

The  
California  
Geographer

Annual Publication of the  
**CALIFORNIA COUNCIL OF GEOGRAPHY TEACHERS**

**ROBERT A. KENNELLY, Editor**

**1966**

# THE CALIFORNIA GEOGRAPHER

The annual publication of the  
**CALIFORNIA COUNCIL OF GEOGRAPHY TEACHERS**  
ROBERT A. KENNELLY, *Editor*



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# A MODIFIED KOEPHEN CLASSIFICATION OF CALIFORNIA'S CLIMATES ACCORDING TO RECENT DATA\*

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## INTRODUCTION

Many papers have discussed the classification of California's diversified climates. Although all of these past presentations have merit and have contributed much to the understanding of the state's climates, the author will not attempt to go into the discussion of these investigations, other than to list a few of them.<sup>1</sup> It can be noted that many of the references listed have employed the Köppen classification, or modifications thereof.<sup>2</sup> This paper also employs the Köppen system with certain modifications introduced by Russell<sup>3</sup> and the author (e.g., a quantitative limit to determine the "m" areas, delimitation of the "m" and "i" areas, etc.).

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\* The basic field and office research for this paper were conducted in 1958 and 1959 while the author was employed by the Climatology Group, California Department of Water Resources, Sacramento, California. More recent research (1963-1964) has brought the information up-to-date.

The author is indebted to Dr. Brigham A. Arnold, Department of Geography, Sacramento State College, Sacramento, Dr. Arnold Court, Department of Geography, San Fernando Valley State College, Northridge, Dr. Peveril Meigs, Chief, Earth Sciences Division, U.S. Army Natick Laboratories, Natick, Mass., Dr. Herbert Schultz, Department of Agricultural Engineering, University of California, Davis, and Messrs. James D. Goodridge and Donald A. Schuder, California Department of Water Resources, Sacramento, for their advice and assistance concerning this project.

<sup>1</sup> E. A. Ackerman, "The Köppen Classification of Climates in North America," *Geographical Review*, Vol. 31 (Jan. 1941), pp. 105-111 (contains some discussion concerning California climates); Frederick S. Baker, "Mountain Climates of the Western United States," *Ecological Monographs*, Vol. 14 (April 1944), pp. 224-254 (a portion of the paper discusses certain areas of California); John E. Kesseli, "The Climates of California According to the Köppen Classification," *Geographical Review*, Vol. 32 (July 1942), pp. 476-480; Peveril Meigs, "Climates of California," *Science Guide for Elementary Schools*, Vol. 5. (August 1938), pp. 1-44; Clyde P. Patton, "The Climates of California According to C. W. Thornthwaite's Classification of 1948," unpublished master's thesis, Department of Geography, University of California, Berkeley, 1951; W. G. Reed, "Climate of Western United States," *Bulletin of the American Geographical Society*, Vol. 47 (1915), p. 9; and Richard J. Russell, "Climates of California," *University of California Publications in Geography*, Vol. 2 (October 1926), pp. 73-84.

<sup>2</sup> Köppen first published what has become known as his classification of climate in 1918 in an article in *Petermanns Mitteilungen* titled, "Klassifikation der Klimate nach Temperatur, Niederschlag und Jahreslauf." He made slight modifications in later publications—in his book *Die Klimale Grundriss der Klimakunde*, in a large scale map by him and Rudolf Geiger published in 1928, and most recently in Vol. 1, part C, of the Köppen-Geiger, *Handbuch der Klimatologie*, published in 1936 with the title "Das Geographische System der Klimate." The changes made in the later publications are, with a few exceptions, insignificant. Earlier Köppen articles in 1884 in *Meteorologische Zeitschrift* and in 1900 in *Geographische Zeitschrift* laid the foundation for the 1918 paper.

<sup>3</sup> Russell, *op. cit.*, pp. 73-84.

This is not to say that the Köppen classification is of higher quality than certain other systems, such as that devised by Thornthwaite.<sup>4</sup> However, the ease of application of basic climatic data to the Köppen model and the presentation of that data in the classified form are outstanding advantages. Another very important benefit that can be noted when certain modifications of the Köppen model utilized is that they show a fairly good climate/vegetation correlation in much of California. (Many papers, such as those by Patton and Bailey, have pointed out various discrepancies in the Köppen classification, some of which seem to be the result of translation difficulties.<sup>5</sup>)

The usefulness of the accompanying map (Figure 1. See map at end of article.) lies not so much in the classification technique, but more in the use of data from over 1,000 climatic stations in California and adjacent areas of Oregon, Nevada and Arizona. This is many times the number of stations used in previous maps of this kind for this area and allows a more detailed analysis of California's climates. All of the climatic stations do not appear on the base map (nor are they plotted on Figure 3) due to space limitations. However, a few of the key sites are noted. All of the data utilized in preparing the climatic map were obtained from the California Department of Water Resources in Sacramento. It represents data from stations operated by the California Department of Water Resources cooperative stations, and United States Weather Bureau official and cooperative climatic stations. (Table 7 is a more detailed description of the legend shown in Figure 1.)

## METHOD

In order to insure a fairly uniform base period for the climatic data used in preparation of Figure 1 the precipitation means were based on the 50-season period 1904-05 through 1954-55<sup>6</sup> and temperature means were generally based on the 22-year period 1931 through 1952. The length of record at the climatic stations varied from approximately five years at a few places to over 100 years in some instances. If a precipitation station had a shorter record than the length of the base period the record was extended by double-mass comparison with nearby longer-term stations that

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<sup>4</sup> C. W. Thornthwaite, "The Climate of North America According to a New Classification," *Geographical Review*, Vol. 24 (October 1931), pp. 633-655; and C. W. Thornthwaite, "An Approach Toward A Rational Classification of Climate," *Geographical Review*, Vol. 38 (1948), pp. 658-672; and a publication containing some modifications of the 1948 Thornthwaite classification.

<sup>5</sup> Clyde P. Patton, "A Note on the Classification of Dry Climates in the Köppen System," *The California Geographer*, Vol. 3 (1962), pp. 105-112; and Harry P. Bailey, "Some Remarks on Köppen's Definitions of Climatic Types and Their Mapped Representations," *Geographical Review*, Vol. 52 (1962), pp. 444-447.

<sup>6</sup> Referring to the "precipitation season," which is the 12-month period from July 1 through June 31. Because of the nature and the timing of Mediterranean type precipitation the cool season is also the wet season, which happens to fall into two calendar years. Thus, in speaking of the year's precipitation it would seem inappropriate to divide December of one year from January of the next merely because the calendar must be changed. This is also the feeling of most state agencies that deal with precipitation data in California.

had records which were adjudged to be homogeneous. The quality of all precipitation data used was checked for homogeneity by the double-mass plot system. In the case of temperature records the regression line method was utilized somewhat as a guide to station validity, but because of a general lack of temperature data compared to precipitation, temperature information was generally accepted at face value. Also, because of this lack of temperature data in some key areas, shorter mean periods than the 1931-1952 base period were utilized in some instances.

### DISCUSSION

In his paper of 1926 Russell<sup>7</sup> made certain modifications of Köppen's classification in order to better suit California and show more detail. For instance, the boundary between "C" and "D" climates as Köppen gave it is 26.6°F. Any station with an average temperature for the coldest month of 26.6°F. or below would be classified as "D," and anything warmer, up to 64.4°F. for the average of the coldest month, as "C." However, Russell shows justification for changing this boundary between "C" and "D" climates to 32.0°F. He thought that a brief cold period may not be as effective on the vegetation cover as a longer, less intense one. The important thing according to Russell was whether or not the ground freezes significantly each winter. As one goes up the west slope of the Sierra Nevada a definite vegetation change from the larger and more dense coniferous (Douglas Fir, Yellow Pine, Sugar Pine) forests at lower altitudes to the smaller higher altitude type (Lodgepole Pine) can be seen. This change occurs more nearly the 32° isotherm for the coldest month than the 26.6° isotherm. Thus, the 32° average temperature for the coldest month seems better suited to California.

In the arid and semi-arid climates Russell made two revisions in Köppen's classification. The addition of the BW<sub>hh</sub> classification to the arid climates gives more detail to the desert regions of southeastern California, and the revision of the quantitative limit of the BS<sub>k</sub>/BS<sub>h</sub> boundary in the semi-arid areas (average temperature of the coldest month 32°F.) suits California better than the original Köppen model (average annual temperature of 64.4°). In the large area of BWh climate in southeastern California the areas with the warmer summers have a distinctly different type of vegetation, a vegetation which is much more sparse than the "cooler" BWh desert. Also, evaporation is higher in the BW<sub>hh</sub> regions. The weather station at Cow Creek near Greenland Ranch in Death Valley compares climatically with certain very hot and dry stations in the North African Sahara region. Average annual relative humidity in this area is among the lowest, and evaporation (averaging over 160 inches per year) the highest, in the United States. It also ranks among the world's hottest places.<sup>8</sup> The following table (Table 1) gives pertinent climatic data for Cow Creek.

<sup>7</sup> Russell, *op. cit.*, pp. 73-84.

<sup>8</sup> See for example, Arnold Court, "How Hot is Death Valley?" *Geographical Review*, Vol. 39 (1949), pp. 214-220; and M. W. Harrington, *Notes On the Climate and Meteorology of Death Valley, California*, USWB Bulletin #1, 1892.

Mean Monthly and Seasonal Precipitation (in inches) (based on 1904-05 through 1954-55 period)												
July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Season
.11	.17	.11	.10	.18	.20	.24	.24	.19	.10	.06	.02	1.72

Mean Monthly Temperatures (in F. $^{\circ}$ ) (based on 1931 through 1952 period)												
Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
52.0	58.3	66.5	77.1	86.8	94.6	101.9	99.8	91.7	77.8	62.0	54.0	76.9

Total Monthly Evaporation (in inches) (based on 1959 through 1963*) (summer half year only, with yearly totals)												
	May	June	July	Aug.	Sept.	Oct.	Annual					
1959	17.13	21.03	21.26	19.84	13.48	10.96	146.88					
1960	16.65	21.34	22.71	21.51	14.69	10.09	147.21					
1961	22.82	25.17	26.39	21.51	17.55	11.60	167.74					
1962	20.04	23.26	24.79	25.50	17.64	13.43	172.64					
1963	21.41	22.20	27.78	23.86	14.82	11.25	168.23					

\* In May 1961 this station was moved slightly (new elevation—195') and renamed Death Valley. The trend at the new location seems to be for higher evaporation rates, as noted in the generally higher totals after 1960.

Table 1. Climatic Data, Cow Creek, Calif. (Elev., 125')

The criteria of at least three consecutive months with average maximum temperatures of 100°F. or over was set up by Russell as the boundary between BWh and BWhh climates. Five of the several California climatic stations that fall into this "very hot" category and their mean monthly maximum temperatures for the warmest months can be noted in Table 2.

Mean Monthly Maximum Temperatures (in F. $^{\circ}$ ) at Selected California BWhh Stations (based on 1931 through 1952 period)									
Station	Elevation	Apr.	May	June	July	Aug.	Sept.	Oct.	
Cow Creek	-125	90.5	100.3	108.5	115.7	113.8	106.5	91.8	
Brawley	-119	88.1	96.4	103.7	109.6	107.9	103.9	92.2	
Indio (U.S. Date Garden)	11	87.4	94.6	101.2	107.3	105.6	101.9	92.0	
Blythe	266	88.3	95.9	102.8	108.5	106.7	102.6	91.3	
Iron Mountain	922	84.7	93.5	101.5	107.3	105.5	100.4	82.5	

Table 2

A sub-symbol that Köppen originated for use with "A" climates was also found to be applicable in California. This is the small "m" for monsoon type precipitation (in this case, with reference to heavy seasonal precipitation). Precipitation data from various stations in northern California were plotted on a graph (Figure 2) by utilizing Köppen's formula for delimiting "m" areas. It was found that in the north coastal area two separate regions, one in Del Norte County and extreme western Siskiyou County (east of Crescent City) and the other in Humboldt County (southeast of Eureka), have this type of climate (See Figure 1).

## BOUNDARIES BETWEEN "sm'" AND "s" CLIMATES

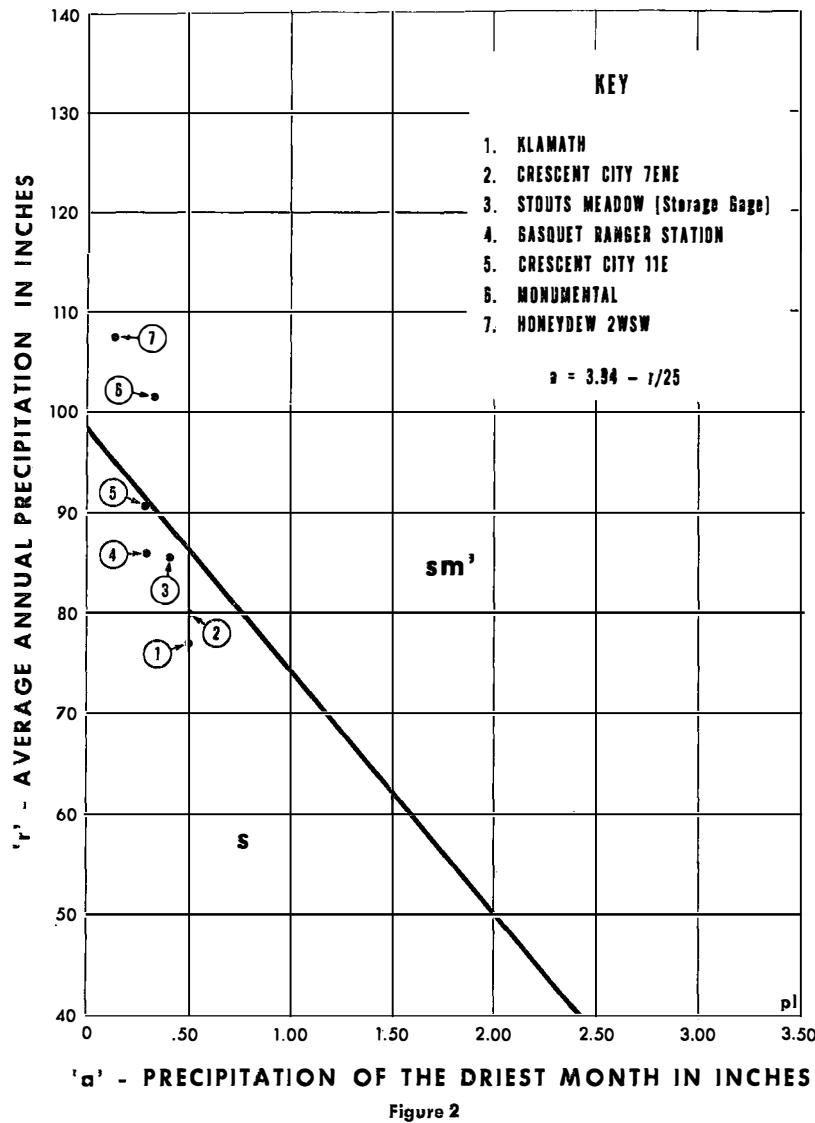


Figure 2

It was also discovered that the boundaries of these Dsbm' and Csbm' areas closely correspond to the 90-inch mean isohyet (Figure 2).

The "m" area was broken into two classifications, Dsbm' and Csbm', because at about the 4,000 to 4,500 foot level in the northernmost of the two "m" areas there is a change apparent in the vegetation cover. Even though the precipitation is extremely high in these higher altitudes (but not as high as it is at elevations below 4,000 feet), and would come under the "m" classification, at least one winter month probably averages below 32°F. There are no weather stations in this Dsbm' area, in fact, there are no year-long inhabitants.

A much smaller region of Csbm' climate can be found along the Mattole River, southeast of Cape Mendocino, in the area around Honeydew. The entire area is probably not more than eight miles in length and less than five miles in width. Precipitation here is heavy, in fact much heavier than nearby places such as the climatic station further downstream at Upper Mattole. The reason for this is due to a funnelling of precipitation into the area. A dip in the NW/SE trending Coast Range (which is not more than 4,000 feet in elevation) in the area immediately southwest of Honeydew is responsible for this. This dip in the coastal mountain range points northeast from the ocean directly toward Honeydew area. The extra-tropical cyclones that enter this region normally approach from the northwest, west-north-west, and west, but because of the counterclockwise circulation of winds around low pressure systems in the Northern Hemisphere precipitation is carried into this region from the south and southwest. This causes the moist air masses to enter directly into the dip and this funnelling combined with the sharp lifting effect of the mountains gives extremely heavy precipitation.

The area around Honeydew and that mentioned earlier in Del Norte County are among the wettest in the continental United States, exceeded only by the western slope of the Coast Ranges in Oregon and Washington. Some extremely high rainfall totals have been recorded in the Honeydew region, where there are two precipitation stations at the present time; at Honeydew (Hunter) and Honeydew 2WSW. For example, in February 1958, Honeydew 2WSW had 58.60 inches of precipitation for the month and in December 1955 that same station had a month's total of 61.50

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Mean Monthly and Seasonal Precipitation (in inches)

Honeydew 2WSW, California (elev., 400')

(based on the 50-year period 1904-05 to 1954-55)

July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Season
.14	.27	1.38	6.88	15.03	19.77	21.33	17.04	12.87	7.39	3.84	1.54	107.48

Monthly Precipitation Totals at Honeydew 2WSW for the 1957-58  
Precipitation Season

July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Season
.70	0	8.50	14.65	9.10	20.20	29.10	58.60	19.65	11.15	.95	1.80	174.40

Table 3

inches. The intensity of the 1955 storm at Honeydew 2WSW can be realized when it is noted that 13.65 inches of rain fell in a 24-hour period, 19.60 inches in two consecutive days, 37.60 inches in five consecutive days, and 51.90 inches in twelve consecutive days. During the 1957-58 precipitation season this station established the highest seasonal total ever recorded in California with 174.40 inches of precipitation. Table 3 gives the average monthly and seasonal precipitation at Honeydew 2WSW, plus the 1957-58 monthly totals recorded at this station.

The small letter "i" that Köppen usually used in conjunction with the "A" climates was found to fit a few small areas along the coast of California. The "i" as Köppen defined it meant that a region must not have an annual variation between the warmest and coldest months of over 9°F. Only three weather stations fall into this category (Pt. Reyes, Pt. Arena and Pt. Piedras Blancas) and only the latter two are in use at present.<sup>9</sup> Table 4 gives the mean monthly temperatures for Point Piedras Blancas.

Mean Monthly Temperatures for Point Piedras Blancas (in F.<sup>o</sup>)  
(based on 1931 through 1952 period)

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Range
51.1	51.0	51.5	51.6	52.7	54.6	55.9	55.8	56.8	55.8	55.1	53.0	5.8

Table 4

Other stations such as Eureka and Point Arguello U.S.C.G. came very close to being in this classification, but did not quite qualify. However, it was felt that certain adjacent areas to these borderline cases should be included as Csbni on Figure 1. The immediate coast line in the normally foggier areas, from the Oregon border to a point west of Santa Barbara, probably experiences this same type of climate. However, this strip of coast line would be so narrow that the width of a pencil line on a map of the scale used here would completely overlay it.

Köppen's sub-symbol "c" was found to cover a considerable area in California's higher altitudes. In this case it is associated with the D climates. The majority of this Dsc region is found in the Sierra Nevada Mountains and is a transition zone between the EH (Highland) climates of the very high altitudes and the Dsb (microthermal with cool dry summer) at lower elevations. Only four reporting stations are actually in this type climate. They are, from south to north: White Mountain #1 — 10,150 feet, Ellery Lake — 9,600 feet, Twin Lakes — 7,829 feet, and the station only recently established (1958) by the California Department of Water Resources at the Mount Shasta Ski Bowl — 8,500 feet in elevation. Table 5 gives the average monthly temperatures for Twin Lakes and Ellery Lake.

<sup>9</sup> A climatic station that was established by the Earth Sciences Division, U.S. Army Natick Laboratories, Natick, Mass. (for a climatic study of nearby Hunter Liggett Military Reservation) at Lucia Willow Springs (between Lucia and Pt. Piedras Blancas on the Central California Coast) in 1963 also has shown temperature data that places it in the Csbni classification.

Mean Monthly Temperatures (in F. $^{\circ}$ ) for Twin Lakes and Ellery Lake (based on 1931 through 1952 period)													
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Twin Lakes	23.7	24.9	28.6	35.3	41.0	48.2	56.0	55.9	50.6	41.7	33.4	27.3	38.8
Ellery Lake	23.2	22.6	26.8	32.2	38.8	46.2	55.0	54.7	48.7	39.0	31.0	25.0	36.9

Table 5

In other areas that are mapped as Dsc there are no climatic stations, or ones with very short records, but with the information obtained from the four stations mentioned above, and ones in key areas with short periods of record, criteria of a certain altitude combined with the typical vegetation found in the other Dsc areas nearby were used to complete these regions on Figure 1.

When drawing the climatic map an attempt was made to avoid classifying individual mountain peaks. However, in a few instances this was impossible, because the mountain was such an outstanding landmark. This reference is to Mount Shasta and Mount Lassen in Northern California which have some EH and Dsc climates, and Mount San Jacinto (West of Palm Springs) in Southern California, which has Dsc climate in its higher reaches. In most other cases, only mountain ranges, some of them admittedly not large in area, but very much dissimilar to their surroundings, were classified differently than the surrounding area if that was found to be the case. An example would be the White Mountains of east central California. Two complete weather stations were established here in September 1955, by the University of California and the U.S. Navy in conjunction with the U.S. Weather Bureau. One of these, White Mountain #1, was mentioned earlier as being in one of Dsc regions of California. The other, White Mountain #2 is almost 2,500 feet higher than #1, and at an elevation of 12,470 feet is the highest complete weather station in the United States.<sup>10</sup> Being at such a high altitude White Mountain #2 easily qualifies for the ET climate as set up by Köppen. In this case it is not adjacent to the polar regions, but in middle latitudes, so we use Köppen's highland symbol for this Hekistothermal area, EH. Table 6 lists pertinent temperature data for White Mountain #2.

Temperature Data for White Mountain #2, California (in F. $^{\circ}$ )  
(based on the 8-year period 1956 through 1963)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Mean Maximum	22.1	21.6	22.8	29.5	34.2	46.1	53.0	52.4	47.3	37.3	30.8	28.4	35.5
Minimum Mean	8.1	6.7	6.8	12.6	18.3	29.6	35.8	35.3	30.3	21.8	15.0	12.2	19.4
Mean Monthly	15.1	14.2	14.8	21.0	26.2	37.9	44.4	43.8	38.8	29.6	22.9	20.3	27.4
Absolute Maximum	41	45	37	47	50	64	62	61	61	52	48	52	64
Absolute Minimum	-25	-21	-32	-15	0	11	18	17	4	-20	-28	-12	-32

Table 6

<sup>10</sup> The University of Colorado, Institute of Arctic & Alpine Research, has a complete weather station at approximately 12,300 feet elevation in the Front Range west of Boulder. This station, however, is not manned as is White Mountain #2, but instead is equipped with automatic equipment and is visited weekly.

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BSk*	Semi-arid (Steppe). Mean Temperature of coldest month 32.0 F. or below.
BSh	Semi-arid (Steppe). Mean temperature of the coldest month above 32.0 F.
BShn	Semi-arid (Steppe). Mean temperature of the coldest month above 32.0 F. Frequent fog; annual average of 30 days or more of dense fog.
BWh	Arid (Desert). Mean temperature of the coldest month above 32.0 F.
BWhh	Arid (Desert). Mean temperature of the coldest month above 32.0 F. Mean maximum temperature averages 100.0 F. or over for three months or more each year.
Csa**	Humid Mesothermal (Mediterranean or Dry Summer Subtropical). Mean temperature of the coldest month below 64.4 F. but above 32.0 F. Hot summer; mean temperature of the warmest month over 71.6 F.
Csb	Humid Mesothermal (Mediterranean or Dry Summer Subtropical). Mean temperature of the coldest month below 64.4 F. but above 32.0 F. Cool summer; mean temperature of the warmest month 71.6 F. or less.
Csbn	Humid Mesothermal (Mediterranean or Dry Summer Subtropical). Mean temperature of the coldest month below 64.4 F. but above 32.0 F. Cool summer; mean temperature of the warmest month 71.6 F. or less. Frequent fog; annual average of 30 days or more of dense fog.
Csbni	Humid Mesothermal (Mediterranean or Dry Summer Subtropical). Mean temperature of the coldest month below 64.4 F. but above 32.0 F. Cool summer; mean temperature of the warmest month 71.6 F. or less. Frequent fog; annual average of 30 days or more of dense fog. Range of mean temperature between the warmest and coldest months less than 9.0 F.
Csbm'	Humid Mesothermal (Mediterranean or Dry Summer Subtropical). Mean temperature of the coldest month below 64.4 F. but above 32.0 F. Cool summer; mean temperature of the warmest month 71.6 F. or less. (Monsoon); short dry season, but extremely heavy precipitation during the wet season so that mean annual totals are generally in excess of 90 inches. Precipitation of the driest month less than 2.40 inches. (See Fig. 2.)
Dsa	Humid Microthermal (Mediterranean type with colder winters). Mean temperature of the coldest month 32.0 F. or less. Mean temperature of the warmest month above 50.0 F.
Dsb	Humid Microthermal (Mediterranean type with colder winters). Mean temperature of the coldest month 32.0 F. or less. Mean temperature of the warmest month above 50.0 F.
Dsbm'	Humid Microthermal (Mediterranean type with colder winters). Mean temperature of the coldest month 32.0 F. or less. Mean temperature of the warmest month above 50.0 F. Cool summer; mean temperature of the warmest month 71.6 F. or less. (Monsoon); short dry season, but extremely heavy precipitation during the wet season so that mean annual totals are generally in excess of 90 inches. Precipitation of the driest month less than 2.40 inches. (See Fig. 2.)
Dsc	Humid Microthermal (Mediterranean type with colder winters). Mean temperature of the coldest month 32.0 F. or less. Mean temperature of the warmest month above 50.0 F. Cool short summer; less than four months with mean temperatures averaging over 50.0 F.
EH	Hekistothermal (Highland Climate). Mean temperature of the warmest month below 50.0 F. but above 32.0 F.

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Table 7. Detailed Legend for Climates of California Shown in Figure 1.

Except for the various changes mentioned earlier in this paper the climatic areas on the accompanying map (Figure 1) were determined by use of Köppen's classification system and any formulas that he devised to be used with it (see Figure 3). The only exception to this could possibly be the "n" or foggy climates, to which Köppen attached no quantitative limit. This author tentatively attached a limit of 30 days each year with dense fog (as defined by the U.S. Weather Bureau) to be used to delimit the "n" areas. Previous climatic maps of California have been much too conservative in delimiting this foggy region. For example, Russell, in his 1926 classification failed to include Santa Maria in the fog belt.<sup>11</sup> Eureka, included by Russell as an "n" area, has only 49 days a year of dense fog, while Santa Maria A.P. has 88 days.

An effort will not be made to go into the location and explanation of each of the remainder of the fifteen separate climatic regions plotted on the climatic map that accompanies this paper (Figure 1). All of the symbols used on the map can be interpreted with the use of the information in Table 7 and Figure 3. Where no climatic data were available the criteria of elevation, vegetation cover, nearby stations, and knowledge of the landscape by the author and others were used to determine parts of some of the climatic boundaries. As more data becomes available in the future such "second-best" as mentioned above can be eliminated. This map is certainly subject to revision as such additional information shows changes should be made.

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<sup>11</sup> Russell, *op. cit.*, climatic map.

**Notes for Table 7 on opposite page.**

\*See Figure 3 for graph showing Köppen's boundaries between semi-arid, arid and humid climates.

\*\*"s": Summer dry; at least three times as much precipitation in the wettest month of winter as in the driest month of summer; also the driest month of summer receives less than 1.20 inches of precipitation.

**BOUNDARIES BETWEEN  
BW (DESERT), BS (STEPPE), AND HUMID CLIMATES  
WHEN PRECIPITATION IS CONCENTRATED IN WINTER**

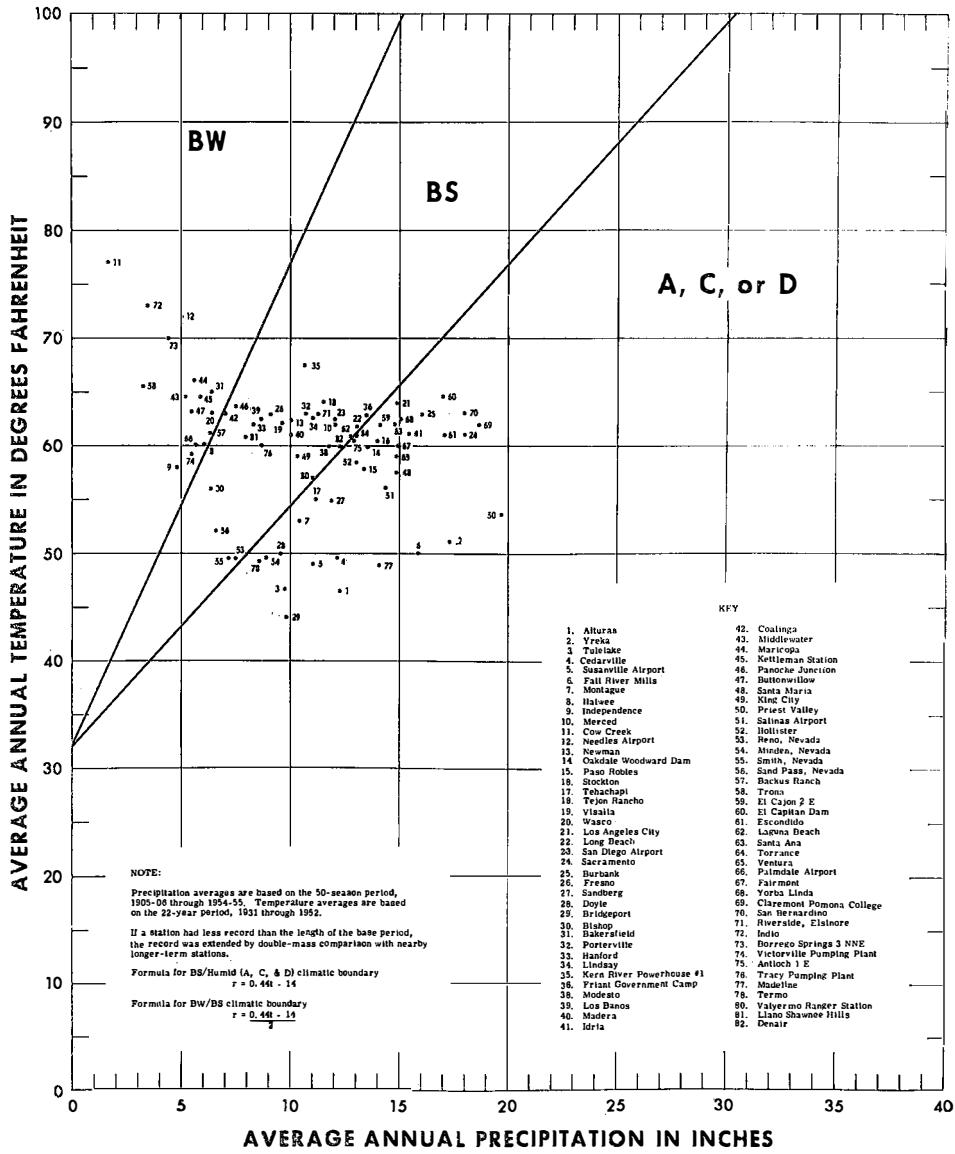
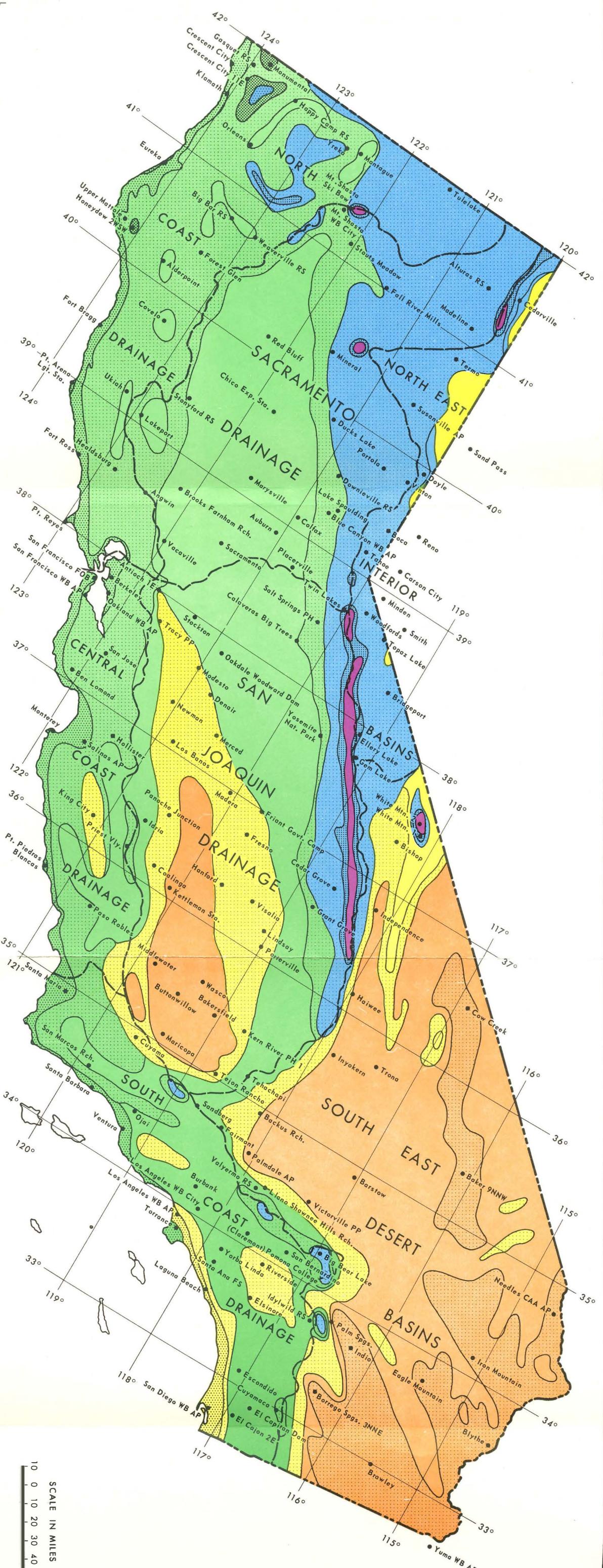


Figure 3

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# CLIMATES OF CALIFORNIA



# PLANNING GEOGRAPHY IN THE CURRICULUM OF A NEW COLLEGE\*

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Many college professors complain about the academic organization of their college. Most would like the opportunity to revise it, and the revision would probably vary directly with the academic field of the reviser. A reviser from the field of geography may probably suffer from the same self-centered characteristics that produce biases by one in any discipline, but the eclectic nature of the field of geography should encourage understanding of other fields and open, at least, the possibility for an objective job.

## AN ACADEMIC PLAN

The following academic plan has been conceived by the planning staff at the California State College at Palos Verdes. A geographer had a hand in it as one of the initial seven (later nine) on the staff, and, as a result, the field of geography is well represented. As a first step in the analysis, a succinct description of the total plan is made in order that the framework upon which geography and other fields are developed may be understood.

1. The academic plan is organized around the liberal arts and sciences. No professional schools or divisions are planned in the undergraduate curriculum, though there is some undergraduate provision for applied arts and sciences which I will mention in connection with the interdisciplinary or interdepartmental major. This liberal arts and sciences framework is divided into three major parts called schools: Humanities and Fine Arts, Natural Sciences and Mathematics, and Social and Behavioral Sciences. Departments are organized under these three major divisions. The departments are traditional in every sense of the word, are limited in number to 16 traditional ones,<sup>1</sup> and include, for example, geography and economics in the social sciences, physics and chemistry in the natural sciences, and English and philosophy in the humanities and fine arts.
2. The basic characteristics of the curriculum include the following:
  - a) A set of required basic studies courses, largely freshman and sophomore oriented (though they are carried into the upper division in each school), which are presumed to cover all fields of knowledge. They are breadth studies, taught by traditional discipline departments and given course names and departmental prefixes.

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<sup>1</sup> The 16 departments are English, art, music, foreign language (may be divided later), philosophy, biological sciences, physics, chemistry, mathematics, economics, geography, history, political science, psychology, sociology, anthropology.

- b) Each student must have two majors: One in a discipline and one in an interdiscipline. Discipline majors are traditional in that they come from departments such as geography and philosophy. They do, however, take advantage of significant new trends and developments and are often innovative. The interdisciplinary majors are those made up of courses from the regular departments and each is put together by a faculty committee made up of members from appropriate departments. They are presumed to overcome the occasional accusation that there is too much college emphasis on a single field. It is within these interdisciplinary areas that it is possible to give a student some contact with the more professional applied arts and sciences. Such an interdisciplinary field as the Structure and Development of American Business or Earth and Space Sciences makes professional contact for the student possible, but the contact is through a liberal arts and sciences framework which allows the disciplines most closely related to decide what courses are appropriate for undergraduate training in this "professional" area.
  - c) The third part of the undergraduate curriculum is the one-fifth of the student's time left for elective studies. Electives may be used for greater depth and breadth in the majors and for pre-professional work or may be selected on a student-interest basis.
3. The graduate program, which will probably be rather large, is developed within the administrative framework of the three major schools. Graduate degrees in disciplines will be handled by schools and departments. Certainly the Department of Geography should be primarily responsible for a master's degree in geography. There is a potential problem of organization, however, in the applied arts and sciences in what may be described as professional types of programs. Such advanced degrees as those in teacher education, business, engineering, or other applied fields, are less easily placed in the hierarchy of organization. For these areas of graduate interest, there will be established a graduate institute. Each institute is placed under the administrative line of one of the three major schools and provides some kind of released time for the director.

Within this framework, geography appears in the undergraduate program, as a contributor to the basic studies program, as a discipline major, and as a part of certain interdisciplinary programs. In the graduate area, geography will develop its own M.A. degree and be an important element in certain institute programs, such as, Environmental Design and Urban Studies, Business Management, and the Earth and Space Sciences.

#### **THE CONTRIBUTIONS OF GEOGRAPHY AS RELATED TO THE EMPHASES WITHIN THE FIELD**

From the foregoing description, geography does appear to be capable of a number of contributions to the academic plan. There are spatial ar-

rangements of features which when interpreted help us to understand problems involving other spatial arrangements. We are also aware that the relationships between physical environment and man deserve our interest and consideration. Geography has spent many years studying these relationships and has developed experts in their interpretation. Certainly geography has as good or better an opportunity to contribute to the curriculum in the framework herein described as it would in any other setting. Other developments within the field, however, pose problems that beg an investigation before the final plans for the nature of the program in geography can be made.

#### PRINCIPAL PROBLEMS

Geography, like many other disciplines, seems to have two categories of problems: Those which have been with the field for many years and seem to be never-ending, and those which are new. The old ones have to do with physical versus cultural geography, regional versus systematic geography, the placement of geography in the administrative organization, and the confused or denigrating attitude of the general population toward the field of geography. The new ones are based largely upon differences of opinion as to methodology within the field.

Our plan calls for geography to be administered as part of the social sciences. At the same time, however, there is considerable evidence that the association of geography and the physical sciences should not be broken completely. It is thus necessary to consider how geography may be related to the other physical sciences, particularly the earth-space sciences. In our plan, the interdisciplinary program helps solve this problem by requiring a physical geography course of all majors in the earth and space sciences.

How to change the attitude of so many that geography is countries and capitals to be studied in the elementary grades only is a great puzzle. Time, good works, and public relations seem to have unctuous qualities, though they heal our problems slowly.

The second category of problems relates to the current conflict within the field of geography, and it is here that a great struggle for position is being waged. Traditionally, geographic specializations have usually been described as physical geography, economic geography, settlement geography, or political geography. If more specific differentiation seemed necessary, such specialties as climatology, geomorphology, industrial, or urban geography have served to separate scholarly interests. To modernize our terminology and make possible another analytical basis upon which to staff a geography department, I would like to suggest the following classification of geographic specialization: humanist, diffusionist, theorist, and computerist. Whether or not such terminology can be justified is a question—but let me explain briefly, at least, how it may be possible to characterize each of these groups.

The first, the *humanists* are those geographers who have been part of the profession for many, many years. Their principal contributions have been in communicating the field to others through descriptive writing and fairly highly emotionalized teaching. Their literary style is often creative. They are frequently great salesmen for geography. Where writing and

teaching have been of a scholarly nature, geography has profited and thousands of students have been inspired. But their impact in the profession of geography at this time seems to be at low ebb.

The second group, which I have called the *diffusionists*, is a significant and well developed segment in geography that has solidified its role out of recent conflicts within the profession. These conflict lines have probably been most solidly drawn between theoretical geographers and those who see the development of culture through the diffusion of ideas within areas and regions. The word diffusion itself suggests that it is difficult to touch all the variables in a geographic problem, let alone expect to control variables or study one aspect of a problem in isolation from other aspects. Scholarly scrutiny of the literature (in all appropriate languages), careful field study, and analysis of the chronology of occupancy mark the geographers counting themselves in this group. Diffusionists have been centered pretty largely, it seems to me, on the West Coast and have recently become much more competitive with geographers in other groups.

A third group I have chosen to call the *theorists*. This group seems to have come largely from the economics-oriented geographers who have become acquainted with the successes economists have had in developing a theory that goes with the field and who have followed developments in regional economics. Theorists have found that mathematical equations are often helpful in building theory; they have experimented with model buildings, and have generally moved nearer to many of the methods of the natural sciences. Their contributions have accelerated in recent years and have begun to show up among other groups of geographers. The significance of their position in the profession was evidenced when at the "kick-off" meeting of the recent national geography convention in Columbus, Ohio the topic was "The Spatial Organization of Economic Activity."

Economics, with its multitude of data in the behavior-generating mediums of exchange, stands out among the social sciences in theory building. Jevons described such data in this way: "A unit of pleasure or of pain is difficult even to conceive; but it is the amount of these feelings which is continually prompting us to buying and selling, borrowing and lending, labouring and resting, producing and consuming; and it is from the quantitative effects of the feelings that we must estimate their comparative amounts."<sup>2</sup> Furthermore, it has a long history of theoretical development from the early seventeenth century to the present.

The geographer theorists, with far less historical assistance, are putting together a cogent theory of geography. They are producing a new organization of the field. They are classifying variables in such a way as to discover their behavior under model conditions. They are selecting and trying methods from other disciplines that lead in both theoretical and applied aspects of their field.

From this theorist group comes another segment which depends to a very large extent on handling numbers for its research. Perhaps an ap-

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<sup>2</sup> William S. Jevons, *The Theory of Political Economy*, (New York: MacMillan, 1871-1879) p. 12.

proper name for these "fortran followers" is the *computerist* group because they usually feel it is more valuable to their problems to use the computer to develop matrices and ranking systems and to compare with deviations and covariation, than to spend a greater share of research time in the field, or on maps and other devices commonly used by geographers. Evaluation of "computerists" and their contributions usually raises emotions. Some of our colleague-practitioners are accused of "computer-doodling." Such an accusation may at times even be justified; but justification of criticism is most real when results generated from a computer are limited because the data used were invalid. Or, as my neighbor cynically refers to the input-output function of a computer, "garbage in, garbage out."

No doubt each of these groups has a contribution to make. Even the computerists, newer than the other categories, are making a contribution to geography by regularizing spatial relationships and giving them some greater currency with modern science.

Individual geographers may, of course, combine talents to produce new categories or sub-types of those groups listed. A political scientist not long ago told me that, in his opinion, the good quantifier-theorist political scientist was one who had moved into these interests from a "traditional" background. Combinations of the groups posed here and traditional specialties will no doubt continue to develop. From such mergers should come geography's contribution to the revolution in discipline alignment, research cooperation, and teaching effectiveness.

The time does come, however, when the academic plan must be submitted and first appointments made. Many of us feel that all interests of the field should be satisfied and that the optimum is being approached when such is the case. For the more pragmatic, however, it will no doubt be recognized that if all of these features of geography are promoted and developed within the department, one may reach an end to fiscal feasibility and be faced with a choice of reducing breadth of program or being satisfied with mediocrity of professional talent. Promotion of all approaches and all interests in geography may really lead to a "customer-is-right approach." Whatever is asked shall be done so long as it enhances size of classes and subsequently the size of the faculty. Our answer to this problem is, I hope, a narrowing of offerings in factual accumulation and an expansion in the application of theoretical concepts to model and then real conditions. Theorists move in these surroundings, their research seems at the heart of modern geographic inquiry, they are occupying more and more journal space, and I see no reason why theorists cannot teach as well as anyone else.

While I may expect that our teaching and research emphasis will turn out to be principally economic geography, it is probable that my only real opportunity to have an influence on this pattern of development is the initial appointment. Oliver Wendell Holmes said it this way, "The great thing in the world is not so much where we stand, as in what direction we are moving."



# MANUFACTURING IN TAHITI

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Throughout the world small islands share the handicaps of isolation and a paucity of resources. In spite of these, however, if their populations possess an effective demand for modern goods, they often develop small-scale manufacturing industries to supply local needs. The island of Tahiti, for example, has responded to a varied demand in a profitable, and frequently ingenious, manner in the face of these limitations.

On first thought it may be difficult to take seriously such a title as "Manufacturing in Tahiti." To be sure, no smoking factories or sprawling assembly plants disturb the island's groves of coconut palms, but 60 different manufactured items are in production by more than 600 firms—establishments which by their nature, if not by their size, would be classed as manufacturing firms by the United States Census of Manufactures.

Tahiti lacks most of the essentials for manufacturing. Raw materials and energy sources are few, labor is unskilled and expensive, and the market is small.

It is this market, however, that permits the 600 firms to thrive. Although limited in size it is protected by distance from other producing areas. It is 2,381 miles to Honolulu, and more than 3,300 miles to important industrial centers such as Los Angeles or Sydney. The 40,000 inhabitants of Tahiti are not naked savages living on bananas and fish, but have acquired Western tastes in food, clothing, and shelter which is reflected in demand for baked goods, soft drinks, beer, ice, ice cream, cooking oil, men's and women's clothing, soap and bleach, simple furniture, and perhaps most important of all, electric power. All, at least in part, are produced locally.

Tahiti's manufacturing is presented not as a significant segment of the world total, but as an example of the type that, regardless of the absence of other locating factors, is attracted to a market—in this case one as isolated as any of comparable size on earth. It is, to an extent, representative of that found in all small island communities.

In Tahiti manufacturing establishments producing for sale are licensed for each product. A list of licensees, then, after eliminating duplication, gives a count of the firms. Since they are not required to report the number of employees, nor the value nor volume of their product, no other quantitative description is possible.

Of the processes preparing the important locally-produced exports, copra drying and pearl shell cleaning are not considered manufacturing, while vanilla curing is included.

## NUMBER OF ESTABLISHMENTS

The following count includes the establishment on the islands of Tahiti, nearby Moorea, and the phosphate island of Makatea.<sup>1</sup>

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<sup>1</sup> Data is from unpublished sources made available by the municipal authorities in Papeete.

The most numerous concerns are those producing pastry products, of which there are 273, and bread, numbering 119 (there is much duplication involved here); and women's clothing and men's clothing, 134 and 67 respectively, also involving duplication. There are 48 furniture manufacturers, 26 vanilla dryers, 18 mattress manufacturers, 18 producing sausage and related products, 17 making soap, 14 shoe repair and sandal manufacturing concerns, and 14 tinsmiths who make such products as roof drains, vents, sprinklers, and vanilla boxes.

Eight concerns bottle soft drinks, seven produce tobacco, six make candy and six produce cooking oil. There are five boat builders, five printers (in addition to the Government Printing Office), five producing picture postcards, and five blacksmiths whose output includes stoves, wagon wheels, rims, coconut graters, fishing spears, and goggle frames. Four concerns make saddles, harness, and belts; four produce torteaux, the coconut meal cake for cattle feed. There are three tanneries, three firms that make cement blocks, and three making curios, largely of pearl shell. There are two coffee roasters, two sawmills, and two firms each are engaged in the production of ice, jewelry, cheese, coconut fiber, bleaches, and phonograph records.

Pottery, rum, bottled grapefruit juice, baskets of rattan and bamboo, and vanilla crates of the local purau wood are produced by one firm each. There is one meat packer, one brewery, and one electric power plant.

Public Works makes large concrete drain pipe and culvert sections, and since it has the only large metal cutting machinery on the island, does some contract work for others.

Not licensed, and hence not included in the count, are "family manufactures" made in the home even though for sale in the market, on the street, or to retailers. Among such products are grated coconut, poi, guava jelly, dried fish and other prepared foodstuffs sold in the Papeete market, coconut husk rope, coconut fiber or leaf brooms, and mats, hats, and baskets of coconut or pandanus leaf. Three unlisted items, charcoal, coral lime for construction and whitewash, and pandanus leaf sections, are produced in large volume.

Additional industries which have been tried in the past but which failed, largely because of undependable raw material supply, include the canning of tuna, pineapple, and papaya; the production of perfume from the native gardenia, the tiare Tahiti; and cane sugar refining. An attempt was made to make bleach from sea water, but the product was inferior and the venture failed.

#### LOCATION FACTORS

The characteristics of Tahiti's manufacturing are disclosed by a consideration of the principal factors of industrial location: raw materials, power and fuel, labor, and market.

Examination of the list of products reveals heavy dependence on imported but easily shipped materials. Among them are wheat flour from France; cotton textiles from France, United States, and Hong Kong; hops from Germany and malt from France; refined sugar from Holland; chemicals for soap, bleaches, and carbonated drinks from France and United

States, sheet metal from France; lumber from the United States and Canada; and bottles from France, the United States, and Australia.

The principal local materials used include vanilla, coffee, sugar cane for rum, rattan and bamboo, tobacco, native hardwood timber, meat and hides, coral rock, and above all, the coconut, the fiber, meat, and oil of which are used as ingredients, and the husk and shell of which become fuel.

To make up for deficiencies there is frequent use of scrap materials and the re-use of containers. The raw material of the blacksmith's products is often scrap metal; the tinsmiths make use of old oil drums for Chinese stoves and chimneys. (Figure 1) The metal parts of wrecked boats are sal-



**Figure 1. Tinsmiths make a variety of products, frequently using scrap metal as their raw material.**

vaged and re-used. Bottles are used again and again and may contain many different substances during their lifetime, and old wine casks are used for the shipment of pearl shell.

Power and fuel represent the greatest deficiencies among the island's factors of production. Potential water power is undeveloped and mineral fuels are lacking entirely. Wood and the husks and shells of coconuts are the common fuels used for heating the Dutch ovens of the bakeries and the boiling pans for soap manufacture, for drying coconut, and for firing the boilers for oil distillation.

Before the war even the electric power plant was a steam plant fueled with coconut shells and firewood. Following the war it was converted to diesel power, and now, with five engines, has a capacity of 1,500 kilowatts per hour. Most of the manufacturing plants requiring power are located in Papeete and purchase electricity. Two out-of-town concerns buy fuel oil and produce their own power, one producing electricity and one using diesel power directly to operate equipment.

The Phosphate Company (*Compagnie Francaise des Phosphates de l'Oceanie*) that exploits the deposits of tricalcium phosphate on the

island of Makatea, long had the monopoly on diesel oil, receiving it from freighters from the United States that carried it in the ship's tanks in 500- or 1,000-ton lots. From the main dock the oil was pumped by ship's pumps to company tanks from which it was trucked next door to the tanks of the power plant or dispensed in 50-gallon drums to small users. In 1956 a bulk oil terminal and tanker berth were established at the north end of the harbor to handle all oil products.<sup>2</sup>

#### ROLE OF LABOR

Labor has a relatively important role in Tahiti's industrial picture as there is little modern equipment or mechanization. (The power plant and the brewery are notable exceptions.) Most of the tasks, however, demand little in the way of skill. The few skills that are required, and the necessary industriousness, are provided by the Chinese residents of Papeete who in many instances are also the entrepreneurs. Labor for pay does not attract the Tahitian and, with high copra prices, is frequently unnecessary. It is, therefore, costly. Certainly no industries are attracted to Tahiti by a favorable labor situation.

This leaves, then, the market dominant among the factors of production. Tahiti's 35,000 native inhabitants, 2,000 Europeans, 5,000 Chinese and their demands require local production of goods that cannot be shipped profitably from remote sources. Thus it is the typically market-oriented industries that are conspicuous—those with final products that cannot be shipped at all such as electric power, or which are perishable and hence expensive to ship, such as ice, ice cream, and baked goods, or those that because of weight or bulk per unit of value are likewise expensive to transport—cement building blocks, cheap furniture, and the various bottled liquids.

A detailed description of a few of Tahiti's manufacturing enterprises and their processes will illustrate more specifically the employment of these factors of production.

The most abundant of the manufacturing firms on the island are the bakeries (a situation that prevails also in the United States). Twelve bakeries serve Papeete, each producing from 1,000 to 1,800 loaves of French bread daily. Assam's establishment in nearby Pirae is typical. A large indoor Dutch oven of stone is heated by burning wood and coconut husks within it for a few hours. After the ashes are raked out, the long loaves, which have been mixed, weighed, and shaped by hand, are inserted on a long paddle and slid off with a quick jerk. The heat lasts for five or six lots.

Finished loaves are removed by a paddle, one at a time. Some are broken by the narrow opening. The rest get the dust wiped off of them, then are stacked for delivery. None are wrapped. Assam bakes twice a day, in early morning, and again at 7 p.m. for 3 a.m. delivery. One baker uses a modern oven burning fuel oil and some have machine dough mixers, but most resemble Assam's in equipment and method.

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<sup>2</sup> *Pacific Islands Monthly*, Nov. 1956, p. 68.

Next door to Assam's is a coffee roasting establishment. Coffee beans are hulled in a small electrically-run machine. Each morning roasting is done in an oil drum revolving over a wood fire by an electric motor. Two drums are roasted daily. Coffee is ground in a small electric grinder as each customer arrives with his own container.

Also in Pirae is the "Trichlore" factory producing bleach. A quonset hut houses a simple array of mixing and storage vats in which the powdered concentrate from France is mixed with water. The paddle mixers are electrically driven. Bottles are filled from a faucet at the base of the mixer then carried to an adjoining shack for hand labelling, storage and retail sale. The three employees produce from 100 to 200 bottles per day.

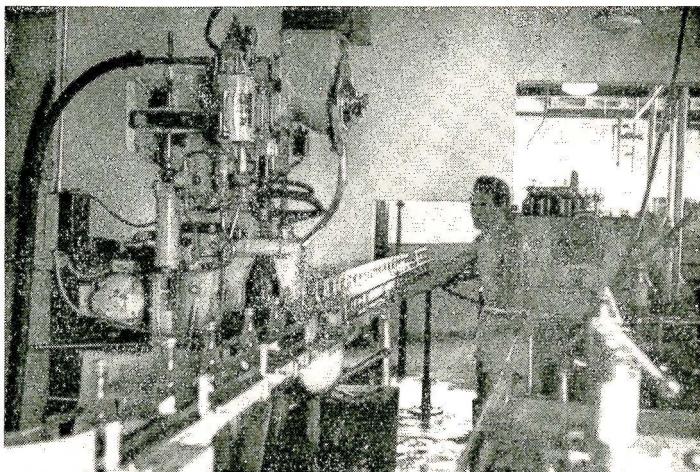


Figure 2. One of the island's few pieces of modern equipment is found in this "limonade" bottling plant on the outskirts of Papeete.

"Limonade," the name for all soft drinks, carbonated or not, is bottled by eight firms, all in or near Papeete. The two largest, with automatic equipment, have capacities of 40,000 or more bottles per month, buy new bottles for their products, and sell to retailers. The others, employing two or three persons only, have capacities from 1,500 to 5,000 bottles per month, sell only on the premises, and in used bottles.

One of the largest, Petillante, bottling limonade, soda, and "siphon," employs seventeen. Purchased electric power runs a modern American bottle washing and sterilizing machine feeding onto a moving belt to the filling and capping units. (Figure 2) Operating at a rate of about 25 bottles per minute, it is slow enough so the man at the end can pack cases, load onto the truck outside and fetch more boxes. Syrup, mixed on the upper floor, is fed by hose.

#### COCONUT INDUSTRIES

Two of Tahiti's larger and more picturesque establishments make use of the island's one abundant raw material, coconuts. Burtchkey's Usine

Cocorape in Paea, 19 kilometers south of Papeete, produces grated desiccated coconut for export. The building, roofed but without walls, is located among large coconut groves and is surrounded by enormous piles of nuts, copra drying racks, and bonfires of burning husks.

The nuts are husked by hand on sharp stakes then carried by wheelbarrow to the building where women chip off the shells with small hatchets. Three powered lathe-like machines rotate the nuts while the brown skin is removed with a hand directed knife. The peeled nuts are dumped into a concrete tub and crushed by trampling on them to remove the milk which soaks the dirt floor for yards around. They are then shoveled to a table where there are chopped with a knife, then into the power-operated grater. The grated coconut is hand lifted to the dryer and from it to the power-agitated sifter. Finally it is packed in paper bags and loaded onto trucks.

Power from a French diesel engine is delivered by overhead shaft and belts to the three cutters, the grater, the dryer and sifter. The dryer burns coconut shells but not the husks. Unfit nuts are made into copra. About 40 men and women, all Tahitian except the manager, are employed in husking, chipping, peeling, crushing and chopping the nuts, attending the grater, dryer, and sifter, stenciling the bags, and sacking and loading the product.

Chin Foo, employing 18, operates the only coconut oil extracting plant on the island. He buys copra, rather than producing it, giving it additional drying if needed. The coconut meat is shoveled by hand onto the power-operated oil press, usually going through twice to remove all the oil. The extracted oil is packed in used fuel oil drums, some to be used in the plant for cooking oil and soap manufacture, some to be sold to other local soap manufacturers, some to be exported to France. Electric power is produced in the plant with surplus fuel oil burning equipment obtained from military installations on the island of Bora Bora after the war.

Cakes of the meal residue known as torteaux, a by-product of oil extraction, is sold in bulk for cattle and chicken feed.

Refining of the crude oil to cooking oil quality consists of removing the free acids with caustic soda, followed by steam distillation in an old locomotive boiler fired with coconut husks. The refined oil, also packed in drums, is sold to restaurants and to retailers who dish it out to customers in reclaimed bottles.

Soap is made by boiling the residue of the refined oil with more caustic soda in large pans or oil drums over a wood fire. It is poured into wooden molds to harden, cut into long bars with a wire, and allowed to dry in storage. To satisfy certain customers it is frequently colored with bluing. Several other soap manufacturers, usually producing three or four tons a month, buy coconut oil from Chin Foo.

#### BOAT BUILDING

Boat building, important in all island communities the world over, is undertaken by several small concerns. All of the wood working (of local or Canadian timber) is done locally. Metal parts are obtained from the United States or are salvaged from wrecked boats. Several inter-island

schooners have been built, the largest being about 300 tons. Some are converted yachts. In recent years with increased labor costs it has been cheaper to buy used boats in the United States and send crews to sail them to Tahiti.

Quite in contrast to most of Tahiti's manufacturing enterprises is the modern brewery. (Figure 3) New automatic equipment from Nancy, France, was installed in 1955, reducing the necessary labor force from 35 to ten. Using imported malt, hops, and bottles, the brewery has an annual capacity of one third of a million gallons. Ice is a by-product.

In summary, Tahiti's manufactures are of three types. Simple hand-craft industries such as the making of canoes, fishing gear, baskets and



Figure 3. Tahiti's industrial plants are not impressive in appearance. This brewery, however, houses modern French equipment.

mats represent remnants of the earlier Polynesian culture with its self-sufficient economy. Only a few such items are produced for sale and still fewer, principally objects for the tourist trade, are produced for export.

A second group represents the processing or utilization of local materials, the vanilla, coconuts, fruit, coffee, tobacco, fish, meat, hides, coral rock, or timber. Although produced in quantity for sale, these items are largely for local use with the exception of the vanilla and some of the coconut products, which are based on the only two raw materials that Tahiti has in surplus.

Finally there are the market-oriented (transportation cost-conscious) industries using imported raw materials to create products usually more bulky or perishable in nature, hence impossible to ship or more costly to ship than the imported components. Among them are electric power, bread, clothing, ice cream, beverages, bleach, tinsmith products, cement blocks, furniture and mattresses. These are entirely for local use.

Since most of the manufacturing in Tahiti is for the local market, it is not surprising to find that exports of manufactured goods are few, with

vanilla and coconut products accounting for most of them. Most important by far is cured vanilla. In 1961, 195 tons with a value of 175,914,000 francs were shipped overseas.<sup>3</sup> Coconut products have been insignificant in recent years but as late as 1958 amounted to a value of 18,889,000 francs for unrefined coconut oil and 14,919,000 francs for shredded coconut.<sup>4</sup> Smaller amounts of coconut fiber, rum, and such tourist items as wood carvings, shell curios, baskets and hats were also sent abroad.

Vanilla exports went to France, Germany, the United States and Australia, the coconut products and rum entirely to France, and the souvenirs and curios to France, the United States, and New Caledonia.

#### SITE FACTORS

Site factors influencing the immediate location of Tahiti's manufacturing concerns are generally simple and straightforward, again illustrating in most cases dependence on location near labor, power, raw material supply, or market. Nearly all of the establishments are in Papeete which represents the concentration of the market and of the labor supply, the only source of power, and the entry port of the imported raw materials.

The downtown section of Papeete consists of several blocks of two-story frame buildings housing retail stores mingled with small carpenter shops, tinsmiths, mattress factories, and garment factories producing for sale both on and off the premises, and invariably operated by Chinese who live on the floor above. Some of the larger bottling works and cement block manufacturers with greater space requirements are on the edge of town but within range of electric power distribution.

The power plant itself lies near the waterfront adjoining the fuel oil storage tanks of the Phosphate Company. The ice plant is also on the waterfront as it utilizes the freezer of the former fish cannery. Likewise the boat works obviously require waterfront location and are clustered around the north end of the harbor, removed from busy liner and schooner docks and yacht anchorages. (Figure 4)

The two large processors of coconuts, both independent of city power, are located some miles from town in the midst of coconut producing areas. Vanilla curing is similarly located on the plantations.

Most widespread are the many small units of the baking industry located throughout Papeete and in every village on the island—distributed as are their customers. The brewery adjoins the cathedral, perhaps through some causal relationship that has escaped the author.

Tahiti, the most Westernized of any of the South Sea islands of Polynesia, has by far the greatest quantity and variety of manufacturing. In contrast, the people of Samoa, although three times as numerous, retain native culture to a greater degree and do not present a universal demand for Western foods, beverages, clothing and household goods, thus

<sup>3</sup> *Pacific Islands Yearbook and Who's Who*, 9th ed., 1963, p. 157. The Pacific franc exchanges at 89.8 for \$1.00.

<sup>4</sup> From data in *Statistiques Douanières, Année Entière 1958, Supplément au Journal Officiel de la Polynésie Française du Avril 1959*. In 1958 the Pacific franc exchanged at 63 for \$1.00.

the islands have no brewery, no garment or furniture factories, and only an occasional establishment producing soap, bread, or bottled drinks. Curios are the only items produced for export. A similar situation prevails in Tonga.

Unique in all of Polynesia is the garment factory on Rarotonga in the Cook Islands producing cheap shirts for the New Zealand market, utilizing imported materials and inexpensive native labor which attracted the industry to this unlikely place.

Presenting a picture of manufacturing activity more comparable to that of Tahiti are the small islands of the Lesser Antilles. Although generally larger in population and less isolated from other producing centers,



Figure 4. Boat Building on the shores of Papeete's harbor requires a minimum of equipment.

they present a population that is entirely Western in culture and hence in demands. Sugar cane products replace those of Tahiti's coconuts in manufacturing and exports, but almost all, like Tahiti, have bottling plants, bakeries, boat works, and producers of apparel, tobacco products, soap, ice, and cooking oil for the local island buyers.<sup>5</sup>

Although all small island communities tend to develop industrially in similar fashion, the character of such development will vary with remoteness, with the resources available locally, and with the size and degree of "Westernization" of the population.

<sup>5</sup> Barbados, with a population of 235,000 and a role as supplier for many of the neighboring islands has a more impressive list of manufacturing concerns, employs more than 18,000 in manufacturing and produces many items for export. Otis P. Starkey, *The Commercial Geography of Barbados*, pp. 8, 19.



# COASTAL GEOGRAPHICAL FEATURES OF LAGUNA GUERRERO NEGRO

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Lagoons on the lower western coast of Peninsula de Baja California, Mexico, between 24 to 30 degrees North are allied both geologically and biologically to those found further north in the States of Baja California, Mexico, and California, United States of America. The largest lagoon complex is the Bahia Magdalena series centered on 25 degrees North. Another large lagoon area is that one encompassing Laguna Ojo de Liebre (Scammon Lagoon) at 28 degrees latitude.

The Laguna Ojo de Liebre complex is on the depressed edge of an extremely flat alluvial plain lying between the Sierra de San Borjas of the Peninsular Range to the northeast and the Sierra Vizcaino de San Andreas, a range to the southwest that toes off into the Pacific Ocean at Punta Eugenio. Laguna Guerrero Negro lies near the center of this 200-odd square mile complex composed from north to south of three lagoons. They are Laguna Manuela (6 square miles), Laguna Guerrero Negro (41 square miles), and Laguna Ojo de Liebre (156 square miles). Each of these opens to the sea by its own separate mouth and a bar is deposited across each entrance. Narrow land bridges separate the three lagoons, each of which is surrounded by extensive tidal flats.

The central axis of pear-shaped Laguna Guerrero Negro dips to the northwest (Figure 1). The north-south length is eight miles and the east-west width is approximately five miles. Wide-shelved and precipitously-walled meanders drain the lagoon. Typically, the deepest channels are immediately at the head of the entrance channel behind the lagoon barrier, which is a large sand island covered by scalloped barchans. There at the entrance depths are from 35 to 40 feet whereas the drainage laterals are 25 to 30 feet deep.

Barchans also lie on the northern and northwesterly shores of the lagoon. In places the lee slopes impinge directly on the channel, and at these points the channel sides slant as much as 40 degrees.

## SALT PROCESSING

The combination of these natural features is such that the lagoon is an excellent site for large-scale salt processing operations. Puerto Venustiano Carranza lies within Laguna Guerrero Negro at  $28^{\circ}02.1'N$ ,  $114^{\circ}08.0'W$  and was established in 1957 as a company-operated port by Exportadora de Sal, S.A., to handle its salt trade.<sup>1</sup> Deep-draft freighters are accommodated at this port, which is located approximately 325 nautical miles southeast of San Diego, California, and 60 miles due east of Isla Cedros in Bahia Sebastian Vizcaino.

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<sup>1</sup> U.S. Hydrographic Office, *Sailing Directions for the West Coast of Mexico*, 1951, 9th ed., pp. 8-11, 41-42.

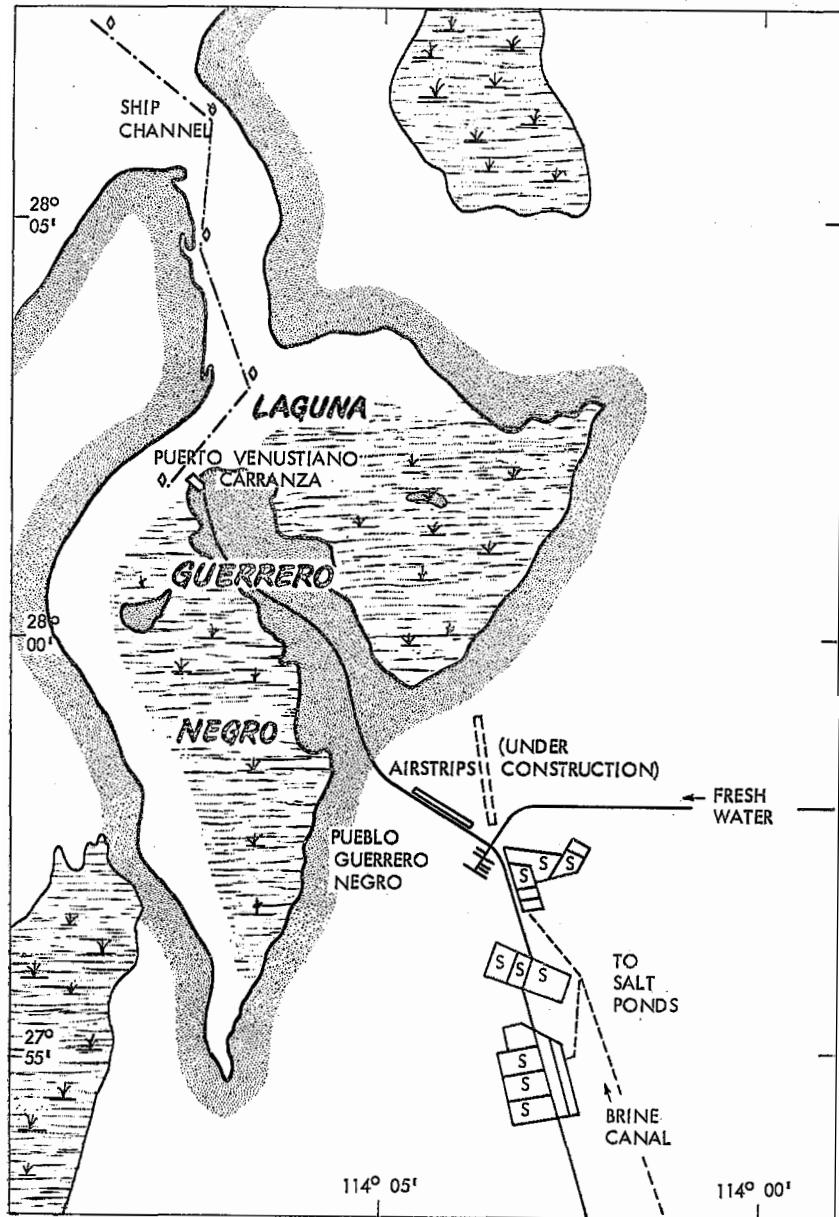


Figure 1. Geographical and cultural features of Laguna Guerrero Negro, Baja California del Sur, Mexico in 1962-64.

Although common salt is among the less spectacular marine products of commerce, there seems to be no end in the demand for this resource. Solar evaporation, the most common process used to obtain salt from the sea, is the basis for salt trade originating at this port. Salt operations were conducted in the immediate vicinity of Laguna Guerrero Negro for the last 80 years in a desultory fashion. However, in 1951, after a survey indicated promise, modern industrial techniques were introduced. By mid-1963 approximately 21 million dollars had been invested in evaporation, bulkloading, and administrative facilities at the port and Pueblo Guerrero Negro, a nearby settlement. This investment has been managed by National Bulk Carriers, New York City, of which Exportadora de Sal is a subsidiary.<sup>2</sup>

The port is reached via a seven-mile channel that is kept open by dredging. Because the channel walls are continually slumping, dredging is virtually a 24-hour task. Natural protection is given the port by the barrier island. Pilotage is required, and since Puerto Venustiano Carranza is a port-of-entry, customs and stores inspections are likewise mandatory. Port captain's duties are discharged informally by the salt company manager. No personnel of the Armada de Mexicana are stationed at the port, consequently the chief federal officer and authorized port captain is an Army officer commanding a garrison of 22 troops at Guerrero Negro.

Controlling depth of the entrance channel is 28 feet. The channel is buoyed for 6.3 miles of its length and is marked by ranges. Two square miles of anchorage lie within a three-mile arc of the headlands. In an emergency at least five times that area could be obtained for fair weather mooring.

To the casual eye at flood tide, all parts of the lagoon appear open to navigation. However, extensive shallow flats appear on the falling tide. Access to the upper reaches can only be obtained via lateral channels formed into a tortuous dendritic pattern. The lower laterals are 150 feet wide and remain well-defined for as much as eight miles from the barrier entrance before they grade into shallow water. However, the southern channel can be ascended only three miles with a vessel drawing six feet, while the northern channel is open for scarcely double that distance.

Configurations of the channels and the adjoining shelves are such that tides flood the lagoon complex with remarkable celerity. The tide rises across the tidal flats almost faster than a man can walk; consequently, vast areas become inundated within a few minutes. By reverse token, ebbs quickly expose the flats. Shallow pools appear in profusion across the flats after low water, but these are never more than a few yards in diameter and only a fraction of a foot deep. After a short time these pools disappear, probably by vertical drainage, and the bare tidal flats seem completely free of any life.

Notwithstanding the formidable appearance of the tidal race, currents are not greater than 2.3 knots. Phleger<sup>3</sup> made a similar observation in

<sup>2</sup> Cutting, P. J., Director General, Exportadora de Sal, S. A., personal communication, 1963.

<sup>3</sup> Phleger, Fred B., and Gifford C. Ewing, "Sedimentology and Oceanography of Coastal Lagoons in Baja California, Mexico," *Bulletin of the Geological Society of America*, Vol. 73, 1962, 145-182.

Laguna Ojo de Liebre. Afternoon ebbs carry away water that is perceptibly warmer than floods of an earlier hour. This follows, no doubt, from insolation of the sheets of water lying across the broad shelves of the flats. Horizontal underwater visibility varies during tidal stand from 8 to 11 feet during hours of bright sunshine.<sup>4</sup> When tides are flowing however, suspended debris turns the water murky. Tidal ranges are 3 to 5 feet.<sup>5</sup>

Waters of Laguna Guerrero Negro are known to be isohaline.<sup>6</sup> (There is no route by which salt brine from the industrial beds can drain into the lagoons.) Mid-summer salinities are 35.5 to 37.5 parts per thousand (0/00), while those of the winter are 34.7 to 35.6 (0/00). Presumably, this indicates the influences of increased evaporation and insolation during the summer months. Flood tide salinities, naturally, are more dilute than those of ebbs.

Bottom sediments of the lagoon basin are predominantly minute gray sand particles intermixed with organic silt. There are occasional outcrops of fine-grained fossiliferous sandstone strata. A coquina specimen taken from the southern part of the lagoon proved to be cemented detrital limestone. The cement was calcium carbonate, and detrital components were shell fragments plus pulverized foramens.<sup>7</sup> Occasional cobbles of limestone appear in dredge tailings.

Extensive salt beds surround the head of the lagoon, and in these the overburden is either pure salt or a mixture of salt and wind-blown sand. Levees separate the industrial sites from the natural tidal pans.

#### CLIMATE

Although the lagoon lies in the hot and dry BW climatic zone,<sup>8</sup> the wintertime climate is benign because of the offshore California current and upwelling in Bahia Sebastian Vizcaino.<sup>9</sup> Weather observations recorded in the port captain's log indicate that the mean monthly maximum temperature runs from 68 to 95 degrees F. and the minima from 30 to 48. Wintertime temperatures are in the mid-eighties, but are tempered by a daily afternoon breeze (12-16 knots). January is the usual period for freezing. In the late summer, temperatures regularly pass into the nineties but may go as low as 45 degrees at night.

After the spring equinox, the area is periodically dominated by 20- to 30-knot northwesterly winds in the afternoon.<sup>10</sup> This may last for 8 or 9 days and be followed by 3 to 5 days of gentle breezes. Occasionally warm winds sweep out from the desert. In the fall, pressure gradients over the mainland further curtail any wind, and, accordingly, temperatures remain high.

<sup>4</sup> Evans, William E., and Wheeler North, personal observations, 1963.

<sup>5</sup> U.S. Coast and Geodetic Survey, *Tide Tables, High and Low Water Predictions, 1964, West Coast North and South America Including the Hawaiian Islands*, 1962, pp. 70-73.

<sup>6</sup> Phleger, and Ewing, *loc. cit.*

<sup>7</sup> Inderbitzen, Anton, personal communication, 1963.

<sup>8</sup> Espenashade, Edward B., ed., *Goode's World Atlas*, 11th ed., Chicago, Rand McNally & Company, 1960, pp. 8-9.

<sup>9</sup> U.S. Hydrographic Office, *loc. cit.*

<sup>10</sup> *Ibid.* and Phleger and Ewing, *loc. cit.*

Rainfall is slight. In 1938 and again in 1951 there were two storms that swept the area. From 1961 to 1963 the total rainfall was scarcely above two inches, and this small amount fell between January and March.

Fog is not uncommon along the entrance channel and near the bar in the winter. However, at the same time ten miles inland the sky is open and visibility unlimited.

#### FLORA AND FAUNA

Vegetation of the dryland fringes of the lagoon is dominated by salt bush (*Suaeda californica*) and pickleweed (*Salicornia virginica*). Marsh grass (*Spartina foliosa*) is the principal species of the exposed tidal flats. Eel grass (*Zostera marina*) grows at the extreme edge of the tide lines and will be found along the margins of the lateral channels down to a depth of twenty feet. *Salicornia* blends into heavy stands of marsh grass (*Batis*) in the direction of the salt marshes, but toward dry land it phases into *Suaeda*. Samples of foramenifera taken from the beach sands contained abundant concentrations of *Elphidium gunteri* and *Quinqueloculina laevigata*. All of these samples contained small amounts of *Rotorbinella versi*, *Q. lamarckiana*, *Q. limbata*, and *Q. costata*.

The most abundant copepod in the winter appears to be *Acartina tonsa*. Also present with incidental frequency are *A. lilljeborgii*, *Paracalanus*, and *Psuedodiaptomus* spp. The indicator species of the marshes are the fiddler crab (*Uca crenulata*) and the horn snail (*Cerithidae californica*). On the flats one will often find bubble shells (*Bulla gouldians*), starfish, and, if one digs, an abundance of clams and sweet potatoes (*Molpadia arenicola*). Common fishes of the channels are guitarfish (*Rhinobatos productus*), mullet (*Mugil*), and species of bass (*Paralabrax* spp). Ducks and shorebirds, especially whimbrels (*Numenius phaeopus*) and curlews (*N. americanus*), are present in the winter by the tens of thousands. Bottlenose dolphin (*Tursiops gilli*) and calving gray whales (*Eschrichtius gibbosus*) occasionally enter the lagoon.

Among the latent resources of the lagoon complex are those that are based on the harvest or observation of wildlife. One can see multitudes of sea ducks and other edible waterfowl, since these lagoons lie within the Pacific flyway. Fishing, certainly a likely source of recreation, may also serve as a base for a limited commercial fishery. Green turtles were seen infrequently. These are used elsewhere on that coast for food, and fishermen from Isla Cedros enter the lagoon to take them for market.

For the moment, however, salt processing is the sole industry. The belt conveyor structure on the salt wharf and a gleaming white hill of salt nearby dominate the flat landscape from miles around. A stream of 70-ton tractor-trailer units continually replenishes the 45-foot high stockpile. A two-hundred foot long concrete and sheet piling-faced dock lies under an adjustable bulk loader, which can be elevated from 30 to 50 feet above the wharf.

In 1962, the total export was slightly over 2 million tons of industrial grade sodium chloride. During that year 97 vessels flying the flags of Japan, Greece, Canada, and the United States called and carried away

2,202,346 tons of salt. Japanese markets took 700,000 tons, the Pacific American 400,000 and various European ports the remainder of the total.

Salt is obtained by progressive solar evaporation of impounded waters drawn from Laguna Ojo de Liebre. As the salinity of these waters increases, the bittern is transferred by pumps to settling beds. From there the bittern is drawn off at a rather low density for final processing. As a result, nearly pure sodium chloride is obtained. Laboratory samples of recently harvested salt were noted to be above 99.8% purity. Salt so processed is trucked directly to dockside loading facilities.

Included in the harbor facilities are a heavy-duty harbor tug used for docking, a small harbor tug, and two survey boats. Two crawler cranes service the wharf. There are limited fuel and water supplies.

#### COMMUNITIES

Pueblo Guerrero Negro is located approximately five miles inland from Puerto Venustiano Carranza. It is a "company town" with 125 houses laid out on a grid pattern. There are one dozen concrete-block houses occupied by supervisory employees. There are also 60 double-unit frame dwellings and 30 Quonset buildings likewise divided in half. In addition to these types, another two dozen structures in varying grades of excellence serve town folk who are not directly employed by the salt company. The population of this settlement is approximately 500 people.

Fresh food supplies are available in local grocery stores and from itinerant farmers. Water is drawn from wells five miles to the eastward and piped to homes after chlorination. Electricity is supplied by three 110 volt 100 kilowatt generators. Communications within a 25-mile radius are furnished over a short-wave radio band used by all company units.

There is a church, a hospital, a library that adjoins a large social hall, two military buildings, and a school. The small central business district includes a department store, restaurant, barber shop, and two groceries identified by garish signs and advertisements. Goods offered include beverages and toiletries as well as canned goods under familiar American brand names but from Mexican manufacturers. At least one-quarter of the town area is taken up by a vehicle maintenance yard and fenced storage compound. Adjoining this area is the company office and administration building. The streets are unpaved but are graded and kept in repair.

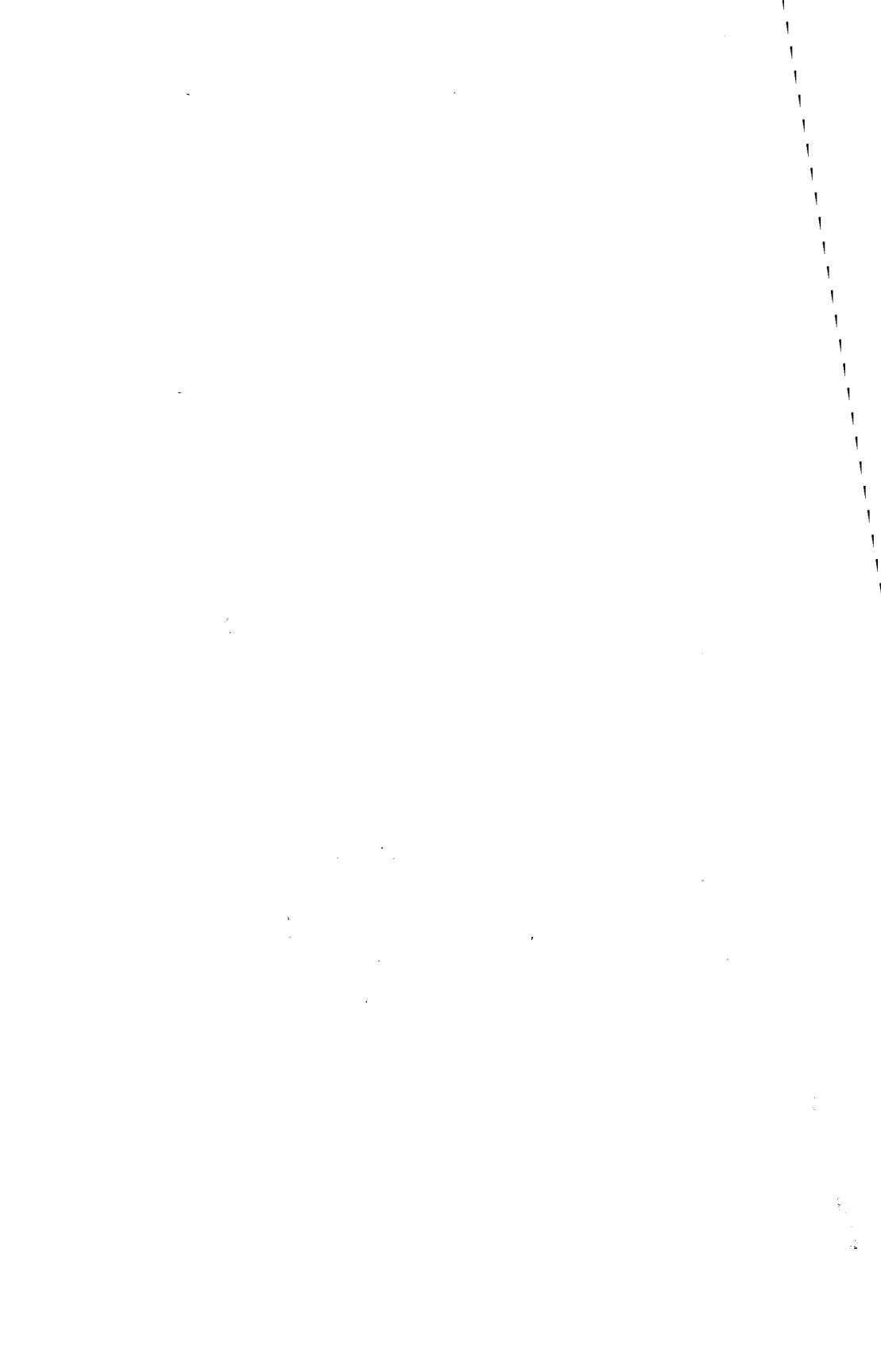
A 6,000-foot airstrip with a 40 x 40-ft. hangar is next to the town. Company-operated aircraft, one a two-engined transport and the other a light monoplane, use this field regularly. Bi-weekly non-scheduled commercial flight connections with the rest of the peninsula can be made in advance. A secondary 3,000-feet dirt-surfaced airstrip nearby is no longer in regular use.

The nearest settlement is a village of seven frame buildings approximately three miles away at the northeast corner of the lagoon. One of the principal occupations of those who live there is fishing. This hamlet is not under control of the salt company.

A 50-mile road net surrounding the salt ponds culminates at the salt loading area. The roadway is kept in excellent condition for the use of rapidly shuttling truck and trailer rigs. A full stock of graders, bulldozers, and utility trucks used in loading and hauling is in the best of operating condition. A few private automobiles were seen.

Exportadora de Sal spends large sums each year to maintain an efficient, large-scale salt processing facility. The enterprise is well-run and shows an air of flourishing progress. A company-sponsored program of civic development and public building is enhancing the well-being of Pueblo Guerrero Negro's population. However, one natural condition overshadows whatever commercial development may transpire. Here the reference is to the recurrent silting of the ship channel. Heavy discharge of sand with each ebb tide as well as continual slumping of the channel walls combine to make dredging a formidable but essential task. When the last of these field observations was made (early in 1964) two schemes were being considered to alleviate this confrontation with nature. One was to re-orient the overland truck route northwestward to an anchorage in Laguna Manuel that would not be exposed to tidal discharge. The other was to build an entirely new port within the barrier island directly to the westward of the present port. This new port, likewise, would not be subjected to tidal silting.

As it stands today, Laguna Guerrero Negro has become the site of the largest salt producing facility along the eastern Pacific coast. Processors at San Francisco and San Diego have responded to this challenge by increasing their production. The future of Puerto Venustiano Carranza is now limited by coastal oceanographic factors which cannot be controlled economically through current engineering techniques. Consequently, it appears that the configurations of the present port and lagoon will be changed to allow further industrial development.



## TWO KEYS FOR THE HISTORICAL INTERPRETATION OF AERIAL PHOTOGRAPHS\*

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The techniques and practices associated with the exploitation of aerial photography in the study of air archaeology and historical geography were pioneered during World War I by German and British scholars. Many individuals contributed to the succeeding development and perfection of methods, based upon experience in the field, during the next fifty years. O. G. S. Crawford, a leading British pioneer in this area, codified the techniques of prehistorical interpretation when he devised a simple but most effective grouping of site attributes in two cornerstone publications.<sup>1</sup> The familiar categories of shadow-sites and shine marks, soil-sites, and crop-sites serve as foundational departure points for the archaeologist, anthropologist, and historical geographer working over either vertical or oblique photographs. The full range of what can be achieved from photography in terms of ingenuous techniques working upon obscure data is splendidly illustrated by John Bradford in his *Ancient Landscapes*.<sup>2</sup> This much of technique and interpreted data is, therefore, secure, essential, and difficult to improve upon.

The very rapid expansion of the usage of aerial photography in a wide number of fields and according to a bewildering variety of techniques is a development of the last 25 years. The photo interpretation key has been evolved to aid in the basic tasks of recognizing and identifying objects which appear on the photos, and two justifications for the development and use of keys have been agreed upon.<sup>3</sup> They may serve as valuable short cuts in interpretation especially if highly trained personnel are not available, and they assist greatly in the training of photo interpreters. It would seem that a third justification for the photo key might reside in the need to process the large volume of photography available today for the initial isolation of features which, by reason of their susceptibility to easy destruction, are rapidly passing from the visible scene. It is with this latter requirement foremost in mind that the following two photo interpretation keys are advanced as being suitable for usage by historical geographers.

### TYPES OF KEYS

The photo interpreter endeavors to identify objects by employing processes of selection and of elimination. He can tell either what something is, or he can identify and reject something which it is not. Both

\* This paper was originally delivered before Symposium S4a, "The Rural Landscape and its Evolution," of the 20th Congress, I.G.U., July 1964.

<sup>1</sup> O. G. S. Crawford, "Air-Survey and Archaeology," *Ordnance Survey Professional Paper*, n.s. No. 7, (1924), 39 pp., and "Air-Photography for Archaeologists," *Ordnance Survey Professional Paper*, n.s. No. 12, (1929), 44 pp.

<sup>2</sup> John Bradford, *Ancient Landscapes: Studies in Field Archaeology*. London: George Bell, 1957, 297 pp.

<sup>3</sup> Interdepartmental Committee on Air Surveys, Department of Mines and Technical Surveys, *Proceedings of a Seminar on Air Interpretation in the Development of Canada*, (Ottawa), 1964, Pt. 4, pp. 38-40.

approaches work better if they are broken down into a number of intermediate steps of decision-making. A key provides an orderly arrangement for such decisive steps. If the key is illustrated with single or stereo photography, the identification process is made even more accurate and dependable.

The selective type of key illustrates and describes classes of phenomena, and the interpreter must select the closest fit for his particular specimen.<sup>4</sup> The amount of detail which can be handled by means of this type of key is restricted, but it is easier to prepare, and it has the added advantage of treating the subject as a whole.

Elimination keys, on the other hand, proceed step by step through an array of possible identifications, and here the interpreter must discard all incorrect choices.<sup>5</sup> A refinement of the elimination key occurs when a dichotomous format is employed. Choices are then paired throughout a series of characteristic-categories which become more and more restricted at each division point until the ultimate choice of alternatives is reached. The most familiar dichotomous device in the realm of the geographer is the botanist's taxonomic key.

The advantage of the dichotomous key is that one works from general toward more particular characteristics, and thereby the way through a mass of detail is more easily found. Choices are almost always limited to two alternatives because this tends to reduce confusion and ambiguity. If an incorrect choice is made, the hope is that it will be quickly recognized when the succeeding criteria of choice do not fit the specimen at hand.

Design of a suitable key is a matter of balancing the desired ends against the level of ability of the interpreter. If a key is to be used by experienced interpreters, it is possible to impart a higher degree of complexity both in its subject matter and in the degree of refinement of its selection criteria. One must, therefore, first measure the man and then the range of phenomena. Both simple and complex keys are needed, for no one key will do all jobs incidental to the historical interpretation of photographs.

As will be seen below, the geometric properties of features of historical interest will be stressed here. Recent experience with small-scale satellite photography indicates that, detectability and ground resolution parameters notwithstanding, the ground-feature geometric properties of linearity and focality show up amazingly well.<sup>6</sup> In addition, association analysis which is the study of features in both their areal arrangement and context is basically predicated upon a *Gestalt* which is in large measure geometric.<sup>7</sup>

In order to illustrate two types of keys which can be designed as well as to indicate the incidental problems in their usage, the following

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<sup>4</sup> American Society of Photogrammetry, *Manual of Photographic Interpretation*, Washington: American Society of Photogrammetry, 1960, p. 112.

<sup>5</sup> *Ibid.*

<sup>6</sup> U.S., House of Representatives, Select Committee on Astronautics and Space Exhibition, *Space Handbook: Astronautics and Its Applications*, 86th Cong., 1st Sess. 1959, House Document No. 86, pp. 173-174.

<sup>7</sup> American Society of Photogrammetry, *op. cit.*, pp. 104-105.

proto-types are discussed here. It should be noted that ideally these examples would be illustrated with annotated photography, preferably stereoscopic pairs of pictures.

### THE SELECTIVE KEY (KEY 1)

The first device is a Selective Key, and its operation is illustrated by reference to a particularly choice area in Wiltshire county, England. (Figure 1.) Five categories have been set up according to basically geometric criteria to assist in the simple, initial identification of historic objects on aerial photographs. The geometric properties were chosen because pattern, outline, inter-relationships in space, and spatial overlaps are all readily spotted on aerial photographs even at very small scales. In the key itself the categories are listed in order of their seeming prominence on a photograph. The assemblage of features included within each category is enumerated, and illustrative examples are included from Figure 1 in lieu of photographs.

Aerial features which constitute the "grain" or overall pattern of a land surface will consist here of historical man-made aspects of agricultural, forestry, artificial water body, and expansive settlement elements. In the territory illustrated here, such features will consist of so-called "Celtic Fields" and lynchets. With respect to these two groups of things it should be noted that both the time of day of the photography and the season of the year will be essential parameters for successful interpretation.

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#### KEY 1: A SELECTIVE KEY FOR THE HISTORICAL INTERPRETATION OF AERIAL PHOTOGRAPHERS

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Category	Assemblage of Features and Illustrations
1. AREAL FEATURES—	"Grain" or pattern of the land surface, consisting here mostly of agricultural features. e.g., Celtic Fields, Lynchets.
2. LINEAR FEATURES—	Travelling earthworks, boundaries, alignments, and transportation lines. e.g., Roman Road, Wansdyke, the Old Bath Road, the Kennet and Avon Canal.
3. FOCAL FEATURES—	Ritual centers, settlements, habitation complexes, and communications junctions. e.g., the Avebury Complex, Windmill Hill.
4. POINT FEATURES—	A great range of possibilities, including monuments, small enclosures, and isolated buildings. e.g., Silbury Hill, Knap Hill Fort.
5. COMPLEX FEATURES—	Overlaps in position or in usage characterize these, and usually reflect origins at different times. Includes overlapping land uses, and military or political frontiers. e.g., overlap (a) between Roman Road and Ridgeway, and (b) Roman Road and Wansdyke; the Avebury Circle, occupied since Bronze Age.

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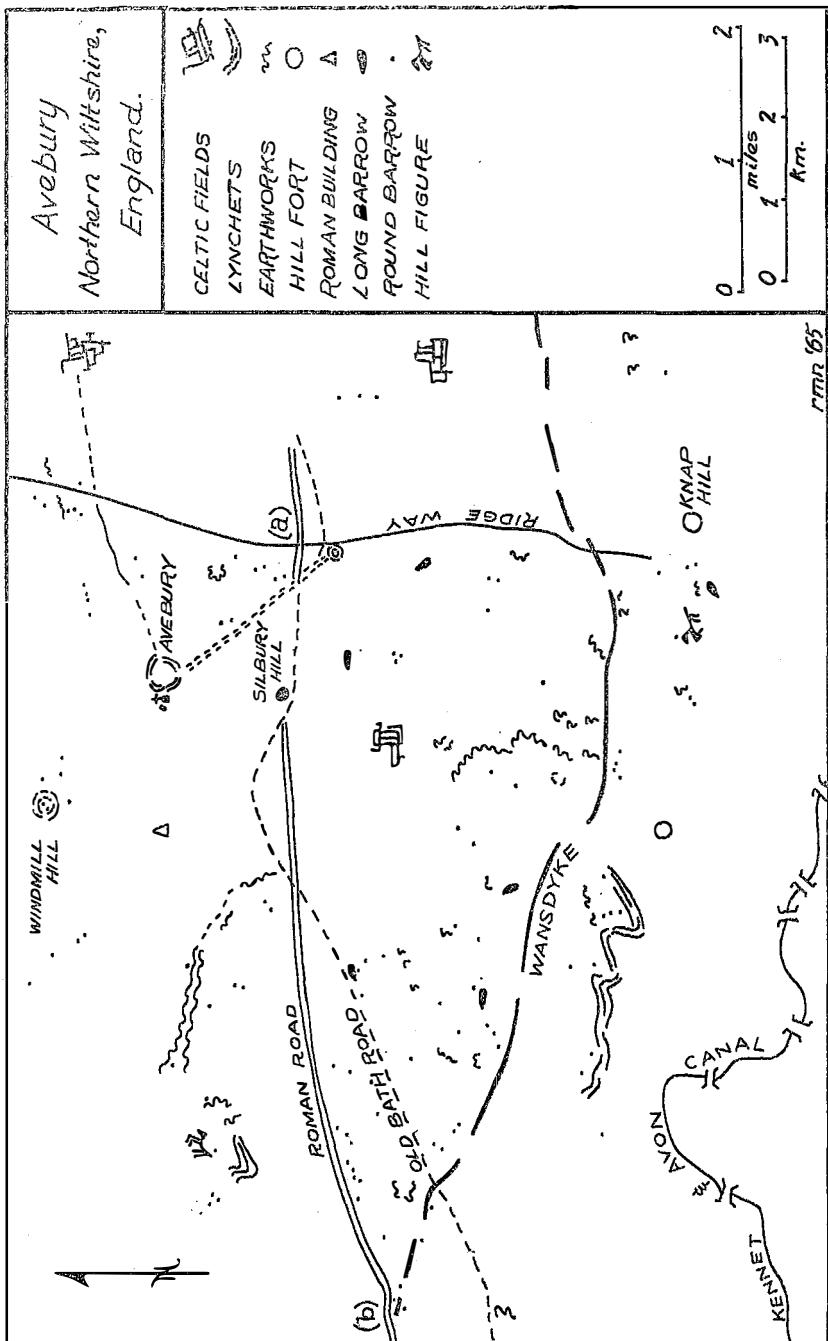


Figure 1

Although not nearly as extensive in areal coverage, linear features are remarkably visible upon photography of even the smallest scales. The more regular the linearity and the longer its extent the more easily visible will the feature be. As cited in the key itself, the travelling earthwork of Wansdyke stands out most clearly by reason of its size and favorable configuration for the casting of shadows. Both the old Roman Road and the much later Old Bath Road are intermediate in visibility. The Kennet and Avon Canal, a monument to the more recent historic vogue in navigational construction, would emerge more clearly if reference were made to the road network which leads to and crosses this feature but which is not depicted on Figure 1.

Congeries of visual clues help in the identification of focal features. A concentration of elements about a center, such as characterizes Avebury, or the funneling of trackage about a habitation site, now alas no longer visible about Windmill Hill, tend to draw the eye of the interpreter to a prime focus.

Point features frequently require photography of high ground resolution characteristic before they can be recognized. In Wiltshire the great abundance of sizeable burial mounds, which cast good shadows at the proper time of day, would not be overlooked. A hill fort such as that on Knap Hill would also be relatively visible by reason of the shadows it cast. The white horse hill figure just to the west of the fort would tend to show up as a tonal difference between the exposed white chalk of the feature and the surrounding grass.

With respect to the analysis of complex features, it would appear that the more one knew about the area under interpretation the better would be the chances of identification. The overlap of linear features at point (a) for instance could be seen, but the significance of this overlap could not be ascertained from the photography alone. However, the relative sequence of construction could be ascertained if details of construction and peculiarities of mutual interrelations were visible upon the print.

The chief problem faced in the design of a Selective Key is making certain that all of the possible classes or categories of phenomena have been included without excessive subdivisioning or ambiguous compartmentalization. An additional perplexity arises when one attempts to analyze the functioning of the phenomena; it is quite obvious that a Bronze Age Trackway would look and operate quite differently from either a Roman Road or a 17th century coach route. The limitations imposed by ethnocentric conditioning in the interpreter have been partially avoided through the use of gross geometric characteristics as the main criteria of identification. It is assumed that the recognition of significant geometrical features is independent of cultural bias. However, it is well recognized that the mental set of the interpreter is one of the five bases for object identification.<sup>8</sup> Last to be mentioned among the short-comings of this key is that it reveals nothing about absolute chronologies. However, the relative se-

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<sup>8</sup> A. P. A. Vink, "Some Thoughts on Photo-Interpretation," *Publications of the International Training Centre for Aerial Survey, Series B, Number 25*, Delft: I.T.C., 1964, p. 9.

quencing of events and features can sometimes be revealed through the close study of overlaps and displacements among surface objects.

### THE DICHOTOMOUS ELIMINATION KEY (KEY 2)

The following sample key for the recognition and identification of ancient fields in Britain has been constructed upon the basis of three premises.<sup>9</sup> First, the essential decision for the user is supposed to be a simple "either . . . or" type of choice. Secondly, the progression in the scheme of the key is from the general, easily identified characteristics of the objects to the more highly specific details. Lastly, the emphasis has been placed upon the basic features of size, shape, and interrelationships, all geometric properties. (See Figure 2.) For purposes of simple illustration the relevant but highly complex details of overlap and semi-obliteration brought about by time and alternative usages have been set aside.

Two additional areas of omission in this key must be explained. Again in order to maintain a simplicity of illustration, the necessary but far from unanimous units of measure characterizing each feature were left out. It is quite clear that mathematical values would have to be assigned before the interpretation of size or shape differences would be entirely meaningful. For the same reason the dozen or so other features of ancient agricultural land use, many of which are debatable both as to terminology and identification, were not included.<sup>10</sup>

Figure 2 is an attempt to depict in a visual manner the objects and their shapes as defined within Key 2.

The first choice which the interpreter must make is with respect to the Size of the enclosed agricultural field unit. If the feature is large, that is on the order of several acres, then he assumes that he is dealing with a prehistoric cattle ranch, pastoral enclosure, or landed estate as defined by visible boundaries. If the size of the enclosed area is small, by contrast, then he moves to the next branch of the key, Branch (II).

Small size of field features then requires an assessment of areal Shape. Irregularity as indicated in Figure 2, Branch (A) leads to a subordinate branching which is predicated upon whether this irregularity is rectilinear or long and narrow. If the interpreter opts for the former category, then he may assume that he is dealing with corn fields of Neolithic or Bronze Age varieties. On the other hand, lynchet features and terraces would be irregular but also long and narrow areas.

When, however, feature Shapes are regular, then the person using this key follows the branch which descends from Branch (B) in the dia-

<sup>9</sup> The importance of the study of "agrarian archaeology" is suggested in Institut Pedagogique National, *Archéologie Aérienne et techniques complémentaires*. Paris: I. P. N., 1963, p. 72.

<sup>10</sup> The omitted field types would include such things as transversely divided strips, embanked enclosures, cultivation banks, cultivation terraces, "Medieval fields", and Roman *per scamna et strigas* systems. The terminology for the field systems in Key 2 was drawn from H. C. Bowen, *Ancient Fields*, London, British Assoc. for Adv. of Sci., 1961, 80 pp., and E. Cecil Curwen, "Air Photography and Economic History: the Evolution of the Cornfield," *Economic History Society*, Pamphlet No. 2, 1929, 31 pp.

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**KEY 2: A DICHOTOMOUS ELIMINATION KEY FOR THE  
INTERPRETATION OF ENCLOSED FEATURES OF  
ANCIENT BRITISH FIELD TYPES.**

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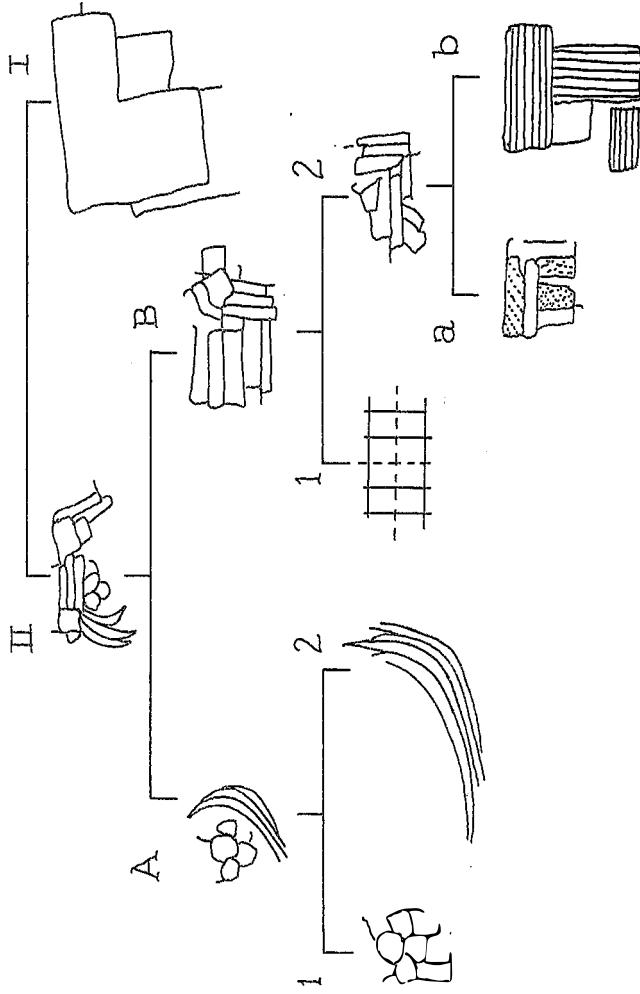
- I. SIZE of Enclosed Area large..... agricultural enclosures such as ranch boundaries, cattle corrals, pastoral enclosures, and estate boundaries.
- II. SIZE of Enclosed Area small
  - A. SHAPE of Area irregular
    - 1. Irregular but rectilinear..... corn plots of Neolithic and Bronze Age.
    - 2. Irregular but long and narrow..... strip-lynchets, lynchets, terraces.
  - B. SHAPE of Area regular
    - 1. PATTERN or Relationship with other Enclosures
      - highly regular..... Roman fields, *e.g.*, centuriation.
    - 2. PATTERN or Relationship with other Enclosures
      - irregular
        - a) CULTIVATION MARKS
          - absent, although may have slight scratch-ing marks of culti-vation, usually 2 sets crisscross..... Celtic Fields.
        - b) CULTIVATION MARKS
          - present, banks and hollows or ridge and furrow in elongated strips bundled into rectangular groupings..... Ridge and Furrow.

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gram. His next criterion is that of Pattern or Shape relationship with respect to the adjacent field features. A highly regular field Pattern, within the confines of the area and samples cited here, would suggest Roman centuriation to the interpreter. An irregular field Pattern would cause him to descend from Branch (2) to the final bifurcation of the key.

Small Size, regular Shape, irregular Pattern, and the photo-reader is faced with a final decision based upon the absence or presence of Cultivation Marks over the surface of the field areas under photo study. Ridge and Furrow tends to show up very well in any of the traditional site attribute categories mentioned above if prolonged deep plowing has

*Illustration of a Dichotomous Elimination Key for Interpretation of Ancient Field Types.*



rmn 65

Figure 2

not been practiced. The *ard*, supposedly the cultivation implement of the Celtic Fields, leaves very slight if even detectable surface cultivation marks.

The unsolved problems relevant to Key 2 would be, first of all, the oversimplification which is inherent in this present device. There are many other features of ancient agricultural land use which have not been included here. In addition, the categories of existing features as well as their several sets of identifying characteristics are not agreed upon yet by all students of ancient fields. If quantitative criteria relative to size and shape were added to the Key, its operability would be correspondingly enhanced. Lastly, this particular Key is useful for the interpretation of photography only from Britain. A key for the identification of types of German or Andean ancient fields would have to be quite different.

### CONCLUSIONS

Even so obscure a subject as the development and usage of keys for air photo interpretation has enjoyed an impressive but perhaps unreasonable vogue. Within the pages of *Photogrammetric Engineering* between the years 1952 and 1958 there appeared a total of 16 articles on the subject of P.I. Keys. In 1955 a Symposium on keys produced alone ten of these articles. The usefulness of keys for the establishment of interpretative short-cuts and as aids in the training of interpreters has already been mentioned. However, cautionary voices have sounded the warning that the key is not a substitute for the well-trained and knowledgeable interpreter.<sup>11</sup>

With respect to an assessment of the utility of photo keys within the fields of air archaeology and historical geography, three contrasting opinions can be cited. J. K. St Joseph, Director of the Committee for Aerial Photography at Cambridge and dean of present efforts in air archaeology in Britain by reason of his energetic field work and publication schedule, expressed doubts as to the usefulness of keys in the interpretation of historical landscapes.<sup>12</sup> His stand was based upon the facts that very many special cases exist among historic features and that categories tend so to grade one into another. The diversity of features to be handled, when added to the experience characteristic of mature interpreters, would tend in the end to limit the usefulness of such keys to basic instructional levels and for highly generalized initial surveys.

Kirk H. Stone, long a worker with air photography as related to rural settlement analysis, occupies a middle position regarding the usefulness of keys for historical studies.<sup>13</sup> The development of the dichotomous key for many applications has reached a point of surfeit, but the need for historical keys is great presumably because fewer of these exist.

Robert N. Colwell, who has concerned himself over a long period with the precise exploitation of air photography especially in applications to forestry, was enthusiastic about the future for keys of the type illustrated

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<sup>11</sup> Interdepartmental Committee on Air Surveys, Department of Mines and Technical Surveys, *op. cit.*, pp. 38-40.

<sup>12</sup> J. K. St. Joseph, personal communication, April 1964.

<sup>13</sup> Kirk H. Stone, personal communication, May 1965.

here.<sup>14</sup> The existence of a large reservoir of archaeological sites which are now coming more and more under the impartial eye of the aerial camera provides the student with a mounting interpretative work-load. A second argument for the usefulness of such keys resides in the fact that so many historical sites are in current and pressing danger of destruction. Hence, there exists the acute need for site identification and evaluation as guides for subsequent site reservation or rescue excavations.

A compromise position relative to the value of keys for historical interpretation of aerial photography might be phrased as follows.<sup>15</sup> In this day of voluminous satellite photography of increasingly higher quality and with a gathering interest in the geographic exploitation of remote sensing systems, P.I. keys designed specifically for the analysis and identification of historic landscape features are needed. The eventuality that large volumes of photography will of necessity be screened by interpreters not trained in the facts and viewpoints of air archaeology and historical geography argues for the acceptability of even simplified keys. The related possibility of programing keys in order that guidance might be provided to a dispassionate data processing mechanism responsible for photo interpretation probably lies within current technological capabilities.

Within this small compass it has not been possible to provide more than a slight suggestion of the intriguing possibilities offered by the design of photo interpretation keys suitable for the historical study of landscapes by means of airborne sensors. The photo key by itself cannot do the entire job, of course. In the hands of an interpreter who is experienced in both interpretation and field work, and who employs skillfully the concept of the convergence of evidence, the photo key can help to shed new light upon the exploration of the "archives of the earth".<sup>16</sup>

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<sup>14</sup> Robert N. Colwell, personal communication, May 1964.

<sup>15</sup> Robert H. Alexander, "Geographic Data from Space," *The Professional Geographer*, Vol. XVI, No. 6, November 1964, pp. 4-5.

<sup>16</sup> Paul Chombart de Lauwe, ed., *La Découverte Aérienne du Monde*, Paris, Horizons de France, 1948, p. 98.

# THE MEXICALI VALLEY WATER PROBLEM

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The Mexicali Valley of Baja California has become a prime producer of cotton and one of the world's great processors of raw cotton. General agriculture has flourished, too. Like a phoenix arisen from the desert this region has been reclaimed from the arid conditions that have gripped the entire area since before the white man arrived. Now, salinity left in the soil by draining irrigation waters threatens to wipe out the progress of half a century. Only salt-tolerant cotton may survive conditions which have become an international issue.

North of the border in the summer of 1961 the U.S. Bureau of Reclamation completed the Wellton-Mohawk Irrigation and Drainage District project. The \$14,000,000 drainage system includes 70 deep drainage wells with pumps, and a 50-mile concrete-lined conveyance channel with an outfall on the Gila River above Yuma, Arizona (Figure 1).

Drainage water being pumped in the Wellton-Mohawk system is not return flow in the usual sense of the word, but water accumulated over a long period of time as a result of interior drainage. From before the turn of the century until 1952, Wellton-Mohawk farmers depended upon underground flow of the Gila River for irrigation water.<sup>1</sup> The quality of this water was uniformly so poor that it was disclosed in testimony before the United States Senate in 1945 that the irrigated area was down to 8,000 acres (as of 1943; later, even less was in crops) and that samples were taken showing a salt content of 12,000 parts per million.<sup>2</sup>

In 1952, Colorado River water became available with the completion of the Gila Project. As substantial amounts of water were used to leach accumulated salts, 50,000 acres were soon in crops and much of the land quickly became waterlogged. The drainage project was designed to alleviate this problem.

Pumping this water and conveying it to the Gila created many problems. The city of Yuma reacted almost immediately, abandoning its source of municipal water from the Colorado below its confluence with the Gila, and making arrangements to obtain water upstream. The areas under discussion are included in Figure 4. The farmers of the Mexicali Valley were hit by high salt loads almost immediately thereafter, with disastrous losses resulting.

## MEXICALI FARMERS PROTEST

What were the complaints of the Mexicali farmers? Newspaper and other accounts first reported protests about water diverted at Morelos Dam which was used to irrigate grains in the fall of 1961. Water had not been ordered in advance for use on these crops, which had germinated early due to rains. Water taken from the Alamo Canal at this time did not constitute

<sup>1</sup> Colorado River Board of California, *Salinity Problems in the Lower Colorado River Area* (Sacramento, Sept. 1962) p. 15.

<sup>2</sup> *Ibid.*, p. 23.

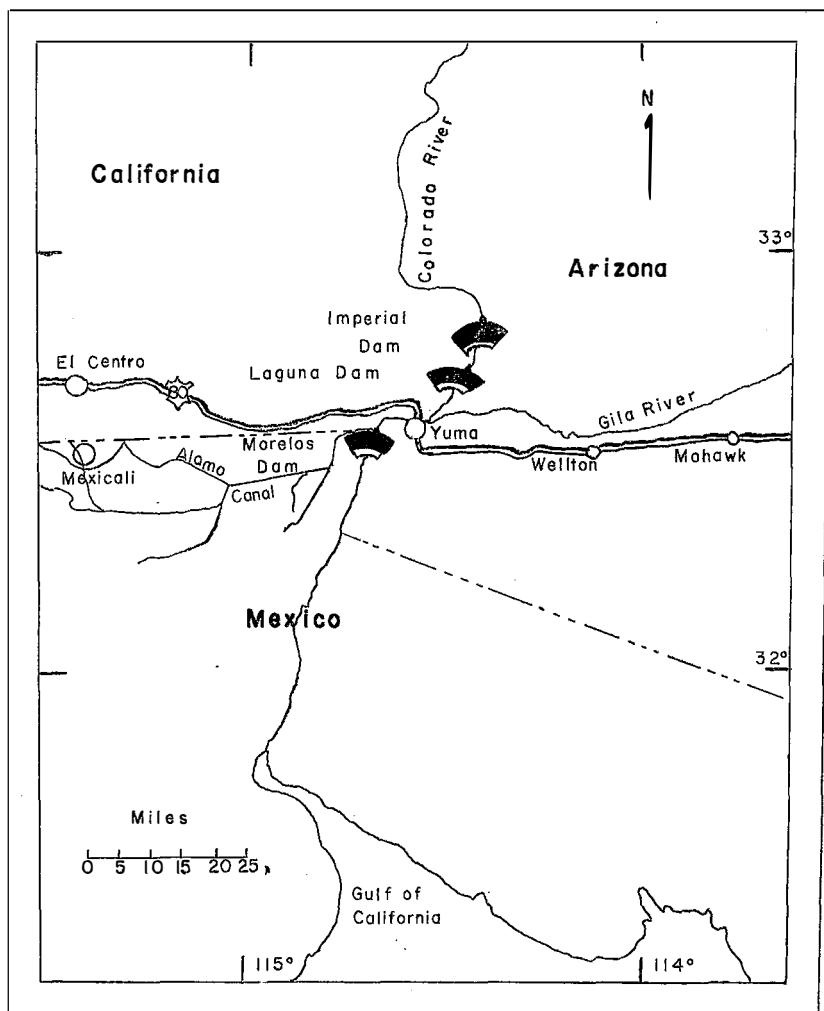


Figure 1

a part of Mexico's Colorado water quota, but was used as the need arose. Grains of all types were endangered. Within a few days the normally green shoots were speckled with yellow and much of the winter grain crop soon died.<sup>3</sup> Baja California Governor Eligio Esquivel reported that 43,000 hectares of wheat, alfalfa and oats were destroyed after November, 1961, as a result of the river's high salt content.<sup>4</sup> With a normal salt content of 700-800 parts per million, water taken for irrigation from Imperial Reservoir a few miles upstream is used in the Imperial and Coachella Valleys of California. During the winter of 1961-1962 however, salinity at the International Boundary measured 2,700 parts per million and more (rapid evaporation of this water sometimes left a crust of salt upon the surface of the soil).

#### WATER USE IN THE LOWER BASIN

A characteristic of Colorado River water is a high content of mineral salts—sodium and potassium chlorides. There are adverse effects when this water is used for irrigation in the hot, arid southerly part of the Lower Basin. This would be true even if the salt content remained nearly constant within prescribed safe limits. To avoid salinization of large areas of land, several precautions must be taken:

1. Deltaic soils tend to form hard-pan, and must be plowed occasionally with a special deep plow.
2. The soil must be thoroughly leached with water, generally between plantings.
3. Appropriately close-interval tilling is necessary to drain off the leaching water, keep the ground water at safe levels, and prevent saline waters in the area below the drainage system from returning to the soil surface.<sup>5</sup>

These precautions are vital because both the Imperial and Mexicali Valleys present conditions favoring salt accumulation in the soil, especially at the root zone. These conditions are low rainfall, high evaporation rates and water use by plants in intensive cultivation. In spite of the foregoing, Colorado River water normally will prove suitable for most Lower Basin crops providing the pH factor is not too high and that the soil is properly washed. Provision must be made for adequate drainage.

#### WATER ALLOCATION

In addition to compacts allocating Colorado River water, there is the treaty between the Republic of Mexico (ratified in 1944) and the United States (ratified in 1945). Mexico is guaranteed 1,500,000 acre-feet annually.<sup>6</sup> There is no provision in the treaty covering the quality of water to be delivered. However, analysis of salinity data clearly indicates a major source of salinity close to the International Boundary. Thus, only the

<sup>3</sup> Dick Nall, "Salt Caused the Crisis," *San Diego Union*, Jan. 21, 1962, p. a35.

<sup>4</sup> *Hispanic American Report*, XIV-12 (Feb. 1962) p. 1075.

<sup>5</sup> Jerome Molof, "Drainage in the Imperial Valley of California," *Journal of Soil and Water Conservation*, XVI-6 (Nov.-Dec., 1961) pp. 267-69.

<sup>6</sup> Mexico actually used 300,000 acre feet more than this in 1943.

Mexicali growers suffer from this contamination. A delegate of the Mexican Agricultural Department, Alejandro Garcia, has been quoted as saying: "We don't have enough water to wash the land. If we put in a high content of salt, it remains."<sup>7</sup>

It would be fortunate for Mexico if the treaty were renegotiated and more water awarded. This is not likely to occur. For 30 years the river water level has been trending downward because of recurring droughts. One of the worst drought years on record was 1961. The United States has an enormous investment in major dams to protect the dwindling supply, a fact which makes the Colorado the most carefully husbanded of any major river system in the world. As the average flow at the time of the treaty was estimated at 17,400,000 acre-feet and only 2,000 square miles of the Colorado Basin's 242,000 square miles are in Mexico, the Mexican quota appears appreciable if not generous.

This, then, is the dilemma of Mexico's stake in Colorado River water. She has still more irrigable land in the Mexicali Valley which might be very productive but she has insufficient water to irrigate properly what is already being cultivated. The restrictions which had to be imposed after the 1961-1962 crisis were harsh. Only 180,000 of a potential 375,000 hectares were planted in the summer of 1962.<sup>8</sup>

#### REMEDIAL MEASURES

Presidents of the United States and Mexico in 1962 told their representatives on the International Boundary and Water Commission to recommend remedial measures which could be put into operation within the shortest possible time "without prejudice to the legal rights of either country."<sup>9</sup>

Numerous projects were then advanced. Storage facilities behind Imperial Dam could be increased by creating a larger reservoir. Release of this additional water would dilute salinity originating from Wellton-Mohawk drainage. Mexico would like to receive its quota from a point north of the confluence of the Gila and the Colorado, bypassing Arizona's return flow. A reservoir on the Gila east of Yuma could control the release of Wellton-Mohawk's saline drainage. This is one of several proposals engineers with the Colorado River Board of California presented as feasible. Others are:

1. Installation of additional drainage wells in the Wellton-Mohawk area making it possible to pump at a lesser rate in winter than at present and a higher rate in summer when more river water is available for dilution;
2. Construction of a new conveyance channel that would bypass the Wellton-Mohawk drainage to a point on the river below the Mexican diversion structure;
3. Installation of a tile drainage system beneath the soils of the Wellton-Mohawk Project and cessation of deep drainage pumping;

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<sup>7</sup> Nall, *loc. cit.*

<sup>8</sup> Feature in *Hispano-americano* (19 de Febrero, 1962,) pp. 25-26.

<sup>9</sup> Colorado River Board of California, *op. cit.*, p. 25.

and various combinations of these.<sup>10</sup> In 1965 both countries reached accord to proceed with the second proposal above, although no appropriation had passed Congress at the time this was written.

The Bureau of Reclamation in 1964 announced the completion of 25 more drainage wells costing \$6,000,000 in the Wellton-Mohawk Project. Because the salt content varies in different parts of the aquifer, selective pumping can help determine the salinity of drainage water.

#### CONCLUSIONS

Additional water projects in the Southwest will provide for more diversion of Colorado River water. In resolving present problems, making use of what is known about utilization of saline water and realistic expectations for future use of Valley soils will help, along with tilling and improved agricultural practices.

This international water quality problem is acutely symptomatic of potential trouble with increasing salinity throughout the Lower Basin. Point 10 of the pending Pacific Southwest Water Plan calls for a ground water recovery project near Yuma, obtaining 220,000 acre-feet of water annually which now flows underground to Mexico. This water presently feeds 610 wells Mexico has drilled on the west side of the Colorado River in Mexicali Valley's northeast corner. These wells provide water for almost 40% of the area's acreage.<sup>11</sup> Then, too, the Wellton-Mohawk Drain contributed 59% of the minerals in water delivered to Mexico from October, 1961, through February, 1962, although the drain outfall constituted only 19% of the total water available at the International Boundary. These facts may sound a note of caution in terms of future extension of water uses in the Lower Basin.

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<sup>10</sup> *Ibid.*

<sup>11</sup> Sid Love, "Udall Water Plan Tosses New Salt in Wounds, Say Mexicali Farmers," *San Diego Union*, Dec. 22, 1963, p. f6.



## BOOK REVIEW

*East of Shannon—West of Moscow*, by Valene L. Smith (William L. Brown Book Company, Dubuque, Iowa, 1965. 144 pp.)

The intent of this book is to change a tourist who simply sightsees into a geographically oriented traveler who wants to know why Europe has so "many faces." The author is one of a few professional geographers who already ten years ago started to answer the many questions of prospective travelers in special travel geography classes at Los Angeles City College. For these courses she prepared a manual, complete with maps and place name exercises. The first three chapters of the present book are a revision of the 1965 manual. Chapters one and two offer updated technical advice on such items as choice of transportation in relation to Europe's road net, or on best clothing for the tourist season. Chapter three gives a brief introduction to climate, landforms, flora, fauna and human occupancy of the European continent. The following eleven chapters appear in print for the first time. They are regional, each with an introductory black and white map and ending with a list of sightseeing highlights. They cover all the countries of Western Europe which usually are included in a good travel itinerary. In addition, the fourteenth and last chapter is dedicated to the increasing number of Americans who seek first-hand information on Eastern Europe. With only nine pages this chapter seems all too brief.

The ten regional presentations, from the British Isles down to the Iberian Peninsula and across to Greece, become a pocket size human geography of Western Europe for the traveling layman. Throughout the book basic geographic concepts lead to sound advice. For instance, the author emphasizes that no part of Britain is without maritime influence and that late summer months are the least rainy. Or the visitor to Germany is alerted to the importance of location and topography because "to understand her location in the heart of Europe and to recognize her leadership in its total economy is essential to any well balanced tour." The recommendations for the Netherlands is to understand the Dutch people's reclamation of and relation to the sea. Just as the story of Spain becomes clear only if one realizes that this country has "the highest average altitude of any in Europe" with uncertainty of rainfall.

All in all, the author offers information which can come only from a trained geographer. This reviewer knows from experience how inquisitive the alert traveler becomes and how he repeats the same question in each Western European country. "How did so little earthspace gain so much influence?" This is the theme of *East of Shannon—West of Moscow* with the subtitle "The Many Faces of Europe."

For a hoped-for second edition a few suggestions might be in order. The book refers only in its title to Shannon Airport, while throughout the book more emphasis could be given to airports and air travel. The selection of highlights for sightseeing seems arbitrary. Even if you can not name them all, places like the Vienna Hofburg, the Berlin Wall or Windsor Castle seem more worthy of inclusion than some of the author's recommendations. Abrupt statements like "Water is safe to drink everywhere except

in Spain" or the image of the American as a "gregarious, loud, back slapping individual" are too dated to be acceptable in a new edition. But most of all, the operation of the Common Market is too visible throughout Europe to be left out in a book that is dedicated to "true international understanding." Valene Smith offers her work as a supplement to "the many excellent tourist guidebooks." It is more than that. It is a geographer's valued contribution in a field in which geographers could be but not often are the logical leaders. —Adolf Stone, Long Beach City College

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ROBERT W. DURRENBERGER  
*San Fernando Valley State College*

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