 4000 and 6000 mm. The dryest station in the area is El Coyol, along the Rio Santa Rosa at 410 m; it receives only 1300 mm ~~anually~~. Thus, there is a precipitation gradient from very humid in areas near the volcano to moderately dry at the west end of the lake, to rather dry on the Pacific side below Tilaran.

Tosi (1980) divides the Arenal-Tilarán area into three precipitation provinces: humid (1400-2000 mm), perhumid (2000-4000 mm), and superhumid (over 4000 mm). The classification is aided by the fact that 40 meteorological stations exist in the area. Thus, the area is one of the best in the world for studying microvariation in the tropics. The humid area, according to Tosi, is almost ideal for agriculture. The dry months generally have enough soil moisture to maintain crops. The erosion risk is low, particularly compared with the two other precipitation provinces. The humid province has the highest solar radiation figures and the lowest relative humidity. The soil acidity (pH) is the best of the three, and Tosi feels this is the best of the three for short-term cultivars.

The perhumid province takes up the greatest percentage of the Arenal area, and includes virtually all the sites recorded by our research. It is intermediate in all conditions. There are three to six months of excessive precipitation, and soils are often saturated (anerobic). Soils are moderate to poor in fertility, and are rather acidic. Agriculture is rated as marginal except along shallow slopes or along alluvial areas. Tosi feels permanent or semi-permanent crops are more appropriate than annual crops.

The superhumid province is judged inappropriate for agriculture. There is excessive water in most months. At most, one-fourth of the precipitation is used by the vegetation, despite its massiveness. That excess must run through or over the soil, with obvious erosional and leaching hazards if the soil is exposed. Soils here are the most acid and have the lowest actual and potential fertilities. The thorough saturation of the soils inhibits oxygen contact with plant roots, and nitrogen fixation is greatly reduced. This area experiences the lowest sunlight (solar radiation), and has the highest number of cloudy and rainy days of the three provinces.

According to Tosi (1980) the Arenal area is exceptionally cloudy. Based on 11 years of data from Arenal Viejo, the annual average is only 4.4 hours of direct daily sunlight. Most months have only 3-4 hours of sunlight. Only the months of February, March, and April have up to 6 hours of sunlight. Thus, crops that do well in partial shade can thrive in the area. The lack of solar radiation is a limiting factor for many cultigens.

Landforms are quite variable in the area. They range from alluvial flats and gently sloping piedmonts to low and high mesas, and include numerous valleys, hills, some recent volcanic structures, and some very steep slopes. These are presented in descending order of suitability for habitation. Flat areas, or areas with minimal slopes, which had relatively easy access to year-round fresh water, were preferred for housing. In contrast, the tops of steep hills or ridges evidently were preferred for funerary areas.

Certainly, landforms have varied in the past. The drainage prior to Arenal and Chato Volcanoes was more directly toward the east, to Fortuna and beyond (Tosi 1980). The volcanic deposits of Chato and Arenal have blocked drainage and created a lake with a fluctuating water level, as stream erosion competed with volcanic blockages to respectively lower and raise the water level. Prior to the recent construction of the Sangregado dam, the water level was 512 m above sea level. Previous lake sediments—undated—were seen by Tosi (1980:17) as high as 530 m. The general tectonic depression in which the lake rests dates to the end of the Miocene, and it is delimited by two large faults, one along the northern shore and one along the southern shore. That the region remains tectonically active is evidenced by the major earthquake of 1973, and the fact that in 4 years (1973-77) a total of 2400 earthquakes were recorded with magnitudes up to 4.0 on the Richter scale

Tosi (1980) conducted a detailed study of soils in the Arenal-Tilarán area. They found that 93°/o of the area had soils developed from volcanic ash, with the rest from basalts. They classified the soils into four types.

The Typic Hydrandept covers 67°/o of the area, and is derived from recent volcanic ashfalls. All sites found by this project are within this soil type. These soils are low in density, and high in water retention capacity. The soils are judged to be fairly fertile. They possess high to very high percentages of organic matter, and have pH readings from 4.5 to 6.6, depending on moisture. The available phosphorus and potassium are low, as are zinc and manganese, which would have limited agricultural potential in the past as well. Iron, copper, calcium, and magnesium are relatively abundant.
dant.

Andic Tropudult soils cover 12°/o of the area, and they are formed on older volcanic ashfalls. They are found to the north and south of Volcan Arenal. Their inherent fertility is low.
area. They are without significant tephra from Arenal, and are found in the southwestern part of the study area, between Tilarán and Cañas. They have a high clay content, a low organic content, and are moderate in inherent fertility.

Alluvial or lacustrine sediments account for the remaining 3°/o of the area. They have largely been removed from view by the flooding created by the ICE dam and the enlarged Lake Arenal. The soils are very heterogeneous, and were studied very little.

A note of explanation is needed here. Frequent references to the ICE project will be found in the articles to follow. ICE, the Instituto Costarricense de Electricidad, contracted with Tosi and the Tropical Science Center for a study of climate, soils, topography, hydrology, flora, fauna, and other aspects of the area, and that was completed in 1980. That study is the primary source of environmental information presented in this chapter. Other sources are referenced as they appear. ICE began construction of a large, earthfill dam across the Rio Arenal, just west-north-west of the volcano. Construction of the dam, the tunnels, and other facilities, was largely completed by 1980. The dam greatly enlarged the lake from what was a shallow, largely swampy body of water to a lake of some 80 square kilometers. The lake level was raised from 512 m to a maximum of 545 m. The lake level fluctuates seasonally, and may drop to about 535 m in April or May. Eight towns were flooded, and 2500 people had to be relocated. The water is diverted under the continental divide to two hydroelectric stations between Tilarán and Cañas. Eventually, the water may be used for irrigating a large section of dry, lowland Guanacaste.

The primary forest in the area is generally high, dense, and composed of medium to large diameter trees with a very high species diversity. Some of the trees are about 50 meters tall. Much has now been cut for agriculture or pasture. According to local informants, the exensive cutting has decreased precipitation and increased temperature.

Most of the earlier native terrestrial fauna have been killed off, except in the areas with residual natural vegetation. That fauna included deer, goats, "tepezcuintles," **"guatusos,"** wild turkeys, coyotes, wild cats, monkeys, and others. Manatee *(Trichechus manatus)* inhabited the lake up to a few decades ago (Tosi 1980:75) but were overhunted and eliminated. They would have been an excellent source of animal protein and fat. In addition, the lake had 25 species of fish and numerous bird species.

PREVIOUS ARCHAEOLOGICAL RESEARCH IN NORTHWESTERN COSTA RICA

Archaeological research in northwestern Costa Rica is a microcosm of the changes in method and in theory that have occurred in the discipline during the past century, as outlined by Willey and Sabloff (1971). The early days of exploration and unfettered speculation shifted to classification and description in the early 20th century, culminating in explanatory and processual concerns in the past decade or two. Numerous detailed histories of Costa Rican archaeology have been published (Lothrop 1966, Willey 1971, Aguilar 1972, Ferrero 1981, Stone 1977, Lange 1984b, and Snarskis 1984), making only a brief summary necessary here.

Following the early explorations directed toward recovery of ceramic and jade artifacts came Hartman's excellent research (1901, 1907) in various locations in Costa Rica, including grave excavations at Las Huacas in the Nicoya Peninsula. Lines (1936) continued Hartman's interests, and Lothrop (1926) surveyed the ceramics of the country. Stone has often descriptively summarized the prehistory of the region, the most recent being in 1977. The era of modern archaeology was initiated two decades ago by Claude Baudez and Michael Coe (Coe and Baudez 1961). The 1970's witnessed a veritable explosion of research, involving scholars such as Abel-Vidor, Accola, Aguilar, Dillon, Drolet, Fonseca, Hurtado, Lange, Snarskis, and others. In northwest Costa Rica, the most intensive research has been conducted along the coast, particularly in the bays of Salinas, Culebra, Santa Elena, Tamarindo, and the Gulf of Nicoya. For example, the entire Volume 6 of *Vínculos* is devoted to the Bahía Culebra area (Lange and Abel-Vidor 1980). The second most intensely studied area is inland lowland Guanacaste. The third area, the cordillera, has received much less attention, and it is in the cordillera that we wish to make a contribution.

Norr (1979) conducted surveys and test excavations in the Rio Naranjo area about 25 km northwest of Tilarán. Both the Tilarán and the Rio Naranjo areas are low passes between mountain complexes, and they share many characteristics of climate, topography, and vegetation. Rio Naranjo seems to be slightly lower as a pass (500 versus 700 m) and slightly moister (3000 mm rather than 2500 mm annual precipitation) than Tilarán. Norr's sites were predominantly Zoned Bichrome, and most were discovered by finding stone funerary mounds. Creamer's survey (1979) at Upala, about 30 km northeast of Rio Naranjo, divulged consistently later occupations, dating to the Early and Middle Polychrome Periods.

Specifically in the Arenal area, there have been three previous projects which have attempted to learn something of the prehistory of the cuenca. The first was the work of George Metcalf (1970) with William Melson (Article 3) in 1969, following the explosive eruption of Arenal. Metcalf spent three weeks excavating a site found during construction of an observatory north of the volcano. Some 428 sherds were recovered, along with a mano, a celt, and a few chert chipped stone flakes. Accurate stylistic dating or radiometric dating of these materials has not been conducted. In 1977 Carlos Aguilar, of the Universidad de Costa Rica, conducted the largest research program in the cuenca prior to the current program. He conducted numerous excavations and a survey around the eastern end of the lake. His research was made urgent by the rising lake level, as the Sangregado Dam began to retain water. As bulldozers cut 20 m deep to extract fill for dam construction at the site known as El Tajo, some artifacts were encountered incidentally. Aguilar excavated ceramics, human bone, features, and other artifacts. Aguilar (personal communication 1981) is preparing a manuscript for submission to National Geographic Research Reports. A radiocarbon dating of wood from a hearth yielded a date of 220±65 B.C., placing the deposits in the Zoned Bichrome Period. The El Tajo site was of extraordinary importance because vegetative preservation was excellent. Melson observed casts of vegetation in and near the site. Unfortunately the site is now inundated by water of the enlarged Lake Arenal.

The third archaeological project in the Arenal area was a short survey around the lake by Tom Murray. A number of sites were found at or near the shore of the old lake, and most were Zoned Bichrome (Lange, personal communication 1983). Unfortunately the results still remain unpublished. The fact that Zoned Bichrome and later sites were found along the old lake shore at 512 m in elevation does resolve one issue. Tosi (1980) mentions evidence for a higher lake level sometime in the unspecified past, at about the 530 m level. The presence of archaeological sites at the 512 m level indicates that the higher lake level predates the known human occupation of the area.

Thus, this project is the fourth to operate in the area. The project began with a suggestion from Michael Snarskis to Sheets that the Arenal area may provide the active volcanological framework to study settlement and adaptation, as had been done in El Salvador. Sheets and Melson visited the area in 1981 to collect samples and study the feasibility of collaborative research. Sheets and Robert Drolet examined the large graveyard, now numbered G-150 (Fig. 2), on the Finca El Silencio, and decided it offered opportunities to study funerary practices 'sandwiched' by volcanic ash layers.

PROJECT OBJECTIVES, METHODS

A major project objective was to determine the stratigraphic relationships between the various tephra layers and times of human use of the area. This necessitated a regional research design that required recording of strata from numerous localities, tephra and artifact sampling, and laboratory analyses. The results are presented in the articles that follow.

Although certain problems remain, a regional tephra sequence has been proposed (Article 3). That sequence, in part, is well related to the El Tajo sequence, but some correspondences are not yet confirmed geochemically. Soils formed on top of the tephra layers, during periods of volcanic quiescence, and archeological sites were found associated with those soils. Thus, human re-use of the volcanically hazardous area was the norm, with people remaining in the area following thinner ashfalls, or re-occupying areas with thick ashfalls when soil and vegetative recovery were sufficient.

Figure 3 presents, in condensed form, the El Tajo volcanic sequence, and the best approximation of how it relates to volcanic ash sequences at El Silencio and around Tilarán. Further research should help refine these relationships. Also presented are our best judgements, given present knowledge, of temporal relationships of these volcanic phenomena with cultural periods and ceramic phases.

A project objective was to determine, insofar as possible, the subsistence strategies of the peoples of the cuenca. One of the best approaches is direct recovery of carbonized organic remains, and Matthews (Article 13) identified numerous specimens of cultigens. Pollen and phytolith samples were collected for analysis, which should provide additional subsistence data. Use-wear and other functional analyses of ceramic, groundstone, and chipped stone artifacts contribute toward subsistence reconstructions.

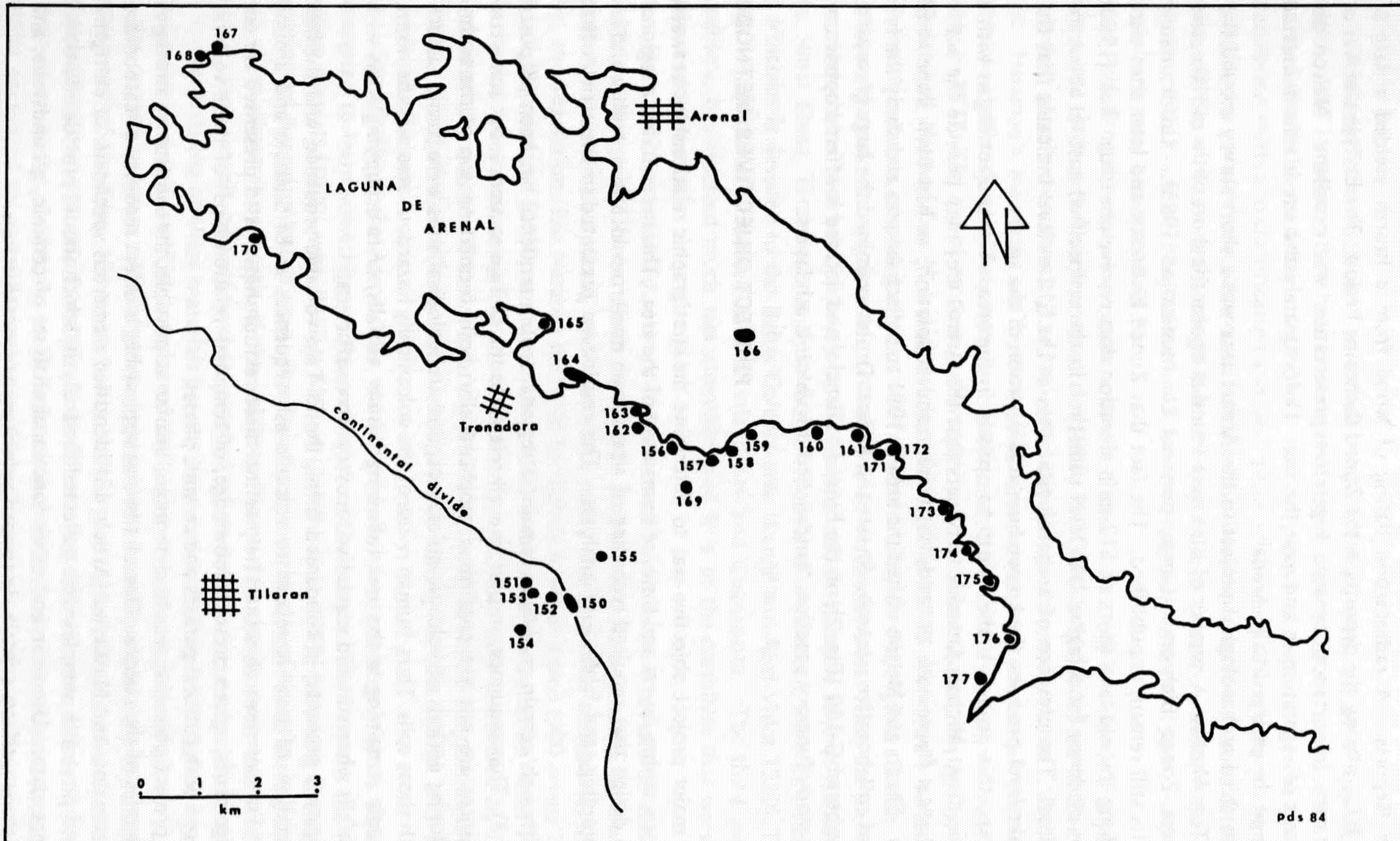

Figure 2. Archaeological Sites Encountered in the Silencio area and along the Laguna de Arenal lakeshore during 1984 fieldwork, Proyecto Prehistórico Arenal.

Another project objective is to determine the variation in site locations, in chronology, and in site functions within the area. Excavations were conducted in two funerary sites (Article 6) and in two habitation sites (Article 8) very close to the continental divide. The survey of the present lakeshore of Laguna Arenal yielded excellent data on sites of various periods from the Formative to about the Conquest (Article 4). Many are habitation sites, and some are funerary. Test pits were excavated into some of the sites, with the results presented in Article 5. Two somewhat problematic large laja (flat-fractured volcanic rock) features near a large graveyard were excavated, and they are described by Chenault (Article 7).

The analysis of artifacts from the project allows for a detailed reconstruction of variation through time, and allows for the first detailed artifact sequence for the cordillera in northwestern Costa Rica. The ceramics were analyzed by Hoopes (Article 9), the chipped stone artifacts by Sheets (Article 10) and the groundstone artifacts by Chenault (Article 11).

Samples of bone from burials were collected for analysis for stable carbon isotopes. The amount of maize that people consumed can be recorded in their bones by the ratio of Carbon-13 to Carbon-12. Unfortunately, bone preservation in the area ranges from very poor to nil, because of high precipitation and acid soils.

A total of seven radiocarbon dates were calculated on samples submitted to the University of Texas Radiocarbon Laboratory. It should be noted that the text of these articles was written prior to receiving these dates in late October of 1984; thus, only partial revision of the articles has been possible. On the other hand, the dates have not necessitated extensive revision. The dates are presented in Figure 3 and on Table 1, with information on their artifactual and volcanological contexts as well as placing them in a regional and national archeological sequence. Here, only brief comments are needed per date.

Date Tx-5077 is from the later use of the high status cemetery, G-150, and is a few hundred years later than expected. Given the fact that two rather thick ash layers, Units 41 and 40, separate the two times of graveyard use, one might expect a considerable time break between uses, allowing time for soil and vegetation recovery. However, artifact analyses indicate strikingly little culture change, implying very little temporal separation in the two times of use.

Date Tx-5078 was collected to date the earlier end of graveyard use, and turned out to be earlier than expected. It was collected from an undisturbed grave, sealed by ash layers above and below, and associated with a gold pendant. The dating of gold in northwestern Costa Rica to about the third century A. D. is surprisingly early. The style of pendant dates to A. D. 700 or later in other areas of Costa Rica (M. Snarskis, personal communication 1985).

Date Tx-5079 chronologically fixes the latest occupation of the Silencio area, based upon remains at site G-154. It postdates Units 41 and 40, and predates the deposition of Unit 20, and thus makes sense archeologically and volcanologically.

Date Tx-5080 was from charcoal associated with late Arenal Phase artifacts, and thus was expected to be about A.D. 300-500. It is a bit more recent than anticipated.

Date Tx-5081 is problematic, in that its small size resulted in such a large 2-sigma standard deviation that it is not very useful. The range does overlap into the anticipated Middle Formative Period, but this does not help resolve finer dating problems.

Date Tx-5082 is somewhat helpful, in that it dates late Arenal Phase artifacts and

Figure 3. First Approximation of Periods, Phases, and Stratigraphic Relationships, Proyecto Prehistórico Arenal.

SAR Periods	Radiocarbon Dates	Dates	Guanacaste Periods	Atlantic Periods	Arenal Project Ceramic Phases	Silencio Strata	El Tajo	Tilarán Sequence
		AD				10 20	1 2	
Late VI	5079 5083 5077	1500 1400 1300 1200 1100	Late Polychrome	Late	Tilarán	30	1520	
Early VI		1000 900 800	Middle Polychrome				3	
Late V		700 600					4?	
Early V	5080 5082	500 400 300 200 100 AD/BC	Early Polychrome	Transitional	Silencio	40 41		
Late IV	5078	100 200 300 400 500 600 700 800 900 1000	Zoned Bichrome	Zoned Bichrome II	Arenal	52 53? 53a?	5 6?	Black 5? White 5? Black 4? White 4?
	5081			Zoned Bichrome I		54	7	Black 3 White 3
							220BC	
Early IV				Middle Formative	Tronadora	55 55a	8	Black 2 White 2
		BC				60	9	Black 1 White 1
						65 Aguacate	10 Aguacate	

Table 1. Radiocarbon Dates from 1984 Research, Proyecto Prehistórico Arenal

Number	Event/Context Dated	Catol. No.	5568 1/2-life	Corrected Central Date and Range	Notes
TX–5077	Silencio Phase artifacts, later use of high status cemetery.	G–150 C2 (No.2)	740 ± 50	AD 1275, AD 1215–1330	
TX–5078	Early use of G–150 cemetery, gold pendant, pre–40 & 41.	G–150 B5 (No. 4)	1770 ± 60	AD 235, AD 20–445	
TX–5079	Tilarán Phase midden, after 40 eruption, before 20 eruption.	G–154 A2 (No. 15)	570 ± 30	AD 1362, AD 1304–1420	Latest occupation of Silencio area.
TX–5080	Arenal Phase (late) artifacts	G–161 B4 (No. 38)	1340 ± 70	AD 695, AD 590–795	
TX–5081	Tronadora Phase occupation	G–163 C2 (No. 31)	2030 ± 300	105 BC, 765 BC–AD 560	Sample very small, had to combine with sample No. 55 (G–163 D1).
TX–5082	Late Arenal Phase ceramics, Unit 50 soil. Prior to 41 deposition.	G–175 B1 (No. 34)	1530 ± 130	AD 490, AD 225–755	Small sample; had to augment with sample No. 43 (G–175 B6).
TX–5083	Arenal Phase intrusive pit	G–175 B7 (No. 51)	670 ± 190	AD 1270, AD 1030–1505	Is much too recent.

Note: All figures are 2–Sigma range; corrections by *Radiocarbon* V. 24 No. 2, 1982.

the Unit 50 soil, and that it antedates the Unit 41 eruption. The 2-sigma range is too large to assist in fine-grained dating.

Date Tx-5083 is curious, in that it was collected from an intrusive pit that had Arenal Phase ceramics above and in it, yet it is very recent.

In summary, some of the radiocarbon dates do help in more precise dating of cultural and natural events in the Arenal area, particularly the dates with tight 2-sigma ranges. The dates with large 2-sigma ranges are not very helpful, other than indicating general spans of time. Only one date (Tx-5083) is vastly out of the anticipated range.

The order of presentation of the articles in this volume is from general and regional to more specific. Following Bobbi Klausing-Bradley's data control chapter, the regional volcanological sequence and the extensive lakeshore survey results are presented. They are followed by the lake site testing program and the excavations into two funerary sites in the Silencio area. Then, information on the two laja features and two habitation sites in Finca El Silencio is presented. Detailed artifactual analyses follow the excavated site data. The final data chapter presents results of macrobotanical analysis, which gives direct information on cultigens and wild utilized plants.

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