

# GEOGRAPHY OF THE SIERRAS JUAREZ AND SAN PEDRO MARTIR, BAJA CALIFORNIA, MEXICO

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The Sierra Juárez and the Sierra San Pedro Mártir are two Mexican, crystalline highlands which are parts of the Peninsular Range. They extend, in line, southward for some one hundred seventy miles from the Laguna Mountains in San Diego County, California (Fig. 1).

Published materials have been concerned less with these high, timbered sierras of northern Baja California than with other parts of the peninsula because aborigines did not permanently occupy these areas nor were missions established in the mountain forests. Moreover, in the twentieth century economic development in northern Baja California has been concentrated on the Delta of the Colorado River and along the Pacific coast, while the northern high sierras have remained little exploited. Nevertheless, these mountains contain valuable natural resources which have in the past attracted temporary settlement, are today being slightly utilized, and in the future offer promise of increased exploitation.

That part of the Baja California peninsula in which the Sierras Juárez and San Pedro Mártir are located is a west-tilted fault block of which these mountains form the crest. The block consists mainly of crystalline rocks associated with a deeply unroofed batholith intrusion which recent investigations indicate was mid-Cretaceous.<sup>1</sup> On the east the crystalline core rises precipitously, as an escarpment, above the profoundly deep Gulf of California Diastrophic Trough. On the west the slope is much more gradual, especially in the Sierra Juárez.

Just south of the international boundary along the crest of the east-facing escarpment lies a series of narrow granitic ridges and piled masses of huge granite boulders known as the Sierra Juárez (Fig. 1). This sierra stands only slightly above the gently-sloping, old, erosional-surface plateau to the west, which is probably of Eocene age. The range itself includes many nearly level areas, known as *bajios* in the higher, wetter places. Elevations range from about 3,100 feet at the United States border to 6,676 feet at Cerro Colorado, near the southern end of the sierra where the granite is buried beneath mesas of lavas, tuffs, and sediments.

The Sierra Juárez terminates at San Matías Pass (elevation 3,300 feet) which separates this range from the Sierra San Pedro Mártir to the south. This pass may be the eastern expression of the Agua Blanca Transverse Fault—a major strike-slip fracture zone extending to the west coast on the north slope of Punta Banda (Fig. 1).<sup>2</sup>

A slightly dissected fault block, which forms an elongated, corrugated plateau of granitic rocks, rises on the batholith south of San Matías Pass to

<sup>1</sup> L. T. Silver, F. G. Stehli, and C. R. Allen. *Lower Cretaceous Pre-Batholith Rocks of Northern Baja California* (Pasadena: California Institute of Technology, Div. of Geological Sciences, Contribution No. 799, 1956), pp. 1-11.

<sup>2</sup> C. R. Allen, L. T. Silver, and F. G. Stehli. "Agua Blanca Fault—A Major Transverse Structure of Northern Baja California, Mexico," Abstract in *Bulletin of the Geological Soc. of America*, LXVII (Dec., 1956), p. 1664.

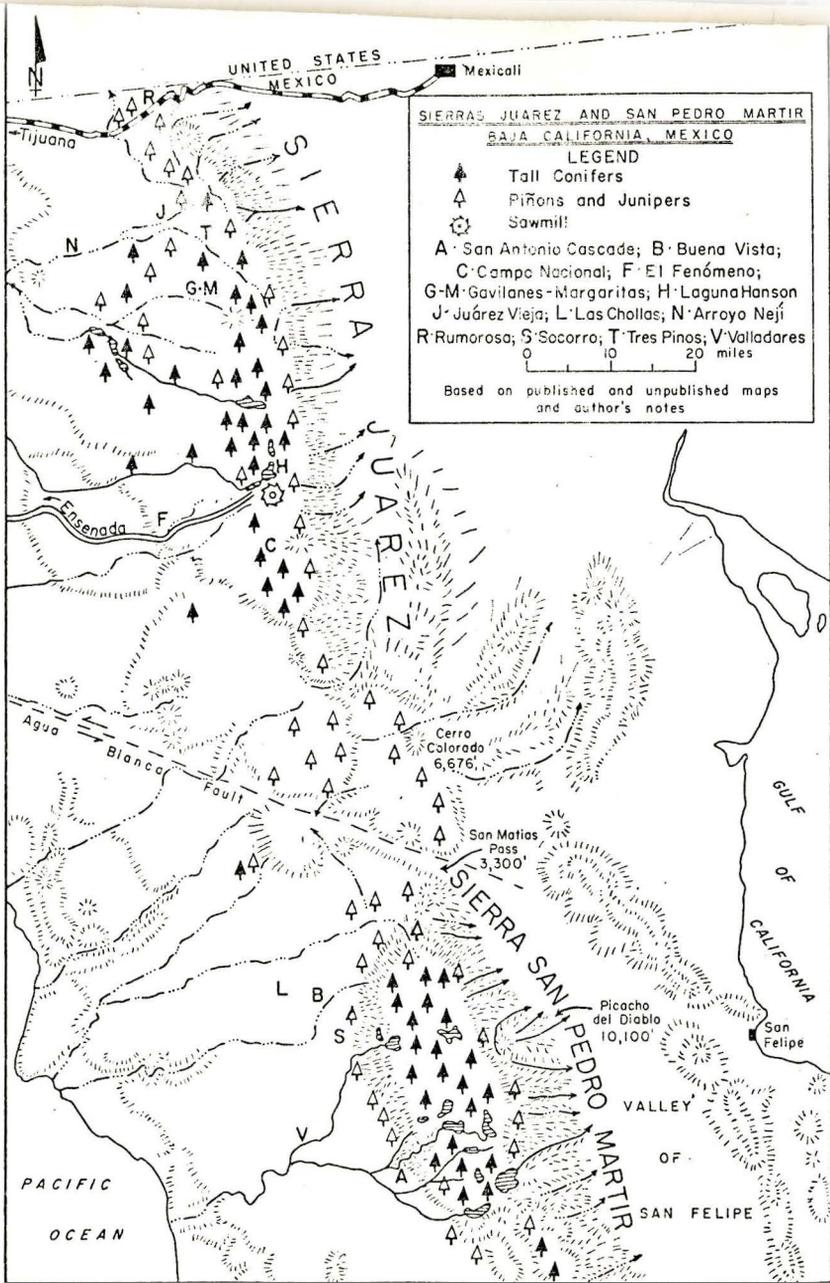


Fig. 1

form the Sierra San Pedro Mártir. On the plateau, which stands at 5,000 to 9,000 feet, are two marginal ridges which rise 500 to 1,000 feet above the plateau surface. Toward the Gulf of California from the more serrated eastern ridge the escarpment plunges from the highest point on the peninsula, Picacho del Diablo,<sup>3</sup> (10,000 feet), to an elevation of some 1,500 feet in the Valley of San Felipe. Among the piles of gigantic granitic boulders at the base of the eastern ridge lie the delightful, pine-surrounded, grassy basins and wet meadows which have given that part of the plateau the name Los Vallecitos.<sup>4</sup>

Meigs has classified the climate of most of the area in the sierras of Northern Baja California as Mediterranean, hot-summer, Köppen Csa).<sup>5</sup> The same author has called the climate of Catalina mesas, at the southern end of Juárez Range, hot steppe-desert transition (Köppen BSh), and that of the highest parts of the San Pedro Mártir microthermal, dry-summer (Köppen Ds).<sup>6</sup> Climatic records at Rumorosa, El Compadre, and Ojos Negros indicate that the annual precipitation in the Jeffrey pine forest to the south and east is probably fifteen to twenty inches.<sup>7</sup> May and June are the only months that are, in some years, devoid of precipitation. Snow falls and frosts are frequent every winter in the San Pedro Mártir and in the higher parts of the Sierra Juárez. Summer rainfall is heavy enough in the San Pedro Mártir to make the dry-summer climatic classification doubtful. No climatic stations exist in the forest of the San Pedro Mártir, but annual precipitation there is probably as much as thirty inches. Both of the sierras are wetter than the lands to the west and east of them.<sup>8</sup>

The only coniferous forests with merchantable timber on the peninsula cover most of the surface on the highest and wettest parts of northern Baja California, the Sierras Juárez and San Pedro Mártir. On the west these forests are bordered by chaparral, and on the east the conifers give way abruptly to species of the vegetation association of the Colorado Desert. Large stands of Parry piñon pine (*Pinus cembroides parryana* Voss.) and one-leaf piñon (*P. cembroides monophylla* Torr. and Frem.) are found on the drier, lower edges of the sierras down to about 3,000 feet. California juniper (*Juniperus californica* Carr.) grows in association with

<sup>3</sup> Also known as La Providencia, Cerro de la Encantada, Calamahué Mountain, and Cerro Santa Catalina.

<sup>4</sup> For a detailed description of the geology and landforms of the Sierra San Pedro Mártir see A. W. Woodford and T. F. Harriss, "Geological Reconnaissance Across the San Pedro Mártir, Baja California," *Bulletin of the Geological Soc. of America*, XLIX (Sept., 1938), pp. 1297-1336.

<sup>5</sup> Peveril Meigs, *The Dominican Mission Frontier of Lower California* (Berkeley: University of California Pubs. in Geography, 1935), VII, p.14.

<sup>6</sup> *Ibid.*, pp. 14, 126.

<sup>7</sup> Data from the files of the Secretaría de Recursos Hidráulicos, Dir. Gral. de Hidrología, Sección de Climatología, México, D. F. Sixteen years of record are available for Rumorosa.

<sup>8</sup> Annual average precipitation at Ensenada is 13 inches, and at Mexicali is 2.98 inches. At San Felipe most years on record have less than 4 inches of rainfall. Data from Jorge A. Vívó and José C. Gómez, *Climatología de México* (México, D. F.: Instituto Panamericano de Geografía e Historia, 1946), Pub. No. 19, p. EM12, and from the files of the Servicio Meteorológico Mexicano, Dir. Gral. de Geografía y Meteorología, México, D. F.

the piñons. A large piñon forest extends northward from the Tres Pinos-Neji Arroyo, in the Sierra Juárez, to the international boundary (Fig. 1). From the Tres Pinos-Neji Arroyo a nearly pure stand of Jeffrey pine (*P. jeffreyi* Murr).<sup>9</sup> extends southward through the *bajios* (mountain meadows) to the volcanic mesas at the southern end of the Sierra Juárez.

In the San Pedro Mártir there is a mixed coniferous forest dominated by Jeffrey pine. The next most abundant species here is lodgepole pine (*P. contorta* Dougl.), which is found at elevations over 7,500 feet. Other trees which grow in the forest of the San Pedro Mártir are sugar pine (*P. lambertiana* Dougl.), incense cedar (*Libocedrus descurrens* Torr.), white fir (*Abies concolor* Lindl. and Gord.), and aspen (*Populus tremuloides* Michx.).

Most stream run-off from the Sierras Juárez and San Pedro Mártir flows toward the Pacific Ocean because the climate is more moist and the catchment basins are larger west of the crest of the fault block than they are east of this peninsular drainage divide. The majority of the streams in northern Baja California originate in the high sierras, and many of them have their headwaters in the high mountain meadows in which standing water accumulates in wet years. Laguna Hansen, in the Juárez Range, is the largest of these intermittent mountain lakes, and its waters have covered as much as 500 acres. From the meadows the streams flow westward. Those of the San Mártir tumble off the upper plateau in rapids, and on the San Antonio branch of the Río Santo Domingo, in a high cascade (Fig. 1).

In all but the cool, moist months the streams disappear in their beds before they reach the sea. In wet years one or several may reach the sea all year. East of the crest of the sierras small streams follow numerous canyons cut into the face of the escarpment. Here permanent waters cascade the desert where they are lost in sands, over steep surfaces, and flow through enchanting palm-lined pools toward

In the Sierras Juárez and San Pedro Mártir mammals which are the subjects of hunters are more abundant than they are in the more settled and accessible lower areas. However, even here, especially in the Juárez Range, where there are automobile roads, wild game has been badly depleted. The mule deer (*Odocoileus hemionus fuliginatus* Cown) and the mountain lion (*Felis concolor californica* Max) still inhabit the sierras. On the dry, precipitous east slopes of the mountains, in what Griffing Bancroft has called "the most inhospitable region in temperate North America," the mountain sheep (*Ovis canadensis crennobates* Elliot) survives in considerable numbers, isolated from all but the hardest of hunters.<sup>10</sup>

Water fowl, quail, and pigeons are still hunted in the mountains, but are less numerous than they were fifty years ago. The magnificent, giant California condor (*Gymnogyps californianus* Shaw) apparently disappeared from the sierras in the nineteen-thirties when the last individuals

<sup>9</sup> J. Robert Haller, *Taxonomy, Hybridization, and Evolution in Pinus ponderosa and P. jeffreyi* (Ph.D. dissertation, University of California, Los Angeles, 1957), p. 1; Fig. 1A.

<sup>10</sup> Griffing Bancroft, "The Faunal Areas of Baja California del Norte," *Condor*, XXVIII, No. 5 (Sept.-Oct., 1926), p. 210.

were reported in the San Pedro Mártir. Slaughter of this bird for sport and for its quill feathers, the hollow bases of which were used as gold-dust receptacles, probably accounts for its eradication.

A geographically isolated species of rainbow trout, the Nelson trout (*Salmo nelsonii* Evermann), is found in the Sierra San Pedro Mártir. This boreal kind of fish was found originally only in the San Antonio branch of the Santo Domingo River, but has since been planted in other mountain streams.

Man's utilization of the natural resources of the sierras of northern Baja California on a large scale dates from only the last three decades of the nineteenth century. Indians penetrated the high country to hunt and to gather piñon seeds, and mission livestock herds grazed lush mountain meadows in the San Pedro Mártir for a few years.<sup>11</sup> By the mid-nineteenth century, cattle from ranchos located west of the sierras were pastured in the mountains.<sup>12</sup>

It was, however, gold-rushes, which occurred between 1870 and 1900, that brought concentrated human occupation and large-scale exploitation of natural resources to the sierras. Mining camps were established in, and at the western edges of, the mountains; cattlemen increased their herds to meet the demands of prosperity; timber was cut for construction and mine timbers; and professional hunters began to despoil game for meat and deer skins. Since the gold rush days, utilization of natural resources in the sierras has fluctuated in intensity with mineral discoveries, but has also increased generally with the economic growth of northern Baja California.

Today the major value derived by man from the Sierras Juárez and San Pedro Mártir is that imputed to irrigation and drinking water. About sixty per cent of all irrigated land lying west of the sierras, or some 24,000 acres, is made productive by surface or underground water which flows toward the Pacific Ocean from the water sheds of the high mountains.<sup>13</sup> Moreover, the major source of drinking water for the city of Tijuana, with 130,000 inhabitants, is the Río de las Palmas, and this stream has its headwaters in tributaries in the Sierra Juárez.

Forage consumed by livestock on the ranges of the Northern Baja California mountains is second to water among the values derived by man from the sierras. There are approximately 550,000 acres of grazing land within the areas of coniferous forest in northern Baja California. Grasses, forbs, and sedges are plentiful on the meadows, and also grow under the trees. Thus, the northern sierras contain the best ranges in all of the Baja California peninsula. Although recent dry years have brought about a reduction in herd size, there are probably still about 9,000 head of cattle, that is, about twenty per cent of all beef cattle in the State of Baja California, which graze the ranges of the high sierras at least part of the year. Some eight to ten thousand sheep, or about one-half of the sheep in the State,

<sup>11</sup> Meigs, *op. cit.*, p. 127

<sup>12</sup> Ulises U. Lassepas, *De la colonización de la Baja California y decreto de 10 de marzo de 1857* (Mexico: Imprenta de Vicente García Torres, 1859), pp. 142-143.

<sup>13</sup> Other sources of irrigation water west of the Sierras Juárez and San Pedro Mártir are the watersheds of the coastal mountains, aquifers in interior basins, and geologic water trapped beneath the San Quintín Plain.

are driven yearly by Basques over public and rented private ranges between Tijuana and the San Pedro Mártir Mountains. Individual ranching operations, with the exception of the sheep drives, are small because Mexican agrarian law limits ranch and ranch-based herd sizes.

The State of Baja California is perhaps the poorest of all Mexican states and territories in forest resources. Only .23 per cent of the forested area of Mexico is in this state.<sup>14</sup> Nevertheless, the approximately 225,000 acres of tall coniferous forests in the State, excluding piñon areas,<sup>15</sup> could meet more than the local needs for lumber if the forests were fully but judiciously exploited.

Present local yearly demand for lumber is twenty-six million board feet. Actual production is only one million board feet, but reserves of merchantable timber probably are between five and ten billion board feet. The virgin forest of the San Pedro Mártir has even attracted surveys by American companies interested in exporting lumber from Baja California.

Although small sawmills had operated intermittently in the Sierra Juárez for some forty years, it was not until the mid-nineteen fifties that timber cutting there began on a scale large enough to support a lumber camp. Today the only sawmill in northern Baja California is operated at El Aserradero by members of the forest and ranching *ejido*, Sierra Juárez—the largest *edjido* in all Mexico.<sup>16</sup>

Firewood for kilns is cut by lime miners from the piñon forest at the northern end of the Sierra Juárez. Juniper trees are logged commercially for sale as fence posts.

Although small scale gold placer mining dating from the mission period was followed after 1870 by gold rushes to the plateau west of the Sierra Juárez, gold mining in the Juárez Mountains did not begin until the nineteenth century. Then as large placer deposits were opened, mining camps sprang up at such places as Juárez Vieja, Tres Pinos, and Campo Nacional (Fig. 1). At Campo Nacional the gold came from Cerro Prieto, A flat-topped hill of well-packed, dark-colored auriferous metamorphic gravel. This dark-colored rock is not found on the granitic batholith in the area of the Cerro Prieto gravels, and thus the gravels are believed to have been deposited by large streams, flowing from the east, which antedated the Gulf Diastrophic Trough. By the end of the nineteenth century gold was also being mined, mostly from placers along the western edge of the San Pedro Mártir at such camps as Socorro, Valladares, Buena Vista, and Las Chollas (Fig. 1).

Disturbed economic and political conditions during the early years of the Mexican Revolution suspended mining in the sierras of northern Baja

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<sup>14</sup> Jorge L. Tamayo, *La República Mexicana y la Baja California* (Mexico: Ediciones ACPA, 1956), p. 75.

<sup>15</sup> Statistics relevant to timbered area, lumber production and demand, and timber reserves were supplied by Ing. Ramiro García Pérez, Mexican government forester in northern Baja California.

<sup>16</sup> An *ejido* is a Mexican communal land-holding. For the size of *Ejido* Sierra Juárez see Ramiro García Pérez, *Problema forestal y social de "Sierra de Juárez" en el Estado de Baja California* (Published thesis, Escuela Nacional de Agricultura, Chapingo, Mexico, 1956), pp. 3-4.

California, but during the years between 1920 and 1940 the gold placers were reworked intermittently. The rise in the price of gold in the United States in 1933 brought another gold rush to the Sierra Juárez, and for some five or six years activity at the old placers was brisk. However, by 1937 most of the gold had apparently been mined. Mining along the western edge of the San Mártir never recovered from the suspension of operations imposed by the Mexico Revolution and worked-out placers.

After 1937 tungsten extraction in the Sierra Juárez became the most important mining activity in northern Baja California, although *gambusinos* (prospectors) still rework the gold areas. Tungsten is found in sheelite, a contact metamorphic mineral which was formed in tactite rock.<sup>17</sup> The tactite replaced calcareous beds of marble where the marble rested as roof pendants on the batholith. Between 1937 and 1943, in response to high tungsten prices before and during the Second World War, 100,000 tons of tungsten ore were milled at El Fenómeno (Fig. 1). Later, during the Korean War, mills operated at Gavilanes and Margaritas (Fig. 1). Low prices today have forced the suspension of tungsten mining in Baja California.

The only active mining carried on in the sierras of northern Baja California today is centered just west and south of the town of Rumorosa. In 1928 the mining of lime from roof pendants of marbleized limestone began here and still continues. One large mechanized, and twenty-two small, primitive kilns are in operation near Rumorosa. The lime is used for mortar in the urban centers of northern Baja California, but total production is small.

As most soils in the sierras are thin, coarse lithosols or acidic, wet meadow soils, there is little land available for agriculture. Farming has never been important, but a few ranchers do raise such crops as beans and potatoes on a subsistence basis, and grain and clover fodders are planted in small fields to supplement range pasturage.

Probably the least developed, yet potentially most valuable, source of income in the Juárez and San Pedro Mártir Mountains is recreation. Although the outlines of a national park in each of the sierras have been established, and hunting laws exist, game wardens are so few and governmental financial resources so limited that little has been done to regulate hunting or promote recreation in the mountains. It would seem that a well-financed program aimed at restoring wildlife, and developing streams, to be planted with native trout, would in the long run pay for itself many times over in income derived from recreation. However, the most limiting factor in the promotion of recreation is the almost total absence of good roads.

Although the paved Tijuana-Mexicali highway crosses the northern end of the Sierra Juárez, the rest of the range is traversed only by poor dirt tracks and roads (Fig. 1). The main road leads northward and southward out of El Aserradero from which lumber is trucked to Mexicali and Ensenada. Log roads, now abandoned, were built in 1950 from Buena Vista

<sup>17</sup> Carl Fries and Eduardo Schmitter, "Sheelite Deposits in the Northern part of the Sierra Juárez, Northern Territory Lower California, Mexico," *Geological Survey Bulletin*, No. 946-C (Washington: U. S. Dept. of Interior, 1945), p. 73.

and Socorro to the San Pedro Mártir in anticipation of logging operations which did not materialize.

Only the residents of the sierras and the hardiest of tourists now use the mountain roads or invade the San Pedro Mártir on horseback. Good roads could attract thousands of sightseers and many sportsmen to the sierras annually. The income derived from these visits to the mountains would probably exceed that now gained from all other sources of revenue in the sierras.

#### SUMMARY

Ranchos, mining booms, and watersheds in the Sierras Juárez and San Pedro Mártir, and the slaughter of game and the cutting of timber in these mountains, have all contributed to the economic development of northern Baja California. However, today man's subjugation of nature for agricultural production on the Delta of the Colorado River, and his creation of amusement and tourist centers, to serve hordes of Americans, between Tijuana and Ensenada have left the sierras of northern Baja California as thinly populated and little used areas lying between the main currents of economic life in the State of Baja California.

The future economic value of the Juárez and San Pedro Mártir Mountains rests in the husbanding of their watersheds, and the careful development of lumbering and recreation. These mountains have the potential natural resource capacity to supply some 24,000 acres of farmland with irrigation water, much of the domestic water needs of the city of Tijuana, the lumber needs of the State of Baja California, and a large income from recreation. With a population of over one-half million persons, and a population increase of nearly six hundred per cent between 1940 and 1958,<sup>15</sup> there is little doubt that more income from, and more jobs in, the Sierras Juárez and San Pedro Mártir will soon be needed in the State of Baja California.

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<sup>15</sup> Based on data from the office of the Oficial Mayor of the State of Baja California, and *Anuario estadístico de los Estados Unidos Mexicanos 1955-56* Sec. de Economía, Dir. Gral. de Estadística (Mexico: Talleres Gráficos de la Nación, 1957), pp. 35-6.