

MORPHOLOGY AND FUNCTION OF THE ROAD NETWORK OF  
EASTERN SONORA

by

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## ABSTRACT

By most standards the roads of Eastern Sonora are in poor condition, admitting only sturdy vehicles. They have a regular function, however; commercial vehicles, buses, and private trucks pass over them daily. Road conditions are best and traffic heaviest on links near external urban centers. Roads that do not serve to connect places in Eastern Sonora to major cities outside the area tend to be of very poor quality and have little traffic.

Because of limited finances and the diffuse nature of settlement, roads are built as cheaply as possible, taking advantage of natural pathways such as ridgelines and arroyos where possible. Road building is particularly expensive in the mountainous eastern portion of the state.

The nineteenth century development of Guaymas and Hermosillo altered the colonial pattern of travel and reoriented many roads towards a previously undeveloped coastal zone. Many of the early automobile roads departed from the valley-bottom cart roads and mule trails for the interfluves because water and pasturage were no longer necessary for travel and because flooding was sometimes a problem in the lower areas. Most evidence leads to the conclusion that the network of roads was generated by a fairly stable settlement pattern.

## CHAPTER 1

### INTRODUCTION

In the eastern part of Mexico's northwestern state of Sonora are a group of small settlements strung out along the major tributaries of the Yaqui, the Sonora, and the Mátape Rivers. These rivers flow through roughly parallel north-south trending valleys that are separated by fairly steep mountain ranges. The settlements are connected with each other and with major cities outside the area by a series of very rough roads, which often will not accommodate ordinary passenger vehicles, and thus have a low volume of traffic. It is my purpose to explore possible explanations for the routes taken by these roads and for the functions they serve in connecting this area to outside areas by circulating goods, people, and ideas. Those explanations which relate the roads to other areal characteristics, past or present, will be emphasized.

My study problem has two different, though interrelated, facets. These two different aspects are morphology and function. The term "morphology," as I choose to employ it, denotes a description and explanation of characteristics of road form. Discussion may pertain to a single road, a series of roads, or a network of roads, and involve various scales of observation. This means that both the overall pattern of the roads as well as the adjustment of a single road to local features such as terrain are important. The term "function" is used in a broad

sense, generally meaning "basic purpose" with implications of "effect" or "impact" on other geographic features and on place-to-place relationships. Certainly, these aspects of roads are interrelated. One can conceive of a road being constructed at some time in the past, under a given set of circumstances which at some later time are no longer present. However, the road may continue to serve some purpose solely through inertia.

The normal approach to the geographical treatment of road systems has been from this latter, the functional, point of view. Appleton (1967) has recently decried the lack of morphologic studies dealing with all types of transportation networks. There has been another tendency among geographers to consider that the paths roads would take are obvious, given certain terrain and settlement characteristics. Instead I take Appleton's (1967, p. 36) and Meinig's (1962, p. 395) position that the form characteristics of any network of communication have no easy interpretation nor obvious explanation. On the contrary, lines of communication such as roads are, at every point along their length, influenced by both site and situation. It was also Appleton's (1967) idea that transportation networks could be viewed from a number of points of view or explained in terms of different "contexts." I choose to take this approach, interpreting according to different "contexts," examples of which might be the "physical context," the "economic context," or the "historical context."

Early studies by Sauer (1932) and by West and Parsons (1941) on the origins and functions of single roads in northwestern Mexico serve

as an inspiration for the present work. More recently, some geographers have undertaken the analysis of whole transportation systems or networks. The economic impact of changing highway systems has been considered by Garrison et al. (1959). Political and historical factors affecting railway networks have been studied by Wolfe (1962) and Meinig (1962).

A landmark in the geographical treatment of transportation networks as entities that could be studied for their own sake was a monograph on Ghana by Gould (1960). Later Gould, Taaffe and Morrill (1963) proposed a general model for transportation development in underdeveloped countries based on evidence from Ghana and Nigeria. Several stages were identified in the development through time of the road and rail system for these two countries. The initial stage was taken as given, without reference to its origin and development. It represented conditions up until the late nineteenth century: small scattered ports each had lines of communication into a very limited hinterland. A stage of port concentration ensues as some ports increase in importance and others decline. This concentration is a result of an expanded hinterland of some ports to important inland centers. Eventually, in later stages, these inland centers become interconnected with each other and an integrated transportation network and system of settlements emerges. I will go into more detail with this model in a later chapter and, by comparing it with the development of the network in Sonora, give a partial test of its generality.

It is difficult to discuss a network of roads without treating the settlements or urban centers they connect. Burghardt (1969, p. 418)

felt that it was this inextricable relationship between roads and settlements that caused the former to be a somewhat neglected aspect of geography. Relative settlement sizes are generally in a state of flux as a network of roads develops connecting them, but it is difficult to isolate the causal factor. Settlements may increase in size for some reason unrelated to a change in the quality and quantity of their road connections. However, the relationship of the location and size of settlements to the development of a network is a question that will be answered for Sonora as definitively as the evidence allows.

Functional significance of the present day roads will be another important aspect of this thesis. Presumably, using certain economic or social criteria, a set of hierarchical or tributary relationships between settlements can be established. Thus, the road network will also be viewed as one element in the spatial organization of the area. In this thesis investigation is concentrated on discovering which roads in eastern Sonora are oriented toward the capital city of the state, Hermosillo. It is to be hoped that a boundary can be drawn separating the influence of Hermosillo from that of other centers.

In recent years there has been increasing interest in the mathematical analysis and description of single lines of communication and networks of all types. Haggett (1966) reviews several studies in which factors influencing the deviation of routes from direct courses is discussed. Principles in the construction of optimal networks have been developed by Quandt (1960) and Garrison (1960), and Kansky (1963) has attempted to relate network geometry to areal characteristics. Haggett

and Chorley (1969) treat these subjects in a comprehensive fashion which includes mathematical aspects of drainage networks and networks of boundaries, as well as networks of communication. These topics, in their relevance to the roads of eastern Sonora will be touched upon in a later chapter, but will not be an emphasized part of this thesis. This de-emphasis is not intended as a denial of the importance of this type of approach, but merely reflects the interests and abilities of the author.

The study area with which I am concerned might generally be called east-central Sonora. A more precise delimitation of the area will be given in Chapter 2 (see Figure 1), but for the time being we may designate it as that part of Sonora lying east of the International Highway, starting somewhat south of the border, and including the broad middle portion of the state.

There is a fairly wide range of literature which touches upon this area in whole or in part, much of which is in some way relevant to my topic. Specifically geographical work has been done by Sauer (1932, 1934, 1935), Hewes (1935), Pfeifer (1939), Ives (1948), Dunbier (1968), and Schubel (1969) among others. Sauer's (1932) monograph which he called "The Road to Cíbola" has been mentioned previously, and is the geographic work most specifically related to mine. He discussed the Spanish explorations up the west coast of Mexico and the resulting routes of travel in colonial and later periods. Pfeifer (1939) and Dunbier (1968) have authored the only two professional geographic publications which treat Sonora from a general point of view, though both of these works deal with larger areas than just Sonora. The other geographic studies are more specific in nature.



Archaeological work has been limited to a few reconnaissances and surveys. Hinton (1959) and Spicer (1962), among others, have written on the acculturation of Indian groups into Spanish and Mexican society.

There is a fairly ample amount of historical literature which in some way treats of the valleys of eastern Sonora. Among the more well known of these are Bancroft (1884, and 1889), Bolton (1936), Villa (1937), Dunne (1940), and Bannon (1955). While the main value of these works is as background material, other historical accounts and regional descriptions from varying time periods have provided some information on the nature of travel during these periods. Hardy (1829), the British naval lieutenant, traveled extensively in Sonora in search of mines and pearl beds. For the previous century there are several travel itineraries extant (Lafora 1939, Morfi 1967, Murphey 1938). Bartlett (1965) on the United States and Mexican Boundary Commission visited various localities in northern and central Sonora, Lumholtz (1902) left from eastern Sonora on his scientific expedition to the Sierra Madre. Francisco Velasco (1861) and Alfonso Velasco (1893) provide geographical and statistical descriptions. Earlier descriptions, such as that contained in the Rudo Ensayo (Guiteras 1951), are valuable but contain less specific information. In addition the State of Sonora has made available progress reports on agriculture, industry, and communications from time to time. There is some rather detailed information on cart roads and mule trails in an unpublished government report for 1891.

Documentary sources which have yielded some information on travel and commerce in Sonora during the nineteenth century and earlier are

available at several libraries in Tucson, Arizona, and Hermosillo, Sonora. Particularly valuable are the microfilm copies of the documents in the Parral Archives and the Documentos para la Historia de Sonora (Pesqueira, n.d.). Nineteenth century Sonoran newspapers such as La Estrella de Occidente, published in Ures, 1859-1876, also have provided some information. The maps contained in these libraries are especially important for this thesis.

Some of the documentary sources are so voluminous that a complete perusal of their contents is beyond the scope of this project. Rather, I intend to rely more heavily on the comparison of eighteenth, nineteenth, and twentieth century maps. The main objective in so doing is to see to what extent modern automobile roads have followed earlier wagon roads and mule trails.

My thesis is that modern automobile roads are distributed in a pattern, that is similar, in most respects, to the network of cart roads and mule trails that existed in the late nineteenth century, but that an examination within small areas would show limited, but distinct, differences in the routes taken by the two types of roads. In addition, I argue that the position of settlements in Eastern Sonora has been the main determinant of the road pattern, and that very few settlements have been located because of thoroughfares.

## CHAPTER 2

### EASTERN SONORA AS A CULTURE REGION

Because so much of the modernization in Mexico is associated with paved highways, it should be informative to take a brief look at the nature of an area as yet served only by dirt roads. This overview of eastern Sonora should introduce the reader to a few basic cultural characteristics of the area, some of which set it apart from other areas of Mexico.

Northwest Mexico, especially Sonora and northern Sinaloa, has been the scene of much human activity in recent times. Irrigation schemes and urban developments have transformed many areas of formerly barren landscape since the 1940's. Geographers such as Dozier (1963) and Dunbier (1968) have focused some professional attention on these irrigation projects in the Sinaloa, Fuerte, Mayo, Yaqui, Mátape, and Altar valleys and on the Costa de Hermosillo. In these areas many thousands of acres have been given over to the cultivation of wheat, rice, sugar, cotton, and tomatoes. Here, also, urban centers such as Ciudad Obregón, Hermosillo, Navojoa, and Los Mochis have had phenomenal growth.

But in stark contrast to the modern cities, huge fields, and paved highways of the coastal area are the landscapes of Eastern Sonora. In the narrow valleys of Eastern Sonora, which are sources of the water

that irrigates the coastal area, are small scattered settlements of farmers and ranchers living in a predominantly subsistence economy. One might call this area "Old Sonora," for it was here that some of the earliest Jesuit missions in Northwest Mexico were established. This area coincides fairly closely with the old Opatería and Pimería Baja. The missions of Pimería Alta were not founded until forty or fifty years later in the seventeenth century. The Yaqui and Mayo country and the silver mining district of Alamos to the south had a somewhat separate existence socially and politically as the province of Ostimuri. In spite of its lack of modern features, it should not be construed that Eastern Sonora is the poorest area of the state. The greatest poverty in Sonora is probably to be found in the cities and in some of the newly established ejidos of the western area, not in the old part of the state where a way of life is well established and food sources are near at hand. Neither should it be supposed that the economic life of Eastern Sonora is unchanged since colonial times. Dramatic changes have come about as a result of the use of the truck and the import of manufactured articles previously made in the home. It is the relative speed of change which differentiates Eastern Sonora from the western coastal area where twentieth century technological advances are adopted with less resistance. There was less established in the coastal area of Sonora in the past that might resist change.

Eastern Sonora, then, is characterized by a subsistence agricultural economy in which small surpluses of crops and a few cattle are the main cash products. The crops, and many of the techniques for

planting and harvesting them, have not significantly changed since colonial times. Changes in transportation modes and in the system of circulation have, however, brought the remote valleys of Eastern Sonora into contact with the modern world. In addition to the plow, tractors are now used for some of the field work. There is regular traffic in packaged and canned food, manufactured cloth and clothing, rope, leather goods, tools, and metal pots and pans. These items are sold in small general stores which often are the only commercial establishments in the towns. The stores, in addition, sometimes serve as markets for local produce such as vegetables or flour.

In Eastern Sonora one can see the relic features of a technology and a way of life which were formerly more widespread. Wheat is threshed, hand-winnowed, and ground in animal powered arrastras in a way that is almost reminiscent of medieval Spain. In remote communities in the Sierra Madre wooden plows without metal parts are still used (see Figure 2). Here, and in other parts of Eastern Sonora, cattle are still driven for many miles to market by leather clad vaqueros. Only recently have new breeds replaced most of the original Spanish longhorns. Modern agricultural methods are now being adopted, but only very slowly and in conjunction with the older techniques.

It is apparent that Eastern Sonora deserves mention as one of Mexico's unique culture regions. It should be born in mind, however, that its distinctiveness is recent and is largely the result of the modernization of adjacent areas. In past centuries there was probably

(a)



(b)



Figure 2. Ancient Agricultural Techniques and Implements.--(a) Winnowing wheat in the San Miguel Valley. (b) Plowing corn field near Tarachi.

a similarity of life style and economy throughout upper Sonora (including northwestern Sonora and southern Arizona).

One of the outstanding distinguishing features of Eastern Sonora is that it is one of few areas of Mexico, and perhaps the largest, where a rural subsistence population eats wheat. Tortillas are usually made from wheat flour rather than from the traditional corn, as is common elsewhere in Mexico. There are a number of possible explanations for this difference. The period of mild weather in the latitudes of Eastern Sonora is long enough for the growth of a good winter wheat crop, whereas at low elevations in the south (southern Sonora and northern Sinaloa) temperatures that are too warm for wheat might persist for eight to nine months out of the year.

The environmental explanation may not be completely tenable, however. Other areas in the central highlands or in the Sierra Madre of Mexico that are similarly suitable for wheat growing have not necessarily developed this tradition. It may be more significant that the valleys of Sonora spent many years under the mission system. The Jesuits tried to introduce Mediterranean crops where they could.

Perhaps still more significant was the influx of whites and mestizos that followed the expulsion of the Jesuits in 1767 (Hastings 1961, pp. 338-340). Eastern Sonora retains today a racial character that is more white than Indian. This is typical of Northern Mexico where Spanish miners turned to ranching after deposits of gold and silver could no longer be worked. It is not typical of an area formerly inhabited by a sedentary aboriginal population such as were the Opata. A notable

decline in Opata and Pima population took place in the eighteenth and nineteenth centuries (Pffeferkorn 1949, pp. 264-265), while at the same time there was a constant flux of immigration and emigration of whites and meztizos. Eventually the Opata language and many of Opata customs died out completely (Hinton 1959). The Pimas were more resistant to assimilation, but they, too, are now becoming indistinguishable from the Mexican peasantry.

The main contribution of the Indians has been their crops which, in addition to wheat and a few introduced vegetables and fruits, form the basis of the local diet. Aside from these elements of diet, the basic features of the culture derive from the Spaniards. The racial and cultural mixture of Eastern-Sonora, however, remains more white than aboriginal.

## CHAPTER 3

### THE ROAD NETWORK OF EASTERN SONORA: ITS PHYSICAL CONTEXT

The settlements of Eastern Sonora are connected to each other and to the outside world by a series of roads which, by most standards, would be considered very poor. Pavement is a recent phenomenon east of Ures, completed beyond this place only in 1970. Many roads are difficult or impossible to travel in ordinary passenger vehicles. The main traffic involves private and commercial trucks or other vehicles with high road-clearance. Moreover, during the summer wet season all travel is seriously impeded. Some communities may be cut off for weeks, and in the far eastern part of the state traffic to some isolated communities usually stops for several months during this period.

Despite the poor condition of the roads in Eastern Sonora, they carry interregional traffic as well as local traffic. There is even daily bus service over some of the roughest roads.

The modern road map (Figure 3, in pocket) shows those roads in Eastern Sonora can be used for motor traffic between major areas. It does not include private or local roads used exclusively by ranchers, miners, or lumbermen. On this map I have classified roads into three categories: (1) paved roads, (2) dirt roads passable by vehicles of all types, and (3) truck roads. The third category includes roads, in my

judgment, passenger vehicles cannot use because of insufficient road-clearance. As can be seen from the map, many important places in Eastern Sonora are connected to the outside by one of the third category, primitive type of roads.

A few preliminary comments of a descriptive type should be made regarding the pattern of roads in Eastern Sonora.

Hermosillo, the capital of the state, is a major external focus of routes leading out of Eastern Sonora. At least three major roads extend eastward from Hermosillo to centers of population further inland. To the northeast, a paved highway reaches beyond Ures, and continues to Moctezuma as a dirt road. Going almost due east from Hermosillo to Mazatán, Bacanora, and Sahuaripa is a good dirt road which also passes by the newly constructed Novillo Dam. And slightly to the southeast is a road connecting La Colorada, San José de Pimas, Tecoripa, and Tónichi with Hermosillo.

Other roads have a north-south orientation following the river valleys. In addition there is a generally greater density of roads in the western area, and very few roads that extend far to the east. The reputation of the Sierra Madre as a transportation barrier is proverbial. The only two roads that cross this mountain barrier completely from Sonora are in the vicinity of Yécora and Bavispe. Both of these roads are very rough and relatively little traffic goes over them. In addition there may be a series of ranch roads which would provide a complete connection across the Sierra, but these roads are extremely poor and virtually unused except by the ranchers themselves, if usable at all. All

other roads eventually terminate somewhere in the eastern part of the state.

It should probably be pointed out here that there now remain very few towns in this section of Sonora that are not served by a road of some kind. Teópare and Nátorá, located east of Sahuaripa, are probably the only two places of any consequence not yet connected by motor roads. They have no more than one or two hundred people each and are supplied by mule train.

#### Relation of Roads to Topography

The greater part of Eastern Sonora has a basin and range type of topography. The valleys have a structural origin (King 1939, p. 1636), but are much narrower than is the case for the basin and range province in the United States. Moreover, some valleys are completely closed off at both ends. This makes transportation between them rather difficult as there is no way of avoiding mountain passage. In the area immediately east and southeast of Hermosillo and northeast of Guaymas the ranges are lower and more widely spaced while the basins are broad and interconnected resembling more the basin and range province further north in Arizona. Here, of course, the mountains are not a hindrance to travel other than to cause roads to be detoured around them. This area of smoother topography has a greater density of roads, especially ranch roads, despite its sparse population. This condition is a result of ease of construction and the fact that many roads are hardly constructed at all, being just tire tracks worn by trucks driving across the desert plains.

Extreme eastern Sonora and parts of Chihuahua is barranca country, extremely deep gorges cut by streams eroding headward into the main plateau of the Sierra Madre (King 1939, pp. 1631-1635). It is these deep, twisting canyons that make the Sierra Madre such a formidable barrier to transportation. The ascending ridgelines are generally too steep to be used as pathways, and the canyon bottoms, if dry, eventually come to dead-ends against the steep west side escarpment of the plateau. Therefore, truck roads, for the most part, have to be cut over a stretch of many miles into the steep sides of the barrancas.

Clearly, there is no technological reason that more roads crossing the Sierra Madre could not be built if they were considered to be justified within the limits of financial resources available from local, state, or federal governments. Of course, if there were a technological advancement in road building, such roads might be financially feasible. However, it is difficult to predict what the benefits of a good road between Sonora and Chihuahua might be, given the similarity of their economies. This aspect of the roads will be discussed in further detail in a later chapter. Suffice it to say, here, that the Sierra Madre as a physical barrier to transportation must be viewed in the light of local economics and human resources.

Investigation locally of many roads in Eastern Sonora indicates an adjustment to topography that is interesting with respect to my previous statements. The small settlements of Sonora are so dispersed that many miles of roads are needed to connect them to important centers. Because of this, the roads are built as cheaply as possible. Engineers

have taken advantage of any natural pathways that exist. Of course, river valleys provide easy communication between the numerous small pueblos and ranchos that lie along them. But even in more rugged areas many roads make use of the beds of arroyos. Since most of these streams have water in them only during rains, only occasionally are they unusable. In higher country ridgelines are used wherever possible. In fact, my observations and references by others (Roca 1967, p. 270) lead to the conclusion that the need to utilize ridge lines and arroyos as pathways is so great that distances between many places are miles longer than they would be if direct routes were feasible (see Figure 4).

#### Problems Imposed by Climate

Despite Sonora's general aridity, summer thunderstorms can be intense. This fact, taken into consideration with the nature of the roads and the erodibility of the landscape in the eastern part of the state, conduces to even more difficult road conditions during part of the year (see Figure 5). The more important roads are repaired as soon as possible after they are washed out, but if the surface is very wet and mud becomes deep, the road is impassable until it dries out, unless construction of detours is possible. Small outlying communities may be cut off for weeks or months at a time during the summer wet season. This is the case at the towns of Tarachi, Mataráchic, La Iglesia, and Mulatos in the Sierra of southeastern Sonora. Smaller ranchos may be similarly cut off from all traffic except that of pack trains.

The occasional cyclonic disturbances that reach Sonora in the winter sometimes have an effect on transportation. If these storms are



(a)



(b)

Figure 4. Natural Pathways.--(a) Ridgeline road. (b) Road in arroyo.



Figure 5. Thundershower on Road to Tarachi.

widespread enough or occur at the time of melting snows in the mountains, rivers may flood their banks, making adjacent roads impassible. In anticipation of these floods many roads, as well as townsites, are built up off the valley floodplain proper. In some cases a torturous route is built along the valley side continually entering and leaving tributary arroyos so as to avoid the main valley bottom. The road between Arispe (spelling varies) and Sinoquipe is much like this. Sometimes there are two roads connecting important towns to other areas of Sonora. The one most often used follows a valley whereas an additional route passing through higher or mountainous terrain is used during the wet season.

#### Problems Imposed by Vegetation

Climate also acts through vegetation to produce areal differences in the relative difficulty of road building. The western coastal area is very dry, the sparse vegetation presenting few problems to the construction of roads. Precipitation increases markedly as one goes inland. In the areas immediately above the desert, grasslands are typical, and in still higher areas oak and pinyon juniper occur in open stands. Only in limited areas are there dense stands of Ponderosa Pines, and these pose no difficulty in most of the state because of their very restricted distribution. The road to Yécora is the only road of any importance that passes through such an area.

Probably the most difficult vegetation region for roads is that of the thorn scrub forest found in the east central and southeast portion of the state at intermediate elevations. It is the same vegetation that is generally found much further to the south in central Sinaloa. The

local term for this vegetation is monte. It characterizes especially the foothill zone adjacent to the Sierra Madre in much of Sinaloa and in the southern half of Eastern Sonora. The dense vegetation must be cleared before roads or trails can be constructed through it. Also any road in this area has to be repeatedly cleared because of the perseverance of this thorny, bushy vegetation.

Important Indian roads may have followed this foothill zone up the west coast of Mexico before the coming of the Spaniards. In any case the camino real of colonial times from Guadalajara to the Sonora Valley was built largely through vegetation of this type. Vegetation on Indian trails would have had to be cut to greater height and width to enable passage of packed horses or mules. If the trail was well maintained, despite the difficulty of the monte, the route was obvious. In addition the monte area is moister than the arid coastal plain, and therefore, sources of water and pasturage are at less widely spaced intervals.

## CHAPTER 4

### HISTORY OF SETTLEMENT

There is an obvious mutual dependence between lines of communication and the settlements they join. Roads do not wander aimlessly, nor can towns exist by themselves without drawing sustenance from outside areas. It is a more difficult task to determine which is antecedent. Nevertheless, this is certainly a problem that should be investigated. Therefore, I will first outline the history of settlement within Eastern Sonora in hopes that this information may provide evidence for a local solution to the general problem of causality.

#### Indian Settlement

The distribution and characteristics of settlement of the indigenous populations at the time of contact with the Spanish Explorers is not known with precision. Díaz, a member of Coronado's expedition describes the Sonora Valley as having more people and more cultivated ground than any area over which they had recently passed (Bolton 1949, p. 104). The central Sonora Valley today has the densest settlement of any part of Eastern Sonora. It is even possible that some of the larger Indian pueblos were in the same locations as the major towns of today.

Coronado's base camp, called Corazones, was probably located near a Pima Indian town which became the modern Ures (Sauer 1932, p. 23). The town

of Ispa was encountered in a more northern part of the valley, and this is probably the modern Arizpe (Bolton 1949, p. 104). Other than these, few places are mentioned which can be identified with modern settlements. We do get a picture of population distribution for part of the state that is similar to that of today. Small settlements were encountered on the Yaqui at intervals, dense settlement was seen in part of the Sonora Valley, and the area between the two rivers was relatively empty of people.

After the entrada of Francisco de Ibarra in 1564 there is no recorded Spanish entry into the state for almost 40 years.

The Jesuit pioneers on the western slope of the Sierra Madre began their active period of missionization at the Sinaloa River in 1591 (Dunne 1940, pp. 22-25). In little more than half a century they had not only established themselves and their institutions among the tribes of the lower courses of the Sinaloa, Fuerte, Mayo, and Yaqui, but had penetrated deep into present-day Sonora itself. Missions had been established along the tributaries of the Yaqui and Sonora almost as far north as the present international boundary. It remained only for Kino in the 1680's to further extend the limits of New Spain northwest to Pimería Alta.

It is from reports made by these early missionaries, histories written about them, and especially from their maps that we get an early picture of the indigenous settlements of Sonora. With a few exceptions and with a few additions all the towns of Eastern Sonora had an existence as Opata or Pima settlements in the seventeenth century. An examination

of early maps reveals the same settlements in approximately their present locations. In some cases names have been changed; in other cases spellings have changed as Indian names became Hispanicized. It is known that the locations of some towns have been shifted a few miles up or down streams. A few new towns (usually mining towns) have risen where formerly there were none. Other than few changes a map of Eastern Sonora in the seventeenth century is remarkably similar to a modern one.

The major settlements and the missions established in them should perhaps be reviewed valley by valley.

After the Jesuits had gained a firm foothold among the Yaqui Indians, who occupied the lower course of the river of the same name, missionaries were sent up river to the Pima rancherías whose inhabitants had been asking for the padres since 1614 (Bannon 1955, p. 25). In 1620 permanent missions were established among the Pima Bajo, as this group was later called. These included the settlements of Buenavista, Cumuripa, Onavas, Tónichi, and Soyopa (Gálvez 1971, p. 15). The missions of Suaqui Grande and Tecoripa were established on an affluent of the Yaqui which enters from the north, and Movas and Nuri on a tributary joining the same river from the south, were missionized at the same time. All of these places are modern day towns in Sonora.

There were other Pima Bajo settlements both to the east and west of those on the Yaqui River. However, missions in the Sierra to the east were not founded until much later. Yécora and Maycoba were established in 1673. To the west and northwest the Pima settlements on the Mátape River were not firmly under the control of the padres until 1629 (Gálvez 1971, p. 16).

The next major area to come into the fold of the Jesuits was the Sahuaripa Valley. This was accomplished after a prolonged solicitation on the part of its inhabitants, Opatas and Jovas, in 1628 (Bannon 1955, p. 45). In a very short time missions were established in Sahuaripa, Arivechi, and Bacanora, which is in a small valley slightly to the west of Sahuaripa (Gálvez 1971, p. 19). These are the most important towns in this area today. Others which appear on seventeenth century maps are Onapa and San Mateo.

The Sahuaripa River is an eastern tributary of the Yaqui and is fairly isolated. Neither from here nor from the main course of the Yaqui itself is it easy to communicate with areas to the north. Instead one must leave the river in the vicinity of Soyopa and travel to the northwest. Near the present town of Mátape one can either travel northwest to the Sonora drainage or to the upper portions of the Yaqui drainage. There are two main branches of the Sonora River, the San Miguel in the west and the Sonora itself. These join near the modern city of Hermosillo. To the east one encounters two major tributaries of the Yaqui: the Moctezuma and the Bavispe. Communications are affected by the fact that the northern tributaries form three valleys, because the Bavispe River flows through two distinct structural valleys. In the easternmost valley the upper Bavispe flows north through a settled area. It then makes a sharp bend in uninhabited canyon country before flowing south toward Oputo and Húasabas (spelling varies).

These five northern valleys were the scene of competition between Jesuits and another Catholic religious order, the Franciscans.

Apparently as early as 1610, a Franciscan coming from Chihuahua had visited the Opata settlements along the upper Bavispe (Roca 1967, p. 210). In the 1640's Perea, capitan-general of Sinaloa and Sonora, attempted to establish Franciscans in other parts of northern Sonora. Castaño, a Portuguese Jesuit, had already worked with considerable success among Opatas of the Sonora Valley, here founding the missions of Baviácora, Aconchi, Banámichi, and Sinoquipe. These missions and others in the San Miguel were occupied by Franciscans for a brief period before the viceroy disapproved the plan. Perea died in 1644 enabling Jesuit missionaries to extend their realm of influence north. In 1646 Oposura and Cumpas were selected as sites for churches among the Opata villages in the Moctezuma Valley. Between 1645 and 1653 several more missions were founded along the length of the Bavispe and its tributaries (Spicer 1962, pp. 93-96; Gálvez 1971, pp. 28-29).

Thus by the early 1650's the mission system had been established from southern Sonora through almost the whole length of the northern valleys. At Santa Rosa the frontier was only 40 miles south of present United States. For about 35 years this boundary stood in place. It was not until the 1680's when Padre Kino preached among the Pimas Altos that the frontier again advanced, this time to the north and northwest into present Arizona. During this intervening period gains were consolidated and Indian villages in small tributary valleys were Christianized.

The remaining question is: what effect did missionization have on the aboriginal settlement pattern? In their desire to bring the Catholic faith directly to the people, the Jesuits invariably established

their missions in already existing Indian settlements. In some cases actual mission churches may have been built on ancient Indian ceremonial sites (Lumholtz 1902, p. 18). Most of the towns still bear their Indian names, usually with some changes in spelling and pronunciation. Thus most of these places, especially in Eastern Sonora, existed in the seventeenth century, and probably in prehistoric times. But there were many other settlements in addition to these important ones that became mission centers. In 1646 forty Opata rancherías in the Moctezuma Valley were visited by Father del Río (Spicer 1962, p. 95). If each of these settlements had several families, this would be greater than the total number of such places in this area today. It can be safely assumed, then, that many more Indian settlements existed than were chosen as mission sites. The Fathers probably established themselves in the largest and most centrally located of the Indian villages. Outlying villages of substantial size might be classified as visitas. If the Indians were inclined to accept missionization, and by all accounts the Pima and especially the Opata were, then probably some of the smaller villages declined in population at the expense of the settlement in which the mission was located. Though towns such as Oposura and Cumpas may have had primacy before the first Spanish contact, their local importance after the establishment of a resident missionary and the construction of churches, must have increased.

The Indian ranchería was a loosely agglomerated group of individual dwellings with some agricultural land between them. Sauer (1932, p. 25) indicates that the Opata settlements were more compact than

rancherías, resembling a "town." Nevertheless, all Pima and Opata settlements were restricted by the amount of contiguous cultivable land, presence of water, and sites on which building villages was feasible and safe. In many cases slightly elevated bluffs near rivers were the chosen places. In any case the extent of area suitable for settlement, above river level but within the area of cultivable land, defined the limits of the Indian towns. The padres sought to change the settlement pattern in their missions to approved forms. First they gathered all the neophytes they could into more concentrated Christian pueblos. Some of these mission towns eventually took on the grid pattern form typical of New Spain (Stanislowski 1947), with the church and a rectangular line of houses facing an open area (Treutlein 1965, p. 151 ) (see Figure 6).

We can probably assume that a concentration of population in some Indian settlements, that is in the mission settlements, was attendant upon the establishment of Jesuit control in Sonora. Conversely, some of the smaller Indian rancherías probably became depopulated. In fact, it is likely that the total number of Indian settlements declined.

The missionization of Eastern Sonora was complete by the 1670's. It remained for Father Kino to extend the Christian frontier to the north and west during the next decade. Pimería Alta is essentially outside of our area, but of course is important as an external focus of travel, and will be discussed in that connection in a later chapter.

#### Spanish Settlement

Scholars have not devoted as much attention to the Spanish settlement of Sonora as they have to its mission history. White occupation of



Figure 6. Church and Plaza in Santo Tomás.

central Sonora was, in fact, contemporary with its missionization and in some cases actually preceded it (Spicer 1962, p. 96). The first important area of Spanish settlement was in the Moctezuma Valley. According to Spicer (1962, p. 97) there were a few mining camps located here as early as 1630. A little over a decade later other mining camps were to be found in the Sonora and San Miguel Valleys (Almada 1952). In the 1650's the civil capital of the Province of Sonora, San Juan Bautista, was established in the Moctezuma Valley. Like most Spanish settlements in Sonora at this time it was a mining center, or real de minas. The influx of whites was almost always associated with new mineral finds. To take advantage of the new-found wealth came merchants, cattlemen, farmers, and eventually military government.

By the 1680's, before the silver mines of Alamos in southern Sonora were opened, about one thousand Spaniards lived in various parts of east-central and northeastern Sonora (Spicer 1962, p. 97). Reports in the Parral Archives indicate that the mining districts surrounding San Juan Bautista and San Miguel Arcangel were of considerable size and importance at that time. This latter mining district was probably located in the mountainous area along the Yaqui River in the vicinity of Soyopa. San Miguel Arcangel is reported as having 16 stores in 1682 by Visitor-General Cuervo de Valdez. North of San Juan Bautista in the same valley was Rosario de Nacozari, founded in 1660, a forerunner of the present mines of the same name in that area (Almada 1952, p. 499). The Bacanuche Valley, through which flows one of the northern affluents of the Sonora River, was also an important area of early Spanish

settlement, containing one third of all Spaniards in Sonora (Robert West, personal communication). A visitor here in 1685 found three mines working, at least six cattle ranches, and three stores (Bannon 1955, p. 138). According to Spicer (1962, p. 97) there was some Spanish mining activity around Batuc, Sahuaripa, and Arivechi in the 1680's. East of here, in the sierra, the real de minas of San Ildefonso de Ostímuri had been in operation since 1673. Eventually this mining center became capital of a province called Ostímuri which included all land between the Yaqui and Mayo Rivers. Some Spanish mines and cattle ranches seem also to have been located in the Sonora, San Miguel, and Teuricachi Valleys at various times during the seventeenth century (Bannon 1955, p. 138; Bandelier and Bandelier 1926, p. 295).

Thus it appears that the Spanish colonization of Sonora was contemporary with its missionization. White settlers occupied areas not inhabited by Indians, but generally close to the mission centers. That Sonora was still a frontier is a fact; that it was not lacking considerable mining and commercial activity is attested by the one hundred thousand marks of silver shipped to Chihuahua and registered at Parral between 1659 and 1680 (Almada 1952, pp. 615-620).

The 1680's were a turning point in many respects for the province of Sonora. Attacks by the nomadic tribes, especially the Apaches, on the northern frontier became increasingly frequent and severe during this period. The Seri on the west began to raid far inland, and even formerly loyal nations eventually rose in rebellion. The frequent incursions of the Apache and Seri led to the establishment of a long chain of presidios

across northern Sonora and in the west at Pitic, Buenavista, and San Miguel de Horcasitas in the eighteenth century. Despite the danger of rebellious Indians Father Kino and others opened up Pimería Alta to Christianity starting in the 1680's. In this same decade mines were discovered near Alamos in the south leading to one of the most important bonanzas of the colonial period.

We may say, perhaps, that the decade of the 1680's was important in other aspects affecting settlement. Spanish settlements became numerous, and at the same time whites began to intrude upon Indian lands, despite the vehement protests of the padres. In addition many Indians were lured away from their mission to work in the mines, ranches, and haciendas. Thus there was a general mixing of the population, and it becomes increasingly difficult from this time on to distinguish between its racial elements. Regarding Spanish settlements in Sonora a Jesuit Padre in 1730 declares:

Not only do the sixty-six Indian pueblos of this province compel the zeal of the padres, but also it is extended to the administration of the more than two hundred settlements of Spaniards, Coyotes, and Mulatos who are scattered throughout the whole land in reales de minas, haciendas, ranchos, farm estates, mineral districts, small valleys, and neighborhoods to whom they administer by prayer and as the charges of secular priests (Anonymous 1945, p. 621).

There was a general decline in the Indian population of Sonora during the eighteenth century, probably for a number of reasons, while at the same time the Spanish population actually increased in spite of the ferocity of numerous Indian attacks. In 1685 in the Opatería there were fifteen thousand Indians living under mission influence. At the same time there were about one thousand Spaniards living in Sonora.

By 1764 the Opata population decreased to about one half of its former number and there were over four thousand Spaniards living in central and upper Sonora alone (Spicer 1962, p. 97). These figures, of course, have to be used with some caution because of the mobility of the population and the miscegenation that took place. Nevertheless, it seems apparent that the indigenous population was decreasing as white and mestizo population increased. This process was most intense shortly after the expulsion of the Jesuits, as was mentioned in Chapter 2.

Although a Jesuit priest (Guiteras 1951) paints a desolate picture of the Province of Sonora in 1763, with incessant hostilities of the Apaches and Seris that had turned much of Sonora into a wasteland of abandoned farms, ranches, mines, and missions, it is difficult to imagine a country as barren and decadent as the one he describes in view of its former prosperity. Some of the desolation the Jesuit depicts is to be expected in such a region. The ephemerality of the mining town and its dependent ranches always accounts for a great number of abandoned settlements. One might expect Sonora to have this appearance in many areas in many periods, but, of course, in this case the Indian invasions accentuated the condition.

The author of the Rudo Ensayo (Guiteras 1951) lists all of the missions, Indian pueblos, mines and ranches with which he is familiar, many of which I have tried to locate on the map (Figure 3). If one takes into account abandoned places as well as inhabited ones, there had been an increase in the number of known settlements since the seventeenth century, despite the overall decrease in population. This

was an outcome of the influx of Spanish settlers at that time. It is not known, however, how many Spanish settlements grew out of unlisted Indian villages. On the late eighteenth century map, I do not distinguish between Indian and Spanish settlements. It seems obvious that Spaniards were usually concentrated in mining towns, and in towns of Spanish origin.

We may conclude by saying that the main settlement features of Eastern Sonora were fixed by the seventeenth century. In this period the missions were established in the main centers of Indian population thereby giving religious sanction to the settlement site. Mines were opened up in areas nearby leading to the establishment of a few mining towns. Though towns based on mining are short lived because the resources play out, most of the important mining towns in Sonora today have roots in the colonial period.

#### Population

Estimates of aboriginal population vary widely. Sauer (1935, p. 5) gives a figure of 60,000 for the Opataría based on early descriptions of the productive nature of the land and the people and on baptismal records. Spicer (1962, p. 99) considers this estimate to be too high and replaces it with a figure of 20,000. If Sauer's figures for both the Opata and Pima Bajo country are correct, then the population of Eastern Sonora has not changed much since prehistoric times. The Opata cultivated the alluvial valleys of Sonora intensively using irrigation for their crops of maize, beans, squash, and cotton. Today there is an

emphasis on animal husbandry, a less efficient use of the land. Certainly, the environment was suitable to provide for a number as great as subsists there today. Whether the total area was occupied is open to question, however. Because of contact with the white man and the hostilities of nomadic tribes, the settled Indian population of Sonora declined throughout much of the seventeenth and eighteenth centuries. At the end of the colonial period and again in the 1840's and 1850's many left Sonora for California. The incursions of the Apache continued to be serious until the 1880's, also limiting population increase. The increments of the nineteenth and twentieth centuries were mostly in the western part of the state, especially at Guaymas and Hermosillo. Today an area equivalent to the old Opata and Pima Bajo country contains about 90,000 people, somewhat less than in 1940, because of the decrease in mining activity, but about equal to the population in 1910. In the last 30 or 40 years, emigration from Eastern Sonora has been one of the principal sources of growth in the major cities of the state.

## CHAPTER 5

### ROADS IN COLONIAL SONORA

Although direct references to roads in the colonial period are limited, scattered bits of evidence yield at least some knowledge of their pattern and function (see Figure 7). The author of the Rudo Ensayo (Guiteras 1951) refers to specific roads at various places in his regional description of the Province of Sonora. Some confusion arises from the use of the Spanish word "camino" which may mean simply "the way" instead of a specific visible road or path. However, when a road is described as being rough, winding, or as passing by certain points, I think we may assume that it is a visible part of the landscape. The question remaining is whether a road such as this is simply a well worn path, or is a road that was constructed at one time and is improved or occasionally maintained.

Apparently, road maintenance to a limited extent was a fact in Colonial Sonora (Charles Polzer, personal communication), mostly in mountainous or hilly areas where it was necessary to important routes. Most travel in Sonora at this time was within a well-established pattern; essentially the same routes were taken by travellers through the centuries. Thus, we may use the indirect information in travel itineraries to arrive at a conception of the ancient network. In many cases these itineraries only list the towns that were visited, and it is left for us to speculate on the route taken between them.

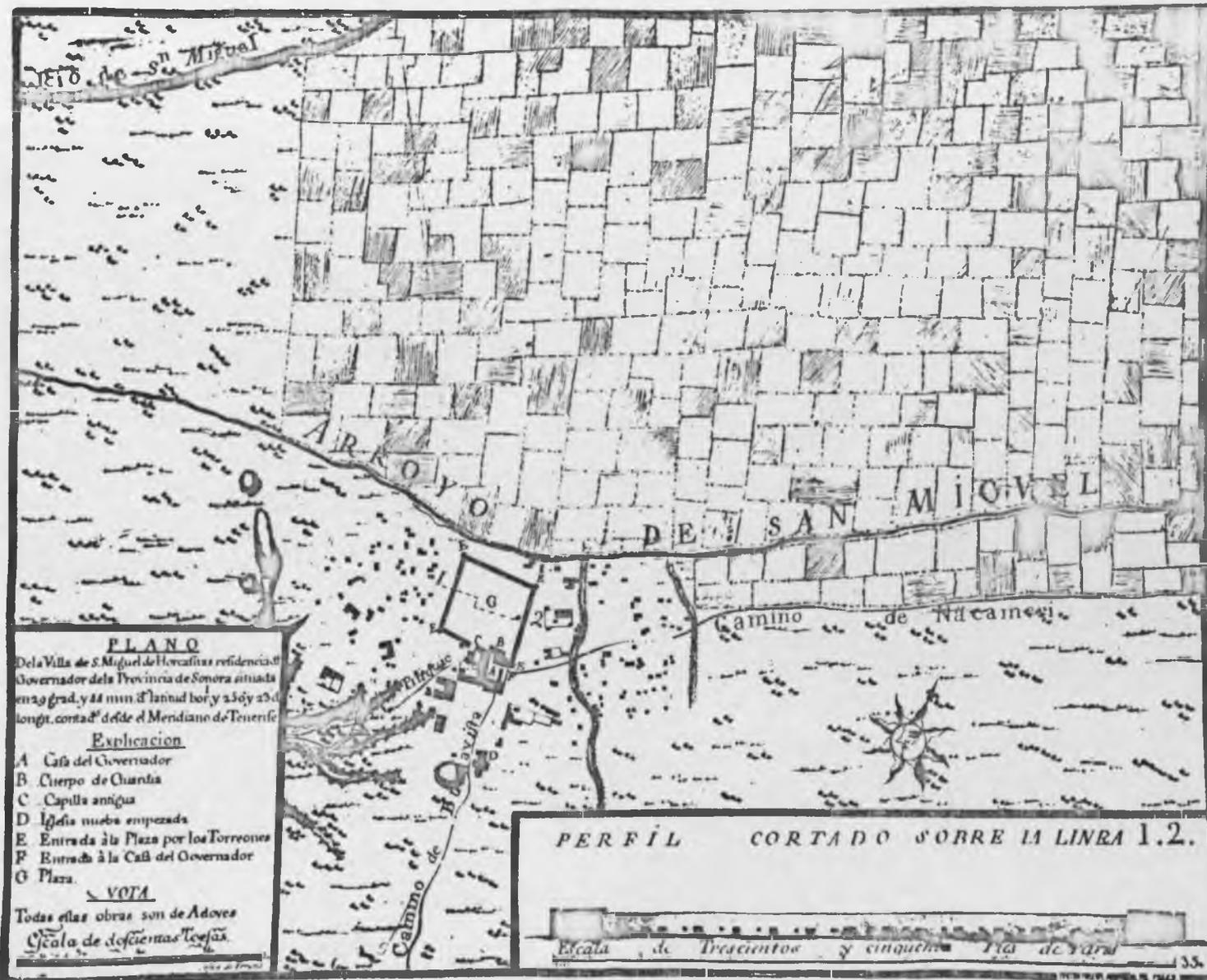


Figure 7. Urrutia's Map of San Miguel de Horcasitas.--Courtesy of Arizona State Museum.

Shown on the maps (Figures 8 and 9) are probable routes taken between various places in Eastern Sonora for the time periods indicated. In all cases there may not have been roads or even well beaten paths or marked trails in these locations. However, these are the approximate routes based upon various travel accounts, documents, maps, inference from later sources of information, and topographic considerations.

#### Connections with Chihuahua

Three separate areas of Sonora had communication with towns in Chihuahua, which was in the seventeenth century simply the northern part of Nueve Viscaya. The southernmost, the Chínipas area, had negligible traffic and was not used by thru-travelers. The two remaining crossing areas were northeastern Sonora and the Yécora-Macoba area.

Travel from northeastern Sonora to Chihuahua involved the use of one of three passes. Most commonly used during the colonial period were Carretas Pass and Púlpito Canyon which connected the upper Bavispe Valley with the high plains of northwestern Chihuahua. The significance of "Carretas" as a place name probably stems from the fact that at this point goods had to be transferred from wagons to muleback as the descent from the smooth tablelands of Chihuahua to the valleys of Sonora is precipitous. This place was also called "Cuesta de Carretas" which adequately describes the steep face of the western slope of the Sierra Madre in this locality. Púlpito Canyon is only a few miles north of Carretas Pass and possibly was first used by Ibarra at the northern end of his entrada into Northwest Mexico (Sauer 1932, p. 47). These were the most important passes across the northern part of the Sierra Madre for most

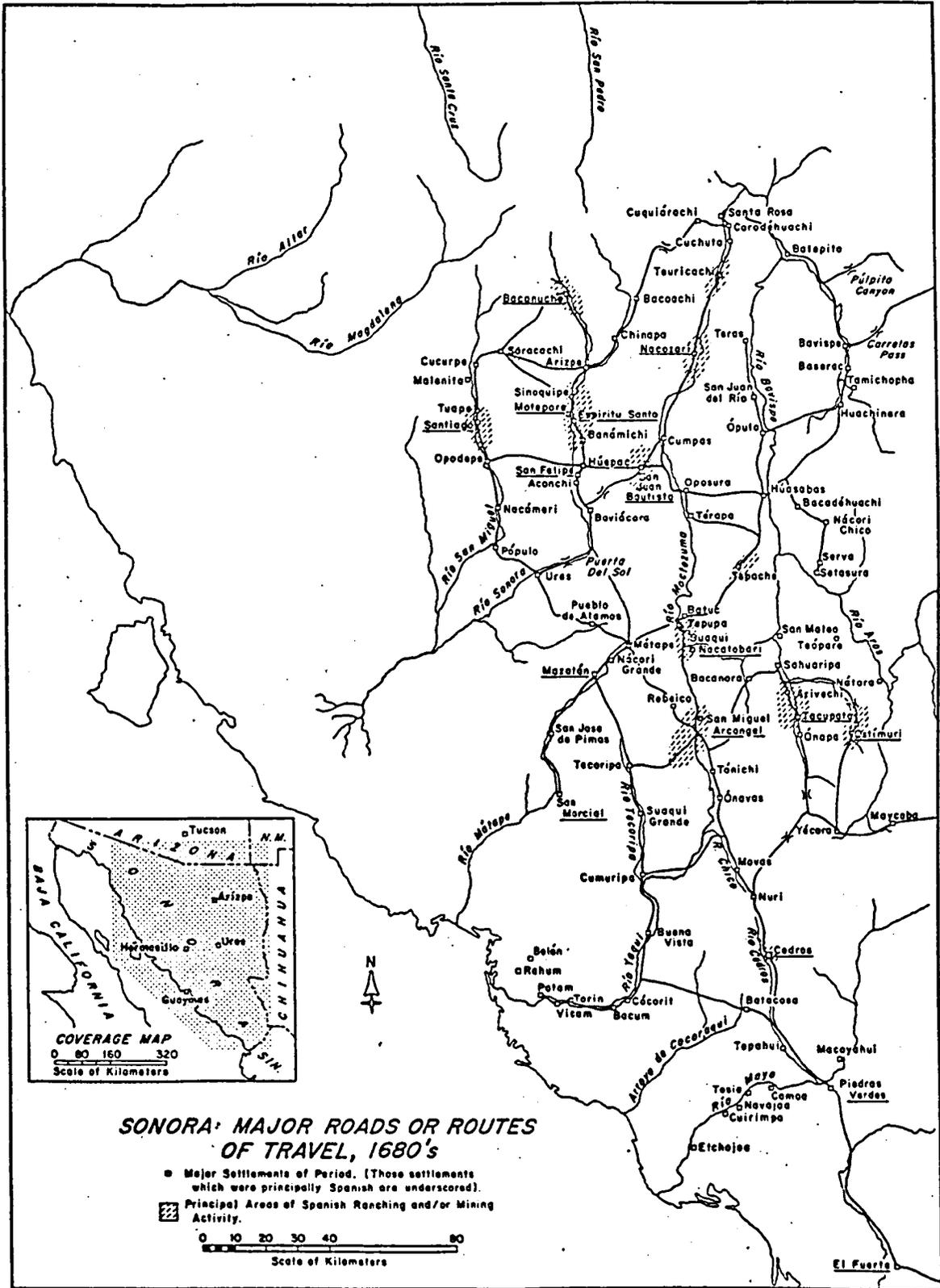


Figure 8. Travel Routes in the 1680's.--Base map taken from Mapa de Sonora.



of the seventeenth century. Bars of gold and silver were transported across here to be registered and taxed at Parral. A third pass was probably first used sometime around 1700. This was Guadalupe Canyon in extreme northeastern Sonora, only a few miles below the present international boundary. Pedro de Rivera probably used this entry point to Sonora on an inspection trip in 1715 (Murphey 1938, p. 378). It was the only way across the Sierra Madre north of Jalisco which could be traversed in wagons, and only with great difficulty. All three of these northern passes were infrequently used by commercial traffic in the eighteenth century because of the hostilities of the Apaches. Armed parties, however, continued to cross between Fronteras and Janos once these two places had been established as presidios, and it was because of these excursions that Guadalupe Canyon came to have importance. This importance increased when the Fronteras presidio was moved north to San Bernardino for a short time (Shull 1968, p. 85). Fray Juan Agustin de Morfi (1967, p. 245) crossed here in 1779. However, when in 1780 Bavispe was suggested as a site for a presidio by Teodoro de Croix, one of the advantages noted was the shorter distance going by way of this settlement (Thomas 1941, p. 163). Also this route would be by way of "Cuesta de Carretas" which was less exposed to Apache attacks and ambushes. Upon the establishment of Bavispe as a presidio once more Carretas Pass and Pulpito Canyon became the major entry points from Sonora into Chihuahua for several decades. Guadalupe Pass continued to be used in the late colonial period and in the nineteenth century. Its function, however, was to connect Sonora with New Mexico which will be discussed in a later section.

The Yécora-Maycoba area was less frequently used as a path across the Sierra Madre (García 1971, p. 43), although there has been a connection in this vicinity with Chihuahua for several centuries. Apparently the first white man to use this route was Jerónimo Figueroa, a Jesuit missionary who desired to visit the Yaqui missions by travelling from the Tarahumara country in 1641 (García 1971, p. 43). The actual route is not specified by García (1971); it may not have passed through the missions of Yécora and Maycoba, but somewhat north of them. Some of the American immigrants to California used a more northern route whereas the royal inspector Lafora (1939, p. 159) and the Jesuit missionary Och both went through Yécora and Maycoba in the 1700's. In any case this route was unimportant unless passage was impracticable on northern routes or on the Topia Road from Durango to Sinaloa.

#### The "Camino Real" from Sinaloa

The most important external connection for Sonora was to the south through Sinaloa to Central Mexico. For several centuries the southern part of this route was more or less fixed (Sauer 1932, p. 13; Bolton 1936, p. 236). The route it took through Sonora is less well defined. The paths taken by the Spanish explorers seem to be different from those used a century or more later. All travel probably came through the vicinity of Alamos to the Mayo River. Where it went north from here is open to question. Sauer (1932, pp. 33-34) suggests that the route taken proceeded up the Cedros Valley, a northern tributary of the Mayo, then a low divide was crossed to the headwaters of the Río Chico, a stream which flows approximately northwest to the Yaqui. This

is also the route suggested by García (1964, p. 128). The banks of the Yaqui served as a road leading north, until canyon country near Soyopa, forced a more westerly passage. Here the destination was the fertile Sonora Valley. Passage over the dry plains was made feasible by sources of water along various points of the Mátape River. Ures was the entry point for the Sonora Valley. Coronado, Marcos de Niza, and Ibarra all seem to have followed this same path, which may have been a result of previous Indian travel. Though this route was certainly used in later centuries, it seems not to have been the major pathway. The missions of the lower Yaqui were the first to be founded after those on the Mayo had been reduced. It was not until several years later that Jesuits reached as far as Tónichi on the Yaqui. Actually, Tecoripa, which is on a western affluent of the same river, was established by 1619. There are later reports which indicate that most north-south travel proceeded up the Tecoripa River and not the main trunk of the Yaqui. Pedro Tapia, a visitor of Sonoran missions in 1715, came down to Tecoripa from the north. The next place he mentions is Onavas, lower down on the main part of the Yaqui. Lafora and the Marquez de Rubi also used this same route on their presidial inspection trip in 1767, although their eventual destination was east of the Sierra Madre (Kinnaird 1958, p. 119). Going down the Tecoripa, one passed the missions of Suaqui (Grande) and Cumuripa, which is at the junction of this river with the main course of the Yaqui. How and where the crossover from the Mayo to the Yaqui was accomplished is somewhat in doubt. Sauer (1932, p. 12) states that the old Indian trail from the Mayo to the Yaqui left from Camoa and passed

through Alquihiquiche and Cocoraqui before reaching Cócorit. Perez de Ribas (1645) writes that he and another missionary were guided by Yaqui tribesmen from the Mayo over a distance of eleven leagues to Yaqui rancherías. These rivers are at least fifteen leagues apart. The total distance is decreased slightly, however, if one leaves by way of the Cedros tributary. In any case the exact route is unknown for this time period, but must have passed water holes if travel between the two great rivers was undertaken during the dry season. After 1740 Buenavista, a presidio established because of the Yaqui revolt, became an important stopover point. A map of the presidio by Urrutia shows a road approaching the town from Cedros to the east. Again, the exact route taken by this road can only be guessed at, but it may have passed near the Mayan mission of Batacosa or in the eighteenth century by the mining settlement of Baroyeca.

The missionization of the Yaqui Indian pueblos took place in 1617. A few years later, in the 1620's, several missions had been established among the Lower Pimas in the north. It is possible that travel may have taken the Cedros-Río Chico route that Sauer (1932, pp. 33-34) describes after this time, especially if one had no desire to visit the Yaqui Indian settlements. It is noteworthy that few Spaniards other than clergy had much to do with the Yaquis for many years, which is largely a result of a lack of gold and silver in their territory. It is also noteworthy that this interior path was used by the first regular mail service in Sonora in the 1760's. The mail was sent monthly from San Miguel de Horcasitas through Mátape and San Antonio de la Huerta (a mining town on the Yaqui near Soyopa) to Alamos (Almada 1952, p. 195).

As has been mentioned previously, travel along the Yaqui north of Soyopa was quite difficult because above Soyopa the river is enclosed by steep canyons. Most traffic went to the northwest toward the settlements on the Río Mátape. From here one could either continue on a northwesterly course through Pueblo de Alamos to Ures on the Sonora River or head northeast to the vicinity of Batuc and the Oposura (today Moctezuma) Valley. Ures is just below where the Sonora River breaks through a granitic range and leaves the Sonora basin proper. Sauer (1932, p. 17) called this gap the gateway to the entire province. It was necessary to go through this canyon in order to reach the dense Opata settlements of this rich valley. There was an alternate route around these mountains, however, that did not necessitate passage through Ures. It approached Babiácora from the south, also from Mátape.

#### Internal Connections

The mission town of Mátape, near the headwaters of the river of the same name, was a crossroads for north-south traffic from several valleys. It was also an administrative center for the Jesuit missions. It was a convenient place for missionaries from outlying posts to gather, many coming here when ill. It had the status of a colegio incoado, or incipient college, for much of its history which gave Mátape important educational and economic functions within the mission system (Polzer 1972). One of these functions was supplying the new establishments on the expanding northern frontier. The Mátape mission had vast herds of cattle in addition to its agricultural land. In the latter part of the seventeenth century some of these cattle were driven as far south as

Central Mexico (Polzer 1972, p. 129). When missionary activity came to a standstill in Pimería Alta, Mátape became a supply depot for the newly formed missions of Lower California, although the Yaqui and Mayo Indian country was equally important as a source of supplies at first because of its proximity to the coast. From a very early time Mátape and other missions in the vicinity supplied food to miners in the area. Most of the food for those living at the Real de San Miguel came from Mátape (Polzer 1972, p. 145). The relative ease of travel from here to many parts of Sonora was probably the reason for its choice as a colegio incoado. The Mátape River never had a great amount of crop land along its banks, though there were large areas suitable for grazing nearby. It never had a large native population. Its primary importance during the Jesuit period seems to have stemmed from its function as a supply depot and transportation center. Shipping lists, exemplified in Polzer (1972, pp. 234-237), attest to this importance. Church decorations and ornaments, clothes, manufactured items, exotic foods, and tools were some of the more important things shipped. Probably travelling the same roads was a somewhat different set of items destined for stores in the mining towns.

The physical nature of the country, evidence from later maps, and historical reference all attest to Mátape's importance as a central place. The exact routes taken by the roads leading to it could not be known without an extensive field examination. Nevertheless, with a knowledge of the necessities imposed by travel one can arrive at reasonable guesses. Water was the most critical factor for both man and beast.

Because of this roads most often ran along stream courses. If not, one had to have an intimate knowledge of the locations of water holes. On the northward journey pack trains probably left the Yaqui in the vicinity of Soyopa and travelled up the intermittent tributary on which Rebeico is located or approached Mátape directly from the south by way of the Tecoripa River. From Rebeico it is only about twenty miles to Mátape, and part of the trip may be accomplished by travel up an arroyo where some water might be had. If one's destination were the Sonora Valley, going by way of Pueblo de Alamos would have provided a stopover and watering point, then one could continue to Ures, another important mission center. The terrain around Ures is level, affording easy communication. Although it lies on the banks of the Sonora River, it is in the same structural valley as the San Miguel River. It is not a difficult journey, then, to go from Ures to Nacámeri on the San Miguel River. However, to reach the many towns of the central Sonora Valley one must follow the bed of the river through the mentioned narrow canyon lands to the east before encountering its south flowing northern portion in a valley several miles wide. This stretch of the valley with its level terrain, abundant water and pasture, and series of towns and villages, formed a natural line of communication (see Figure 10). For similar reasons the north-south trending valleys parallel to this one, through which flowed the Moctezuma, the San Miguel, and the Bavispe rivers, were also extensively used for all types of travel along portions of their lengths. There are several reasons for this preponderant use of the major river valleys of Sonora for communications: (1) the major



Figure 10. A Colonial Thoroughfare?--Road in Sonora Valley near Banámichi.

settlements were located here; (2) level terrain made the need for constructing roads minimal (in many cases the beds of ephemeral streams provided a natural road); (3) the principal sources of water and pasturage were in the river valleys.

In some cases, however, the rivers flow through canyons in almost unpopulated country. This is the case with the Bavispe River along much of its length. The same situation occurs along parts of the Moctezuma. Stretches of these rivers in this type of country were not greatly used. Usually, they were skirted along the interfluves, or routes led through adjacent valleys.

Several mountain passes were also important. Besides those passes already mentioned connecting Sonora with Chihuahua, many other inter-valley passes were utilized for several centuries. There were probably two important connections between the Sonora Valley and the Moctezuma (then Oposura) Valley. One of these was a link between San Juan Bautista, the Spanish capital located in hill country on the western flank of the Moctezuma Valley, and the rich central part of the Sonora Valley. The road, remnants of which are still to be seen (see Figure 11), probably ended in the vicinity of Húepac if the path followed by Kino is representative (Bolton 1936, p. 242). Other connections to the east undoubtedly emanated from the Bacoachi area in the extreme northern portions of the Sonora River. Here the terrain flanking the river is hilly but not mountainous, except at some distance from the river. To the southeast the ranges between Bacoachi and the Moctezuma Valley are not high and may be crossed without great difficulty. The



Figure 11. Remnant of a Colonial Road near San Juan Bautista.--  
Courtesy of Charles Polzer.

eastern terminus of the path was near the present Los Hoyos, between Cumpas and Nacozari, as it still is today. Northeast of Bacoachi is a mountain range called Sierra de los Ajos which exceeds eight thousand feet in places, and beyond these is the Fronteras River which, though a north flowing tributary of the Bavispe River, is in the same structural valley as the Moctezuma River. Despite the presence of this high mountain range traffic crossed one of its passes, perhaps as early as the middle part of the seventeenth century. This route was definitely used after the establishment of the Fronteras Presidio in 1690 and must have increased greatly in importance when Arispe was made capital of the Provincias Internas in 1776. Mababi is mentioned as one of the points along the way, and today this is a name of a ranch on the eastern flank of the Sierra de los Ajos. It is possible that the mountain pass had this name also. The road left the Sonora River in the neighborhood of Bacoachi, crossed the mountains to the northeast, and then on the other side continued in approximately the same direction the Cuquiárachi Arroyo and mission of the same name. A short distance east along this arroyo was Santa Rosa de Corodéhuachi or what later became the presidio of Fronteras. Depending on the route chosen for passage to Chihuahua, the mountains east of Fronteras were either crossed directly in the direction of Batepito or their northern end was skirted in order to encounter the south flowing tributary of the Bavispe, the San Bernardino Arroyo. This latter route was probably not used much until the late part of the colonial period.

There were other mountain passes to the south leading to the important Sahuaripa Valley from the Yaqui River and from the Yécora area. Evidence from later maps seem to indicate that the most frequently used route was that which left the main course of the Yaqui in the vicinity of Tónichi, crossed a low pass to the northeast and followed a tributary arroyo of the Bacanora River until that settlement was reached. From Bacanora it is not more than a few hours' trip over low mountains to Sahuaripa. This approach to Sahuaripa followed essentially the same route until 1960, and definitely seems the easiest. However, depending upon how one interprets and attaches importance to the map made by Juan Balthasar in 1744 (Figure 12), this route may not have been the usual one. His map shows various mission settlements of Sonora connected by straight lines with the distances between them indicated in leagues (Dunne 1957). It is not known whether the lines drawn actually show the order in which the missions were encountered during his visitation or simply show distances between the missions. If this latter point is the case, then it is difficult to explain that almost none of the places are connected by more than one line. If these lines are a representation of Balthasar's journey, then he ascended the Yaqui as far as Onavas and somehow cut across the mountains to the pueblo of Arivechi in the Sahuaripa River Valley. This approach seems unlikely, but he may have travelled to the mining district of Trinidad, then begun a descent into the Sahuaripa Valley from its headwaters to the main part of the valley northward. Yet the mission site of Onapa is shown as being some seven leagues off the hypothetical route he took. This trip would have been



a very difficult one, through a large tract of uninhabited land, if, indeed, it did take place. It is possible that Balthasar wished to visit mining districts immediately west of Arivechi. His map also shows a line connecting Oposura thirty-five leagues to the northwest with Sahuaripa. It is quite possible that mule trails in this area did exist, however this route should not be construed as an important one, as it is largely in uninhabited and difficult country. Other aspects of his map are not implausible. Ures and Arispe, on the Sonora River, are joined by a road which passes along the river through Banámichi and Aconchi. Mátape is shown connected to Ures, Batuc, and Tecoripa, all in different directions, confirming its function as a crossroads. The line connecting Cucurpe with Arispe is somewhat difficult to interpret. A fairly direct course may have been followed between the two places. It is not known with certainty what routes were usually followed between the upper San Miguel and the upper Sonora. Father Zapata, several decades before, went directly from Cucurpe to Bacanuchi (Bannon 1955, p. 138). Another possible way is that which goes through the Cañada de Montepori and intersects the Sonora Valley between Banámichi and Sinoquipe. This is the route of one to the modern roads connecting the two valleys.

It must be kept in mind that Balthasar probably had little baggage to encumber him during his travels. Therefore he might have chosen mountainous mule trails if they followed a more direct course to his various destinations. There were other important mountain trails. Among them were those which connected Oposura with Húasabas, Húasabas with Bacadéhuachi and Nácori Chico, the lower Bavispe with the upper Bavispe, and Mátape with Batuc.

Because of the availability of pasturage and water and the levelness of the terrain, river valleys and their tributaries were the main avenues of interregional traffic. Yet, because the major river valleys of Eastern Sonora are so tightly enclosed by mountains, suitable passes through them had to be found. Undoubtedly, the Indians were aware of their existence and used them. The Spaniards later utilized those routes which were convenient for travel by pack trains. It is probable that many trails existed. Examination of nineteenth century maps, a time in which Sonora had only increased modestly in population from the previous century, reveals a large number of travelled routes. Which were the most important is what I have endeavored to find out with only moderate success. It is difficult to single out routes which were the most important in terms of commercial exchange and the other forms of interregional intercourse. It is well substantiated and obvious that the major river valleys were the main lines of communication because here is where travel is easiest and where the largest settlements are located. Many intermountain trails were used, some were important for long periods of time as the major routes between valleys, others had a varying importance with time, and some were perhaps used only very occasionally.

There were two main motivations for overland supply. One was the supply of mission centers, the other of mining communities. Though many caravans probably supplied both, the products carried were, in most cases, quite different. The missions received mainly church decorations, and items deemed necessary for the acculturation of the natives such as tools and European clothing. Because the missions in Sonora were mostly

self-supporting, they were expected to provide food for themselves. However, missions such as Mátape and Oposura had large herds of livestock eventually to be used on the expanding frontier. Also for a time Sonoran missions contributed food to the establishments in Lower California, as these had difficulty in providing for themselves. Mining communities were in need of food supplies, equipment, tools, and other merchandise as could be provided. Often mining communities were located near mission lands because of the need for food. Normally the necessities of the Spanish population in the mining towns involved a much different assortment of commodities than that which went to the missions. Because of the great distance from Central Mexico and important sea ports, the cost of most items was very high (García 1967, p. 41).

The opening up of two new mission fields in the late seventeenth century profoundly changed the sphere of settlements and communications known to the Spaniards. The first territory to be reduced was that known as Pimería Alta which encompassed the Altar-Magdalena drainage and parts of the Santa Cruz and San Pedro, tributaries of the Gila. The well-known Padre Kino here established more than a dozen mission centers by 1700. Almost at the same time, starting in 1697, the first mission in Lower California was established at Loreto. The missionization of a new area brought rapid change. The natives were concentrated in various centers where their population started slowly to decline. They were taught to cultivate new crops in addition to their traditional ones, and soon learned methods of animal husbandry. As was usually the case Spanish colonists infiltrated the new areas in search of gold and silver. If mineral sources were not found, or if they did not last, the newcomers

would encroach on Indian lands, or lived a parasitic existence, depending upon the native population for their subsistence.

Baja California and Pimería Alta, then, became new foci for lines of supply, commercial exchange, and communication from Sonora. The Upper Pima settlements were mainly approached from the headwaters of the San Miguel and the Sonora. In fact the first Pima pueblo missionized by Kino was Dolores which lies along the extreme northern portion of the San Miguel River above Cucurpe. From here direct routes were established by Kino from Dolores northwest to San Ignacio and Magdalena (Bolton 1936, p. 250) and possibly also from Cucurpe to the latter place (Roca 1967 p. 46). The upper Santa Cruz which forms a loop in extreme northern part of present day Sonora was usually approached from Dolores on the upper San Miguel through Cocóspera or from Imuris on the San Ignacio River of the Altar drainage through Cocóspera. Either the Bacoachi or Bacanuche tributary of the Sonora River was used on occasion as an avenue of approach to the upper Santa Cruz and upper San Pedro. These are parts of the prehistoric trade route postulated by Sauer (1932). Once the presidio of Fronteras had been established in 1690, and friendly contacts had been made with the Pimas of the Santa Cruz and San Pedro valleys, the way was open for communication between the two places. These high plains and mountains in the northern part of Sonora are more easily traversed due to the open nature of the basins, and pasturage and wood are easily obtained on them. Kino travelled between Fronteras and Santa María Soamca in 1697 and again in 1698 (Bolton 1936, map). From Santa María one could visit Pima settlements along the San Pedro by

skirting the northern end of the Huachuca Mountains in Arizona and then travelling a short distance east. When a presidio was established at Terrenate near the headwaters of the San Pedro in 1742 these northern routes were put to much greater use, especially by the military. The main evidence we have of pre-Spanish trails is from the travels of Kino (Bolton 1936). Moreover, his explorations had a great deal of significance in the establishment and continued use of many roads connecting the older part of Sonora with Pimería Alta.

The port of Guaymas was used as early as 1668 by Francisco Lucenilla (Almada 1952, p. 323) and as an important supply point during the founding of the Baja California missions. In 1704 Father Kino explored a new route from the San Miguel Valley by way of the present city of Hermosillo to Guaymas via the Mátape River. This road approximately follows the present railroad in its southern portion (Bolton 1936, p. 528). There are no indications that Guaymas was anything more than a very good natural harbor without rooted population in early times, the first attempts at permanent settlement beginning in the 1750's when Ignacio Lizazoain attempted to establish a mission for the Guaimas Indians. Later a garrison of troops was put there in 1767. It is an apparent coincidence that the Jesuits were expelled during the same year. They were incarcerated in Guaymas for a few months before being shipped out. In any case the harbor of Guaymas became increasingly important during and after the late colonial period. In 1768 the river road from Guaymas up the Mátape Valley was called the "Camino Real de Guaymas a San José de Pimas" (Pesquera, n.d.). Urrutiás map (1769) of

the presidio of San Miguel de Horcasitas shows a road leaving the town in approximately a southeasterly direction and it is labeled "Camino de Buenavista" (Figure 6). Perhaps this was a new route established in the direction of the Mátape Valley. The fact that some other closer and more important town is not mentioned may be a result of the fact that Urrutia was the cartographer for José de Gálvez's presidial inspection trip. Buenavista was a presidio on the Yaqui River south of Cumuripa, but north of the main Yaqui Indian pueblos. It is likely that the major part of this road was the main Camino Real from Ures to Tecoripa and the Yaqui country.

The extreme northern route from Chihuahua to Sonora used in the latter part of the nineteenth century was discussed previously. Suffice it to say, here, that the existence of this road is also attested by Urrutia's map of the presidio of Janos, Chihuahua. From this town one road is shown leading west to Carretas Pass, one of the older routes, whereas another road points north and is labeled "Camino de Palotada." This was one of the points along Morfi's (1967, p. 243) journey in 1779. This route is also mentioned as existing in Kino's time by Bolton (1936, p. 245).

Also in the latter part of the eighteenth century there were several attempts to open up a direct line of communication between Sonora and New Mexico for use by military forces and for trade. In spite of other trails the only one that continued to function in the next century was that taken by an expedition of Juan Bautista de Anza in 1780 (Thomas 1969). Instead of approaching Guadalupe Pass from the southeast, that

is, from Janos, he came out of New Mexico from the northeast. The intention was to meet with another expedition going in the opposite direction from Santa Cruz, Sonora. This plan was never completed, but both parties did reach their respective goals (Thomas 1969, pp. 37-39), although the expedition had no immediate results. Military commanders busied themselves with finding a more northern route through present Arizona and New Mexico, hoping to reduce the total travel distance. Finally Zúñiga connected Tucson with the Zuni country of New Mexico by an expedition in 1795 (Hammond 1931). Because these routes ran right through the heart of the Apachería there was little chance of their continuance after these tribes resumed their warlike ways in the early 1800's. However, in the early part of the nineteenth century and into the independence period there was regular trade between Sonora and New Mexico. The receiving port in New Mexico for much of this trade was the Santa Rita Copper Mines (Bartlett 1965, p. 272).

#### Transportation Mode

Though both the four wheel wagon and the two wheel cart were used in Mexico during the colonial period, they do not seem to have been much used in Sonora at this time. The nature of the terrain was almost prohibitive to wheeled vehicles in Eastern Sonora. Of course the river valleys could have been used for carts as could the smooth uplands of the north or the western basins and coastal plains. New Spain never had more than a tenuous grasp of the area of high plains and mountains of Sonora and modern Arizona. The smoother and broader basins of western Sonora north of the lower Yaqui and below Pimería Alta did not become important

until the nineteenth century. In most of the occupied area the transport of goods for any considerable distance involved steep mountain slopes, narrow canyons, many miles of dissected alluvial fans or valley fills, and very bad roads. Because of all these factors pack horses or mules were much more prevalent than carts or wagons in colonial Sonora. Bartlett (1965, p. 279) in the middle 1800's, noted their absence even where it was possible to employ them. Carts may have been used for local hauling, but only with the growth of Hermosillo and Guaymas in the nineteenth century does an interregional network of caminos carreteros develop.

#### The Colonial "Road" Maps

The maps (Figures 7 and 8) are not merely supplementary material, but are an integral part of this thesis. The attempt has been, albeit speculative, to show the major roads or routes of travel during the colonial period. The first map is for the 1680's; the second represents travel in the late eighteenth century. These time periods were chosen for reasons given in Chapter 4. It is best to use these maps in conjunction with the insert map (in pocket) so that one may get a clear conception of the relation between roads and the major mountain systems. The routes drawn are those that seem probable in the light of present evidence for the two time periods, but are not claimed to be indisputable. That some were important roads is almost a certainty. The nature of the evidence, however, is quite fragmentary both as to time and place. For this reason the existence of some of the roads, especially those between

valleys, is only based upon one or two travel accounts or other incidental historical notes. Neither should it be assumed that all the lines represent true roads. While we do know that improved roads did exist, they are rarely specifically described as such. Moreover, many roads in Sonora are created by centuries of use. In other cases, while traffic was restricted along certain avenues it might not have followed any specific path.

I have concerned myself mainly with the eastern part of the state; nevertheless, I have also attempted to show important external roads connecting it to adjacent areas.

## CHAPTER 6

### NINETEENTH CENTURY ROADS

Beginning with the independence movement in 1810 there were profound changes in settlement and communications within Sonora, although most of the routes already established in Eastern Sonora continued to be used. The basic needs of travel had not changed; there was no new technology of overland transport. The communities of northeastern Sonora continued their existence somewhat freer of marauding bands of Apaches than in the previous century, although Yaquis and Seris became increasingly troublesome in the central and southern portion of the state. The most significant change, and the one that was to have the most far-reaching effect, was the growth of Guaymas and Hermosillo. In 1811 commercial traffic, heretofore not allowed, was authorized by royal officials for the port of Guaymas because of insecurities along the land route from the south caused by the presence of rebel forces (Almada 1952, p. 325). At this same time Hermosillo began to grow as a functional counterpart to Guaymas. Though Hermosillo had its origin in one of the many attempts to settle Seri Indians in permanent villages, and it had both military and religious functions at various times during the eighteenth century, it was only when Guaymas became open to commerce that the population began to grow rapidly. Hermosillo had certain qualities of site that gave it importance. Among these was its nearby agricultural

land. Some of Sonora's wealthiest men owned sugar and cotton plantations in the vicinity (Hardy 1829, pp. 97-109). As early as 1770 irrigation canals had been opened (Almada 1952, p. 344), but probably more important was Hermosillo's position relative to the rest of Sonora, at the confluence of the San Miguel and Sonora Rivers. Hermosillo became a distribution center for much of central and northern Sonora in the 1820's. In addition, it was both a market and a depot for the products of these areas (Hardy 1829). Lack of water was a hindrance to travel in the western part of Sonora, but the smoothness and open nature of the valleys lent advantage to transport by wagons, a cheaper method of carrying goods where the terrain allows it than that of pack animals. Once definite watering places had been located, the aridity of the country was less of a problem. Thus, in the early part of the nineteenth century many wagon roads led from various parts of Sonora to Guaymas and Hermosillo. In time the Guaymas to Hermosillo route diverted the majority of the north-south traffic going to inland destinations in upper Sonora. Hermosillo became connected to towns in the east-central part of the state, in the direction of Sahuaripa. Roads to Ures and San Miguel de Horcasitas had become well established.

The camino real from the south continued to go through Alamos, but there it swung west. One branch probably went through the Yaqui pueblos, the other through the mineral district of Baroyeca. Both of these roads converged upon Guaymas. The interior route was still used, though to a lesser extent.

Hardy (1829), a British Naval Lieutenant, who travelled extensively in Sonora in the 1820's, gives some space to a description of roads. In some parts of the state his account may be taken as representative of colonial routes of travel since his visit came so soon after independence. Even this time, however, Guaymas and Hermosillo were centers of communication and commerce.

Hardy's travels in Eastern Sonora included a trip from Hermosillo to Moctezuma by way of San Miguel de Horcasitas, Ures, and Baviácora. He then went south through Térapa, Batuc, Soyopa, Tónichi, and Tesopaco to Alamos. A year later he retraced his steps from Hermosillo to Moctezuma, where he was delayed because of illness. He resumed his journey a few months later travelling to Huasabas, and Bavispe where he left Sonora by way of Carretas Pass.

Hardy's descriptions confirm the existence of roads, though one is still left in doubt about whether any had been constructed or maintained or were merely worn paths. He describes them thus:

Roads in many parts of Mexico, and particularly in the interior provinces are merely paths traversed by horses and mules, but never by a coach or wagon. And it requires a great knowledge of travelling, constant observation, and nice discernment, to make out the tracks which distinguish a high road from one which merely leads to a rancho or to the open country, frequented only by those who go for wood; or even from a rabbit track as they all resemble each other as much as the two blades of a pair of scissors (Hardy 1829, p. 224).

Upon leaving Huásabas Hardy gives a picturesque account of the difficulties of travel in a very mountainous part of Sonora.

The hills and valleys are most formidable here and the mules can make but little progress over them. It is a constant ascent and descent over large rocks. As every mule which passes along this road puts his hoof in precisely the same

tracks, by constant friction, those spots have become perfectly smooth, while the intermediate space continues in its original state of roughness (p. 452).

#### Commercial Functions

In the first half of the nineteenth century there was considerable commercial activity between Sonora and neighboring provinces. Wheat was sent by caravan to Chihuahua, Durango, and Alta California (Stevens 1964, p. 45). It was also sent by sea from Guaymas to Loreto and La Paz in Baja California, Mazatlán, San Blas, and Acapulco (Zuñiga 1948, p. 39). The impact of the Santa Fe trade with the United States was felt as far away as Sonora. Among interior provinces Sonora traded primarily with Chihuahua, but also with New Mexico which in turn was engaged in active commerce with Missouri over the Santa Fe trail. Chihuahua received large shipments of salt from Sonora. An observer at the presidio of Janos in 1849 reported a train of 700 pack mules coming from Sonora destined for the principal cities of Chihuahua laden with produce and provisions. The mules, themselves, seem to have been one of the products bartered (Hardy 1829, p. 458). Cattle, sheep, gold, and silver also came out of Sonora over some of the same routes, sometimes destined for the Santa Rita Copper Mines in New Mexico where copper vessels were obtained in exchange (Bartlett 1965, p. 272). Most trade in Eastern Sonora at this time, however, was not with New Mexico but with the port of Guaymas, with Hermosillo acting as an intermediate depot.

#### California Emigrants

Some emigrants to California during the gold rush of 1849 came through Sonora, though the first important contingent of Americans had

already passed through in 1846. This group was the Mormon Battalion of the U. S. Army under Colonel Cooke who left New Mexico to claim California for the United States. He crossed the very northern part of modern Sonora entering by way of Guadalupe Canyon, the well-known pass established by the Spanish presidial forces in the eighteenth century. It was the only route across the Sierra Madre that could accommodate wagons between Jalisco and New Mexico, and only with great difficulty, as attested in the journals of Cooke (in Bieber 1937) and Bartlett (1965). Hardy (1829, p. 461) had called this route the coach road from Janos to Fronteras in 1827. Its poor condition twenty years later probably was a result of the growing Apache menace toward the middle years of the nineteenth century and the cessation of most of the trade over this road in the 1830's.

Though most emigrants to California used northern routes, Guadalupe Canyon was sometimes used. Travelers would leave the Rio Grande in central New Mexico and go southwest through the panhandle of New Mexico. If they managed to get through Guadalupe Canyon which is just a few miles south of the present international boundary, they continued through the former presidio and abandoned hacienda of San Bernardino and crossed the high plains of northern Sonora to either the headwaters of the San Pedro River or those of the Santa Cruz. One of these two rivers was then followed to the Gila whence the journey was continued westward. A number of Sonorans were also attracted to the gold-fields of California and followed parts of these routes.

A few Americans, including Audubon, the famous ornithologist and artist, crossed the Sierra Madre in the vicinity of Yécora, parts of their journey probably following one of the old trails from Chihuahua to Sonora. Their journey north was ill-advised, however, for after reaching Ures the group swung west over the Altar Desert on their northward march to the Gila, and they nearly died of thirst as a result (Audubon and Hodder 1906).

Because of the peace with Mexico and the appointment of John Bartlett to the U. S. and Mexican Boundary Commission in 1850, we have a few more precious notes on travel in Sonora. Bartlett, like Cooke before him, had both pack mules and wagons in his party. He followed a similar route from New Mexico. After crossing Guadalupe Pass with great difficulty and passing through San Bernardino the party left Cooke's road and went south to Fronteras. From Fronteras they went southwest along the old colonial road to the Sonora Valley where they visited Bacoachi and Arispe. Bartlett then retraced his steps almost without deviation to the Santa Rita Copper Mines of New Mexico.

In another journey into Sonora he crossed the San Pedro River in present day Arizona and then turned southwest touching the Santa Cruz and from there went to Magdalena. From this point he went by way of the San Miguel Valley to Ures. In the latter place he was detained a long while because of illness. Since his final destination was San Diego, upon recovering his health he proceeded to Hermosillo and Guaymas where he took a boat to California.

Bartlett made a number of observations about road conditions and commodities that passed over them. The routes he took gives us a fair idea of some of the lines of travel during this period of time. It is most interesting that he was able to cross the Sierra de los Ajos between Fronteras and Bacoachi with wagons. This is a fairly high range of mountains and it would seem some road construction would have been necessary to enable such a crossing. The route, of course, was an important one in the eighteenth century, connecting Arispe with the presidio of Fronteras, and was the main east-west route in northeastern Sonora. Bartlett's use of the San Miguel Valley to go from Magdalena to Ures and Hermosillo confirms the importance of this valley as a major north-south artery. For many years it was the usual pathway between Hermosillo and Ures to the major towns of the Altar and Magdalena drainage and probably also to Tubac and Tucson. The present highway and railroad follow the broad basin to the west which is of very meager resources. The use of Cucurpe and Dolores for departure points on the journey to Pimería Alta gave the valley an early importance. When Hermosillo and Ures grew in the nineteenth century this importance increased. The major portion of north-south traffic in this part of Sonora was diverted from the Sonora Valley to this new route.

Bartlett observed that in many parts of Sonora roads were almost non-existent. Yet he described parts of Cooke's (in Bieber 1937, p. 294) road as "perfectly smooth." Between Bacoachi and Arispe the road was mainly the river bed itself, which it is today.

He says of the road between Guaymas and Hermosillo:

The road, however, is excellent; and though it has been travelled for two centuries without a day's labor being expended on it, it is still smooth, level, and hard, the soil being a fine gravel (Bartlett 1965, p.462).

The road was probably of more recent origin than Bartlett's estimate. From his list of ranchos passed, it appears to be almost exactly the same one used by Hardy 25 years earlier.

Bartlett, like Hardy before him, noticed the lack of wheeled vehicles in most of Sonora, though they were used between Guaymas and Ures where the terrain is smooth. But even in some areas where the terrain is not difficult they were absent.

He also comments on the commercial functions of Hermosillo:

It has a large trade with Guaymas, from there it receives all its goods, which are distributed from Hermosillo throughout the State; and in return, the products of the State are chiefly concentrated here for transportation to that place (Bartlett, 1965, p. 472).

#### Road Conditions at Mid-century

The earliest evidence that I have been able to find that roads were maintained is dated 1855. In that year a proposal was made to the government by a José Landry to clean up and reconstruct portions of the road between Guaymas and Hermosillo. The contract would call for cleaning from the road all loose stones and branches for a width of six to eight varas along its total length. Ruts would be refilled and a few small bridges constructed. The job was to have taken fourteen men 51 days at a cost of 804 pesos. No information was found as to whether the job was completed. Other aspects of roads in Sonora were discussed in the proposal, however. It was mentioned that, in general, Sonoran roads

were in poor condition. The problem of arroyos in the roads not being filled was particularly noted. Landry also stated that responsibility for construction and upkeep fell upon local ayuntamientos that concentrated on maintenance near their own pueblos, but that in between the towns road conditions were very bad.

A few years later in 1861 reconstruction of a bridge on the camino real from the south was proposed. These few documents are evidence that road construction was one of the functions of government in the nineteenth century, even if not persistently pursued. A stagecoach had operated between Guaymas and Ures, then the capital of Sonora, as early as the 1830's, and even before this time there was regular mail service between Arizpe and Guaymas, at which place mail was sent and received by boat. Thus there was probably some need for road upkeep, at least along this route.

#### Arizona Settled

The Anglo occupation of Arizona was the next historical event to affect communications in Sonora in the nineteenth century. The mines and ranches and military posts north of the newly formed border provided new foci for a series of north-south roads. Because of the Apache problem and the Civil War, Arizona was not well settled until the 1870's during which time several routes came to be used connecting southern Arizona settlements with those of northern Sonora. The valleys of Sonora were a source of food for the new mining communities, such as Tombstone, Bisbee, and certain mines in and near the Santa Rita Mountains. The Sonora Valley was the primary source of food supplies for the towns of

Bisbee and Tombstone whereas Magdalena had most of the trade with mining camps near the Santa Ritas (Browne 1874, p. 169).

The influx of Anglos in the late nineteenth century was a stimulus for many kinds of economic activity. There was an increase in mineral exploration both north and south of the border, and a resulting increase in interregional commerce. In addition, there was probably a greater circulation of people between the narrow valleys of Eastern Sonora and the United States than exists today. Instead of a single external focus of communication for much of Eastern Sonora there developed many foci along the Arizona-Sonora border.

#### Railroads

The first railroad to serve Sonora was a line completed between Guaymas and the newly created town of Nogales in 1882, financed mostly by American capital. The railroad continued to Tucson connecting it with the main east-west Southern Pacific line. Eventually this line continued all the way to Mexico City from the United States, but this was not accomplished until 1927 (Dunbier 1968, p. 163). Originally the line may have been conceived as an outlet from the interior southwest to the sea. One of its primary functions, however, was to transport concentrates and smelted ores and to supply the mines. Although there were not many mines immediately adjacent to this first railroad line, several stations specialized in the shipment of concentrated ores either to the United States by way of Nogales or to Guaymas for passage by sea to other points. These stations became focal points for many roads leading from Eastern Sonora. South of Hermosillo ores were brought from the middle Yaqui by

wagons across the broad basins of this part of the state to Estación Torres or Estación Ortiz. From the San Miguel Valley, northeast of Hermosillo, roads were soon built connecting Horcasitas with Estación Pesquiera, and Opodepe with Carbó, another newly founded train stop settlement.

Around the turn of the century several new lines were built in Sonora, all in conjunction with mining. The new lines enabled processing of low grade ores at Nacozari and Cananea. These lines were independent of the Nogales-Guaymas railroad, and the places they served were directly across the border in the United States. The smelter at Douglas processed the copper concentrates from both these mines. Two lines which since have gone out of existence were branches of the main west coast line. One line joined the Minas Prietas-La Colorada mining district with the main line at Estación Torres. This link was short and not used after the 1920's. The other branch line left from the newly extended rail line to Obregón and went along the banks of the Yaqui to Tónichi. Its main reason for existence was to transport ores from the San Javier and adjacent mineral districts. There was considerable discussion at one time about extending this line to meet the rail head at Nacozari. The Tónichi line, however, was eventually covered by the waters of Presa Alvaro Obregón.

The new railroads became both a source of competition to roads and a cause of their development. Roads that paralleled railroads seemed to decrease whereas certain points along the railways served as nodes for several routes. Although the status of Guaymas and Hermosillo as central

places was reaffirmed by the passage of the first Sonoran Railway through them, this railway, like the international border, generated new foci for the orientation of roads from Eastern Sonora at several points along its length.

The two maps (Figures 13 and 14) of nineteenth century Sonora represent the final stages in the development of an integrated network of cart roads and mule trails. The 1867 map (Figure 13), though somewhat distorted, seems to be a fair representation of the road system shortly before the advent of the railroads. The 1891 map (Figure 14) is based upon highly detailed information in an unpublished government report. At this period of time the Sonoran government was actively involved in road construction and maintenance, and they produced itineraries for travel between all places along major roads and trails. To the network based upon these reports, I have added a few roads which I believe must have existed. Of particular interest on this map (Figure 14) are the roads connecting various places on the newly constructed rail line with points in the interior.

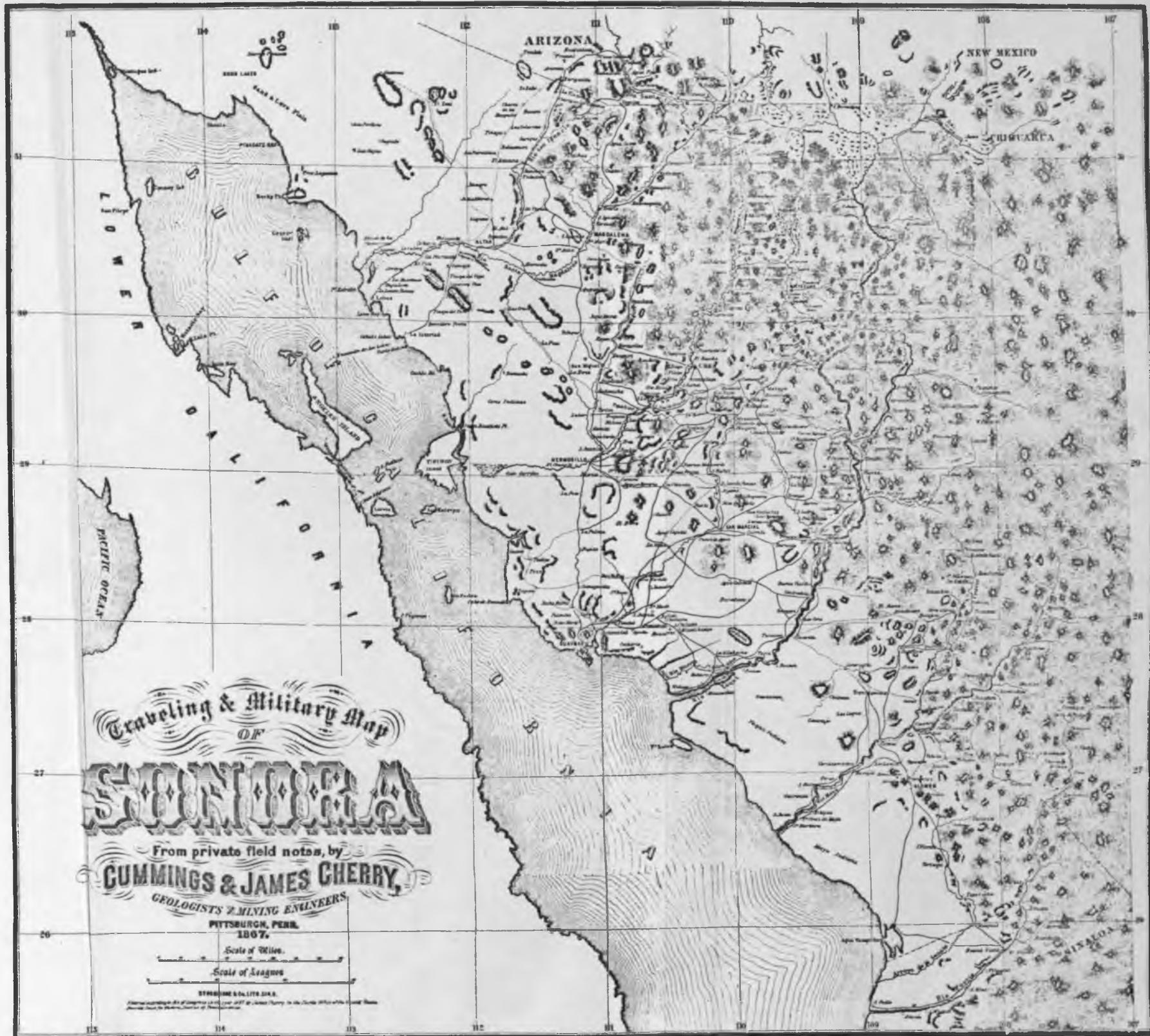


Figure 13. Roads in Sonora in 1867.--Courtesy of Arizona Pioneers' Historical Society.

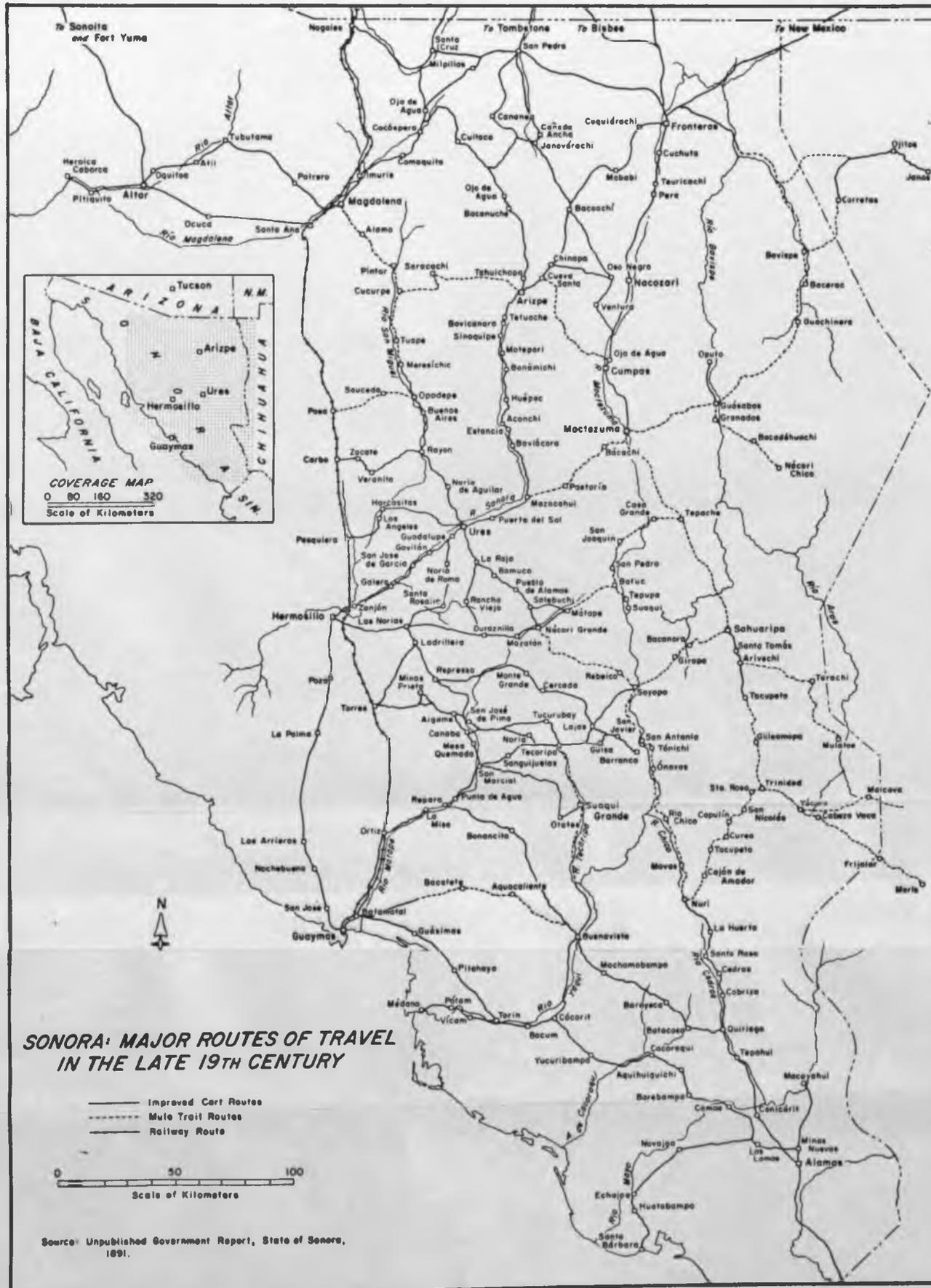


Figure 14. Roads in Eastern Sonora about 1890.

## CHAPTER 7

### DEVELOPMENT OF THE MODERN ROAD NETWORK

As elsewhere in the United States and Mexico, cars and trucks came to Sonora before there were roads built to accommodate them (Dunbier 1968, p. 167). The 1937 American Geographical Society Map of Sonora classifies all of the roads in the state as either wagon roads or mule trails. Yet several roads specifically designed for motor vehicles had already been built by this time, even though none of them was paved. In flat desert areas where vegetation was relatively sparse, trucks could be driven across the open country to nearby ranches or wood cutting areas without much difficulty. In more dissected country with thicker vegetation sturdy vehicles could still be used, but some road construction was necessary and circuitous routes had to be followed. Old wagon roads, of course, were often used by the automobile. A wagon is probably the less mobile of the two types of vehicles, especially in hilly and rocky country.

#### Early Road Construction

In Sonora roads designed specifically for automobiles were first built in the 1920's. Among the first of such were several serving Eastern Sonora, at this time still an economically important part of the State.

In 1928 construction was started on a road between Hermosillo and Arispe. By the following year this road reached as far each as Mazocahui. From Hermosillo to Ures, it closely followed upon the route along the bed of the Sonora River. North of Mazocahui a road built above the valley proper was begun. The extension of this link progressed slowly. Also begun at this time were several roads in the western, southern and northwestern parts of the State. Construction was started on the International Highway between Nogales and Navojoa. Work on this project was temporarily halted during the 1930's due to lack of funds.

Much work on automobile roads came during the regime of Governor Roman Yocupicio in the late 1930's. By the beginning of his administration, besides the road to the middle Sonora Valley, roads in Eastern Sonora from Baviácora to Cumpas had been built; and from the last place north to Nacozari and south to Matezuma. Also a road had been constructed connecting Agua Prieta to the upper Bavispe Valley, and from there a link joined Chihuahua with Sonora through Púlpito Canyon.

Aside from completing much of the work on the west coast highway, he built several roads in the eastern part of the State. The circuitous route from Hermosillo to Moctezuma through Baviácora and Cumpas was avoided by construction of a direct line east from Mazocahui. Work was also completed on roads from Baviácora through Arispe to Cananea, from Sinoquipe to Magdalena, from Cananea to Bacoachi, and from La Dura to Yécora and the Chihuahua border. La Dura and Yécora had their principal connections to the south through Movas to Obregón and Navojoa.

The first automobile roads in Eastern Sonora were built to connect Hermosillo with the central Sonora Valley, still an important part of the State agriculturally. In the Sonora Valley, Baviácora served as a connecting point with the Moctezuma Valley through Cumpas, indicating another motive for early road construction in Eastern Sonora, to join the mining district of Nacozari with Hermosillo. Though no automobile road was built between Nacozari and the border town of Agua Prieta it is probable that trucks used the old cart road between the two places. In addition, apparently no automobile roads, as such, served the Mazatán-Mátape area, nor San José de Pimas and other towns directly east and southeast of Hermosillo before 1940. Yet, there are unpublished accounts of people going to these places by automobile in the 1930's (McIntyre 1934). One must conclude that either private concerns had built roads in this area or that motor vehicles were using the old cart roads.

The new roads often followed old paths. However, they took on a distinctly different character in other places. In uninhabited areas the roads often traversed hills or mountains in order to avoid stream courses (Figure 15), a radical change from the routes followed by mules and wagons. No longer was there a necessity to remain close to sources of water and pasturage. Moreover, it was deemed advisable to build roads away from the rivers to avoid floods; however, this practice has not been entirely beneficial. Although travel is not impeded during the frequent summer and occasional winter flooding of the stream courses, roads in the mountains suffer from intense erosion during the violent summer thunderstorms, and some of them become rocky or badly gullied.



(a)



(b)

Figure 15. Mountain Roads.--(a) Rough mountain road east of Arivechi.  
(b) Good mountain road between Hermosillo and Sahuaripa.

Often, because of the lack of funds for construction, early motor roads followed circuitous routes where only a minimum of earth removal was needed in their construction.

The early motor road from Hermosillo to Mazocahui exemplifies condition described in the statements made above. Between Hermosillo and Ures the new road stayed close to the ancient pathway. It served various ranchos, haciendas and other small settlements along this part of the Sonora River. Upon reaching the narrows above Ures, the new road departed from the old camino real toward the high country, swinging in a wide arc away from the river. Mules and wagons continued to use the old road along the canyon bottom; cars and trucks used the mountain road (Sauer 1932, p. 17).

Two more important roads were built during the 1940's. The first one completed went from Hermosillo to Sahuaripa by way of La Colorada, San José de Pimas, Tecoripa, Tónichi, and Bacanora. In 1947 work was finished on what was called the Hermosillo-Bavispe Road (Estado de Sonora, Informe 1947, p. 99). In reality, this road was an extension of the road from Hermosillo to Moctezuma. It connected Húasabas as well as the towns of the upper Bavispe Valley to Hermosillo. It also joined the central part of the state to Chihuahua by the road which went through Púlpito Canyon. At a latter time another road was constructed over Carretas Pass a short distance to the south (Estado de Sonora, Informe 1948, p. 47). In 1948 a branch road was completed which connected Nácóric Chico and Bacadéhuachi to the main road at Rancho Los Coyotes (Estado de Sonora, Informe 1948, p. 47). Local roads in the lower Bavispe Valley joined Oputo and Granados to the main road at Húasabas.

These new highways served to bring outlying areas, previously supplied only by mule trains, into the economic and social sphere of influence of the main urban centers in Sonora. Significant changes in the lifestyle of the inhabitants of these villages have slowly come about as a result. Many household utensils and items of clothing are now commonly bought in stores rather than made in the home. Regular commercial exchange, though small in scale, has brought these formerly isolated valleys into increased contact with the outside world.

Hermosillo has played a dominant role as the center of innovation from which change was stimulated in much of Eastern Sonora. The major highways radiate from Hermosillo, the state capital as a result of political as well as economic motivation. Promises of road building, including construction of highways across the Sierra Madre to Chihuahua, have been part of every governor's platform. This progressive orientation of routes toward Hermosillo is part of a process begun as early as the 1820's. The resulting road pattern is one of east-west roads intersecting the older north-south routes along the valleys. Roads run east, northeast, and southeast from Hermosillo to the valleys; other roads connect places on the railroad north and south of Hermosillo to settlements in the interior.

Before 1950 the emphasis in road building seems to have been to connect as many outlying places as possible to major cities. After this time there was an emphasis on paving. The International Highway was the first to be paved. Later, branch highways, such as the Imuris-Cananea road, and the Santa Ana-Altar road were given new surfaces.

During this period large scale commercial agriculture was developed in the lower Mayo, Yaqui, and Mátape Valleys and in a large area west of Hermosillo (Dozier 1963). Most of the energy and financial resources available to the state government were employed in the development of these zones, leaving Eastern Sonora a neglected region. Many miles of paved access roads have been built in the Yaqui and Mayo deltas, and in the "Costa de Hermosillo." Agricultural re-settlement campaigns have concentrated most of their efforts in these highly developed zones. Eastern Sonora, by contrast, has become a backwater area. The major road building efforts in this region came twenty or more years ago. State and local governments have had too much difficulty in maintaining the present network to make significant additions to it. Most construction efforts have concentrated on adding short links and in slowly improving already existing roads.

The largest project in the 1960's was the extension of a road from Hermosillo, previously terminating in Mazatán, to Novillo Dam, some forty miles to the east. This dam was built on the Yaqui River about 1960 to regulate amounts of water reaching the lower Yaqui floodplain. A road was then extended from the dam to Bacanora making it the shorter route from Hermosillo to Sahuaripa.

Recently the state government has initiated projects for the paving of two roads in Eastern Sonora. In 1965 pavement reached Ures, forty-five miles northeast of Hermosillo. By 1970 a new paved road was built along hills immediately above the Sonora River between Ures and Mazocahui, interesting because the new motor road is much closer to the

ancient pathway than was the older automobile road connecting the two places. From this town paved roads are now being extended up the Sonora Valley and northeast toward Moctezuma (Figure 16). Both of these highways are envisaged as links which will serve as alternate routes into Sonora from the U. S. (Tucson Daily Citizen, July 19, 1971).

One might expect drastic change to come to this part of Eastern Sonora if these plans are ever realized. Dunbier (1968 pp. 166-168) sees the highway as the major vehicle of change in northwest Mexico. There is a striking coincidence between those areas of Sonora which have developed agriculturally and commercially and those areas of the state which are served by paved highways. Conversely, the underdeveloped parts of the state are served only by rough dirt roads. The major highways have facilitated the influx of people and ideas from central Mexico and the United States. The American tourist, however, rarely leaves the pavement.



(a)



(b)

Figure 16. Roads Under Construction.--(a) Obregón-Tesopaco.  
(b) East of Ures.

## CHAPTER 8

### FUNCTIONS OF THE MODERN ROAD NETWORK

In the summer of 1972 I visited the area for approximately five weeks. During this period and on several other shorter trips data were collected relevant to functional aspects of roads in Eastern Sonora. Because of the nature of the study problem and because of limited time the data are crude and were not gathered according to a rigorous methodology. Information was fragmentary and informally obtained as to the types of goods carried over the roads. As a crude measure of the intensity of use of the various road links vehicles were counted, mileage measured, and travel times between towns were recorded. It is to be hoped that these data may serve as rough estimates of amounts of traffic. Perhaps the most valuable sources of information were interviews with local store owners. Even small villages usually have general stores, and these stores are often the only commercial establishments in the towns. Proprietors were asked about their sources of supplies and the routes used in deliveries. These questions were intended to reveal information about hinterland boundaries. Also sought was information on bus routes and schedules and on items exported from the various localities.

#### Time Required for Travel

In order to help the reader achieve a conception of the meaning of distance in terms of road conditions, I have furnished a map in which

time is shown as distance (Figure 17). All of the roads were traveled by the author in a three-quarter ton pickup truck except the link connecting Mulatos. The travel time to there was determined by local inquiry. The links on the extreme left represent the paved west coast highway. The distance from Nogales to Navajoa by the highway is approximately 380 miles. For purposes of comparison Mulatos is about 200 miles east of Hermosillo by road. The map especially shows the low accessibility of towns in the mountainous eastern portion of Sonora and the difficulty of travel there. Times are to be measured only along the lines.

#### Types of Traffic

Few types of cars can negotiate the roads of Eastern Sonora. Vehicles are not used casually. Moreover, the wear sustained by any vehicle on long trips, makes desirable the transport of a load that will help bear the cost of travel. Trucks are the most common type of vehicles seen on most roads in this part of the state. They vary in size from half ton "pickups" to trucks with about ten tons capacity. Trucks larger than this are too big for the mountain roads. Wagons and pack animals are still used, but to a limited extent (see Figure 18).

The main obstacles to travel are gullies, rocks, and the fact that some roads have been worn down to the jagged outcrops of underlying strata. Streams have to be forded in places (Figure 19). For all these reasons vehicles with high clearance are essential. Sometimes, after heavy rains, not even the trucks can get through to towns in the extreme eastern part of the state.

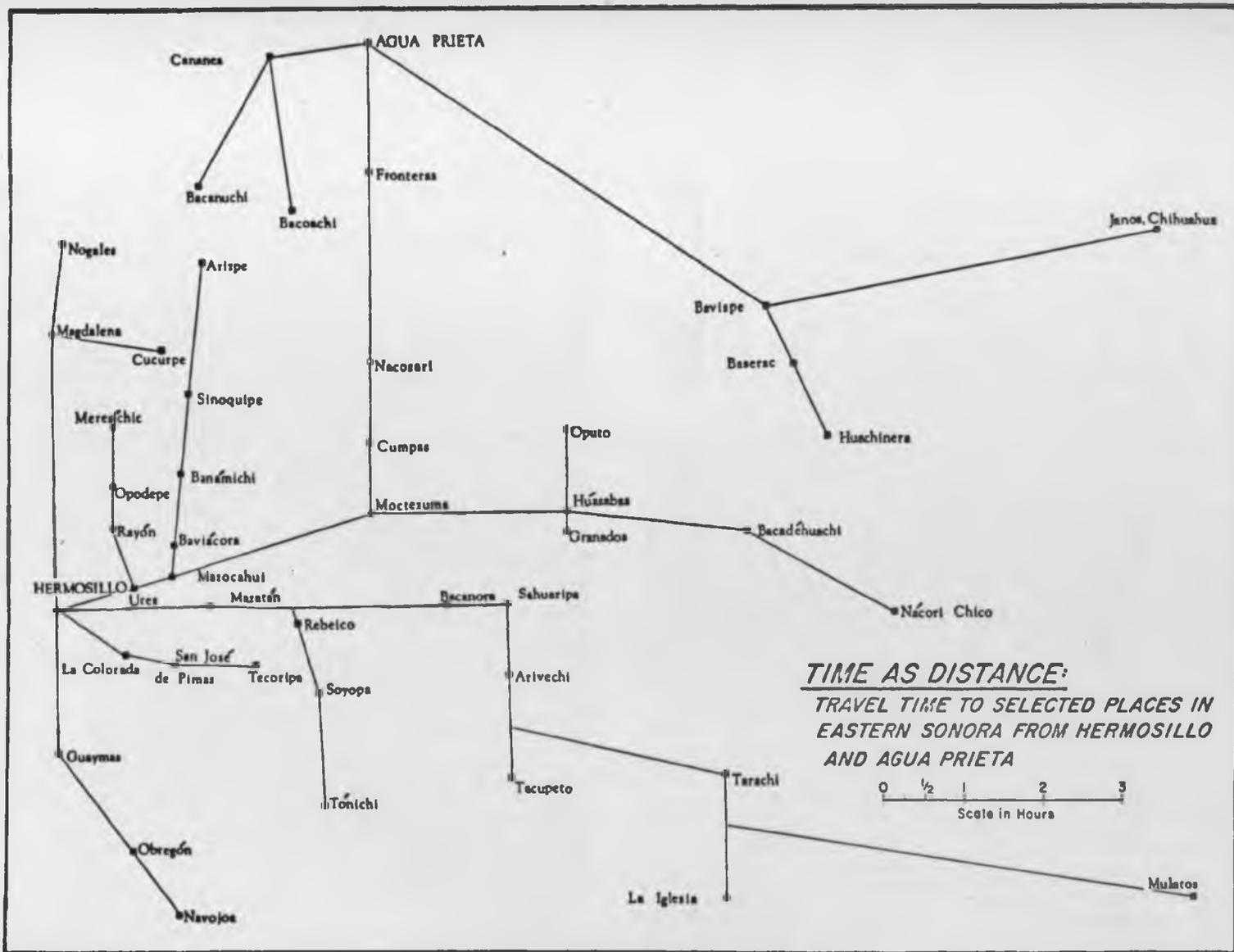


Figure 17. Time as Distance Along Selected Roads in Eastern Sonora.



Figure 18. Animal Transport.--(a) Near Ures. (b) Near Sahuaripa.



Figure 19. Crossing of Yaqui at Soyopa.

Farm products, including livestock, are sent out, and household supplies, farm supplies, and wood for construction and fuel are the main items brought in over the roads. In mining areas various ores, gold, and silver bars, lumber for mine timbers, and mining equipment all have to be brought in over the available roads. Often branch lines are built to the mines themselves. There is a certain amount of commercial lumbering in the high country around Yécora and Maycoba. This lumber is usually transported to Obregón, but is sometimes sent through Sahuaripa to Novillo Dam or Hermosillo. The exports of Eastern Sonora are variable both as to type and destination. Cattle buyers may come into the area from as far away as Tijuana. Though much of the crop production is consumed locally, either by humans or animals, some farm products are transported to adjacent areas of demand. Mining centers in Eastern Sonora have always been a market for the food supplies of nearby ranches and farms. Many of the agricultural settlements in the Moctezuma Valley purvey to Nacozari. The decline of mining in Eastern Sonora since the beginning of the century and the subsequent decrease in commercial outlets for agricultural products is one reason for stagnation in the present day economy of the area.

I have no data for exports of the area other than those that have come from local inquiry and observation. The primary commodity exported from the area is probably cattle. Much of the farmland in this part of Sonora is in feed crops, and the mountainous area between the rivers are pasture for large herds. From the area around Yécora cattle are driven to the edge of the lowlands and then transported in trucks to the larger

cities. Cotton is sometimes exported from the Bavispe Valley over Carretas Pass. Citrus fruits from the valleys of lower elevation are often sent to areas that are too cold for their cultivation. The Sonora Valley exports some chile, but vegetables are usually consumed or sold locally. Some traffic in the area is related to support of dam operations and construction at Presa Novillo and Presa La Angostura.

There is bus service over even some of the roughest roads in Sonora. For this purpose a truck is often converted into a passenger vehicle. In the eastern part of the state service is usually less frequent than once a day, and sometimes is scheduled only once a week. The operating bus lines are shown in Figure 20.

#### Intensity of Traffic\*

During my travels in Eastern Sonora I counted all vehicles which I encountered in order to obtain a rough approximation of the relative importance of each road. I estimated the approximate number of vehicles that might use a certain road link in one day. As the amount of time I spent on any one road varied and because of the fact that I made these observations at different times of the day, week, month, etc., they can only be used for a very crude estimate. In making these judgments, I also used information obtained from local inhabitants. Among the roads of Eastern Sonora, those links which emanate eastward from Hermosillo receive the most use (Figure 21). As one proceeds east the number of vehicles one is likely to encounter usually diminishes. In addition there is a fair amount of traffic (over 25 cars and trucks per day) on

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\* See Figure 21.

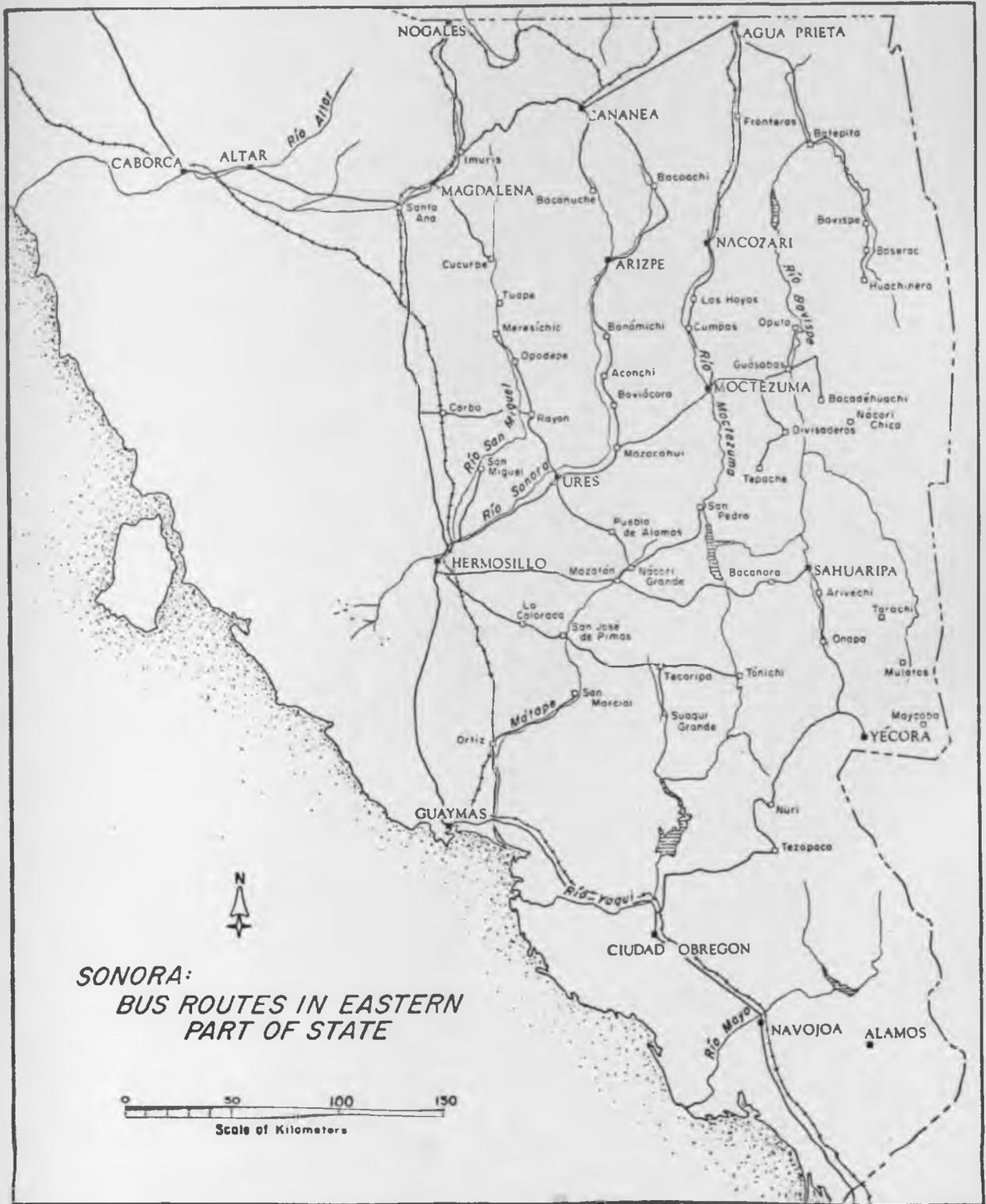


Figure 20. Bus Routes in Eastern Sonora.--Adapted from Torres

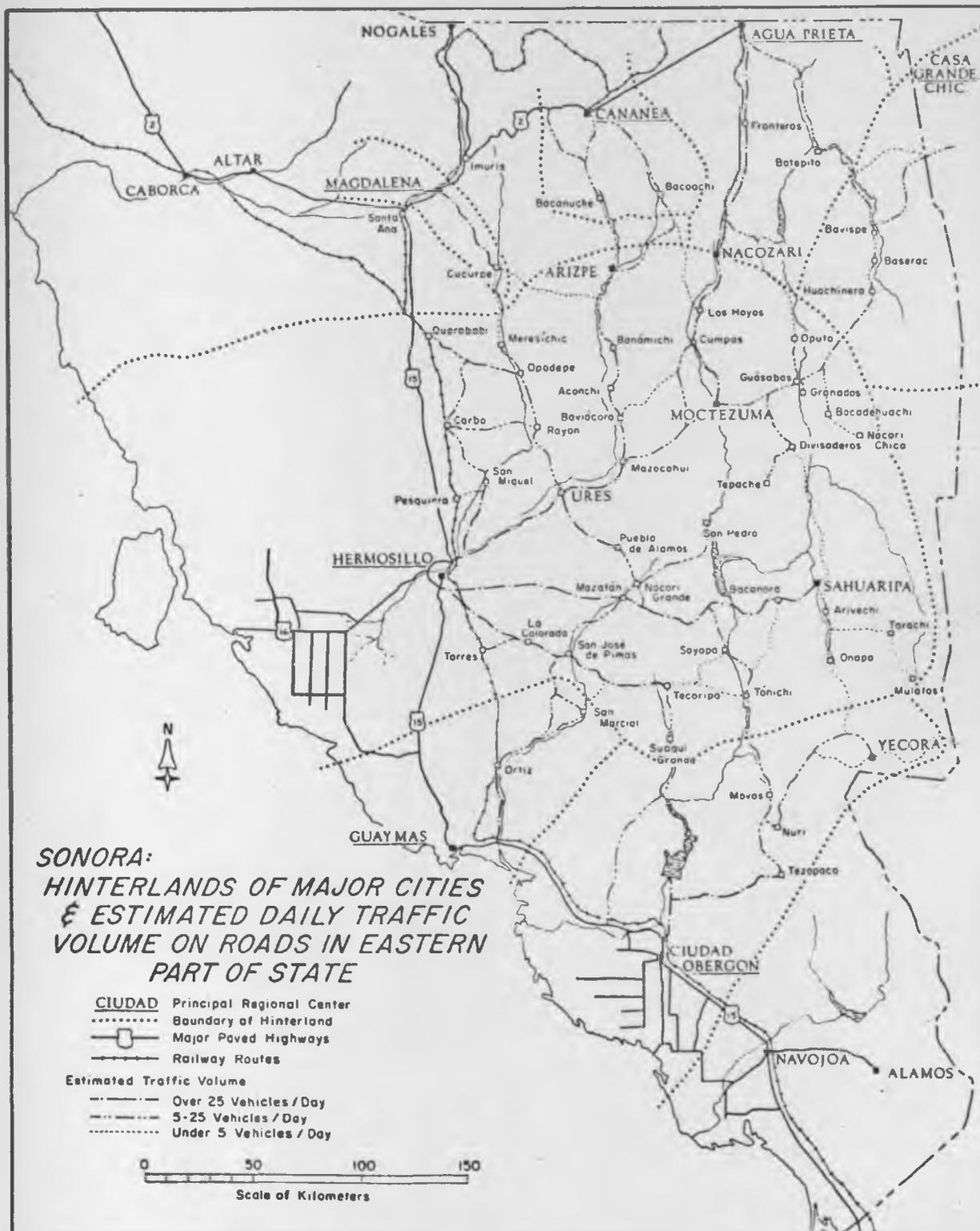


Figure 21. Traffic Intensity and Urban Hinterlands in Eastern Sonora.-- Adapted from Torres

the road from Agua Prieta to Moctezuma, and immediately south of Cananea on the Bacanuche road. Also the Obregon-Rosario road (see Figure 16), which is now being paved, appears to be used frequently. On other roads one may travel several hours without meeting a single truck. Roads that do not serve as links between the small towns of Eastern Sonora and major centers outside the region seem to be in very poor condition and have very light traffic.

#### Regional Foci\*

Stores in most small Sonoran towns sell a variety of goods. Some of the products, such as flour or vegetables, come from the local areas. However, the majority of the items for sale come from outside areas. A list of these things might include kitchenware, canned food, bottled medicines, tools, leather goods, clothing, and cloth. Though a few of these things are made within Sonora, it is assumed for purposes of this study that most items come either through or from the United States or from central Mexico.

Store proprietors were asked from where they were supplied the items contained in their stores. If more than one place was given, an attempt was made to determine from where the greatest number of items came.

It was found that Hermosillo is the dominant supplier for most of the stores in the east-central portion of Sonora. In this sense, Hermosillo serves as a central place for the lower portions of the San Miguel, the Sonora, the Moctezuma, and the Bavispe Valley. It serves

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\* Indicated on Figure 21.

towns directly east such as Mazatán, San José de Pimas, Nácori Grande, and Villa Pesquiera (Mátape) in the Mátape Valley, Sahuaripa, Arivechi, Pónida, Bámori, Tacupeto and other settlements in the Sahuaripa Valley as well as the intermediate town of Bacanora. Truckers from Hermosillo go as far as Soyopa, Tónichi and Onavas in the middle Yaqui. They also serve Tecoripa and Rebeico nearby. Merchandise from Hermosillo reaches the far eastern parts of the state, being trucked to Bacadéhuachi and Nácori Chico to the northeast, and to certain small settlements in the Sierra east of the Sahuaripa Valley.

Other cities have hinterlands that reach into the area I have defined as Eastern Sonora. Certain towns in the southern part of this area are oriented more toward Obregón than Hermosillo. Nuri, Santa Rosa, Santa Ana, Yécora, and Maycoba are all along a road which leads to Obregón, and these places have their primary commercial exchange with that city. Santa Rosa and Santa Ana are mining communities whereas Yécora, though a mission settlement, receives much of its economic stimulus from nearby lumbering operations. Because of these activities the Obregón-Yécora road has a fair amount of traffic despite its very poor condition. There is also daily bus service over this road as far as Yécora. Another road branches off the latter one leading to Movas on the Río Chico, and La Dura, Onavas, and Tónichi along the middle Yaqui. La Dura receives most of its supplies from Obregón whereas Onavas receives some from both Obregón and Hermosillo. A third road follows the Tecoripa tributary north from Cumuripa to the town of Tecoripa whose most important connection is with Hermosillo. Such evidence as I have

indicates that the intermediate town of Suaqui Grande is linked functionally with Hermosillo, Cumuripa being oriented toward Obregon.

Northeastern Sonora has a somewhat different orientation. The border exercises influence here. Cananea, because it is on a paved highway, is used as a point of entry into the two branches of the upper Sonora River. It is the main supplier for Bacanuche and Bacoachi as well as small settlements above the latter place. Cananea, in turn, receives its merchandise both from the south by way of Hermosillo and Imuris and from across the border. A bus runs between Cananea and Arispe from where one can connect with buses going toward Hermosillo. The principal border town is Agua Prieta. From here two reasonably good dirt roads lead south and a paved highway goes to Cananea. Thus Agua Prieta imports sizeable quantities of American goods destined for northeastern Sonora. Because it is at a long distance from the point of origin of most items of Mexican manufacture, its influence as a supplier of these items is small. Nevertheless, the quickest route from central Mexico to towns directly north of Nacozari is by way of Agua Prieta. The most important relationship of northeastern Sonora with Agua Prieta is that of the former supplying the latter with wheat flour and other basic foods.

The upper Bavispe towns of Huachinera, Baserac, San Miguelito, and Bavispe receive most of their merchandise through Nuevas Casas Grandes, Chihuahua. The interior path from the Mexican highlands to Northern Mexico is shorter and less difficult than the west coast route. For this reason items coming from Chihuahua over Carretas Pass can

compete successfully in the upper Bavispe Valley with goods routed through Hermosillo. The upper Bavispe area has always been influenced somewhat by Chihuahua, yet the only bus service to it comes from Agua Prieta.

Several of the larger towns of eastern Sonora serve in a very limited way as sub-centers for their local areas. Ures, for example, has important road connections to the San Miguel Valley, the Sonora Valley, and Pueblo de Alamos. Likewise, Sahuaripa owes some of its importance to its position at the main entry point for the valley of the same name. Moctezuma is, in the same sense, a very small scale distribution center for towns to the east and south of it.

## CHAPTER 9

### MODELS OF NETWORK FORM

Recently, some geographers have become interested in the formulation of models of network form and development. Because of the emphasis now placed on this type of analysis of transportation networks, I feel that it is necessary to attempt to apply these techniques to my area. Much of the mathematical treatment of transportation network structure stems from the work of Kansky (1963) and Garrison (1960). Kansky applied a number of concepts from the field of mathematical topology to the measurement of certain characteristics of railroad and highway networks. He then compared the variation of these measures with selected regional characteristics, including degree of economic development. Gould et al. (1963) devised a model predicting the development of transportation networks through time in their "ideal typical sequence." This formulation was inductively derived from observation in Ghana and Nigeria. I attempt in this chapter to apply certain concepts developed by these and other individuals to the transportation network of Sonora.

#### Refraction

One phenomenon observed in all types of communication lines is that they tend to bend or take different direction upon encountering a new cost region. That is, when a transportation line meets an area which

is significantly more difficult or significantly less difficult to penetrate than the area just crossed, the line tends to take a new direction. This phenomenon has been compared to the behavior of light passing through different substances, bending as it increases or decreases in velocity. Thus, it is said that a railroad line or a road is "refracted" upon entering areas of differing relative costs of construction or transport.

Haggett (1969) gives one example of refraction which does not involve specific lines or routes of communication (Figure 22). Consider the problem of shipping a commodity from an inland site to some destination across a body of water. The aspect of the shoreline is such that it is not perpendicular to a straight line drawn from the point of origin to the point of destination. It is commonly known that freight rates on water are considerably less than those on land. If any route can be taken over either the land or the water, and freight costs per mile are twice as high over land, the most efficient route, the best compromise between distance and difficulty of land transport, would be the one shown in Figure 22. It is also assumed in this ideal situation that the cargo can be unloaded off the terrestrial carrier and onto boats at any point along the shoreline. This point would then be at B, 13 miles below A and 13 miles above C.

The same principal might operate in the construction of a rail line or a motor road, depending on the perception of the problem by the engineer. Mountainous country would tend to "refract" lines of communication from courses followed across flatlands. Of course, the variation

# REFRACTION

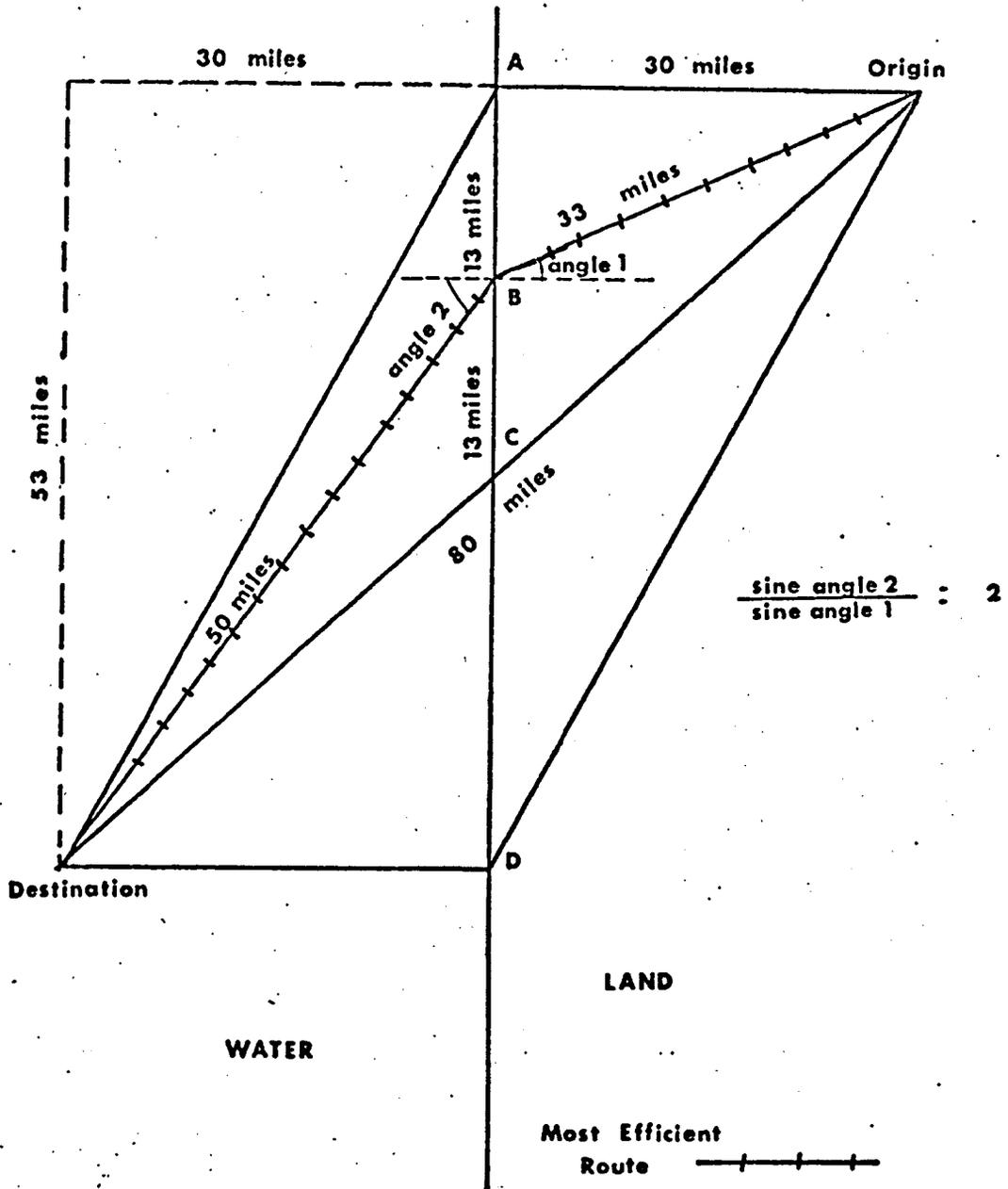


Figure 22. Example of Refraction.

in the relative difficulty of different types of terrain is complex, and much of this variation depends upon construction techniques.

By inspection of the present day road map one can find evidence of refraction. The Moctezuma-Mazocahui road takes a southern course along the Moctezuma River Valley for a short distance before swinging west across the mountains, which is closer to the direct route. However, this bend in the road may not be an example of road "refraction" because a small settlement which lies immediately south of Moctezuma is served by this road. Therefore, the road may have followed this route, not to take advantage of the smooth valley bottom, but to serve the small settlement.

It is hard to find clear-cut examples of road refraction in Eastern Sonora, though one might expect them because of the nature of the terrain. The valleys and mountains are well defined, and in part of the state, form a regular repeating pattern. Nevertheless, the ability to discern instances of route refraction is impaired by the necessity that roads serve certain settlements, and the existence of critical mountain passes and other topographic conditions. Moreover, in any area it would be difficult to assign numerical values indicating relative costs of road construction. Rather, a better procedure would be to assign values to the different areas based on the angles of refraction and taking other factors, such as settlement, into account. To do this, for even a small area, would be a laborious process of definition, data gathering, and evaluation. Such a task is beyond the scope of this project. I wish, merely, to point out that the phenomenon of refraction possibly is observable in a few isolated instances in the road network of Eastern Sonora.

Connectivity

One of the more commonly used measures of network structure is the index of connectivity (B) (Garrison 1960; Kansky 1963; Haggett 1969; Yeates 1968, pp. 113-117). This measure is defined as the ratio of the number of edges or lines in a given network to the number of vertices in that network, or  $B = e/v$ . In the following diagram connectivity ratios are given for certain simple networks (Figure 23):

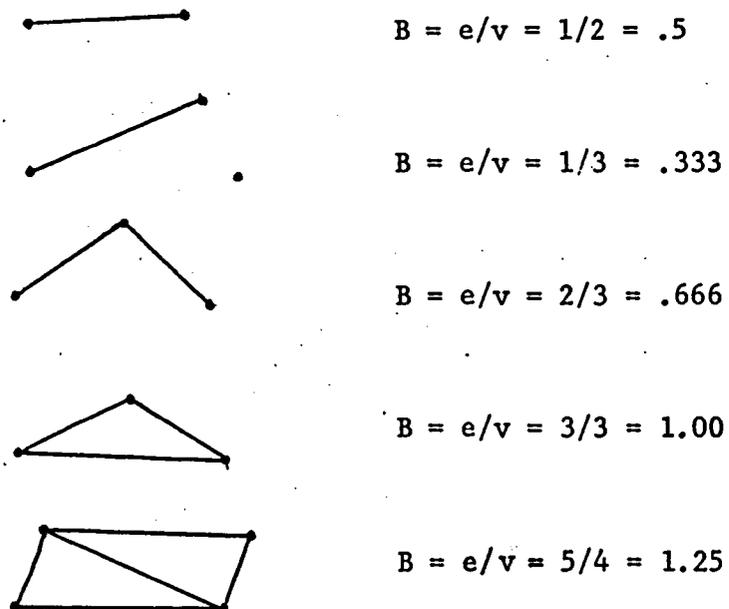


Figure 23. Connectivity Ratios for Selected Simple Networks.

Kansky (1963) correlated the index of connectivity and other measures of network form with economic development in certain countries

and obtained significant results. However, the index of connectivity has a number of disadvantages. The index of connectivity may reach higher values when there are a greater number of settlements. In spite of the fact that the set of points in Figure 24a are completely interconnected, the second network (Figure 24b) has a higher value of B. Furthermore, an array of towns may have a lower index of connectivity even though all settlements are connected with all other settlements by the shortest possible route (Figure 24c).

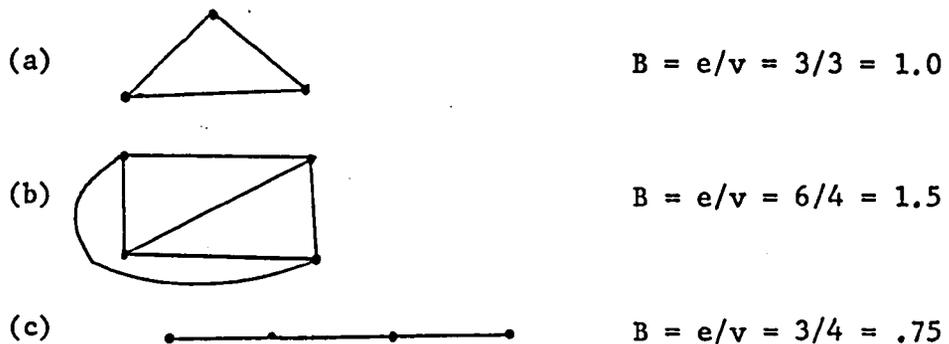


Figure 24. Comparisons of Connectivity Ratios.

After a process of simplification in which major towns were subjectively chosen and links between them were considered as straight, the connectivity ratio for Eastern Sonora and adjacent main highways was calculated and a value of 1.345 was obtained. This signifies advanced interconnection as might be found in highly developed countries (Yeates

1968, p. 116). The reason for this discrepancy probably results from the fact that this ratio was calculated for very primitive roads in Eastern Sonora, but for railroads and first order highways by Kansky (1963) and Yeates (1968). To make adequate comparisons the connectivity ratios would have to be calculated for other areas served by networks of primitive roads.

Perhaps another network measure would be more appropriate. The gamma index as defined by Kansky indicates how well connected a certain network is, given the number of vertices in that network. It may be written as  $y = e/v(v-1)/2$  where  $e$  is the number of edges and  $v$  is the number of vertices. The denominator,  $v(v-1)/2$ , is equal to the maximum number of edges in a system with  $v$  vertices. This measure may be expressed as a percentage, and is independent of the number of vertices in the system. Unfortunately, Kansky (1963) did not calculate percentage connectivity values for any of the countries he analyzed. In any case, little information from primitive road networks necessary for the calculation of these measures has been compiled.

The connectivity ratio for Sonoran paved highways and for Sonoran railroads are 1.07 and .944 respectively for towns > 500. The railroad connectivity is considerably less than for Mexico as a whole. A scale of expected per capita income values associated with given network connectivities by country would show Sonora as being among the very poorest or least developed areas (Yeates 1968). This is contrary to the facts. Sonora per capita income in 1960 is probably in the vicinity of \$400, somewhat higher than for Mexico as a whole (United Nations

1964, pp. 28 and 515; Anuario Estadístico 1965, p. 314). Perhaps the underestimation stems from the fact that Sonora is only a state and not a country. We have to conclude that connectivity is a poor measure of economic development in Sonora.

#### Network Development Through Time

In 1963, Gould et al. outlined their "ideal typical sequence" of transportation development based upon research in Ghana and Nigeria (Figure 25). Briefly the steps in this idealized sequence are as follows: (1) In the first phase small isolated ports carry on limited sea trade near coastal forts. These ports are the focus of a few local bush trails from a very small hinterland. There is very little interconnection of routes either between ports or with inland centers. (2) The second phase consists of the growth of certain ports attendant upon the emergence of new lines of penetration to the interior. The newly connected inland centers also grow at this time. (3) There is a development of feeder routes which focus on the growing ports, the major inland centers and on certain points on the line itself in the third phase. There is a subsequent decrease in the size of the smaller ports as the larger ones grow at their expense. (4) In the fourth phase there are beginnings of interconnection between the lines of inland penetration. This is shown as occurring at the major inland centers as they start to develop networks of their own. (5) In the fifth phase lateral interconnection continues until all major centers are linked by lateral routes. (6) Finally, in the last phase major centers, not yet directly connected, develop "high priority main streets."

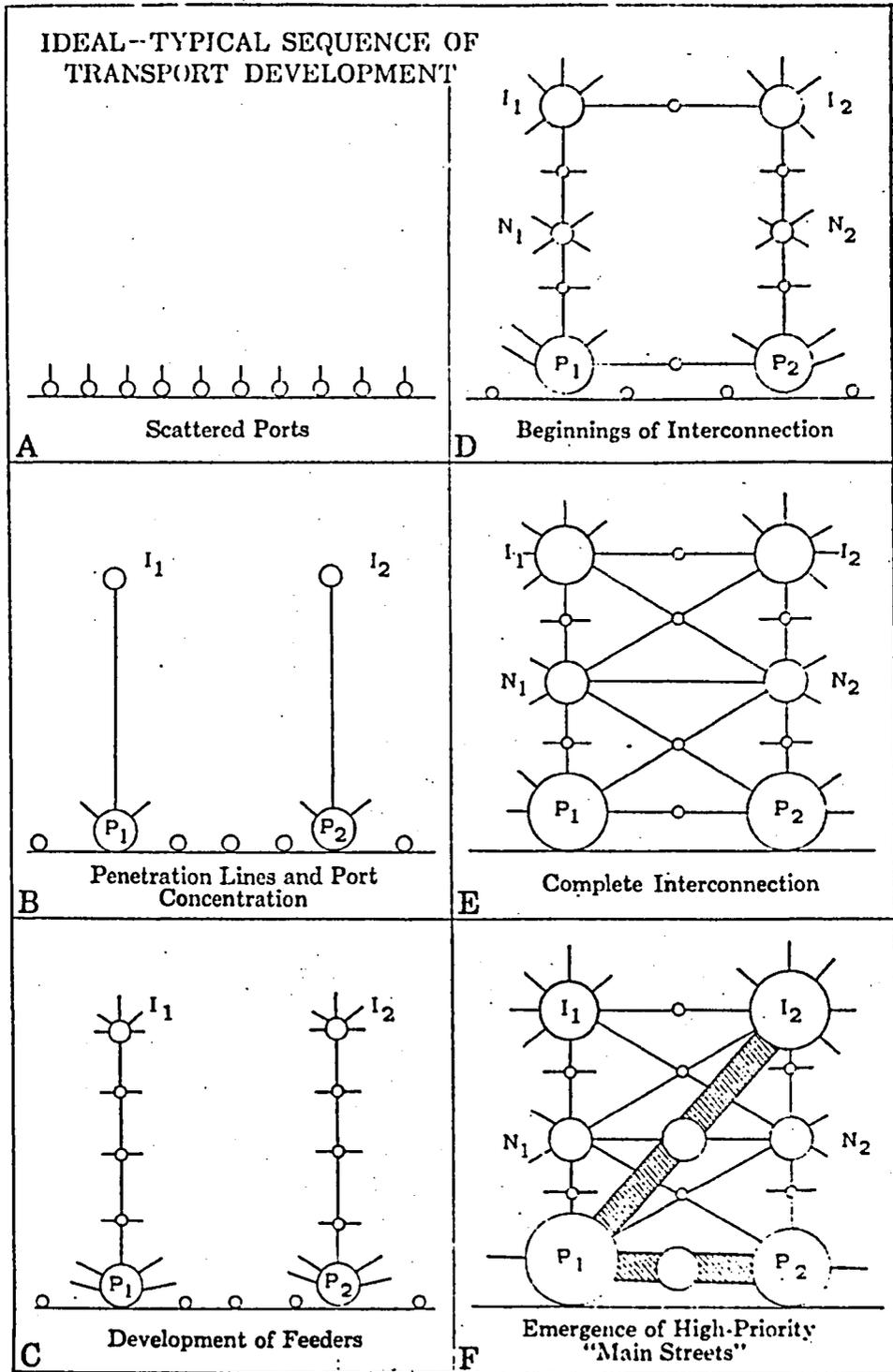


Figure 25. Model of Transport Expansion. --After Gould, Taaffe, and Morrill (1963).

Gould et al. (1963) further describe the actual examples of these processes as they occurred in Ghana and Nigeria. They feel that there were three principal motives for construction of the early lines penetrating the interior. Among these motives, the desire to connect interior areas to the coast for political and military reasons was the strongest, the desire to reach areas of potential mineral value and areas of potential agricultural export production being secondary.

The difficulty of applying Gould's transportation model to Sonora stems from several causes. In several senses the two areas are not comparable. Although Ghana and Sonora are about the same size, Sonora has a much smaller population. Sonora has never had an important port other than Guaymas. The other small ports on the Sonoran coast are newcomers rather than remnants of former days. Thus we have only one major penetration line from the Gulf of California. The highways that today lead to Puerto Peñasco and Kino Bay are maintained mostly as a result of tourism. The two places don't serve as shipping ports.

The railroad line connecting Guaymas with Nogales and the United States was completed in 1882. This railroad served more to connect the United States with Sonora than as an adjunct to the port of Guaymas. More freight went through Nogales than through Guaymas before and after the turn of the century (Colegio de Mexico 1960, p.473 ). The import and export traffic in Guaymas has always been modest in scale, and recently the port has had competition from the railroads and highways built to the south.

The major railway from Guaymas to Nogales did see the development of nodes with small feeder routes at certain points along its length. The railroad was not responsible for the early growth of either Guaymas or Hermosillo as these places had become important relative to the rest of Sonora sixty years earlier. The railroad did, of course, stimulate the further growth of these two cities. Nogales, on the other hand, was completely the product of the railroad and the border.

The main highway from Nogales to Navojoa, built much later, followed approximately the route of the main railroad, thus becoming a source of competition for the latter. There remained, then, only one main transport route in Sonora. There were some proposals to continue one branch of the railroad from its terminus near Tónichi to the copper mines at Nacozari. This plan was later abandoned due to the construction of a dam and reservoir, Presa Alvaro Obregón, and the subsequent covering of the tracks by water (Theodore Dodge, personal communication). Had this line been completed the development of connecting routes in Eastern Sonora might have proceeded at a much greater rate, and perhaps the Sonoran transportation network would conform more closely to the Ghana and Nigeria model. One might say instead that Sonora is a special case of this model proposed by Gould et al. (1963) in which only one major line of penetration developed.

Some confusion arises from the statements and terminology employed by Gould. Reference is given to "port concentration," "interior concentration" of nodes, and "development of nodes" (Gould et al., 1963, pp. 505-513). It is not clear from the article whether the nodes spoken

of are merely junctions at which loading takes place or are actual settlements. From their series of maps (p. 507) it is evident that certain of the nodes along the penetrating rail lines were pre-existing settlements. Furthermore it is not clear what is meant by the term concentration as used with reference to ports and nodes. It could mean simply increase in volume of transported items handled and not necessarily increase in population. In Eastern Sonora there has been interconnection and some increase in traffic at nodes without increase in population. Moreover, many road junctions are miles from the nearest town.

It is clear that most towns on the railroads have benefited from such a position in terms of commercial activity and population increase. However, some of these towns, such as Imuris, Magdalena, and Santa Ana, were established long before the advent of the railroad. Other small settlements did come about because of the railroad. Several of these, Pesqueira, Ortiz, and Torres, were loading points for ores from several mines. In addition most towns along paved highways have grown as a result of the advantages provided by these arteries of communication. However few towns in Eastern Sonora have benefited as a result of their position along dirt roads or at junctions of them. The population of Eastern Sonora has remained much the same since 1910 (Dirección General de Estadística 1910); the increases have come almost entirely in the western part of the state and along the border. There has been some concentration at the larger eastern settlements. This is probably related to the general trend toward urbanization which is evident throughout Latin America. The town of Moctezuma is possibly an exception to the

rule. It is a crossroads for a sizeable amount of traffic from several directions. A bus carries passengers to and from Húasabas and Bacadéhuachi to the east. Buses stop at Moctezuma on their way to Nacozeni and Agua Prieta from Tepache and Divisaderos directly to the south and from Hermosillo to the southwest. As a result of these passenger services and other types of transport, Moctezuma has a few gas stations, hotels and restaurants. Ures has developed similar roles as a result of its function as a gateway between Hermosillo and the San Miguel and Sonora Valleys. However much of Ures' growth is related to the paved highways which now serve it. One might argue that Sahuaripa has similarly benefited from its dirt roads, but it serves no important function for thru traffic. Most of Sahuaripa's growth is related to its function as a central place for agricultural settlements to the south, and small villages and ranches in the sierra to the east. Settlement sizes throughout Eastern Sonora are much more closely related to amount of agricultural land than to markets for agricultural products.

I will conclude by saying that, at best, the development of the Sonoran transportation network is a special case of the Gould model or one in which there is only one major line of penetration. The route of the International Highway does not deviate significantly enough from the path of the railroad to consider it a separate line of penetration. There are several short connecting routes between the railroad and the highway, however. In spite of the fact that there are several connecting routes between the paved highway and the north-south dirt roads in the eastern portion of the state, little "node concentration" has taken

place. This is primarily the result of the paucity of thru-traffic in this area. For example, one might go by road through Eastern Sonora from Agua Prieta to Obregón. These roads are sometimes collectively called the Agua Prieta-Obregón highway, but have no such function. It is doubtful whether anyone has ever travelled from Agua Prieta to Obregón using this route (Nacozari, Moctezuma and Sahuaripa) unless he had intermediate objectives. An arduous trip such as this would take a minimum of three days whereas by the main highway the distance could conceivably be made in one day. Because of the fact that most of the traffic in Eastern Sonora has local objectives and is not thru-traffic such as on the main highway and railroad, there are striking differences between the development of the transportation network relative to settlement in Sonora and the development in Ghana and Nigeria.

Perhaps a "model-simulation" could be made to show the growth of the modern network of communications considering either the highway or the railroad or both as an initially given stage upon which feeder routes develop. The roads leading east from the major route would be the lines of penetration per Gould. One might argue that there has been some "node concentration" in the interior (at Ures and Moctezuma) with the development of the north-south connecting links. However, the process differs from the Gould model at its inception, because the analogy between the sea-coast of Ghana and the railroad and main highway lines of Sonora is a poor one. The Gould model describes a process whereby certain ports grow at the expense of others, and subsequently many of the older ports decline or go out of existence. This has not been the case in Sonora;

rather, there has been a "concentration" of traffic and population at many points (at large cities as well as at railroad stops) where formerly there was no settlement.

## CHAPTER 10

### CONCLUSIONS

There is little evidence that any Sonoran town grew purely as a result of its location with respect to thru-traffic before the nineteenth century. In this sense, I am talking about traffic that is destined for an external area and not the local area. Local resources were undoubtedly the most important locational factor. There was a tendency, however, for mining settlements to be located near the main camino real and near other major routes. Perhaps seventeenth century Matape, an agricultural mission settlement, grew as a result of passing traffic, yet it probably never had a large population despite its function as a supply center for northern missions. Although small ranches along the principal roads supplied travelers with food, water, pasturage, and lodging, I think one can assume that road traffic was never intense enough to generate settlements which did not have a sound local resource base. Bartlett (1965, p. 474) observed in 1851 that the position of the ranches along the road from Guaymas to Hermosillo was fixed solely with reference to grazing.

Thru-traffic had little impact on the growth of settlements until the nineteenth century. During this period Hermosillo, especially, benefited from traffic between Guaymas and the valleys of upper Sonora. Of course, a significant part of Hermosillo's growth was also related to its function as a central place for various goods and services, and many

roads were therefore routed to it. Hermosillo became even more important when the state capital was shifted to it from Ures in 1879.

The development of those settlements related to transportation awaited the railroads. Shortly after the completion of the railroad from the United States border to Guaymas in 1882 several small stations were established along its length. Of these, Nogales came to have major importance. Other small settlements came into existence around the turn of the century on railroad lines constructed in conjunction with mining operations at Cananea and Nacozari. Principal among these were Agua Prieta and Naco, both also border towns. Hermosillo and Guaymas, of course, benefited in terms of population from construction of the main railroad. Smaller villages such as Benjamin Hill, Carbó, Torres, and Ortiz all owe their origins to the railroads.

Motor traffic cannot be said to have had much influence on settlement until paved highways were built. Moreover, the highways tend to parallel the railroad lines. Therefore many towns which had locational advantage due to the railroads increased their growth by virtue of their position on a nearby highway. Paved highways are such recent phenomena in Sonora that their full effect on settlement has not yet been realized. They certainly have lent advantage to the towns through which they pass, but few of the towns owe their origins to the highways. The unsurfaced roads in the eastern part of the state have had even little effect on the distribution of commercial functions within the towns.

In Eastern Sonora the available evidence points to a network of roads which developed upon a fixed settlement base. The roads, it seems,

owe their origins to the settlements, not vice-versa. The ancient "road to Cibola" (Sauer 1932) followed stream courses, along some of which was dense agricultural settlement, such as in the Sonora River Valley. Though productivity may have been stimulated here because of trade, it does not seem plausible that these settlements came into being as a result of this trade.

The road pattern of Eastern Sonora shows adjustment to topographic conditions and settlement geography. The network is a composite of roads reflecting differing needs and technological levels at various times in history. Distant urban centers are responsible for a series of new roads superimposed on an older pattern of trails that followed stream courses and valley bottoms. Hermosillo and Guaymas became a focus of travel to and from Eastern Sonora as early as the 1820's. Hermosillo assumed even more importance upon becoming permanently the capital of the state in 1879. In the nineteenth century Hermosillo also became the hub of several roads connecting it with the older north-south valley roads of Eastern Sonora. There was no radical change in the appearance of the road pattern with the advent of the automobile, but the actual routes of some individual roads designed for motor traffic differed from the older roads.

There is no easy answer to the question of whether the modern roads of Sonora follow old wagon roads and mule trails. In some cases present day automobile roads follow paths which are markedly similar to older trails, but in other cases, the new roads have no predecessor. The nature of the terrain and settlement pattern in the San Miguel,

Sonora, Moctezuma, Bavispe, and Sahuaripa Valleys almost dictates that there be a road somewhere along the valley bottom or immediately above it. Thus the roads along these valleys could not have deviated far from ancient pathways. Moreover, all old itineraries indicate that these valleys were, indeed, used for most travel. Along much of the San Miguel Valley trucks use the bed of the river itself as has all travel for centuries. In the Sonora Valley the road is in a similar river-bed situation for about half the distance between Arispe and Bacoachi (see Figure 26). In the central portion of the valley, a new road is being constructed which lies on terraces about twenty feet above the level of the flood plain, whereas the older roads all kept nearer to the river. In some cases as in the Moctezuma Valley there are broad terraces above the river along which travel is relatively unhindered. Along certain portions of the Bavispe, Sonora, and San Miguel Rivers the valleys are narrow and all traffic uses the river bed as it has for centuries. The roads which traverse the mountainous areas between valleys tend to deviate significantly from the older mule trails except for the approaches to certain critical mountain passes. Carretas Pass, Pulpito Canyon, and certain passes in the vicinity of Yécora continue to be used for travel to Chihuahua. In much of the rest of Eastern Sonora an automobile road taking any other mountain pass which has been used for centuries is more the exception than the rule.

The hypothesis that the roads of Eastern Sonora serve to connect settlements of the area with external urban centers and not with each other holds up fairly well. One can see this especially in road



Figure 26. Road in the Bed of the Sonora River Above Arispe.

conditions and volume of traffic. Those roads which are in relatively good shape and have regular traffic are usually the main connection between one of the towns of Eastern Sonora and the city which supplies it and others along the way. The rougher unused roads often connect two of the small towns which are served by different routes to the cities which supply them. Such a route functions only to connect the two small towns to each other and not to the outside world. In many cases these roads were formerly main arteries of communication, but their use diminished. They may continue on as ranch roads, but usually are in very poor condition. For example, the first automobile road from Hermosillo to Sahuaripa took a southeasterly course through Tecoripa and Tónichi, before heading northeast through Bacanora to Sahuaripa. About 1960 a road was constructed directly east of Hermosillo which passed through Mazatán and Novillo Dam, thence to Bacanora and Sahuaripa. The first road continued to be kept in good condition as far as Tecoripa. However, the links from Tecoripa to Tónichi and from Tónichi to Bacanora decayed very rapidly probably because they were no longer used in any travel to and from Hermosillo. Today these roads are barely passable and carry mostly incidental traffic. Likewise, roads that connect towns that are in different urban hinterlands tend to be in very poor physical condition. For example, though Sahuaripa and Yécora are both fairly important towns in Eastern Sonora, a considerable portion of the road connecting them is quite poor. Sahuaripa is supplied through Hermosillo whereas Yécora's main connection is with Ciudad Obregón. In northeastern Sonora similarly poor road conditions prevail between the areas of Hermosillo's influence

and that of Cananea, Agua Prieta, and Nuevas Casas Grandes, Chihuahua. Only in the Moctezuma Valley does one continuous smooth road connect Hermosillo with a northern center (Agua Prieta). In this valley the mining center of Nacozari exerts some influence, and is economically important enough to have good road connections with both Agua Prieta and Hermosillo. Along the hinterland boundary, between Opodepe and Cucurpe in the San Miguel Valley, between Arispe and Bacoachi in the Sonora Valley, and between Húasabas and Huachinera in the mountainous country which separates the upper and lower portions of the Bavispe River, roads receive little maintenance.

It should be mentioned that relationship to urban centers is only one factor explaining road conditions. Topography is also very important. In the flat, dry western area of Sonora some unimportant roads remain in good condition despite lack of maintenance. In the mountainous eastern portion of the state, on the other hand, important road links often are impassible to cars because of the rough terrain. Yet some roads, even in relatively smooth areas, are in horrible condition for lack of upkeep.

Though the road network of Eastern Sonora is open to traffic from several directions, functionally it is dendritic, similar to that described by Johnson (1970, p. 85) as being typical of underdeveloped countries. In other words, though a town in eastern Sonora may have road connections with more than one external urban center, such as Hermosillo and Ciudad Obregón, it usually exchanges goods with only one center (see Figure 21).

Hermosillo has become the dominant center for most of eastern and central Sonora. Hermosillo's area of influence is expanding and slowly displacing that of other centers. At the same time its influence is intensifying. Certain mountain communities in the far-eastern part of the state, such as Tarachi and Mulatos, were supplied through Yécora and Obregón to the south only a few years ago. Now these towns are connected to the Sahuaripa Valley and therefore to Hermosillo. Their other road connections are now almost obliterated, and the few trucks that visit these places come from the west. In addition to this process of "hinterland piracy" there is also a process of intensification of communication taking place between Hermosillo and those towns immediately to the east and northeast of it. This is directly the result of construction of paved roads to these areas.

As yet the influence of Hermosillo in most of the eastern country is weak, and the resultant change of rural lifestyles is very slow. However, significant changes have come about since the construction of the first automobile roads in this area. A greater dependence on goods manufactured outside the area now prevails, whereas formerly home industries were more important. Changes in the appearance of towns should become much more apparent upon the arrival of paved highways. Already Ures has many of the commercial outlets, such as car agencies and furniture stores found in larger cities. Along with this economic dominance of urban centers external to Eastern Sonora will come the superimposition of an urban culture on the older rural culture region. Paved highways, now planned for Eastern Sonora, will probably be the most important agent of this change, which until now has been very slow.

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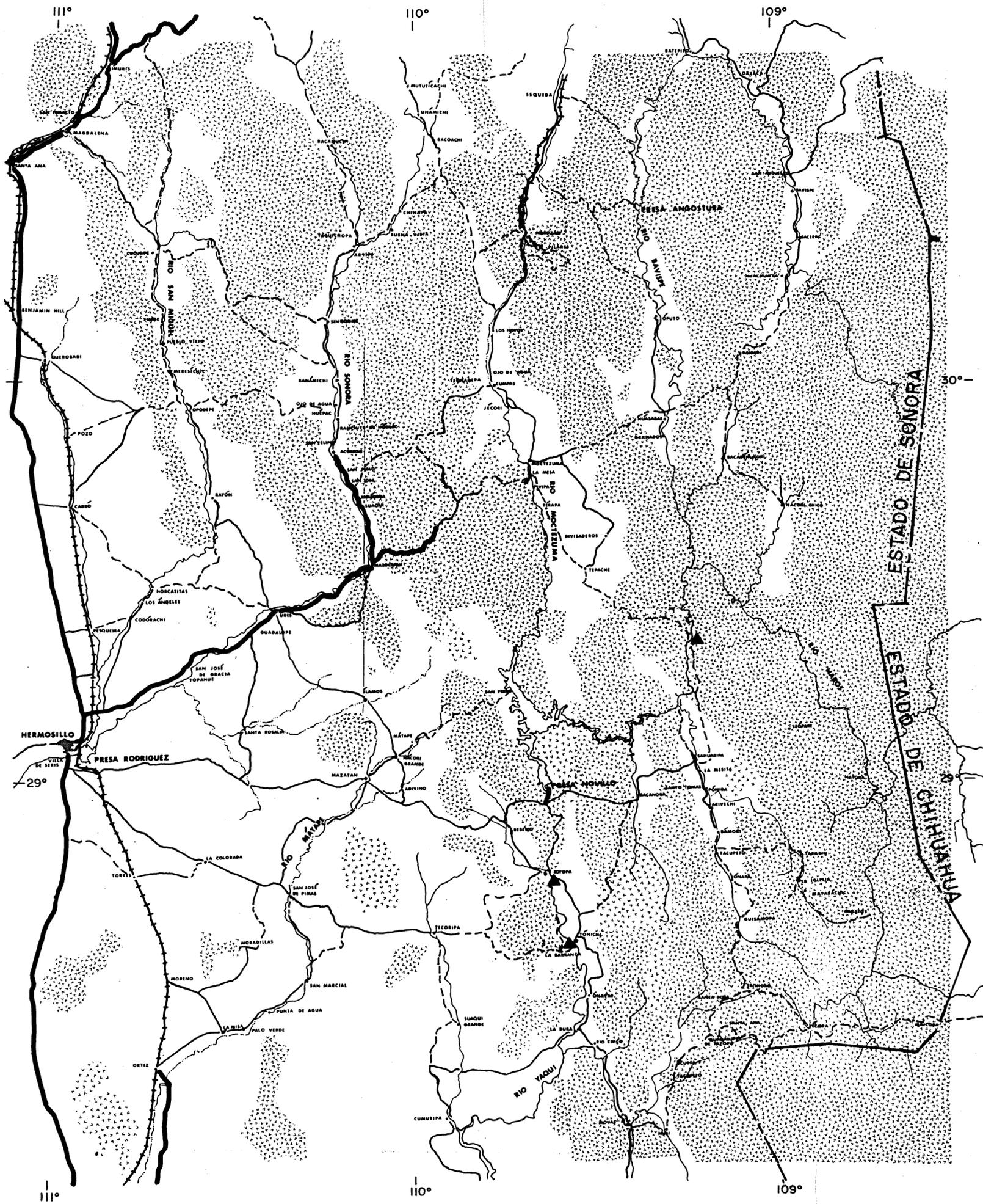
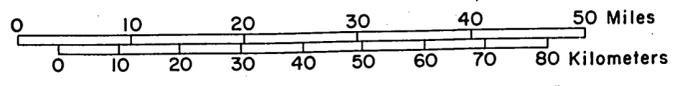
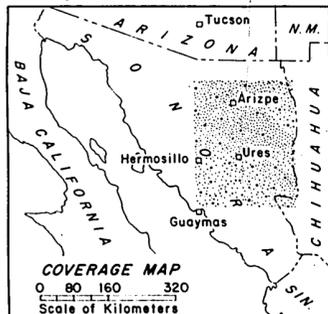


Figure 3. *PRESENT-DAY ROADS IN EASTERN SONORA, MEXICO*

- Paved Highway
- Dirt Road
- Truck Road
- Railroad
- Area of high relief
- Area of low relief
- Raft crossing



Adapted from "Tactical Pilotage Chart H-22B"



Dodge, thesis  
Geography, 1973

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