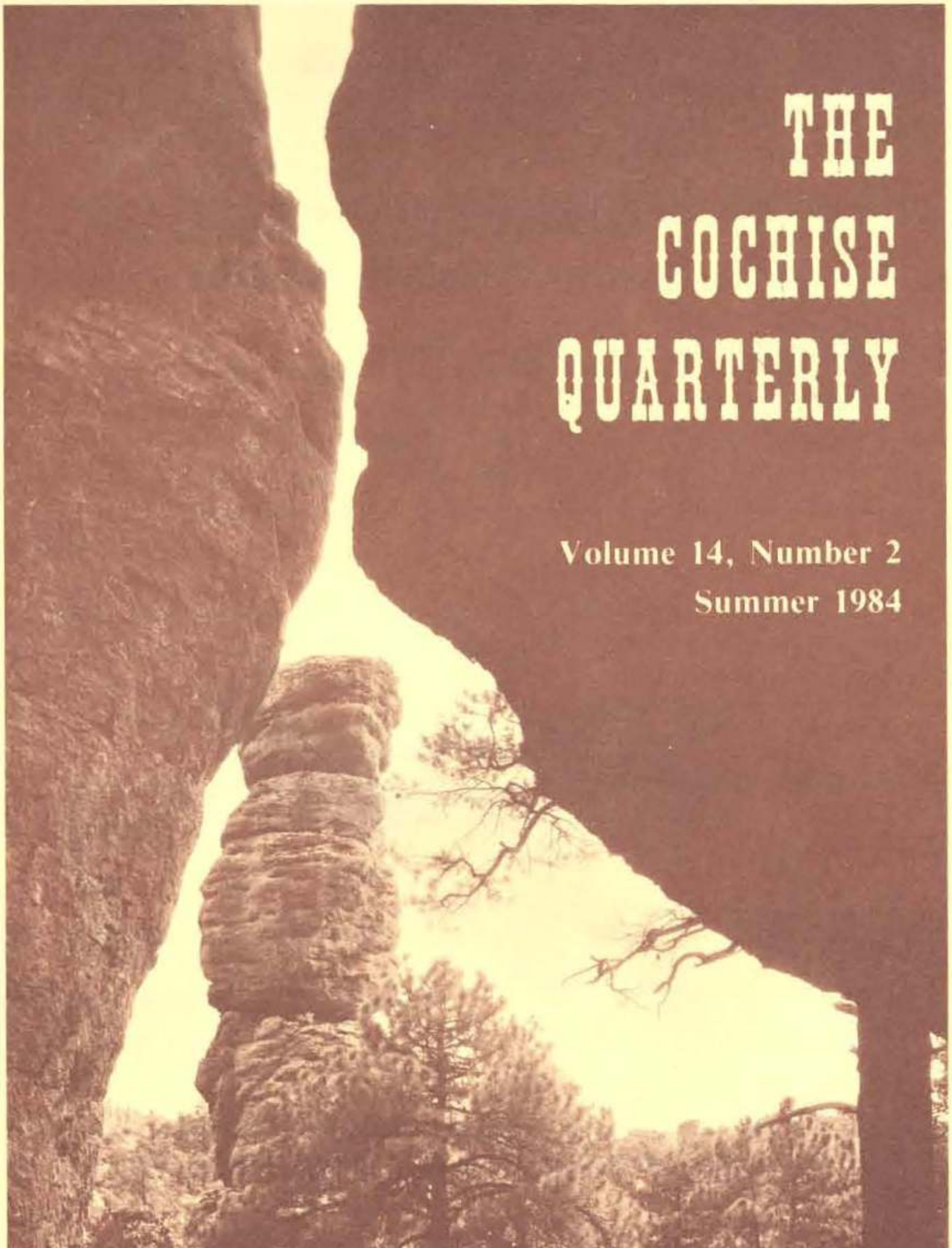

THE CHANGING LANDSCAPES OF SOUTHEASTERN ARIZONA

TABLE OF CONTENTS

Cochise Head

FRONT COVER: Wonderland of Rocks, Chiricahua National Monument; From the N.L. (Nick) Pavlovich Collection, Bisbee Mining and Historical Museum.

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The Cochise Quarterly, a journal of Arizona history and archaeology, contains articles by qualified writers as well as reviews of books on history and archaeology in this area. It is a publication of the Cochise County Historical and Archaeological Society.

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THE DAY THE VALLEY SHOOK

by Loraine Mackintosh

It was like any other spring day in the Sulphur Springs Valley of Cochise County, then Territory of Arizona. Men went about their business tending ranch or farm; women baked bread or mended clothing; the children at school anxiously awaited the closing bell. In the towns and villages, shopkeepers tallied orders and chatted with customers.

Suddenly, on this peaceful Tuesday afternoon of May 3, 1887, something happened that the people would never forget in their lifetimes. Shortly before 3:00 p.m. a rumbling sound was heard in the distance, and within seconds the earth shook and split open!

At the southern end of the Dragoon Mountains, on Abbott Ranch, thirty cowboys were engaged in rounding up cattle, when they felt the earth shudder beneath them and observed huge rocks tumbling down the sides of the hills, raising a cloud of dust. Fissures appeared in the earth and water gushed forth. A mile and a half from the Abbott house, a geyser four or five feet across shot 100 feet into the air; the arroyos ran full. Off on the mountain-side a trickle of water became a stream; racing down the canyons it became a lake fully a mile wide at the foot of the mountain.

At Fort Bowie, horses pulling the Globe stage were knocked to their knees and their noses hit the ground. In Bisbee, houses shook and walls cracked; dishes and bottles flew to the floor and smashed. Hundreds of feet beneath the town, miners felt the earth rumble. Throughout the valley, cattle stood splay-legged, bellowing, eyes bulging in terror. Horses neighed and ran skittishly. People dashed from buildings, shrieking! Clocks stopped. Railroad tracks were bent.

What was this phenomenon? Surely, not the end of the world! The people of the Sulphur Springs Valley would later learn that a major earthquake had taken place, with the epicenter located at Batepito, now known as Colonia Morales, in Sonora, Mexico, about 30 miles south of the border. The magnitude of the quake is estimated to have been at least 7.2, although there was no Richter scale to verify it at the time.

The area shaken by this earthquake covered nearly a million and a half square miles, including roughly the lower half of Arizona, about two-thirds of New Mexico, a portion of Texas, and a large area of Mexico, including the entire states of Sonora and Chihuahua. Only 51 deaths have been attributed to the quake, all of them in Sonora.

Because of the sparse population of Arizona Territory at the time, there were no recorded deaths, although there probably were injuries due to people being knocked to the ground or hit by falling objects.

The duration of the quake was described by witnesses as being anywhere from a few seconds to half an hour, although rumblings could be heard for several hours in some locations. Many people complained of motion sickness.

At Sheriff John Slaughter's ranch, just east of where Douglas is now located, and straight due-north of the epicenter, not a building was left standing! Built of adobe, without reinforcement, all were leveled. Of 7,000 adobe bricks used to build the houses, stables, and assorted buildings on the ranch, only 120 bricks were found intact after the tremor.

In Tombstone, every clock was stopped! In the Crystal Palace Saloon, globes fell from the chandeliers, smashing to the floor. The north wall of Schieffelin Hall was badly cracked. The magnetic needle of a surveying instrument stood upright, rather than in its usual horizontal position, testifying to the electrical charges generated by the quake.

A story is told to this day about the redwood schoolhouse in Tombstone: It seems that all the classes but one were emptied out when the walls of the school began shaking. When the teacher was advised to take her class outdoors, she remarked that she thought the rumbling was simply an altercation between Superintendent Metcalf and an unruly student!

When night fell in the Sulphur Springs Valley, indeed in all of southeastern Arizona, all the mountains seemed to be blazing. Were there volcanoes emerging in the Dragoons? Some thought so, that first night. The Chiricahuas, Dragoons, and Whetstones, Huachucas, and other mountain ranges burned out of control. In Rucker Canyon, in the Chiricahuas, ranchers fought the fires for three days to protect their homes.

The fires had been caused by the friction of tumbling boulders and rocks showering sparks on the dry brush. U.S. Government Observer, Dr. George E. Goodfellow, of Tombstone, was of the opinion that some of these fires were fed by gases that had been trapped beneath the rocks.

In the San Pedro Valley, the town of Charleston suffered greatly. It was reported that all of the windows were broken, with many of the buildings beyond repair. The adobe walls disintegrated into dust, filling the air with a murky veil. Here, too, smoke hung heavily in the air from the fires raging in the mountains. Ash sifted down into the river, killing all the fish.

Later on, in the foothills around Charleston (and other areas as well), rains would wash away the good soil, the roots of the brush and grasses too badly weakened by the fire to contain the soil. This led to the cattlemen leaving the area and contributed to the eventual demise of Charleston as a community.

It was reported that the Sunday following the quake found many people attending church service, both sides of the border, even though many church buildings had suffered damage, to the extent of total destruction in many Mexican towns.

The 1887 earthquake was the largest in the western states, not including California, and the only earthquake to do major damage to Arizona. Shockwaves were felt as far as Phoenix, Prescott and Yuma, and in San Diego as well. In New Mexico, they were experienced as far north as Santa Fe and Albuquerque. El Paso, Texas reported shaking and swaying of buildings, with cracked walls in some of them.

The worst of the damage in Arizona took place in the Sulphur Springs Valley, and the southern portions of the San Pedro and San Simon Valleys. Aftershocks were felt for days following the quake, and in some instances up until four months later, but none with the damage of the initial tremor.

Fissures were evident covering a wide portion of the lower half of the Sulphur Springs Valley, extending westward to Tombstone and Charleston, then northerly along the San Pedro Valley to Tres Alamos, several miles north of Benson. At the Mexican border, the fissures extended southward for nearly two hundred miles along the Sonora, Fronteras, Oputo and Bavispe Valleys. Vertical displacements measured from a mere few inches to 20 feet in some areas, with claims of up to 100 feet in others. Scientific studies are still being made of the major escarpment which runs from five miles south of Douglas to more than thirty-one miles into Sonora, the area of the epicenter.

Heavily forested mountain peaks were shaken up and thrown down into nearby canyons, leaving denuded mountain tops. Ramsey Peak, in the Huachucas, is just such an example. Trees and soil were deposited in Box Canyon. Biscuit Peak, in the Mustang Hills, near Elgin, in Santa Cruz County, is another peak which shows the devastating effects of an earthquake.

The quake was responsible for many changes in the water supply. In some areas springs were destroyed, such as the Bear Springs, near Fort Bowie. At St. David, in the San Pedro Valley, artesian springs appeared, which are still in use today. The San Pedro River bed, which had been a narrow creek in the St. David area, became a wide river at this point, due to the earthquake.

Is there a possibility for another major earthquake to occur in our state? We are not sitting on a San Andreas Fault, but, since there has been a severe quake here in the past, there could be one in our future. The rural areas would not fare too badly except for disruption of power lines and damaged homes and vehicles, but think of the horrendous potential for chaos and utter destruction in ever-growing Tucson and the heavily populated metropolitan Phoenix area.

Today, the houses in Arizona are still being built largely of adobe and other types of brick, a little more refined, but basically, the same type of structure so heavily damaged in 1887. Wood structures seem to fare better than masonry in an earthquake.

Recently, in January and February of 1983, there have been reports of slight tremors in the Tucson and Phoenix areas. Let us hope that the 1887 Earthquake is the last major one to touch Arizona.

Resource: DuBois, Susan M. and Ann W. Smith. The 1887 earthquake in San Bernadino Valley, Sonora, Mexico. University of Arizona, Tucson. Bureau of Geology and Mineral Tech., (1980).

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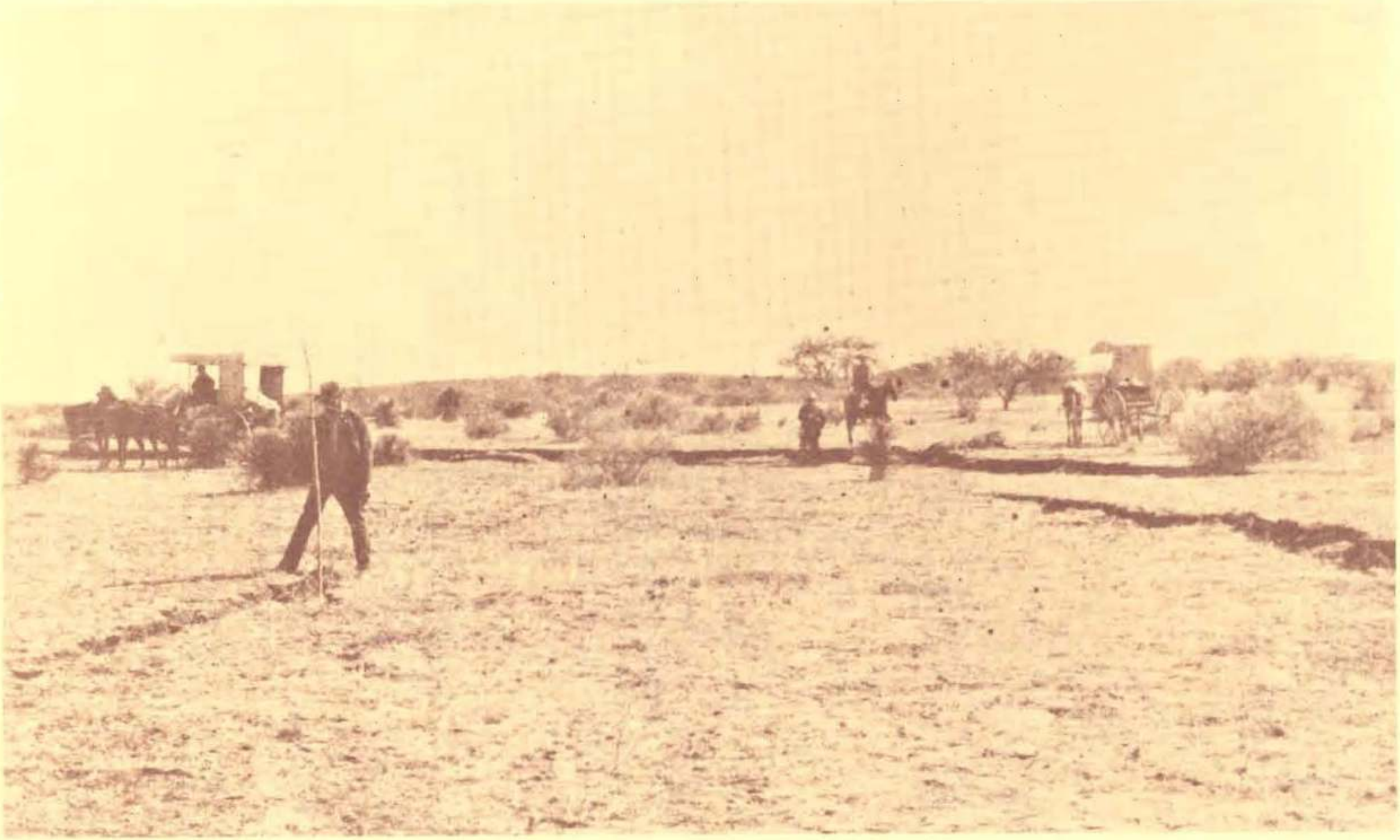
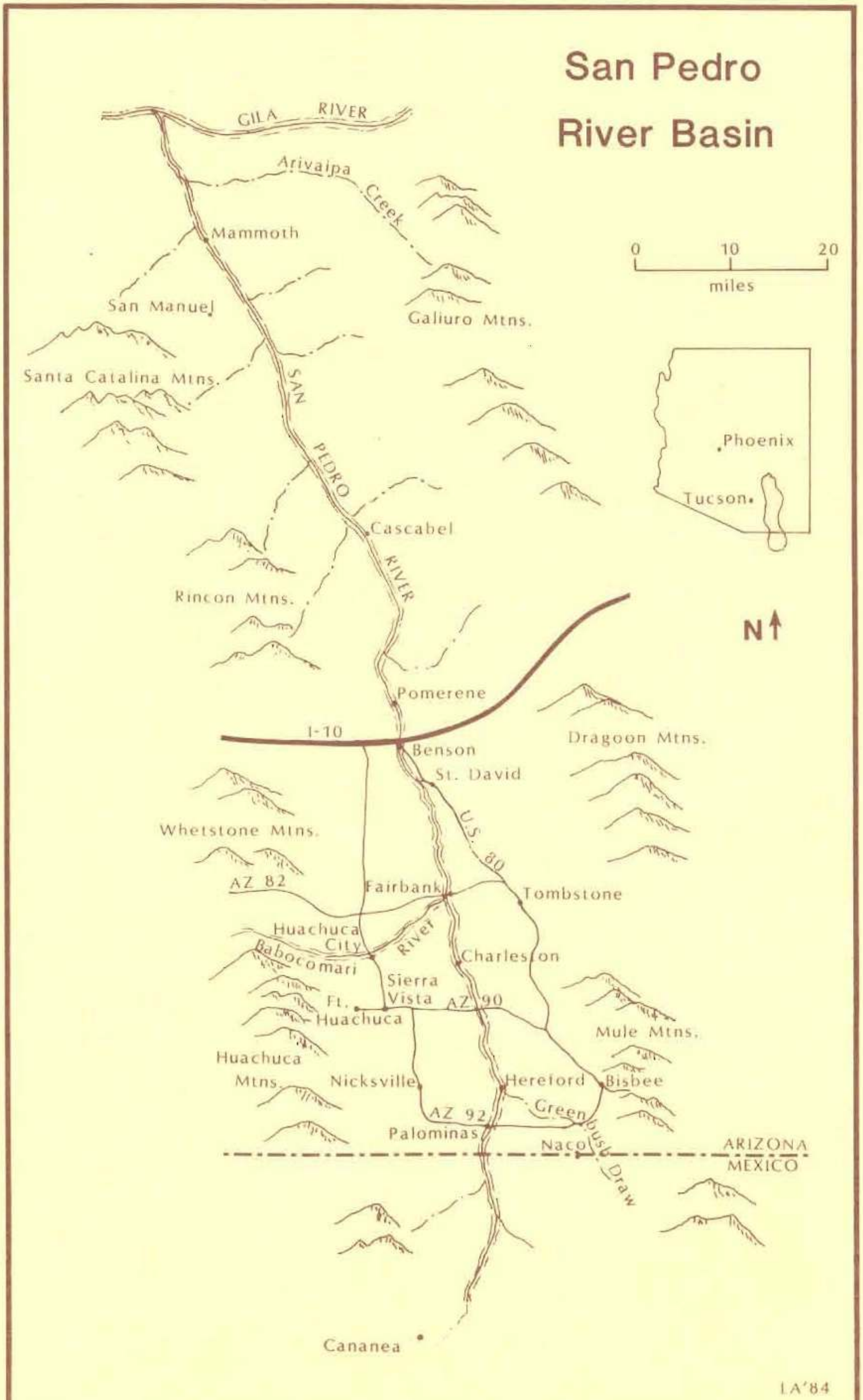


Earthquake effects south of Agua Prieta
(Photo by C.S. Fly — permission of Bisbee Mining and Historical Museum.)


San Pedro
River Basin
GILA RIVER
Arivaipa Creek
Mammoth
San Manuel
Galiuro Mtns.
Santa Catalina Mtns.
SAN PEDRO RIVER
Cascabel
Rincon Mtns.
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miles
Phoenix
Tucson
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Pomerene
I-10
Benson
St. David
Dragoon Mtns.
Whetstone Mtns.
U.S. 80
AZ 82
Fairbank
Tombstone
Huachuca City
Babocomari River
Charleston
Sierra Vista
Ft. Huachuca
AZ 90
Mule Mtns.
Huachuca Mtns.
Nicksville
Hereford
Bisbee
Greenbush Draw
AZ 92
Palominas
Naco
ARIZONA
MEXICO
Cananea
LA'84

THE UPPER SAN PEDRO RIVER VALLEY
A Century of Environmental Change in Cochise County, Arizona

by Richard V. Francaviglia

Introduction

The San Pedro is a rarity among North American rivers in that it flows from *south to north.* As the San Pedro River flows northward from Sonora, Mexico, it joins the Gila River at Winkelman, Arizona, after diagonally flowing through Cochise County. In so doing, it cuts through several ecological zones and reveals significant historical and environmental change in its varied, beautiful landscapes.

It would be difficult to overestimate the importance of the San Pedro River Valley in the history of Cochise County: For a century it has been the major water supply for the western half of the county. Its lowlands have witnessed the county's major ranching, farming, and transportation activities, while the hills and mountains which flank the San Pedro Valley have yielded some of the greatest mineral wealth in Arizona history.

An "Upside-Down" Valley

This paper focuses primarily on the *Upper San Pedro Valley;* that is, the southern portion of the valley which lies above about 3000 feet in elevation. Today this upper portion is characterized by a scrubby vegetation pattern, called "Chihuahuan" by biologists. Geographically, the Upper San Pedro begins in Mexico and reaches down stream to the "The Narrows," a point some twenty-five miles north of Benson.

Continuing downstream (northward) past "The Narrows," the river runs through another zone, one more desert in appearance. This is the lower portion of the river basin, where Sonoran vegetation, and its hallmark — the large columnar Saguaro cacti — is found.[1]

It is the northern, or lower, portion of the valley which has remained rather isolated: It once was a proposed railroad route — but none materialized. It still has no paved through roads (though hopes persist that the road from Benson

[1] *Cochise County's only stands of Saguaro cacti are found along the San Pedro River Valley in the extreme northwest corner of the county.*

to San Manuel will someday be paved), and it remained without regular telephone service into the 1980's. The lower San Pedro has apparently suffered less from man's activities than that section of higher, more settled country south of Benson to Palominas, on the Arizona - Mexican border — the Upper San Pedro Valley.

A Transformed Landscape

The Upper San Pedro has witnessed aggressive railroad, road, ranching and urban development, and its landscape has been branded by a century of environmental use and abuse. The Upper San Pedro forms the subject of this paper — which documents the major environmental changes which have occurred in the century from the 1880's into the 1980's. Emphasis will be placed on four aspects of the Upper San Pedro Valley's environment that have shaped history — and been shaped by it. These elements, which are all interrelated, are:

- Geomorphology — lay of the land
- Biogeography — vegetation and animal communities
- Hydrology — water resources
- Land use — man's economic activities

I. Changes In The Lay Of The Land

Regarding geomorphological changes in the San Pedro Basin in the last one hundred years, the following observation is frequently cited:

> Where the San Pedro River of Southeastern Arizona formerly wound its sluggish course northward through a marshy, largely unchanneled valley, in August, 1890, it began carving a steep-walled trench through which it thereafter emptied rapidly and torrentially into the Gila. (Hastings and Turner, 1965, p. 3)

Although minor erosion of the San Pedro River's main channel and tributaries apparently existed before 1880, especially north of Benson (Cooke and Reeves, 1976, p. 94), the photographic records and descriptions of the last century reveal startling changes in the geomorphology of the Basin. On the average, the present river bed is probably twelve feet lower than its former (i.e., pre-1880's) location. In some cases, the San Pedro is today entrenched, or cut down, into arroyos twenty feet or more deep. In contrast, photographs from the 1880's reveal the river to have had gently sloping banks, and a rather indistinct channel. There were extensive areas of *cienegas,* or marshes, along the valley bottom. Most of these, like the *cienega* near Saint David, have vanished.

Hastings and Turner provide classic "then-now" comparisons of photographs taken in the 1880's and 1890's with "contemporary" photos in the 1960's. Although their major concern was with changing vegetation patterns, they make frequent reference to the more impressive topographic changes. At Fairbank, (the confluence of the Babocomari and San Pedro Rivers), for example, they use a rare 1880 photograph which

> "...verifies much of what has been alleged about conditions along the rivers before the onset of arroyo cutting. Neither stream has a distinct channel. Babocomari Creek winds sluggishly through a marshy, grass-choked plain; and the course of the San Pedro is almost invisible." (Hastings and Turner, 1965, p. 174)

By the 1960's they noted that "in carving a channel, ... Babocomari Creek has cut deeply into the hill from which the original picture was taken," (Ibid., p. 175) in effect removing the original photographic vantage point! Here, near Fairbank, the San Pedro River now flows in a "trench" about fifteen feet deep. Other areas of intense arroyo formation can be found near Benson and Pomerene. Certainly, the entire Upper San Pedro is today entrenched from the border north to "The Narrows." Much of this arroyo development occurred between 1890 and about 1920. Some observers pinpoint a date of August, 1890, at which time heavy floods initiated intense downcutting.

Although it is difficult to construct a "typical" historic cross section of the valley, early (pre 1880) descriptions (and photographs) reveal that the San Pedro Valley bottom lands were several hundred yards wide and gently sloping, or occasionally terraced, toward the river. The river meandered along in a rather indistinct channel. In only a very few locations can one today encounter these relatively "pristine" conditions along the upper San Pedro: The area near Lewis Springs appears to be one, although the impact of successive waves of erosion and deposition may be difficult to sort out from the "natural" topographic pattern.

By the 1890's, then, increasing arroyo development began to create today's familiar San Pedro landscape: An incised channel ten to fifteen feet deep running through nearly vertical walls of silty loam and unconsolidated sediments (former bottom land). Steep "cutoff banks" and dune-like areas of siltation on the valley floor are a common sight today. The main channel is joined by tributary streams which likewise are entrenched deeply for miles away from the main river channel. Areas of heaviest erosion in the Upper San Pedro, according to the Soil Conservation Service, include the area from Fairbank northward to near Curtiss,

MARKERS OF CHANGE: In places, the San Pedro River has cut deeply into the valley bottom, leaving high bluffs. Here, near the old railroad town of Fairbank, the highway bridge road surface (right and center) marks the river level of about 1880, while the unstable steep twenty foot high bluffs (left) are susceptible to continuing erosion. *(December 1979, photo by Richard V. Francaviglia).*

and in two large areas near Benson. The U.S. Soil Conservation Service estimates that this erosion removes from 1.5 to 4.5 acre feet of soil per square mile annually, creating eerie areas of "badlands" topography.

Several researchers have speculated as to the causes of such severe erosion. Some attribute extensive downcutting to *"cultural"* factors, *e.g.,* "grazing," road (and railroad) development, etc., or to *"physical"* changes (climatic change in particular, but the effects of seismic disturbance from the May 3, 1887 Bavispe Earthquake must also be considered). The eradication of the extensive beaver populations once reported in the valley may also have triggered erosion.

William Rodgers (1965) analyzed land use activities in relation to environmental changes, and concluded that "...the causes of the changes to the landscape in the Upper San Pedro River Valley must be attributed primarily to disturbed woodland cover of the surrounding mountains and secondarily to overgrazing." (Rodgers, 1965, p. 154) He contends that deforestation of the mountains for mine timbers, construction materials, and for firewood (or charcoal) used in mining and ore smelting activities led to accelerated erosion in the lowlands, and that grazing activities were secondary in creating the classic erosion pattern in the Upper San Pedro River Basin. Not everyone is in agreement with this hypothesis.

The most realistic (and safest) conclusion accounts for a change in stream dynamics:

> "...at present the best hypothesis to explain arroyo formation along the major valley floors of southern Arizona acknowledges the possibility of increased valley floor discharge due to climatic and/or vegetation changes but emphasizes the role of drainage concentration features and related changes along valley floors." (Cooke and Reeves, 1976, p. 99)

Major topographic changes occurred as a consequence of the Bavispe quake (1887), which in some cases created steps or terraces (DuBois and Smith, 1980). Reeves (1980, personal communication) noted that, in some places in the San Pedro Valley, arroyo formation is traceable to the development of the sectional road network, but that "single factors" such as this over-simplify the complex conditions occurring. Reeves and others, having dismissed singular explanations such as "decline of the grassland" or "over-grazing," note that steepening of gradients is associated with arroyo formation, and that steepening can be achieved by changes in frequency of precipitation events, changes in land configuration, or a *combination* of these and other factors. (See Cooke and Reeves, 1976, pp. 90-94)

Such geomorphic changes cannot be considered in a vacuum: The net effect of arroyo formation, however, has most likely been one of increasing aridity —

downward cutting of streams has changed the subsurface hydrology and contributed to the more barren, "desert" look of today's landscape in much of the Upper San Pedro basin.

II. Changes in Plant (and Animal) Communities

The striking geomorphic changes in the valley and its tributaries during the last century were accompanied by (and possibly, but not necessarily, caused by) equally striking changes in the vegetation. Early observers tell us that the San Pedro River Valley was vegetated with a classic riparian (or river bottom) forest community (comprised of cottonwoods, willows, and sycamores) located along the river which ran through a grassland community dotted here and there by yucca, mesquite, and cacti. The middle elevations of the valley slopes (ca. 3500 feet) would have been characterized by an oak grassland community; the upper reaches (above 5000 feet) were most likely forested with oaks, pines and junipers. There is photographic and written evidence that oaks, which are today confined to the hills, were even found on the valley floor in the upper San Pedro, at least at elevations above 3500 feet, about a century ago.

By 1890, the riparian vegetation pattern along the valley floor had already begun to be drastically altered. The landscape consisted of rolling grassland with occasional clusters of mesquite, acacia, and yucca. Notable by their absence were the larger trees, especially cottonwoods, which had once apparently lined the river bottom. Their demise has been attributed to the coming of the railroad in 1880, and, more specifically, the prevalence of mining — which depended on charcoal for smelting and wood to provide (steam) power for milling ores.

Located in grassland along the San Pedro's banks, the long-vanished town of Charleston thrived from 1880 until about 1887 as a major ore milling town. Almost every living tree in the area succumbed to the axe as Charleston's industrial and urban growth continued until the earthquake of 1887. Today only its site remains, the location having been reclaimed by dense riparian vegetation in the absence of significant human disturbance. (Hastings and Turner, 1965, pp. 162-163; see also Tiller, 1982.) Tombstone, Bisbee, and mining camps in the Huachucas contributed to the deforestation on the hills and mountains which flank the San Pedro River Valley.

Hastings and Turner creatively used their "then-now" vignettes to show the significant vegetation change which has affected the "desert grasslands" of the San Pedro from 1890 to the 1960's. Combining photographic evidence with contemporary written descriptions, they deduced that during this 70-year period the grassland declined as shrubby species invaded the range. Particularly aggressive were acacia *(Acacia vernicosa)* and mesquite. They concluded that a "Chihuahuan" vegetation pattern invaded the former native grassland.

DECEPTIVELY PASTORAL: What appears to be bucolic, placid setting along the peaceful San Pedro River was once the site of the booming silver ore milling town of Charleston, Arizona. Trees have returned to reclaim the site, while the river, which flows all-year-round at this point, periodically swells to a rampaging flood which cuts banks, removes trees, undermines bridges, and re-arranges the "changeless" landscape. *(November 1979, photo by Richard Francaviglia).*

Causes of the invasion have been ascribed, by various researchers, to: Suppression of fire; overgrazing; climatic change, etc. Causes, however, are less clear than their effects; certainly by the 1930's the vegetation had substantially changed from a grassland to an area dominated by brush and scrub. Photographic and written evidence amply documents the "invasion."

Along with native American invaders we find the ubiquitous "Russian Thistle" — or tumbleweed *(Salsola kali)*. Originally native to southwestern Asia, this romanticized but pesty invader has come to dominate the farmed landscapes along the river bottom and the overgrazed ranching areas of the entire valley. Although cattle can eat the young shoots of new tumbleweeds, these plants soon become thorny and inedible. Blown along by the wind, they scatter their seeds throughout fall and winter.

Rodgers (1965) links vegetation change (specifically decline of the grassland) directly to geomorphic change, stating that:

> "As a result of channel cutting the surface water level dropped eventually 20 to 30 feet... (and) former sheet runoff...and consequent percolation which provided moisture for the grasses was diverted to the arroyos. This left the grass cover without sufficient soil moisture to maintain its former growth and combined with continued overgrazing provided an opportunity for the rapid incursion of desert scrub already present, although scattered throughout the valley." (Rodgers, 1965, p. 149)

Some observers contend the widespread fires following the earthquake of 1887 decimated the native vegetation and ushered in the brush or scrub species (DuBois and Smith, 1980), especially on the upland slopes.

In the valley bottoms, however, quite a different situation was occurring, namely, the *re-establishment* of riparian vegetation following the cessation of wood-cutting activities. (Reichhardt, *et al,* 1978) The riparian habitat, which was nearly absent from the valley floor in the 1890's, comprised approximately 22% of the total acreage of the valley floor by 1935. By 1978 this had "unexpectedly" risen to 39%, an increase of 43%. (Reichhardt, *et al.,* 1978, p. 14) Such a categorical increase, however, is liable to be misleading because the *composition* of this vegetation category has probably differed from 1890 to the recent past. As Reichhardt, et al. noted, "...we may assume that cottonwoods have diminished along the San Pedro River," and that, "in contrast, mesquite has been increasing." (1978, p. 16) Tamarisk, or "Salt Cedar," "has also drastically increased since its introduction...(and) since it is capable of germinating at the expense of native riparian species, it has intruded into many situations." (*ibid.*)

Mesquite was present, but rather inconspicuous, in the basin before the 1880's. It is a suspected invader from the Southeast (i.e., Chihuahua). Given its presence in a similar climatic region, its deep tap root development, and its ability to survive in heavily grazed environments, one might identify mesquite as an "intruder." This, coupled with decreasing water levels, would explain the increase and dominance of "phreatophytes,"[2] and the decline of shallow-rooted trees (e.g., cottonwood, sycamore) dependent on perennial surface flows, during the last century.

Numerous observers and ecologists have reported the lack of young cottonwoods in the San Pedro. In the 1980's the cottonwood population, which consisted mainly of large trees (ca. 35 or more years old), was not being replaced. Many environmentalists contend that cattle grazing to the river's edge are at the root of the problem, but this condition may in fact be exacerbated by "...upstream impoundments, channel cutting, channelization, irrigation diversions, groundwater pumping and, in many areas, increased water salinity." (McNatt, 1978, p. 203)

In summary, then, riparian vegetation is closely related to, and dependent on, water quantity and quality, land use patterns, economic activity, and climatic conditions. The riparian vegetation of the San Pedro has been the focus of ecological interest because "only a few southwestern drainages such as the Rio Magdalena in Sonora, Mexico, and the San Pedro in Arizona, presently contain any extensive linear forest development." (McNatt, 1978, p. 203)

This rich and varied habitat in southeastern Arizona constitutes an extremely important environment for migrating birds. The region possesses the highest bird and mammal species diversity in the United States! The riparian corridor of the San Pedro has consequently attracted conservationist's attention, and the river was listed in the "nationwide rivers inventory, phase 1" (1980) having potential for status as a "nationally significant wildlife ecosystem" and a "unique wildlife ecosystem." (1978)

III. Changes in Water Resources

Profound changes have occurred in the hydrology of the basin since 1880:

> "By 1890...during the course of a single summer, many of the streams of the region underwent a striking change in their hydrologic regimes. Where the San Pedro River...formerly ran more or less consistently throughout the year, after 1890 its flow became intermittent, leaving the new channel dry over much of its length for most of the time." (Hastings and Turner, 1965, p. 3)

[2] *A phreatophyte is defined as a plant with deep roots which tap underlying water supplies.*

To judge from contemporary (and later) accounts, the earthquake of 1887 had a phenomenal effect on ground and surface waters in the valley. In some cases springs appeared, while others dried up. (DuBois and Smith, 1980)

The flow of the San Pedro responds to both surface runoff and ground water flows which feed the valley's numerous springs. These springs may amount to surfacing artesian groundwater in some areas. In response to rainfall conditions, the river's runoff tends to have a bi-seasonal distribution: The largest flow, that of summer, is a consequence of "monsoon" rains.[3] Seventy percent of the annual precipitation in the uppermost (southerly) parts of the basin occurs in July, August, and early September. Despite the large amount of precipitation delivered by these storms, however, their spotty nature insures that their impact on the main channel will be lessened. Nevertheless, summer is usually a time of fairly predictable flows in the river channel.

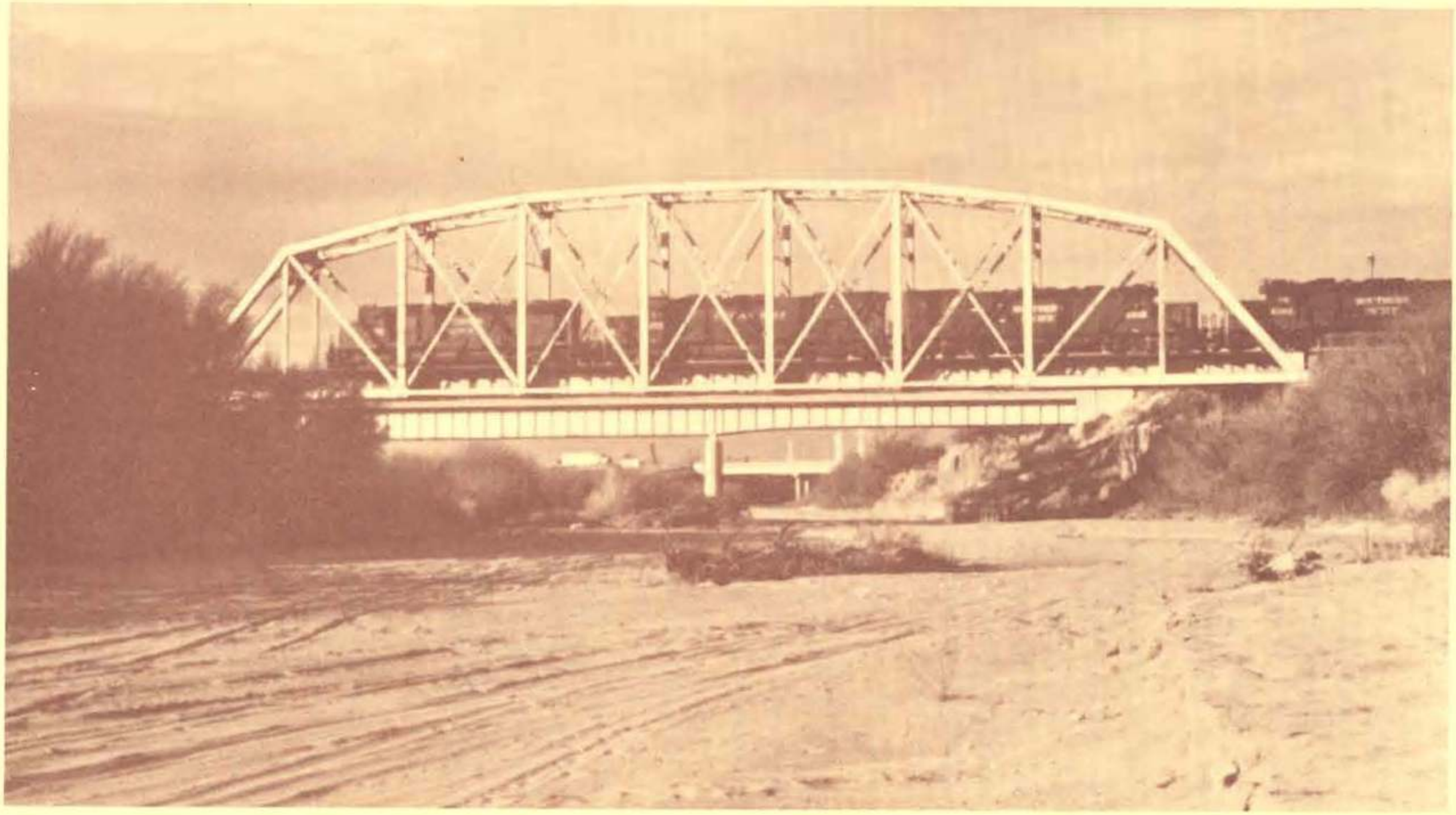
Winter rains are usually cyclonic or frontal in nature, and derive from the eastward-moving North Pacific ("California") low-pressure centers. These winter rains are liable to be more gentle, but they often last for up to several days. Such storms bring only about 30% of the yearly precipitation in the upper portion of the basin. Nevertheless, the more "gentle" winter rains, if prolonged, can produce an angry swollen river carrying up to 10,000 cubic feet per second (cfs) and capable of damaging bridges and tearing out river banks.

Despite folklore to the contrary, there is no evidence that the climate has significantly changed: As in most parts of the Southwest, "average" precipitation has little meaning. A year will more likely be "above average" (wetter) or "below average" (dryer) than normal.

One of the most striking features of the San Pedro Valley today is the intermittent nature of the river's flow at most stations. What was once a perennial (year round) flowing river has become an intermittent stream today. Perennial flow exists only in areas of dependable springs, or, more importantly, in those places where groundwater is forced to the surface by subsurface (bed rock) constrictions. Today, 60% of the channel is liable to be dry during a substantial portion of the year, namely, the dry seasons of spring and fall.

Of course, groundwater is present under these dry stretches, usually anywhere from 10 to 20 feet at most. Hydrologic studies show that there is a continuity of subsurface flow throughout much of the basin (Roeske and Werrell, 1973). One of the most interesting aspects of the river basin today is the disappearance and re-emergence of swiftly moving water as one traverses the channel during "dry periods." The observer is encountering groundwater

[3] *(i.e., intense convectional storms which move into the area from the Southwest — the Gulf of California and Pacific Ocean is their source — and are triggered over the mountains of northern Sonora and southeastern Arizona.)*



A DRY RIVER: Whereas the San Pedro was described, in the 1880's, as flowing year-round, today a substantial portion of the Channel is dry for at least part of — and sometimes much of — the year. Here, at Benson, an S.P. freight train crosses the San Pedro's dry river channel which is lined with the tracks of dirt bikes and dune buggies. *(January 1980, photo by Richard V. Francaviglia).*

which is surfacing and flowing at specific locations where subsurface flow is constricted. This gives rise to the popular misconception that the San Pedro is a rapidly flowing "underground river."

One must conclude, in addition to the channel itself "dropping" about ten or more feet in the last century, that the water table in the immediate vicinity of the river has also dropped to the level of, or below, today's channel. The implications for wildlife, such as fish, are obvious. Habitat alteration has been severe. The main reason that the fish population has not been entirely eliminated is due to the existence of the *perennial* sections or reaches of 1) the main river channel, and 2) the lateral tributaries — such as the Babocomari and Aravaipa Canyon, which flow year round.

Thus, fish populations are naturally returning (albeit slowly) to the main channel after abatement of the heavy pollution spill from the copper mine tailings ponds at Cananea, Mexico, in 1978-1979. Conditions at that time were found to be highly acidic (pH levels of ca. 2.5) with lethal concentrations of heavy metals (such as copper and zinc) as far north as Benson. The effect on benthic organisms[4] and aquatic life was disastrous. Yet, with mitigated conditions approaching "normal," a riverine aquatic population began to re-establish itself in the perennial reaches in 1979 and 1980. By 1984, the river appeared to be in relatively good condition.

Hydrologic changes in the last century have been significant, and have resulted in changes in stream profile and well levels. Habitat alteration, especially impact on riparian vegetation, has probably been severe. Given increasing urbanization of the valley (e.g., the Sierra Vista area), the increase of agricultural activities, and the possible increase in industrial activities, one can anticipate more rapid removal of groundwater. This will signal the beginnings of accelerated decline in well water levels, (which has been verified in the Sierra Vista area), possible continued contraction of perennial reaches of the stream, increased (or at least sustained) heavy erosion in parts of the channel, and continued change of riparian vegetation in favor of phreatophytes and at the expense of shallow-rooted species.

The *relative* stability of the deeper water tables in the San Pedro (Roeske and Werrell, 1973) as compared with Tucson and Phoenix has frequently been cited by development-oriented citizens that the valley has a nearly "unlimited" capacity to support urban and agricultural development. In the light of experience with similar basins, however, such an attitude may constitute wishful thinking more than reflect actual conditions: The Anglo-American populations, in particular, have ascribed nearly magical regenerative powers to non-renewable resources.

[4] *Those creatures which depend on the stream bottom to live out part of their life cycles, such as flying insects which deposit eggs (larvae) there.*

IV. Changes in Land Use

The year 1880 marked the coming of the railroad, the beginning of the mining era, and the start of a period during which Indian raids were subsiding as the U.S. military put greater emphasis on controlling the area. Nevertheless, the San Pedro was, at the beginning of this "Anglo" period of settlement, very sparsely settled. We must remember that earlier, say 1780, the valley's population density may have been higher: Sedentary Indians had been living in the valley, and the Spanish attempted, and failed, to settle the area and missionize these Indians during the century from the late 1600's to the late 1700's. Both groups had been driven out by hostile Indians, and the area's early sedentary Indian and Spanish agricultural activities had essentially ceased.

In 1880, therefore, the San Pedro was perhaps more "natural" in appearance than it had been a century before. Land use activities have a direct impact on water resources. There were six major kinds of activities in 1880: (1) the cultivation of small farms in the valley bottom where irrigation water could be obtained with little effort, (2) the beginnings of fairly aggressive utilization of the open range for cattle grazing and ranching activities, (3) the rise of mining communities, especially Tombstone (1879) and Bisbee (1880) and ancillary communities where ores were crushed and milled for shipment by either wagon or railroad, (4) the then-floundering Mormon settlement at St. David, (5) the continued development of Ft. Huachuca (i.e., the reaffirmation of the federal presence in the orderly settlement of the area), and (6) the early railroad towns which served as "railhead" locations for the shipment of cattle and ores from the San Pedro hinterland.

In 1880, then, our "contemporary" urban and land use pattern began to take shape as improved roads and railroads began to connect this rich area with the remainder of the developing Southwest. As we noted, the desert grassland and the topography and hydrology of the San Pedro River basin were about to be drastically transformed. By 1890, photographs and written records show that the transformation was well underway.

It is probable that all of the above-listed activities utilized only about 3,000 acre feet of water annually in the Upper San Pedro in 1880, and that irrigated agricultural land in the Upper San Pedro totalled only about 800 acres. Irrigated acreage along the entire San Pedro valley grew rapidly, to 2,672 by 1890 and 3,500 acres by 1899. (Newell, 1901, pp. 352-353)

As regards Mormon activities, the *St. David Ditch* was constructed in 1881. It effectively drained a swampy, miasmatic lowland burdened by malaria. It is said that the earthquake of 1887 radically altered St. David; the streams began to downcut into the swamp, draining it; and artesian wells appeared. Later efforts at irrigation and drainage in this area included the Pomerene Canal

MAN AND NATURE: An aerial photo shows the San Pedro River — which appears as a meandering dry channel (left) — flanked by the Copper mining tailings at San Manuel. Impact of mining on the vegetation, landscape, and environment of Southwestern watersheds is still debated, but has been significant for a century. Summer 1981 view looks South. *(Photo by Richard V. Francaviglia).*

(1912). In 1968, these two "Mormon" irrigation districts alone diverted 6,000 acre feet of water for use on 2,400 acres of farmland. (USGS 1970 data cited in Roeske and Werrell, 1973, p. 6)

In a recent riparian habitats study based on comparative air photo analysis for the years 1935, 1966 and 1978, Reichhardt (*et al.*) classified land use patterns in the San Pedro Valley into nineteen categories. Four major categories (1) Dense Riparian, (2) Agricultural, (3) Cultural-Industrial, and (4) "Other" were differentiated by these researchers in order to simplify the study. They found that "Dense riparian, agricultural, and cultural-industrial land have all increased since 1935."

Although Reichhardt's study was conducted for the *entire* San Pedro Valley, an analysis of the 23 original map overlays (approximately half of which deal with the Upper San Pedro Valley) indicates that these findings also hold for the Upper San Pedro; namely, *that agricultural and urban-industrial land uses have continued to grow, and that riparian vegetation has probably continued its "return," during the last forty years.* However, it must be remembered that these categorizations tell us little or nothing about the *quality* of such changes (or their environmental impacts). The researchers conclude that "even over the past 43 years — land use on the San Pedro has changed greatly. The ecosystem of the floodplain itself has undergone incredible change through the years." (Reichhardt, *et al.*, 1978, p. 17)

"Agricultural" activities center on irrigated cropland and ranching activities. Crops grown in the valley include sorghum, cotton, barley, hay, corn, and irrigated pasture crops. Expansion of irrigated farmland is expected in the Tenneco "land grant" area near Lewis Springs to Hereford. The (Mormon) irrigated area around St. David-Pomerene continues to grow, but not as rapidly. Currently in the Upper San Pedro, agriculture uses approximately 60% of the total water drawn: Most of the 35,400 acre feet used today is "agricultural" (22,100 acre feet), followed by mining and industry (6,600) and public water supplies (6,700).

Ranching activities generally occupy most of the land not used by urban and irrigated farming activities. They are developed on a crazy quilt of state and private lands. Given the prevailing deteriorated conditions of the range, carrying capacity tends to be fairly low. Ranching activities depend on two water sources: (1) wells drilled in various locations, and (2) surface waters. Ranches at the periphery of the valley (*i.e.*, in the alluvial uplands) are most likely to be dependent on wells, some fairly deep, for domestic and livestock use. In the case of ranches closer to the river, cattle frequently drink river water — hence the strong concern of ranchers that this water not be "polluted."

Industrial activities represent a small land area, but consume about 20% of the water drawn. They have strong potential to adversely impact water quality.

Public water supplies consume the remaining 20%. It is expected that the urban or public water supply demands will increase (probably double) by the year 2000, and that agricultural uses may consequently consume a smaller percentage of the total. It is also suspected that continued water demand in all categories will have the effect of lowering groundwater levels, especially in the southwestern portion of the Upper San Pedro (in the vicinity of Sierra Vista). Rapidly growing "remote subdivisions," too, will have an increasingly larger role in water demand, and consequent water pollution.

Conclusions

The Upper San Pedro River Basin has been characterized by significant environmental change in the last century, *i.e.,* from 1880-1980. Whereas the valley was very sparsely populated and lightly used in 1880, that year marked the coming of the railroad and the beginning of a mining boom whose impacts are still seen in the landscape today. These activities, coupled with the dominance of livestock and agricultural uses, have led to substantial change in the valley's landscape.

Despite these changes, the (upper) San Pedro remains in what some researchers consider a "relatively undisturbed" state *compared to other southwestern basins.* Recent conservation efforts at "saving the San Pedro" have focused on its uniqueness as one of the longest undammed stretches of river in the arid Southwest. Lessons from the last century teach us that, unless a careful strategy of growth is developed, the environmental quality of the San Pedro is liable to deteriorate at an accelerated rate as water levels drop and as surface and groundwaters become increasingly polluted by man's activities in the late Twentieth Century.

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About the Author

Richard V. Francaviglia currently serves as Director of the Bisbee Mining and Historical Museum. His special interest is in "landscaping evolution" — the ways in which places are created, and the ways in which they change over time. Francaviglia, who holds a Ph.D. in geography and architectural history from the University of Oregon, is author of *The Mormon Landscape, Copper Mining and Landscape Evolution,* and *Mining Town Trolleys.*

He served as project manager of the Environmental and Community Development Planning Section of the Southeastern Arizona Governments Organization (SEAGO) from 1979 to 1983, during which time he wrote several regional water quality plans, including those for the San Pedro and Santa Cruz River basins.

THE WONDERLAND OF ROCKS

Chiricahua National Monument

by Enid C. Howard

The Chiricahua Mountains, in the extreme southeastern corner of Arizona, are an oasis in a flatland of grass, an ever-rising sea of grass that gives no advance information about the hidden world of the Chiricahuas as the visitor approaches the entrance to Chiricahua National Monument at Bonita Canyon.

This mountain range, with secret hidden trails, deep canyons, forested sides, shady glens and strange massive rock formations, turrets, spires, and balanced rocks that defy gravity, is historically rich in all phases of man and his occupation and passage through the verdant forests of this "Wonderland of Rocks."

Within the generation of our immediate forebears, these mountains were known as the homeland of the Chiricahua Apache Indians. Apache Pass, at the north edge of the range, was a natural route from the Rio Grande country to Tucson and California.

The Butterfield Mail Stages established regular runs through Apache Pass from St. Louis to the west coast, and were bitterly resented and attacked many times by Apache warriors.

Students of American history are well acquainted with the almost legendary Chief Cochise and his warriors of the Chiricahua Apache Indians. They held the white man at bay for 25 years in a futile attempt to halt the advance west into their homeland and across the Chiricahua Range and the Dragoon Mountains a few miles west.

After the establishment of Fort Bowie near Apache Pass in 1862, open warfare, with ambush and massacre, were practiced on both sides until the final surrender of Geronimo in 1886. The fierce Apache had been subdued by the determined white men, but the exploits of some of their leaders are remembered as one looks out over Massai Point and Cochise Head which immortalizes two famous Apache chiefs.

A section of the Chiricahuas was created a National Monument on April 18, 1924 by President Calvin Coolidge. Entrance to the Monument is on the west side, from Willcox. Off Interstate 10, take State Highway 186 south, or via U.S. 666 then State 181, from Douglas, Arizona. Facilities include a 37-unit campground in Bonita Canyon where the elevation is 5,340 feet, one-half mile from the Monument Headquarters. Drinking water, fireplaces and tables are provided. Fireplaces burn charcoal, so bring your own.

The campgrounds are maintained in a clean and sanitary manner, and spaces are well placed among trees which create a pleasant setting. Trailers up to 22 feet can be accommodated, but no hook-ups are available. The Monument is open all year. Mean daily temperatures around 40 degrees in January, and 74 degrees in July are ideal for comfortable relaxing.

Also, the mild winters and cool summer days are perfect for exploring the many maintained trails throughout the Monument for a truly rewarding visit with a most unusual land. Trail guide maps available at Monument Headquarters list time and distance. The trails are not difficult and extremely interesting.

The first feature the visitor will notice is the fantastic array of rock formations consisting of spires, pinnacles and imagined figures of people or animals. The rock surfaces are literally clothed in lichens of every hue: yellow, blue, grey, green. They coat the surfaces of the columns and create a softening glow to the formations.

The geological forces, which created this "Wonderland of Rocks," are of volcanic origin. Strangest of all is the volcano, that produced the white hot ash which became the singular, and sometimes quaint or comical formations, was located 10 miles distant. It took geologists several years to locate the source of the volcanic deposit that had been laid down intermittently.

Finally, when the eruptions ceased, water deposits, uplifting, erosion, rain and wind began the cutting and wearing away of upper strata. Erosion is still working at the softer layers of the tuff, while the harder layers of breccia and agglomerate, and a massive 800-foot-thick rhyolite lava deposit resist the cutting action and stand tall in pinnacles that astound us with their form and variety.

Lush green forests dominate the steep sides of the west and north exposures within the Monument. Life zones overlap because of the extremes in altitude, and results in a mixing of biotic communities that ordinarily would be separate. Two distinct biotic situations and a portion of a third are found here; the desert grasslands of the extreme upper edge of the Lower Sonoran Zone, the chaparral community of the Upper Sonoran Zone, which extends its full range in Bonita Canyon, and the forest community of the Transition Life Zone which tops out at Sugarloaf Peak, the Monument's highest point at 7,308 feet.

Because of this unusual span of biotic communities, a wealth of deciduous and evergreen trees, shrubs, chaparral, flowers, cacti, and incredible numbers of birds and animals thrive at altitudes and in situations where they have no business to be living. However, there is an orderly sequence to the plan because of what is called micro-climates, where the zones overlap to create a biotic potential, and where flora or fauna can live well in both zones.

The Chiricahua Mountains are a bird watcher's heaven as more than 250 species and sub-species have been recorded, with about 100 of them sighted within the Monument boundaries. They range from the ground floor occupants to those who will live only on the topmost cliffs. Sightings have been made of some of the exotic birds of Mexico who have extended their summer range into Arizona where the living accommodations seem more to their taste. One of these is the Trogon whose long, copper-colored tail is indeed spectacular and identifies him immediately.

A paved road to Massai Point presents an immense panorama of the colorful pinnacles which are the outstanding feature of the area. One may walk the paths around the point where extensive views to the west across Sulphur Springs Valley, and the San Simon Valley on the east, unfold against a far out horizon.

The varied life zones of the Chiricahuas shelter an amazing number of animals and it is a lucky visitor who is privileged to see some of these natives. The bannertail kangaroo rat is one of three species of kangaroo rats found here, along with the desert cottontail, the high-jumping blacktail jackrabbit, whitetail deer, the gray fox, raccoons and bobcats.

Occasional visitors from across the border are the ocelot, who are spotted and about twice the size of a house cat, and the jaguar, also spotted but as large or heavier than a mountain lion. A Mexican resident who has definitely migrated to the Chiricahuas is the noisy, blatantly hungry Coati. He is also a very gregarious fellow and hangs around the campgrounds, posing for pictures and snooping for food. His appearance is awkardly unbalanced with a long heavy tail making up most of his length.

Great pictures are everywhere, around every bend in the road or turn on the trail, so don't forget your camera when you visit "The Wonderland of Rocks" in southeastern Arizona!

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PUNCH AND JUDY — Wonderland of Rocks, Chiricahua National Monument (from a postcard in CCHAS Museum).

THE MUSHROOM — Wonderland of Rocks Chiricahua National Monument (from a postcard in CCHAS Museum).