

AW632586

# Publications in Geography

Technical Paper Number 66-1

1966

## TRINCHERA DISTRIBUTION IN THE SIERRA MADRE OCCIDENTAL, MEXICO

code 1

*William A. Howard*  
*Thomas M. Griffiths*

|  |           |     |    |
|--|-----------|-----|----|
| CLEARINGHOUSE<br>FOR FEDERAL SCIENTIFIC AND<br>TECHNICAL INFORMATION |           |     |    |
| Hardcopy   | Microfilm |     |    |
| \$ 4.00  | \$ .75    | 104 | 25 |
| <b>ARCHIVE COPY</b>  |           |     |    |



Department of Geography  
University of Denver

Publications in Geography #66-1

TRINCHERA DISTRIBUTION IN THE  
SIERRA MADRE OCCIDENTAL, MEXICO

William A. Howard

and

Thomas M. Griffiths

Department of Geography  
University of Denver

April 1966

This publication is under the technical supervision of:

Thomas M. Griffiths  
Professor and Chairman

Clark N. Crain  
Professor

Research reported in this publication was supported by U. S. Army Natick  
Laboratories, Natick, Massachusetts, Project No. 1V025001A129  
and Contract No. DA19-129-AMC-789(N)

## TABLE OF CONTENTS

|   | <u>Page</u> |
|---|-------------|
| PREFACE . . . . .   | vii         |
| I. INTRODUCTION . . . . .   | 1           |
| Importance of Trincheras . . . . .  | 2           |
| Previous Study on Trincheras . . . . .  | 6           |
| Objectives of Study . . . . .   | 6           |
| Location of Study Area . . . . .  | 7           |
| Techniques Utilized in Study . . . . .  | 7           |
| II. PHYSICAL SETTING OF THE SIERRA MADRE<br>OCCIDENTAL . . . . .                | 11          |
| Terrain . . . . .   | 11          |
| Climate . . . . .   | 18          |
| Vegetation . . . . .  | 26          |
| III. DISTRIBUTION OF TRINCHERAS . . . . .                                       | 35          |
| Distribution of Sierra-type Trincheras: General<br>Characteristics . . . . .    | 35          |
| Distribution of Sierra-type Trincheras: Specific<br>Characteristics . . . . .   | 37          |
| Basin and Range: East and North of Study Area . . . . .                         | 37          |
| Rio San Pedro - Ojo Frio - Altamirano . . . . .                                 | 38          |
| Arroyo del Oso and Arroyo Carretas. . . . .                                     | 47          |
| Rio de Bavispe . . . . .  | 53          |
| Upper Rio de Bavispe Valley and Tres Rios. . . . .                              | 56          |
| Rio del Gavilan . . . . .   | 57          |
| Rio Piedras Verdes and Its Tributaries . . . . .                                | 70          |
| The South. Rio Negro - Garabato - Baranca del<br>Cobre . . . . .                | 72          |
| Distribution of Sonoran-type Trincheras: Overall<br>Characteristics . . . . .   | 77          |
| IV. FACTORS AFFECTING THE OCCURRENCE AND<br>DISTRIBUTION OF TRINCHERAS. . . . . | 81          |
| Trincheras in Relation to Habitation Sites . . . . .                            | 81          |
| Trincheras in Relation to Topography . . . . .                                  | 84          |

## TABLE OF CONTENTS (Cont. )

|   | <u>Page</u> |
|---|-------------|
| Trincheras and Archeology . . . . .   | 84          |
| Trincheras Density and Distribution . . . . .   | 84          |
| Trincheras and Further Research on Their Effects on the<br>Physical Environment . . . . . | 85          |
| BIBLIOGRAPHY . . . . .  | 87          |
| APPENDIX . . . . .  | 91          |

## LIST OF FIGURES

|  | <u>Page</u> |
|--|-------------|
| Frontispiece   |             |
| In the Heart of the Sierra Madre Occidental. Air View<br>near Tres Rios . . . . .  | xi          |
| 1. Modern Check Dams, "Trincheras," in Field near<br>Colonia Juarez, Chihuahua. . . . .  | 4           |
| 2. Modern Check Dam Constructed by Bosques de Chihuahua<br>at Mesa del Huracán . . . . .   | 5           |
| 3. Location Map of Study Area . . . . .  | 8           |
| 4. Area of Trinchera Occurrence in Sonora and Chihuahua . . . . .  | 10          |
| 5. Physiographic Diagram of Northern Mexico. After<br>Lobeck . . . . .   | 12          |
| 6. Trinchera Area with Respect to Sierra Madre Occidental<br>and Adjacent Physiographic Provinces . . . . .                      | 15          |
| 7. Deeply Incised Volcanic Surface of Sierra Madre<br>Occidental at Rio Piedras Verdes, North Central Part<br>of Range . . . . . | 16          |
| 8. Barranca del Cobre . . . . .  | 17          |
| 9. Weather Reporting Stations for the State of Chihuahua,<br>Mexico . . . . .  | 19          |
| 10. Average Annual Isotherms, 1958-1962, for State of<br>Chihuahua . . . . .   | 20          |
| 11. Average Annual Isohyets, 1958-1962, for State of<br>Chihuahua . . . . .  | 21          |
| 12. Average Number of Days with Some Precipitation, 1958-<br>1962, for State of Chihuahua . . . . .                              | 22          |
| 13. Weather Reporting Stations within or Close to the<br>Trinchera Area . . . . .  | 23          |
| 14. Climates of Chihuahua . . . . .  | 25          |

## LIST OF FIGURES (Cont.)

|   | <u>Page</u> |
|---|-------------|
| 15. Winter Storm Clouds over Sierra Madre Occidental<br>West of Nuevo Casas Grandes . . . . . | 27          |
| 16. Fresh Winter Snow (February) at Mesa del Huracán . . . . .                                | 28          |
| 17. Precipitation Record for Station at Rio Gavilan -- 1964<br>and 1965 . . . . .             | 29          |
| 18. Open Oak Forest on Rio Gavilan . . . . .  | 31          |
| 19. Pine Forest South of Mesa del Huracán . . . . .   | 33          |
| 20. Partially Excavated Ruin Complex at Casas Grandes . . . . .                               | 36          |
| 21. Foothill Zone at East Edge of Sierra Madre Occidental . . . . .                           | 39          |
| 22. View to West Toward the Sierra Madre from Floor of<br>Bolson near Casas Grandes . . . . . | 40          |
| 23. Upper Portion of Rio San Pedro, Looking South . . . . .                                   | 43          |
| 24. Ejido de Altamirano . . . . .   | 45          |
| 25. Air View of Double Cave at Arroyo del Oso . . . . .                                       | 48          |
| 26. Floor Plan of Double Cave at Arroyo del Oso . . . . .                                     | 50          |
| 27. Ground View of Double Cave at Arroyo del Oso . . . . .                                    | 51          |
| 28. Ruin in Double Cave, Arroyo del Oso. . . . .  | 52          |
| 29. Dissected Alluvial Fans along East Side of Upper<br>Bavispe Valley . . . . .              | 54          |
| 30. Central Portion of Upper Bavispe Valley . . . . .   | 55          |
| 31. Aerial View Looking Northeast up Rio Gavilan Valley . . . . .                             | 58          |
| 32. Modern Fields on Elvin Whetton Ranch - Rio Gavilan . . . . .                              | 59          |
| 33. Air View of Cave Ruin on Rio Gavilan . . . . .  | 61          |
| 34. Cave Ruin on Rio Gavilan . . . . .  | 62          |
| 35. Floor Plan of Cave Ruin, Rio Gavilan . . . . .  | 63          |
| 36. Lower Gavilan Canyon . . . . .  | 65          |

## LIST OF FIGURES (Cont.)

|  | <u>Page</u> |
|--|-------------|
| 37. Ruin and Associated Trincheras on Spur Shown in<br>Figure 36. Lower Gavilan Canyon . . . . . | 66          |
| 38. Ruin of Small Field Hut at Mesa Top Trincheras, near<br>Amarillas . . . . .                  | 69          |
| 39. Colonia Chuhuichupa . . . . .  | 75          |
| 40. Outer Wall of Sonoran-Type Trinchera, Santa Ana, Sonora.                                     | 79          |
| 41. Sonoran-Type Trincheras from Above. Near Santa Ana,<br>Sonora . . . . .                      | 80          |

## PREFACE

This is the second of the formal reports covering various field studies on terrain features of the extremely rugged northern sections of the Sierra Madre Occidental of Chihuahua, northern Mexico. A substantial amount of background information, both from the field and elsewhere, has been gathered over a number of years. In 1964, a summer of intense field work was concentrated on a restricted trinchera complex in the north central Sierra Madre. This was reported in the University of Denver Department of Geography Technical Paper 65-1, Publications in Geography, 1965, Laurance C. Herold, "Trincheras and Physical Environment Along the Rio Gavilan, Chihuahua, Mexico."

During the summer of 1965, a small field party, with grant support, undertook another phase of the work: namely, an attempt to determine the spatial extent of the features known as trincheras, which were studied in such great detail in the previous report. This present paper deals with the 1965 investigations.

In addition to the extensive field work carried out by the 1965 party under Mr. William Howard, several reconnaissance trips were made by other members of the Department at other times of the year. It is now becoming increasingly apparent that the physical characteristics of trincheras, as well as their influences on the physiography and hydrology of the area, compose an unusual and apparently unique phenomenon. Comparison with similar types of check dams and terraces in other parts of the world illuminates both the similarities and the unique features of the Chihuahua phenomenon.

The problems of logistics continue to plague work in this area.

This is some of the most rugged and deeply incised mountain country in the Western Hemisphere; roads are almost non-existent, and those car trails which do exist are mostly uncharted, narrow, difficult, steep, axle-breaking tracks, which are quickly rendered completely impassable by the slightest inclement weather. Numerous small, precarious landing strips have permitted a certain amount of low-level aerial reconnaissance in light airplanes. Even travel by horseback and muleback is sometimes difficult and hazardous. In spite of this, a surprising amount of data have been gained from the field work in the area. Some studies continue, notably by graduate students seeking to probe specific problems for the purpose of developing graduate theses.



As is frequently the case with field research, the advance of knowledge is more than matched by the new questions raised and the new challenges presented. This study is no exception. Recent aerial and ground reconnaissance, for example, has shown that in at least one case a modern counterpart of the ancient trincheras is being experimented with by a Mexican lumber company. This recent disclosure presents many possibilities for controlled experimentation and comparative study. Other new questions also arise.

In spite of this, the feeling among the field staff now is that we have a good grasp of the characteristics, the physical qualities, and the over-all gross effects upon physiography of this interesting and unique phenomenon.

Clark N. Crain

## ACKNOWLEDGMENTS

The authors wish to thank the many individuals who made it possible to complete this research effort.

Numerous officials of the Mexican Government gave much counsel, aid, and support. These include Señor Hector Jara, Mexican Consul in Denver; and Francisco Gonzales Carrion, Oficina de Telegraphos, Nuevo Casas Grandes, who made available the local weather records.

Officials in Ciudad Chihuahua who were most helpful include Señor Angel Alvarez Gomez, Chief of the Meteorological Service, State of Chihuahua, who placed at our service records and reports from his office; Mr. Arthur Clark, U. S. Weather Bureau, Chihuahua, Head of the United States-Mexican Joint Weather Bureau Mission at the University of Chihuahua.

In Ciudad Chihuahua, staff and officials of Bosques de Chihuahua, a lumber and wood-products company, went out of their way to be helpful. Among these should be mentioned Ing. Vicente Arreola, General Manager; Fernando Villarreal, Disbursing Agent; and Señor Emilio Flores Calderon, Forestry Officer.

While doing the basic field work in Mexico during the summer of 1965, Mr. Howard had the considerable aid and counsel of a field crew which consisted of Clifford Peterson, Arthur Griffiths, Thomas Naylor, students; and Alfonso Sing Chen, native helper and interpreter. Without all of them, the summer's work could not have been accomplished.

Numerous individuals went out of their way to be helpful at various places and times during the summer field work. Deserving special attention are the following: Ralph Lane, rancher at Chuhuichupa; Jorge Lane, rancher at Nuevo Casas Grandes; Elvin Whetton, rancher at the Gavilan; and Nelda Whetton, who kept a precipitation gauge at the Gavilan during the summer and fall of 1965.

On a number of photographic and exploratory flights from Ciudad Chihuahua and Nuevo Casas Grandes, various members of the field party were aided greatly by Captain Marquez, senior pilot of Servicio Aereo Leo Lopez. His knowledge of all parts of the Sierra Madre Occidental helped the exploration immeasurably, while his skilled piloting of small aircraft into obscure mountain airstrips extended the search for trincheras into sectors which could not be reached otherwise.

**BLANK PAGE**

On visits to the Bosques de Chihuahua lumber camp at Mesa del Huracan in the winter of 1965-66, many members of the staff were most helpful. Ing. Frederico Montante and Ing. Eduardo Briseno went out of their way to make it possible to visit trincheras on Bosques de Chihuahua timber lands in the Amarillas and Rio Negro areas.

Finally, we wish to acknowledge the help given us at various times by Mr. Laurance Herold and his wife Joyce, who undertook the trinchera field work on the Rio Gavilan in 1964, and to Mr. Charles R. Stevens who helped greatly in the preparation of the manuscript.



**Frontispiece: In the Heart of the Sierra Madre Occidental. Air View Near Tres Rios**

## CHAPTER I

### INTRODUCTION

In a previous report (Herold, 1965), it was pointed out that stone structures known as "trincheras," found principally in northern Mexico, but also occurring sporadically in the southwestern United States, have been reported in the literature since the arrival of European man in the Americas. "Trinchera," translated from Spanish, means entrenchment, trench, deep cut, or ditch. These are the most common meanings in ordinary usage. But the word has been used in a more specific and specialized sense, i. e., to indicate structures resembling stone terraces or check dams built by prehistoric inhabitants of northern Mexico and the southwestern United States. Even in this more restricted sense, the term trinchera has been used to describe two features which, constructionally, are very similar but functionally are probably distinctly different.

In the west-central portion of the Mexican state of Sonora are found trincheras that, on the basis of present-day appearance, come closest to the ordinary connotation of the term. Many of these structures do give the appearance of having been trenches, or more precisely, protective barricades. Actually, some of these structures are quite modern and are not related to prehistoric inhabitants of the area. They were built during the Mexican Revolution as fortifications. However, these particular structures were modeled after similar features built by the Indians that occupied this region prior to the arrival of European man. These Indian-type trincheras are most typically found atop isolated mountains, completely encircling or partially encircling the summits. Like the Mexican Revolution fortifications, these Indian structures were built primarily for defensive reasons, yet there is some evidence pointing to their utilization for residential and religious purposes.

To the north, east, and south, primarily in the high Sierra Madre Occidental along the border between Sonora and Chihuahua, is another type of trinchera. Unlike the Sonoran-type trincheras, these are more like terrace walls or check dams. Appearing most typically in echelon up dry stream courses or arroyos, these trincheras are much more abundant than those found in western Sonora. Ranging in height from just a few inches to more than twenty feet, these structures compose a very conspicuous part of the physical landscape in many areas of the Sierra Madre, whereas the Sonoran-type trincheras by comparison are less significant. The present report is concerned with this second type of trinchera.

While the purpose, or perhaps purposes of these Sierra trincheras are not fully known, there are a number of possibilities that can be suggested. To begin with, soils of the high Sierra are not very well developed. They are very thin and, in many instances, almost completely absent. Trincheras, therefore, may have been constructed to stabilize soils and prevent their removal by erosion. Modern-day examples can be seen where trinchera-like structures have been constructed for this very purpose. Next, and related to the possibility of trincheras being constructed for soil conservation, is a secondary function of their serving to slow down run-off, allow the water to spread out over the surface, to soak gradually into the mantle behind the trincheras, and thus facilitate a form of moisture storage. Finally, there is the most obvious possibility of all, namely, these structures were built to provide additional arable land for food production, with the other factors being secondary to this primary function.

Importance of trincheras. In many areas of northern Mexico, trincheras form an important part of the prehistoric cultural milieu. In large measure, archeologists and anthropologists have concentrated their energies on the more abundant cultural remains of the southwestern United States and southern Mexico, with the result that very little attention has been given to the intervening areas. Once the importance of these neglected areas is recognized and steps are taken to discern their cultural significance, the study of trincheras and their distribution will be an important consideration. Mention was made earlier to the fact that there are found in southwestern United States, notably in Arizona, Colorado; and New Mexico, trincheras that are similar to those of the high Sierra Madre. On this point alone, a study of trincheras will be most useful in determining the cultural spread of a distinct invention and the possible modifications of their structure and use.

But trincheras are important from points of view other than just that of representing cultural artifacts. The trincheras of the high Sierra are a very conspicuous part of the landscape and, as such, have unquestionably had some effects in altering the physical environment. This can readily be seen in the context of erosion control. There are many areas in the Sierra Madre Occidental where soil mantle is found only behind trincheras. An adequate testimony to this important function is seen in examples of modern-day ranchers and farmers constructing similar structures in order to control erosion. In this connection, once the properties and function or functions are fully recognized and understood, some consideration may be given to promoting the use of

trinchera-like structures to reduce erosion in areas like northern Mexico, where overgrazing has resulted in a very real problem. See Figure 1. In southeastern Arizona are found numerous examples of modern-day trincheras built specifically for soil conservation. Others can be seen in Colorado and New Mexico.

In 1964 and 1965, Bosques de Chihuahua, a lumber company operating at a number of locations in the Sierra Madre Occidental of western Chihuahua, at the suggestion of their Forestry Officer, Señor Angel Flores Calderon, built a set of modern trincheras in the watershed of a single stream which had caused considerable damage in the past by flash flooding. The site of this work was near Mesa del Huracán where the company has a large lumber mill. The watershed was located on a local ejido, the upper reaches being under cultivation, the lower sections traversing a steep declivity into a master stream. The upper, cultivated portions of the watershed showed extensive gully damage. The total watershed comprises about 6,000 hectares. In this area were constructed 1,200 trincheras at a total cost of about 160,000 pesos (approx. \$13,328 U. S.), bringing the average cost per trinchera to approximately \$11. See Figure 2.

The eventual outcome of this experiment is not yet known. At the present time (March 1966), the Department of Geography, University of Denver, has a small crew in the field measuring and mapping the watershed. This will be followed by other measurements. Bosques de Chihuahua is eager to cooperate, and it is hoped that over the next few years results from the study of this watershed can serve as a control for measurements of trinchera areas in other parts of the Sierra Madre.

From a strictly scientific point of view, trincheras have interest in that they have had at least some effect on the normal erosion pattern, but just how much is unclear. Certainly, the overall effect is not as great as one author (Leopold) would have us believe, i. e., that these structures have been responsible for circumventing the normal erosion cycle, slowing down or retarding the rates of erosion, and "propping up," so to speak, the Sierra Madre.\* As will be made abundantly clear

---

\* "Therefore, our southwestern mountains are now badly gutted by erosion, whereas the Sierra Madre range across the line still retains the virgin stability of its soils and all the natural beauty that goes with the enviable condition." Aldo Leopold, "Conservationist in Mexico," American Forests, Vol. 43, 1937, p. 118.



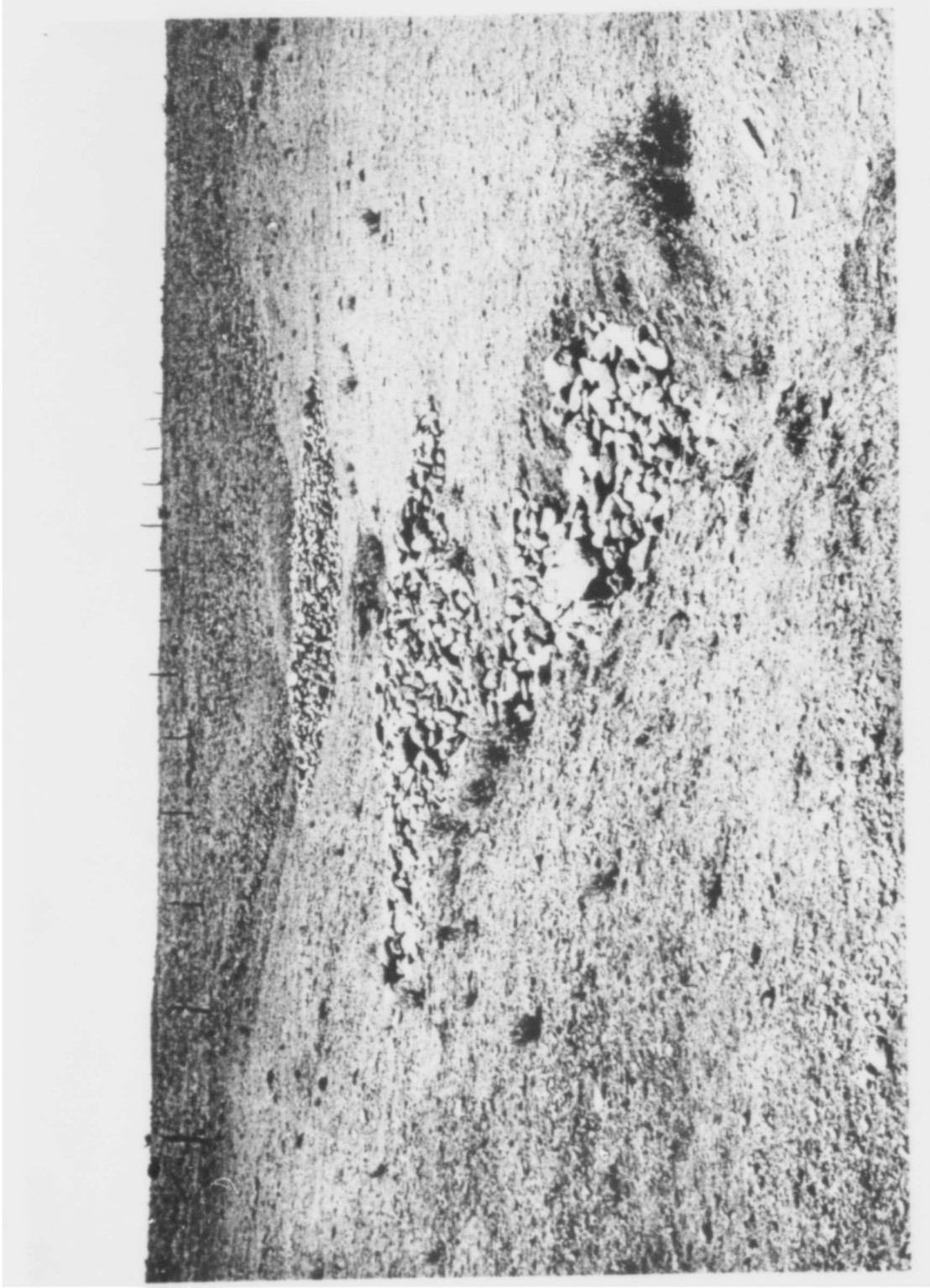
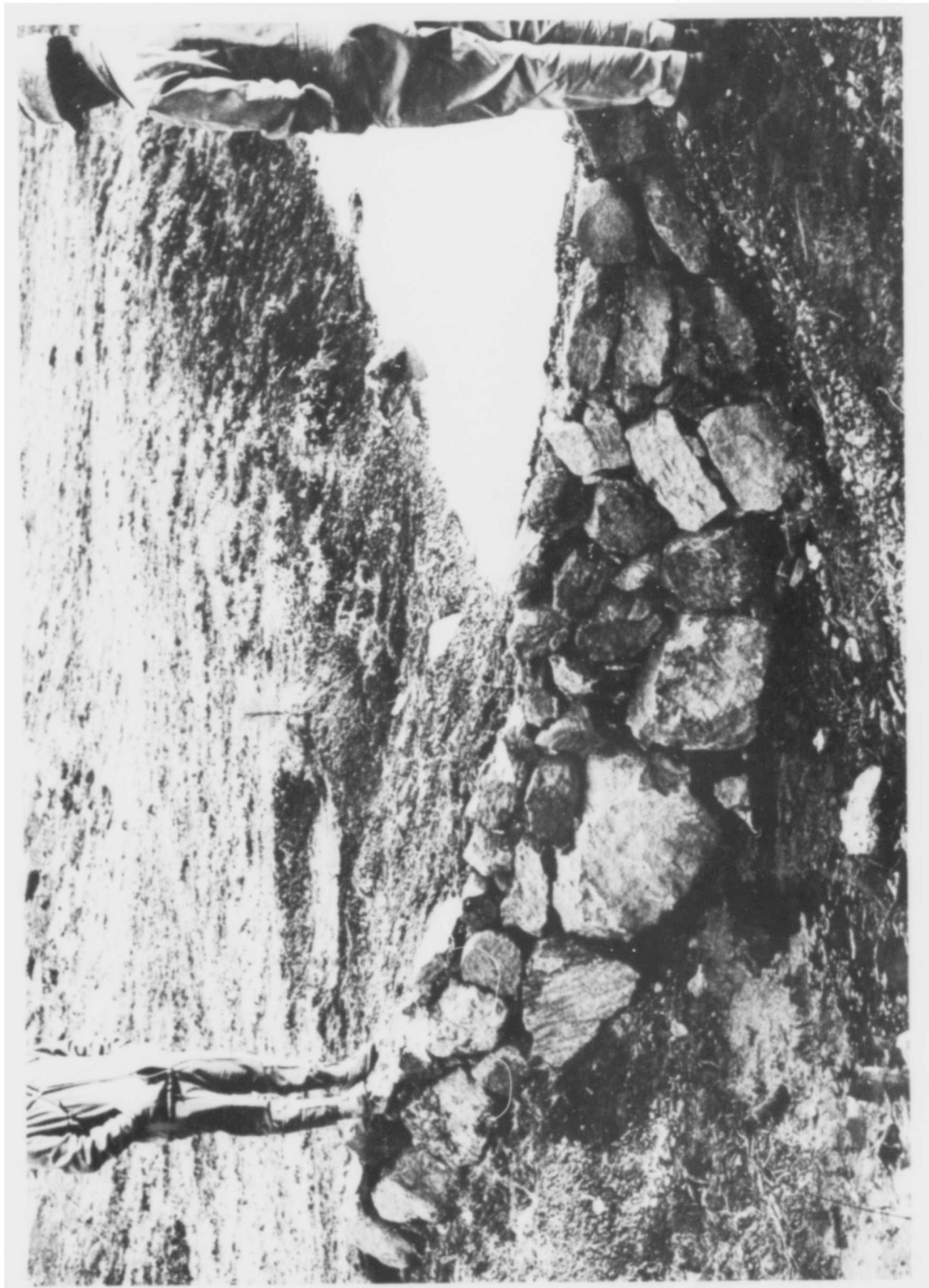


Figure 1. Modern Check Dams, "Trincheras", in Field Near Colonia Juarez, Chihuahua



**Figure 2. Modern Check Dam Constructed by Bosques de Chihuahua at Mesa del Huracán**

later in this report, the occurrence of trincheras alone is insufficient, except in localized circumstances, to have had an appreciable effect on the degradation of the mountains. Nonetheless, in areas where trincheras are most abundant their effect on local run-off and hydrology may be quite profound.

Previous Study on Trincheras. In the summer of 1964, faculty and students of the Department of Geography, University of Denver, conducted an intense field study of trincheras in the western Sierra Madre of Mexico. Previous reconnaissance trips had been made into the area prior to this date. Jointly sponsored by the Earth Sciences Division, U. S. Army Quartermaster Research and Engineering Command, and the University of Denver, the 1964 expedition had as its main objective the intensive study of trincheras in relationship to the physical environment. In a restricted area on the Rio Gavilan, trincheras were mapped and determinations made on constructional features and distributional patterns. Comparisons on a localized scale, were made between areas protected by trincheras and those areas which were unaffected. A description was made of the physical setting of the study area, including such factors as vegetation, climate, geology, soils, and topography. In general, an attempt was made to ascertain what elements of the physical environment might have had an influence on the location of trincheras. The report that came out of this study (Herold, 1965) is the single most definitive examination of trincheras to date, especially in terms of their physical properties.

Numerous other studies, considerably less intensive, and resulting in primarily general descriptions, have been made on trincheras. As early as 1892, Bandelier described the Sonoran-type trincheras. Subsequent descriptions include McGee (1896), Lumholtz (1912), Huntington (1914), Sauer and Brand (1931), Ives (1936), and Johnson (1960). In his report of 1892, Bandelier also described the Sierra-type trincheras. This was followed by descriptions by Lumholtz (1903), Blackiston (1905, 1906), Leopold (1937), McCabe (1955), and Withers (1963).

Objectives of Study. Out of the expedition conducted by the Department of Geography, University of Denver, during the summer of 1964, there arose a number of fundamental questions regarding the nature of trincheras. Of course, there is the most fundamental question of all, namely, who built them and for what purpose or purposes? Also, of what age are these structures? Despite the importance of these questions, the single most impressive observation that came out of the 1964 study was the apparent vastness of area which trincheras seemed to cover.

Unfortunately, the objectives of that study precluded the examination of this particular aspect of trincheras. Information gleaned from various sources, though, pointed to the possibility that these structures might cover an area in excess of 60,000 square miles, primarily in the high Sierra of Chihuahua and Sonora. Obviously, in such a large area there was considerable variation in their distribution, density, types, and in the relationship of trincheras to the physical environment. Determining just how considerable these possible variations may be is the general objective of this study. Specific objectives include the following: (1) to map, on a small scale, the general area of trinchera occurrence, (2) to make some measurement of regional variations as to density, (3) to describe in a general manner the physical relationships of trincheras to geology, topography, vegetation, and hydrology, (4) to describe observable constructional variations among trincheras, and (5) to locate habitation sites in order to facilitate further study.

Location of Study Area. No definite limits were assumed for the study other than an understanding that no attempt would be made to examine trincheras known to exist in the southwestern United States. Thus, the focus of the study is restricted to northern Mexico, principally to the states of Sonora and Chihuahua. In the case of the latter, the chief concern was to be on the higher portions of the Sierra Madre Occidental. Figure 3 shows the general area of the study.

Techniques Utilized in Study. Prior to taking to the field on this expedition, it was known that numerous problems would beset such an undertaking, especially as regards logistics and communications. Enough was known about the accessibility of the supposed area of trinchera occurrence from the activities of previous studies to make it all too apparent that any effort to cover the whole area would be confronted by many hurdles. Roads in this portion of northern Mexico are relatively non-existent. What few there are have been built to facilitate lumbering activities, and during periods of abnormal weather many areas are completely impassable. Almost all roads are in poor states of repair. In some instances, where lumbering activities have declined, many roads have been completely abandoned. There are, however, numerous small air strips located throughout the study area. These have been constructed primarily in response to the needs of lumbering activities. It was decided, therefore, in order to cover as much of the area as possible in the time allotted, to use both wheeled vehicles and chartered aircraft.

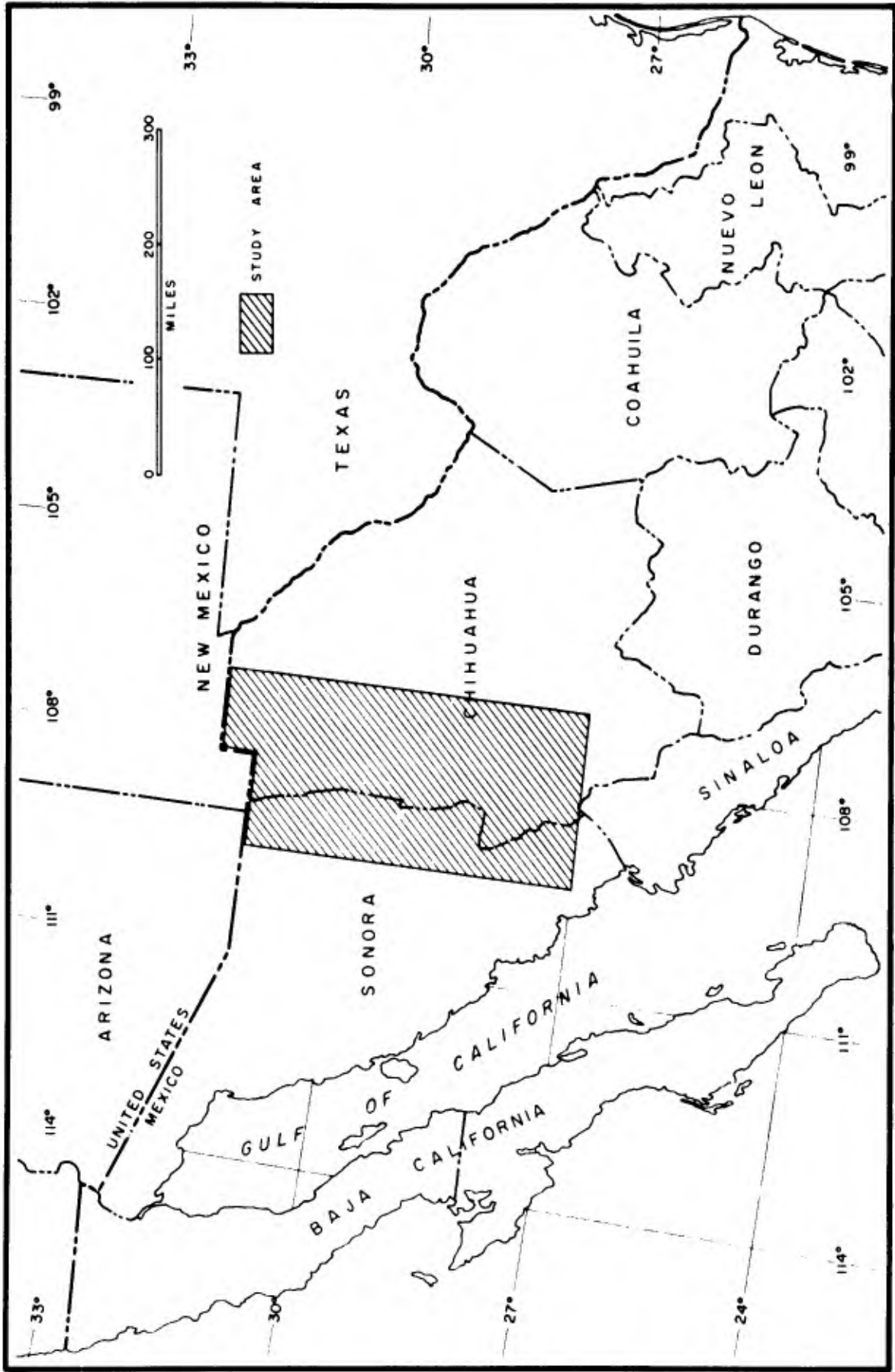


Figure 3. Location Map of Study Area

It was assumed during the preparatory stages of the expedition that the problem of reconnaissance surveying would be facilitated by the use of high altitude aerial photographs. Coverage for the study area of 1964 was already in hand. Unfortunately, attempts to acquire additional coverage proved fruitless. This necessitated falling back on the best available map coverage. In this instance, World Aeronautical Charts at a scale of 1:1,000,000 were the only maps available that were not restricted as to use and that could be acquired readily. At this scale these charts were almos. wholly unsuited for the kind of work to be undertaken. Nonetheless, buttressed by knowledge possessed by members of the expedition of local geographic features (two members of the expedition had traveled extensively throughout the study area), as well as by descriptive material about local phenomena, these charts proved quite useful. Actually, additional map coverage was secured in the latter stages of the study. Topographic maps at a scale of 1:250,000, acquired from the U. S. Army Map Service, were used to correlate information plotted on the WAC charts.

Construction of a map of trinchera distribution was aided by exploiting the confusion surrounding the term. On previous trips into northern Mexico, especially during the expedition of 1964, numerous individuals encountered (some of them living not too distant from the immediate vicinity of the study area) proved wholly unaware of trincheras. In other words, when questioned, the more specific meaning of the term was completely new to them. It was decided, therefore, that by using this change in word meaning as a field technique, i. e., by making numerous trips into the study area, inquiring along the routes for knowledge of trincheras, using photographs where verbal descriptions seemed not to evoke any recognition, by checking the authenticity of the information where time and accessibility of area would permit, and by plotting the information on available maps, the task of deriving a trinchera map would be made immensely more easy. Figure 4 shows the extent of trinchera occurrence in the Sierra Madre Occidental, derived by the field methods outlined above. The total area consists of about 11,200 square miles of rugged, mountainous terrain, extending some 500 miles along the axis of the range, and having a maximum width of about 125 miles.

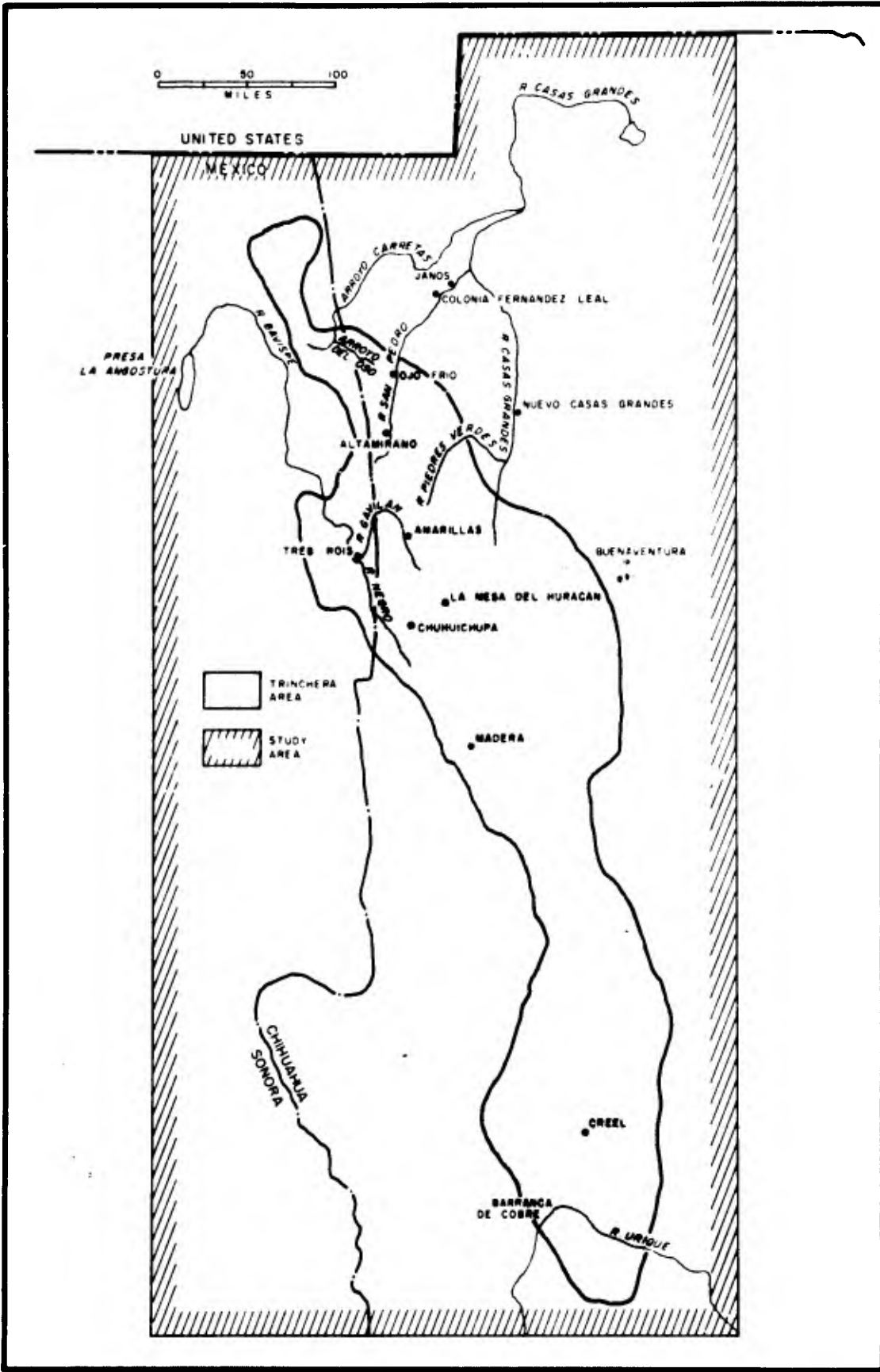


Figure 4. Area of Trincheras Occurrence in Sonora and Chihuahua

## CHAPTER II

## PHYSICAL SETTING OF THE SIERRA MADRE OCCIDENTAL

Before undertaking a detailed discussion of the various centers where trincheras were found during the present study, it would seem advisable to provide the reader with a general description of their physical setting. This description will include the physiography of the region, the climate, and the present-day vegetation. To provide a regional framework, the physiography will be discussed first.

Terrain. The physiographic setting of the northern part of the Sierra Madre Occidental (Western Sierra Madre) is complex. See Figure 5. The regional structure is part of a geologic and geomorphic complex which lies across the United States-Mexico border. Physiographic regions found north of the border extend southward deep into Mexico. The general trend of the structure is approximately NNW to SSE. Most of the trincheras dealt with in this study are found in the Sierra Madre Occidental.

If one travels eastward along a line between a point on the Pacific shore of Baja, California, 340 miles NW of Cabo San Lucas to a point on the Rio Grande River due west of Marfa, Texas, he will be moving at approximately right angles to the structural trend of northern Mexico, and across the middle of the region under discussion, in a WSW to ENE direction. On such a trip, the first 70 miles would be taken up crossing the peninsula of Baja California. Along this line, the Gulf of California (Sea of Cortez) is 100 miles wide. The next 140 miles cover the Sonoran Desert, a cruel, broken expanse of low desert ranges, and parched, rocky basins. From the eastern edge of the desert, the Sierra Madre Occidental rises abruptly to a height of 6,000 to 8,000 feet. At this locality, the mountains are about 100 miles wide. To the east, the flanks of the range drop gently into a basin and range province marked by sharp, short ranges separating numerous internal drainage basins, often floored with playas and shifting sand dunes. Only at the Rio Grande, 150 miles from the mountains, is the intermittent drainage again tapped by a stream which finds its way to the sea.

For the purposes of this study, the Sierra Madre and the two provinces to each side of it are of greatest importance. The Sonoran Desert on the west is an extension southward of the desert of southern Arizona. Actually, it is more accurate to say that the Sonoran Desert extends northward into southern Arizona as far as the Mogollon Rim.



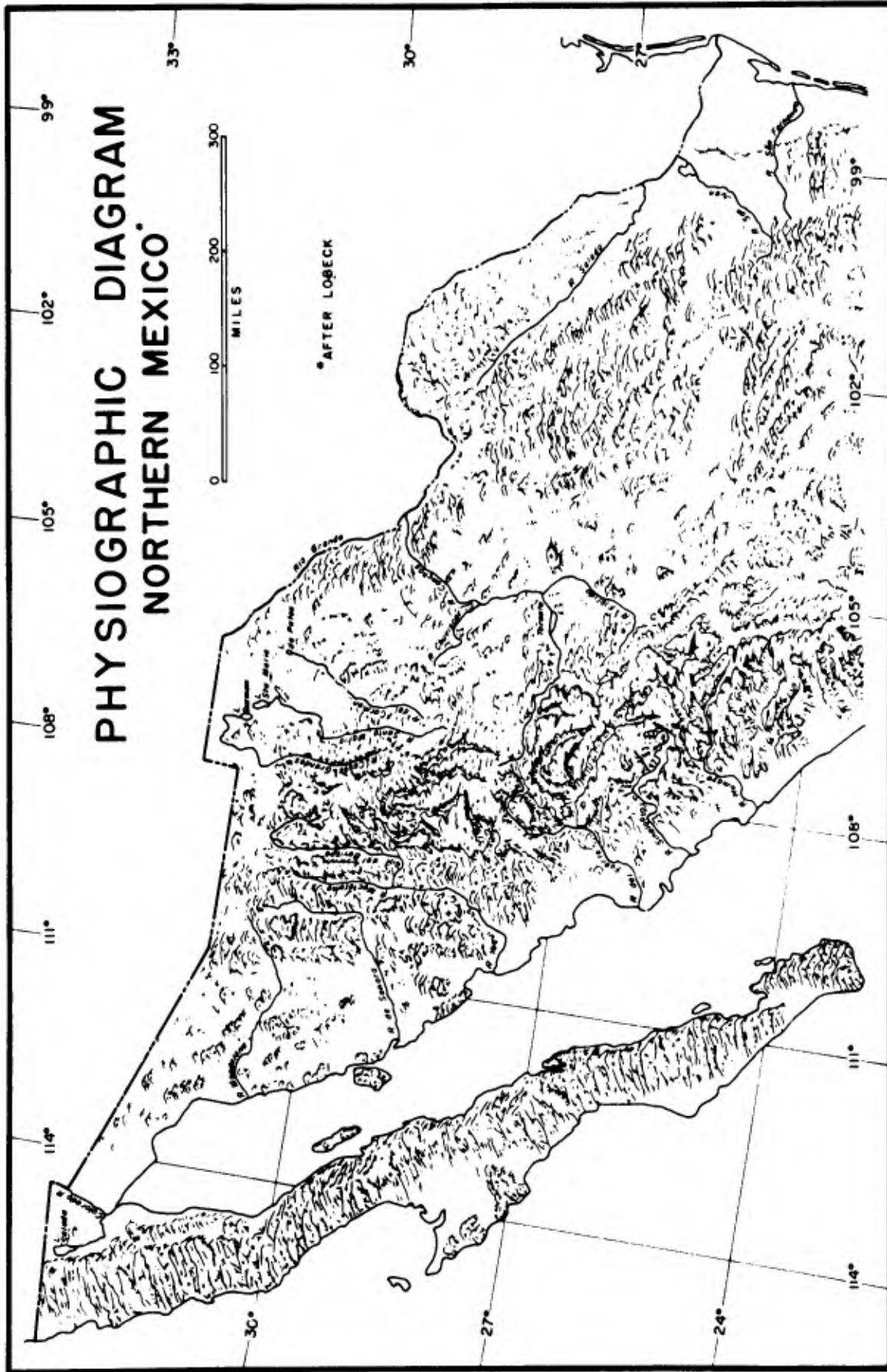


Figure 5. Physiographic Diagram of Northern Mexico. After Lobeck

It is the archetype for mid-latitude, west-coast deserts, extending inland from the sea northeastward to the interior of the continent. Its lowland surface and rocky basins are broken by numerous short, barren, block-faulted ranges which are usually not high enough to wring much moisture out of any of the sea winds which find their way inland during the winter months.

The basin and range province to the east is an interrupted extension southward of the same province in Nevada. The Nevada basins and ranges are cut off on the south by the Colorado Plateau through which the Colorado River and its tributaries have carved a massive set of canyonlands. To the south and east, the range and basin structure resumes its integrity again in southeastern Arizona and southwestern New Mexico, from whence it extends southeastward until it reaches the integrated drainage basin of the Conchos River, which flows into the Rio Grande south of Chihuahua City. Most of the internal drainage basins in this province are from 3,500 to 4,000 feet above sea level. The short, steep, block-faulted ranges which hem them in rise to narrow crests at 5,000 to 7,000 feet. Many of the streams which descend the eastern flank of the Sierra Madre make their way into bolsons (internal drainage basins) surrounded by these ranges. When flying at moderate elevation between El Paso and Chihuahua City, one is never out of sight of at least one bolson. In the north and northeast, the basins are generally floored in part by huge masses of shifting sand dunes, pushed to the east side of the basin by westerly winds. In the south and west, the bolsons are frequently floored by extensive playas.

Between these two dry realms, the Sierra Madre Occidental lifts its forested upland. The Sierra lies mostly above 6,000 feet in elevation, extending up to 9,000 feet in a few localities within the trinchera area. At the north, the Sierra Madre rises from basins at the New Mexico-Mexico border. San Luis Pass, just north of the border, crosses the range at an elevation of 5,300 feet. The range rises slowly southward until it abuts upon the east-west Mexican volcanic axis near the latitude of Mexico City. South of the trinchera area, elevations reach above 12,000 feet.

Structurally, the Sierra Madre Occidental is part of the North American Intermontane Plateau province, which reaches from central Alaska to the volcanic axis of south-central Mexico. It forms the western rim of what Lobeck\* classifies as the Mexican Highlands,

---

\* A. K. Lobeck, Physiographic Provinces of North America, The Geographical Press, C. S. Hammond & Company, Maplewood, New Jersey.

including the basin and range province already described, the Sierra Madre Oriental at its eastern border, and the volcanic section at the south. The eastern edge of the Sierra Madre Occidental is less clearly defined than the western edge, which rises abruptly from the Sonoran Desert. On the east, the mountains give way gradually to a series of basins and isolated mountains, which are almost as high as the east edge of the Sierra. Within the Sierra proper and along its east margin are a number of high, open vegas - grassy flat basins which are now intensely cultivated for grain and fodder crops. See Figure 6.

Throughout its extent, the Sierra Madre Occidental is underlain by extrusive volcanic rocks, primarily horizontal beds of ash, breccia, and lavas. The core of the range consists of Cretaceous and older sediments which were uplifted and deformed during the Rocky Mountain Orogeny. Following this uplift, the region was peneplained almost to sea level. Then, in middle Tertiary time, extrusive vulcanism piled great thicknesses of ash and lava upon the older surface. Little tectonic activity has taken place since that time; most of the volcanics in the range still lie in an almost horizontal attitude. See Figure 7.

Into this uplifted volcanic tableland, streams have cut deep, steep-sided canyons. At Barranca del Cobre, near the south extent of the trinchera area, a tributary of the Rio Fuerte has carved a narrow canyon more than 6,000 feet deep. Everywhere are similar though less spectacular canyons. Building a surface transportation line across the heart of the range would be an engineer's nightmare. See Figure 8.

Because prevailing winds bring greater moisture to the west side of the range, Pacific streams have been able to cut headward almost to the eastern edge of the upland in a number of places. The drainage pattern is complex. The range does not have a true crest. Actually, it is quite difficult to trace the location of the divide between the Sonoran drainage to the west and the short drainage which flows into bolsons on the east. In many cases, the headwaters are intermingled in a complex pattern, with the heads of Pacific-flowing streams lying east of the headwaters of short streams which flow toward the basin and range province. One reason for the great depth of many of the canyons arises from the fact that the upland tilts gently to the east with the highest plateau being at the western edge, where many Pacific streams have cut across it close to base-level.

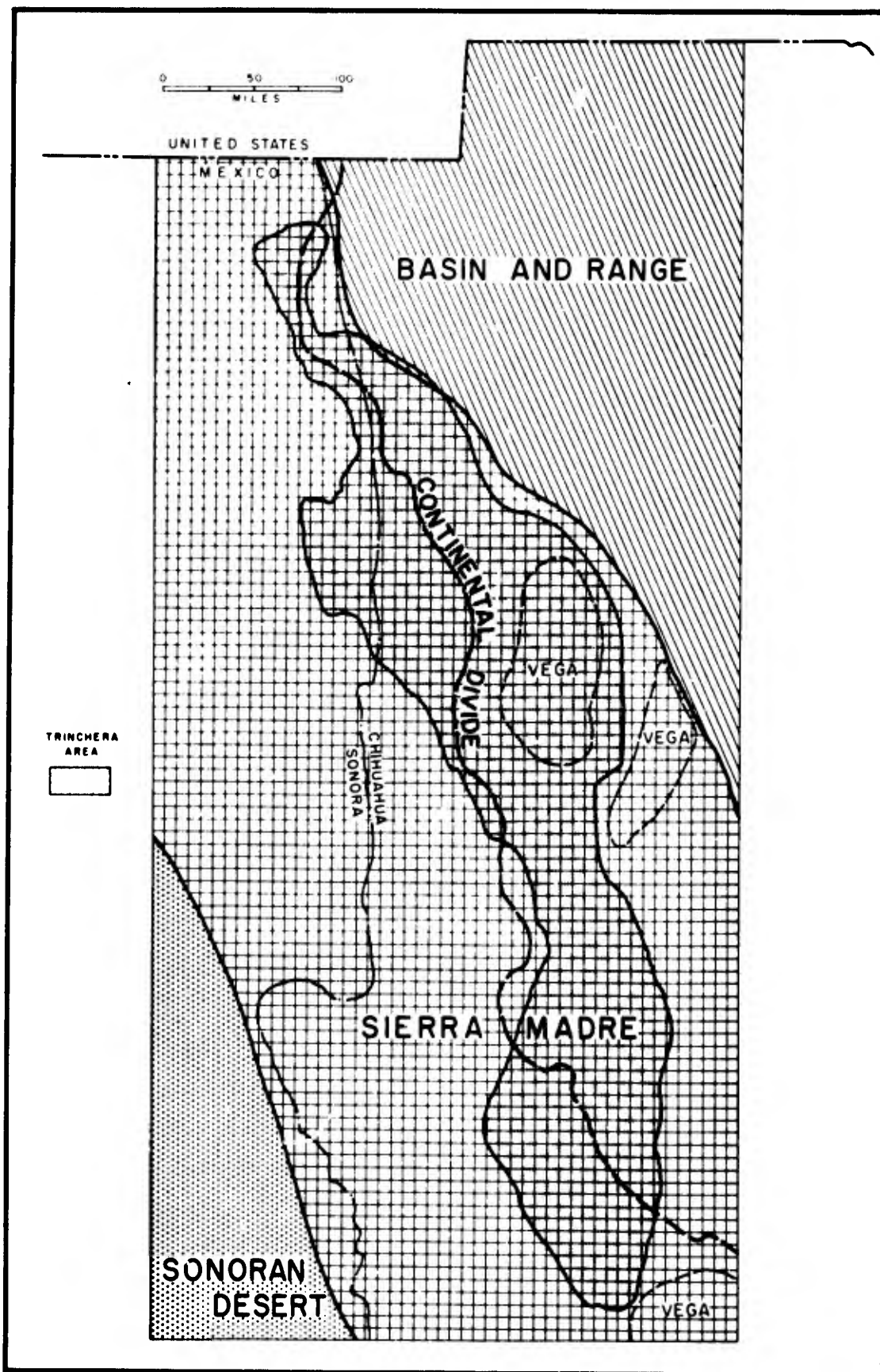
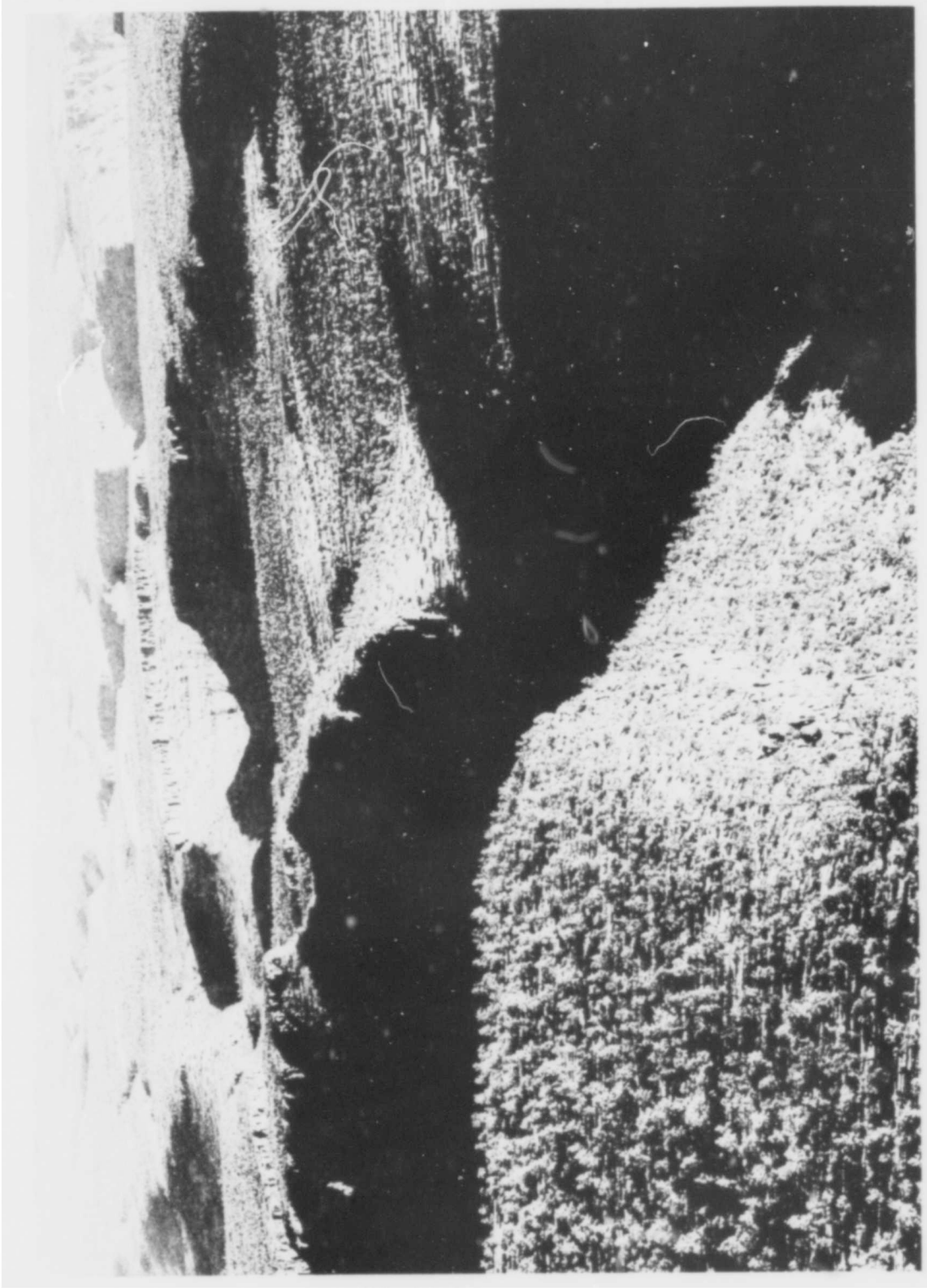


Figure 6. Trincheras Area with Respect to Sierra Madre Occidental and Adjacent Physiographic Provinces



**Figure 7. Deeply Incised Volcanic Surface of Sierra Madre Occidental at Rio Piedras Verdes, North Central Part of Range**



**Figure 8. Barranca del Cobre**

It is this high, rugged, deeply dissected, volcanic tableland which is referred to by the term Sierra Madre Occidental, the setting for the activities of the trinchera builders dealt with in this report.

Climate. The oft-repeated comment that "mountains make their own climates" holds as true for the Sierra Madre Occidental as for any other mountain range. The possibility of characterizing the climate in great detail is further hampered by the scarcity and poor distribution of reporting stations within the mountain zone. The best that can be done is to provide some broad climate zones based upon information gathered for the most part outside the trinchera area, or to provide some meager information from specific sites within the area. In either case, the reported information will depart from reality, either because elevation and local site factors have been ignored, or because the length of record is short and fragmentary. Some of the stations shown in Figure 9 record only one element of the weather, such as evaporation, precipitation, or temperature. Only a few large stations have a more complete record.

The Meteorological Service of the state of Chihuahua has supplied most of the information upon which the generalizations depicted in Figures 10, 11, and 12 have been based. Figure 13 shows the location of weather reporting stations which lie either in or close to the area of trinchera distribution. Table I contains general weather averages for the 10 stations shown in Figure 13. Figure 14, which depicts the climates of Chihuahua, is not very useful since we were unable to determine from discussions with Señor Alvarez Gomez precisely what climatic parameters were used for the representation. Nevertheless, it will serve to illustrate the generalization that the Sierra Madre gets wetter as one progresses southward, and that the west side of the range is wetter than the east, facts borne out by Figure 11.

It will be seen that, in general, isotherms and isohyets tend to run parallel to the strike of the landforms. Most weather comes into the area from the southwest. The width of the continent at this point is not great enough to develop a strong seasonal monsoonal circulation, although a peripheral circulation is probably affected by the continental system to the north.

In the mountains, elevation and exposure are the dominant weather controls. Most locations in the central and northern part of the Sierra Madre show a precipitation maximum in July, August, and September, with a distinct dry period in March, April, and May. This

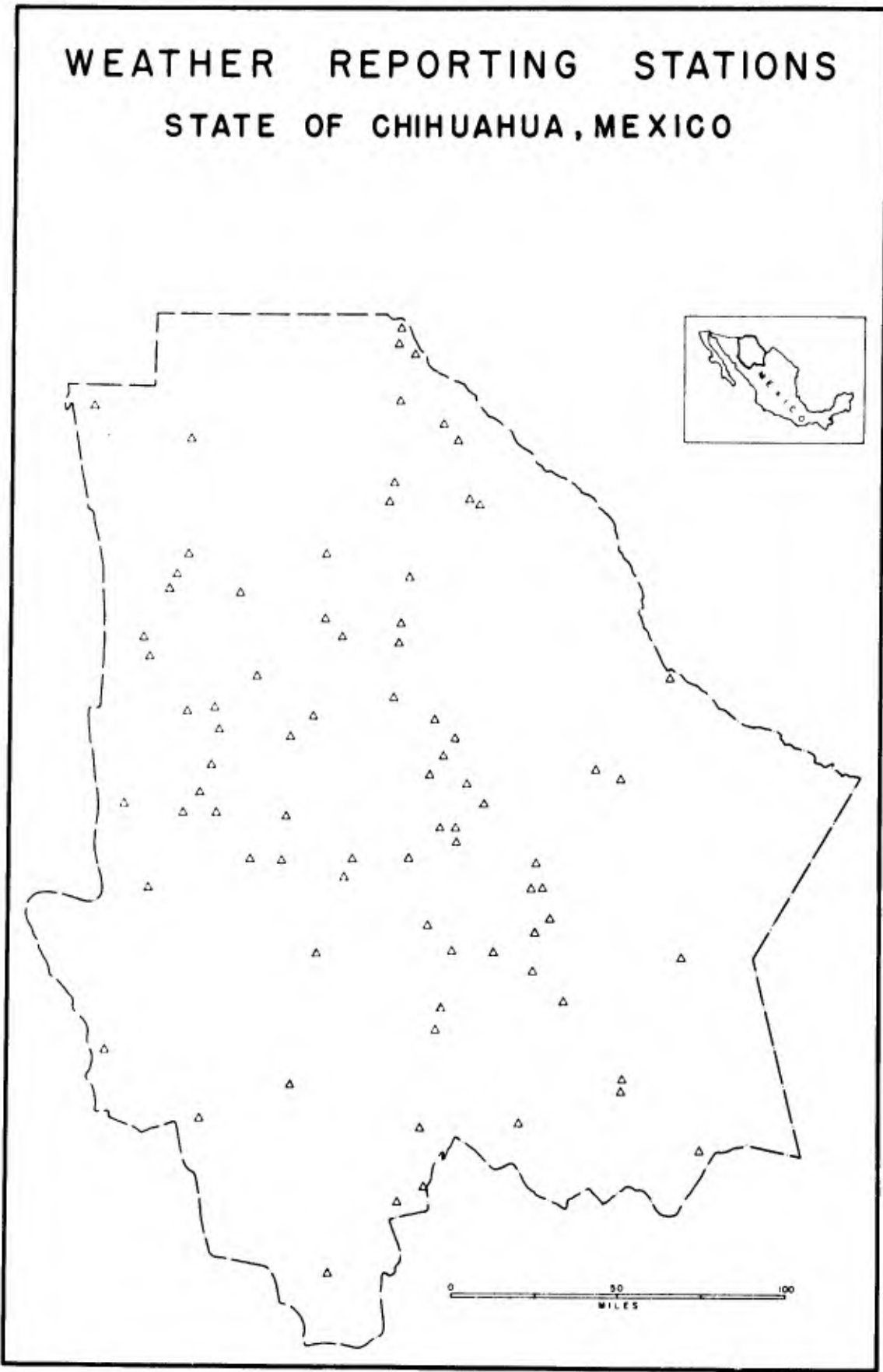


Figure 9. Weather Reporting Stations for the State of Chihuahua, Mexico



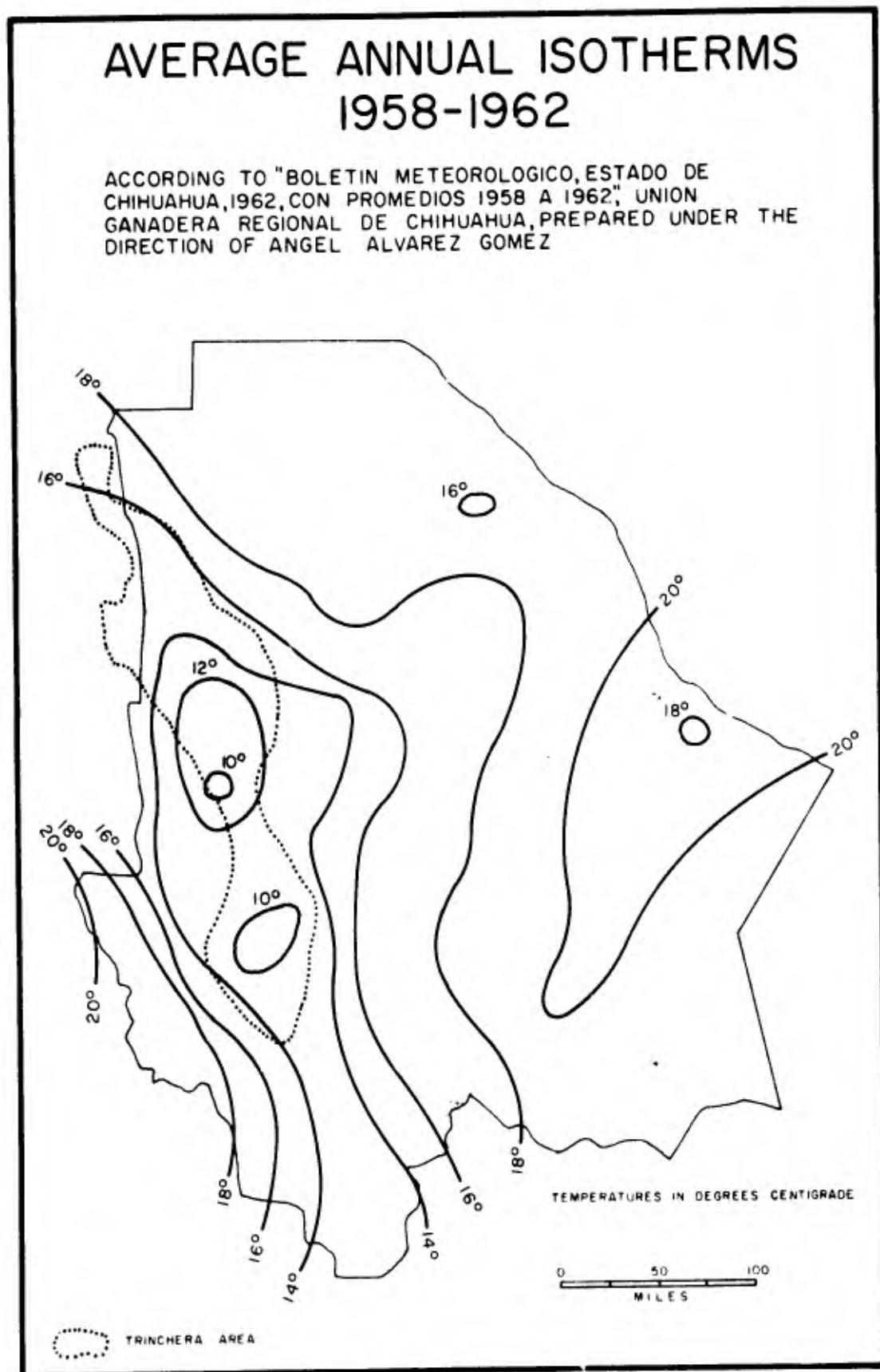


Figure 10. Average Annual Isotherms, 1958-1962, for State of Chihuahua

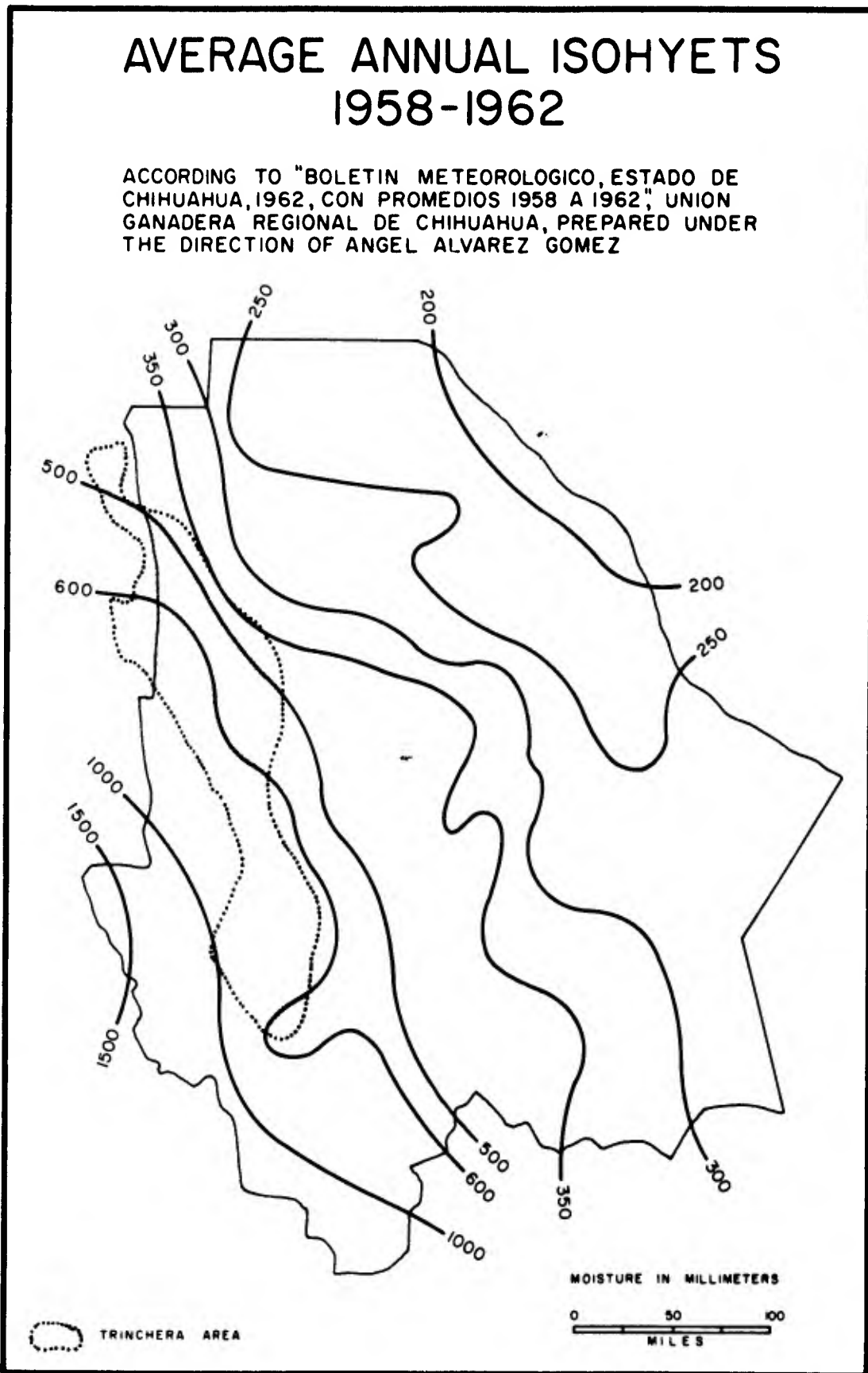


Figure 11. Average Annual Isohyets, 1958-1962, for State of Chihuahua

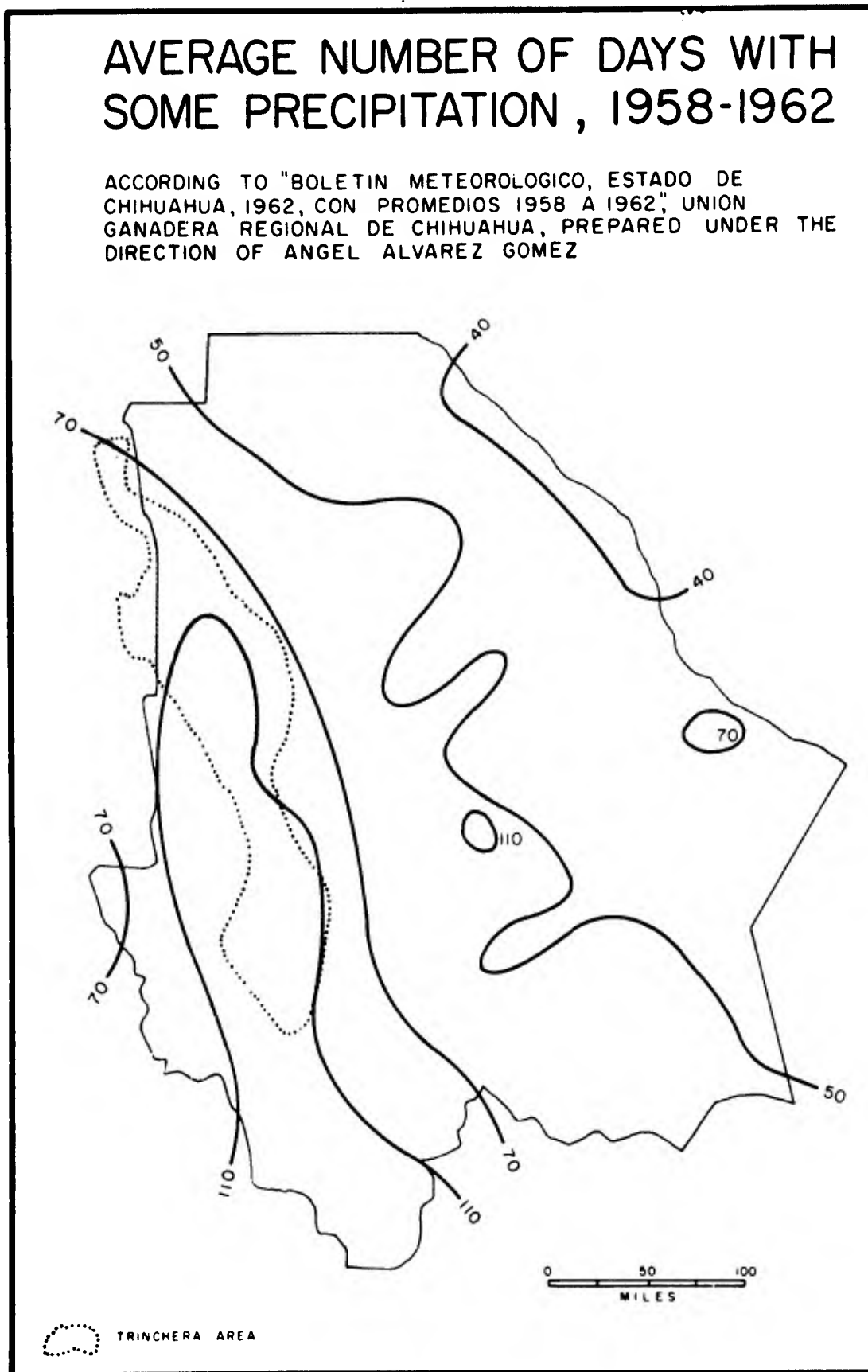


Figure 12. Average Number of Days with some Precipitation, 1958-1962, for State of Chihuahua

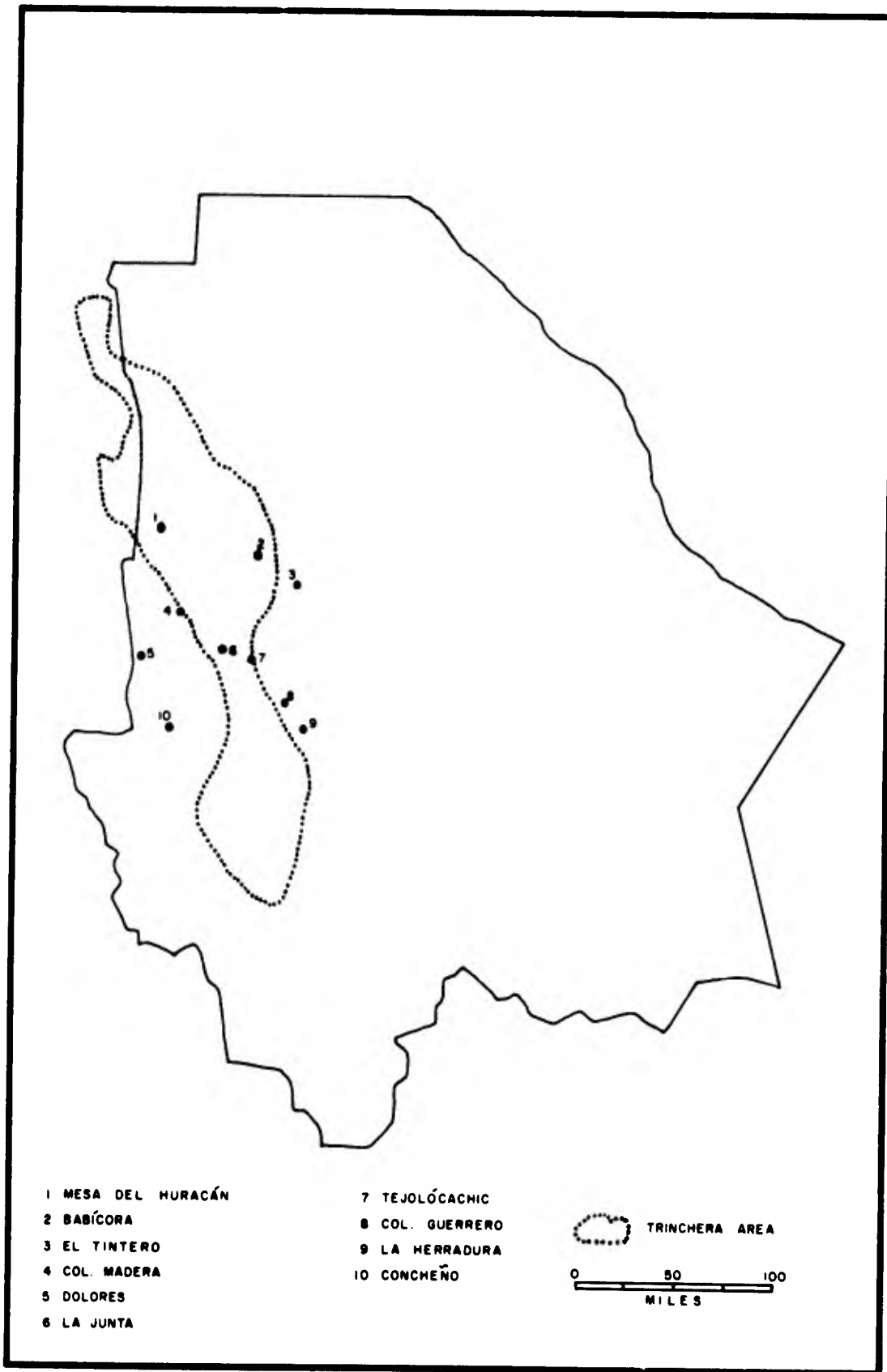


Figure 13. Weather Reporting Stations Within or Close to the Trinchera Area

TABLE I  
 Five-Year Weather Averages (1958-1962) for Stations  
 Near Trinchera Area

| Map<br>Numbers | Station          | Median<br>Temp<br>°C | Max<br>Temp<br>°C | Min<br>Temp<br>°C | Precip.<br>mm. | No. Days<br>With Rain |
|----------------|------------------|----------------------|-------------------|-------------------|----------------|-----------------------|
| 1              | Mesa del Huracán | 14.2                 | 34.8              | -12.2             | 760.2          | 112                   |
| 2              | Babícora         | 11.4                 | 36.2              | -18.8             | 567.2          | 75                    |
| 3              | El Tintero       | 15.8                 | 36.8              | -10.8             | 342.8          | 73                    |
| 4              | Cd. Madera       | 11.1                 | 32.7              | -17.3             | 579.4          | 100                   |
| 5              | Dolores          | 15.4                 | 35.2              | -11.0             | 995.6          | 90                    |
| 6              | La Junta         | 17.9                 | 39.0              | - 7.9             | 483.5          | 108                   |
| 7              | Tejolócachic     | 12.4                 | 34.0              | -18.0             | 671.1          | 30                    |
| 8              | Cd. Guerrero     | 14.2                 | 35.0              | -12.2             | 541.2          | 115                   |
| 9              | La Herradura     | 17.0                 | 33.8              | -17.2             | 525.1          | 76                    |
| 10             | Concheño         | 13.5                 | 34.3              | -11.2             | 1119.4         | 79                    |

Source: Boletín Meteorológico, Estado de Chihuahua, 1962, Boletín No. 6,  
 Agosto 1963, p. 85.

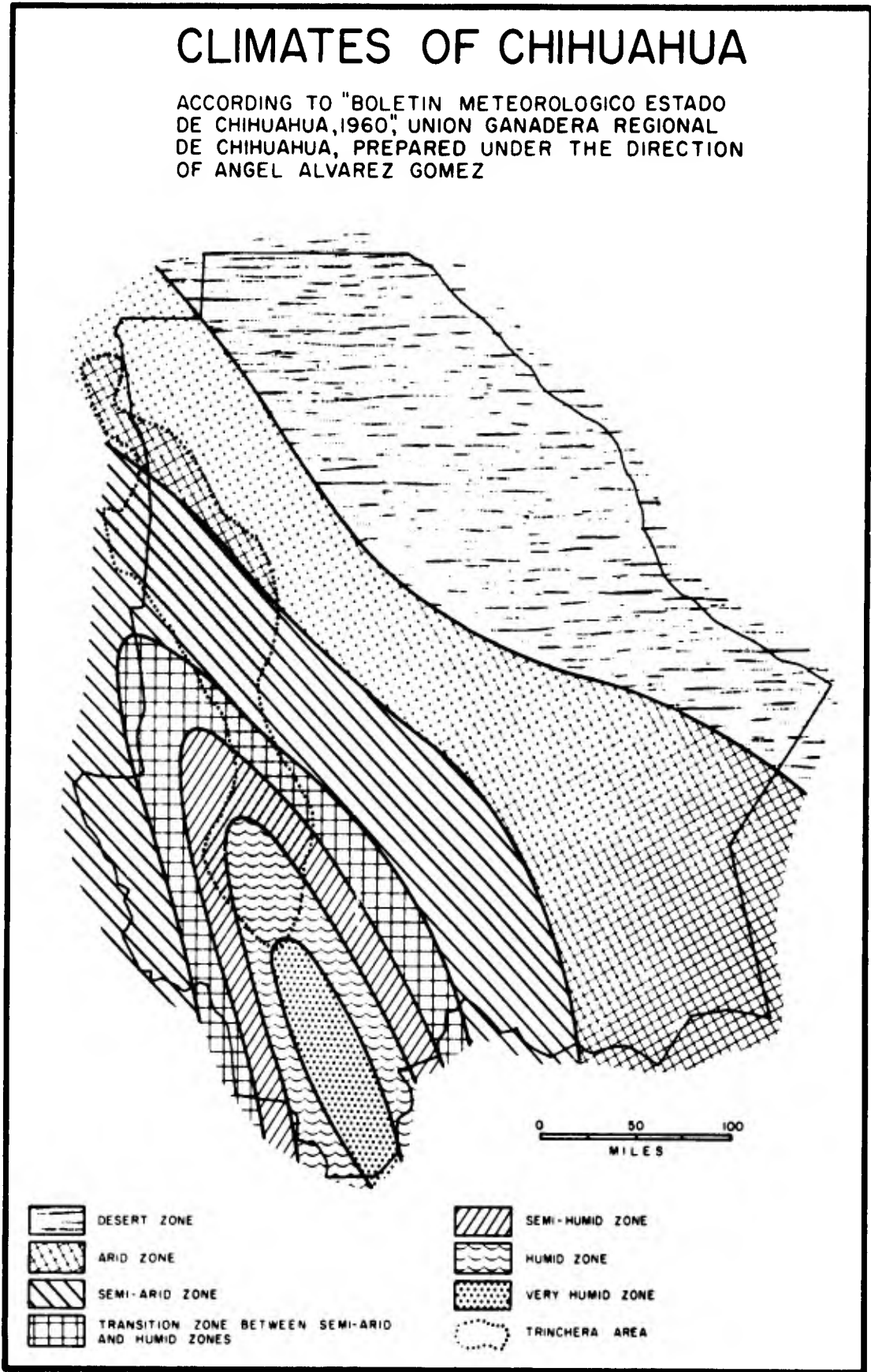


Figure 14. Climates of Chihuahua

does not preclude, however, a respectable amount of snow on the higher zones during the winter months. Figure 15 shows winter storm clouds built up over the Sierra Madre west of Nuevo Casas Grandes in December 1965. Figure 16 shows a fresh fall of snow at Mesa de Huracán in February 1966.

During the height of the wet season in the summer months, severe convectional and orographic thunderstorms develop in the mountains. A good account of the local weather conditions is contained in Herold's report (1965). Attention is called to the date of 12 August 1964, when 2.24 inches of rain fell during the 24-hour period, with a maximum intensity of 1.05 inches during a 10-minute period. The mountains appear to be much like a desert area, in that precipitation is uncertain in total amount, and erratic in the time of falling.

This past summer, a rain gauge was kept until December at the Whetton Ranch on the Rio del Gavilan. It was felt that this record would supplement the record obtained in 1964 at the same site, and extend it beyond the end of the wet season into the early winter. The record from this gauge, plotted with the 1964 record, appears in Figure 17. It adds another summer's record at the Gavilan and provides the first figures for the fall and early winter.

The length of record for all of the material presented so far is much too short. However, as it is added to in future years, it should permit the eventual assembly of a more reliable record than is now available. It is to be hoped that future work on trincheras in this part of Mexico will systematically add to this record.

Vegetation.\* In no way in the Sierra Madre Occidental are the climate and elevation more clearly expressed than in the vegetation distribution. In the bolsons of the basin and range country east of the range, desert or desert-grassland type natural vegetation is found. As one progresses westward into the foothill zone, the grassland is broken by scattered individuals or clumps of oak, juniper, or pinon pine. The oak reach their greatest development between about 6,000 and 7,000 feet above sea level, where they form almost a continuous canopy, even though the trees are seldom more than 20 feet tall. See Figure 18. At about 7,000 feet elevation, pine begin to mix with the

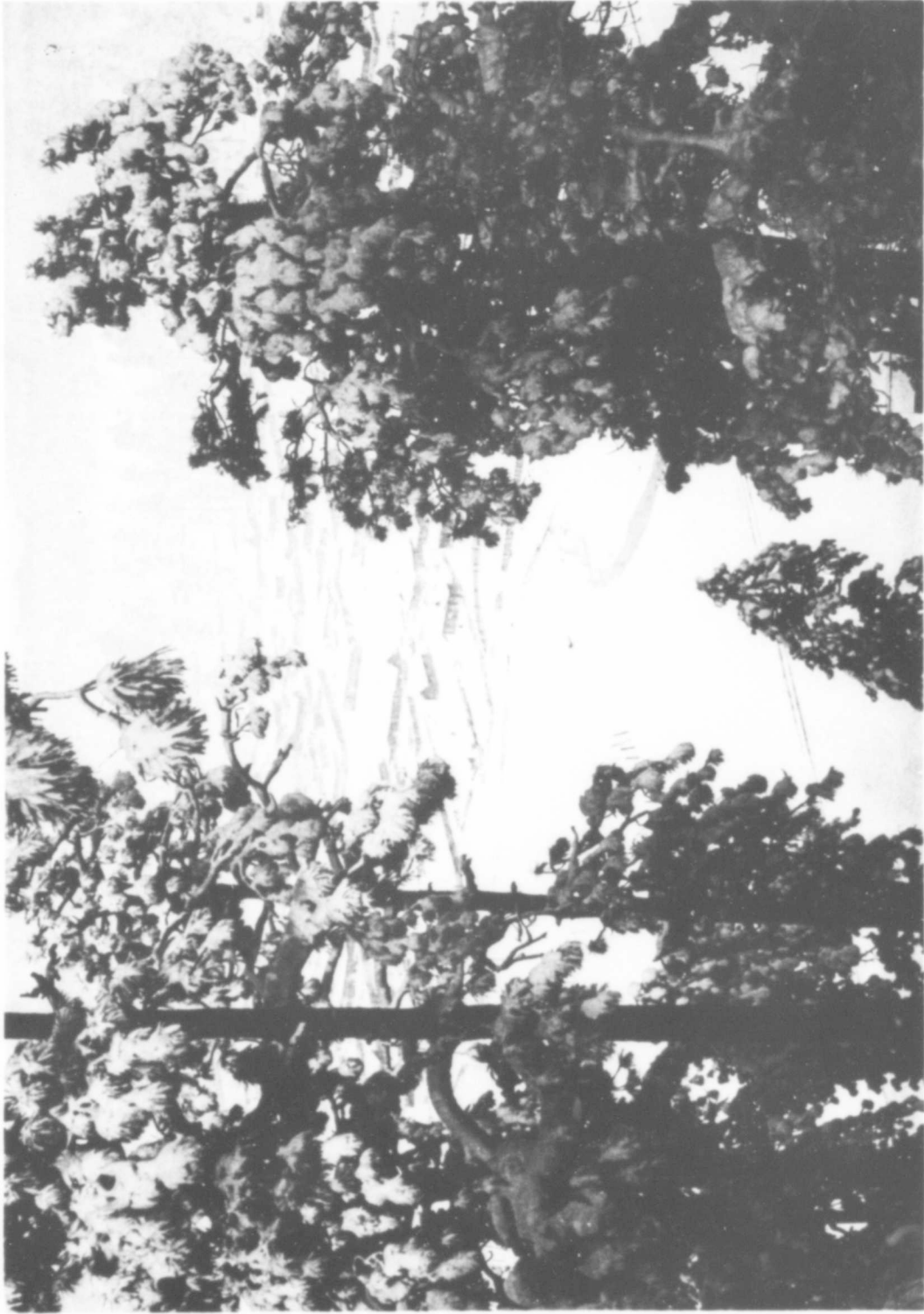
---

\* This material was prepared under the direction of Dr. Robert R. Ream, Department of Geography, University of Denver, who examined the Gavilan area in 1964.



**Figure 15. Winter Storm Clouds over Sierra Madre Occidental West of Nuevo Casas Grandes**





**Figure 16. Fresh Winter Snow (February) at Mesa del Huracán**

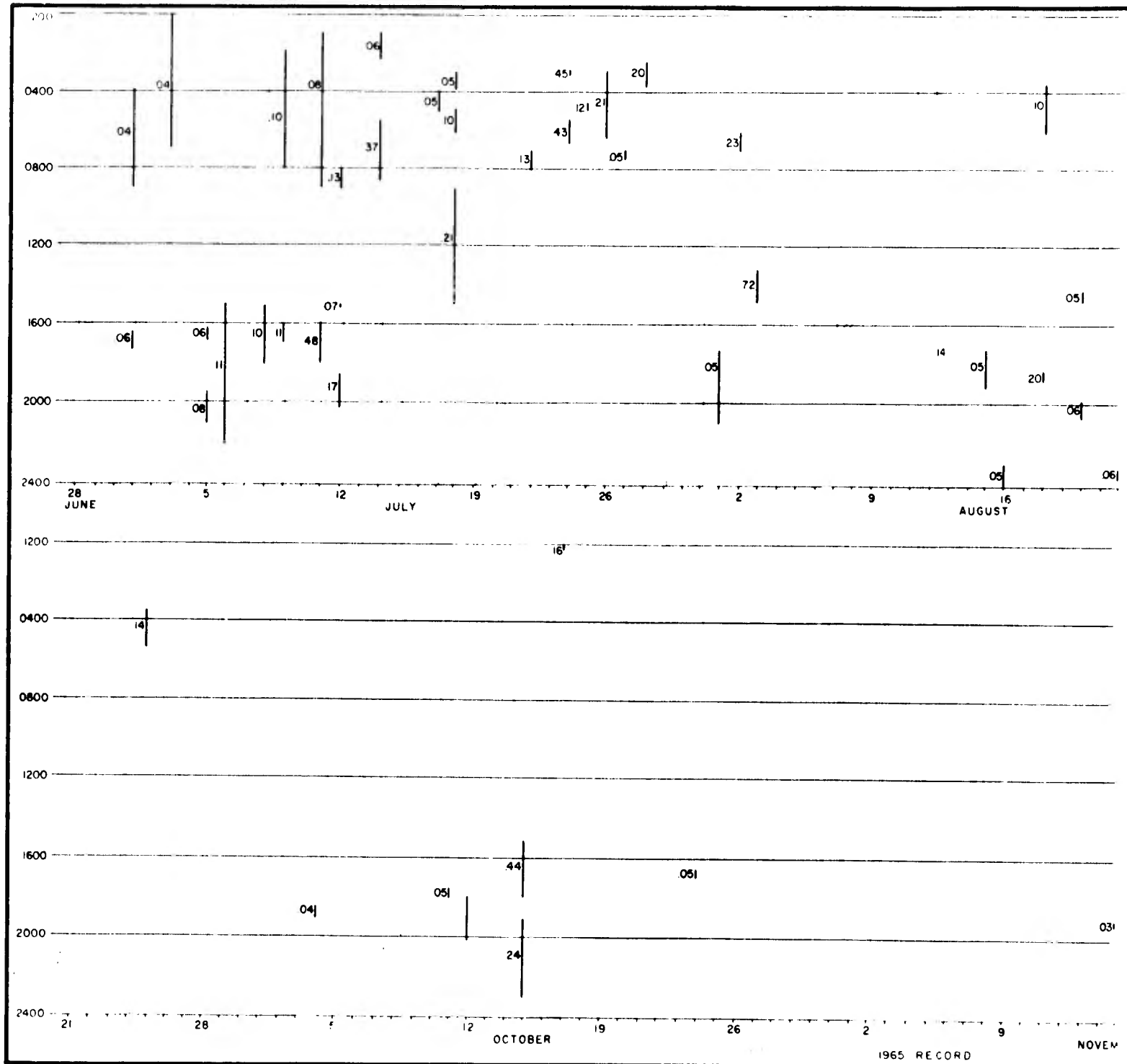
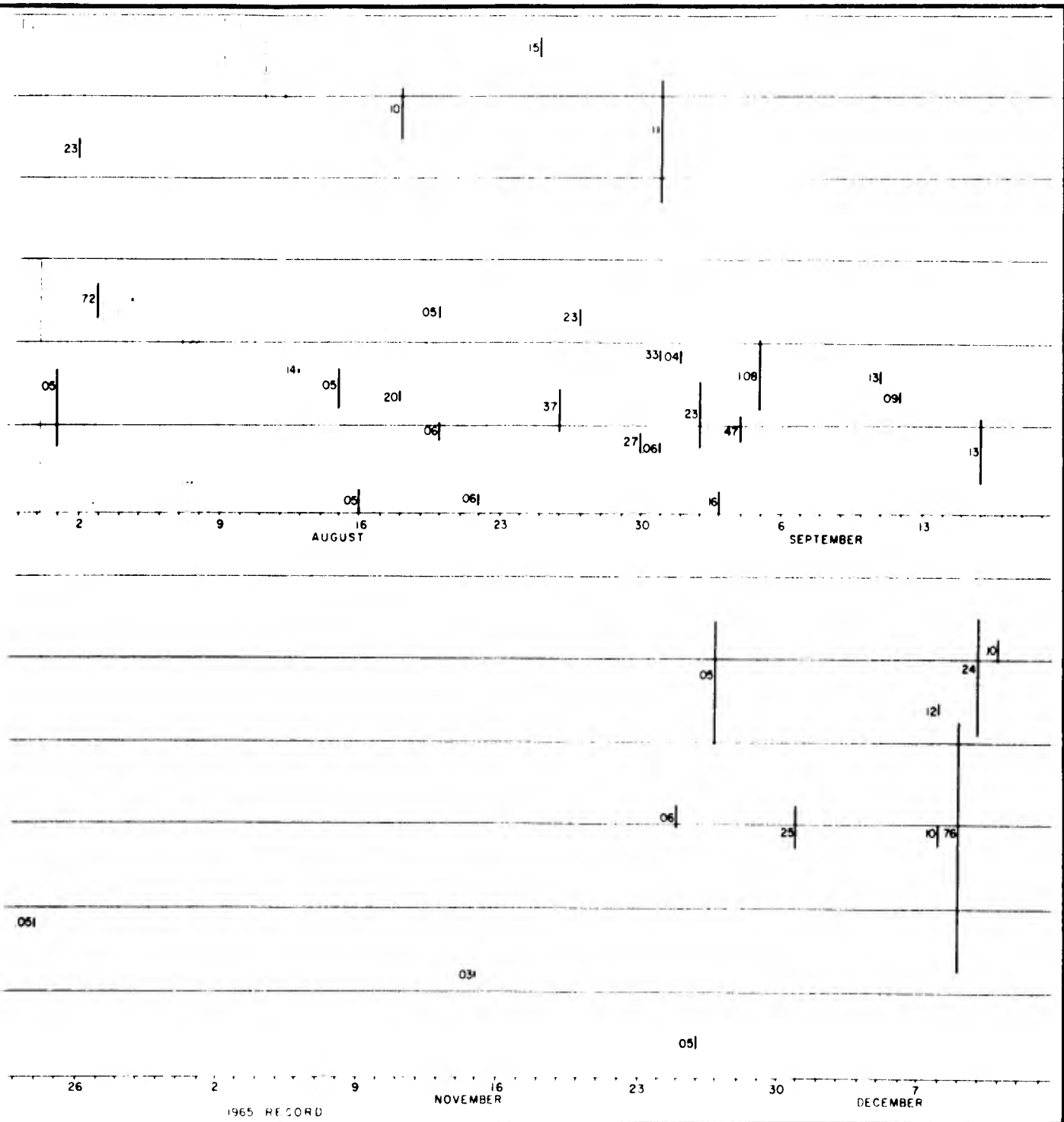


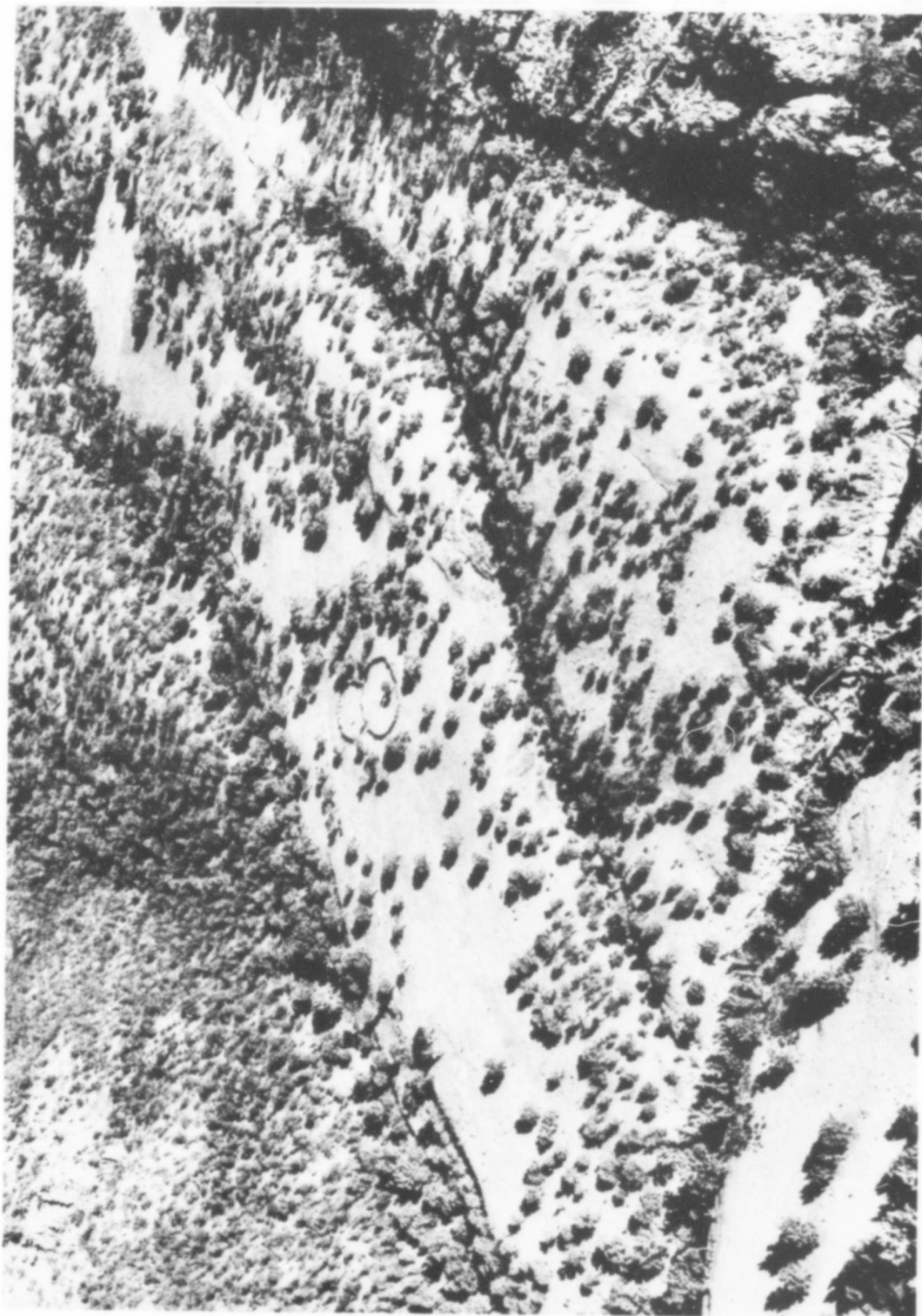
Figure 17. Precipitation Record for Station at Rio Gavilán

A



ion Record for Station at Rio Gavilan -- 1964-1965

**B**



**Figure 18. Open Oak Forest on Rio Gavilan**

oak. Above this elevation, the pine appears to be the dominant tree, even though there are still a large number of oaks forming a lower layer. These pines, Chihuahua Pine (Pinus chihuahuana), and long-leaved pine similar to the Ponderosa Pine (Pinus apacheca and Pinus leiophylla), grow 50 to 60 feet in height. They are fairly open at the lower elevations and become much denser at higher elevations. See Figure 19. At the highest elevations - 8,000 to 9,000 feet - one can find areas with Douglas Fir (Pseudotsuga menziesii), aspen (Populus tremuloides), and even one of the true firs (Abies religiosa), but these sites are very uncommon.

There are, then, four generalized zones as follows:

- |                              |                       |
|------------------------------|-----------------------|
| 1. Desert Grassland          | less than 5,500 feet. |
| 2. Oak Thicket or Oak Forest | 5,500 to 6,500 feet.  |
| 3. Mixed Oak-Pine Forests    | 6,500 to 7,500 feet.  |
| 4. Pine Forests              | over 7,500 feet.      |

These "zones" are not always easily observable in the field, and there is considerable mixture at both the upper and lower limits of each. Also, on the steeper north-facing slopes, one can expect to find these types at much lower elevations than indicated above, because of the cooler, more moist environmental conditions. Conversely, on the south-facing slopes, these types will reach up to higher elevations than indicated above.

The complex pattern is further modified by local edaphic conditions, past fires, evaporation rates, and all of the other complex "controls" which act as constraints and molds for the vegetation pattern.



**Figure 19. Pine Forest South of Mesa del Huracán**

**BLANK PAGE**

## CHAPTER III

## DISTRIBUTION OF TRINCHERAS

Distribution of Sierra-type Trincheras: General Characteristics.

There are a number of general characteristics about the distribution of Sierra-type trincheras that need to be mentioned prior to entering into a description of their more detailed features. To begin with, the range of this particular type of trinchera is quite extensive, essentially from the general vicinity of the Barranca del Cobre in southern Chihuahua, north along the higher portions of the Sierra Madre Occidental, to the international border between the United States and Mexico. Actually, as was pointed out in the Introduction, similar features are found sporadically in the southwestern United States. In addition, based on information volunteered by numerous individuals within the study area, there is the possibility that these structures may actually go much farther south than just to the area near the Barranca de Cobre. Due to the extremely inaccessible nature of this particular section of the Sierra Madre, no attempt was made to verify this information.

Second, contrary to the impression one receives from talking with inhabitants of the area in which the Sierra-type trincheras are found, these features are not found in anything like an even distribution throughout the mountains. In fact, they are anything but. During the summer's work of 1964, it was impossible not to be impressed by the apparent abundance of trincheras. Seemingly, they were to be found in every gully or dry wash in which one looked. In all fairness, it must be pointed out that this study was quite restricted as far as the area involved; and the choice of the 1964 study sites was very fortuitous in that they were located in what appears to be the center of trinchera occurrence. Certainly, the apparent abundance of trincheras in this particular area is exceptional, when the whole of the territorial range is taken into account.

Third, within the general area in which the Sierra-type trincheras are found, the primary characteristic of their distribution is their distinct clustering. Where they occur, the focal point is a habitation site or, what is more normally the case, numerous habitation sites. Within the whole of the range, there is a more marked clustering in the northern part of the mountains than is the case for the south. Just why this is so is unclear, but a number of reasons can be suggested. One which the archeologist will have to decide ultimately is that of proximity to the large ruin complex at Casas Grandes. See Figure 20. This is assuming,





**Figure 20. Partially Excavated Ruin Complex at Casas Grandes**

of course, that the trincheras builders and the inhabitants of the ruin were one and the same. Curiously enough, more trincheras are found west of the Continental Divide than are found to the east. Another factor that might explain the more marked clustering of trincheras in the north is the nature of the terrain there, compared to that of the south. The north is broken up more into distinct ridges than is the case for the south. Numerous "vegas" characterize the south and eastern edge of the mountains. Trincheras are not found on any of these plains. Where they occur in the south and east, they are situated in stream valleys or around the dissected edges of vegas. The prevailing pattern of trincheras occurrence throughout their territorial range is one of clusters in or near stream valleys. In fact, proximity to permanent water supplies seems to be a major control on the vicinal relationships of trincheras distribution and location of habitation sites. All large habitation sites are situated near a permanent water source, usually one of the larger streams that head in the higher mountains. In every instance where large numbers of trincheras are found, there are numerous habitation sites close at hand, and usually near the water source.

Finally, as is partly implied by the use of the designation, "sierra-type" trincheras, almost all these structures are found in the higher portions of the main mountain complex. The single exception to this is near Buenaventura, where, immediately east of the village, examples of trincheras can be seen within the basin and range province. On the basis of a superficial examination of the area, there is the suggestion that this occurrence may represent cultural "borrowing." Certainly, pottery and other artifacts found in the area are not similar to the mountain trincheras sites. These appear more related to desert peoples whose cultural remains are more prevalent north and east of the village of Janos.

#### Distribution of Sierra-type Trincheras: Specific Characteristics.

This section of the report is arranged along the routes and directions taken in conducting the field work. There is first a consideration of certain cultural remains within the basin and range province along the northeastern margins of the study area. This is followed by descriptions of trincheras and habitation sites in the Sierra proper, proceeding from north to south.

Basin and Range: East and North of Study Area. While only one example can be cited of trincheras occurring in the basin and range province, the area immediately east of the mountains, especially the

portion from Buenaventura north to Janos, does have important significance in attempting to describe the vicinal relationships that possibly have a bearing on the over-all pattern of trinchera occurrence and distribution. See Figures 21 and 22. Actually, from a physiographic point of view, the area along the eastern margins of the Sierra Madre, principally along the courses of the Rio Casas Grandes and the Rio San Pedro, is not overly important to the purposes of the report. It is somewhat typical of the basin and range province, with isolated ranges from 10 to 15 miles in length and up to 8,000 feet in elevation, and with basins relatively smooth-floored at 4,500 feet or above. What is important about this area is the fact that there are numerous aboriginal habitation sites along the courses of both streams. The most important of these sites, indeed probably the most important in this part of Mexico, is the large ruin at Casas Grandes. Others are quite small by comparison. The location of the ruin at Casas Grandes (near the banks of the river) is typical of the others. See Figure 20. All are of the surface type and they vary one from the other with respect to size. They are constructed of adobe; aside from the absence of trincheras, they resemble mountain adobe ruins in all respects. It is for this last reason that mention of them is made in the context of this report. The expertise required to ascertain the relationship of these sites to similar ruins found in the mountains and associated with trincheras goes beyond the competence of personnel who were involved in this study. However, a cursory examination of sites certainly suggests that their former inhabitants and the builders of trincheras were culturally similar, if not actually one and the same. However, this is conjecture and is a subject better left to the skills of the archeologist.

Rio San Pedro - Ojo Frio - Altamirano. Moving southwest along the middle reaches of the Rio San Pedro from Janos to Colonia Fernandez Leal, one passes a number of surface habitation sites. These are conspicuous by the absence of trincheras and appear similar to those along the Rio Casas Grandes. Pottery found in the area is similar. The surroundings of these sites are typical of the foothill topography where the basin and range province and the Sierra Madre meet. Not wholly level, more rolling than is the case farther out into the basin, the area clearly shows the transitional nature of the topography as well as the vegetation. Desert shrub, cactus, with an occasional cottonwood along stream courses, are typical. A few sand dunes are found in the area but are not very conspicuous. Actually, the sites themselves are not very conspicuous either; one can easily pass them by without being aware of their presence. Yet, as one moves into the mountains farther along the course of the Rio San Pedro, the first trincheras can be seen just a few miles distance from these sites.



**Figure 21. Foothill Zone at East Edge of Sierra Madre Occidental**

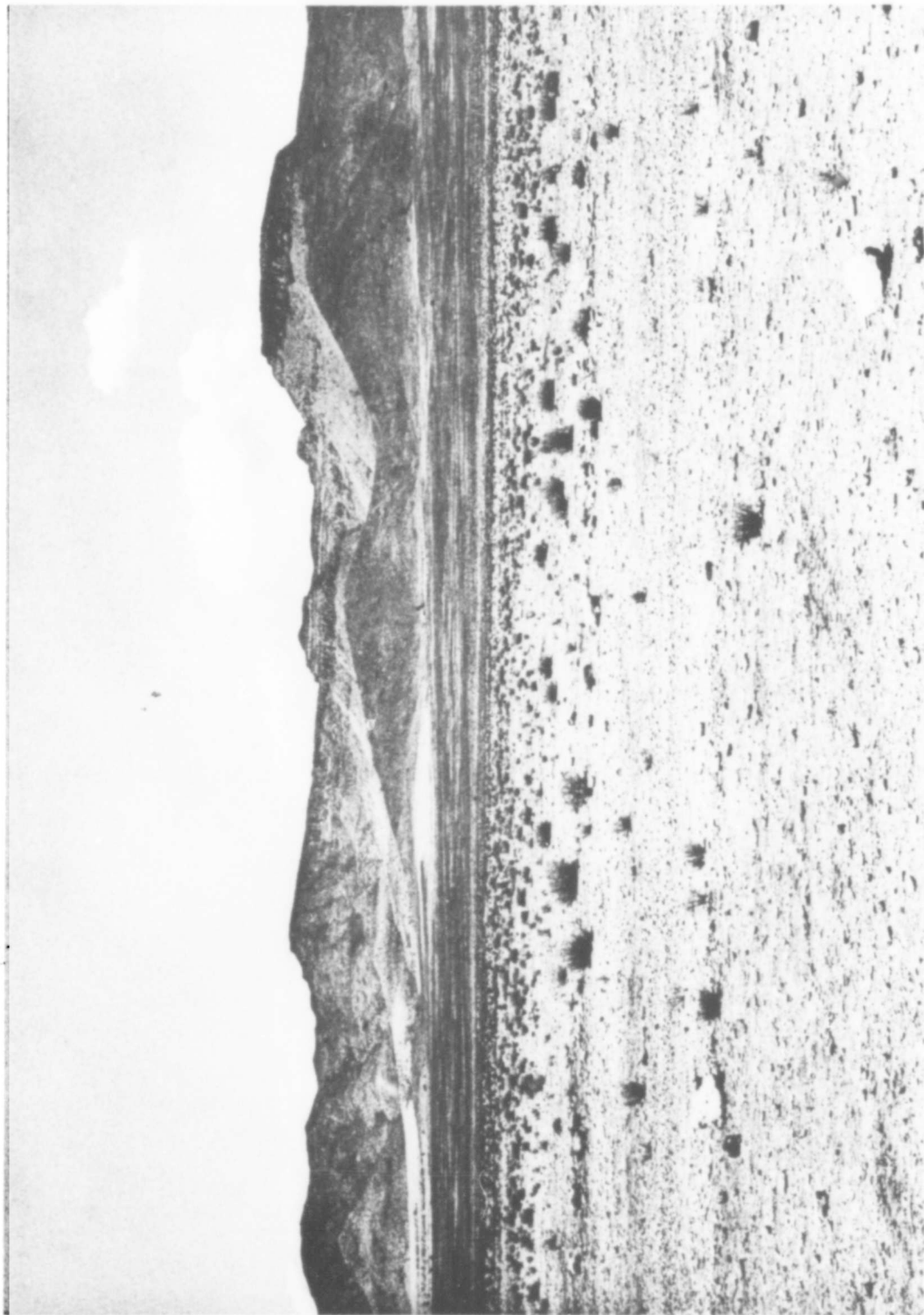


Figure 22. View to West Toward the Sierra Madre from Floor of Bolson Near Casas Grandes

There is some question as to whether the first area of trincheras along the Rio San Pedro represents a distinct cluster. Found approximately two miles south of Ejido Lazaro Cardenas (El Ojo Frio), they appear to be part of a distribution from Ojo Frio to beyond Ejido de Altamirano. This is so, despite the fact that three rather sizeable habitation sites are near Ojo Frio. Situated near the junction of two streams, these in general plan are similar to those along the Rio Casas Grandes and the lower reaches of the Rio San Pedro. These sites are surface-type constructions, and trincheras are found throughout the tributary arroyos and the larger streams.

The physiographic setting of the area is important, as it represents something of a pattern found in other areas. The larger of the two streams (names not known) could not be said to be completely permanent, yet pools of water are readily at hand. The Rio San Pedro is not too far from the site. The approximate elevation of the stream junction is 5,500 feet. Elevations over 7,000 and 8,000 feet are found to the east where part of the higher Sierra Madre is found. The vegetation is represented mainly by live oak, cedar (species unknown), juniper, and pine. The oak appear most common. In the immediate vicinity of the habitation complex, oak and juniper are more prevalent, with the pine at higher elevations. Undergrowth at the time the area was seen - in the early part of the summer and in the latter stages of the dry season - was almost completely absent due to the intense overgrazing by cattle and other animals.

The local geology is indicative of the orogeny of the Sierra Madre - lava flows with occasional beds of ash. In this particular instance, one of the beds of ash was very instrumental in the removal of trincheras. Where erosion has cut down to the ash, there has been a general undermining of the base upon which the trincheras were built, leading to their complete removal. Only a few rocks or boulders can be seen imbedded in the mantle along the sides of the arroyos. Near the habitation sites, two beds of ash can be seen, one below the general level of the site and one above. The bed below seems to be the only one that has had a definite effect on the position of trincheras. In fact, no trincheras are found at elevations where the upper bed could have affected their occurrence in one way or another. In general, though, the area's geology would have to be characterized more by the lava flows than by ash, despite the fact that the effects of the ash bed below the general level of the habitation sites are much more readily seen.

With the exception of a number of contour-type trincheras, all those seen in the area were of the check-dam type. A goodly number of the trincheras are washed out or broken through, a fact attributable, in part, to the overgrazing which certainly has facilitated greater runoff potential. No particularly high trincheras are seen here. Most are two to three courses in height, averaging one to three feet. From the habitation sites, the distance to the nearest trincheras varies from 300 yards to, in a few instances, as little as 100 yards. Constructionally, no departures can be seen that would distinguish these trincheras from the essential characteristics of the categories developed in the study of 1964.

The habitation sites in this area are located on mesa tops overlooking the main stream valley. The average size of the sites is approximately 300 feet long by 100 feet wide. Each appears to have been constructed of adobe. Weathering and erosion have reduced the walls to about 2 or 3 inches in height. They appear to have been single-story constructions. Compared to other ruins in the immediate vicinity, these would probably be considered in average condition, despite a small amount of digging that appears to have been done recently on one of them. (Pot hunting is a very strong activity among the occupants of this particular area of Mexico. A ready market can usually be found for such artifacts. Hence, many of the habitation sites have been thoroughly gutted by individuals seeking to supplement their meager incomes.)

From Ojo Frio to Altamirano is a distance of 15 to 20 miles, depending upon whether the calculation is made on a straight line or by the road. See Figure 23. Most of the Rio San Pedro along the route has some permanent water throughout the year. Sycamore and cedar are quite common along its course. Moving upslope, away from the river bottom, pine and oak are more common, especially the oak. Throughout the distance from Ojo Frio to Altamirano, the Rio San Pedro occupies a restricted valley. Only near Altamirano does the valley broaden so that sizeable parcels of relatively level land are found. This widening of the valley and the resulting availability of level land are possibly important in attempting to account for the relative paucity of trincheras in the immediate vicinity of Altamirano. But first, something must be said about the setting of the habitation sites, for while Altamirano is unquestionably the most impressive as far as size, others are found near at hand.

The village of Altamirano is quite remarkable, in that the village is situated on a very large aboriginal ruin. It is very difficult to ascertain just how large this ruin may have been in the past, as the village

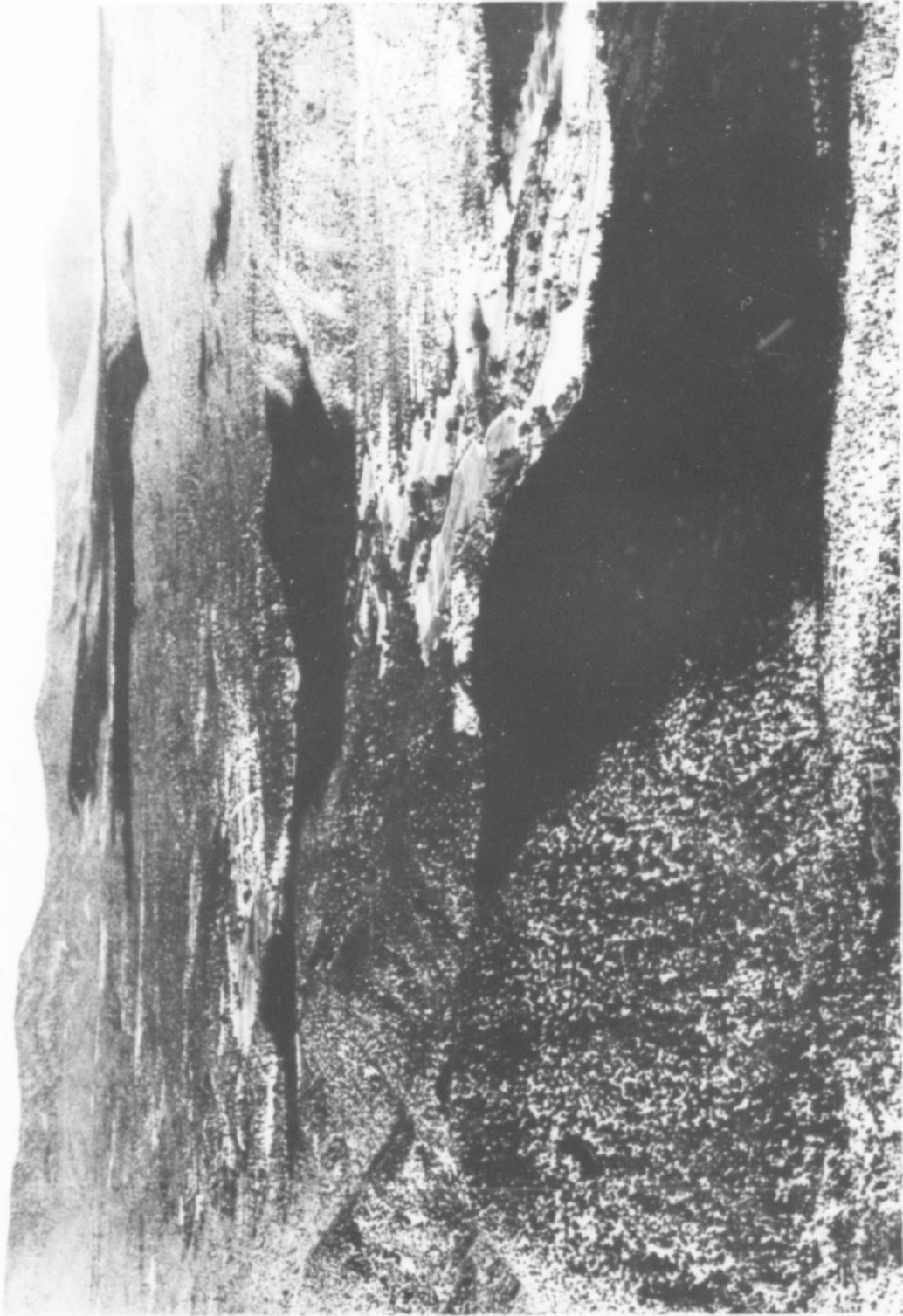


Figure 23. Upper Portion of Rio San Pedro, Looking South



has been occupied for many years. Pottery of the Indian type is found almost everywhere in and near the village. There is the very strong possibility that this site may be second in size to the Casas Grandes ruin. See Figure 24.

Within a short distance of the village are three other habitation sites, none coming close to rivaling the village; and still another is found to the south. All are surface dwellings. Two are situated on stream terraces while the other sits atop a mesa. The two located on stream terraces are situated in modern-day cornfields. Both are quite large, 200 feet wide and that or more long. As much as half of one of these is two-story in construction. All three were constructed of adobe. Subsequent weathering and erosion have reduced each to a low pile of rubble. Artifacts are quite noticeable in and around all these sites, including that in the village of Altamirano. But in none are these cultural remains as noticeable as the two sites located in the cornfields. Metates, manos, molcahetes (stone bowls), hammer stones, pestles, and pottery sherds lie freely over the surface of both these sites. Some have been upturned as a result of the cultivation of the fields.

The physiographic setting of this cultural complex is quite remarkably similar to that of the habitation sites near Ojo Frio. The village of Altamirano sits atop a small mesa overlooking a rather large area of relatively flat land at the point where the Rio San Pedro and one of its tributaries come together. The land lying below the level of the village is presently cultivated by the occupants of the village.

In attempting to assess the position of the village ruin in the whole of the habitation complex, a rather curious feature was noted with respect to trinchera distribution in the general area. While trincheras are found quite readily in the general setting, they are noticeably absent in the immediate area of the tributaries to the Rio San Pedro on the eastern side of the village. Two different types of trincheras can be seen in other areas: check dams and terraces. But none can be found near the open parcel of land. If we assume for a moment that trincheras were constructed to facilitate some kind of agricultural activity, then a possible answer can be suggested that will help to explain why trincheras do not appear in the area in question. The actual answer may be lost to archeological history; nonetheless, the following suggestion seems plausible and is shared by numerous other individuals.

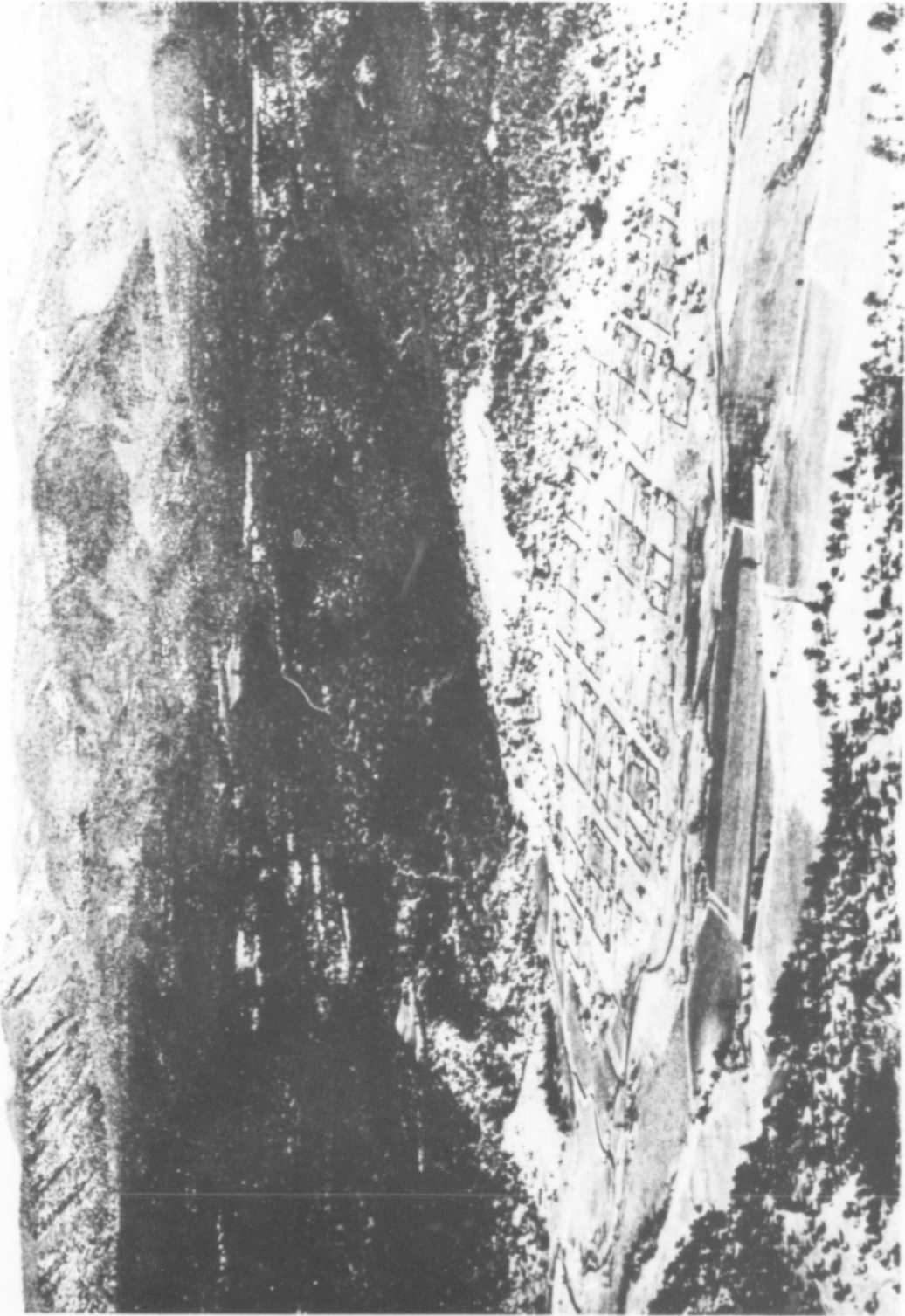


Figure 24. Ejido de Altamirano

If trincheras were constructed for some kind of agricultural purpose (and this is the prevailing body of opinion) in an area such as the relatively flat land lying east of the village of Altamirano, there would have been no particular reason for the construction of these features with the land being relatively flat and easily cultivatable, and with soils quite deep in comparison to other areas nearby. Only when this land was no longer capable of supporting the population at the main habitation site (the assumption is made that, on the basis of size, the village ruin was the center of this particular habitation complex) would it be necessary to construct trincheras in the arroyos away from the village so as to increase the arable land. While the validity of this possibility certainly needs to be investigated further before it receives anything like acceptance, it is curious that in all other areas examined in the Sierra Madre, where somewhat similar conditions are present as at Altamirano, trincheras are also absent.

The vicinal relationships between habitation sites and the distribution of trincheras near Altamirano suggest two other factors that conceivably affected the occurrence and distribution of trincheras. First, there is the suggestion that the location of these features is closely tied to the occurrence of habitation sites. Assuming that the people who built these structures did so with rational purposes in mind, e. g., for agriculture or some related purpose, then it would seem reasonable that distance from habitation sites would be an important determinant in trincheras distribution. As was pointed out earlier, the impression one receives by talking with residents of the study area is that trincheras occur rather generally throughout the mountains. On the face of it, this contention is completely unreasonable. Hydrology, vegetation, lithology, as well as numerous other factors, preclude the construction of trincheras in many situations. Certainly, trincheras were densest in the general vicinity of habitation sites in the area of the 1964 study. This is also true both of the complex near Ojo Frio as well as that of Altamirano. Paralleling the importance of distance from habitation sites in the distribution of trincheras, there is seemingly a strong correlation between habitation-site size, whether it be one site or a complex, and the occurrence of trincheras. The suggestion here is that the larger the habitation site, the more abundant the occurrence of trincheras. This is a factor that needs further examination.

Second, there is the further suggestion that the availability of permanent water is a very strong control in the location of habitation sites. Both the Ojo Frio and Altamirano sites are near permanent water. In the case of the Gavilan study of 1964, forty-nine habitation

sites were found in the nine-square-mile field area, all of which were within relatively short distances of permanent water. This control is stronger the larger the habitation site. (As is abundantly clear from other areas described later, this locational factor is very strong with respect to other sites.)

Before leaving Altamirano, more needs to be said regarding its general physical setting. In general, the local geology is similar to that found at the Ojo Frio site. Lava flows with occasional beds of ash are the major characteristics. The widening of the valley at this point is in part related to the more easily eroded band of ash near the present level of the stream. The topography is much more subdued here than near Ojo Frio, showing the differing abilities of lava and ash to withstand the forces of erosion. Also, the Rio San Pedro is a much more active stream in the Altamirano area. Only minor tributaries of the main stream have been reducing the level of the landscape at Ojo Frio.

The vegetation near Altamirano is very similar to that seen along the course of the stream once the foothills topography is passed. Sycamore, cottonwood, and cedar are the most common tree species along the stream course, while pine and oak are the more common along the slopes and higher hills. Soils near Ojo Frio were quite thin, varying from one to six inches in most instances. Soils on slopes were extremely thin; in fact, most slopes were denuded of soil altogether. By contrast, many areas along the Rio San Pedro at Altamirano have soils developed to as much as two or more feet. Only when one moves upslope from the river bottom do the soils appear inferior and more like those found near Ojo Frio.

Moving beyond Altamirano to the south, trincheras are found almost to the divide between the drainage of the Rio San Pedro and the Rio Gavilan. However, as one moves away from the habitation complex, trincheras are noticeably less dense, supporting the distance factor in the distribution of these structures.

Arroyo del Oso and Arroyo Carretas. Northwest of Ejido de Altamirano, approximately thirty miles across the Sierra de Dos Cabezas, in the Arroyo del Oso, there is found another sizeable cluster of trincheras. These are found near two large caves. See Figure 25. From the valley of the Rio San Pedro into this site, no evidence exists that would indicate a connection of the two areas. No trincheras were observed either from the air or on the ground in intervening areas. While the distance is not very great, some extremely rugged terrain

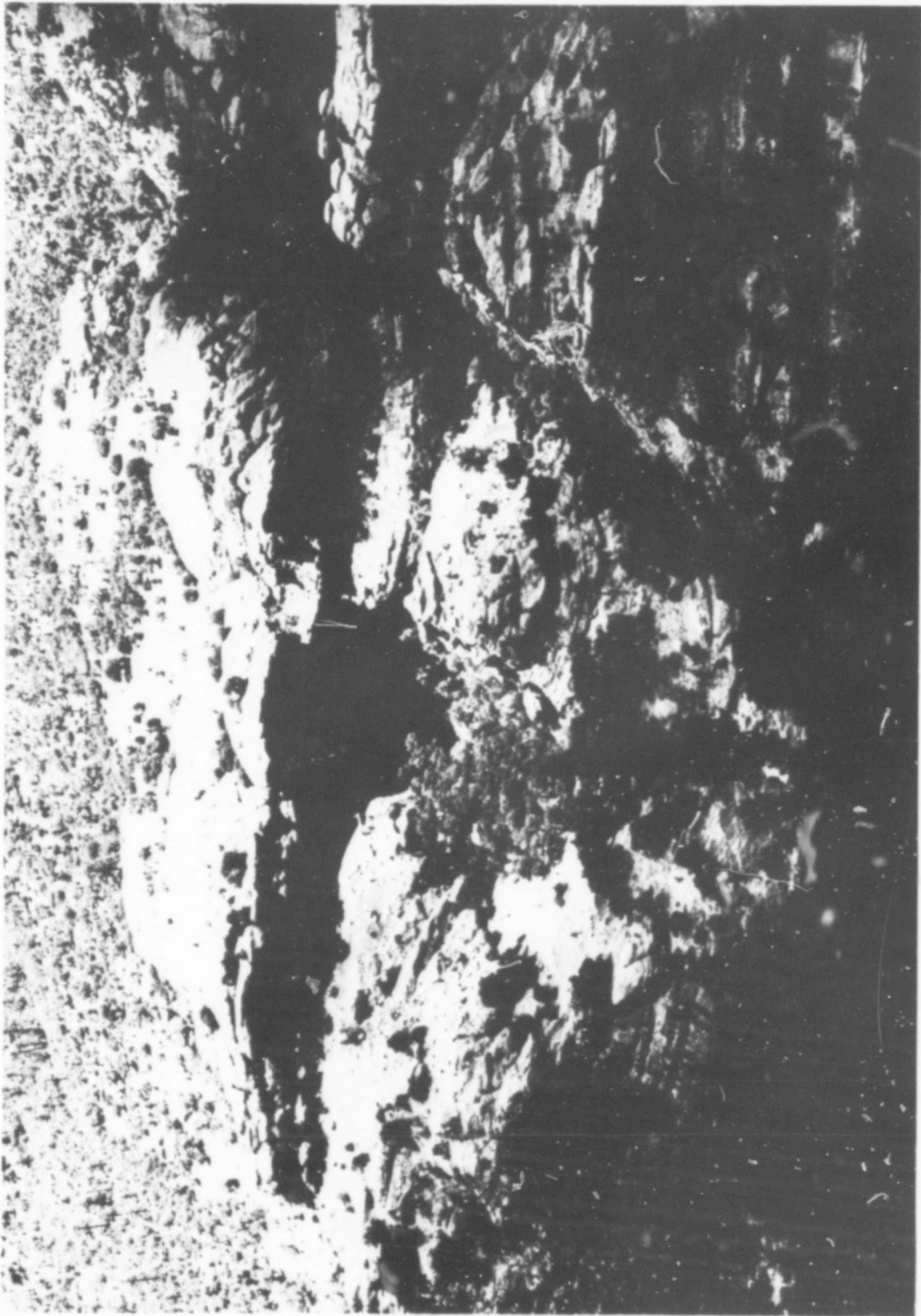


Figure 25. Air View of Double Cave at Arroyo del Oso

lies between them, making it unlikely that the two areas were connected as far as the occurrence of trincheras.

The site along the Arroyo del Oso is situated in the headward portion of the stream which flows westward into the Bavispe drainage. It is separated from the Carretas drainage by a low divide. Access to the Arroyo del Oso is easier from the Carretas than from the Bavispe. Despite the fact that this area was examined during the height of the dry season, and also bearing in mind that this particular site is located near the drier margin of the Sierra Madre, permanent water supplies are quite readily found. The lower reaches of the Carretas are in the basin and range province, where they disappear into the sands of the internal drainage basin west of Janos. The vegetation is indicative of this drier regime; live oak and juniper are the most common species of trees near the site, with pine at higher elevations. Sycamore occur along the stream course. There are many areas where grass is the chief vegetative cover.

The two caves are approximately 300 yards from the Oso, both situated in a band of volcanic ash and capped and floored by lava flows. Both extend back into the ash for more than 100 feet. Figure 26 contains floor plans for the ruins in the caves at Arroyo del Oso. The smaller of the two has eight single-story rooms, while the larger has more than twenty-five rooms, some of them quite positively two stories, and a few sections that were possibly three stories. The dwellings are constructed of adobe, with some stone. They range in condition from excellent to poor. Where they have not been attacked by man, they have been disturbed by animals. The larger appears to have been recently used as a cattle pen. However, several houses still have their original roofs and are in quite good condition. Numerous artifacts are found in the area, among which are metates, manos, bits of weaving, and pottery sherds. See Figures 27 and 28.

Trincheras are found in almost all the arroyos leading to the main stream. Only the check-dam variety were seen. Most are relatively low and fairly wide. No evidence exists that trincheras were constructed across the Arroyo del Oso. The Oso, when it is full, has all the appearances of being a very treacherous stream.

Two other sites must be mentioned that are not too far from the Arroyo del Oso. One lies directly north and is situated on a terrace of the Arroyo Carretas; the other is to the northeast, situated along the foot of the mountains. The site on the Carretas is a surface

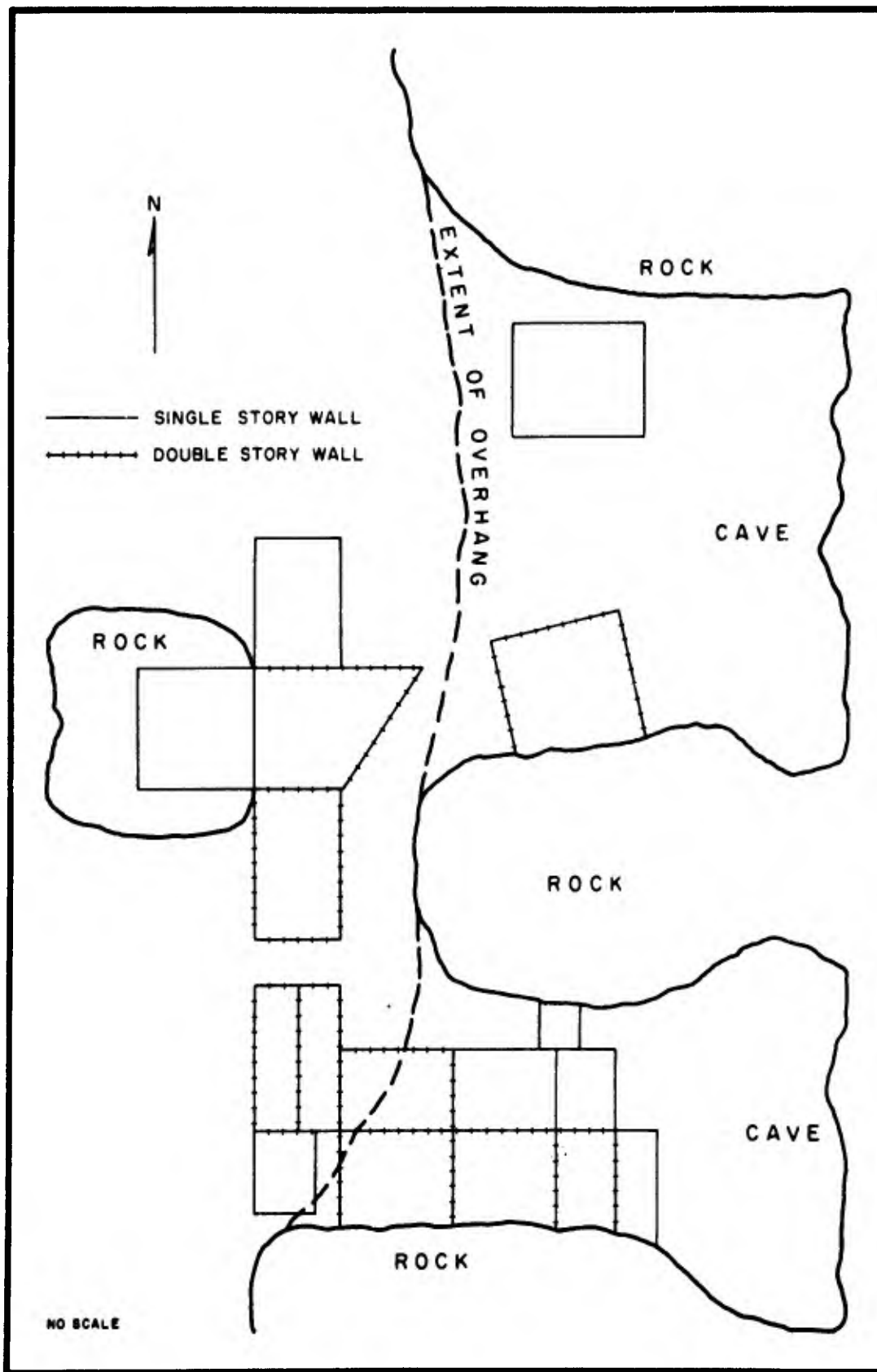


Figure 26. Floor Plan of Double Cave at Arroyo del Oso

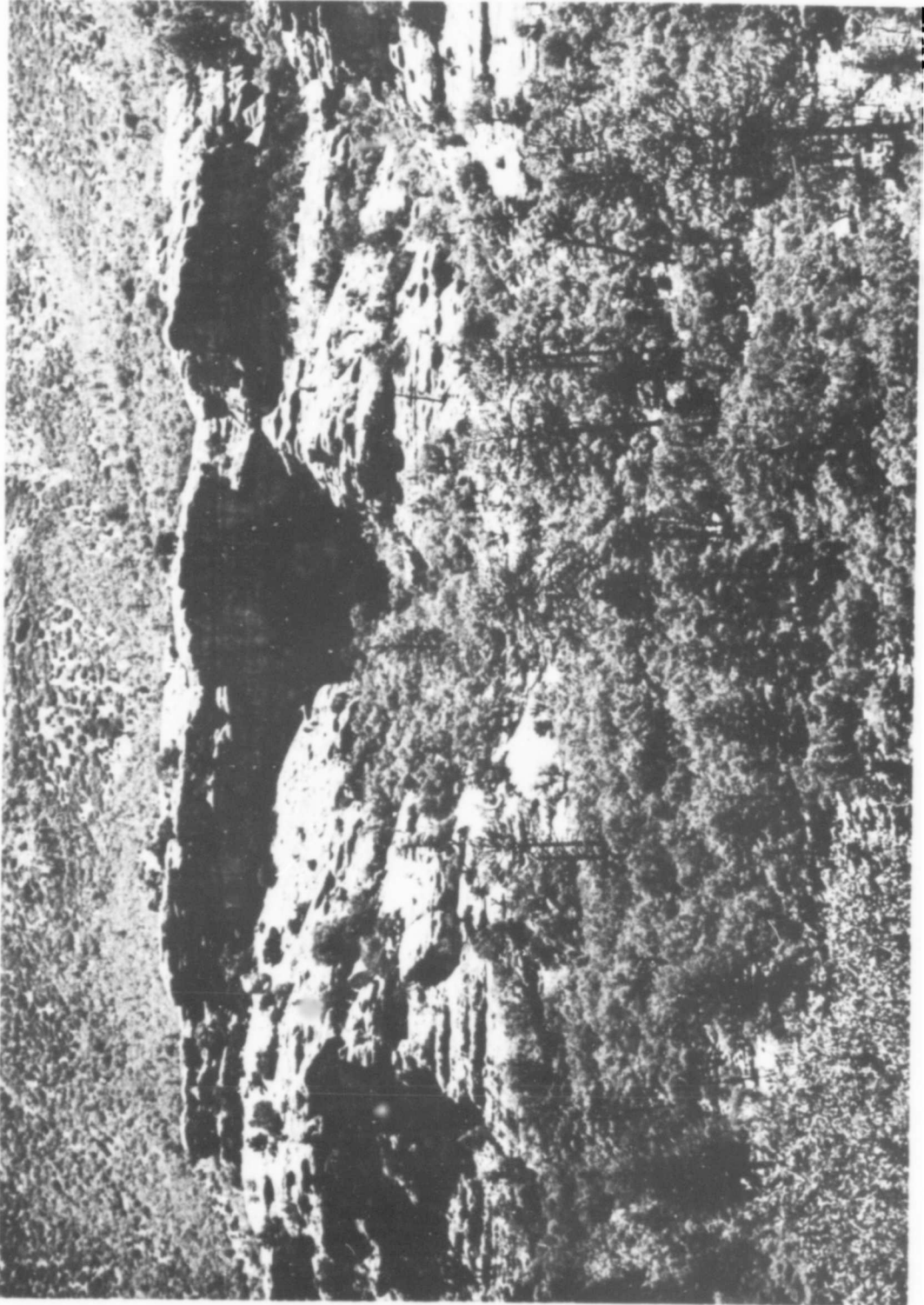


Figure 27. Ground View of Double Cave at Arroyo del Oso



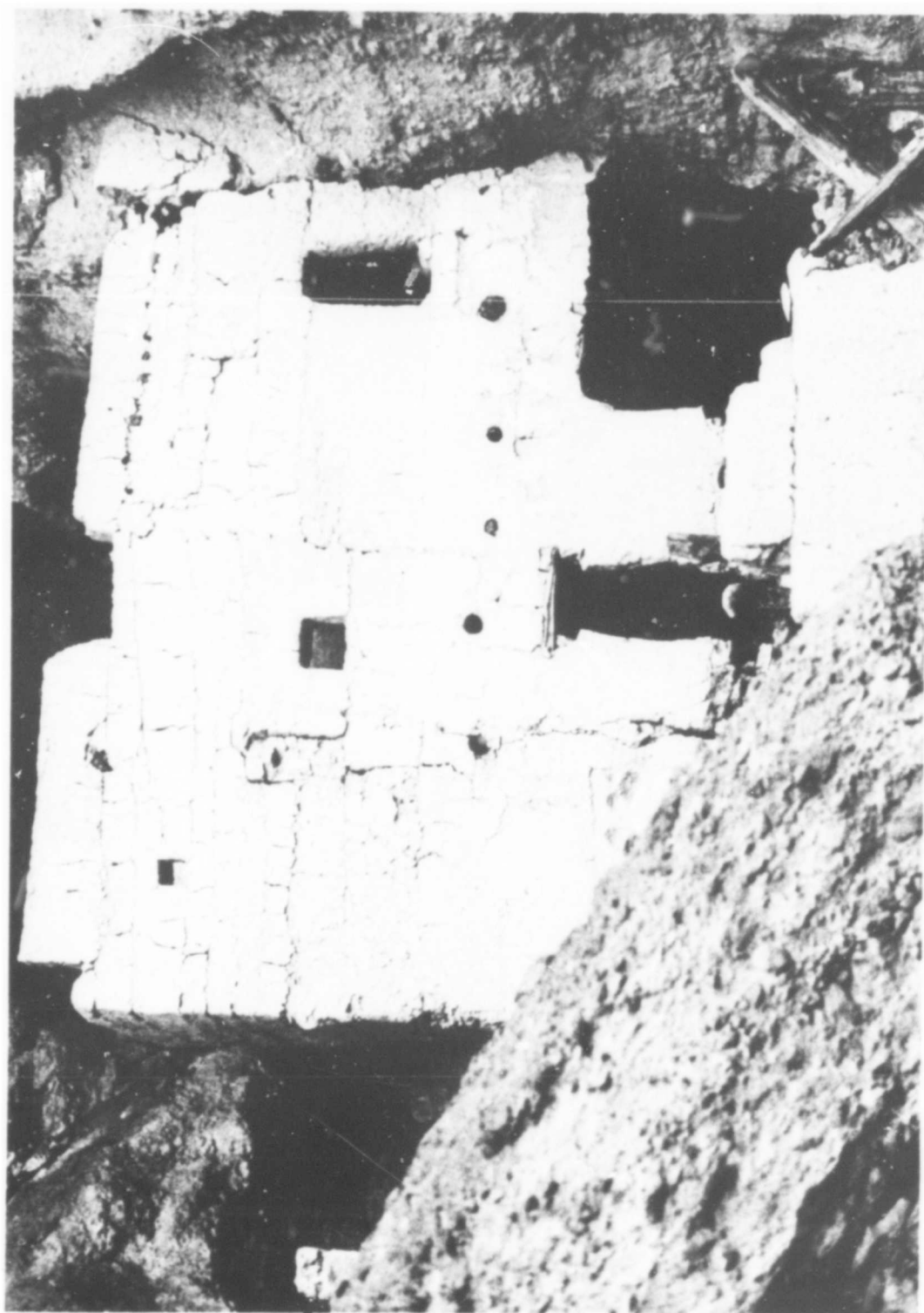


Figure 28. Ruin in Double Cave, Arroyo del Oso

dwelling, about 50 feet by 75 feet. It was constructed of adobe and appears to have been a single dwelling. It is presently in good condition - at least it has not been cut into by pot hunters. The site is around 5,400 feet in elevation. Trincheras, all of which are in the check-dam category, are within 50 yards of the site. Most of them are quite low and have been knocked over by grazing animals. The vegetation is clearly indicative of the drier regime one encounters upon leaving the higher portions of the Sierra. Oak and juniper are most common, with sycamore and cottonwood along the streams. Pine are found only along the tops of hills some distance from the site. The vegetation is basically of the grassland category.

Trincheras are not associated with the site lying farther north, essentially in the foothills zone. The site itself is a surface dwelling approximately 100 feet by 75 feet. The large arroyo near which this site is situated empties into the Llano de Carretas, ultimately disappearing into the sands of the area. The arroyo is semi-permanent in nature, i. e., water holes can be found near at hand even during the dry season. Inasmuch as the site is in the foothills of the Sierra Madre, forests are not present as such. Cottonwood and sycamore are along the arroyo, but grass is present in other areas. An expanse of grassy plain spreads out from this site to the north and northeast.

Rio de Bavispe. Moving west into the valley of the Rio de Bavispe, the western boundary of trincheras occurrence is encountered. The Rio de Bavispe, on its journey to join the Rio Yaqui, makes a complete reversal of direction from that of its flow in its headward reaches. In the headward portion of the Bavispe valley, where the stream flows north, and prior to the point at which it turns west and south and flows into Presa La Angostura, trincheras are restricted to the eastern side of the valley along the flanks of the Sierra Ojos Azules and the Sierra de Dos Cabezas. Where they do occur, they are not very abundant compared to the areas such as Altamirano. Like other areas, they are again associated with habitation sites. They are more abundant in the northern portion of the valley than in the south. See Figures 29 and 30.

Beyond the eastern side of the upper Rio de Bavispe valley, the climate is definitely more like that of the Sonoran Desert. The vegetation indicates the change in precipitation regime; it is characterized by a thorn thicket, rather than the oak, juniper, or pine which are farther east. A trip from Bavispe north to Colonia Morelos failed to disclose trincheras along the valley. Photographs were shown to inhabitants,



Figure 29. Dissected Alluvial Fans Along East Side of Upper Bavispe Valley

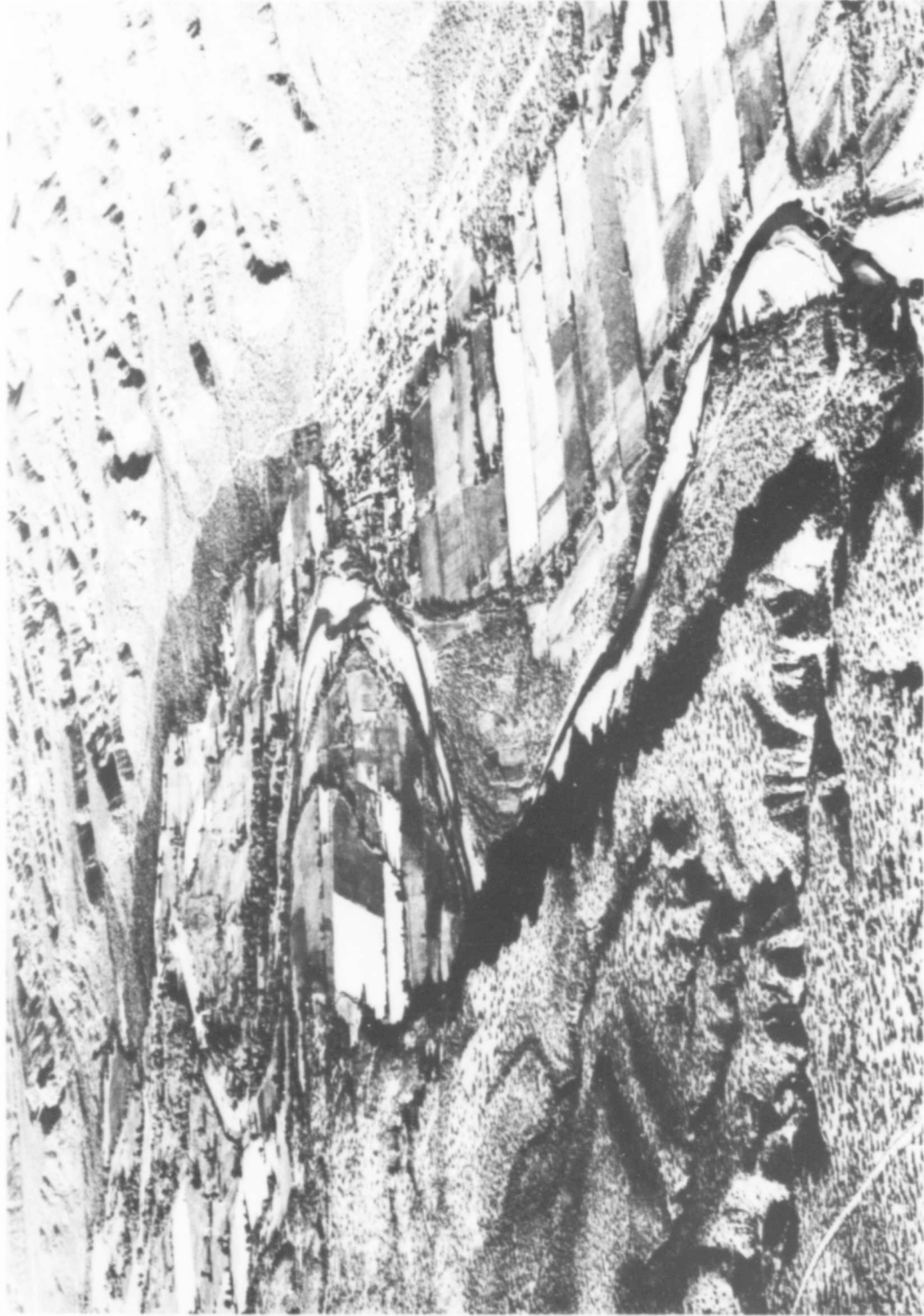


Figure 30. Central Portion of Upper Bavispe Valley

but no one had ever heard of or seen trincheras. To them, the word had no specialized meaning. Furthermore, what little evidence there is of prehistoric inhabitants of this particular area of Sonora suggests that these peoples were culturally distinct from the trinchera-builders.

Upper Rio de Bavispe Valley and Tres Rios. About 50 miles south, up the Bavispe Valley from the settlement of Bavispe, the stream is joined by the Rio de Gavilan and the Rio Negro. This junction is known as Tres Rios. It seems to be a major focus of trinchera occurrence up the three tributaries from the meeting point.

Within seventy-five yards of the Rio Bavispe, just a short distance downstream from the point where the Negro and Gavilan join the Bavispe, is a very large habitation site. Sitting approximately 120 feet above the stream on a mesa top, the former dwelling is quite large compared to others already described, measuring some 300 feet by 200 feet. It shows signs of having been two-story in construction. This particular structure appears to have been built more of stone than was the case with other surface sites. Adobe was used primarily as a chinking material. The appearance of the ruin at present is that of large mounds of rubble. Numerous artifacts can readily be seen at the site; pottery sherds, manos, and metates are quite abundant.

Within 100 yards of this site are numerous trincheras, among which are examples of the terrace type as well as check dams. Although they were not actually seen on this expedition, two sources of information tell of trincheras of great height near this site, some of these exceeding twenty feet. Of those seen, though, no constructional differences were observed that would convey the impression that they represent anything in the way of a departure from other trincheras already reported.

The vegetation near this site is composed chiefly of oak and juniper, with some pine on the higher slopes. Like the area described farther downstream along the Bavispe, where the precipitation regime is more closely similar to the Sonoran Desert farther west, this area also reflects diminishing precipitation as compared to areas to the east. Soils are not well developed, except along the river floodplain, and here they are quite restricted as to extent. In other areas, soils are quite thin; many areas have no soils whatsoever, only barren exposures of rock. The local geology is quite complex, consisting primarily of volcanic extrusives in the form of flows. Some bands of ash occasionally appear. But, like other areas in the Sierra Madre,

the topography reflects the youthfulness of the mountains, and certainly this youthfulness is nowhere more apparent than in the case of soils.

All three streams, the Rio Bavispe, the Gavilan, and the Negro, are permanent, although fluctuating considerably from one season to the next. Most of the minor tributaries of these streams are ephemeral. Some of the larger tributaries may have water the year round, but during periods of prolonged drought they may also be dry.

Rio del Gavilan. In terms of total numbers of habitation sites near its course, as well as the over-all abundance of trincheras, the single most important drainage course in the whole of the area in which trincheras are found is the Rio del Gavilan. It is rivaled only by the Rio Negro or the Piedras Verdes, the latter lying to the east of the Continental Divide.

It was upstream from Tres Rios in the middle reaches of the Rio del Gavilan that the study of 1964 was located. The most impressive feature about the whole course of this stream is the enormous number of habitation sites that are situated in and near its valley. No other area examined reflects anything like the same degree of cultural remains. See Figures 31 and 32.

An ancillary investigation carried out under the direction of Mrs. Joyce Herold, during the 1964 field work, disclosed a total of 49 archaeological sites within the 9 square miles of the study area.\* Of these, 18 were farmhouses or crude 1- to 3-room structures of massive boulders, possibly used as storage places or as temporary dwellings near fields. Twenty-seven of the sites were pueblos - above-surface dwellings constructed of stone masonry (with one exception of adobe) of rectanguloid plan. Of these 27 pueblos, 10 were small (4-10 rooms est.), 10 were medium (10-15 rooms avg. est.), and 8 were large (20-30 rooms avg. est.). In addition, there was one village of slab enclosures which may have been pit houses, and at least two herd areas without discernible structures.

Three types of site locations were recorded for the Gavilan area. These were stream valley situations, mesa top situations, and slope situations. Twenty-three sites were located in stream valleys. These sites were never found on the present floodplain, but on the first terrace,

---

\* The following information has been supplied by Mrs. Joyce Herold, Instructor in Anthropology, Colorado Woman's College.

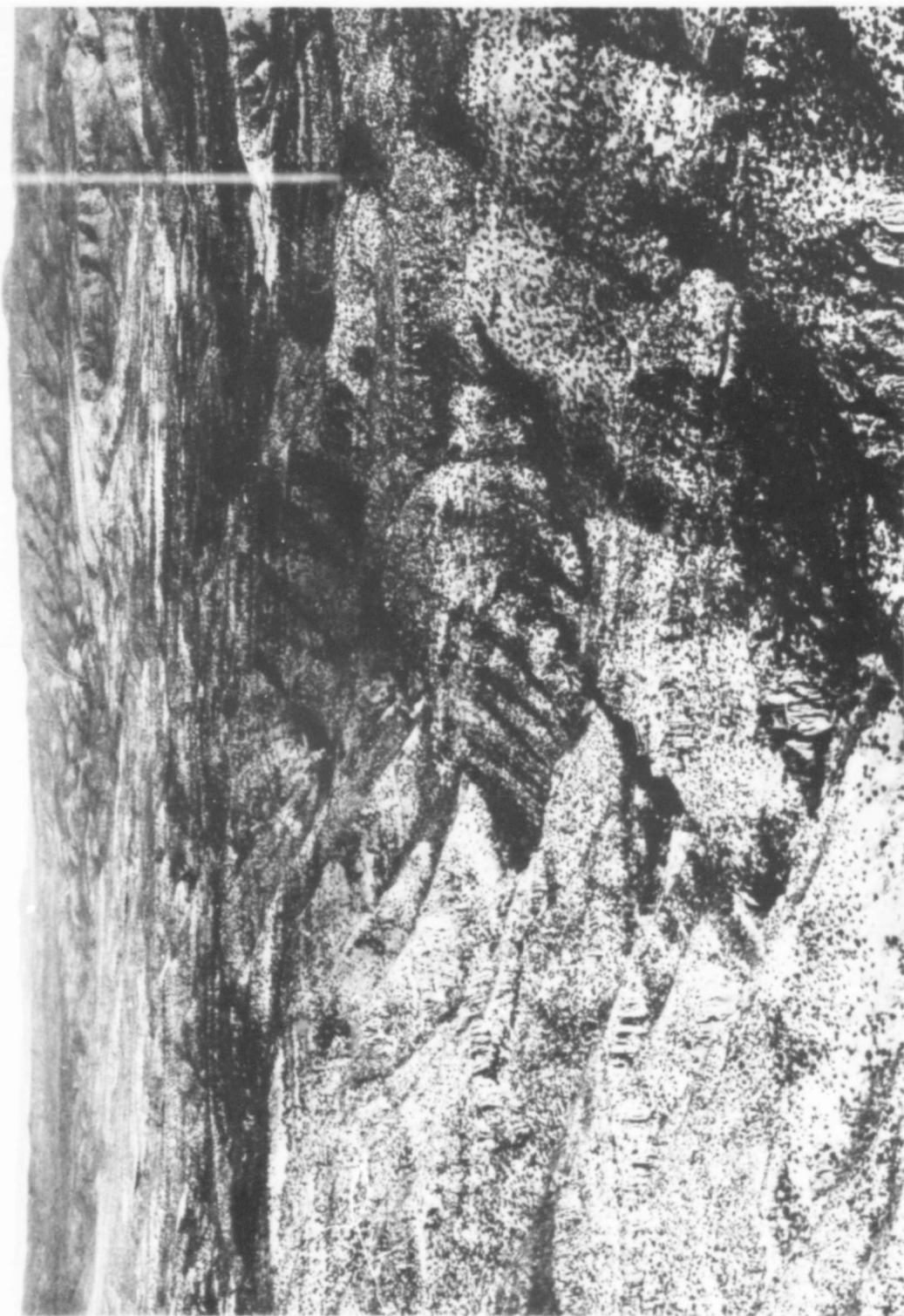


Figure 31. Aerial View Looking Northeast up Rio Gavilan Valley

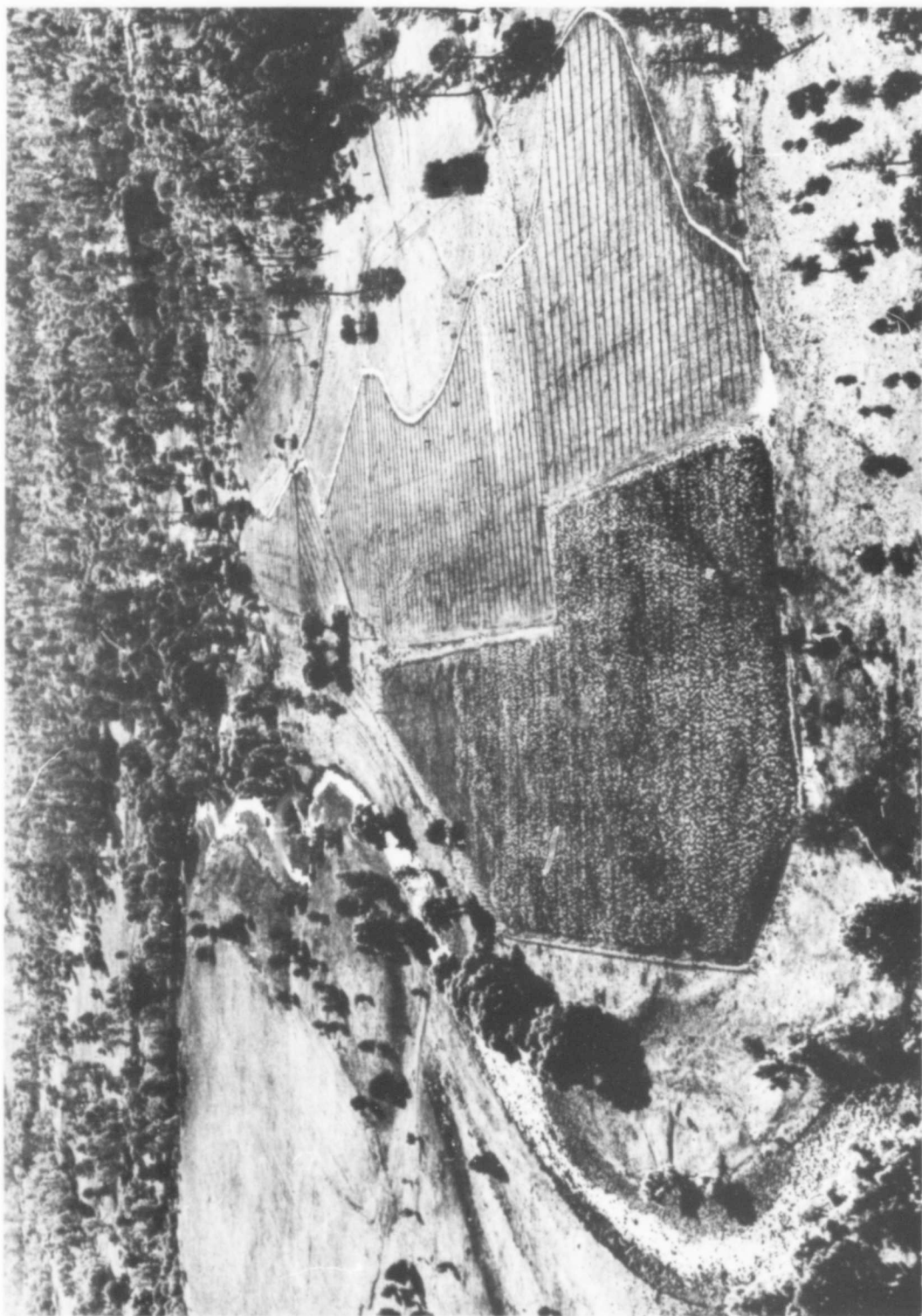


Figure 32. Modern Fields on Elvin Whetten Ranch - Rio Gavilan



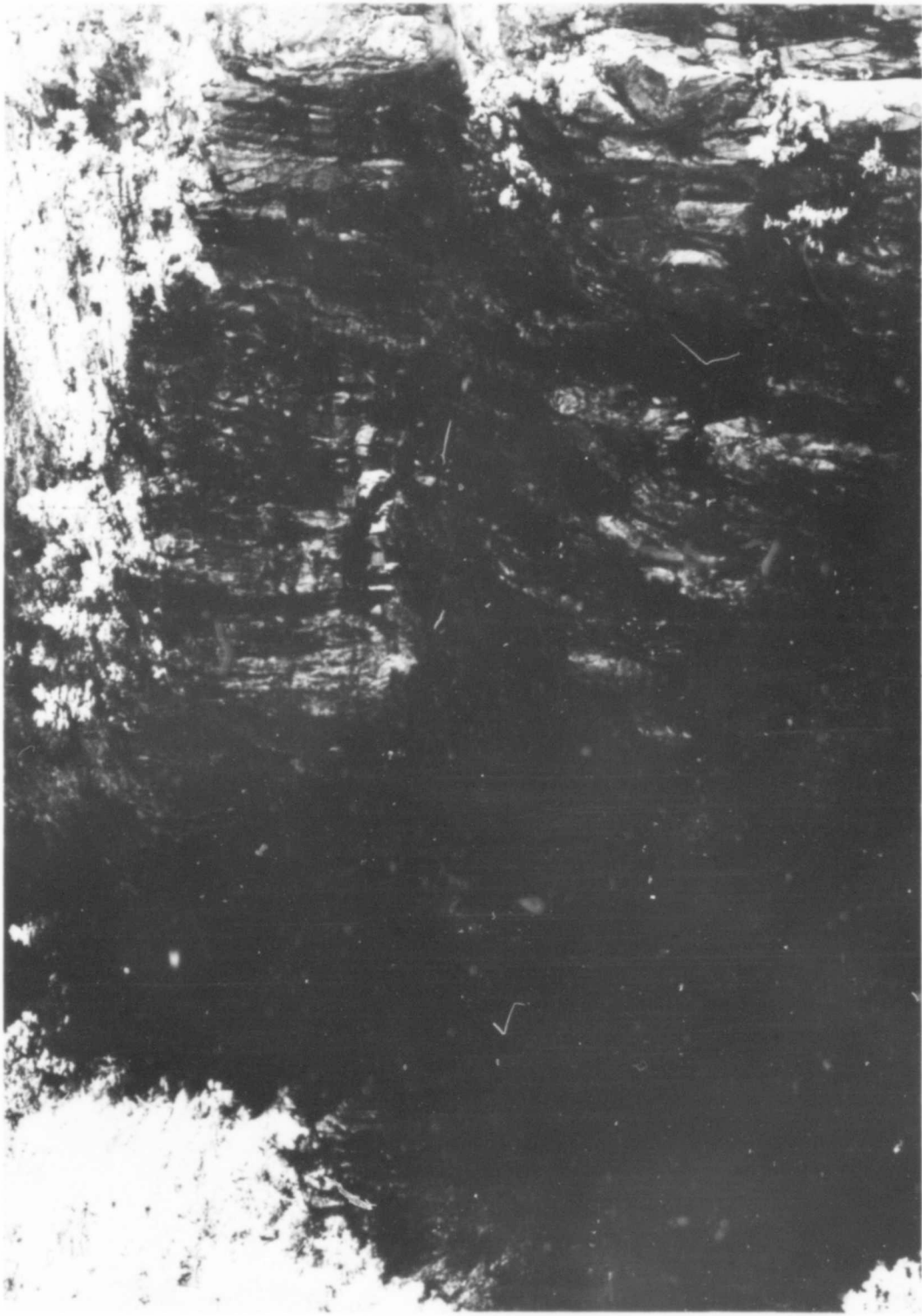
or a low structural terrace, if it was present. Nine sites were found on mesa tops. These locations were usually near ephemeral streams, but some were up to a mile from a permanent stream. Fourteen sites were on slopes, removed from river valleys and frequently quite isolated, although they were often within reasonable reach of an ephemeral stream. A discussion of the locational relationship between the habitation sites on the Rio del Gavilan and the distribution of trincheras there, will be saved for Chapter IV.

Inasmuch as the physical relationship of trincheras to environment along the middle section of the stream were described in the report ensuing from the study of 1964, the present account will dwell primarily on those portions of the stream lying outside of this previous study area.

In general, most ancient habitations on the Rio del Gavilan are similar to dwellings already described. Many are quite small and not very conspicuous. Therefore, attention will be given only to the larger and more important ones, at least as far as trinchera distribution is concerned.

Between Tres Rios and the area studied during the summer of 1964, are a number of important, and in many respects quite remarkable, cultural features. One of these is a very sizeable cliff dwelling situated in a cave approximately two-thirds the way up from the bottom of the 1,200 feet deep Rio del Gavilan canyon. See Figure 33. This particular dwelling is considerably larger than the one on the Arroyo del Oso in the north, described earlier. Whereas the larger of the caves on the Oso contained about twenty-five rooms, the Gavilan site has at least thirty-five rooms. In various parts, it is in excellent condition and quite well preserved. Many beams and door-windows, as well as roofs, are still intact. See Figure 34. Certain parts of the dwelling have been disturbed by animals as well as man. The construction is adobe, mixed with stone. Certainly, portions of the structure were two stories high and in the case of one part, may have been three stories. See Figure 35. Various artifacts are scattered over the site, including metates, manos, and broken axes. Also, one rather curious feature of this particular dwelling is a structure which appears to have been an aboriginal toilet.

Trincheras, exclusively of the check-dam variety, are found within a third of a mile of this site. None of these depart in any way from previously described constructional features. Most are from one to three courses high and are found mainly across dry washes feeding into the river below. The river itself is approximately one-half mile



**Figure 33. Air View of Cave Ruin on Rio Gavilan**



Figure 34. Cave Ruin on Rio Gavilan

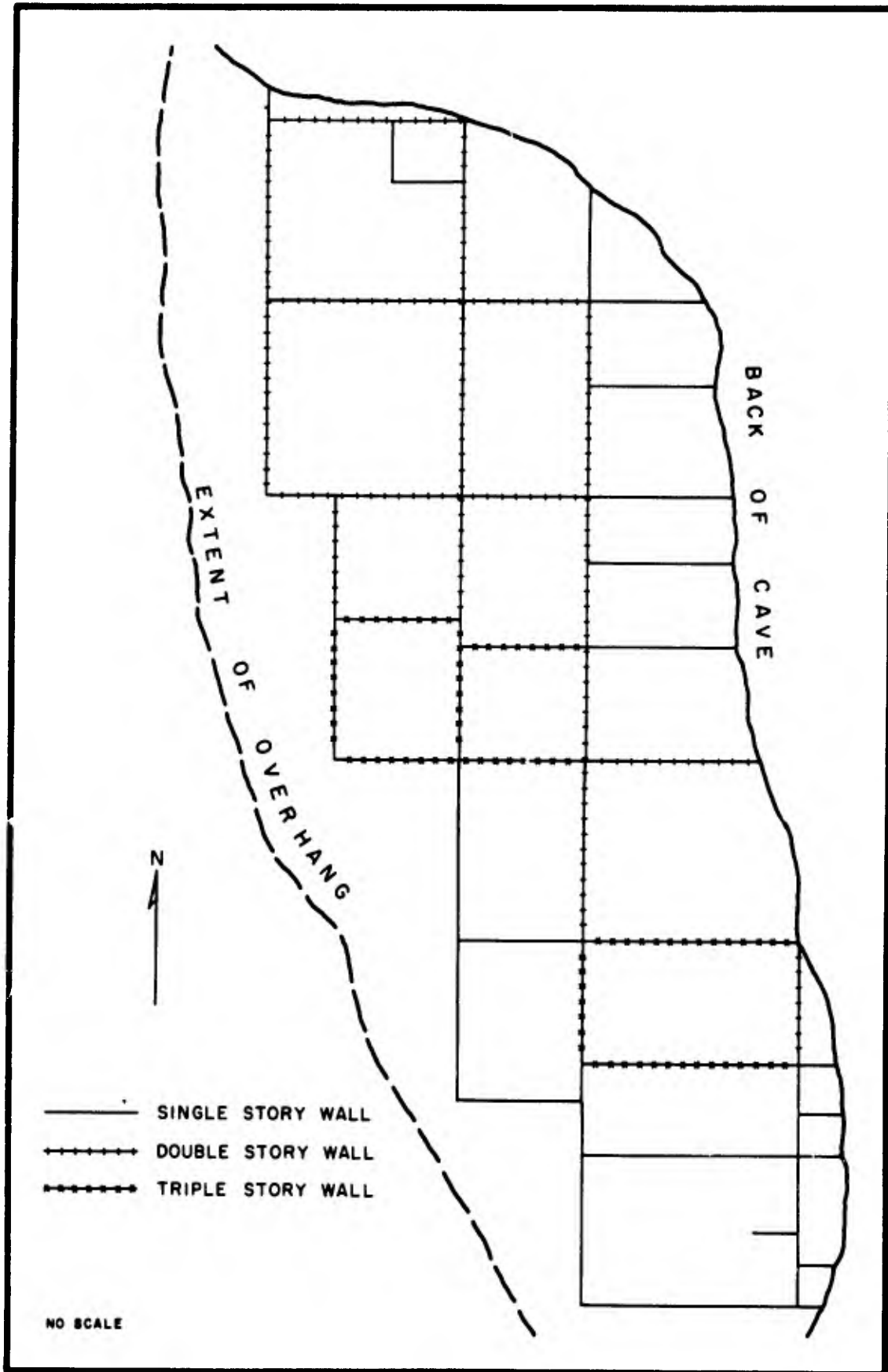


Figure 35. Floor Plan of Cave Ruin, Rio Gavilan

from the cave site, and as was mentioned earlier, the Rio del Gavilan in this portion of its course is permanent throughout the year, carrying considerable water even during the height of the dry season. The vegetation is mainly pine and oak with the pine more apparent in this location for two reasons: (1) the area has not been logged over as much as other areas nearby, and (2) this particular site is higher in elevation than others examined thus far. The approximate elevation is of the order of 6,000 feet. The local geology is again indicative of the general characteristics of the Sierra Madre complex as a whole. In this particular instance, varying flows of lava can be seen along the canyon walls. The cave itself is situated in an ash layer topped and floored by a flow. Topography of the immediate vicinity is dominated by the relatively deep river canyon, which has been incised into an undulating plateau.

Further upstream, there are numerous habitations near the river course. Some of these are of the type designated from the study of 1964 as "field houses" - small, one-room, single-story structures, often found associated with terrace trincheras, and presumably utilized as shelter or quite possibly as living quarters during times when the soil plots accumulated behind the long, terrace-type trincheras were being tilled. This particular type of structure appears too frequently to describe and indicate the location of each for the purposes of this study. Actually, most are quite similar in appearance. Many are situated atop mesas and appear to have been used possibly as lookout points rather than field houses. While the probable function of these features is important in the context of the whole cultural milieu, it is the larger habitation sites that command the greatest initial attention. There are a number of these larger sites along the middle and upper reaches of the Gavilan.

One of these large habitation sites is situated on a knoll a short distance upstream from the cave site. Here, trincheras radiate away from the dwelling site, nearly all of the check-dam variety. From the air, this appears to have been a three or more room structure. It is approximately one-third of the way down the canyon wall. See Figures 36 and 37.

Downstream, southwest of the cave site, are found many smaller habitation sites associated with considerable numbers of trincheras. In this particular location, the soils behind many of these trincheras have actually been cultivated in recent times, principally by Mexicans growing beans and corn. Many of these trincheras are as much as 600 feet apart, rising upslope from the river bottom on a gently inclined



Figure 36. Lower Gavilan Canyon

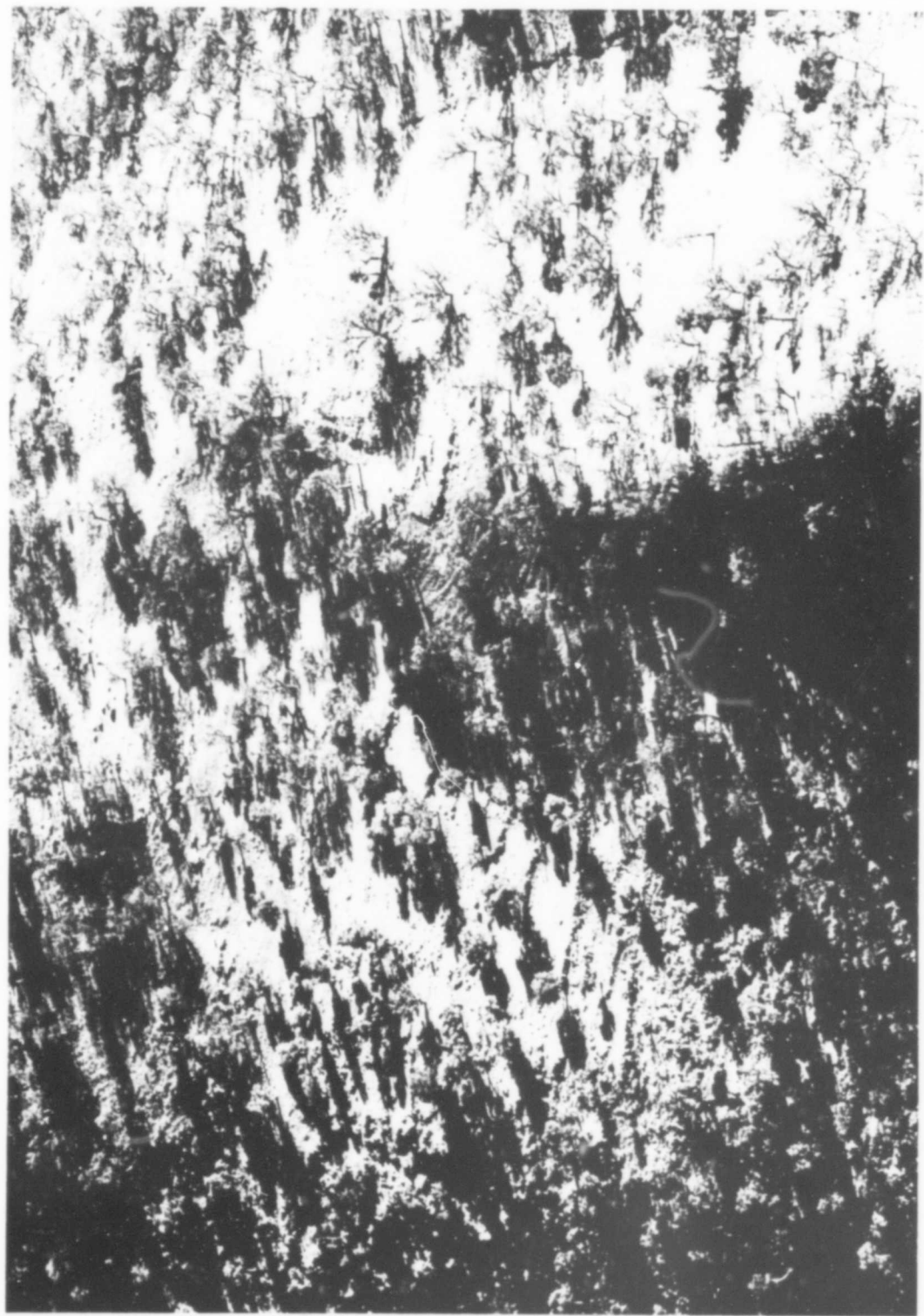


Figure 37. Ruin and Associated Trincheras on Spur shown in Figure 36. Lower Gavilan Canyon

terrace. Many of the trincheras seen at this location are among the best preserved yet seen.

Farther upstream, there is another large habitation site situated in a bowl-like area, approximately one-half mile in diameter, near the source of the Huitle Arroyo, a northwest tributary of the Gavilan Norte. This ruin is large, compared to the majority in this region, being approximately 250 feet by 100 feet. The buildings were two stories in height. It is a surface ruin and was constructed chiefly of stone and adobe, with more stone being used than appears to have been the case with other ruins in the general vicinity. It is in poor condition at present, having been cut into by pot hunters. Numerous artifacts can be found at the site, including axes, pottery, molcahetes, metates, and manos.

Trincheras are within 100 yards of the site. All those observed fall into the check-dam category. Most are from one to four stone courses high, with a few going higher. The vegetation in the area is principally pine. The approximate elevation of this site exceeds 6,800 feet.

Other habitation sites comparable in size to that along the Huitle Arroyo can be found along the lower reaches of the Rio del Gavilan Norte and the middle reaches of the main stream. All are surface sites and, in general, do not depart from the essential characteristics of the Huitle site. Most of these are in much better condition than the Huitle. In fact, some have not been disturbed at all, except by the forces of weathering and erosion. Nearly all these sites are located near the stream course. Typical of most of these ruins is a site located on a large mesa between the Rio del Gavilan and the Rio del Gavilan Norte. Like the main stream, the Gavilan Norte is a permanent stream, although fluctuating more than the master stream from season to season. This particular site is large, more than 350 by 150 feet in size. It appears to have been two stories high in certain parts. It was constructed chiefly of adobe. Broken bits of pottery are found quite readily in and around the site. Trincheras are within 100 yards and both the check-dam and terrace variety are represented. No departures in construction were observed that would distinguish any of these from others already described.

As was attested to earlier, no area seen compares with this area near the confluence of the Rio del Gavilan and the Rio del Gavilan Norte for sheer concentration of habitation sites and associated trincheras.



It is difficult not to draw the conclusion that this may have been the center of trinchera-building activity, if abundance alone is used as the criterion. Yet, when placed in the whole of the cultural milieu of northern Mexico, this area may not be as important as the occurrence of trincheras would lead one to believe. This is principally a problem for the archeologist to solve, but as was intimated earlier, the relationship of these mountain habitation sites and their associated trincheras to the large ruin at Casas Grandes seems to be the key.

One other site in the Gavilan drainage must be mentioned. This is on the upper reaches of the main stream in an area known as the Amarillas. The name comes from a ridge of mountains nearby called the Aingas Amarillas. The ruin itself is a surface site situated on a mesa top overlooking the river. It is considerably larger than similar surface sites farther downstream, being more than 300 feet on either side. Constructed of stone and adobe, and probably a goodly portion of it double-story, the ruin is approximately 200 yards from the stream and appears in excellent condition. The floor plan of the site indicates that the center portion of the structure was probably two stories with a plaza on the eastern side and a courtyard on the south. Two small, two-story structures on the south and north sides defy current interpretation. Such artifacts as pottery sherds, metates, manos, and numerous broken axes are much in evidence. This is one of the more important surface sites in the whole of the Gavilan drainage. Figure 38 shows the ruin of a small hut near some mesa top trincheras in the Amarillas area. Small huts of this sort are found frequently throughout the trinchera area.

The physiographic setting of the Amarillas site is remarkably like that near Altamirano. To the southwest and south of the site are open fields presently being cultivated by contemporary inhabitants of the area. A portion of the cultivated area is part of the river floodplain. The soils are deep and well developed compared to those beyond the river, toward the more rugged mountainous areas. The approximate elevation is 7,000 feet and the vegetation is almost wholly pine. In fact, the most active lumbering operations to be found in Mexico are just a short distance to the west and southwest. The headquarters of Bosques de Chihuahua (Forests of Chihuahua), a private company, is just a few miles to the southwest of this particular site. The Continental Divide is just to the east of the site and here elevations exceed 8,000 feet.



Figure 38. Ruin of Small Field Hut at Mesa Top Trincheras, Near Amarillas

As at Altamirano, trincheras are found mostly when one moves away from the site for some distance. (There are some very low trincheras within 200 yards of the habitation site, but these are the only ones within immediate proximity of the site.) Most trincheras near this site are quite low and fall into the check-dam category.

Rio Piedras Verdes and Its Tributaries. Before considering the area south of the Amarillas, there is one important area to the north which must be mentioned. It also is focused on a river drainage. The area in question is the valley of the Rio Piedras Verdes and its associated tributaries, especially the Arroyo de La Tinaja and the Arroyo de Tapiecitas.

From the headwaters of the Rio Piedras Verdes to the point where it is joined by the Arroyo de La Tinaja on the eastern side of the Sierra Madre, habitation sites of various types can be found all along its course. Trincheras, however, are not found throughout its full course. They are restricted to the portion of the stream's course found in the higher mountains.

Beginning with the headward portion of the stream, we find a relatively large habitation site near Colonia Garcia. The site is situated on a hill overlooking the large "vega" upon which Garcia is situated. The Continental Divide lies directly to the west, and the stream near the site, one of the headward tributaries of the Piedras Verdes, is within one mile of the ruin. The stream is permanent except during times of extreme drought. The site is of the surface type and is quite peculiar in that the entire site is enclosed by a one-course terrace wall. The dimensions of the site are in the order of 150 to 100 feet. It is in relatively good condition; pot hunters have not plundered it yet. Numerous artifacts can be seen, including such items as manos, metates, pottery sherds, broken stone bowls, as well as axes. The approximate elevation of the site is 7,000 feet.

Trincheras near this site fall into two categories, terraces and check dams. The only instance seen of the terrace category is the wall enclosing the habitation site. Check dams can be found within 150 yards of the site. All the latter are relatively low, averaging from one to three feet in height. Actually, there are not many trincheras found within the immediate vicinity of the site. The answer may again be the location of the ruin with respect to the large expanse of open land found to the east of the ruin. The ruin itself sits within the edge of the forest on the southwestern edge of the Garcias vega. Those trincheras found

near the site are in the dry arroyos to the west and southwest of the ruin, around the dissected margins of the vega. Similar circumstances can also be seen on the northeastern margins of the vega where trincheras are found within the arroyos at its margins. As with the case of the Altamirano site, the Amarillas ruin, and other somewhat similar situations along the Gavilan, there is the suggestion that trincheras were only necessary under circumstances where arable plots of soil were no longer sufficient to support existing populations. However, there is more reservation about this possibility with this site at Garcia, for here the expanse of arable land in the immediate proximity of the site is quite large. If this land was actually utilized by the inhabitants of this ruin, then it becomes quite difficult to visualize a situation where "population pressure" necessitated the construction of trincheras in order to bring more lands under cultivation. For Altamirano, Amarillas, and many of the smaller sites along the Gavilan, such a visualization is quite easily made, but in the case of this particular site, it seems extremely remote. Were the trinchera builders so wedded to the construction of this feature that they did not recognize the possibility of utilizing the already existing soils? This notion is possible but a ready answer seems extremely remote.

The physiographic setting of the Garcia site is not unduly different from the Altamirano and Amarillas sites. It actually is more like areas found to the south of the Amarillas near Colonia Chuhuichupa, which will be described later. The Rio Piedras Verdes flows northward along the eastern margins of the Garcia vega, while the habitation site is situated along the western margin on one of its tributaries. The vegetation near the site is predominantly pine, with grasses on the vega. The plain has not been cut into much except around its margins. Most of the vega is presently under cultivation by residents of the village of Garcia. Soils are relatively well developed on the vega, ranging in most instances from one to two feet deep.

Moving downstream along the Piedras Verdes, principally in its middle reaches near Colonia Pacheco and Ejido Ignacio Zaragoza, numerous habitation sites with clusters of trincheras can be seen quite easily. Sample Area D, described in the report of 1964, was near the village of Zaragoza. Trincheras and habitation sites are found near the village of Pacheco. A rather impressive, yet by no means large, cliff dwelling is found near Pacheco. The site is known as Cave Valley. Beyond Ejido Ignacio Zaragoza, as far downstream as Rancho de La Escondida, trincheras are numerous, always associated with habitation ruins. But out beyond the eastern flanks of the mountains, along the

lower portions of the Piedras Verdes, an entirely different situation is found. Habitation sites can be found quite readily along the course of the Piedras Verdes, as well as its major tributaries, such as the Arroyo de La Tinaja and the Arroyo de Tapiecitas, but trincheras are absent. A description of one of these sites along the Tinaja is sufficient to give the essential characteristics of these numerous sites.

Almost all of these sites are located along the courses of the Rio San Pedro and the Rio Casas Grandes. Quite typical is a rather large site near the confluence of the Piedras Verdes and the Tinaja. Situated on a terrace, approximately 50 yards from the bed of the Tinaja, this particular site is a surface structure of adobe, probably two stories in height. It compares in size with many of the large surface dwellings found in the mountains. The dimensions are about 200 by 100 feet. The present appearance is one of a mound of earth, quite inconspicuous; as with many of these sites, one can pass it by without being aware of its existence.

The physiographic setting of the Tinaja site is in striking contrast to that of similar structures found in the mountains. The surrounding landscape is one of a rolling, untimbered, grassy valley. Sycamore and cottonwood are the only trees seen, and these are found only along the stream banks. The approximate elevation of the site is about 5,000 to 5,200 feet. The Arroyo de La Tinaja is ephemeral in its lower reaches, with pools of water found in its upper reaches. In almost all respects, this setting is quite similar to the sites along the Rio San Pedro and the Rio Casas Grandes.

The South. Rio Negro - Garabato - Barranca del Cobre. Thus far, the habitation sites described have exhibited none of the characteristics that would lead one to conclude that they may have been located for defensive reasons. Of course, when considering a cliff dwelling, it is always easy to think of such a location as offering a measure of protection. But in the case of surface dwellings, and these certainly make up the majority of habitation sites in the northern Sierra Madre, most have been located along stream terraces or on mesa tops. All have been quite open. With very few exceptions, none have been so located as to be atop a peak or in such a position as to have a commanding control of a strategic point. To the south and southwest of the Amarillas site, however, the location of habitations and defensive considerations are closely bound together. This is quite evident in the area of the Rio Negro.

In this more southerly portion of the range of trincheras, a striking factor is evident - a paucity of both habitation sites and associated trincheras. Apparently, the general area south and southwest of Chuhuichupa was quite marginal to the trinchera-building culture. Whether or not this is an indication that the trinchera culture moved up from the south and that the trincheras found here are earlier constructions is difficult to say. Trincheras within this area appear to be more crudely constructed than those of the north. On the other hand, they could be the southern extent of the trinchera-builders' cultural area. As such, they would appear more crudely constructed, since they were in a marginal position with respect to the center of the cultural area. Careful examination of the archeological materials should throw light on these speculations. The over-all pattern of this area shows diminishing occurrences of trincheras. Where they are found, the associated habitation sites are located so as to take advantage of defensive positions.

Quite typical for many of these sites is a ruin found on the Rio Negro a short distance upstream from where it is joined by the Rio Chuhuichupa. The ruin is on the very top of a small peak just a short distance from the Rio Negro. Compared to other surface ruins already described, this particular site is large. It is approximately 200 by 150 feet. It is constructed of stone and probably was two stories high in certain parts. The western side of the ruin is built up in a series of terraces. The ruin is ideally situated for defensive needs, having steep cliffs on three sides and a narrow access way from the peak onto another point nearby. The ruin is in very good condition. It has not been cut into at all by pot hunters, although a graveyard situated at the base of the eastern side of the peak has been disturbed. More artifacts are found near this site than any other thus far discussed. Numerous metates and manos are found scattered about the site; pottery and axes are also quite abundant.

Two types of trincheras are found near the site. Terrace-type trincheras constitute part of a retaining wall along the western side of the habitation structure, while check-dam trincheras are found in gullies near the site. Neither type represents a marked departure in over all appearance from other trincheras seen up to this point, although most of these reflect less care in construction. This appearance of crudeness in construction could, however, have been brought about by time. Within the general area of this particular site, trincheras are found quite readily. They are most abundant in the lesser tributaries of the Rio Negro. Most of these are nothing more than arroyos which seldom have water in them, except during the rainy season.

In February of 1966, part of the Rio Negro drainage was examined again, working out of Mesa del Huracán with the help of personnel from Bosques de Chihuahua. The impression gained at this time corroborates that contained in the previous few paragraphs. The area examined lay between the Rio Negro and the Rio Chuhuichupa, a short distance above their junction. Trincheras were found in a number of short tributaries to both streams. Invariably, the structures were smaller and the workmanship was more crude than that of trincheras on the Rio del Gavilan or the Rio Piedras Verdes. Likewise, they were much less numerous than on drainages farther north.

There is the suggestion that the complex of habitation sites along the Rio Negro, and the one described certainly is not the only one, represents a continuation of the cultural complex from Tres Rios south. Access is gained to the intervening region either by foot or horseback. Information volunteered by residents of the area indicates very little difference in the material culture of the intervening area. Throughout this area, lying to the west of the large vega upon which Colonia Chuhuichupa is located, are found habitation sites similar to that described along the Rio Negro, each in turn associated with trincheras. The physical characteristics of this area are depicted in Figure 39. This area does not compare on the basis of cultural density with the Gavilan nor the Piedras Verdes drainage areas. Habitation sites and trincheras clusters are more discrete and are found chiefly within the headward portions of streams cutting into the western margin of the Chuhuichupa vega. There is a large portion of the area, from south of Colonia Chuhuichupa, north past Mesa del Huracán, to the middle reaches of the Gavilan, where trincheras are conspicuously absent. This is a broad, relatively uniform area straddling the Continental Divide, covered with heavy timber. Physiographically, the forested portion is similar to the almost flat vega near Colonia Chuhuichupa. It is at the margins of this flat-to-rolling upland that habitation sites with associated trincheras are found, more so in the west than to the east, although there is a very important habitation site just southeast of the Mesa del Huracán.

Before describing the territory from Chuhuichupa south to the Barranca del Cobre, attention must be drawn to the largest cliff dwelling in the whole of the northern Sierra. This is situated in a large cave on the northern side of the Arroyo Garabato, a tributary of the Rio Chico. At least forty rooms in size, this site is immensely impressive in its location. The construction is adobe, mixed with stone, and portions of it are three stories in height. Its present condition ranges from poor

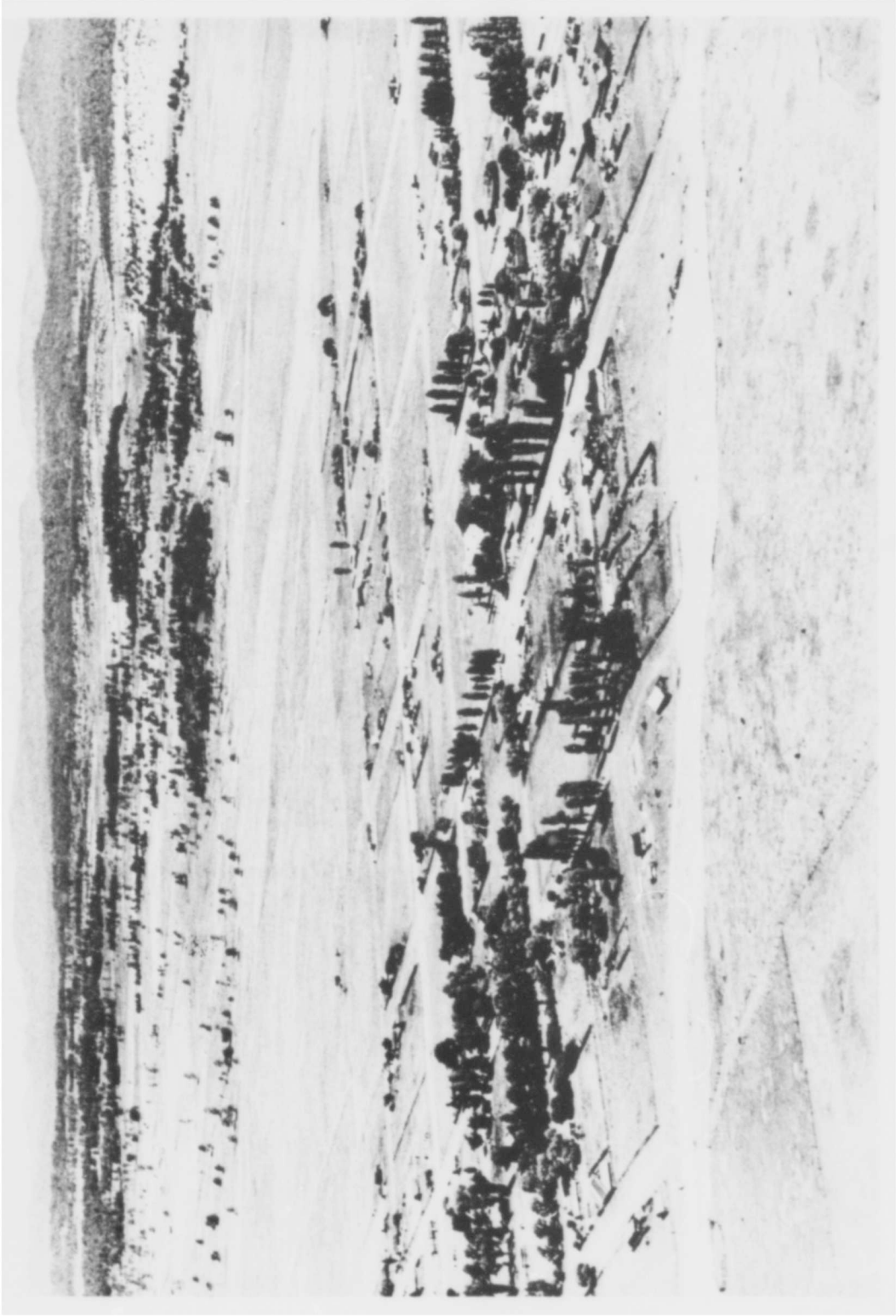


Figure 39. Colonia Chuhuichupa



to good. Some of the original roofs are intact, although large portions have suffered damage from domestic animals and man.

The setting of the cliff dwelling is remarkably like that along the Gavilan, described earlier. Situated at approximately 7,500 feet, the site is considerably higher in elevation than most others previously examined. The surrounding countryside is plateau-like, but deeply dissected by cliff-sided canyons. The vegetation is composed chiefly of pine and fir. The stream near the site is permanent, although fluctuating considerably from season to season. Like most of the caves found throughout this part of the Sierra Madre, this particular one occurs within a bed of ash, capped and floored by lava flows. No trincheras are found near the dwelling site itself, although directly across the canyon are numerous check dams of intermediate heights. Where trincheras are found near this site, they do not appear in as good a state of repair as those in the Gavilan drainage to the north. This last statement applies to all areas south and southwest of Chuhuichupa.

As was pointed out earlier, the nature of the topography in the southern part of the study area is considerably different than that in the north. More of the landscape consists of enormous vegas, open flat grasslands, which are now cultivated intensely by dry land farmers. The higher portions of the Sierra, along which the Continental Divide follows, and which lie to the west of the vegas, are extremely rugged and very inaccessible. In this difficult area are to be found the few trincheras present in this southern area. Beyond the area immediately southwest of Chuhuichupa, habitation sites as well as trincheras are relatively rare. Habitation sites are small and trincheras are scattered, in poor states of repair, and, in general, not as impressive in appearance as those of the north.

Most habitation sites south of Chuhuichupa do not differ to a marked degree from sites along the Rio Negro. One exception is found on the northern edge of the Barranca del Cobre, the enormous canyon cut by the Rio Urique in the southern part of Chihuahua. Rivaling the Grand Canyon of the Colorado in size and exceeding it in depth (over 6,000 feet in its deeper parts), this feature exemplifies the rugged nature of the terrain in this part of the country. Here, trincheras are found in the pine zone, which lies at the elevation of the tableland into which the canyon is incised, from 7,500 to over 9,000 feet. At the edge of the canyon is found a habitation complex with associated trincheras. Most of these structures are low, between one and four feet, and all that were observed were in the check-dam category.

Despite the distance from the apparent center of trinchera construction, these trincheras at the Barranca del Cobre exhibit characteristics similar to those in the north, although they appear to have been constructed with less care.

Distribution of Sonoran-type Trincheras: Over-all  
Characteristics.

Up to this point, the discussion has been concerned with the characteristics and distribution of Sierra-type trincheras. However, Sonoran-type trincheras have received some attention in the past, and it was principally from reports of them that attention was first called to this type of prehistoric structure. The small village of Trincheras in Sonora probably was named for the Sonoran-type structures near it. In order to draw a clear distinction between types, several centers of Sonoran-type trincheras were visited. This distinction is made in the Introduction and is now elaborated upon.

Sonoran-type trincheras are found principally in west-central Sonora in the vicinity of Santa Ana and farther west and north near the village of Trincheras. They appear most typically as terraces atop prominent peaks. They appear to have been used principally for defense; however, artifacts found scattered over many sites indicate that they were also used for residential purposes. As has been pointed out by other writers, these structures may have actually had some sort of religious significance.

The construction of these features has some similarity to the Sierra-type trincheras; yet upon close examination, they are quite different. Rubble piled in such a manner as to create a rock wall or terrace is the main characteristic that the two have in common. However, the care taken in constructing the Sierra-type trincheras is not always obvious in the Sonoran type. Only the outer wall appears to have been so constructed that the rocks were actually put into place to create a uniform surface. Behind this wall, rubble is dumped for filler. No use of adobe for chinking was observed at any point in these structures. In general, the dam-like characteristics of the Sierra-type trincheras are not found in the Sonoran-type features. If the mantle is removed from behind one of the Sierra-type structures, one observes a wall, usually broader at the base than at the top. Mantle is not found behind the Sonoran-type trincheras. Rather, rubble has been dumped behind the outer wall in most instances, creating a barricade or terrace-like structure. In a few instances, one can observe trenches left behind the

walls, indicating the defensive purpose of these structures. See Figures 40 and 41.

Many of these Sonoran-type trincheras completely encircle the tops of isolated peaks. Looking upslope at these features, one gains the distinct impression of viewing a fortification stronghold. They appear one after the other and may number as many as ten or more walls encircling or partially encircling the summits. One such peak, just east of Santa Ana, shows the recognition by the builders of the importance of landform shapes. This particular peak has a very steep drop-off on one side, making it very difficult to ascend at this point, while the remaining slopes are gentle. Trincheras were constructed on the three sides where an obvious need existed, while the other side was left without any sort of barricade. The location of these structures near summits quite removed from stream lines tends to rule out their use for agricultural purposes.

As was pointed out in Chapter I, many of these Sonoran-type trincheras may easily be confused with similar features constructed as fortifications during the Mexican Revolution. Both appear under similar topographic circumstances. The vegetation of the region does not offer much in the way of cover, which explains why both the Indians and the later Mexicans would have seen the necessity of building these structures for protection. Only on the higher mountains to the east do trees appear, and in a few instances these strongholds were constructed to take advantage of this additional protection.

Near the Indian trincheras examined there were numerous artifacts, especially pottery. Some pieces of pottery were sufficiently large to lead one to the conclusion that they originally were part of water storage vessels. Whether the builders of these structures actually lived on the site or not is difficult to say. In one instance, a small habitation structure was found downslope from the fortification. This might suggest that the inhabitants lived away from the site of the trincheras and retreated there only when under attack.

Taken as a whole, these Sonoran-type trincheras do not form an important element of the landscape. In fact, unless called to one's attention, their presence could go completely unnoticed. It is very doubtful if they have had an appreciable effect on the physical environment, except in a very small way, e. g., offering a measure of protection to the upper slopes of affected peaks, preventing loose debris from washing down with runoff. Even here, the actual areas affected would be extremely small indeed.

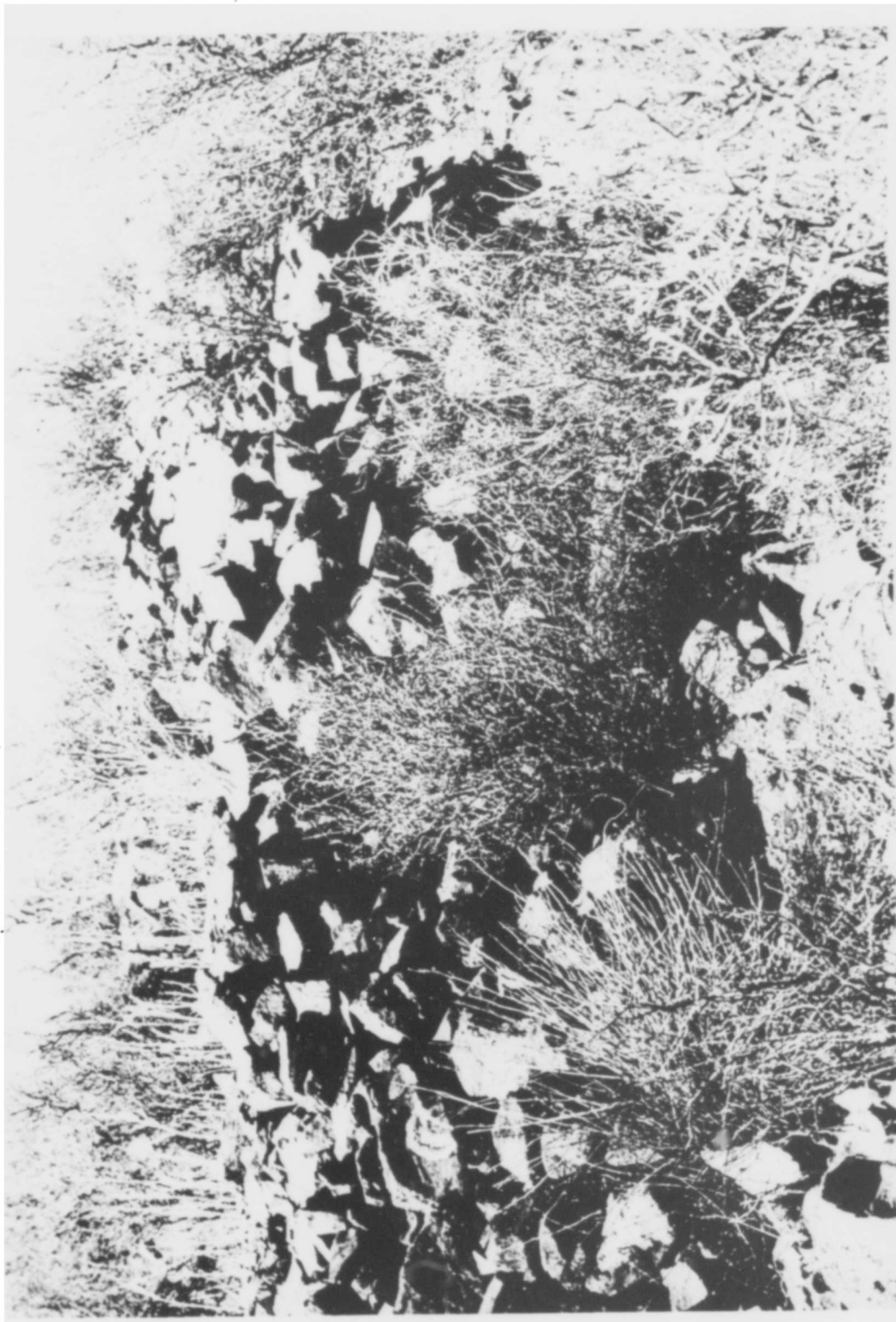


Figure 40. Outer Wall of Sonoran-Type Trinchera, Santa Ana, Sonora

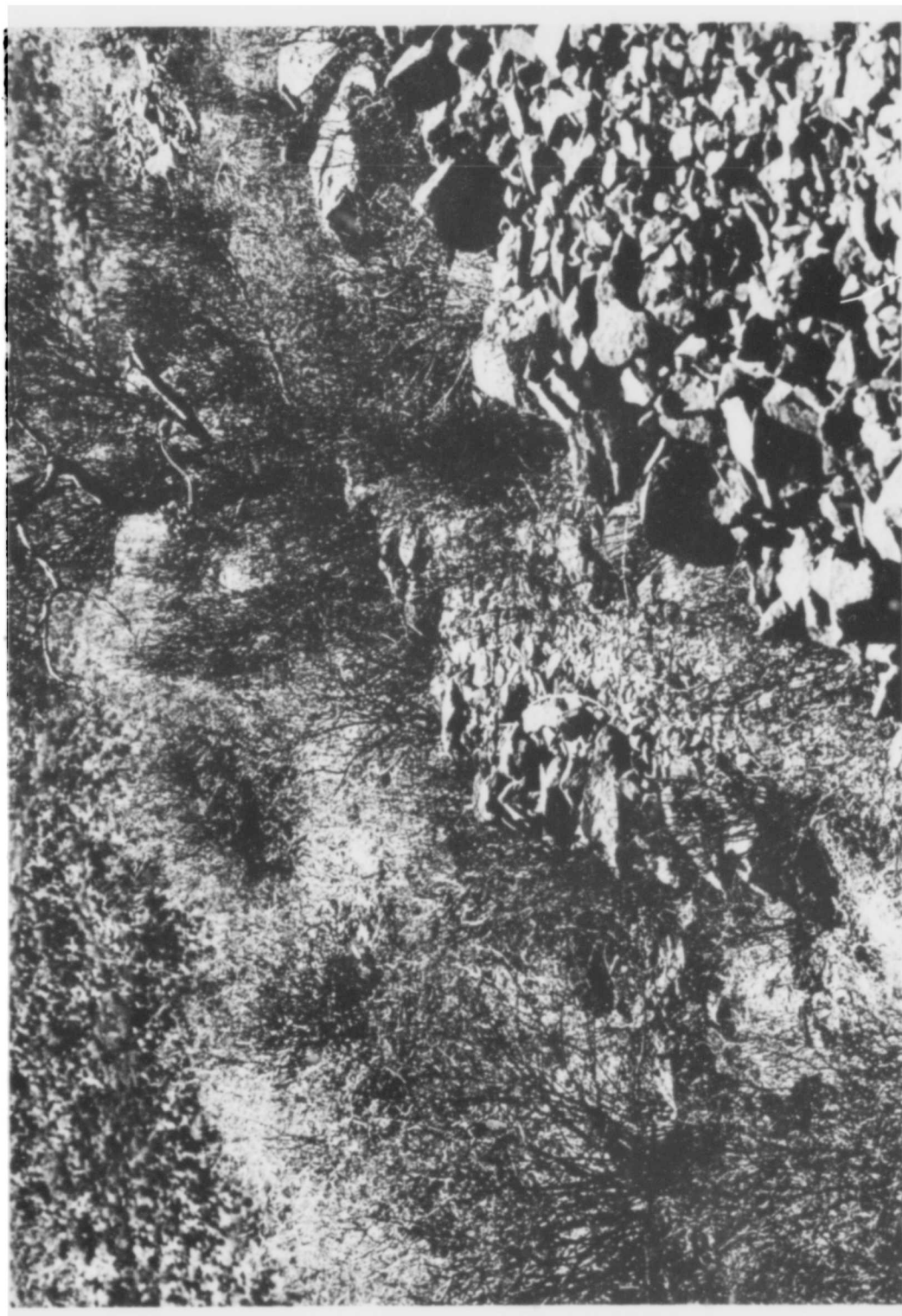


Figure 41. Sonoran-Type Trincheras from above. Near Santa Ana, Sonora

## CHAPTER IV

FACTORS AFFECTING THE OCCURRENCE  
AND DISTRIBUTION OF TRINCHERAS

A number of factors appear to have a discernible influence on the over-all occurrence and distribution of trincheras. At least three major associational relationships seem to exist: (1) the association of habitation sites and trincheras; (2) relationships to topography; and (3) factors not so readily discernible, which would more properly be termed archeological in nature.

Trincheras in Relation to Habitation Sites. Attention is primarily focused on the relationship of the Sierra-type trincheras to habitation sites. For the purposes of this report, the Sonoran-type trincheras are secondary in importance.

The association of trincheras with aboriginal habitation sites is unquestionably the single most important factor controlling the occurrence and distribution of these structures. They are found only in conjunction with these former dwelling sites. As was pointed out earlier, trincheras do not occur in a general fashion throughout the Sierra Madre. There are many areas within the mountains where they are completely absent. In fact, taking the whole range of trincheras, these structures actually affect a very small portion of the total territory in which they are found. Trincheras were apparently built by a people who lived permanently at the site of their construction and who used them when they were built. There does not seem to be any evidence that trincheras were built at a great distance from the culture center, to serve some vague purpose such as flood control or water conservation.

Topographic variations played an important role in determining the locations where trincheras were actually constructed, but it is difficult to think that topography was the primary factor. The evidence seems to indicate that habitation sites were developed first and trincheras were built later.

Mrs. Herold made the following observations during the 1964 field work:\*

- "1. Settlement is definitely related to the presence of trincheras.

Adjacent to or within every extensive area of trincheras development, there are indications of settlement, including either or both:

- a. Farmhouses, located at the immediate trincheras sites.
- b. Pueblos, located near (within several hundred yards) the trincheras.

With very few exceptions, settlement sites are associated with some degree of nearby trincheras construction.

2. However, neither the amount of trincheras-controlled mantle nor the number of trincheras is directly correlated with the size of the pueblos nearby.

The larger settlements are found in areas (river valleys) of only moderate trincheras development.

The greatest concentrations of trincheras are most directly associated with some of the more medium-sized settlements.

3. Each functionally-integrated trincheras system, perhaps in one drainage area, is not necessarily associated with a single pueblo or settlement grouping.

In the several cases where multiple pueblos in different locations are associated with a well-developed trincheras system, the pueblos may or may not represent different periods of settlement.

4. Examples: (trincheras areas from Herold, 1965)
- a. Within the mesa and slope land of Area A, which has extensive development of trincheras, are situated 2 farmhouses and 2 pueblos, medium

---

\* Personal communication.

and small in size. In the river valley at and near the mouth of the stream, which drains Area A, and .3 mile from the trincheras of Area A, are 2 small and 1 large pueblos.

- b. Within the valley situation of Area E, associated with a moderate development of trincheras, is found one of the large pueblos with 2 small farmhouses.
- c. In Area B, where trinchera control is high, are one medium-sized pueblo on the river terrace and 3 farmhouses in slope and structural situations.
- d. Near the sites of the large adobe pueblo and the pithouse (?) village near the Whetton Ranch, evidences of trincheras are few, but a large extent of arable alluvial soil is available.
- e. Several large pueblos along the river valley have only small to moderate development of trincheras nearby, as well as rather limited alluvial soils."

Two important factors apparently helped to determine the location of major habitation sites. First was the proximity of the site to permanent water supplies. All large habitation sites observed during the course of this study were near permanent sources of water. Even relatively minor sites, where size is used as the criterion, were not too distant from sources of water. Second, in a number of instances, e. g. , the Altamirano site, the Amarillas site, and some of the sites along the Gavilan, there is the suggestion that habitation sites were located to take advantage of deposits of alluvial soils. Whether these soils were actually cultivated is problematical. Within the Sierra region, soils of any importance are found only as alluvial deposits along stream courses or as accumulations behind trincheras. The larger habitation sites were located near soils easily utilized. It seems unlikely that this is a mere accidental relationship.

Another rather obvious factor had an important bearing on both the location of habitation sites and the construction of trincheras. This association occurs only where the forces of weathering and erosion have produced the rocks necessary for the construction of trincheras. One might be inclined to think that these building materials could be found anywhere within the mountains, but this is not the case, especially in the southern part of the area.



Trincheras are clearly concentrated in the northern portion of the Sierra Madre. This observable pattern seemingly is not to be explained by topographic or climatic relationships. It is very likely that the relationship between the mountain habitation sites and the large ruin at Casas Grandes holds the key. This is a problem for the archeologist.

Trincheras in Relation to Topography. As was made abundantly clear in the study of 1964, trincheras occur in a variety of topographic situations. The most typical location is one across ephemeral stream valleys, giving rise to the designation "check dams." But they are also found in other situations, including mesa flats, gentle slopes, steep slopes, and interfluves. In a very few instances, they are found along the courses of permanent streams, apparently either crossing the stream or extending out from the banks to the possible highest water level. Only two instances of the latter have been observed throughout the period trincheras have been under study by this group; however, they merit classification. The other topographic situations appear over and over again in the many areas examined. While each area exhibited topography with similarities to other areas, the important point is that diversity of site topography makes it difficult to make any density and distribution estimates based solely on the factor.

Trincheras and Archeology. It was stated in the early stages of the Introduction that trincheras are an important part of the pre-historic cultural milieu of northern Mexico. In this connection, answers to the most fundamental questions about these features come within the realm of the archeologist. What the age of these structures may be, who were the builders, and what was the relationship of the features to the over all culture of the area can only be answered by a close examination of the cultural remains associated with these structures. This is sufficiently vital to be one of the next research steps in the study of trincheras.

Trincheras Density and Distribution. There is the very strong suggestion that the larger the habitation complex, the more abundant and widespread are the trincheras. But, a density figure for one area may prove completely meaningless in another, due, in part, to the variations and differences in localized topography. Thus, to arrive at a density figure for the areas affected by trincheras in the whole of the Sierra Madre would necessitate the large scale mapping of all areas affected and the derivation of some designation of average density for

the areas concerned. During the work of 1964, it was pointed out that the total acreage controlled by trincheras was approximately 10 per cent of the total land surveyed. Since the Gavilan seems to have been more densely settled than most other parts of the Sierra Madre, a density figure derived from it would be inaccurate for the remainder of the region. At the same time a 10 per cent density figure seems light for an area which has been characterized as heavily populated with these features. This would seem to indicate the absolute density figures should not be equated with the cultural influence of trincheras.

Distribution or areal spread of trincheras is very definitely related to the size of the habitation complex. Local topography determines where they actually occur, but how far outward they extend is related to the function for which they were constructed. We must assume that they are the works of individuals with definite functional views in mind, e. g. , agriculture (this appears to be the most plausible and also the most widely-accepted function), and as such, they would not appear helter-skelter over the countryside with no attention to distance. Thus, trincheras were constructed near the habitation sites and, to the extent that they spread away from the dwelling sites, need was the determining factor. In most instances observed, it is extremely difficult to distinguish trincheras that may have been a part of the vicinal pattern of one habitation site as contrasted with another.

Trincheras and Further Research on Their Effects on the Physical Environment. Aside from the need for further archeological research on these structures, their physical effects on the topography should be investigated in greater depth. This should shed some light on the functions of these structures, complementing the efforts of the archeologist.

Two avenues of approach suggest themselves. First, a thorough examination of the effects of trincheras on soil conservation would be a very worthwhile endeavor. A possible starting point would be a study of the success achieved by Bosques de Chihuahua in constructing modern trincheras to prevent erosion. A comparison of these contemporary trincheras with areas affected by aboriginal structures could prove quite revealing as to total effects. The modern trincheras could likewise serve as a control for studies of aboriginal structures in the same environment.

Second, a possible avenue for determining what the physical environment was like during the time these features were being constructed would come from additional work in pollen analysis. This should be tied to further study of the relict forests found in many places throughout the Sierra Madre. Douglas fir, spruce, and aspen are found in isolated pockets in the higher mountains. An attempt to reconstruct the forests which covered the mountains during the time these structures were being built should open a number of avenues toward an understanding of these features.

## BIBLIOGRAPHY

- Bandelier, A. F., 1892, Final Report of Investigations Among the Indians of the Southwestern United States Carried on Mainly in the Years from 1880 to 1885, Papers of the Archaeological Institute of America, American Series III and IV: Cambridge, John Wilson and Son, 323 pp. and 591 pp.
- Blackiston, A. H., 1905, "Cliff Dwellings of Northern Mexico," Records of the Past, Vol. 4
- \_\_\_\_\_, 1906, "Cliff Ruins of Cave Valley, Northern Mexico," Records of the Past, Vol. 5
- Boletin Meteorologico, Estado de Chihuahua, 1958, Circular la Campana No. 2, Septiembre de 1959, 117 pp.
- Boletin Meteorologico, Estado de Chihuahua, 1959, Circular la Campana No. 6, Noviembre 1960, 67 pp.
- Boletin Meteorologico, Estado de Chihuahua, 1960, Marzo 1962, 67 pp.
- Boletin Meteorologico, Estado de Chihuahua, 1962, Boletin No. 6, Agosto 1963, 86 pp.
- Brand, Donald D., 1935, "The Distribution of Pottery Types in Northwestern Mexico," American Anthropologist, n. s., 37, No. 2
- \_\_\_\_\_, 1937, "The Natural Landscape of Northwestern Chihuahua," University of New Mexico Bulletin, Geological Series, 5, No. 2
- Bryan, Kirk, 1929, "Flood-Water Farming," Geographical Review, 19, No. 3, pp. 444-456
- Carey, Henry A., 1931, "An Analysis of the Northwestern Chihuahua Culture," American Anthropologist, n. s., 33, No. 3
- Forde, C. Daryll, 1931, "Hopi Agriculture and Land Ownership," The Royal Anthropological Institute Journal, 61:357-405
- Hack, John T., 1942, The Changing Physical Environment of the Hopi Indians of Arizona, Papers of the Peabody Museum of American Archaeology and Ethnology, Vol. 35, No. 1: Cambridge, Peabody Museum, Harvard University, 80 pp.
- Heede, Burchard H., 1960, A Study of Early Gully-Control Structures in the Colorado Front Range, Station Paper No. 55, Fort Collins, Colorado: U. S. Forest Service, Rocky Mountain Forest and Range Experiment Station, 42 pp.

- Herold, Laurance C., 1965, Trincheras and Physical Environment Along the Rio Gavilan, Chihuahua, Mexico, Technical Paper 65-1: Denver, Colorado, University of Denver, Department of Geography, 233 pp.
- Hovey, Edmund Otis, 1905, "The Western Sierra Madre of the State of Chihuahua, Mexico," Bulletin of the American Geographical Society, 37:531-543
- Huntington, Ellsworth, 1914, The Climatic Factor as Illustrated in Arid America, Carnegie Institution of Washington, Publication 192, 341 pp.
- Ives, Ronald L., 1936, "A Trinchera Near Quitovaquita, Sonora," American Anthropologist, 38:257-259
- Johnson, Alfred E., 1960, The Place of the Trincheras Culture of Northern Sonora in Southwestern Archaeology, Unpublished M. A. Thesis, University of Arizona
- King, Robert E., 1939, "Geological Reconnaissance in Northern Sierra Madre Occidental of Mexico," Bulletin of the Geological Society of America, 50:1625-1722
- Leopold, A. Starker, 1949, "Adios, Gavilan," Pacific Discovery, Vol. II, No. 1, pp. 4-13
- Leopold, Aldo, 1937, "Conservationist in Mexico," American Forests, 43:118-120
- \_\_\_\_\_, 1953, Round River (From the journals of Aldo Leopold): New York, Oxford University Press, 173 pp.
- \_\_\_\_\_, 1949, "Song of the Gavilan," A Sand County Almanac and Sketches Here and There: New York, Oxford University Press, 226 pp.
- \_\_\_\_\_, Carl S. Leopold, and A. Starker Leopold, 1953, "Sierra Madre," Round River: New York, Oxford University Press, pp. 130-141
- Lister, Robert H., 1958, Archaeological Excavations in the Northern Madre Occidental, Chihuahua and Sonora, Mexico, University of Colorado Studies, Series in Anthropology No. 7: Boulder, Colorado, University of Colorado Press
- Lobeck, A. K., 1948, Physiographic Provinces of North America: Maplewood, N. J., C. S. Hammond

- Lumholtz, Carl, 1903, Unknown Mexico, Vol. 1: London, Macmillan and Co., Ltd., 530 pp.
- \_\_\_\_\_, 1912, New Trails in Mexico: New York, Charles Scribner's Sons, 365 pp.
- McCabe, Robert A., 1955, "The Prehistoric Engineer-Farmers of Chihuahua," Wisconsin Academy of Sciences, Arts and Letters, 44:75-85
- McGee, W. J., 1896, "Expedition to Seriland," Science, n. s., 3: 493-505
- Rohn, Arthur H., 1963, "Prehistoric Soil and Water Conservation on Chapin Mesa, Southwestern Colorado," American Antiquity, 28, No. 4: pp. 441-455
- Sauer, Carl, and Donald Brand, 1931, Prehistoric Settlements of Sonora, with Special Reference to Cerros de Trincheras, University of California Publications in Geography, Vol. 5, No. 3: pp. 67-148
- Sayles, E. B., 1936, An Archaeological Survey of Chihuahua, Mexico, Medallion Papers, No. 22: Globe, Arizona, Gila Pueblo
- Steward, G. R., 1940, "Conservation in Pueblo Agriculture: I, Primitive Practices; II, Present-Day Flood Water Irrigation," Scientific Monthly, 51, Nos. 3, 4: pp. 201-220, pp. 329-340
- Steward, G. R., and Maurice Donnelly, 1943, "Soil and Water Economy in the Pueblo Southwest: I, Field Studies at Mesa Verde and Northern Arizona: II, Evaluation of Primitive Methods of Conservation," Scientific Monthly, 56, Nos. 1, 2: pp. 31-44, pp. 134-144
- Wernstedt, Frederick L., 1961, World Climatic Data: Latin America and the Caribbean: Pennsylvania State University, Department of Geography, 54 pp.
- Withers, Arnold, 1963, "Rock Check Dams in the Northern Sierra Madre, Chihuahua, Mexico," a paper presented at the 32nd Annual Meeting of the Society for American Archaeology, Boulder, Colorado
- Woodbury, Richard B., 1961, Prehistoric Agriculture at Point of Pines, Arizona, Memoirs of the Society for American Archaeology, No. 17, 48 pp.

APPENDIX A  
Daily Weather Information for Nuevo Casas Grandes  
Months of May through November 1965

| Date   | Temperatures (Centigrade) |      |      |          |      |      | Vapor Pressure (Centimeters) |     |       | Relative Humidity (Percent) |      |       |      | Barometric Pressure (Centimeters) |      |       |      | Tr = Tr |      |      |     |       |
|--------|---------------------------|------|------|----------|------|------|------------------------------|-----|-------|-----------------------------|------|-------|------|-----------------------------------|------|-------|------|---------|------|------|-----|-------|
|        | Dry Bulb                  |      |      | Wet Bulb |      |      | Extremes                     |     | Hour: |                             |      | Hour: |      |                                   |      | Hour: |      |         |      |      |     |       |
|        | 0600                      | 1200 | 1800 | Avg      | 0600 | 1200 | 1800                         | Max | Min   | 0600                        | 1200 | 1800  | 0600 | 1200                              | 1800 | Avg   | 0600 |         | 1200 | 1800 | Avg | 0600  |
| May 29 |                           |      |      | 23.6     |      |      | 33                           | 14  | 2.0   | 0                           | 2.4  | 59    | 35   | 38                                | 44   |       |      |         |      |      |     | 38    |
| 30     |                           |      |      | 25.0     |      |      | 33                           | 15  | 2.0   | 2.4                         | 2.0  | 59    | 36   | 39                                | 39   |       |      |         |      |      |     | 39    |
| 31     |                           |      |      | 23.6     |      |      | 32                           | 13  | 2.0   | 2.0                         | 2.0  | 64    | 24   | 24                                | 41   |       |      |         |      |      |     | 24    |
| June 1 |                           |      |      | 22.6     |      |      | 31                           | 11  | 2.0   | 1.0                         | 1.0  | 64    | 20   | 18                                | 34   |       |      |         |      |      |     | 18    |
| 2      |                           |      |      | 24.3     |      |      | 32                           | 12  | 2.0   | 1.0                         | 1.0  | 70    | 18   | 20                                | 46   |       |      |         |      |      |     | 20    |
| 3      |                           |      |      | 23.0     |      |      | 31                           | 11  | 2.0   | 2.0                         | 0    | 70    | 28   | 16                                | 38   |       |      |         |      |      |     | 16    |
| 4      |                           |      |      | 20.6     |      |      | 29                           | 12  | 1.0   | 0                           | 2.0  | 42    | 46   | 28                                | 39   |       |      |         |      |      |     | 28    |
| 5      |                           |      |      | 21.6     |      |      | 31                           | 9   | 1.0   | 2.0                         | 2.0  | 59    | 36   | 27                                | 41   |       |      |         |      |      |     | 27    |
| 6      |                           |      |      | 24.0     |      |      | 34                           | 11  | 2.0   | 2.0                         | 2.0  | 70    | 30   | 24                                | 41   |       |      |         |      |      |     | 24    |
| 7      |                           |      |      | 26.6     |      |      | 36                           | 12  | 2.0   | 2.4                         | 2.0  | 65    | 35   | 24                                | 41   |       |      |         |      |      |     | 24    |
| 8      |                           |      |      | 26.3     |      |      | 35                           | 15  | 2.0   | 2.0                         | 2.0  | 61    | 29   | 24                                | 38   |       |      |         |      |      |     | 24    |
| 9      |                           |      |      | 23.0     |      |      | 35                           | 15  | 2.0   | 2.0                         | 2.0  | 40    | 30   | 45                                | 38   |       |      |         |      |      |     | 45    |
| 10     |                           |      |      | 23.0     |      |      | 29                           | 15  | 2.4   | 2.4                         | 2.0  | 66    | 41   | 22                                | 43   |       |      |         |      |      |     | 22    |
| 11     |                           |      |      | 22.0     |      |      | 31                           | 9   | 2.0   | 2.4                         | 2.0  | 66    | 37   | 24                                | 42   |       |      |         |      |      |     | 24    |
| 12     |                           |      |      | 22.0     |      |      | 30                           | 13  | 2.0   | 2.0                         | 0    | 65    | 24   | M                                 | 44   |       |      |         |      |      |     | M     |
| 13     |                           |      |      | 26.2     |      |      | 36                           | 13  | 2.0   | 2.0                         | 2.0  | 65    | 29   | 20                                | 38   |       |      |         |      |      |     | 20    |
| 14     |                           |      |      | 27.6     |      |      | 37                           | 16  | 2.0   | 2.0                         | 2.4  | 60    | 26   | 26                                | 37   |       |      |         |      |      |     | 26    |
| 15     |                           |      |      | 26.0     |      |      | 36                           | 14  | 2.0   | 2.0                         | 2.0  | 50    | 20   | 25                                | 32   |       |      |         |      |      |     | 25    |
| 16     |                           |      |      | 26.3     |      |      | 35                           | 16  | 2.0   | 2.0                         | 2.0  | 60    | 20   | 23                                | 34   |       |      |         |      |      |     | 23    |
| 17     |                           |      |      | 26.2     |      |      | 37                           | 14  | 2.0   | 2.0                         | 2.0  | 50    | 28   | 20                                | 33   |       |      |         |      |      |     | 20    |
| 18     |                           |      |      | 26.2     |      |      | 36                           | 17  | 2.0   | 1.0                         | 2.4  | 40    | 20   | 34                                | 31   |       |      |         |      |      |     | 31    |
| 19     |                           |      |      | 27.3     |      |      | 36                           | 16  | 2.4   | 2.4                         | 2.4  | 72    | 34   | 26                                | 44   |       |      |         |      |      |     | 26    |
| 20     |                           |      |      | 27.6     |      |      | 36                           | 15  | 2.7   | 2.4                         | 2.0  | 80    | 32   | 20                                | 44   |       |      |         |      |      |     | 20    |
| 21     |                           |      |      | 28.6     |      |      | 37                           | 18  | 2.7   | 2.0                         | 2.4  | 67    | 25   | 27                                | 40   |       |      |         |      |      |     | 27    |
| 22     |                           |      |      | 27.6     |      |      | 36                           | 17  | 2.7   | 2.4                         | 2.0  | 75    | 30   | 20                                | 42   |       |      |         |      |      |     | 20    |
| 23     |                           |      |      | 24.3     |      |      | 34                           | 18  | 2.4   | 2.4                         | 2.7  | 50    | 30   | 78                                | 53   |       |      |         |      |      |     | Tr 78 |
| 24     |                           |      |      | 26.0     |      |      | 36                           | 16  | 2.7   | 2.7                         | 2.4  | 90    | 40   | 29                                | 53   |       |      |         |      |      |     | Tr 29 |
| 25     |                           |      |      | 26.0     |      |      | 34                           | 16  | 2.7   | 2.0                         | 2.0  | 81    | 50   | 23                                | 51   |       |      |         |      |      |     | 23    |
| 26     |                           |      |      | 26.3     |      |      | 33                           | 16  | 2.4   | 2.0                         | 2.0  | 72    | 24   | 20                                | 39   |       |      |         |      |      |     | 20    |
| 27     |                           |      |      | 27.0     |      |      | 34                           | 15  | 2.0   | 2.0                         | 2.4  | 50    | 50   | 23                                | 41   |       |      |         |      |      |     | 23    |
| 28     |                           |      |      | 29.0     |      |      | 38                           | 16  | 2.0   | 2.4                         | 2.4  | 66    | 25   | 23                                | 38   |       |      |         |      |      |     | 23    |
| 29     |                           |      |      | 28.6     |      |      | 33                           | 18  | 2.7   | 2.4                         | 2.4  | 67    | 24   | 28                                | 40   |       |      |         |      |      |     | 28    |
| 30     |                           |      |      | 29.3     |      |      | 32                           | 19  | 2.4   | 2.4                         | 2.7  | 61    | 29   | 30                                | 40   |       |      |         |      |      |     | Tr 30 |
| July 1 |                           |      |      | 29.0     |      |      | 36                           | 18  | 3.1   | 2.7                         | 2.0  | 76    | 38   | 20                                | 45   | 65.6  | 65.6 | 65.3    | 65.5 |      |     | Tr 20 |
| 2      |                           |      |      | 30.0     |      |      | 32                           | 20  | 2.7   | 2.7                         | 3.3  | 76    | 35   | 39                                | 50   | 65.6  | 65.6 | 65.3    | 65.5 |      |     | Tr 39 |
| 3      |                           |      |      | 29.0     |      |      | 32                           | 18  | 2.7   | 2.4                         | 2.4  | 75    | 25   | 24                                | 41   | 65.6  | 65.6 | 65.3    | 65.5 |      |     | 24    |
| 4      |                           |      |      | 28.0     |      |      | 31                           | 18  | 2.7   | 3.1                         | 2.4  | 75    | 45   | 26                                | 49   | 66.3  | 66.3 | 64.9    | 65.8 |      |     | 3     |
| 5      |                           |      |      | 29.3     |      |      | 32                           | 19  | 2.7   | 2.7                         | 2.4  | 69    | 38   | 22                                | 43   | 65.6  | 65.6 | 62.3    | 64.5 |      |     | 22    |
| 6      |                           |      |      | 29.3     |      |      | 33                           | 18  | 2.7   | 2.7                         | 2.4  | 68    | 35   | 24                                | 42   | 63.2  | 65.3 | 61.9    | 63.4 |      |     | 24    |
| 7      |                           |      |      | 29.3     |      |      | 32                           | 18  | 2.4   | 2.4                         | 2.4  | 55    | 30   | 25                                | 37   | 63.2  | 63.6 | 61.7    | 62.8 |      |     | 25    |
| 8      |                           |      |      | 28.0     |      |      | 32                           | 20  | 2.7   | 2.7                         | 2.0  | 70    | 40   | 26                                | 45   | 62.9  | 63.2 | 60.9    | 62.3 |      |     | 26    |
| 9      |                           |      |      | 29.0     |      |      | 32                           | 19  | 3.1   | 2.7                         | 2.4  | 78    | 38   | 26                                | 47   | 62.9  | 63.6 | 61.2    | 62.5 |      |     | Tr 26 |
| 10     |                           |      |      | 26.0     |      |      | 32                           | 18  | 2.7   | 2.7                         | 2.4  | 85    | 39   | 35                                | 53   | 63.6  | 63.6 | 62.5    | 63.2 |      |     | 4     |
| 11     |                           |      |      | 26.0     |      |      | 31                           | 17  | 2.7   | 2.7                         | 2.4  | 85    | 38   | 38                                | 54   | 63.2  | 63.6 | 60.9    | 62.6 |      |     | 38    |
| 12     |                           |      |      | 27.3     |      |      | 31                           | 19  | 3.1   | 2.4                         | 2.4  | 78    | 67   | 38                                | 61   | 62.9  | 63.2 | 63.2    | 63.1 |      |     | 30    |
| 13     |                           |      |      | 26.0     |      |      | 31                           | 17  | 2.7   | 2.7                         | 2.4  | 81    | 37   | 30                                | 49   | 63.6  | 64.3 | 62.9    | 63.6 |      |     | 2     |
| 14     |                           |      |      | 25.6     |      |      | 30                           | 17  | 2.7   | 2.7                         | 2.7  | 68    | 40   | 40                                | 49   | 63.6  | 64.0 | 62.9    | 63.5 |      |     | 40    |
| 15     |                           |      |      | 25.6     |      |      | 30                           | 18  | 2.7   | 2.7                         | 2.7  | 84    | 45   | 36                                | 55   | 63.2  | 63.6 | 62.3    | 63.0 |      |     | 5     |
| 16     |                           |      |      | 24.6     |      |      | 30                           | 19  | 2.7   | 2.7                         | 2.4  | 75    | 45   | 22                                | 47   | 62.9  | 62.9 | 62.5    | 62.7 |      |     | 1     |
| 17     |                           |      |      | 24.0     |      |      | 26                           | 16  | 3.1   | 3.3                         | 3.3  | 100   | 65   | 100                               | 88   | 64.3  | 64.7 | 61.7    | 63.6 |      |     | 8     |
| 18     |                           |      |      | 23.0     |      |      | 28                           | 16  | 2.2   | 2.7                         | 2.7  | 81    | 54   | 50                                | 62   | 61.9  | 65.3 | 62.9    | 63.4 |      |     | 3     |
| 19     |                           |      |      | 25.0     |      |      | 29                           | 18  | 3.1   | 3.1                         | 3.1  | 90    | 50   | 55                                | 65   | 63.9  | 64.3 | 61.7    | 63.3 |      |     | 4     |
| 20     |                           |      |      | 27.0     |      |      | 30                           | 18  | 2.7   | 2.7                         | 2.0  | 68    | 41   | 38                                | 49   | 63.2  | 63.6 | 59.9    | 62.2 |      |     | 1     |
| 21     |                           |      |      | 24.0     |      |      | 29                           | 18  | 2.7   | 3.1                         | 3.1  | 84    | 55   | 55                                | 65   | 63.6  | 64.3 | 62.9    | 63.6 |      |     | 4     |
| 22     |                           |      |      | 21.0     |      |      | 27                           | 18  | 2.7   | 2.7                         | 2.7  | 68    | 45   | 49                                | 54   | 64.3  | 64.7 | 64.3    | 64.4 |      |     | 1     |
| 23     |                           |      |      | 22.0     |      |      | 28                           | 17  | M     | M                           | M    | M     | M    | M                                 | M    | M     | M    | M       | M    |      |     | M     |

24-31 No data available

M = Missing

APPENDIX A

Weather Information for Nuevo Casas Grandes  
Months of May through November 1965

| Midnight<br>(Tr) | Barometric Pressure<br>(Centimeters)   |      |               |      | Precipitation<br>(Centimeters) |     |               |      | Winds<br>(Mph) |           |                     |                     |  |                          | Cloud Cover              |                          |                          |                          |   |  |  |  |  |  |
|------------------|--|------|---------------|------|--------------------------------|-----|---------------|------|----------------|-----------|---------------------|---------------------|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|---|--|--|--|--|--|
|                  | Adjusted to 0°C and to sea level. 760 normal. Place the number seven (7) before figure shown, i.e., 763.6. |      |               |      |                                |     |               |      | Tr = Trace     |           |                     |                     | From Beaufort Scale of Wind Force. Number equals lowest mph velocity of Beaufort class. i.e., 4 mph equals lowest velocity in Beaufort Class 2, 12 mph equals lowest velocity in Beaufort Class 4. |                          |                          |                          |                          |                          | Ci = Cirrus<br>Ac = Alto-cumulus<br>Sc = Strato-cumulus<br>Cc = Cirro-cumulus<br>Cs = Cirro-stratus |  |  |  |  |  |
|                  | Hour:<br>1800  | Avg  | Hour:<br>0600 | 1200 | 1800                           | Avg | Hour:<br>0600 | 1200 | 1800           | Character | 0600 hrs<br>Dir Vel | 1200 hrs<br>Dir Vel | 1800 hrs<br>Dir Vel  | 0600 hrs<br>1/10ths Type | 1200 hrs<br>1/10ths Type | 1800 hrs<br>1/10ths Type | 0600 hrs<br>1/10ths Type | 1200 hrs<br>1/10ths Type | 1800 hrs<br>1/10ths Type  |  |  |  |  |  |
| 38               | 44   |      |               |      |                                |     |               |      | Tr             | W 4       | E 12                | E 12                | 6  | Ci                       |                          | 6                        | Ci                       | 6                        | Sc  |  |  |  |  |  |
| 39               | 39   |      |               |      |                                |     |               |      |                | W 4       | E 4                 | W 4                 | 2  | Ci                       |                          | 2                        | Sc                       | 3                        | Sc  |  |  |  |  |  |
| 24               | 41   |      |               |      |                                |     |               |      |                | E 4       | S 4                 | S 12                | M  | M                        |                          | 3                        | Ci                       | 2                        | Ci  |  |  |  |  |  |
| 18               | 34   |      |               |      |                                |     |               |      |                | E 4       | S 4                 | W 4                 | 0  | --                       |                          | 0                        | --                       | 2                        | Ci  |  |  |  |  |  |
| 20               | 46   |      |               |      |                                |     |               |      |                | S 4       | S 4                 | W 12                | 2  | Ci                       |                          | 2                        | Ci                       | 0                        | --  |  |  |  |  |  |
| 16               | 38   |      |               |      |                                |     |               |      |                | E 4       | N 4                 | W 4                 | 2  | Sc                       |                          | 2                        | Ci                       | 6                        | Ci  |  |  |  |  |  |
| 28               | 39   |      |               |      |                                |     |               |      |                | W 12      | W 12                | W 12                | 0  | --                       |                          | 0                        | --                       | 0                        | --  |  |  |  |  |  |
| 27               | 41   |      |               |      |                                |     |               |      |                | N 4       | W 4                 | S 4                 | 0  | --                       |                          | 0                        | --                       | 0                        | --  |  |  |  |  |  |
| 24               | 41   |      |               |      |                                |     |               |      |                | W 4       | W 4                 | W 4                 | 0  | --                       |                          | 1                        | Ci                       | 1                        | Ci  |  |  |  |  |  |
| 24               | 38   |      |               |      |                                |     |               |      |                | W 4       | E 4                 | S 4                 | 6  | Ci                       |                          | 3                        | Ci                       | 3                        | Ci  |  |  |  |  |  |
| 45               | 38   |      |               |      |                                |     |               |      |                | W 4       | S 4                 | W 4                 | 6  | Ci                       |                          | 6                        | Ci                       | 5                        | Ci  |  |  |  |  |  |
| 22               | 43   |      |               |      |                                |     |               |      |                | E 4       | W 4                 | E 12                | 5  | Sc                       |                          | 6                        | Sc                       | 6                        | Sc  |  |  |  |  |  |
| 24               | 42   |      |               |      |                                |     |               |      |                | E 4       | S 4                 | W 4                 | 6  | Ci                       |                          | 5                        | Sc                       | 4                        | Sc  |  |  |  |  |  |
| M 44             |  |      |               |      |                                |     |               |      |                | W 4       | E 4                 | W 4                 | 2  | M                        |                          | 2                        | Ci                       | 3                        | Ci  |  |  |  |  |  |
| 20               | 38   |      |               |      |                                |     |               |      |                | S 4       | S 4                 | M                   | 0  | --                       |                          | 2                        | Sc                       | 5                        | Sc  |  |  |  |  |  |
| 26               | 37   |      |               |      |                                |     |               |      |                | E 4       | S 4                 | S 4                 | 0  | --                       |                          | 0                        | --                       | 0                        | --  |  |  |  |  |  |
| 25               | 32   |      |               |      |                                |     |               |      |                | W 4       | S 4                 | S 4                 | 0  | --                       |                          | 2                        | Sc                       | 4                        | Sc  |  |  |  |  |  |
| 23               | 34   |      |               |      |                                |     |               |      |                | S 4       | S 4                 | W 4                 | 0  | --                       |                          | 0                        | --                       | 0                        | --  |  |  |  |  |  |
| 20               | 33   |      |               |      |                                |     |               |      |                | S 4       | S 4                 | S 12                | 0  | --                       |                          | 0                        | --                       | 0                        | --  |  |  |  |  |  |
| 34               | 31   |      |               |      |                                |     |               |      |                | S 4       | E 4                 | E 4                 | 0  | --                       |                          | 0                        | --                       | 1                        | Sc  |  |  |  |  |  |
| 26               | 44   |      |               |      |                                |     |               |      |                | W 4       | S 4                 | S 4                 | 0  | --                       |                          | 2                        | Sc                       | 5                        | Sc  |  |  |  |  |  |
| 20               | 44   |      |               |      |                                |     |               |      |                | S 4       | E 4                 | S 4                 | 2  | Sc                       |                          | 1                        | Sc                       | 6                        | Sc  |  |  |  |  |  |
| 27               | 40   |      |               |      |                                |     |               |      |                | S 4       | S 4                 | S 4                 | 0  | --                       |                          | 2                        | Sc                       | 6                        | Sc  |  |  |  |  |  |
| 20               | 42   |      |               |      |                                |     |               |      |                | S 4       | S 4                 | S 4                 | 2  | Sc                       |                          | 3                        | Sc                       | 6                        | Sc  |  |  |  |  |  |
| 78               | 53   |      |               |      |                                |     |               |      |                | W 4       | S 4                 | E 4                 | 0  | --                       |                          | 0                        | --                       | 6                        | Sc  |  |  |  |  |  |
| 29               | 53   |      |               |      |                                |     |               |      |                | W 4       | S 4                 | S 4                 | 6  | Sc                       |                          | 6                        | Sc                       | 7                        | Sc  |  |  |  |  |  |
| 23               | 51   |      |               |      |                                |     |               |      |                | W 4       | S 4                 | E 12                | 5  | Sc                       |                          | 4                        | Sc                       | 6                        | Sc  |  |  |  |  |  |
| 20               | 39   |      |               |      |                                |     |               |      |                | S 4       | S 12                | W 4                 | 0  | --                       |                          | 4                        | Sc                       | 4                        | Sc  |  |  |  |  |  |
| 23               | 41   |      |               |      |                                |     |               |      |                | S 4       | W 4                 | W 4                 | 0  | --                       |                          | 0                        | --                       | 0                        | --  |  |  |  |  |  |
| 23               | 38   |      |               |      |                                |     |               |      |                | E 4       | S 4                 | S 4                 | 2  | Ci                       |                          | 2                        | Sc                       | 3                        | Sc  |  |  |  |  |  |
| 28               | 40   |      |               |      |                                |     |               |      |                | W 4       | S 4                 | E 4                 | 4  | Ci                       |                          | 5                        | Ci                       | 6                        | Sc  |  |  |  |  |  |
| 30               | 40   |      |               |      |                                |     |               |      |                | S 4       | S 4                 | E 4                 | 3  | Ci                       |                          | 1                        | Sc                       | 6                        | Sc  |  |  |  |  |  |
|                  |  |      |               |      |                                |     |               |      |                | S 4       | W 4                 | E 4                 | 4  | Ci                       |                          | 4                        | Sc                       | 6                        | Sc  |  |  |  |  |  |
| 20               | 45   | 65.6 | 65.6          | 65.3 | 65.5                           |     |               |      |                | W 4       | S 4                 | E 4                 | 2  | Ci                       |                          | 4                        | Cs                       | 5                        | Cs  |  |  |  |  |  |
| 39               | 50   | 65.6 | 65.6          | 65.3 | 65.5                           |     |               |      |                | W 4       | W 4                 | E 4                 | 5  | Cs                       |                          | 3                        | Cs                       | 6                        | Cs  |  |  |  |  |  |
| 24               | 41   | 65.6 | 65.6          | 65.3 | 65.5                           |     |               |      |                | S 4       | E 4                 | S 4                 | 1  | Cc                       |                          | 4                        | Cs                       | 6                        | Cs  |  |  |  |  |  |
| 26               | 49   | 66.3 | 66.3          | 64.9 | 65.8                           |     |               |      |                | S 4       | S 4                 | S 4                 | 3  | Cs                       |                          | 2                        | Cs                       | 5                        | Cs  |  |  |  |  |  |
| 22               | 43   | 65.6 | 65.6          | 62.3 | 64.5                           |     |               |      |                | S 4       | N 4                 | S 4                 | 2  | Ci                       |                          | 3                        | Cs                       | 5                        | Cs  |  |  |  |  |  |
| 24               | 42   | 63.2 | 65.3          | 61.9 | 63.4                           |     |               |      |                | S 4       | S 4                 | S 4                 | 2  | Ci                       |                          | 4                        | Cs                       | 6                        | Cs  |  |  |  |  |  |
| 25               | 37   | 63.2 | 63.6          | 61.7 | 62.8                           |     |               |      |                | S 4       | W 4                 | E 4                 | 2  | Ci                       |                          | 3                        | Cs                       | 4                        | Cs  |  |  |  |  |  |
| 26               | 45   | 62.9 | 63.2          | 60.9 | 62.3                           |     |               |      |                | W 4       | E 4                 | S 4                 | 2  | Cs                       |                          | 4                        | Cs                       | 6                        | Cs  |  |  |  |  |  |
| 26               | 47   | 62.9 | 63.6          | 61.2 | 62.5                           |     |               |      |                | W 4       | E 4                 | W 12                | 6  | Cs                       |                          | 6                        | Cs                       | 6                        | Cs  |  |  |  |  |  |
| 35               | 53   | 63.6 | 63.6          | 62.5 | 63.2                           |     |               |      |                | W 4       | E 4                 | W 12                | 6  | Cs                       |                          | 6                        | Cs                       | 6                        | Cs  |  |  |  |  |  |
| 38               | 54   | 63.2 | 63.6          | 60.9 | 62.6                           |     |               |      |                | W 4       | S 4                 | W 12                | 3  | Ci                       |                          | 1                        | Cs                       | 6                        | Cs  |  |  |  |  |  |
| 38               | 61   | 62.9 | 63.2          | 63.2 | 63.1                           |     |               |      |                | S 4       | E 4                 | W 4                 | 5  | Cs                       |                          | 5                        | Cs                       | 6                        | Cs  |  |  |  |  |  |
| 30               | 49   | 63.6 | 64.3          | 62.9 | 63.6                           |     |               |      |                | W 4       | S 4                 | S 4                 | 3  | Cs                       |                          | 4                        | Cs                       | 7                        | Ac  |  |  |  |  |  |
| 40               | 49   | 63.6 | 64.0          | 62.9 | 63.5                           |     |               |      |                | W 4       | E 4                 | W 4                 | 6  | Cs                       |                          | 4                        | Cs                       | 6                        | Cs  |  |  |  |  |  |
| 36               | 55   | 63.2 | 63.6          | 62.3 | 63.0                           |     |               |      |                | S 4       | S 4                 | S 4                 | 6  | Ci                       |                          | 4                        | Cs                       | 5                        | Cs  |  |  |  |  |  |
| 22               | 47   | 62.9 | 62.9          | 62.5 | 62.7                           |     |               |      |                | W 4       | E 4                 | S 4                 | 6  | Cs                       |                          | 6                        | Cs                       | 6                        | Cs  |  |  |  |  |  |
| 100              | 88   | 64.3 | 64.7          | 61.7 | 63.6                           |     |               |      |                | W 4       | S 4                 | W 4                 | 5  | Cs                       |                          | 5                        | Cs                       | 7                        | Ac  |  |  |  |  |  |
| 30               | 62   | 61.9 | 65.3          | 62.9 | 63.4                           |     |               |      |                | S 4       | E 4                 | S 4                 | 2  | Cc                       |                          | 3                        | Cs                       | 6                        | Ac  |  |  |  |  |  |
| 35               | 65   | 63.9 | 64.3          | 61.7 | 63.3                           |     |               |      |                | S 4       | S 4                 | S 4                 | 7  | Cs                       |                          | 5                        | Cs                       | 7                        | Ac  |  |  |  |  |  |
| 38               | 49   | 63.2 | 63.6          | 59.9 | 62.2                           |     |               |      |                | S 4       | S 4                 | S 4                 | 7  | Ac                       |                          | 6                        | Cc                       | 6                        | Cs  |  |  |  |  |  |
| 35               | 65   | 63.6 | 64.3          | 62.9 | 63.6                           |     |               |      |                | S 4       | W 4                 | W 4                 | 5  | Cs                       |                          | 5                        | Cs                       | 6                        | Cs  |  |  |  |  |  |
| 49               | 54   | 64.3 | 64.7          | 64.3 | 64.4                           |     |               |      |                | S 4       | E 4                 | W 4                 | 6  | Ci                       |                          | 5                        | Ci                       | 6                        | Ci  |  |  |  |  |  |
| M                | M  | M    | M             | M    | M                              |     |               |      |                | M         | M                   | M                   | 6  | Ci                       |                          | 6                        | Cc                       | 6                        | Ac  |  |  |  |  |  |

B









APPENDIX A (Continued)

| Barometric Pressure<br>(Centimeters)<br>Adjusted to 0°C and to sea level. 760 normal. Place the number seven (7) before figure shown, i.e., 763.6. |      |      |      | Precipitation<br>(Centimeters)<br>Tr = Trace |   |               |      | Winds<br>(Mph)<br>From Beaufort Scale of Wind Force. Number equals lowest mph velocity of Beaufort class, i.e., 4 mph equals lowest velocity in Beaufort Class 2, 12 mph equals lowest velocity in Beaufort Class 4. |      |                     |      |                     |   | Cloud Cover<br>Ci = Cirrus<br>Ac = Alto-cumulus<br>Sc = Strato-cumulus<br>Cc = Cirro-cumulus<br>Cs = Cirro-stratus |   |                          |   |                          |  |
|--|------|------|------|--|---|---------------|------|--|------|---------------------|------|---------------------|---|--|---|--------------------------|---|--------------------------|--|
| Hour:<br>0600 1200 1800 Avg  |      |      |      | Hour:<br>0600 1200 1800 Character            |   |               |      | 0600 hrs<br>Dir Vel  |      | 1200 hrs<br>Dir Vel |      | 1800 hrs<br>Dir Vel |   | 0600 hrs<br>1/10ths Type   |   | 1200 hrs<br>1/10ths Type |   | 1800 hrs<br>1/10ths Type |  |
| 64.9   | 66.0 | 66.3 | 66.0 |  |   |               | S    | 4  | E    | 12                  | E    | 4                   | O | --   | O | --                       | O | --                       |  |
| 66.3   | 66.3 | 66.7 | 66.0 |  |   |               | S    | 4  | S    | 12                  | E    | 4                   | M | M  | M | M                        | M | M                        |  |
| 66.7   | 66.7 | 66.7 | 66.0 |  |   |               | S    | 4  | S    | 4                   | N    | 4                   | 2 | Sc   | 2 | Ci                       | 3 | Ac                       |  |
| 66.7   | 66.7 | 66.3 | 66.0 |  |   |               | S    | 4  | Calm | --                  | S    | 4                   | 1 | Ci   | M | M                        | M | M                        |  |
| 62.5   | 66.3 | 64.9 | 65.0 |  |   |               | S    | 4  | N    | 4                   | S    | 4                   | M | M  | M | M                        | M | M                        |  |
| 64.7   | 64.9 | 64.9 | 65.0 |  |   |               | S    | 4  | E    | 4                   | S    | 4                   | M | M  | 4 | Ci                       | 1 | Sc/Ci                    |  |
| 64.9   | 64.9 | 64.7 | 65.0 |  |   |               | S    | 4  | S    | 4                   | S    | 4                   | M | M  | M | M                        | M | M                        |  |
| 64.7   | 64.7 | 64.3 | 65.0 |  |   |               | S    | 4  | Calm | --                  | Calm | --                  | M | M  | M | M                        | M | M                        |  |
| 64.7   | 64.9 | 64.9 | 65.0 |  |   |               | S    | 4  | E    | 4                   | Calm | --                  | M | M  | 1 | Ci                       | 4 | Ci                       |  |
| 64.9   | 64.9 | 64.9 | 65.0 |  |   |               | SW   | 4  | S    | 4                   | S    | 4                   | 5 | Ci   | 5 | Ci                       | 6 | Ci                       |  |
| 64.9   | 64.9 | 64.9 | 65.0 |  |   |               | S    | 4  | N    | 4                   | E    | 12                  | 6 | Ac   | 6 | Sc                       | 2 | Ac                       |  |
| 64.9   | 64.9 | 64.7 | 65.0 |  |   |               | S    | 4  | S    | 4                   | S    | 4                   | M | M  | M | M                        | 5 | Ci                       |  |
| 64.9   | 64.9 | 64.3 | 65.0 |  |   |               | S    | 4  | S    | 4                   | S    | 4                   | M | M  | 6 | Ci                       | 6 | Sc                       |  |
| 64.3   | 64.3 | 64.3 | 64.0 |  |   |               | S    | 4  | S    | 4                   | S    | 4                   | 5 | Ci   | 3 | Sc                       | 4 | Sc                       |  |
| 63.6   | 63.6 | 62.9 | 63.0 |  |   |               | S    | 4  | S    | 12                  | S    | 12                  | 6 | Sc   | 7 | Sc                       | 5 | Sc/Ci                    |  |
| 62.3   | 61.9 | 60.0 | 62.0 |  | 1 | Lt Shower     | S    | 4  | S    | 12                  | S    | 12                  | 5 | Sc   | 5 | Sc                       | 5 | Sc                       |  |
| 59.6   | 59.9 | 59.6 | 60.0 |  | 5 | Lt Shower     | S    | 4  | SW   | 12                  | S    | 12                  | 5 | Sc   | 3 | Sc                       | 3 | Sc                       |  |
| 60.3   | 60.3 | 60.3 | 60.0 |  |   |               | S    | 4  | S    | 4                   | S    | 4                   | M | M  | M | M                        | M | M                        |  |
| 60.3   | 60.5 | 60.5 | 60.0 |  |   |               | E    | 4  | Calm | --                  | Calm | --                  | M | M  | M | M                        | M | M                        |  |
| 60.9   | 63.2 | 63.6 | 63.0 |  |   |               | W    | 4  | Calm | --                  | E    | 4                   | M | M  | M | M                        | 1 | Sc                       |  |
| 64.9   | 66.7 | 66.7 | 66.0 |  |   |               | S    | 4  | E    | 12                  | S    | 12                  | M | M  | 4 | Sc                       | M | M                        |  |
| 66.7   | 64.9 | 66.7 | 66.0 |  |   |               | S    | 4  | S    | 4                   | S    | 4                   | M | M  | M | M                        | 1 | Sc                       |  |
| 66.7   | 66.7 | 66.7 | 67.0 |  |   |               | S    | 4  | S    | 4                   | S    | 4                   | M | M  | M | M                        | M | M                        |  |
| 66.7   | 66.7 | 66.7 | 67.0 |  |   |               | S    | 4  | S    | 12                  | S    | 4                   | M | M  | M | M                        | M | M                        |  |
| 66.7   | 66.7 | 66.7 | 67.0 |  |   |               | S    | 4  | Calm | --                  | S    | 4                   | 3 | Ci   | 2 | Ci                       | 1 | Ci*                      |  |
| 66.7   | 66.7 | 66.7 | 67.0 |  |   |               | S    | 4  | Calm | --                  | Calm | --                  | M | M  | M | M                        | M | M                        |  |
| 66.7   | 66.7 | 66.7 | 67.0 |  |   |               | S    | 4  | S    | 4                   | SE   | 4                   | M | M  | M | M                        | M | M                        |  |
| 66.7   | 66.7 | 66.7 | 67.0 |  |   |               | S    | 4  | Calm | --                  | Calm | --                  | M | M  | M | M                        | M | M                        |  |
| 66.7   | 66.7 | 66.7 | 67.0 |  |   |               | S    | 4  | S    | 4                   | Calm | --                  | M | M  | M | M                        | M | M                        |  |
| 66.7   | 66.7 | 66.7 | 67.0 |  |   |               | S    | 4  | Calm | --                  | S    | 4                   | M | M  | M | M                        | M | M                        |  |
| 66.7   | 66.7 | 66.7 | 67.0 |  |   |               | S    | 4  | S    | 12                  | S    | 4                   | M | M  | M | M                        | M | M                        |  |
| 66.7   | 66.7 | 66.7 | 66.7 |  |   |               | S    | 4  | S    | 4                   | S    | 4                   | 7 | Sc/Ci  | 7 | Ci                       | 6 | Ci                       |  |
| 66.7   | 66.7 | 66.7 | 66.7 |  |   |               | S    | 4  | S    | 4                   | E    | 4                   | 4 | Ci   | 6 | Ci                       | 6 | Ci                       |  |
| 66.7   | 66.7 | 66.7 | 66.7 |  |   |               | S    | 4  | S    | 4                   | S    | 4                   | 6 | Sc   | 4 | Ci                       | 6 | Sc                       |  |
| 66.7   | 66.7 | 66.7 | 66.7 |  |   |               | S    | 4  | E    | 12                  | E    | 4                   | 3 | Ci   | M | M                        | M | M                        |  |
| 66.7   | 66.7 | 66.7 | 66.7 |  |   |               | S    | 4  | E    | 4                   | S    | 4                   | M | M  | M | M                        | 3 | Sc                       |  |
| 66.7   | 66.7 | 65.6 | 66.3 |  |   |               | S    | 4  | SE   | 4                   | Calm | --                  | 5 | Ci   | 6 | Sc/Ci                    | 6 | Sc/Ci                    |  |
| 65.6   | 65.6 | 65.6 | 65.6 |  |   |               | S    | 4  | S    | 4                   | S    | 4                   | 5 | Sc/Ci  | 6 | Ci                       | 6 | Sc/Ci                    |  |
| 66.0   | 66.0 | 66.0 | 66.0 |  |   |               | S    | 4  | S    | 4                   | S    | 4                   | 4 | Sc/Ci  | 6 | Ac/Sc/Ci                 | 6 | Sc/Ac/Ci                 |  |
| 65.6   | 66.0 | 65.3 | 66.0 |  |   |               | S    | 4  | S    | 4                   | Calm | --                  | 1 | Ci   | 4 | Sc/Ci                    | 6 | Ci                       |  |
| 65.6   | 65.6 | 65.6 | 65.6 |  |   |               | S    | 4  | S    | 4                   | S    | 4                   | 2 | Ci   | 6 | Ci                       | 6 | Ac/Sc/Ci                 |  |
| 65.6   | 65.6 | 65.3 | 66.0 |  |   | Not Available | S    | 4  | S    | 4                   | S    | 4                   | 5 | Sc/Ci  | 2 | Sc                       | 2 | Sc                       |  |
| 65.6   | 65.6 | 65.3 | 66.0 |  |   |               | S    | 4  | S    | 4                   | Calm | --                  | M | M  | M | M                        | 4 | Sc/Ci                    |  |
| 65.6   | 65.6 | 65.3 | 66.0 |  |   |               | S    | 4  | S    | 4                   | S    | 4                   | 4 | Ci   | 2 | Ci                       | 6 | Ac/Ci                    |  |
| 65.6   | 65.6 | 65.6 | 65.6 |  |   |               | S    | 4  | Calm | --                  | S    | 4                   | 5 | Ci   | 6 | Sc/Ac/Ci                 | 6 | Sc/Ci                    |  |
| 65.6   | 65.6 | 65.6 | 65.6 |  |   |               | S    | 4  | S    | 4                   | S    | 4                   | 6 | Ci   | 6 | Ci                       | 6 | Ci                       |  |
| 65.6   | 65.6 | 65.6 | 65.6 |  |   |               | S    | 4  | Calm | --                  | S    | 4                   | 7 | Ac   | 6 | Ci                       | 6 | Ac/Ci                    |  |
| 65.0   | 65.6 | 65.6 | 65.6 |  |   |               | S    | 4  | Calm | --                  | Calm | --                  | 5 | Ci   | 6 | Ci                       | 6 | Ac                       |  |
| 65.0   | 65.6 | 65.6 | 65.6 |  |   |               | S    | 4  | E    | 4                   | SE   | 4                   | 6 | Ci   | 6 | Ci                       | 7 | Sc/Ac/Ci                 |  |
| 65.0   | 65.6 | 65.3 | 65.5 |  |   |               | Calm | --   | Calm | --                  | S    | 4                   | 5 | Ac/Ci  | 4 | Ac/Ci                    | 3 | Ci                       |  |
| 65.0   | 65.3 | 63.6 | 65.3 |  |   |               | S    | 4  | Calm | --                  | S    | 4                   | 0 | --   | M | M                        | 2 | Ci                       |  |
| 64.0   | 62.9 | 62.9 | 63.2 |  |   |               | W    | 4  | W    | 12                  | W    | 12                  | 6 | Sc/Ac  | 6 | Sc                       | M | M                        |  |
| 62.0   | 62.9 | 62.3 | 62.7 |  |   |               | S    | 4  | S    | 4                   | Calm | --                  | 4 | Sc   | 6 | Ac/Ci                    | 6 | Sc                       |  |
| 62.5   | 62.9 | 61.7 | 62.3 |  |   |               | Calm | --   | E    | 4                   | S    | 4                   | 5 | Ci   | 6 | Sc/Ci                    | 6 | Sc/Ci                    |  |
| 61.7   | 61.9 | 61.7 | 61.8 |  |   |               | S    | 4  | S    | 4                   | S    | 4                   | 6 | Ci   | 6 | Ci                       | 6 | Sc/Ci                    |  |
| 61.2   | 60.3 | 57.5 | 59.6 |  |   |               | W    | 4  | S    | 4                   | S    | 4                   | 5 | Ci   | 1 | Ci                       | 4 | Sc                       |  |
| 57.5   | 60.9 | 60.9 | 59.7 |  |   |               | W    | 12   | S    | 4                   | S    | 4                   | 2 | Ci   | 2 | Sc                       | 4 | Ci                       |  |
| 61.7   | 61.7 | 61.7 | 61.7 |  |   |               | S    | 4  | W    | 4                   | W    | 4                   | 6 | Ci   | 5 | Ci                       | 6 | Sc                       |  |
| 61.9   | 61.9 | 62.3 | 62.0 |  |   |               | S    | 4  | E    | 4                   | S    | 4                   | 7 | Ac   | 3 | Ci                       | 4 | Sc                       |  |
| 61.7   | 61.7 | 61.0 | 61.7 |  |   |               | S    | 4  | E    | 4                   | S    | 4                   | 4 | Ci   | 5 | Ci                       | 6 | Ci                       |  |
| 61.9   | 61.9 | 60.6 | 61.1 |  |   |               | S    | 4  | S    | 4                   | S    | 4                   | 7 | Ac   | 6 | Ci                       | 6 | Ac                       |  |

**B**

**BLANK PAGE**

UNCLASSIFIED

Security Classification

**DOCUMENT CONTROL DATA - R&D**

*(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)*

|  |  |  |                      |
|--|--|--|----------------------|
| 1 ORIGINATING ACTIVITY (Corporate author)<br>Department of Geography<br>University of Denver<br>Denver, Colorado 80210   |  | 2a REPORT SECURITY CLASSIFICATION<br><b>UNCLASSIFIED</b>                                   |                      |
|  |  | 2b GROUP   |                      |
| 3 REPORT TITLE<br><b>TRINCHERA DISTRIBUTION IN THE SIERRA MADRE OCCIDENTAL, MEXICO</b>   |  |  |                      |
| 4 DESCRIPTIVE NOTES (Type of report and inclusive dates)<br>Final  |  |  |                      |
| 5 AUTHOR(S) (Last name, first name, initial)<br>Howard, William A.<br>Griffiths, Thomas M.   |  |  |                      |
| 6 REPORT DATE<br>April 15, 1966  |  | 7a TOTAL NO. OF PAGES<br>xi + 95   | 7b NO. OF REFS<br>39 |
| 8a CONTRACT OR GRANT NO.<br>DA19-129-AMC-789(N)  |  | 9a ORIGINATOR'S REPORT NUMBER(S)   |                      |
| b. PROJECT NO.<br>1V025001A129   |  | 9b OTHER REPORT NO(S) (Any other numbers that may be assigned this report)                 |                      |
| c.   |  |  |                      |
| d.   |  |  |                      |
| 10 AVAILABILITY/LIMITATION NOTICES   |  |  |                      |
| 11 SUPPLEMENTARY NOTES   |  | 12 SPONSORING MILITARY ACTIVITY<br>U. S. Army Natick Laboratories<br>Natick, Massachusetts |                      |
| 13 ABSTRACT<br><p>Trincheras are primitive dams or walls built of local rock. They occur widely throughout northern Mexico and extend into southwestern United States. They are associated with Indian habitation sites and are of two distinct types. The Sonoran-type trincheras most commonly appear encircling the tops of isolated peaks and are believed to have been crude fortifications. The Sierra-type trincheras are found principally across dry stream courses and are believed to have been built to retain water and/or soil. This paper discusses both types as they occur in or near the Sierra Madre Occidental and describes their distribution, archeological associations, and relationship to the physical geography of the region.</p> |  |  |                      |

DD FORM 1473  
1 JAN 64

UNCLASSIFIED

Security Classification

| KEY WORDS   | LINK A |    | LINK B |    | LINK C |    |
|---|--------|----|--------|----|--------|----|
|   | ROLE   | WT | ROLE   | WT | ROLE   | WT |
| 14<br>Trincheras<br>Sonoran physical geography and prehistory<br>Chihuahua physical geography and prehistory<br>Indian sites<br>Geography<br>Climate<br>Vegetation<br>Soils |        |    |        |    |        |    |

INSTRUCTIONS

1. **ORIGINATING ACTIVITY:** Enter the name and address of the contractor, subcontractor, grantee, Department of Defense activity or other organization (*corporate author*) issuing the report.

2a. **REPORT SECURITY CLASSIFICATION:** Enter the overall security classification of the report. Indicate whether "Restricted Data" is included. Marking is to be in accordance with appropriate security regulations.

2b. **GROUP:** Automatic downgrading is specified in DoD Directive 5200.10 and Armed Forces Industrial Manual. Enter the group number. Also, when applicable, show that optional markings have been used for Group 3 and Group 4 as authorized.

3. **REPORT TITLE:** Enter the complete report title in all capital letters. Titles in all cases should be unclassified. If a meaningful title cannot be selected without classification, show title classification in all capitals in parenthesis immediately following the title.

4. **DESCRIPTIVE NOTES:** If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.

5. **AUTHOR(S):** Enter the name(s) of author(s) as shown on or in the report. Enter last name, first name, middle initial. If military, show rank and branch of service. The name of the principal author is an absolute minimum requirement.

6. **REPORT DATE:** Enter the date of the report as day, month, year; or month, year. If more than one date appears on the report, use date of publication.

7a. **TOTAL NUMBER OF PAGES:** The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.

7b. **NUMBER OF REFERENCES:** Enter the total number of references cited in the report.

8a. **CONTRACT OR GRANT NUMBER:** If appropriate, enter the applicable number of the contract or grant under which the report was written.

8b, 8c, & 8d. **PROJECT NUMBER:** Enter the appropriate military department identification, such as project number, subproject number, system numbers, task number, etc.

9a. **ORIGINATOR'S REPORT NUMBER(S):** Enter the official report number by which the document will be identified and controlled by the originating activity. This number must be unique to this report.

9b. **OTHER REPORT NUMBER(S):** If the report has been assigned any other report numbers (*either by the originator or by the sponsor*), also enter this number(s).

10. **AVAILABILITY LIMITATION NOTICES:** Enter any limitations on further dissemination of the report, other than those imposed by security classification, using standard statements such as:

- (1) "Qualified requesters may obtain copies of this report from DDC."
- (2) "Foreign announcement and dissemination of this report by DDC is not authorized."
- (3) "U. S. Government agencies may obtain copies of this report directly from DDC. Other qualified DDC users shall request through \_\_\_\_\_."
- (4) "U. S. military agencies may obtain copies of this report directly from DDC. Other qualified users shall request through \_\_\_\_\_."
- (5) "All distribution of this report is controlled. Qualified DDC users shall request through \_\_\_\_\_."

If the report has been furnished to the Office of Technical Services, Department of Commerce, for sale to the public, indicate this fact and enter the price, if known.

11. **SUPPLEMENTARY NOTES:** Use for additional explanatory notes.

12. **SPONSORING MILITARY ACTIVITY:** Enter the name of the departmental project office or laboratory sponsoring (*paying for*) the research and development. Include address.

13. **ABSTRACT:** Enter an abstract giving a brief and factual summary of the document indicative of the report, even though it may also appear elsewhere in the body of the technical report. If additional space is required, a continuation sheet shall be attached.

It is highly desirable that the abstract of classified reports be unclassified. Each paragraph of the abstract shall end with an indication of the military security classification of the information in the paragraph, represented as (TS), (S), (C), or (U).

There is no limitation on the length of the abstract. However, the suggested length is from 150 to 225 words.

14. **KEY WORDS:** Key words are technically meaningful terms or short phrases that characterize a report and may be used as index entries for cataloging the report. Key words must be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context. The assignment of links, rules, and weights is optional.