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Alternative Interpretations of Pre-Columbian Water Management in the Western Llanos of Venezuela*

En base a investigaciones recientes se presentan en este trabajo dos alternativas para explicar: a) la no popularización del sistema de campos elevados en los Llanos Occidentales y b) la funcionalidad de las "calzadas". En el primer caso, se sugiere que la población prehispánica haya hecho un mayor uso de las múltiples estructuras naturales (bancos, viejos cauces, etc), que existen en la zona, y que son el resultado de la intensa actividad fluvial. En segundo término, se sugiere que las "calzadas" hayan servido como diques de retención de agua, destinados a una intensa explotación de los recursos acuáticos.

Until recently the south american savannas were considered peripheral zones, occupied mainly by hunting, fishing groups or, at best, Tropical Forest agriculturalists (Cooper 1942, 1942a; Steward 1946, 1949; Meggers 1954). It was believed that their poor agricultural potential, the sea-

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sonal availability of food resources, and the technological poverty of the prehispanic groups limited the existence of more complex culture types. However, during the last twenty years there has been a drastic change in this traditional view, due to advances in research dealing with the physical characteristics of these environments, the archaeological and ethnohistorical record, and the frequent reports on the existence of ridged field systems. Certain areas of these savannas are now viewed as the historic loci of multiple groups, including socio-culturally complex cultures, some of them with considerable populations (Denevan 1966; Morey 1975).

In Venezuela the subsistence strategies of the prehispanic comunities inhabiting the lowland savannas (locally called *Llanos*) seem to have been varied, including multiple alternatives, closely inter-connected and related to the micro-variations of the environment. Due to their seasonal excess and lack of water, the active exploitation of the grass environments within the savannas frequently required the development or use of water management techniques. In this paper we will analize two alternatives that could have been used by the prehispanic groups inhabiting the Western Llanos of Venezuela in the need to intensify the management of this environment.

THE PHYSICAL ENVIRONMENT OF THE WESTERN LLANOS

The Venezuelan Llanos consist of a widespread lowland, covering an area of approximately 300,000 km^2 (Fig. 1), adjacent to the principal mountains of the country: the Coastal Range in the north, the Andes in the west and the Guayana Shield in the south. In the west the Llanos turn south to join the Eastern Colombian Llanos, while in the east they gradually merge into the Orinoco Delta and the Atlantic coastal plain. The morphological differences of this depression originated through the tectonic evolution of two Tertiary basins (Vila 1960: 106). Thus, three different areas can be distinguished within the Llanos: the Eastern Llanos with mesas of tabular topography, the Central Llanos, characterized by low hills, and the Western Llanos with a flat topography. It is to the latter that we will refer in more detail.

The Western Llanos belong to the Barinas-Apure sedimentary basin (Feo Codecido 1969) formed at the close of the Paleozoic Era. In some part of the basin the Cretaceous and Cenozoic sediments reach thicknesses of approximately 5000 m (Feo Codecido 1969). Since the Late Tertiary, erosive processes have washed sediments derived from the Andes into the basin. Pleistocene tectonic activity (mainly uplift) is another geological factor which, along with the variations in parental material, was responsible for the regional morphological differentiation of the area. After the final elevation of the Andes, the Western Llanos were affected by a succession of morphogenetic cycles, with phases of erosion, fluvial, fluvial-lacustrine and deltaic depositions and eolic sculpture. These geomorphologic and climatic phases also influenced many of the Western Llanos soils, which have suffered a complex process of polycyclic differentiation (Sarmiento et al. 1971: 54 f.).

The topography of the Llanos is the result of a long geological and geomorphological evolution, mostly Quaternary, after the sea retired eastward toward the Atlantic ocean. This topography consists of extense alluvial fans and plains in most of the Western Llanos. In this region, subsidence of the Barinas-Apure basin was fast enough to impede complete alluviation. As the Western Llanos were filled with alluvium, and near Andean piedmont were affected by uplift, drainage was promoted north and eastward; the southern part remained relatively depressed and this impeded proper drainage.

These geomorphological processes have produced three different altitudinal levels (Fig. 2): the highest has elevations above 200 m and comprises the piedmont; the middle one has elevations ranging between 100 and 200 m and covers an irregular area near the piedmont; and the third level, with elevations of less than 100 m. This level is of particular interest for this paper and comprises the State of Apure and the southern parts of the States of Barinas and Protuguesa. Due to its insignificant slope (less than 0.25 m per 1000 m), when the level of the main rivers of the area such as the Orinoco, Apure, Portuguesa, Arauca and Meta rises, it dams the lesser affluents, changing their courses and producing extense flooding. In addition, due to the low speed of the Llanos rivers, great amounts of sediments are deposited in their beds, while their banks are gradually raised above the savanna level. During the rainy season, with the heavy precipitacion and the overflow of the secondary currents, these natural dikes are frequently broken, and openings or *salidas de madre* occur. This causes new depositions of sediments. The numerous stream channels, former levees, and other hydrological surface modifications have created a plain of irregular micro-topography.

Within this plain, the highest areas, locally called *bancos* (with heights ranging between 1 and 2 m) are usually selected for settlement and agricultural purposes. On the contrary, the overflow basins, which are seasonally flooded and where water is retained during most of the year, are locally called *esteros*. The intermediate land between the banco and the estero, called *bajío*, is seasonally flooded; however, the water is quickly lost after the rainy season (Roa 1981: 33 f.). The proportion of banco, bajío and estero seems to be different for each area of the Western Llanos.

The regional climate is uniform with very definite alternation of humid and dry periods the latter lasting from 4 to 5 months. The natural vegetation of the area has been grouped into four main types: forests, humid grasslands, dry grasslands and swamps. However in small localized zones seasonal swamps, palm groves and shrub areas are found. Although in the past poor soils have been considered an important factor in grassland genesis, there is no one to one correlation between them and grassland vegetation. Different factors such as the age of the deposits, the influence of the natural vegetation and the topographic, geomorphologic, lithologic and climatic conditions account for the different kinds of soils found in the area. Alluvial soils or regosols with an AC profile lie over the more recent sediments. Over the older deposits or in the better drained areas, due to the nature of the lixiviation process, ABC profiles with textural B horizon have developed. In areas where the laterization process has occured, a horizon with iron oxides, forming hard concretions is found. Hydromorphic soils are widely distributed and lateritic-hydromorphic soils are frequent (Sarmiento et al. 1971: 55).

As we will see in the rest of the paper, the various combinations of morphological, topographic and drainage conditions of the Western Llanos of Venezuela, area of particular interest, offered distinctive opportunities and challenges for the aboriginal exploitation.

INDIGENOUS SUBSISTENCE IN THE WESTER LLANOS

Ethnohistorical accounts indicate the existence of fairly dense populations in the Western Llanos at the time of the Spanish contact (Morey 1975). This population was made up of a variety of groups which included nomadic foragers, specialized fishers and sedentary agriculturalists, all bound together by a widespread and complex trading network, through which the different groups provided each other with their special products (Morey 1975: 197). During early historic time, several agricultural groups controlled the major riverine zones, while others were cultivating on artificially built raised fields in the grasslands. Fishing communities occupied strategic areas known for their year-round resources, while foragers roamed the interfluvial regions.

A large number of plants were utilized by the Llanos people. Corn and manioc seem to have been the main crops and were grown in all the Llanos areas. The cultivation of the former, of which several varieties were known (including one that matured in two months), was emphasized in the northern and western Llanos (Gumilla 1963: 431; Gilij 1965, I: 185). However, in some areas (along the Upper and Middle Orinoco and the Guaviare) maize was apparently less important since a greater emphasis was placed on the exploitation of several palms and fruits (Rivero 1956: 335; Cassani 1967: 240; Gumilla 1963: 440 – 442; Morey 1975: 46).

Several varieties of manioc were consumed, although the bitter types were preferred for their flavor and adaptability to different processing techniques (Morey 1975: 46). Other food crops included sweet potatoes, yams, squashes, melons, beans and peppers (Morey 1975: 46 f.). Tobacco, cotton and a great range of other fruits and plants were also utilized.

The written sources also attest to the existence of three types of agricultural fields. The typical slash and burn plot, generally cut out of the forested areas. Sometimes in these fields, small mounds for improving the local drainage, were constructed for manioc cultivation (Morey 1975: 48). The second type was a *wet garden* placed mainly in flood plains and on the edge of lagoons. These gardens, fertilized through a combination of ashes and river silt (Gilij 1965, II: 276; Morey 1975: 50), were planted seasonally as the flood waters receded. The third type of garden was a *clear* garden, planted in the grasslands. This consisted of raised fields located in humid sites (Gumilla 1963: 429 f.). All the Llanos groups expended a great deal of time and energy in activities of hunting, fishing and gathering. Even cultivators relied heavily upon game and fish as a source of protein (Morey 1975: 56).

WATER MANAGEMENT SYSTEMS RELATED TO SUBSISTENCE

The first known inhabitants of the Western Llanos, the Osoid people (Zucchi 1967, 1972, 1973), entered the area sometime around the beginning of the first millenium B.C. Initially, these groups occupied those areas that offered the best soils and drainage conditions, and probably limited their early agricultural activities to the forested areas along rivers and streams, using the grasslands for settlement. Besides agriculture, their subsistence activites also included gathering, fishing and hunting (Zucchi 1967; Garson 1980: 286).

During the first millenium D.C. other groups entered and settled in the Western Llanos, and between 500 and 1400 D.C, the Osoid, as well as other groups, began to construct artificial earth structures such as mounds, causeways and raised fields (Zucchi 1972: 1973). The construction of these structures seems to indicate population pressures, not only within the Llanos, but also in adjacent areas such as the Middle Orinoco floodplain (Zucchi 1978). The increasing competition between communities apparently forced some of the Llanos groups to extend their subsistence activites, to the grasslands proper, an environment which previously had been used exclusively for settlement purposes and hunting and gathering activities. Occasionally, this grassland exploitation implied the use of earth structures.

Ridged Fields

At present only two raised field systems have been reported for the Western Llanos. One at Caño Ventosidad (Denevan and Zucchi 1978; Zucchi y Denevan 1980), and the other at the Hato de la Calzada (Garson 1980), both in the Barinas State. The results of the research carried out in Caño Ventosidad and the comparisons established between this system and a modern developmental project called *Modulos de Apure* (CODEIMA 1976), currently being undertaken in the Low Llanos, allowed the formulation of several suggestions regarding the characteristics of the system and its probable mode of operation.

1) The ridged fields of Caño Ventosidad run perpendicular to the Ventosidad and other adjacent streams, and are arranged in pairs with an intervening canal and open savanna between pairs (Fig. 3). However, the ridges and canals are not the only constituent part of this system, since the riverbank, the estero and the spaces of savanna located between the pairs of ridges are also functional units (Zucchi and Denevan 1980: 74 – 81). In synthesis we can say that the Caño Ventosidad system combines functionally both natural and artificial features.
2) Some of the ridges of Caño Ventosidad are completely artificial while others seem to be partially or totally natural. This indicates that even for raised areas the groups (El Choque people) took advantage of pre-existing natural topographic features (former levees, natural raised areas), and adapted them to their own particular purposes.
3) The Ventosidad system had a double function: a) drainage, since it provided dry surfaces that could be cultivated during the rainy season, and b) water retention and storage, for use in the dry period (Zucchi and Denevan 1980: 74 – 81).
4) The retention and storage of water probably provided additonal benefits to its users such as the production of organic matter that could be incorporated to fertilize the agricultural ridges, and as a source of protein represented by the acuatic fauna that could live in these artificial bodies of water.

The limited scope of the Caño Ventosidad research project did not permit a satisfactory explanation as to why this kind of system did not attain a wider distribution in the Western Llanos inspite of its apparent productivity. At that time, two possible explanations were suggested: 1) that other similar systems had once existed but had since been buried under sediments which impeded their later discovery, and 2) that the population responsible for their construction migrated from the area soon after this technology was introduced, in this manner reducing the population pressure that might have instigated their original development, eventually leading to their abandonment (Zucchi and Denevan 1980). Recent discoveries in the Portuguesa state permit an alternative explanation, opening up a new perspective regarding strategies developed by prehispanic groups in their efforts to extend their agricultural practices into the seasonally flooded savannas. These finds allow us to see the potential importance of natural features of the irregular savanna topography for the subsistence strategies implemented by these groups.

The site referred to, Ramon Lepage (P-59), consits of a large irregular oval savanna surrounded by a ridge 0.50 to 0.80 m high and 20 to 30 m wide, with two openings to the southeast and southwest. In some parts the ridge is double with a central canal (Fig. 4). The savanna surrounding the structure is slightly higher than the internal area. The two openings probably allow the entrance of excess rain water from the outer savanna into the inner space. No archaeological material was found on the surface on the structure; however no excavations were carried out.[1] The nearest archaeological site discovered so far in the area lies some 2 km from the ridge.

In cross section the ridge has a trapezoidal profile similar to that described for other causeways and ridged fields (Fig. 5). The surface morphology of the ridge and its layout gave us the original impression that it represented an artificial agricultural system, with cultivation practices on the elevated area, while the lower central zone could have served for water retention. Mulch and aquatic plants obtained from the central part of the structure as well as from adjacent *esteros* and ponds, could have been worked into the surface of the cultivated area in order to enrich the soil. However, the examination of the aerial photographs and the preliminary analysis of the soil samples obtained in the ridge, indicate that the structure we have described was natural – not man made – and a direct result of the fluvial activity of the area (Schargel, personal communication).

Natural structures similar to the one described, providing elevated and at the same time, irrigated surfaces for cultivation, are probably frequent

1 In the Llanos, artificial earthworks such as causeways and ridged fields generally do not contain arachaeological material unless they stem directly out of settlement sites, from which some of the construction material was obtained.

in the area due to the fluvial activity. The utilization of natural features such as these would preclude the construction of artificial structures and therefore account for the scarcity of more elaborate ridged field systems, such as that found in Caño Ventosidad. This calls our attention to a viable alternative for the exploitation of poorly drained grasslands that would not entail the investment of the time and energy involved in artificial earthworks. As we have seen, the Caño Ventosidad ridged fields constitute a water management system that takes advantage of both natural and artificial features. It is therefore likely that the Llanos groups could have utilized many of the natural features existing in the area (eg. *bancos,* old levees), with or without further modification or formal layouts.

We do not mean to imply that all the elevated features found in these areas, were in fact, used for this purpose. What we want to emphasize is that they must be considered as *potential prehispanic agricultural grounds,* and for this reason should be studied carefully. If in fact, the aboriginal population took advantage of these features (as the Caño Ventosidad suggests), the surface of seasonally flooded savannas which could be easily transformed into agricultural grounds could be considerably extended, with little investment of time and energy devoted to construction. As a final point we would like to bring up a cautionary note concerning the classification of ridges as artificial features. As evidenced by the ridges at the Ramon Lepage site, it is impossible to establish the artificiality of earth structures in the Western Llanos based only on surface morphology.

Causeways

The second point that we would like to explore is the possiblity that causeways were constructed to serve as dikes in water management systems, intended to intensify the exploitation of aquatic resources. Causeways are artificial earth ridges with variable lengths, that run parallel or perpendicular to nearby water courses. Their heights usually range between 1 and 2 m, and their widths between 3 or 4 m to more than 10 m. Usually they are related to settlement sites. Recent research of the Osoid people's settlement patterns at the Hato de La Calzuda site in the state of Barinas, led to the establishment of a preliminary typology of these artificial features that includes: a) causeways that interconnect settlement, b) causeways that connect settlements with activity areas along rivers and streams and c) intrasettlement causeways (Garson 1980: 291 – 329).

In 1966 Cruxent proposed that causeways could have served as roads, occasional house floors, areas of cultivation and hunting grounds. In a recent work, Garson (1980) maintains that their principal function was to serve as roads, not discounting secondary functions such as those proposed by Cruxent. His interpretation is based on two arguments: a) the use attributed to causeways in other areas (Denevan 1966) and b) the difficulties for foot travel in the areas where these structures are found. In support of this argument this author reports that:

> "... The area of the Calzada Paez is a wet savanna surface as pock marked with depressions, marshes, ponds, streams and other features that make foot travel slow, indirect and treacherous during both the dry and the rainy season. An elevated path or road is one manner of mitigating these difficulties." (Garson 1980: 32)

Considering the peculiar characteristics of the Western Llanos, we are inclined to believe that another important function of the causeways, so far neglected, could be related to water management. This is without denying that, primarily due to their interconnective characteristics, they could have served as roads and, occasionally, also for other uses. Some causeways could have been constructed for the embankment of rain and flood water, in order to increase the number, depth and extension of aquatic environments during the dry season, as a mean to intensify the exploitation of aquatic resources.

We have already stressed that the Western Llanos consist of a mosaic of topographic units which are seasonally affected by different levels of flooding. In the lowest areas, water remains throughout the year, whereas the more elevated sectors dry up completely soon after the rains have ended. The ongoing research in the *Modulos de Apure* (Fig. 6), where rain water is artificially dammed up and controlled, has provided important data on the aquatic fauna of these modified environments. It gives us some idea of the possible benefits that the aboriginal population could have derived from an artificial water retention system, formed by a network of causeways.

The increase of surface water brought about by the construction of dikes in the wet savannas, produces a mosaic of new aquatic environments, each having different condition of depth, stability and physiochemical properties, all of which directly affect the dynamics of their respective living communities. In the *Modulos,* the construction of dikes has effectively extended the original aquatic environments of the grassy savannas, while new ones have been added (borrow pits). Some of these retain water during the whole year.

In addition, the construction of the dikes has produced a partial isolation of the embanked areas, whose nutrients are supplied principally by rainwater, and whose excess exits only through flood gates. This implies that the ichthyo-fauna found within each *Modulo* (cell) is that which was trapped in the area, at the moment of dike construction (Pinowski and Morales 1981: 81). Certain vertebrates adapted for land and water locomotion *(Cayman crocodilus* and *Podocnemis vogli)* have remained in the embanked areas or in its surroundings, since the changes produced by the cell system-are favorable to their species. The coexistence within the *Modulos* of permanent water bodies, areas of low water, and also dry zones, provides the necessary environments for nesting and for the breeding of newly born and immature specimens of the cayman. In addition, the lengthened period of water retention which, in turn, prolongs the food supply, has eliminated the need for long migrations during the dry season (Ramos et al. 1981).

On the other hand, the data regarding fish populations indicates qualitative differences in each aquatic environment of the *Modulos.* The flooded areas covering prior vegetation (large amounts of submerged stolons and vegetal matter in different stages of decomposition) are inhabited only by small species, or juvenile specimens of larger species that prefer deeper water bodies (Pinowksi and Morales 1981: 91). On the contrary, in areas of deeper water, such as the borrow pits, larger species are found. In general, it has been established that within the *Modulos,* large fishes are usually found in the deep water areas that are free from vegetation, and have the best oxigen conditions.

Finally, more than 100 species of birds have been identified in the general area. Twenty species belong to the savanna-forest environment, twenty are predators, while the other sixty five center their activities in the aquatic environments. Thus, the artificial extension of the latter must lead to an increase of the population of aquatic bird species.

The mammalian fauna is also affected by the artificial water retention, favouring the aquatic or amphibious species as well as those that can react quickly to change. However, research in this field is still incomplete (Ojasti 1981).

Although we cannot directly extrapolate the results of the *Modulos* research to a probable prehispanic water retention system formed by causeways, the data obtained in this proyect, have sufficient economic implications as to be taken into consideration when trying to reconstruct the ancient indigenous subsistence strategies of the Western Llanos. However, we consider that the demonstration of the benefits accruing from such a system, as shown in the *Modulos* studies throws a new light on a possible function of prehispanic causeways in the Llanos, and serves further study.

As a last point, we would like to mention that the probable use of causeways as water retention features, which created favorable environments for aquatic species, seem to receive support by the recent data obtained on the subsistence patterns of the Osoid groups, which constructed most of these earthworks. Beside agriculture and the gathering of wild fruits, fishing and hunting were the other means of food procurement of the Osoid people. However fish, reptiles and amphibians were the preferred animals, followed by mammals, birds and moluscs (Garson 1980. 271).

These two alternatives for prehispanic agriculture and animal exploitation of the wet grassland savannas, call attention on the diverse opportunities offered by this environment, a fact which undoubtedly was noticed by the prehispanic populations and favoured the development of multiple exploitative alternatives. The complete knowledge of the techniques employed by the main Llano groups, and their interrelationships will require years of active research. The possibilities presented here are only ideas that will have to be carefully explored in future archaeological research.

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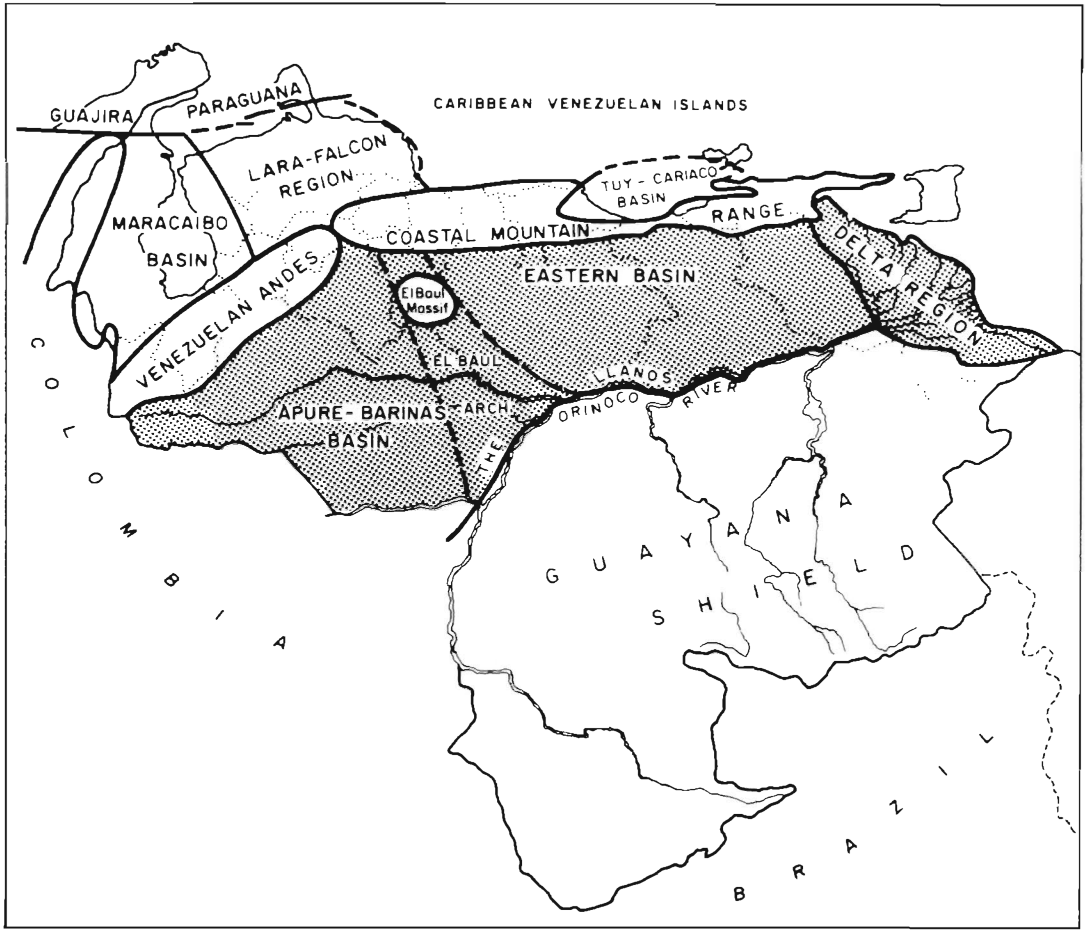


Fig. 1: Location Map of the Barinas Apure and Eastern Basins of Venezuela.

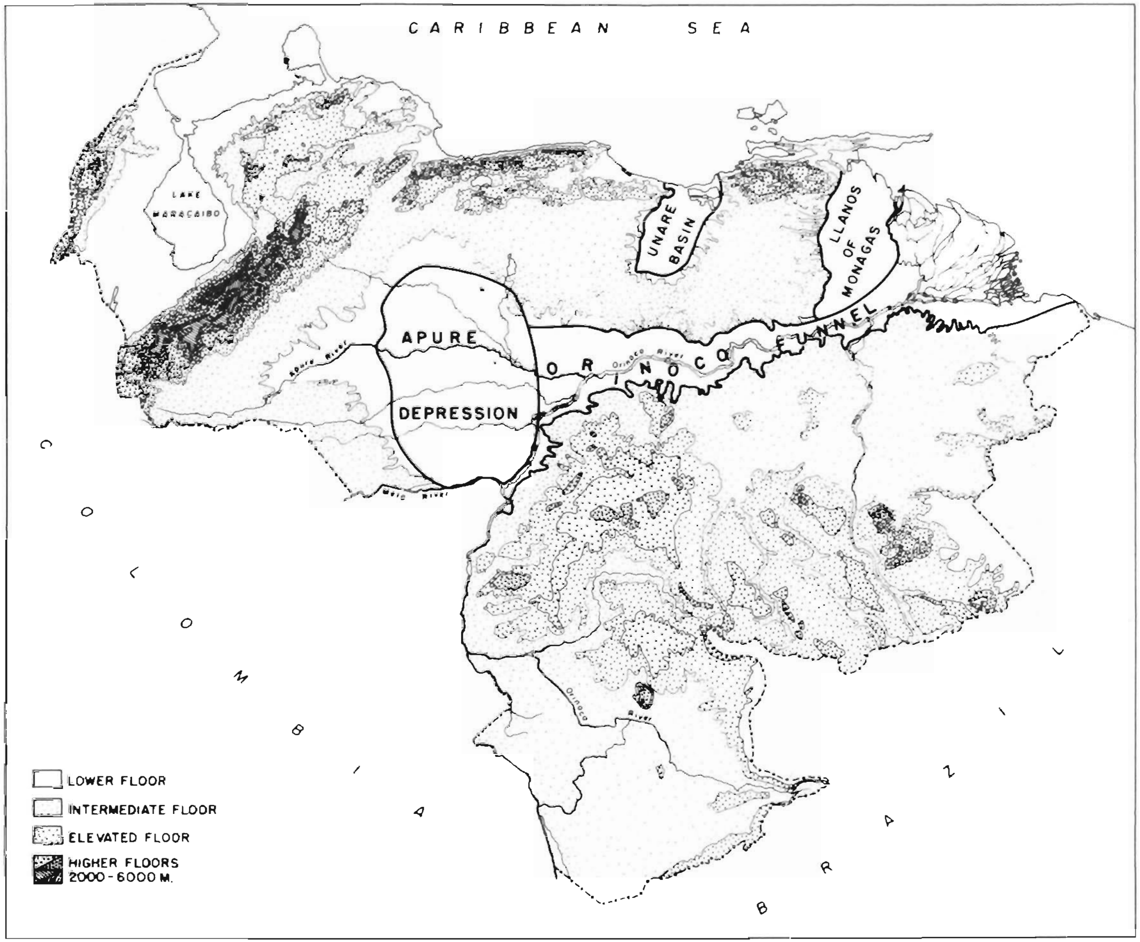


Fig. 2:
Altitudinal levels.

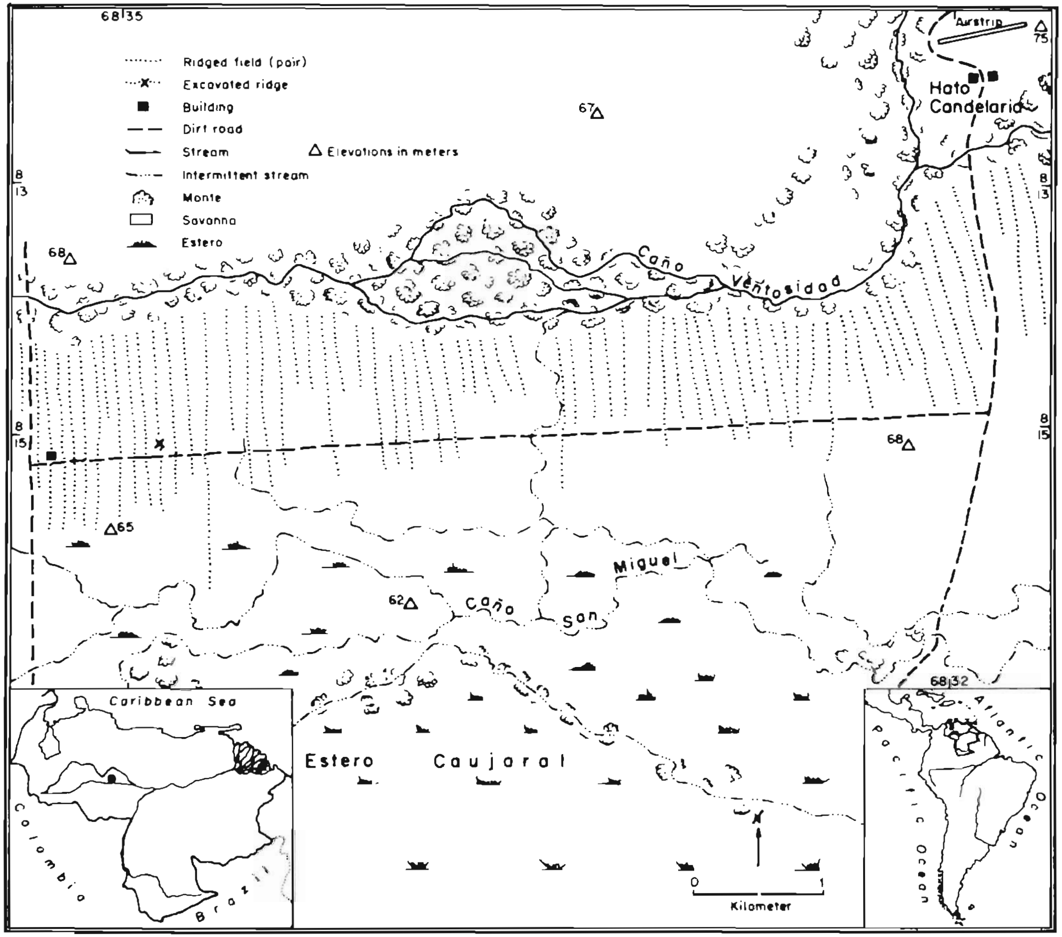
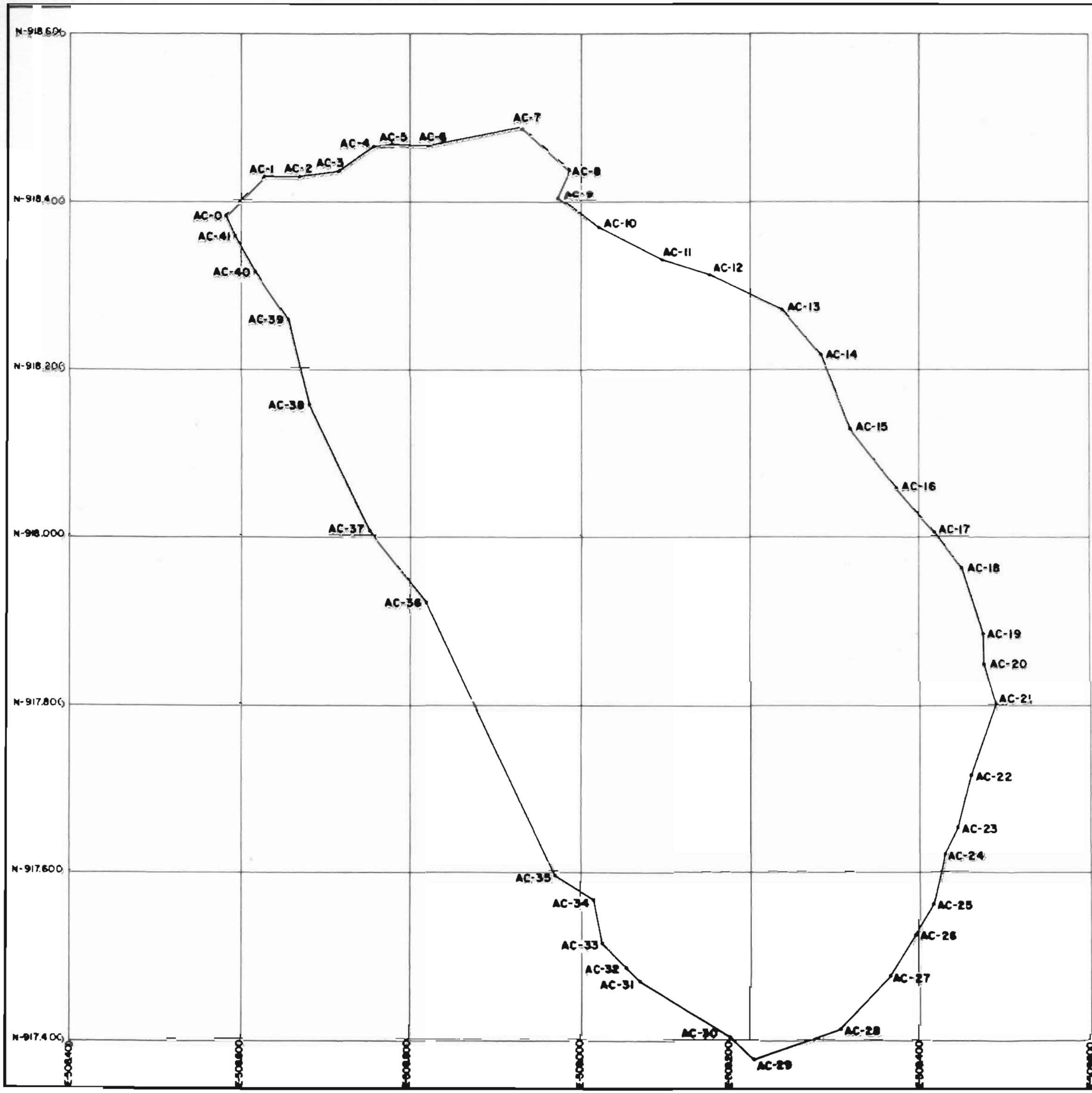


Fig. 3: Ridged fields at Caño Ventosidad.



RELATIVE LOCATION

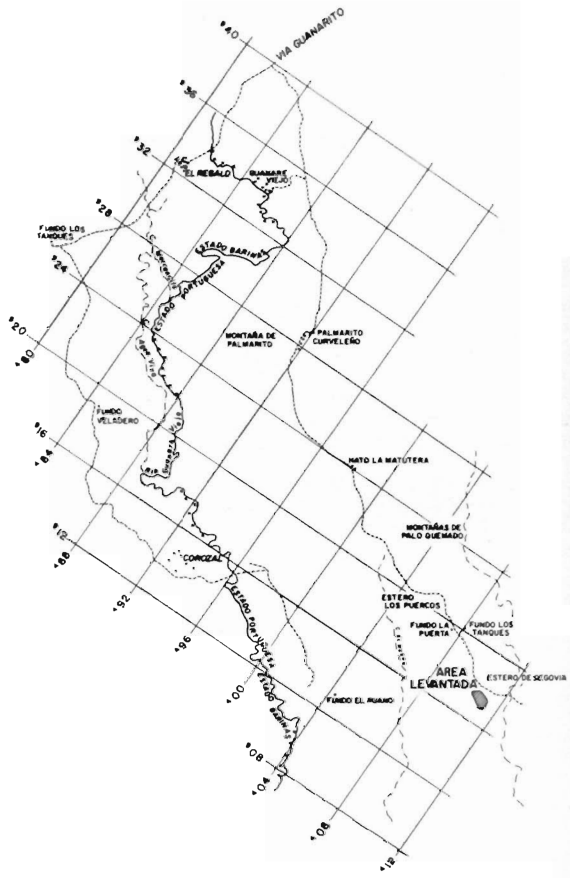


Fig. 4: Topographic Map
of the Ramón Lepage Site.

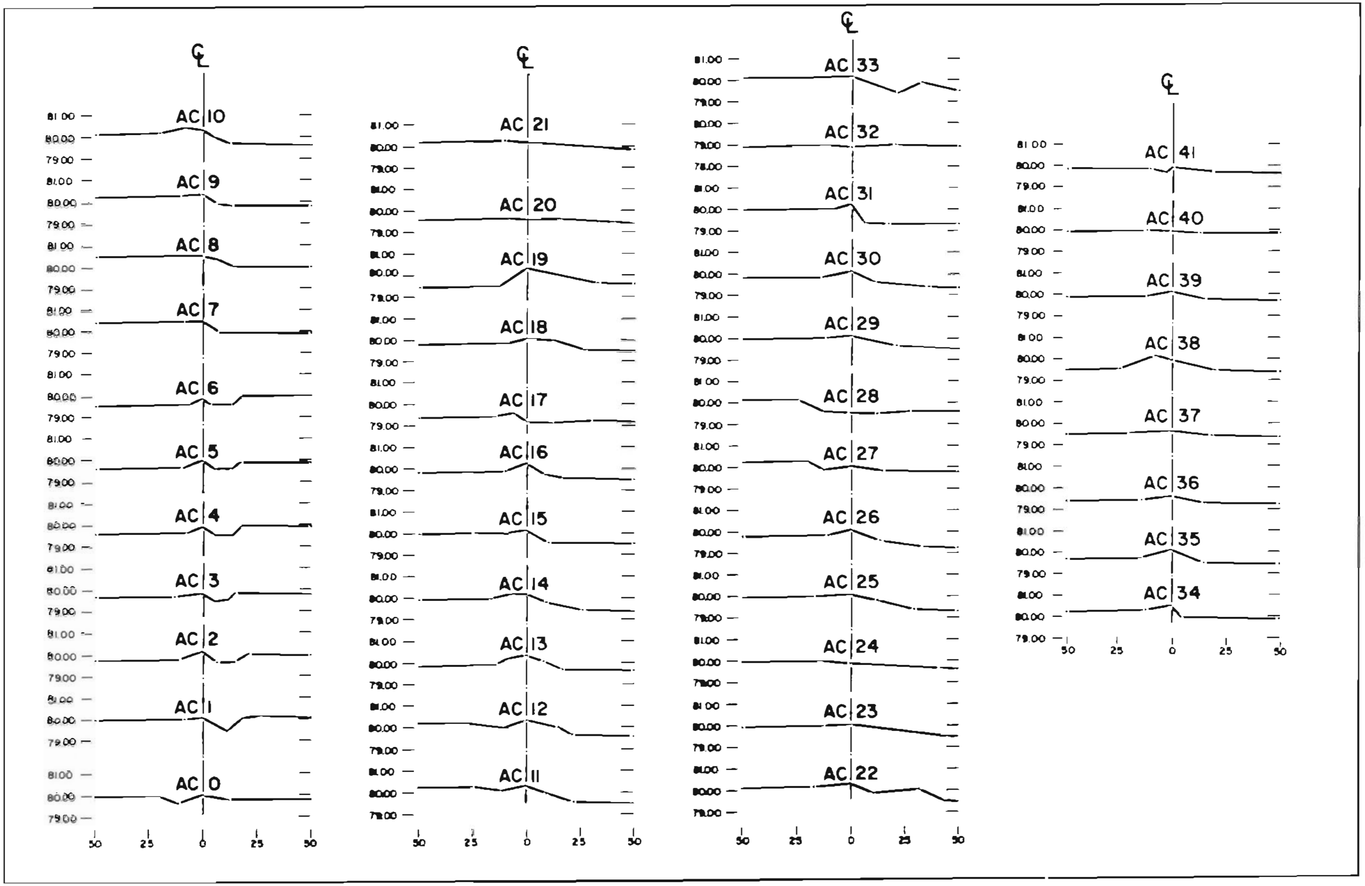


Fig. 5: Profiles of earth structure, Ramón Lepage Site.

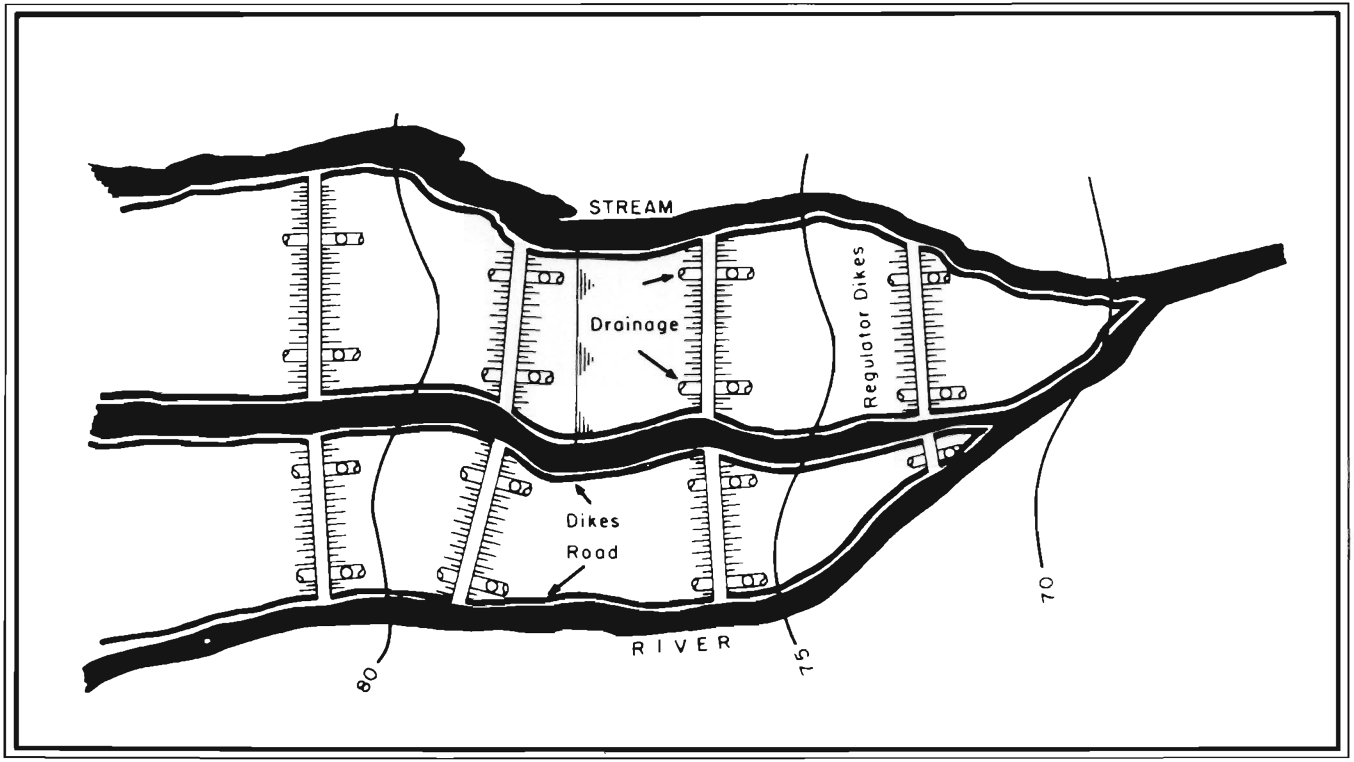


Fig. 6: Network of dikes (Source: MOP 1972).