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PAPERS OF THE MICHIGAN ACADEMY OF SCIENCE ARTS AND LETTERS

EDITORS

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VOLUME XXXVII (1951)

"Pusilla res mundus est nisi in illo
quod quaerat omnis mundus habeat."
—SENECA, *Naturales Quaestiones*

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THE DISCOVERY AND EARLY EXPLOITATION OF IRON ORE ON THE MARQUETTE RANGE, MARQUETTE COUNTY, MICHIGAN

ROBERT J. GOODMAN

KNOWLEDGE of the vast iron reserves of the Lake Superior Region remained a secret from the white man until 1844. No mention of iron appears in the "relacions" of early missionaries who dutifully reported the existence of copper in that region.[1] The white man's discovery of iron was made by a party of surveyors engaged in running a township line in the area which later developed into the Marquette Range (Fig. 1).[2] Samples of the ore were collected and forwarded to Washington, but no immediate exploitation of the mineral resulted from the discovery.

The first discovery of the ore was not generally known. Consequently a rediscovery was necessary before exploitation of the reserves could be effected. Mr. Philo M. Everett, under the guidance of Marji-Gesik, a Chippewa Indian chief, made the second discovery of the ore in 1845. The Indian led Mr. Everett, an official of the newly formed Jackson Mining Company, to an exposure of iron ore under the roots of a fallen pine tree. Everett recognized the high quality of the ore and realized that it was present in large quantity. He staked out several claims and returned to Detroit to raise capital for mining operations.

Little progress in the exploitation of the ore preceded the opening of the ship canal at Sault Ste. Marie (Fig. 1). Before 1850 a small lock served the needs of the fur trade, but steamers, barges, and sailing vessels had to be drawn over the portage by dint of back-breaking labor. Seven weeks to three months was required to portage a boat.[3] Between the years 1850 and 1855 goods were transshipped on a flat-bar railroad. In response to the increasing volume of trade the first of a series of large locks accommodating ships was opened in 1855.[4] The effects of the easy movement of ore through the new canal were soon felt on the Marquette Range.

The first decade of mining on the Marquette Range was one of extreme hardship. The iron ore attracted men in search of easy riches. Instead of immediate wealth, however, they found a life of toil in a wilderness which annually experienced harsh, long-lasting winters beset with snowdrifts commonly fifteen feet deep. This period was marked by "numerous fumblings and ill-fated attempts at mining."[5]

The first iron ore to be mined on the Marquette Range was removed in 1849 from the base of Jasper Knob, a steep-sided rocky hill within the present city of Ishpeming. The Marquette Iron Company, organized the previous year, operated the mine. Large boulders of hard ore were sledged into pieces convenient for handling and were hauled on sleds to the shore of Lake Superior. There, at a company-owned forge, the iron was converted into blooms for shipment down the lakes.[6]

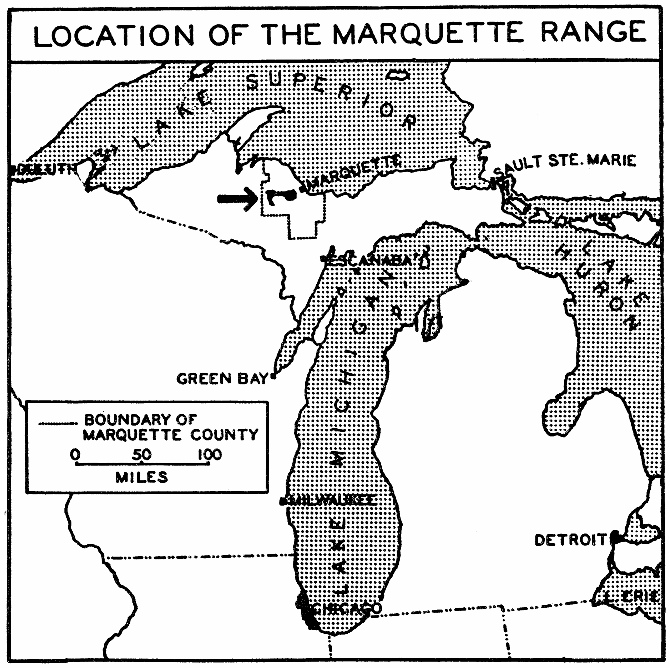

FIG. 1

The Cleveland Iron Company[7] was the first operator to ship any large amount of iron ore from the Marquette Range. In the winter of 1852-53 this company bought the property of the Marquette Iron Company and opened the Cleveland mine at Moody's Location.[8] Although the mine was recorded as embracing a tract of 2,200 acres, operations were confined to a small pit. Two years later, with the opening of the canal at Sault Ste. Marie, 1,449 tons of ore were shipped from the mine to the lower lake ports.[9]

During this early period of mining on the Marquette Range only the Lake Superior Iron Company compared with the Cleveland Iron Company in size of operations. Five other companies were small producers and experienced short lives.[10] The Lake Superior Iron Company, organized in 1853, did not begin mining operations until 1858. Within twenty-three years it was to become the largest producer of iron ore in the United States.[11]

The high cost of marketing iron ore was an important factor which influenced early exploitation of the mineral deposits. Even after the opening of the canal at Sault Ste. Marie iron ore still brought a price of ten dollars per ton at the lower lake ports.[12] Three dollars defrayed the charges of lake transportation, whereas seven dollars were spent to move a ton of ore over the stretch of land lying between the mines and Lake Superior.

At first men attempted to carry ore on their backs over the sixteen miles of difficult terrain. Later they adopted the use of sleds for moving the ore in winter. It was not until 1847 that the first wagon road was cut through the forest. A plank road, begun in 1853 and completed in

1856, was built in opposition to a proposed railroad.[13] This road started at Jasper Knob and ended on the shore of Lake Superior, southeast of the site of the city of Marquette.[14] Construction of the road was slow and laborious. The total cost of construction amounted to $120,000,[15] and the road was used for only two seasons.

Construction of the Iron Mountain Railroad,[16] which replaced the plank road, was begun in 1855 and finished in 1857.[17] It was a crude carrier, with a carrying capacity of 1,200 tons of ore per day. This was considered an enormous amount of ore at that time. The first rail shipment was made from the Lake Superior mine on October 14, 1857.

The transfer of the iron ore from the trains to waiting sailing ships was a time-consuming process. Upon its arrival at the tiny village of Worcester,[18] on Iron Bay, the ore was dumped and stored in stock piles. From the stock piles it was later carted by wheelbarrow to the sailing vessels moored alongside the crude dock.[19] Four days were required to load a 400-ton schooner by this primitive method.[20]

Even the cost of water transportation on the Great Lakes was high during this early period of exploitation of the ore reserves. After the opening of the canal, which produced the greatest savings, costs remained fairly stable. Lower prices came only with new improvements in methods of handling and hauling the ore.

The mines were open pits, and only a few men worked in each one. Drilling was done entirely by hand. "Two men wielded hammers, and a third held the drill and trusted to good fortune that his partners had a straight aim."[21] Black powder was used for blasting, since dynamite was still unknown. "The cap had to be bitten from the fuse. The powder man did this with his jaws, and it was said that iron miners had copper teeth from chewing down on the caps."[22] Patient oxen hauled the huge slabs of ore out of the pits on two-wheeled carts.[23]

This first stage of exploitation of iron ore on the Marquette Range, 1844-63, was a period of small operations. The crude methods employed placed the miner in almost constant danger. It was a time of experimentation, when men lost sizable fortunes invested in a mineral difficult to mine, but even more difficult to transport. These were the trying years preceding the Civil War, when the Marquette Range emerged as the world's primary source of iron ore.

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[1] For translations of selected "relacions" see A. P. Swineford, *Mineral Resources of Lake Superior* (Marquette: Daily Mining Journal, 1876), pp. 90-94.

[2] Jacob Houghton, one of the surveyors, is quoted as saying: "As we looked at the instrument, to our astonishment the north end of the needle was traversing a few degrees south of west" (*ibid*., p. 92).

[3] Hamilton, Charlotte T., "Historic Landmarks of the Sault in 1914," *Michigan History Magazine*, 30 (1946): 745.

[4] The opening date was June 18, 1855. During the first season of operation 106,296 tons of goods passed through the locks (Swineford, *op. cit*., p. 129).

[5] Schoonover, Ruth C, "Pageant: Iron Ore Centennial," *Michigan History Magazine*, 28 (1944): 558.

[6] Swineford, *op. cit*., p. 5.

[7] The Cleveland Iron Company was one of the original companies which merged to form the present-day Cleveland-Cliffs Iron Company.

[8] The Cleveland mine was destined to be one of the greatest ore producers on the Marquette Range. Moody's location was due east of the business district of the present city of Ishpeming.

[9] Andreas, A. T. (ed), *History of the Upper Peninsula of Michigan* (Chicago: The Western Historical Company, 1883), p. 394.

[10] The five companies were the Eureka Iron Co., Collins Iron Co., Peninsula Iron Co., Forest Iron Co., and the Pioneer Iron Co. (Swineford, *op. cit*., pp. 117-121).

[11] Andreas, *op. cit*., p. 401.

[12] *Iron Ore*, January 11, 1919.

[13] Swineford, *op. cit*., p. 122.

[14] *Iron Ore*, July 14, 1900.

[15] Swineford, *op. cit*, p. 123.

[16] Construction began immediately after the passage of the Michigan General Railroad Law, in 1855.

[17] *Iron Ore*, July 6, 1912.

[18] Worcester later became the city of Marquette.

[19] Schoonover, *op. cit*., p. 562.

[20] *Iron Ore*, September 5, 1914.

[21] Schoonover, *op. cit.*, p, 560.

[22] *Ibid*.

[23] *Iron Ore*, July 14, 1900.

THE LYNDON-LIVERNOIS DISTRICT OF DETROIT A STUDY IN URBAN GEOGRAPHY

CHARLES GROSS

THE Lyndon-Livernois district is located near the center of the west side of Detroit (Fig. 1). It is bounded on the east by Livernois Avenue, on the south by Fullerton Avenue, on the west by Meyers Road, on the north by Fenkell Avenue, and occupies an an area of about two and one-fourth square miles. Though it is a small part of Detroit, less than one fiftieth of the city's expanse, this section has been selected for analysis since it is remarkable for the diversity of its industrial, commercial, and residential functions (see Fig. 2). Its 123 industrial plants carry on operations of almost endless variety (see Table I); the residences range from large mansions to dwellings smaller than the average two-car garage; and retail and wholesale businesses cluster around the intersections of the main roads.

The industries of this section, except for those on Wyoming Avenue, are, naturally enough, concentrated on or conveniently near the railroads (Fig. 2). The various food-processing industries include bakeries, an ice-cream plant, a large creamery, and a peanut-butter factory. Service enterprises include a municipally owned incinerator which disposes of garbage, a radio and television transmitter, a publishing house, and several small print shops. There are also a number of metal, chemical, and textile plants. Other concerns specialize in intricate machines and parts, tools and dies, and electrical equipment.

Important manufacturing functions are performed by engineering and design companies, and by wholesale distributors of grocery products, steels, alloys, and radios, as well as by lumber and building supply yards, building contractors, a municipal road-maintenance establishment, and a municipal park-building organization.

The various industries range in size from modest ones employing only 2 persons to a large creamery which uses 600 workers. Some establishments on Wyoming Avenue have only 2 employees, but a large lumberyard and mill have 165. The factories on Meyers Road have from 5 to 80 workmen; firms on Intervale Avenue employ from 5 to 120; those on Lyndon Avenue have from 5 to 600. The short industrial stretch on Birwood Avenue has one enterprise employing only 2 persons and another employing 185. Evidently no definite clustering of very small industries has taken place in this part of Detroit. It is noticeable, however, that ail the larger enterprises (those employing 50 or more persons) are situated on the railroads.

The advantages to industry of a location in this section of the city are numerous. Since it is near the geographical center of the west side (Fig. 1), industries established here can conveniently serve customers situated in any part of the city, especially as there are good transportation facilities, both by rail and by road, and as several main trucking arteries pass through this section (Fig. 1).

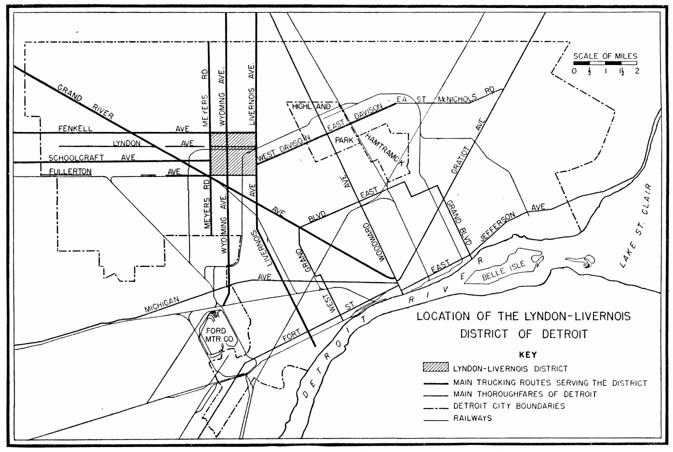

FIG. 1

Livernois and Wyoming avenues and Meyers Road are important north-south routes. Livernois Avenue, in particular, is vital to a good number of the concerns in this area, since it leads directly to the Lincoln-Mercury plant, which these firms supply with parts and materials. Wyoming Avenue, which runs to Dearborn and the great Rouge Plant of the Ford Motor Company, is similarly important. Davison Avenue is one of the main east-west roads of the city, and, since it is a depressed highway along part of its length, communication with Detroit's east side is expedited. Schoolcraft Avenue is a convenient route for west-bound trucks, and Grand River Avenue, which cuts the southwestern corner of this area, facilitates transportation both to the northwest and to the heart of the city. Thus main trucking arteries are available to all parts of the metropolis. Moreover, the growing trading area in the suburbs to the west and northwest can be conveniently reached.

The rail transportation facilities are equally effective (Figs. 1, 2). The Detroit Terminal Railroad serves the industries on the north side of Intervale Avenue, and also the plants on Davison and Schoolcraft avenues at the point where it intersects these roads (Fig. 2). The Pennsylvania Railroad serves the concerns on the south side of Lyndon Avenue and those located where it crosses Wyoming Avenue and Meyers Road. All coal and fuel-oil distributors, lumberyards, and building supply yards are located on these two railroads.

Nevertheless, there has been a trend away from railroad transportation and toward the use of trucks. A considerable number of industrial sites were originally chosen with proximity to a railroad as a prime consideration, but many of the industries thus located have gradually made less and less use of their rail sidings and more and more use of trucks; in some instances truck service has entirely supplanted rail transportation. This has come about because of the greater dispatch with which less than carload lots can be moved by truck, even in interstate shipments. There is no freight differential in favor of the railroads, and the greater flexibility in shipping by truck, especially small consignments, has influenced many of the lesser industries to depend entirely on truck transportation.

On Wyoming Avenue there is a distinct clustering of building contractors and building supply firms, attracted there only two or three years ago by the postwar boom of residential and commercial building in the northwest section of Detroit and the adjacent suburbs. Here they are centrally located with reference to the new building operations and have convenient main roads to serve them.

Generally, industries that are adjacent to one another in the Lyndon-Livernois district show little or no interrelation. Any exchange is usually of a casual and irregular nature, arising, for example, from the immediate need for a certain machine part. The regular clients of the great majority of the industrial establishments are located in all sections of the Detroit metropolitan area, and a considerable number of these companies ship their products throughout the Middle West. Only in two or three instances is a neighborhood source of materials or of customers of any great importance to a firm.

The movement of factories to this part of Detroit is comparatively recent. The first firm to locate on Lyndon Avenue came there in 1920; the next in 1980, and nearly all the others during the 1940's. Intervale Avenue has a similar history, the first industry locating there in 1927 and the others in the 1940's, most of them after the end of World War II. Industrial development began on Birwood Avenue in 1938 with the establishment of two firms. It was not until after World War II that other companies followed. Wyoming Avenue shows the most recent development; with only three exceptions the industrial buildings on this street were all constructed in 1947 and 1948.

Dealers in coal, lumber, and building materials have been the pioneers in moving to this section of the city. Since they needed large areas for the storage of lumber and coal and since these were not available in the older parts of the city, they located outside the heavily settled sections. Often they were the first businesses on their streets. With the passage of the years other industries followed them, as well as residential developments, until now they are well inside the built-up part of Detroit.

There has been a movement of industry away from the congested downtown district of Detroit to this part of the city, especially immediately after the war. A number of firms have made this change because of traffic congestion, deterioration of property, or a desire to move closer to their major markets.

The principal commercial clusters occur at the intersections of the important heavily traveled streets, such as Wyoming, Livernois, and Fenkell avenues (Fig. 2). Important retail clusters are located at the Wyoming-Schoolcraft intersection and also at the Wyoming-Fenkell crossing. Davison Avenue and Meyers Road have smaller commercial centers. Several small retail establishments, usually isolated neighborhood grocery stores, are found on residential streets, away from the commercial areas of the important avenues.

The business sections of the principal streets consist largely of retail stores of all types, along with restaurants, bars, supermarkets, gasoline stations, theaters, bowling alleys, barber shops, and dry cleaners. These retail, service, and recreation units depend to a great degree on neighborhood patronage, and to a lesser degree on transient trade derived from the heavy automobile and bus traffic. Livernois Avenue is devoted to a specialized type of commercial enterprise, for, except for ordinary retail blocks south of Fenkell and Davison avenues, its entire extent in the area studied is occupied largely by used-car dealers. Row on row of used cars make it the used-car center not only of Detroit but of the United States. The national prices of such cars are determined on this unique street.

An attempt was made in this study to classify both residences and residential neighborhoods according to quality (see Fig. 2). Residences have been classified as very superior (Class A, see Pl. I, Fig. 1), above average (Class R, see Pl. I, Fig. 2), average (Class C, see Pl. II, Fig. 1), and below average (Class D, see Pl. II, Fig. 2). The criteria were the size of the house, its age, the state of its repair, and the landscaping. Neighborhoods were similarly classified on the basis of the quality of the houses of which they are composed. But since the neighborhoods were classified by blocks, a certain amount of latitude had to be observed. Frequently the blocks are not composed entirely of houses of one class; many of them contain both above-average and average residences. Where this happened, the type of dwelling which predominated weighed heavily in classifying the neighborhood.

Residences were further classified as single homes (no. 1), two-flat dwellings (no. 2), and terraces or apartment buildings (no. 3). By combining a letter and a numeral it was easy to indicate the character of any residential neighborhood. For instance, a very superior neighborhood composed of single homes could be indicated by the combination A-1, an average neighborhood composed of two-flat dwellings by C-2, and so on (see Fig. 2).

It was discovered that the residential neighborhoods are generally above average in the southern portion of the Lyndon-Livernois district, especially south of Schoolcraft Avenue, but that they tend to decline in quality toward the north, particularly those adjacent to and north of the Pennsylvania Railroad tracks. The only area of below-average neighborhoods occurs north of this railway (see Fig. 2). Though classified as below average, these neighborhoods are not slums in the usual sense, but are composed of small flimsy houses (see Pl. II, Fig. 2); such areas may conceivably become slums if allowed to deteriorate.

A certain amount of residential building has occurred in this part of the city of Detroit since World War II. The entire area shows evidence of such activity, but only in the average neighborhoods north of the Pennsylvania Railroad tracks have whole blocks of new homes been built. They are easily recognized both by their newness and by their distinctive architecture. Although most of the postwar building has been devoted to average-type single homes, an important number of above-average duplex flats and terraces have been constructed on Ewald Circle within the last four years. Elsewhere in this locality postwar building has been well scattered.

Another feature of this part of Detroit is the conspicuous amount of unutilized land in the residential, commercial, and industrial neighborhoods. During the period of rapid growth Detroit's expansion was marked by the development of new subdivisions before all the land in the older sections had been completely utilized. As a result, empty lots occur in most blocks and only a few blocks are solidly built up. The very superior residential section of Oakman Boulevard and the above-average residential section of Ewald Circle show considerable unused stretches. The industrial streets, Lyndon and Intervale, likewise contain vacant, unexploited land. Along the commercial thoroughfares, such as Wyoming and Fenkell avenues, there are many empty lots. Only Livernois Avenue shows an almost complete use of its frontage. Since the used-car dealers on this street find empty lots ideal for displaying their merchandise, nearly all vacant land fronting on Livernois Avenue is utilized in this fashion.

Unoccupied land in the midst of well-established neighborhoods is a symptom of immaturity. As Detroit attains greater maturity, more and more of the by-passed land will be utilized. This process is obvious today in the postwar building now being carried on in this district.

The interruption of residential neighborhoods by industrial belts is quite apparent in the Lyndon-Livernois district; indeed, this phenomenon is characteristic of much of Detroit. Even above-average neighborhoods are subject to such interruptions, which occur where railroads, with their attendant factory zones, cross residential streets. Thus all the north-south streets of this district occupied by dwellings are broken by the east-west corridor of industrialization along the Pennsylvania Railroad tracks, and the east-west residential streets Schoolcraft, Davison, and Buena Vista are severed near one end by the industrial development along the Detroit Terminal Railroad tracks (Fig. 2).

The Lyndon-Livernois area includes, as well, both public and parochial schools, churches, a cemetery, and municipal playgrounds. These, together with the industrial, commercial, and residential developments discussed above, account for both the diversity of this section of Detroit and its self-sufficiency as a place in which to live.

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TABLE I

Industrial Land Use in the Lyndon-Livernois District of Detroit

Location number on Fig. 2	Function of enterprise	Number of employees	Year established on present site
1	Generates electricity	4	1926
2	Repairs and replaces auto upholstery and tops	2	1946
3	Sells coal, coke, and fuel oil at retail	40	1923
4	Manufactures tools and dies	3	1945
5	Sells bricks and masonry supplies at wholesale and retail	4	1940
6	Manufactures store fixtures	30	1937
7	Manufactures high-pressure hydraulic equipment	8	1948
8	Sells coal, coke, and fuel oil at retail	6	1947
9	Sells oil, kerosene, and gasoline at wholesale and retail	4	1945
10	Sells firebrick and high-temperature cement at retail	4	1946
11	Sells refrigeration and air-conditioning equipment at wholesale	24	1948
12	Maintains roads, streets, culverts, and sewers	65	1925
13	Sells lumber and millwork at wholesale and retail	165	1927
14	Serves as warehouse of company on Lyndon St. (see No. 100)	5	1942
15	Repairs automobiles and trucks	2	1947
16	Sells plumbing and heating supplies at wholesale and retail	10	1948
17	Manufactures special tools	17	1945
18	Acts as building contractor	9	1948
19	Sells heating controls at wholesale and retail	3	1948
20	Makes blueprints and photostats	4	1947
21	Does job printing	3	1948
22	Acts as building contractor	15	1947
23	Acts as plumbing and heating contractor	6	1947
24	Acts as building contractor	8	1948
25	Sells lumber at wholesale and manufactures wooden boxes	80	1947
26	Sells building materials at retail	5	1930
27	Sells face brick at retail	4	1944
28	Sells furnaces and parts at wholesale	4	1950
29	Manufactures mattresses and box springs	30	1949
30	(not now in operation)	...	....
31	Builds new parks for the City of Detroit	75	1945
32	Manufactures peanut butter and roasted and salted peanuts	35	1947
33	Provides warehouse for Wrigley's supermarket stores	14	1939
34	Provides warehouse for tool steels and high-speed steels	28	1947
35	Provides steel warehouse and sells steel	40	1945
36	Sells RCA-Victor products at wholesale	80	1948
37	Sells coal and fuel oil at wholesale and retail	17	1916
38	Manufactures automotive parts	120	1949
39	Rebuilds and sells used machinery	7	1947
40	Reconditions and sells wooden barrels and steel drums	40	1948
41	Sells steel	7	1941
42	Sells groceries at wholesale	8	1947
43	Manufactures cinder blocks	12	1927
44	Sells plumbing and heating equipment at wholesale	9	1946
45	Sells tobacco and groceries at wholesale	10	1945
46	Manufactures bolts and rivets	40	1943
47	Manufactures steel stampings	17	1944
48	Does machine shop work	15	1945
49	Manufactures dies	5	1940
50	Manufactures concrete blocks and retails window frames	93	1934
51	Sells lumber at retail and wholesale	20	1938
52	Manufactures tools and dies	7	1945
53	Manufactures calking compound and paint	26	1938
54	Manufactures screw machine parts	10	1942
55	Acts as building contractor	5	1940
56	Manufactures lead pipe	10	1941
57	Manufactures screw machine parts	17	1941
58	Manufactures steel, brass, and aluminum stampings	200	1930
59	Manufactures pressed steel stampings	125	1940
60	Manufactures special machine parts	105	1936
61	Manufactures special machinery of all types	25	1945
62	Does chrome plating	5	1946
63	Manufactures structural steel forms	9	1946
64	Manufactures broaches and broach fixtures	30	1945
65	Manufactures paint thinner, food colors, flavors, and syrups	5	1946
66	Acts as roofing contractor	8	1947
67	Manufactures metal upholstery clips	15	1920
68	Manufactures aluminum market carts and aluminum racks	34	1947
69	Sells lumber at wholesale and retail and manufactures boxes	17	1945
70	Operates television and FM broadcasting station	3	1947
71	Manufactures marking tools and dies	25	1947
72	Manufactures sheet-metal furnace parts	20	1943
73	Sells groceries at wholesale	5	1949
74	Manufactures venetian blinds	35	1947
75	Manufactures diamond tools	9	1946
76	Manufactures paints and varnishes	16	1941
77	Manufactures steel and aluminum stampings	35	1950
78	Does research in corrosion prevention	2	1946
79	Does job painting largely for Ford and Chrysler	8	1946
80	Manufactures awnings and tents	20	1946
81	Manufactures sheet-metal furnace parts	40	1947
82	Manufactures machine parts	50	1945
83	Manufactures autotruck tow wreckers	40	1945
84	Manufactures tools, jigs, fixtures, and gauges	20	1941
85	Processes aluminum to make it corrosion proof	18	1945
86	Processes and sells milk, cream, and cottage cheese	600	1947
87	Manufactures paint rollers	15	1942
88	Manufactures window and door frames	19	1936
89	Fabricates sheet-metal parts	35	1940
90	Manufactures machine parts	40	1941
91	Does general grinding work	12	1939
92	Manufactures automotive replacement molding parts	120	1946
93	Sells welding supplies at wholesale and retail	11	1946
94	Fabricates sheet-metal parts	3	1945
95	Manufactures sheet-metal furnace parts	12	1946
96	Manufactures tools and dies	5	1946
97	Sells garage equipment at wholesale	10	1947
98	Manufactures aluminum window and door frames	21	1947
99	Sells metal shears and presses at wholesale	5	1946
100	Manufactures ice cream	30	1942
101	Repairs and sells electrical motors	6	1938
102	Fabricates sheet-metal parts	40	1940
103	Manufactures iron staircases	10	1945
104	Manufactures industrial fabrics and shop aprons	10	1948
105	Sells plywood at wholesale	40	1949
106	Does general and industrial printing ("Wards Automobile Topics")	16	1946
107	Acts as flooring subcontractor	40	1946
108	Sells coal at retail	20	1920
109	Manufactures concrete sewer pipe	55	1930
110	Sells masonry and gypsum materials at retail	8	1930
111	Manufactures tools	30	1943
112	Manufactures motorcycle accessories	20	1950
113	Does centerless grinding work	5	1948
114	Acts as plumbing, heating, and ventilating contractor	8	1942
115	Manufactures electrical equipment	13	1938
116	Bakes bread and rolls	185	1938
117	Manufactures cardboard parts for automobile bodies	120	1946
118	Manufactures testing fixtures	26	1949
119	Manufactures automobile reconditioning materials	2	1949
120	Manufactures gray-iron and semisteel castings	103	1923
121	Incinerates garbage	53	1938
122	Repairs automobiles	3	1945
123	Manufactures industrial hones	250	1948

FIG. 1. Very superior single house (A-1 type)

FIG. 2. Neighborhood composed of above-average single houses (B-1 type)

FIG. 1. Neighborhood composed of average single houses (C-1 type)

FIG. 2. Below-average single house (D-1 type)

GEOGRAPHIC INFLUENCES ON MICHIGAN'S RESORTS

CLARE A. GUNN

GENERAL CONSIDERATIONS

THE influence of Michigan's geography has much to do with the success of its resorts. Hitherto it has been believed that a lake well stocked with fish was all that was needed. While this is an important asset for summer patronage, research has disclosed other factors particularly necessary for an extended season of operation.

Michigan's wildlife, forests, varied topography and soils, and unusual climate are as important as its surface-water resources. Inspection of the registers of many resorts and interviews with hundreds of operators over the last five years have revealed these influences on seasonal patronage. Since investments in facilities are today very nearly the same for year-round business as for summer operation, much greater returns are obtained from a longer business season.

The abundance of wildlife, especially game, brings fall patronage to many resorts. The popularity of good deer, grouse, rabbit, and other game hunting creates demands for facilities to feed and house hunters. Over 400,000 persons pursue this sport in Michigan each season.

Forest cover provides habitat for wildlife and also scenic appeal for tourists. While great numbers of vacationists may not be seeking forest recreation alone, the vegetative cover is important because of the many pleasures associated with it. As the second-growth forests mature in the future, this influence will take on greater significance. Approximately one fourth of the state is in public forests, and a large part of another fourth, in nonagricultural land, is in private forests.

For the tourists coming to Michigan, land that is rolling, undulating, or mountainous has much greater lure than monotonous plains. The glacial age produced many variations in the topography and soils of Michigan that determined much of the course of its history. It is common knowledge that agriculture and forests are highly affected by such characteristics, and it would be of extreme value to map these physical influences on the location of resorts. Certainly the vistas from high places, encompassing farm lands, forests, lakes, and streams, are assets to any resort region.

Climatic influences on the resort business are great. The prevailing westerly winds and the state's position with reference to the Great Lakes tend to produce far cooler summers and also to increase the snowfall in winter. The rainfall, which is fairly uniform throughout the state, is suitable for good growth of vegetative cover. The many inland lakes, favorite places of recreation, have a cooling influence on the air immediately around them.

Surface water, well distributed over the state, is the greatest geographic influence. There are 11,037 inland lakes of various sizes and beach conditions. Only two counties have no lakes, and seven have more than 300 each. A great deal of the 2,300 miles of Great Lakes shoreline has fine sandy beaches of great recreational utility, and the streams, which have a total length of 36,000 miles, are used extensively for fishing and canoeing.

It is essential, then, for a resort operator to select a site within a region having the greatest possible number of recreational assets. For example, in April an ideal resort location would attract vacationists to fish for trout and, later, for smelt and perch. In May there would come pike fishermen and persons interested in wild-flowers. June patrons would be honeymooners and those who like beautiful scenery. In July and August lakes, forests, and scenic attractions would provide vacations for entire families. September and October would draw those who love fall colors and also grouse hunting. They would be followed by deer hunters—first with bow and arrow, then with rifle. With the proper terrain and snowfall winter sports would be in demand from November on. If favored with an ideal winter, such a business might continue well into the spring. This hypothetically ideal location is not so unattainable as one might suppose. In fact, several resorts already approach it rather closely.

An abundance of natural resources is necessary, but some economic and man-made influences may either augment or detract from them. For example, the average resort is more successful if it is relatively easy to reach. The majority of tourists and vacationists dislike traveling long distances, especially over poor roads. There are exceptions, however, for some people take long trips to reach resorts with outstanding resources and unusually capable managers.

In many businesses severe competition is detrimental to the success of all engaged in them. This may also be true of the resort business in the future. Today, however, each resort has a unique character about it that draws a kind of trade slightly different from that of its neighbor. The most competitive element is the number of comforts and conveniences offered. An increase in them upgrades the entire resort industry.

Resorts thrive better in suitable environments. Cleared agricultural land or industrial developments nearby do not offer the setting necessary to a resort operation. The absence or depreciation of natural resources is certainly detrimental to success. Most of the alarming tendencies are being held in check by private individuals, organizations, or public agencies. The lessening of stream and lake pollution, the soil-conservation programs, the reforestation activities, and the improvement of game and fish habitat—all are fostering the recreational use of many lands unsuited to other activities.

A COMPARISON OF TWO RESORTS

A comparison of two resort situations will aid in understanding the importance of geographic influences.[1] Typical of many extensive resorts in Michigan is Resort 1 (Pl. I), located on the west side of Lake Gogebic in the western part of the Upper Peninsula. On an area of approximately eight acres, it includes a small hotel, several rooms in a row-type building, and some individual housekeeping cottages. Resort 2 (Pl. II), occupying little more than three acres, is typical of the more intensive developments on both inland lakes and the Great Lakes. It is on the Lake Huron shore and Highway U.S. 23, just south of Tawas City. The facilities include a row-type cottage building with six units and a group of duplex cottages. The geographic influences on both resorts are compared in Table I. Though such ratings are somewhat arbitrary, they reflect the differences that geography imposes upon resort situations.

For Resort 1 the waters of Lake Gogebic provide good swimming, boating, and fishing. The cool water tends to restrict swimming to the warmer periods of summer. A great attraction is fall hunting, principally for grouse and deer. In Gogebic County in 1950 52 per cent of the deer hunters were successful, compared to about 32 per cent successful in the state as a whole. Climatic conditions are quite favorable for a cool summer; the average July temperature is 66° F. The land relief creates tourist interest, being in the center of the Gogebic Mountain range, a region of considerable recreational significance. The vegetative cover is an added attraction, since this is in an area of northern hardwoods.

TABLE I

GEOGRAPHIC INFLUENCES ON TWO SUCCESSFUL RESORTS

The importance of the various influences in bringing patronage is indicated by the letters in Columns 2 and 3: A = great; B = high; C = medium; D = low.

Geographic influences	Resort 1	Resort 2
Physical:		
Surface water	B	A
Wildlife	A	D
Climate	B	B
Topography and soils	B	D
Vegetative cover	B	D
Economic and man-made:		
Market	B	A
Ease of access	C	A
Lack of competition	A	D
Historical interest	B	D
Land-use patterns	A	C
Appropriate setting	A	C

Resort 1 is some distance away from large populations. Many people are satisfied to travel shorter distances to spend a summer vacation. The access is good; in fact, it is better than that to the Keweenaw Peninsula. Yet the resort is not located on a direct route from metropolitan centers of lower Michigan, Ohio, or Indiana. It is more accessible to the people of Wisconsin and Illinois, but the northern lakes of Wisconsin may get this trade.

Man-made factors augment the natural-resources because: (1) there is some historical interest; (2) the land-development patterns are extensive and favorable to this type of enterprise; and (3) the recreational lure of Lake Gogebic has not been reduced appreciably, but may be in the future as it continues to be developed.

For Resort 2 the importance of surface water is given a rating "great." Tawas Point, which helps to protect this shore from severe wave action, makes the beach and water ideal for swimming and boating. Good fishing is obtained with craft larger than rowboats or by using the large boat dock at East Tawas State Park. The millions of smelt that run up several streams to spawn make this an important smelt-dipping region. The Au Sable River, nationally famed for its trout, lies just fifteen miles north of this resort. Winter ice fishing has proved so popular that a portion of Tawas Bay has been dubbed "Perchville." Although wildlife, variable land relief, and ample vegetative cover are assets available only a few miles away, they did not appear to be significant in bringing patronage to this particular resort.

The resort shows the influence of being on an excellent highway and near a large market of vacationists. The great metropolitan center of Detroit is only 164 miles away, and many other large cities are within a shorter radius. It is also a direct vacation objective of people from Ohio. This great demand for accommodations has increased competition among resorts in the area, but as yet the number and the variety of types of facilities have not exceeded the demand. Although there is much of historical interest here, it has not been developed to the point of attracting many tourists. The land-development pattern is intensive and of little appeal to the "wilderness" vacationist. The general setting of this resort is agreeable except that it does lack interesting topography, vegetative cover, and protection from many depreciating influences.

CONCLUSIONS

It may be concluded that geographic influences have a tremendous effect upon resorts and that there must be a preponderance of favorable ones if they are to succeed. The two examples illustrate this fact and also show that each resort may have a different combination of such influences. It would be of considerable value to the future well-being of the resort industry if prospective operators would rate their chances of success according to the items listed in Table I. If this should be done, a reasonable estimate of the character and the expected seasons of patronage could be made. Such an estimate would provide a far more logical foundation for the planning of facilities than the guesswork used at the present time. Present businesses would also benefit from such an analysis of their assets because better adjustments to them could then be made to foster future trade and improve land use.

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[1] These data are from “A Study of Ten Michigan Resorts,” an unpublished special problem report made by the author in 1950. It is concerned with the correlation of resort patronage and the organization of facilities. The resorts were selected at random and represented all regions of the state.

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GUNN PLATE I

FIG. 1

FIG. 2

Resort 1, a typical Michigan resort having extensive land development. The photographs of the resort hotel (Fig. 1) and the cottage colony (Fig. 2) show the geographic assets of surface water and forest cover. Other advantages of the region, such as wildlife, climate, topography, and lack of competition, help make the business successful.

GUNN PLATE II

FIG. 1

FIG. 2

Resort 2, an intensive land development typical of areas in high demand. The entire resort as seen from the lake (Fig. 1) and a close view of the cottages (Fig. 2) illustrate the dominant appeal of the fine beach. Other geographic influences important to success are easy access from a fine highway and proximity to a large market of vacationists

WESTWARD URBAN GROWTH AS RELATED TO DECENTRALIZATION AND LAND USE IN THE DETROIT-PLYMOUTH CORRIDOR

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METROPOLITAN districts expand by developing belts of business, industry, and habitation along the major lines of transportation leading from the central city toward the suburban, urblet, and satellite settlements in the surrounding umland. Continuous and interrupted tributary strips growing outward from such main corridors tend to widen and occasionally unite them, thus permitting a more widespread and, eventually, a saturated margin of occupance when viewed in terms of the cultural and natural relationships. Particularly active at this time is the development of land paralleling Plymouth Road and the Chesapeake and Ohio Railroad (formerly the Pere Marquette) and extending due west from the Detroit city limits to Plymouth, Michigan, which is the southern one third of Region 8 as designated by the Metropolitan Planning Commission (Fig. 1).[1] A detailed chorographical study of twenty-nine square miles of territory between Schoolcraft and Joy roads was made in the summer of 1950.[2] Some significant trends concerning the urbanizing process are presented in the resulting geographical analysis of this survey.

In order to understand fully the decentralizing movement in the Detroit-Plymouth corridor we deem it necessary to consider some population changes that are taking place within the central city and in the outside margin as revealed by a study of the latest census reports published. There are 621,038 more persons in the total urban area than there were ten years ago. This gain was divided almost equally by Detroit, the remainder of Wayne County, and Oakland and Macomb counties together. The Detroit increase, however, represents only a 13 per cent average gain. The area east of Conner, north of Six Mile Road and west of Livernois, accounted for nearly all the growth (Fig. 2). The population of Highland Park, Hamtramck, and the area inside Grand Boulevard actually decreased, together with that part to the west of Woodward Avenue, by more than 10 per cent. The demolishing of dwelling units necessitated by the building of expressways, the condemning of residential properties for expanding Wayne University, and the sale of homes for office or small-business use were important factors in the decline. There is additional evidence that some prosperous families are moving away from congested communities where such accompanying undesirable elements as smoke, noise, excessive traffic, and neighbors with a lower social status make life unpleasant and where there is greater risk from the criminal elements.

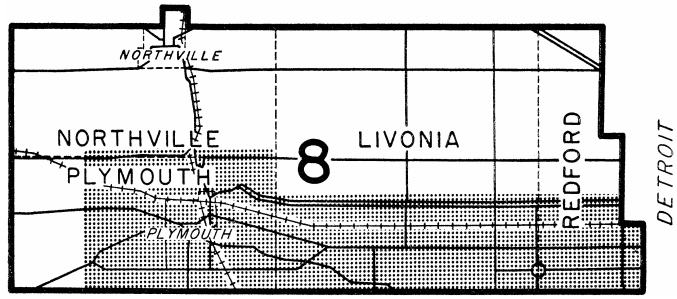


FIG. 1. The Detroit-Plymouth corridor, which occupies the southern one third of Region 8 as outlined by the Metropolitan Planning Commission

Nearly all outlying parts grew at a much faster rate, for the rest of Wayne County shows an increase of 45 per cent; Oakland, 55 per cent; and Macomb, 71 per cent. The suburban, urblet, and satellite settlements as well as the innermost townships that are crossed by heavy traffic arteries or situated in the more accessible lake sector of the moraines made varied gains up to a maximum percentage of 952.3 (Table I).

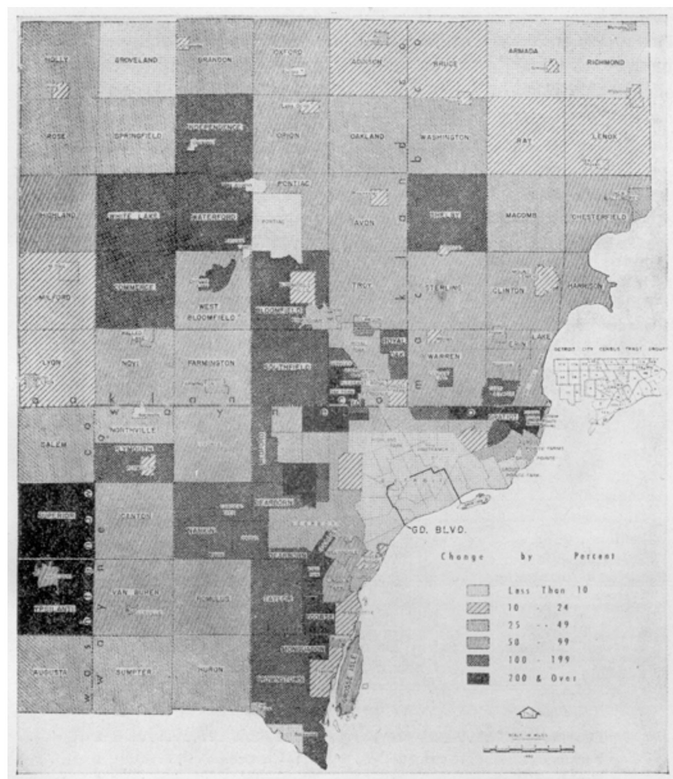


FIG. 2. Percentage growth of population in the Detroit region for the period 1940-50. The number of inhabitants inside Grand Boulevard, Highland Park, and Hamtramck declined (courtesy of the Detroit Metropolitan Area Regional Planning Commission)

It is an established fact that this outward movement of the inhabitants is accompanied by a decentralizing of industry and business. According to the Detroit Metropolitan Area Regional Planning Commission, 143 manufacturing plants moved out of the central city during the period 1937 to 1949 to relocate in outside communities (Table II).[3] The number of manufacturing plants in Detroit increased only 47 per cent from 1939 to

1947, whereas those in the rest of the metropolitan district grew 222 per cent.

TABLE I

PERCENTAGE OF POPULATION CHANGE FOR MUNICIPALITIES AND TOWNSHIPS, 1940–50

Municipalities	*Per cent*	*Townships*	*Per cent*
Oak Park	348.5	Gratiot	952.3
Grosse Pointe Woods	271.0	Ecorse	440.8
Allen Park	252.5	Monguagon	277.4
Huntington Woods	188.5	Royal Oak	198.0
Berkley	179.6	Redford	174.4
East Detroit	149.0	White Lake	154.6
Center Line	139.0	Commerce	148.6
Inkster	136.9	Dearborn	127.8
Orchard Lake	131.5	Brownstown	121.4
Wayne	121.9	Southfield	116.9
Garden City	119.4	Bloomfield	115.8
Livonia	99.5	Plymouth	113.8
Melvindale	98.9	Taylor	110.0
Rockwood	−14.4	Nankin	106.9
Lake Angelus	−13.7	Armada	−14.5
All others	1.5 to 92.1	All others	3.5 to 7.85
Outlying Industrial Centers			
Pontiac	9.7	Wyandotte	19.8
Mt. Clemens	16.9	Plymouth	24.0
Trenton	17.6	Ferndale	31.7
River Rouge	19.7	Ecorse	32.2

TABLE II

NUMBER OF PLANTS THAT RELOCATED IN THE DETROIT METROPOLITAN AREA, 1937–49

Place	*No.*	*Place*	*No.*
Dearborn	25	Hazel Park	4
Ferndale	25	Mt. Clemens	4
Highland Park	13	Plymouth	4
Oak Park	8	Roseville	4
East Detroit	7	Royal Oak	4
Center Line	6	Van Dyke	3
Redford	5	Twenty-one other places	31

Within the last decade the marginal area has shown a rapid transition toward urban activity along the well-established transportation routes (Fig. 3). New residential, industrial, and commercial development illustrates the foregoing movement. Though certain portions of the corridor were already occupied by 1940, the major growth came in a postwar boom and is enhanced at present by the Korean and other world disturbances. Land essentially rural in nature has given way to the pressure of an expanding populace, business, and industry. People have sought residential sites where urban facilities are within reach, but where the peace and freedom of rural life are still near at hand. Business and manufacturing concerns have decentralized to gain greater advantages and to lower costs to meet increased competition.

One of the outstanding features of the inner division (nine square miles) of the Detroit-Plymouth corridor is the great amount of heavy industrial building that has taken place within the last three years. The Ford Motor Company Parts Depot at Middle Belt Road, along with the Lincoln-Mercury Parts Depot at Telegraph Road, are indicative of the trend. Both were completed in 1950, and they now employ 4,500 men in storing automobile parts for shipment to dealers or assembly plants throughout the world (Fig. 4). This decentralization policy of the company represents a departure from its previous procedure, when numerous small plants were operated along larger rivers in rural sections, but are now idle or utilized by other manufacturers.

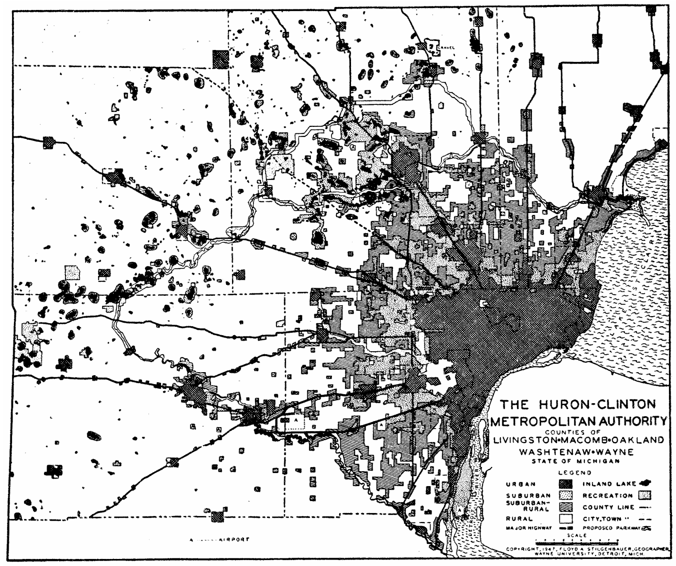


FIG. 3. Primary corridors developing along the major transportation routes

The General Motors Corporation constructed the Diesel Division shops in 1937 at the city limits, where 3,000 people make engines for highway, rail, and marine transport needs in the United States and the world. In 1949 the company built on Plymouth Road the Detroit Transmission Division Hydra-Matic Plant, which employs 2,600 persons to produce gear parts assembled at the main factory on Riopelle Street for all its motorcars. The Standard Tube Company, erected in 1948, engages 300 workers to fabricate metal tubing. These concerns have ample rail and highway contacts with the mother firm, the hinterland market, and the source of raw material.

Conjunctively associated with the large factories are forty-eight light industries, which employ fifteen men (or fewer) in making tools or supplies. These small jobbing shops, largely built since 1945, are widely distributed but are more numerous nearer to Detroit. Concentrations occur on Woodbine Street, one block west of Telegraph Road, where twenty-nine are situated, and in the vicinity of Beech Road, where there are seven. New satellites will be added with the increase of heavy manufacturing and the shift to war contracts. Some of these concerns supply the markets in both Detroit and Plymouth as well as factories in the umland.

These various industries are becoming established along the corridor for locational reasons since fairly level, well-drained land with a firm subsoil is everywhere available. Advantages of a central position within a large metropolis are not too significant, because increased congestion may produce added expenses in transporting commodities. As the locational advantages of many manufacturing areas within Detroit decline, the outside offers more beneficial sites for concerns. Better transportation facilities here permit the rapid and economical distribution of commodities.

Other factors instrumental in causing manufacturers to move into the outer margin of the urban region are: the opportunity to buy low-priced land having a reasonable tax rate, so that they can afford to erect large single-story plants in the interest of efficiency; ample parking facilities to accommodate commuting workers; extensive labor-saving machinery to take advantage of semiskilled and unskilled labor; planned zoning of adjacent reserve land to allow for future expansion; and better working conditions to minimize strikes.

TABLE III

ACREAGES OF EXISTING LAND-USE PATTERNS IN THE DETROIT-PLYMOUTH CORRIDOR

Category	Inner district acreage	Middle district acreage	City of Plymouth	Outer District acreage		
				Sheldon Road		Total
				W	E	
Total area	5760	5120	1254	5520	4592	10112
Forest and bush	1210	1683	23	788	181	969
Idle	992	1109	35	1035	333	1368
General agriculture	294	169		2513	540	3053
Intensive agriculture	165	673	29	1060	1018	2078
Residential	1891	947	753	...	1096	1096
Industrial	434	14	79	...	277	277
Recreation, park, cemetery	276	293	131	...	570	570
Transportation, commercial, others	498	232	204	124	577	701

One of the concerns established in this peripheral zone as early as 1980 is the Koenig Coal and Cement Company on Plymouth Road. It markets products in the vicinity and in outlying communities of western Wayne County. The owners' correct anticipation of early development along this corridor and its tributaries has paid them rich dividends on their original investment. This firm and four smaller ones employ 244 persons.

Additional forms of land use in the inner district are significant. Nearly 33 per cent of the 5,760 acres comprising this district have become established residential property (Table III). The largest home-development project, situated astride Plymouth Road, extends from Burns Air Field westward for one and one-half miles. From the remains of decaying signposts and the presence of scattered older dwellings of a medium type it appears that some occupance was started almost four decades ago during the lot boom in the early part of World War I. The great recession of the early thirties, however, stopped further construction. As activity was renewed, it was halted by the shortage of materials during World War II. When the veterans returned, a great demand for housing was again present, but increased costs of consumer goods made the smaller house more marketable. Without adequate zoning at this time in the umland contractors shifted to the lower-cost cottage type of building, which today predominates in this corridor. Some previously planned residential areas were replatted to make smaller lots since the dwarfed structure requires less land. More communities are growing in convenient locations along highways. At the close of 1950 a total of 3,609 dwellings were occupied by 12,621 people, and new building has occurred throughout the area.

The subdivision along Woodbine Street has shifted to industry, and here one home is completely surrounded by light manufacturing plants. Such changes in occupance create an undesirable locality for residential settlement because of increased traffic, noise, dirt, and smoke. The Detroit Metropolitan Area Regional Planning Commission is eliminating these incongruities in land settlement by organizing zoning development areas, in which the interests of all groups are considered for the best geographic and economic guidance during future growth (Fig. 5). Their proposed layout for the various major activities in the corridor shows the proper disposal for the unused land designated on the survey map (Fig. 6).

Agriculture is rapidly declining, with only about 8 per cent of the land remaining in this category. So intense is the demand for residential sites that many farms are being subdivided by the owners or being sold to real-estate and building interests. With the presence of an active market tilling the land is still profitable, but many of the rural children have taken more remunerative industrial jobs. This leaves their parents to choose between inefficiently operating the farm or selling it in order to secure funds to support themselves in an adequate manner.

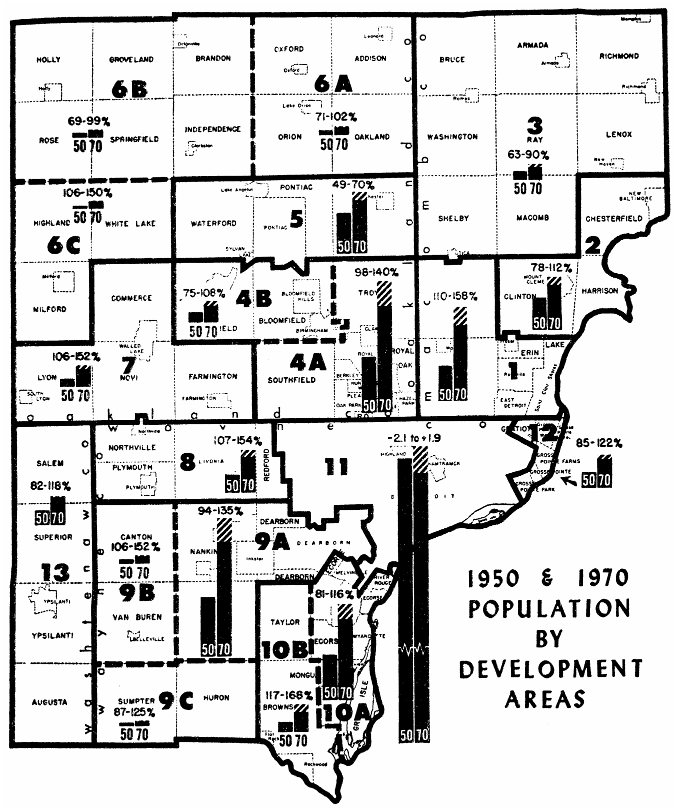


FIG. 5. Development areas comparing the population of 1950 with the scientifically calculated population of 1970 (courtesy of the Detroit Metropolitan Area Regional Planning Commission)

Commercial development, except at the intersection of major highways, was slow in materializing. With the increased employment offered by industries there comes the building of more homes, resulting in a rapid expansion of business. A total of 137 commercial establishments are located in the inner part of the corridor. In the densest residential settlements many chain-produce concerns have built markets. These services are very noticeable along Plymouth Road, which was the first to show such activity.

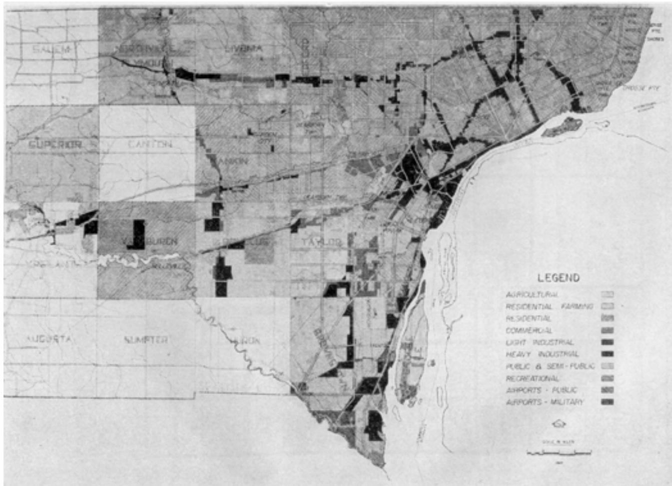


FIG. 6. Generalized zoning map of Wayne and eastern Washtenaw counties. Note the large amount of land along corridors zoned for industry (courtesy of the Detroit Metropolitan Area Regional Planning Commission)

About 4.8 per cent of the land serves in a recreational capacity. In 1950 the Michigan Racing Association constructed an outstanding park for horse racing at Middle Belt and Schoolcraft roads. Built at a cost of $4,500,000, it attracts almost 1,200,000 people during a sixty-day program, and $25,800,000 is registered through tote machines. This is indeed an extraordinary business. The two-way Schoolcraft Road is ideal for taking care of the sporadic traffic. Commercial activity has been stimulated more than home building, and parking lots do a brisk business throughout the racing season.

The middle district is potentially one for considerable manufacturing development, according to the planning analysts, though at present the area is essentially devoted to agricultural, horticultural, residential, and recreational occupance.[4] Only fourteen small plants employing sixty-five persons are scattered over these eight square miles, and most are related to the building trade and vehicle manufacture (Fig. 7). The industries utilize less than three tenths of one per cent of the 5,120 acres.

Extensive tracts of unused land along the Chesapeake and Ohio Railroad in the northern one third are being held as potential industrial property, with about 1,178 acres available for light and heavy manufacturing. Excellent transportation facilities also exist. Rosedale Gardens in the extreme east, with 685 homes occupied by 2,397 individuals; the Stark Road subdivisions, located in the east-central portion, with 363 houses inhabited by 1,260 people; and the Newburgh communities adjacent to the cutoff road to Ann Arbor, with 121 residences having 424 occupants—these are three residential centers comprising large vacant areas in their vicinity for future growth. The 235 remaining dwellings scattered along the highways account for the remainder of a total population of 4,904, which averages 614 persons per square mile. Land lying fallow or in second-growth forest indicates a lesser urban influence.

The entrenched Middle Rouge valley has been improved and added to Outer Rouge Park, which now extends from Northville southward to Plymouth and thence in a southeasterly direction to Farmington and Joy roads. Two artificial lakes at the Nankin Mills and Newburgh power sites, together with other recreational facilities, are attracting homeseekers into the adjacent area. Land in the southern two thirds of the district will become predominantly residential in character, with Plymouth Road serving as one artery of commercial activity. Airport facilities are available just west of Newburgh.

As the Middle Rouge River cut a channel through the moraines during the Pleistocene period of glaciation large deltas consisting of sand, gravel, and silt wrere laid down at the edge of retreating ice-pounded lakes to the eastward, and these deposits extend in a somewhat fan-shaped form astride the present valley. The gentle eastward slope toward the channels of the Rouge Basin provides ample drainage. These loose, loamy soils are excellent for vegetables, flowers, fruits, and greenhouse plants, which are grown on a large scale to supply the urban markets and a steady roadside demand in summer and fall for fresh produce. This activity is also attractive to the prospective home builder, since it adds beauty and variety to the landscape. Property values in the district have been slowly rising, and will continue to advance because of the favorable environment for metropolitan urban development. Skilled planning and the continued cooperation of owners will guarantee a satisfactory permanent long-range service from the land resources.

The geography of the western end of the corridor will be considered from several distinct divisional aspects. They are: (1) the environmental influences which led to the early founding and growth of Plymouth on a favorable site; (2) the subsequent growth into a prosperous industrial community and its dynamic relationship to progress in the township; (3) the potent force exerted by this urblet in drawing an industrial corridor outward from Detroit; (4) the Sheldon Road frontier of the expanding eastern manufacturing zone outside the corporate limits on the lacustrine plain; and (5) the contrasting rural landscape in the adjacent morainic upland toward the periphery of Wayne County (Fig. 8).

The general physical characteristics of Plymouth Township differ in one important respect from those of Livonia and Redford.[5] This section includes not only the gently east-sloping lacustrine plain, but also some of the hummocky Inner Defiance morainal upland (Fig. 9). Because of the land surface, drainage, and soil differences between the latter two areas cultural adaptations and land utilization are in marked contrast, which is becoming more evident here as metropolitan Detroit expands outward along the improved highways immediately paralleling the Chesapeake and Ohio's Grand Rapids Division.

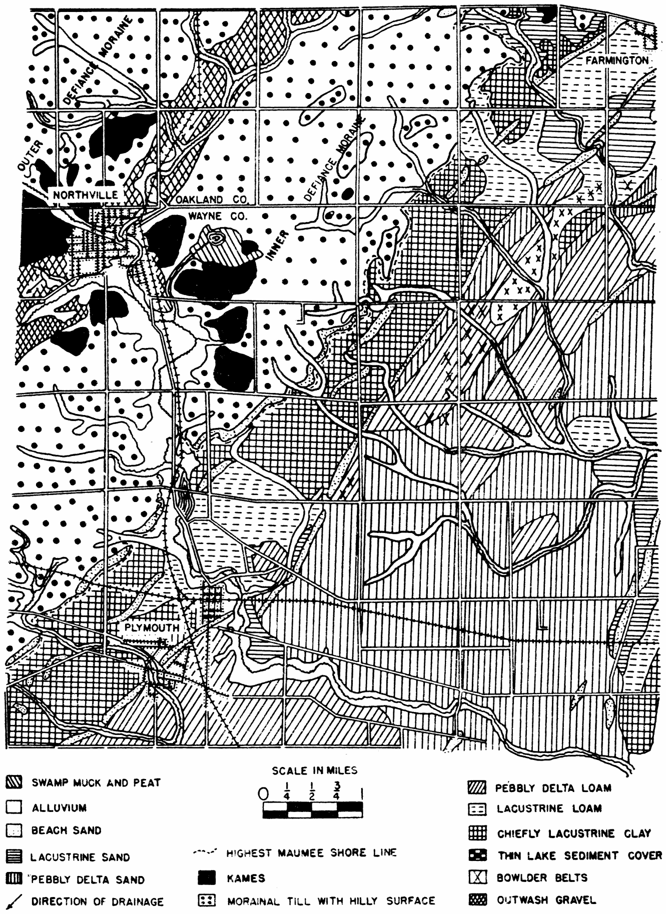


FIG. 9. The surface formations of the Plymouth-Northville area (after Frank Leverett, Frank B. Taylor, and Donald C. MacLachlan)

When Plymouth Township was opened for settlement in 1824 the early settlers moving westward from Detroit utilized preexisting Indian routes. A well-established one was the Ann Arbor Trail from Detroit. This followed the Middle Rouge Valley and then led southwest through the Inner Defiance moraine, where it joined another which followed the course of the Huron River. The pioneers who moved inland along the former route were essentially farmers, and rather than continue into the hilly upland having swampy vales, they tended to settle and clear the densely forested adjacent terrain to the east, where the level, better-drained soils offered greater agricultural advantages after removal of the timber.

The availability and extensive use of the Ann Arbor Trail, which also provided a passage through the forested morainal landscape, was one of the primary reasons for the establishment of the city of Plymouth. As the number of rural inhabitants increased, the development of a village to supply the services and commodities needed by the farmers was a natural response. The selection of a site for this settlement near the Middle Rouge water gap shows a close adaptation to favorable surface features as well as to the preexisting Indian trails. The main street of Plymouth was laid out on a part of the Lake Whittlesey beach ridge, which provided the higher, better-drained ground necessary for transportation lines before concrete highways became a reality. The business core was built around a three-sided park area, which was at that time and still is today one of the foci of routes between Detroit, Ann Arbor, and other points. Main Street formed the northwest edge, the Ann Arbor Trail the southwest margin, and North Territorial Road, which was also an old Indian route, the northeast border of the triangle.

In 1837, when Plymouth was first recorded as a village, there were 300 inhabitants.[6] Settlement in the township must have been rapid to develop a supporting capacity for a village of this size in the thirteen years since the lands had been first opened to occupance. This rapid progress indicates the part which this community has played even in the pioneer days in attracting people inland from Detroit. In the succeeding years the favorable site, an improved transportation system, and a prosperous hinterland have combined to stimulate a migration of families and industries which changed this small hamlet into a city with 6,649 residents and made it the western anchor for an advancing metropolitan corridor.

Several factors have been of paramount importance at different times in the early period in increasing the settlement of both Plymouth village and township. The first attracting force was the potentially good farm land, which supported a dense stand of deciduous hardwood trees. As the pioneer landowners became more numerous, men were quick to take advantage of the consumer possibilities. By 1859 business ventures included six sawmills and a rake factory utilizing local timber; seven gristmills reflecting the extent of grain growing in the clearings; a hotel for the many newcomers seeking property; and eight retail stores to provide supplies for the inhabitants.

In 1871 the completion of railway lines between Plymouth, Detroit, Northville, Wayne, and Lansing introduced a new factor which gave added impetus to the cultural progress here. The railroads, just as the Indian trails before them had done, utilized the site of the village as a focal point because it offered easy access to the morainal upland to the north and west. The Pere Marquette Divisions, as they developed in the logging days, provided direct connections with key places in all major directions, and this service made possible the present phase of industrial manufacturing. As the timber supply was depleted and the sawmills declined in economic importance, it became necessary to develop businesses to replace them if a stagnating movement was to be avoided.

The outer district has undergone three major periods of industrialization. The first one, starting in 1880, lasted for three and one-half decades. Shortly thereafter the Plymouth Iron and Windmill Company was opened within the village, but in 1887, because of unusual local improvements on a French invention, the firm was reorganized under the name of the Daisy Manufacturing Company, which makes air rifles. The concern prospered because the small community afforded cheap land from a declining logging activity and a labor supply that had to be within walking distance when rapid transport was not yet abundantly available. The employment opportunity offered by this plant was one of the primary factors in the growth of this settlement up to 1915.

The second period, covering seventeen years, saw the population of Plymouth increase from about 2,500 to around 5,000 people. It is evident from statistics and personal interviews that much of the change in this interim took place during the boom years after World War I. The paving of highways, resulting in the increased use of motor vehicles for moving labor and goods, was the principal contributing factor. This improvement made feasible the building of small industrial jobbing shops employing fifty persons or more on land removed from rail lines.

Perhaps the most significant development of the small factory between 1915 and 1932 was the establishment of the Ford Motor Company's parts plants at suitable power sites along the Middle Rouge River at Phoenix, Wilcox, and Newburgh lakes (Fig. 8). After management and policy changes had caused the little shops to be sold to Wayne County, larger decentralizing activities, already pointed out, were executed in the inner district. Six other light industries, founded by local residents at this time, make dies, jigs, gauges, fixtures, and miscellaneous equipment for manufacturers in the Detroit region. They take advantage of the excellent transport facilities, cheaper land, lower taxes, and an available labor supply. With these important additions the village assumed the status of a city at a time when its population was increasing at a more rapid rate than that of the township.

During the period after 1932 a very marked change in the trend of development took place. The greater mobility which the people gained and the added advantages achieved through the decentralizing of manufacturing industries brought an impressive prosperity to the rural area as well as some growth within this municipality. In the decade just past the inhabitants of Plymouth Township increased to 4,853, which is a percentage gain of 113.8, whereas the city grew a modest 24 per cent. This movement will continue until the leveling off anticipated in 1970, when metropolitan Detroit will have 4,000,000 individuals, of whom approximately 1,568,000 will be gainfully employed (Figs. 5 and 10).[7]

To the east of the Plymouth city limits lies the chief industrial area in the outer district (Fig. 3). Owing to the crossing of two rail lines and the focus of paved highways nearby, the adjacent land provides an excellent opportunity for the development of factory sites. As a result, much of this part has been zoned as a manufacturing section. The plants already located here and their dates of establishment are: the Burroughs Adding Machine Co., 1937; the Evans Manufacturing Co., 1946; the Whitman Barnes Co., 1949; and the Barnes Gibson-Raymond Division of the Associated Spring Corp., 1951. These firms employ a total of 3,896 workers and produce office equipment, machine tools, and accessories for automobiles and airplanes.

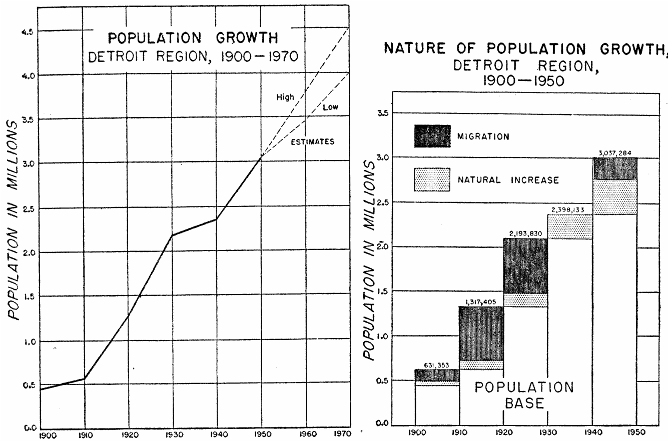


FIG. 10. Nature of the population growth for the Detroit region from 1900 to 1950 and the anticipated future trend to 1970 (courtesy of the Detroit Metropolitan Area Regional Planning Commission)

A minor industrial zone, where 382 people find employment, is located at the city limits of Plymouth between the Ann Arbor Trail and the Ann Arbor Road. The more important manufacturers here are the Wall Wire Products Co., established in 1939; the Pilgrim Steel Corp., 1941; the Willoughby Cold Storage Co., 1947; the Steel Plate Co., 1948; and the Monnier Engineering Co. and the Ann Arbor Construction Co., both founded in 1949. The Koch Sausage Co., started in 1939, is situated at a farm home farther east; it uses meats shipped by truck from the meat-packing houses in Chicago.

These rather recent concerns represent a very significant trend in corridor development throughout the Detroit umland, where more favorable environmental advantages tend to draw industry and habitation away from the main urban core. Factories locate here, also, because of cheaper and larger tracts of land, available labor, greater protection, and ready transportation by rail or truck at a reasonable cost. Expansion can occur only northward or eastward beyond Eckles Road into the central district since Middle Rouge Park, Riverview Cemetery, and residential subdivisions act as barriers.

General agriculture to the east of Sheldon Road is gradually declining. At present about 540 acres of land are used for diversified farming and over 1,000 acres are intensively devoted to gardening, horticulture, poultry raising, and some greenhouse cultivation of tomatoes. Much of the produce is shipped to Detroit by truck, but makeshift stands near the homes also dispose of vegetables, meat, eggs, and fruits, which give the grower an additional daily income. The future of agriculture is not secure because continued outward population pressure gives rise to a thriving real-estate business in home sites that results in inflated land values. Higher taxes, along with upkeep, influence many farmers to dispose of their property to avoid operating at reduced profits.

Residential occupance, which is concentrated in certain parts, covers about 1,100 acres of the district to the east of Sheldon Road. There are 826 predominantly small homes containing about 2,890 individuals. Adjustments are being made rapidly as new residents arrive to take advantage of better site selection; to overcome the housing shortage, and to avoid building codes, high costs of construction, zoning restrictions, and traffic. The possibility of cultivating gardens and keeping animals without interference is also an influential factor in this influx of people.

Racial prejudice and the uncertainty of future property values caused by depreciation of homes in the mixed racial centers of Detroit as compared with the metropolitan periphery have influenced some families to settle near Plymouth. Many homeseekers of similar nationality or religious belief have built in scattered neighborhoods of their choice. The Veterans Housing Loan, too, has contributed to the increased demand for dwellings.

Parks and related uses account for 570 acres of land. The Middle Rouge Parkway is one of the most attractive playgrounds in this section of Wayne County. This development is the result of the efforts of the authorities to expand such facilities on the accepted standard of one acre for recreation to each hundred persons. An excellent paved road, the Edward N. Hines Boulevard, has been built through the valley, and trails for horseback riding are available. Other activities, such as canoeing, baseball, football, tobogganing, and picnicking, have been provided, and they utilize the most convenient features of the landscape.

In two or three decades many of the diversified and intensive agricultural activities will cease. Industry will advance gradually from this area into the adjacent central district because of the lack of suitable vacant sites and the established layout of the surrounding residential communities. Much of the 333 acres of property still available probably will be utilized primarily for low-cost housing.

A brief analysis of the use pattern of the municipal land, covering 1,254 acres, will suffice to point out how Plymouth is slowly adjusting itself to the corridor's westward progress. Ten per cent of the urban land is occupied by railroad property, which is comprised of junction facilities and a roundhouse for two busy divisions of the Chesapeake and Ohio Railroad. With a thriving commercial core spread out along the sides of a triangular park at the foci of major highways, a framework is provided for the settlement forms (Fig. 3). The sharp upward trend of population has made enlarged commercial development profitable. Since 1945 eight new independent and chain stores and four gas stations have been built in the business section.

First-class residences in the central and western parts of the city were built during the middle period, and their owners are generally employed in offices. Moderate-sized houses of similar age, which form the second group, shelter people who work in local factories. Many occupants from the small cottages of the third category supply laborers for the well-established industries. There is still considerable idle land available for homesites.

Six new factories have added to the industrial structure and the wealth of the community in the years since 1932. They are as follows: Plymouth Gauge and Tool Company, 1941; Plymouth Production Company, 1944; Corrugated Box Factory, 1947; Bathey Manufacturing Company, 1948; Superior Furnace and Manufacturing Company, 1949; and the Freeze Rite Company, 1950. These plants, together with the ones established earlier, give employment to about 1,100 persons. Among the chief products are machine parts, tools, steel-storage bins, upholstery materials, containers, furnaces, army-tank parts, wood products, freezers, air rifles, and jobbing specialities.

Both rail and trucking facilities are employed to obtain needed supplies and to send finished goods to market, which is largely in Detroit. A few items are sent by rail to scattered points in the United States or are shipped abroad. Industrial initiative, an ample labor supply, excellent parcels of low-priced level land with moderate taxation, a quiet community with a rural atmosphere, nearness to the central city, as well as to Toledo and Chicago, and the need for decentralizing have all contributed to this growth. Such forces will continue to attract new activities and bring more factories, and, in turn, will draw a considerable number of people to augment the labor supply. A spacious tract just north of the city is occupied by St. John's Seminary for the Catholic dioceses of Michigan and Wisconsin, which was built in 1949.

The frontier of outward industrial growth in the corridor is Sheldon Road, which forms the western boundary of Plymouth and which makes a very abrupt change in the utilization economy. Inland from here the landscape is typically rural, with only a very slight tendency for residential penetration along the principal highways (Fig. 8). Of the 5,520 acres 65 per cent are devoted to agriculture, with less than one third cultivated intensively (Table III). Another fourteen is occupied by forest and bush. Nearly nineteen is idle, which indicates poor drainage and a speculative intent on the part of many owners, who visualize a further westward advance of the urbanizing processes. The hilly nature of the surface will encourage the development of small farms and residential dwellings, except perhaps along the railroad, until the intermediate part of the corridor catches up with the more industrialized parts at the extremities. It appears that a population of 550 persons living in 157 widely scattered homes is far too sparse to attract factories when much denser occupance exists between here and Detroit. Most of the farms, which have changed but little in the past fifty years, except for clearing the timber, will continue to yield agricultural and animal produce for the expanding residential communities to the eastward.

SUMMARY

In conclusion, we wish to sum up the significant points pertaining to decentralizing of settlement and industry as related to corridor development in Michigan's largest metropolitan region.

1. The number of people within the central core of Detroit is declining because of the pressure from expanding commercial, industrial, and transportation activities.

2. Population is growing outward with the larger increases on the periphery of the central city, the adjacent inner umland, and along corridors having rapid transit reaching far into the outer margin of the region.

3. The suburban-rural areas around established small communities and along improved routes connecting them to the chief city are maintaining the highest rate of change and will continue to do so until the leveling-off period about 1970, when, according to present calculations, the population will reach 4,000,000 persons.

4. An outstanding westward spearhead of urban advancement is extending into the umland along the rapid transit lines which lead to the focal location of Plymouth, from where there is ready access in all directions to a resourceful hinterland.

5. At this favorable site early occupance progressed to accumulate sufficient inhabitants and wealth to form a well-anchored industrial urblet, which has become a powerful force in drawing out from Detroit a substantial network of coordinated settlement patterns.

6. The core city provides the greater expanding force through the attached inner extremity of the corridor and tends to hasten the urbanizing of the intermediate district.

7. Tributaries spring up along the main connecting thoroughfares between primary corridors and complete the urbanization of intervening land.

8. Industries decentralize or settle in these corridors in proportion to the Ideational or directional advantage for transporting raw materials, finished goods, utility services, and laborers.

9. A metropolitan city extends itself in definite directions in proportion to the natural and cultural richness of channels available for a varied occupance in the peripheral landscape, which results in a united and closely adjusted urban form at maturity.

10. The Detroit Regional Planning Commission under the skilled leadership of T. Ledyard Blakeman, in cooperation with scores of similar local groups, is directing the way to a better-ordered and more efficient growth of Michigan's greatest industrial metropolis.

[1] Blakeman, T. Ledyard, *Report of the Detroit Metropolitan Area Regional Planning Commission*, 1950. 1002 Cadillac Square Building, Detroit 26, Michigan.

[2] Wade H. Harris, Angus A. McPhillips, and Alexander Wowk gave valuable assistance in this survey.

[3] Blakeman, *op. cit.*, p. 9.

[4] Since this paper was written construction has started on the Ford Tank Arsenal. A total of over two hundred acres have been purchased, and the buildings will cover approximately forty acres. This plant will be situated at the western end of the middle district.

[5] Leverett, F., U. S. Geol. Surv., and Taylor, F. B., Michigan Geol. Surv., Map of the Surface Formations of the Southern Peninsula of Michigan.

[6] Michigan Historical Society, *Michigan Pioneer and Historical Collections*, I (1874): 444.

[7] Reid, Paul M., *Projected Population, Detroit Region Development Areas 1960 and 1970* (Detroit Metropolitan Area Regional Planning Commission, 1950), pp. 1-23; *idem, Population Prospectus for the Detroit Region 1960 and 1970* (1950), pp. 1-42.

RECENT DEVELOPMENTS IN THE CENTRAL VALLEY PROJECT, CALIFORNIA*

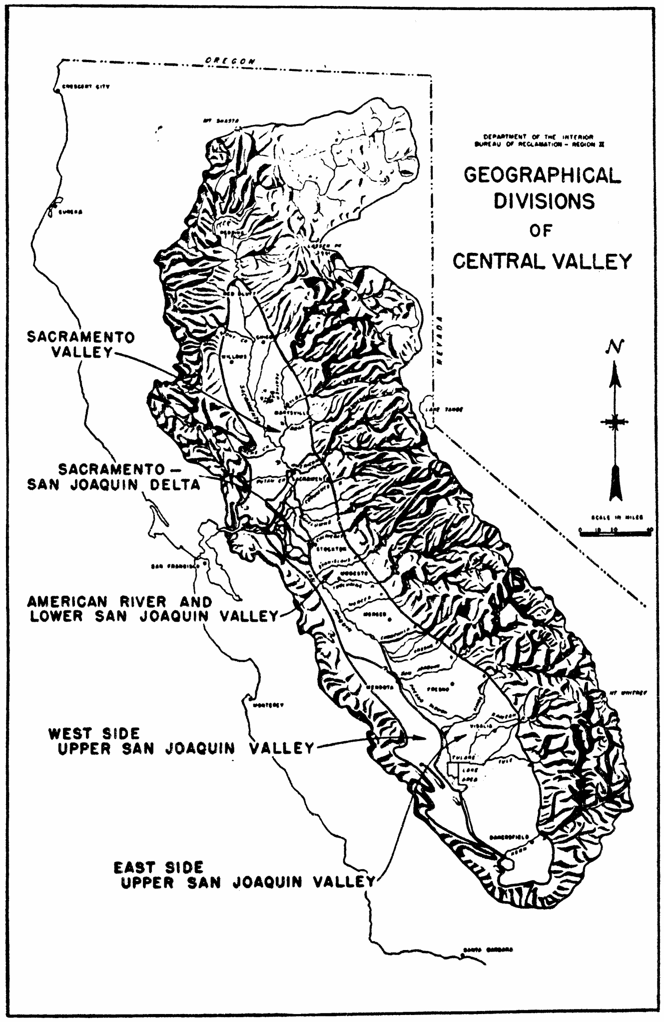
GEORGE KISH

THE Central Valley Project of California is the integration of a series of plans designed for the benefit of the people of that state and for the people of the United States in general. Its primary purpose is the control and redistribution of water in the valleys of the Sacramento and San Joaquin rivers, and of their tributaries that make up the Central Valley. The significance of this project appears best in the light of the results of the Sixteenth Census of the United States. Between 1940 and 1950 the population of California increased 51.6 per cent, which is a higher rate than that of any other state of the Union. To keep pace with this vast increase California will have to augment its food supply and the opportunities for employment offered within its boundaries.

The Central Valley of California is a great alluvial plain stretching 425 miles northwest to southeast from the snowy Sierras of northern California to the dry desert range of the Tehachapi in the south (Fig. 1). In the west it is separated from the Pacific by the low Coast Range, while in the east the Sierras rise between the valley and the dry basins and plateaus of easternmost California and Nevada. The northern part of the valley is drained by the Sacramento River and its tributaries; the southern part by the San Joaquin and the streams that join it along its northward course. The southernmost part of the Central Valley, the basin of Tulare Lake, is an area of inland drainage.

The valley floor itself consists of three types of surfaces.[1] The "red lands" near the foothills on the eastern and western sides represent old valley fill; the "Fresno lands," limited to the southeast side of the valley, are "intermediate fill," deposits of later geological periods, while the most recent alluvial deposits are concentrated along the west side of the valley. The waters of the Sacramento and of the San Joaquin join forces east of

San Francisco and form their common delta before reaching the open ocean through a succession of bays and narrows.



Courtesy of Bureau of Reclamation

FIG. 1

The climatic divisions of the Central Valley correspond, in a rough manner, to the major physiographic areas (Fig. 2). The Sacramento drainage area, as well as the eastern foothills of the San Joaquin Valley, are of the mediterranean climatic type, whereas the greater part of the San Joaquin Valley is either steppe or desert. Rain falls mostly in the northern part of the valley, and on the Sierras near the eastern margin, and there is a marked and rapid decrease of rainfall southward. Red Bluff, on the middle Sacramento in the north, receives an average annual rainfall of 24.31 inches; Stockton, near the delta, 14.10 inches; and Bakers-field, at the far southern end of the valley, receives only 5.62 inches a year.[2] In general terms, one may state that the northern third of the Central Valley receives two thirds of the rainfall, whereas the southern two thirds receive only one third.

The seasonal nature of the rainfall in the Central Valley is another significant characteristic. Winter is the rainy season, and much of the rain falls in the form of snow, high in the watershed, on the flanks of the Sierras. The snow thus accumulated, often ten to twenty feet deep on the high slopes, melts in late spring, and the waters race down the tributaries to the San Joaquin and to the Sacramento, and then out to sea. As a result, destructive floods ravage the valley floor from time to time, and the flood waters, instead of being useful to the farmers of the valley, drain out to the Pacific Ocean.

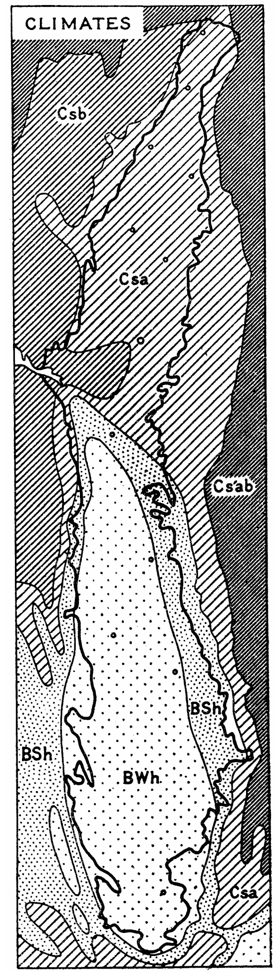


FIG. 2. Climates of the Central Valley (courtesy of American Geographical Society, *Geographical Review*, Vol. 29 [1939], No. 2)

Because summer is a season of drought throughout much of the valley, crops in need of water have to be irrigated. The rivers, once past their flood stage, do not carry sufficient water for irrigation purposes, and in many areas the farmers of the valley have resorted to pumping to obtain water for their fields. In the delta of the Sacramento and the San Joaquin, where the peat and muck of the many islands grow good crops of vegetables, excessive pumping drained much of the underground water supply and, in some areas, the water table was lowered from 25 to 100 feet between 1920 and 1940.

The increasing demand for irrigation water, for salinity control in the delta and for flood control throughout the valley, has been one of the main factors responsible for planning in the Central Valley, which is among the most productive farming areas of the nation. The crops of barley, cotton, rice, beans, alfalfa on the valley floor, of fruits and olives on the slopes, of vegetables in the delta provide a large part of the food supply of the San Francisco metropolitan area, and the surplus is marketed throughout the United States. Furthermore, the demand for power for the industrial enterprises of the San Francisco Bay area and the demand for industrial, domestic, and farm power throughout the valley created a ready market for a vast bloc of power. Thus power generated by falling water became another objective for planning in the Central Valley.

The economic development of this part of California falls into several well-defined phases. The first period, after California's admission to statehood in 1848, was primarily an exploitation of mineral resources, principally gold, with little or no regard for posterity. The scars of that first age of "robber economy" are still visible in the muddy streams arid cutover lands of the region. The second phase, one of extensive wheat farming in the Central Valley, helped deplete the soils, and created serious problems of soil erosion, flood control, and productivity. The last years of the nineteenth century and the first of the twentieth saw the rise of new, intensive farming areas, devoted principally to cash crops of ready market value, such as olives, grapes, and barley. Throughout the last seventy-five years, however, there has been a growing awareness of the problems of the valley, and a series of attempts have been made to remedy the damages wrought by early miners and settlers on the face of the land.

The first significant contribution to land planning in the Central Valley was made in 1874 by a team of engineers and geographers. Their plan, sometimes referred to as the Alexander plan (after Col. B. S. Alexander, chairman of the three-man committee), recognized the imbalance between water supply and farmlands existing in the valley. Because the slope of the valley drained waters toward the common delta, the plans submitted by the Alexander committee envisioned the transfer of Sacramento water by canal to the upper San Joaquin, thus increasing the water supply of the arid and semi-arid lands of the southern Central Valley.[3]

The years between 1874 and 1935 saw numerous plans for the valley laid before the legislature of California and before Congress. It was not until the depression years of the 1930's, however, that a comprehensive plan, designed to tackle all the problems arising from the complex natural and cultural pattern of the Central Valley was adopted. In its present form the Central Valley Project is divided into three phases: an initial phase, to be completed not later than 1955; an intermediate phase, to be completed in 1960; and a final phase ending in 1965.

The initial phase of the project is of the greatest interest to us at present, for the intermediate and final phases will follow the general outlines of the program. Recognizing the basic problem, imbalance between the northern one third and the southern two thirds of the valley, the demands for irrigation water, salinity and flood control, power, as well as other demands, the project proposes a "rebuilding" of the Central Valley. Substantially, this will consist of a transfer of water from the northern, well-watered, Sacramento Valley to the southern, arid or semiarid, San Joaquin Valley; of a redistribution of water throughout the valley; of the assuring of salinity control in the delta; and of the production of large amounts of hydroelectric power (Fig. 3).

The first of these aims is to be fulfilled by the completion of two major dams and several canals. Shasta dam, on the upper Sacramento (completed in 1950), stores water in a great reservoir (capacity, 4.5 million acre-feet; Pl. I, Fig. 1). Water released at Shasta dam flows down the Sacramento River toward the delta. Before reaching the delta, however, the Delta Cross Channel carries part of the Sacramento waters across the delta to the Tracy pumping plant (now under construction). There the water is lifted by giant pumps some two hundred feet, and transferred back to the San Joaquin at that spot. This transfer is necessary to replace water taken from the San Joaquin at Friant dam.

Friant dam, near the city of Fresno, stores the waters of the San Joaquin in Millerton Lake reservoir. Part of the stored water is diverted northward to Madera County by the Madera Canal (now completed); part of it runs southward, by gravity flow, through the Friant-Kern Canal to the arid lands of Fresno, Tulare, and Kern counties. Thus, by the use of the Shasta and Friant dams and the Delta Cross Channel, and of the Delta-Mendota, Madera, and Friant-Kern canals, the natural drainage pattern is profoundly modified and the water deficiency of the southern Central Valley is partially remedied.

The problem of increasing salinity in the delta lands was met by the construction of the Contra Costa Canal, the first unit of the Central Valley Project to go into operation. At Oakley, near the head of the delta, pumps lift Sacramento-San Joaquin water 124 feet. Thence the water moves by gravity flow westward, to irrigate fields in the truck-gardening area of Contra Costa County and to provide domestic and industrial water for the communities along the southern shores of the delta.

The success of the first phase of the Central Valley Project depends upon the transfer of water from the Sacramento River to the San Joaquin and to the lower delta. This, in turn, involves pumping operations to lift water from the Sacramento River to the Delta-Mendota Canal and to the Contra Costa Canal. The necessity of providing power for these pumping operations, irrespective of power needs of the Central Valley and San Francisco Bay areas, made the construction of a power plant at the Shasta dam imperative. Shasta dam (Pl. I, Fig. 2) audits auxiliary unit, Keswick dam, are now in full operation. The powerhouse at Shasta dam has an installed capacity of 375,000 kw. Keswick dam, built to regulate the outflow of water from the Shasta reservoir, has an added capacity of 75,000 kw. Together, Shasta and Keswick dams, with their aggregate capacity of

450,000 kw., represent the largest hydroelectric power plant now in operation in California.

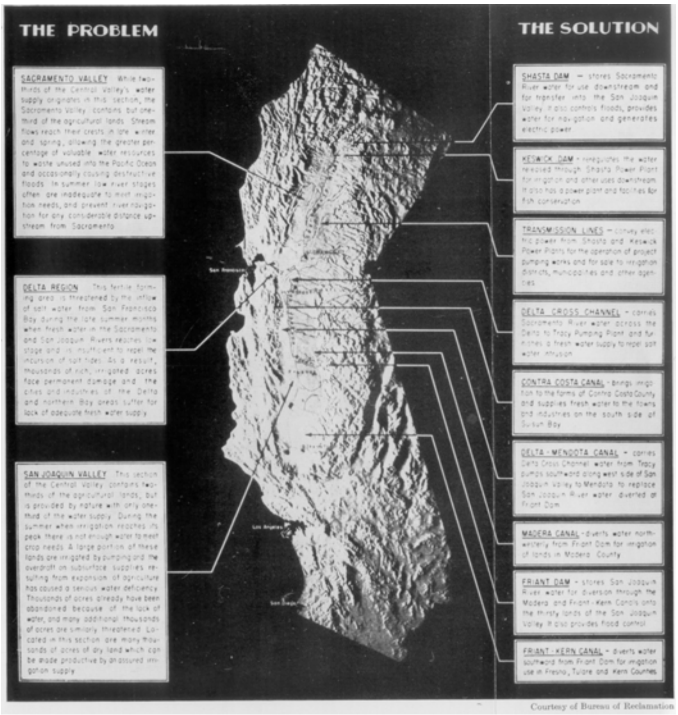


FIG. 3. The Central Valley project today

The benefits of the Central Valley Project are manifold. When completed, the project will have added 3 million acres of irrigable land to the existing 2.4 million acres now in the valley; will afford protection from salinity for the delta; will provide additional water for navigation and recreation, and for industrial and domestic purposes; will improve navigation on the lower Sacramento River; increase land values; and will furnish additional electric power for northern California. Perhaps one way to sum up the benefits of the project, so far as the water resources of the region are concerned, would be to compare the use of the water supply under conditions prevailing prior to the beginnings of the project and those hoped for upon the project's completion. This information is summarized in Table I.

TABLE I

USE OF WATER IN THE CENTRAL VALLEY OF CALIFORNIA

(All figures in annual means of millions of acre-feet)

	1. 1928–34 average	2. Comphrensive project after completion	3. Change
Estimated available supply	19.4	21.5	2.1
Use			
Irrigation	7.45	16.6	9.15
Municipal and miscellaneous	0.3	1.0	0.7
Salinity control	1.9	2.4	0.5
Total use	9.65	20.0	10.35
Loss			
Evaporation	0.35	0.9	0.55
Waste to ocean	9.40	0.6	8.8
Total loss	9.75	1.5	9.35

Source: Bureau of Reclamation, Report 2–40–3, p. 48.

These figures reveal that the end result of the Central Valley Project, achieved at the expense of some 2 billions of dollars (1948 figures), will be of considerable benefit to the semiarid and arid lands of the valley. The vast runoff of former times, when it was impossible to hold the spring floods, will be transformed into water that will irrigate fields, supply homes and factories, and drive turbines throughout the valley in the future.

It would be misleading, however, to believe that the problems of the Central Valley are all of a technical nature. Engineering skill has already wrought profound changes in the region, and dams, reservoirs, power plants, and the like can be built wherever conditions of soil and topography are favorable. However, there are also social, economic, and political problems of no mean magnitude. Prominent among them are those connected with landownership and the policy of the Federal Government concerning irrigation water provided by installations built under Federal auspices and at Federal expense. The Reclamation Act of 1902, the statute applicable to the irrigable land in question, says clearly that land units irrigated by water from Federal projects shall not exceed 160 acres and that the landowner has to be "an actual *bona fide* resident on the land, or occupant thereof, residing in the neighborhood of said land." In California, a state recognizing joint property of husband and wife, such land may not exceed 320 acres. The purpose of this provision was well expressed by F. H. Newell, first Commissioner of the Bureau of Reclamation, in 1905: "The object of the Reclamation Act is not so much to irrigate the land as it is to make homes . . . to bring about a condition whereby that land shall be put into the hands of the small owner, whereby a man with a family can get enough land to support that family, to become a good citizen and to have all the comforts and necessities which rightfully belong to an American citizen."[4]

A rapid field survey of the Central Valley, and particularly of its southern section, reveals that conditions of landownership do not always seem to follow such a philosophy. Especially striking is the contrast between the east side of the San Joaquin, with its many small farms, thriving towns, and villages, and the west side, where "family-sized" farms of 40,000 acres are known to exist. In Madera, Tulare, and Kern counties, in the upper San Joaquin Valley, landownership in 1940 presented the following picture. Some 12,000 farmers, owning less than 320 acres apiece, controlled 47 per cent of the irrigable land; 636 owners of over 320 acres each controlled 53 per cent of the irrigable land.[5]

The example of the southern San Joaquin Valley brings sharply into focus the opposition between the 160-acre limitation, ensured by Federal statute, and the interests of owners of large tracts of land. Since the Bureau of Reclamation is required by law to observe the 160-acre limitation (320 acres in the case of joint property), including contracts for the delivery of water to individuals or to irrigation districts, the controversy between the Federal Government and local land interests is bound to become more pronounced as additional land becomes irrigable through Federal irrigation projects. No final solution is as yet in sight.

A second controversy that has been brewing for a long time is that between the privately owned utilities and the Federal Government as producer of hydroelectric power. In the case of the Central Valley Project the adversary of the Government is the Pacific Gas and Electric Corporation (P. G. & E.), the greatest utility of northern California. Controversies between private utility companies and the Government are not peculiar to California. Rather, the case of the P. G. & E. versus the Federal Government is merely another phase of the fight waged over the Tennessee Valley Authority and in several other instances. It is the intention of the legislation providing for the project that power generated at the Shasta and Keswick dams, and in other dams now under construction or to be built, shall be used in part for purposes inherent in the project (such as pumping), and in part shall be offered for sale. Under Federal law Government-generated power is to be sold preferably to public utilities. It is at this point that the Federal policy of producing power for sale clashes with the interest of private utility companies. It has been the experience of Federal-controlled power plants in the part that the price they charge per kilowatt-hour has been substantially lower than that of private utilities. It is more than likely that this will be true in California, hence the current violent controversy of P. G. & E. versus the United States Government.

Finally, any discussion of the Central Valley Project has to mention the problems inherent in the drafting, budgeting, and administration of it. The Central Valley has been the scene of some rather brisk interagency controversies between the several branches of the Federal Government professing to be concerned with the project. As a matter of interest, it should be pointed out that the "Folsom formula," suggested by President Truman and adopted by the Bureau of Reclamation and the Corps of Engineers of the United States Army, grew out of a controversial issue of the Central Valley Project. Under the Folsom formula dams designed exclusively for flood control are to be under the jurisdiction of the Corps of Engineers in all phases of the project, whereas multiple-purpose dams concerned with irrigation, power, and reclamation, as well as with flood control, will be under the jurisdiction of the Bureau of Reclamation.

Though interagency controversies are a well-established feature of our public life, in water projects a new approach seems discernible in recent discussions on public administration. Federal water projects—completed, under construction, planned, and contemplated—represent an investment calculated at some 57 billion dollars in 1948.[6] Such a sum represents a vast investment and warrants close scrutiny of the principles and methods involved in our water planning.

Water has been assumed to be an inexhaustible resource. Recent events point, however, to a very real danger, manifest in the lowering of the water table and the shrinking of reservoirs, concurrent with a constantly increasing demand for industrial, agricultural, and domestic water. Both the Hoover Commission and the President's Water Resources Policy Commission have taken this matter under advisement.

The Hoover Commission was explicit in its stand on water projects: "In the management of our great rivers the coordinated development of whole river basins with their watershed tributaries is peculiarly essential. . . . The principle of selecting large unified watershed areas is basic to the efficient planning, development and operation of our water resources . . . ."[7] Further on the Commission states: "The unit of water development is the drainage area. Within it are the multiple purposes of navigation, flood control, irrigation, hydro-electric power, municipal and industrial water supply, and the problems of pollution."[8]

The President's Water Resources Policy Commission, in its recommendations for a water policy of the United States, suggested that "Congress set up a separate river basin commission for each of the major basins. These commissions, set up on a representative basis, should be authorized to coordinate the surveys, construction activities, and operations of the Federal agencies in the several basins, under the guidance of independent chairmen appointed by the President and with the participation of State agencies in the planning process."[9]

These recommendations rest on the underlying assumption that projects should be considered not only in their effect on the project area, but in terms of their contribution to the national economy as a whole. Too often in the past this assumption has been overlooked, and projects have been drawn up solely on the basis of local interests. Often, too, various branches of the Federal and state governments locked in struggle for control of these projects. Water is a precious commodity in the West, and its use should be regulated for the benefit of the greatest possible number of our citizens, rather than to satisfy particular interests in the Central Valley or elsewhere.

UNIVERSITY OF MICHIGAN

* Field studies in the Central Valley and subsequent research were supported by a grant-in-aid from the Faculty Research Fund of the Horace H. Rackham School of Graduate Studies of the University of Michigan. The author wishes to express his deep gratitude for help and information received during his field studies from officials of the United States Bureau of Reclamation.

[1] Meigs, Peveril, 3rd, "Water Planning in the Great Central Valley, California," *Geog. Review*, 29, No. 2 (1939): 252-273.

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[3] Alexander, B. S., Mendell, C. H., and Davidson, George, "Irrigation of the San Joaquin, Tulare, and Sacramento Valleys, California," *43d Congress, 1st Session, House Ex. Doc. 290*, 1874.

[4] De Roos, Robert, *The Thirsty Land—The Story of the Central Valley Project* (Stanford, Calif., 1948), pp. 80-81.

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[6] *Congressional Record, 80th Congress, 2d Session,* 94, pt. 8: 9943-9949.

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[8] *Ibid*., p. 37.

[9] President's Water Resources Policy Commission, *Summary of Recommendations*, 1951, pp. 10-11.

KISH PLATE I

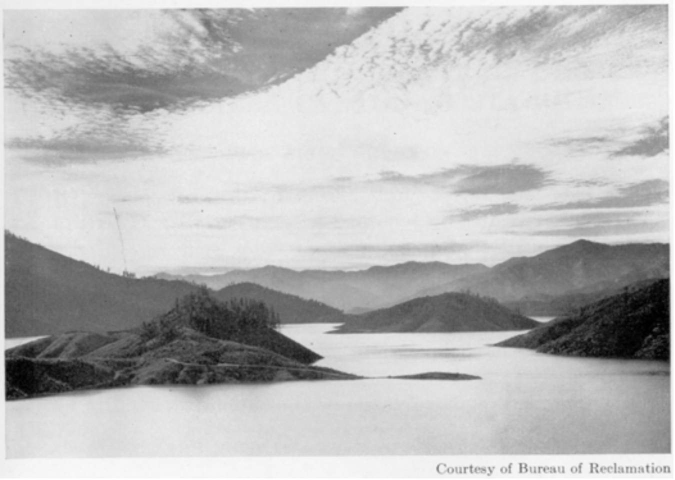

FIG. 1. Shasta Reservoir

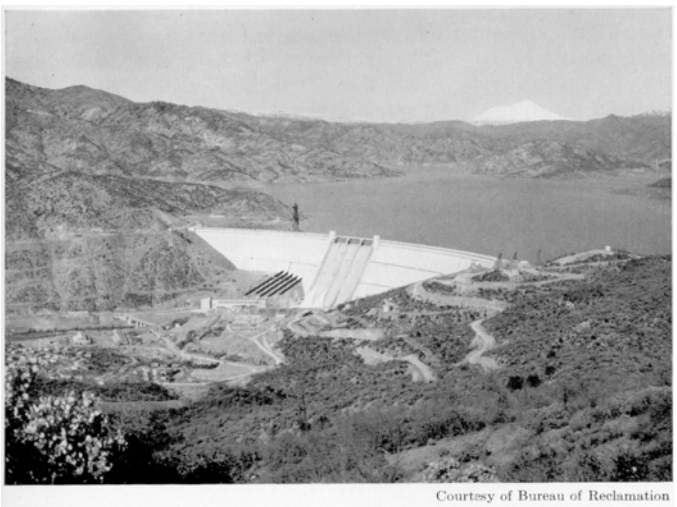

FIG. 2. Shasta Dam

REMAINS OF THE BARREN GROUND CARIBOU IN PLEISTOCENE DEPOSITS OF MICHIGAN

CLAUDE W. HIBBARD

MEMBERS of the Michigan Highway Department in the Highway Field office at Fowlerville, Michigan, gave to the University of Michigan Museum of Paleontology, on October 21, 1937, a caribou antler and a dorsal vertebra of an American mastodon. These specimens became misplaced for several years. The occurrence of the mastodon vertebra, no. 25780, was not reported by MacAlpin (1940).

I am grateful to Doctor W. H. Burt, Curator of Mammals, Museum of Zoology, for the use of specimens under his care and for helpful suggestions in regard to the identification of the antler.

BARREN GROUND CARIBOU

Rangifer arcticus (Richardson)

(Figures 1-2)

Mr. E. V. Fleming, of the Michigan Highway Department, recovered most of a left antler, no. 26589, of an adult caribou from near Fowlerville, Michigan. The broad, flat brow tine and the tip of the antler are missing (Fig. 1). The antler is that of a barren ground caribou, a form now living to the north in the Tundra region of North America.

Little is known in regard to the Pleistocene distribution of this caribou in North America. Its remains appear to be rare in deposits containing the more abundant bones of the American mastodon. This may be due in part to its small size, since it would be confused with the bones of the deer and the elk, which are common in the bog deposits of Michigan.

The barren ground caribou inhabited Michigan in the last period of the receding glacier ice, since it followed the Tundra area northward. To the south of the Tundra, wooded areas existed in which lived the Woodland caribou, *Rangifer caribou*, a larger form and a recent inhabitant of Michigan (Burt, 1946, p. 261). Remains of both kinds of caribou should occur in the post-Wisconsin deposits of Michigan because of the shifting of animal and plant life with the shrinkage of the Wisconsin ice cap.

The antlers of the barren ground caribou are longer, more slender, and generally not so palmated as the antlers of the Woodland caribou. No Woodland caribou antlers have been seen that resemble the specimen from near Fowlerville. It compares in shape and size with the antlers of the barren ground caribou. It is slightly palmated and belongs in Muriels classification (1935, p. 19) of "round antlers, with a minimum of palmation throughout."

Doctor W. H. Burt called to my attention the caribou antler (Fig. 2, no. 84108, Museum of Zoology) which he reported from Michigan in 1942. This antler is from a younger individual. It was recovered from an old peat bog near Minden City, Sanilac County, Michigan. He suggested that it probably belonged to a barren ground caribou. The antler agrees in shape with those of the recent barren ground caribou and with the specimen found near Fowlerville.

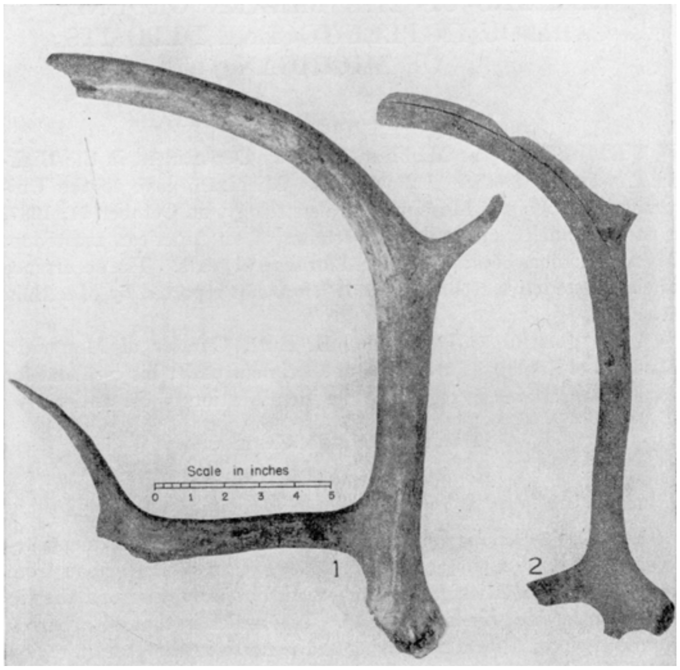

FIG. 1. Left antler, *Rangifer arcticus*, No. 26589 U.M.M.P., from near Fowlerville, Michigan

FIG. 2. Left antler, *Rangifer arcticus*, No. 84108 U.M.M.Z., from near Minden City, Michigan

All the Pleistocene mammal remains found in Michigan to date have been taken from deposits that were laid down after the retreat of the Wisconsin ice sheet. These remains are not of great antiquity, though they furnish considerable information in regard to the animal life of Michigan and of adjoining states during and after the time of the shrinkage of the last glacier.

UNIVERSITY OF MICHIGAN

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AN ANCIENT CUTOFF OF THE RUSSIAN RIVER AT GUERNEVILLE, CALIFORNIA

CHARLES G. HIGGINS

THE Russian River, which drains a large area in the northern California Coast Ranges, empties into the Pacific Ocean at Jenner, sixty miles northwest of San Francisco (Fig. 1). Throughout the lower twenty-two miles of its course the stream is confined to a winding canyon incised into the resistant Jurassic rocks of the coastal highlands. Guerneville, California, is situated on the flood plain of the Russian River at approximately the midpoint of this canyon segment, fourteen channel miles or nine and one-half straight-line miles east-northeast of the river's mouth.

At Guerneville two broad, flat-bottomed valleys, separated by a narrow ridge, enter the Russian River canyon from the north. One mile north of the river the two valleys join, forming a single large horseshoe-shaped valley (Fig. 2; Pl. I). Lone Mountain, the ridge in the center of the horseshoe, is simply an "island" of bedrock rising above the alluvial flood plain which completely surrounds it. The eastern side of the horseshoe is traversed by Fife Creek while the western side (Pl. II) carries a small unnamed intermittent creek. The horseshoe valley is as broad as the Russian River canyon, and it is clear that neither of the small streams which occupy it is at present competent to have excavated either of its sides. It also seems extremely doubtful that either of them could have done so in the past.

Thus it appears very likely that this wide horseshoe was once a north-swinging entrenched loop or meander of the Russian River which was cut off and abandoned after the river had worn through the narrow spur which connected Lone Mountain to what is now the south slope of the Russian River canyon. This hypothesis, originally proposed by R. S. Holway,[1] is supported by the presence of a thick mantle of waterworn gravel, not of local origin, covering the north slope of Lone Mountain. The summit of Lone Mountain is capped by gravel, the elevation of which corresponds to that of a gravel deposit which overlies a stream terrace remnant at 200 to 225 feet above sea level northeast of Guerneville (Fig. 2). If the north slope of Lone Mountain represents the gravelly slip-off slope of an ancient meander and the south slope represents the slope of the more recently formed breakthrough channel, there should be no gravel on the south slope. The writer was unable to find a single water worn pebble south of the southernmost knob of the double summit of Lone Mountain.

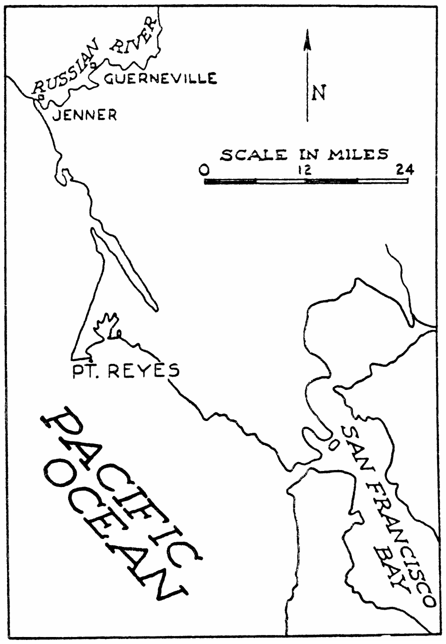

FIG. 1. Location of Russian River

Holway believed that this former loop of the Russian River was cut off in relatively recent time:

"The highest flood plain or lowest terrace of the Lower [Russian] River is practically continuous with the filled-in surface of the old oxbow. The lumbermen report that some of the trees that were cut showed 2400 rings of annual growth. The stumps are so weathered that a recount is difficult but the diameter of some of the stumps still standing is eighteen feet, exclusive of the bark. The fact is also vouched for that in removing one of the stumps in making an excavation, the prostrate trunk of a large redwood was found below. The age of the cutoff must be considerably greater than the age of the redwoods, for the period of aggrading necessary to make the lake into good forest land probably exceeded the time for the growth of the forest. Five thousand years may not be an unreasonable time limit for the period since the cutoff, yet it is one of the recent events in the history of the cañon."[2] However, at the time Holway wrote this, data from wells in the loop were not available. These data show that the bedrock floor of the valley lies far below the alluvial surface and that the depth of fill is considerably greater than Holway realized.

Mr. Freedom Hoffman's well, one-half mile north of Guerneville in the east side of the loop (point A, Fig. 2), was bottomed in quicksand and alluvium at a depth of 102 feet. At a depth of fourteen feet the driller bored two feet through a log. Mr. Hoffman stated that he did not know of any well of considerable depth in Fife Creek Valley in which one or more logs had not been encountered in drilling. Mr. Joseph Buttner told the writer that a log had been penetrated at a depth of sixty feet in Mr. Cole's well (point B, Fig. 2). At least three wells, in addition to Mr. Hoffman's, have been drilled to depths of over one hundred feet in the vicinity. Mr. W. A. Duer bottomed a well in alluvium at a depth of 108 feet in Fife Creek Valley, north of the horseshoe (point C, Fig. 2). Mr. Charles Bean said that, many years ago, Mr. Guerne drilled a well 115 feet deep near the present location of Colonial Village (point D, Fig. 2). The writer inferred from Mr. Bean's description that the well was drilled through alluvium and bottomed in several feet of Jurassic sandstone bedrock. Near this same locality, but much more recently, Mr. Keyt drilled a well through alluvium to a total depth of 100 feet at Murphy's Resort (near point D, Fig. 2).

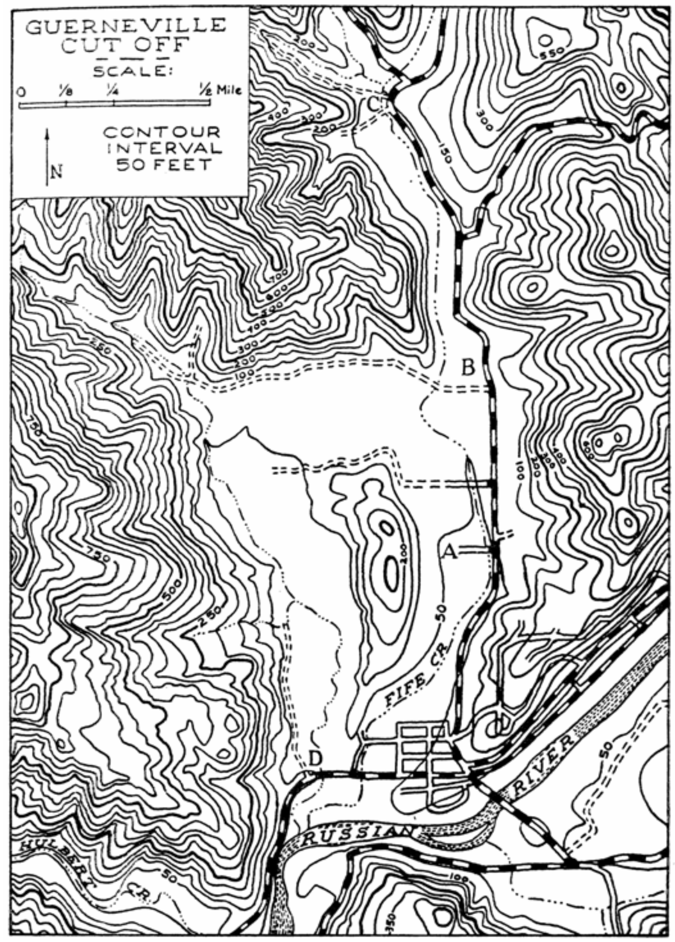

FIG. 2. Topographic map of abandoned entrenched loop of the Russian River north of Guerneville, California. Redrawn from the Cazadero, Healdsburg, Duncans Mills, and Sebastopol quadrangle maps of the United States Geological Survey

The inference to be gained from these well data is that, prior to the time of the cutoff, the Russian River had deepened its canyon at least one hundred feet below the level at which it is now flowing. Three other deep wells in the flood plain of the Russian River indicate that the entire canyon was involved in this deepening. A well at Rolands, near Guerneville, was bottomed in alluvium at 125 feet; a well near Monte Rio, between Guerneville and Jenner, was drilled through 142 feet of sand and silt and bottomed at 152 feet in ten feet of Jurassic sandstone; a well near Jenner was drilled through 146 feet of clay and gravel and bottomed at 148 feet, approximately 130 feet below sea level, in two feet of Jurassic serpentine. The writer believes that this deepening of the Russian River canyon was produced during a period of relatively lower sea level caused eustatically by the withdrawal of water from the oceans to form the great continental glaciers of the Wisconsin stage of the Pleistocene epoch.

Upson[3] has shown that three alluviated coastal valleys near Santa Barbara, California, were formerly graded to a base level more than two hundred feet below present sea level. He correlated this lowered base level with a marked submarine bench three hundred feet below sea level off the southern California coast and attributed the sea level lowering to withdrawal of ocean water during the Wisconsin glacial stage. Though the depth of fill in the Russian River canyon extends at least to 125 feet below sea level, it is apparently not so great as that in the valleys near Santa Barbara. This discrepancy may be explained in two ways. The Russian River may not have reached grade before the sea level began to rise again; its canyon is cut in resistant Jurassic rocks, whereas the valleys near Santa Barbara are cut in more easily eroded Tertiary strata. Or there may have been diastrophic upwarping of the northern California coast relative to the southern California coast at some time after the sea level began to rise. The latter hypothesis is supported by F. H. Bauer's observation that a minor submarine bench is shown at about 200 feet rather than 300 feet below sea level on the nautical charts which represent the northern California coastal area.[4]

Since it is widely accepted that sea level was lowered eustatically during Pleistocene glaciation, and since it seems clear that coastal valleys in both northern and southern California were, at some previous time, deepened in response to a relatively lower sea level than the present one, and, furthermore, since the degree of this valley deepening corresponds roughly with the degree of glacial sea level lowering accepted by many, though not by all, geologists, it seems reasonable to assume that the valley deepening recorded in the Russian River canyon, and in the Guerneville cutoff loop was caused by degradation during a period of glacial sea level lowering.

When the continental glaciers began to wane, the water which had been effectively immobilized in the glaciers as ice was gradually returned to the oceans and the sea level began to rise. Since this, in turn, caused the base level of the coastal streams to rise, valley deepening ceased and the streams began to aggrade their valleys. The argument that the valley deepening may have occurred later than the Wisconsin glacial stage, at a time when the coastal area may have been up warped by diastrophic activity, does not appear to be supported by any evidence which cannot be interpreted as having resulted from eustatic glacial sea-level lowering. Thus it follows from the foregoing assumptions that the deepening of the Russian River canyon occurred no later than Wisconsin time.

The deep wells in the vicinity of the Guerneville cutoff indicate that the Russian River flowed through and deepened the now abandoned loop during this same period of entrenchment. The cutoff may have been effected, as Holway suggested, by the river actively wearing away the neck of the spur. It is equally possible, however, that, as the canyon was deepened, the neck of the spur was narrowed and lowered by slope wash and gullying so that, later, as the river aggraded its valley to the rising sea level in post-Wisconsin time, alluvium eventually buried the sag in the spur, allowing the river to abandon its difficult course around the loop in favor of the shorter course across the buried saddle.

In either case the loop must have been abandoned long ago, when the alluvial surface of the valley was well below the present level. The abundance of logs encountered in wells in the loop suggests that it has long been the site of dense redwood forests similar to the forest still preserved in Armstrong Grove State Park, two miles north of Guerneville. Such forests or concentrations of large redwoods do occur on the present flood plain of the Russian River, but are uncommon and exist only at the extreme margins. Since the writer knows of only one instance in which a log was penetrated in a well located in the Russian River canyon, forests do not appear to have been common on the Russian River flood plain in the past. Therefore, the inferred presence of buried forests in the loop indicates that the river had abandoned the loop prior to their growth. Since several strata of ancient forests must be buried beneath the stumps of the most recent forest which, as Holway noted, is more than 2,400 years old, the cutoff must have occurred during or shortly after the maximum of late Wisconsin glaciation. Recent determinations of the date of the latter event by the radiocarbon method place it about eleven thousand years ago.[5]

DEPARTMENT OF GEOLOGICAL SCIENCES
UNIVERSITY OF CALIFORNIA
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[1] Holway, R. S., "The Russian River, a Characteristic Stream of the California Coast Ranges," *Univ. Calif. Publ. Geog*., I (1913-1917 [1913]): 1-60.

[2] *Ibid*., pp. 30-81.

[3] Upson, J. E., "Late Pleistocene and Recent Changes of Sea Level along the Coast of Santa Barbara County, California," *Am. Journ. Sci*., Fifth Series, 247 (1949): 94-115.

[4] Personal communication.

[5] Flint, R. F., and Deevey, E. S., "Radiocarbon Dating of Late-Pleistocene Events," *Am. Journ. Sci*., Fifth Series, 249 (1951): 257-300.

HIGGINS PLATE I

Aerial photograph of abandoned entrenched loop of the Russian River north of Guerneville, California. Scale: one inch equals approximately 1,800 feet. The small streams draining the loop are clearly incapable of having eroded it

HIGGINS PLATE II

View northeastward from hill overlooking west limb of flat-bottomed horseshoe valley at Guerneville, California. Tree-covered ridge in middle distance is Lone Mountain

PRE-CAMBRIAN ROCKS NEAR GARDINER, MONTANA*

WILLARD H. PARSONS AND ELMER L. BRYDEN

INTRODUCTION

GARDINER, Montana, lies along the southwestern margin of a structural and geological unit known as the Beartooth Mountain uplift (Fig. 1), which has been elevated many thousand feet above the plains to the north and the Bighorn Basin to the east. This uplift is part of a great horseshoe-shaped chain of mountain ranges which makes up part of the middle Rocky Mountains. It is a major deformational zone of critical and significant position (Bucher, 1933), in terms of continental structures. It is bordered on the southwest by the Gardiner thrust fault, which dips about 35° northeast (Wilson, 1934), and on the north and northeast by other great low-angle thrust faults (Lammers, 1937; Perry, 1935), which dip to the southwest. Thus a huge tectonic wedge was flexed during Laramide deformation into a great asymmetrical anticline with an eastward-facing front. Since that time streams and alpine glaciers have dissected the region to a present relief of 5,000 to 7,000 feet in the center of the range. The Paleozoic and Mesozoic strata which once covered the uplifted block have been largely stripped away, exposing a pre-Cambrian core (Fig. 1), which is essentially a granite batholith enclosing schists and gneisses as roof pendants, and cut by various dikes and isolated basic complexes.

The southwestern section of the uplift has been sufficiently isolated by stream dissection along a cross-fault zone to warrant treatment as a separate topographic unit and is known as the Snowy Range (Fig. 1). In its eastern part this is a high-plateau region with table-top ridges which is drained by the Boulder River and its tributaries. Its steep western margin is separated by the valley of the Yellowstone River from the Gallatin Range on the west. The Snowy Range is a broad anticlinal fold, whose axis trends northwest by west. In much of the central part of this range the pre-Cambrian rocks are covered by early Tertiary volcanic rocks (Iddings, 1894), largely breccias, which are part of the Yellowstone Park breccia series.

Very little detailed information is available on the pre-Cambrian rocks in the Beartooth uplift. For this reason it was felt that the easily accessible exposures of pre-Cambrian rocks in and near Yankee Jim Canyon (Fig. 1, locality 1) of the Yellowstone River, some ten miles north of Gardiner, warranted detailed study. Furthermore, this region lies on the western edge of the Beartooth uplift nearest to described pre-Cambrian localities (Peale, 1896) in the Madison Range and the Tobacco Root Mountains to the west and, therefore, presents a possible key area for pre-Cambrian correlation.

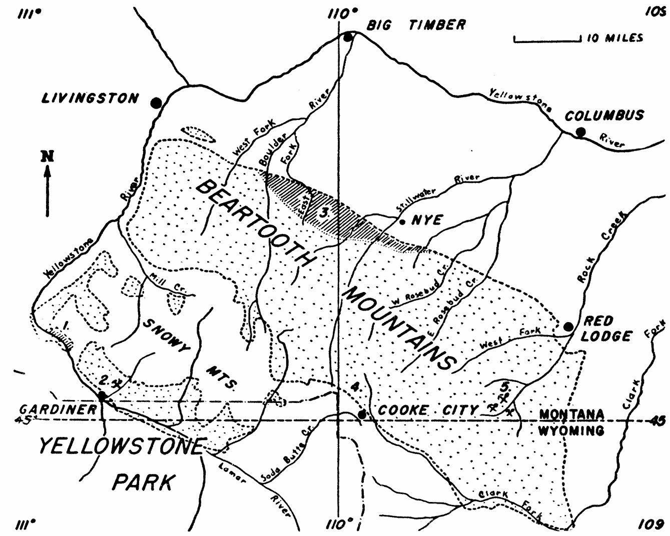

FIG. 1. Beartooth Mountain area, Wyoming

Stippled areas enclosed by broken lines represent pre-Cambrian outcrops

Locality 1. Yankee Jim Canyon and Cedar Creek
Locality 2. Jardine mining district
Locality 3. Stillwater ultramafic complex
Locality 4. Cooke City mining district
Locality 5. Red Lodge chromite district

Field work for this study was carried on by the junior author in the summer of 1949 in cooperation with the Yellowstone Bighorn Research Association of Red Lodge, Montana. This work consisted of detailed mapping of seven or eight square miles of pre-Cambrian rocks along the east side of the Yellowstone River in Yankee Jim Canyon and south as far as Cedar Creek (Fig. 1, locality 1). The field study was continued in the laboratory and petrographic analyses of the various rock types of the area were made. This area is some ten miles north of Gardiner and is traversed by U. S. Highway 89.

The writers gratefully acknowledge financial assistance from Wayne University and from the Yellowstone Bighorn Research Association both in the conduct of the field work and in the preparation of thin sections.

DESCRIPTION OF ROCK TYPES

The pre-Cambrian rocks in the Yankee Jim Canyon area consist of schists and gneisses intruded by granite and diabase dikes. The authors were able to divide the metamorphic rocks into three map units (Bryden, 1950) based on the predominant rock types in each group. Each unit or series, however, is gradational into the next one, and all are cut by a few diabase dikes which are not part of the gradational sequence. These three units are the following: (1) meta-sedimentary schist series, (2) migmatitic gneiss series, and (3) granite gneiss series.

The metasedimentary schist series includes the oldest rocks of the area and apparently represents the original pregranite country rock. The rocks occur in thin conformable beds only a few feet thick and are best exposed in a steep synclinal structure just north of Cedar Creek (Bryden, 1950, plate 2). These rocks have been described in detail by Bryden as consisting of sericite-quartz schists, biotite-quartz schists, quartz-cummingtonite schists, and amphibolite gneisses. These are intruded by a few thin sill-like bodies of granite pegmatite. An unusual rock is the quartz-cummingtonite gneiss which is brownish grey in color and quartzitic in appearance in hand specimen. Microscopic study shows the rock to be composed of quartz (about 40 per cent), colorless cummingtonite, albite, microcline, and minor amounts of chlorite, ilmenite, and garnet. The cummingtonite is in large, well-developed crystals and not in radiating sheaths or bow-tie clusters as usually observed.

The migmatitic gneiss series contains banded or *lit-par-lit* gneisses, massive biotite-feldspar gneisses, amphibolites, an anthophyllite rock, pegmatites, and small granite sills and dikes. Separation of this series from the metasedimentary schist series is made on the relative amount of granitic constituents both as *lit-par-lit* injections and as individual pegmatite bodies. The banded gneisses have white layers composed of quartz, orthoclase, microcline, plagioclase (albite to andesine), and microperthite, whereas the dark bands contain all the biotite with some quartz and feldspar and such accessory minerals as apatite, garnet, sphene, corundum, zircon, rutile, ilmenite, and magnetite. Garnet is locally quite abundant. The massive biotite-feldspar gneisses have a salt-and-pepper appearance and show very little banding but contain about the same proportions of minerals as the banded rocks. Sills and dikes of pegmatite and granite are more numerous and thicker in this migmatite series than in the schist series.

Amphibolites or amphibolite gneisses, usually conformable to the regional schistosity, are present to the same extent and are of similar character in both series. These amphibolites contain from 50 to 85 per cent of hornblende in well-developed oriented euhedral to subhedral crystals. The remainder of the rock is largely labradorite feldspar. The composition of some typical amphibolites, as calculated with a Wentworth-Hunt recording micrometer, is given in Table 1.

A twelve-foot layer of coarse-grained anthophyllite-cummingtonite-quartz rock in the migmatites in Yankee Jim Canyon is an unusual rock type. This rock is dark green to black, with a silky luster on a freshly broken surface, but is completely iron-stained on the surface even in a recent road cut. The rock is made up of about equal amounts of anthophyllite and quartz (about 40 per cent of each), with cummingtonite and local lenses or pods of quartz and garnet. Some of the anthophyllite crystals are an inch or two in diameter. A soda-amphibole, possibly hastingsite, appears as a late replacement mineral. Traces of magnetite, pyrrhotite, and possibly arsenopyrite occur locally. A shallow gossan consisting of limonite with drusy gypsum and traces of arsenic bloom has been trenched by prospectors just above the highway.

The migmatites grade into the granites and granite gneisses. The granites are typical biotite granites with very slight gneissic banding. Small pegmatites cut the granites and contain, in addition to feldspars and quartz, a small amount of sillimanite in acicular, plumose aggregates. About one square mile of this series was mapped, but the outcrop area of granite apparently extends northward on the east flank of Dome Mountain (Bryden, 1950, plate 2).

TABLE I

MINERAL ANALYSES OF AMPHIBOLITES

Minerals	Specimen numbers (Percentages)				
	1*	24B†	39a‡	41B§	41C‖
Hornblende	85.0	68.6	50.2	81.2	80.1
Labradorite	11.7	29.4	44.16	7.8	tr.
Biotite	...	1.34	4.86	2.42	17.6
Quartz	0.8	0.66	tr.	8.6	2.3
Magnetite	3.0	0.72	...	...	...
Apatite	...	tr.	1.12	tr.	¶
Percentage totals	110.5	100.72	100.34	100.02	100.0

* Amphibolite, metasedimentary schist area, north of Cedar Creek.

† Amphibolite, metasedimentary schist area, near contact with migmatite area.

‡ Coarse amphibolite, migmatite area.

§ Massive amphibolite, migmatite area, Yankee Jim Canyon. Interlayered with granite pegmatites.

‖ Amphibolite schist, in a shear zone in same outcrop as the massive amphibolite of 41B.

¶ No apatite; trace of zircon.

Two thin dikes of ophitic diabase cut the schists and migmatites. In the field these rocks appear similar to the amphibolites, but petrographically they are quite different. The diabase is composed of hypersthene and plagioclase, the former largely altered to uralite and the latter in part to zoisite.

ORIGIN

The mineralogy and field relationships of the mica and the quartz-cummingtonite schists definitely point to an original sedimentary character, probably as argillaceous sandstones with siliceous iron-magnesium-rich carbonate layers. The perplexing origin of cummingtonite-quartz rocks is discussed at length by Seager (1944, p. 27), who suggests interactions, under proper conditions, between sideroplesite, silica, kaolin, iron oxide, and perhaps ferrodolomite.

After the metamorphism of the sediments, granite was intruded, probably as the upper projection of a larger stock or batholith. Granitic liquids soaked and injected the country rock outward from the actual intrusive body forming the series of migmatites. The gradation of granite into migmatite and of migmatite into schists attests this action. The migmatitic gneisses represent, therefore, mica and cummingtonite schists which have been selectively reacted upon and replaced by granitic solutions with the formation of various feldspars, occasional garnet, and some additional biotite at the expense of sericite and cummingtonite and perhaps some quartz. The banded migmatites show *lit-par-lit* injection of granite or selective replacement of sericite or cummingtonite-rich layers. The more homogeneous biotite-feldspar gneisses were soaked and recrystallized more evenly. Migmatites near the granite mass contain more feldspar, especially as layers or injections of pinkish material, than do those near the unaltered mica schist areas. Sillimanite in pegmatites in the granite-migmatite contact zone may be the result of assimilation of aluminous country rock by the granite.

The amphibolites have been interpreted as metamorphosed basic igneous rocks which were either injected into the sedimentary rocks as sills or poured out as lava flows. One outcrop of amphibolite in Yankee Jim Canyon shows structures suggestive of pillow lava. The amphibolites are present in about equal quantities in both the schist areas and the migmatite areas, with very little mineralogical difference in the two areas. As shown in Table I, high and low feldspar contents are represented in both areas. Apparently, these amphibolite gneisses were not replaced or altered by granitic solutions, as is indicated by several inclusions of unaltered amphibolite in granite dikes and stringers.

The properties and occurrences of anthophyllite in Montana are discussed in a paper by Rabbitt (1948), but he does not suggest any origin for anthophyllite rocks. The presence of quartz and cummingtonite in the anthophyllite rock in Yankee Jim Canyon might imply an origin similar to that of other quartz-cummingtonite rocks.

AGE RELATIONSHIPS

The pre-Cambrian of Montana has been divided into three groups: the Pony (Tansley, 1933), the Cherry Creek (Peale, 1896), and the Belt series. The oldest series, the Pony, is composed of dark and light gneisses and schists and amphibolites, of mixed sedimentary and igneous origin. The Cherry Creek, of sedimentary origin only, was deposited on an old Pony erosion surface. In its type locality it consists of quartz-feldspar gneisses, quartz-mica schists, marbles, quartzites, and hornblende-biotite schists. The Beltian strata, which were then laid down on the eroded surface of these older metamorphosed rocks, consist of nearly flat-lying sandstones, conglomerates, slates, and limestones that show little or no metamorphism.

The ages of the pre-Beltian rocks are questionable. The Pony series is probably Archeozoic, but the Cherry Creek may be either Archeozoic or Proterozoic. Until recently it was thought to be the latter (Peale, 1896). Rabbitt has suggested that the Pony and the Cherry Creek are the same age and represent sedimentary facies variations (Seager, 1944, p. 22, in quoting John C. Rabbitt). But descriptions of major unconformities (Tansley, 1933) and recent observations by E. Wm. Heinrich (University of Michigan) of the two series in contact discredit this idea.

Heinrich (personal communication), who has studied the pre-Cambrian of southwestern Montana for the Montana

Bureau of Mines, recognizes the following sequence in the pre-Cambrian rocks of the Madison and adjacent ranges (from youngest to oldest): Belt series, diabase dikes, ultramafic dikes and sills, granite and pegmatites, amphibolites and hornblende gneisses, Cherry Creek series, and Pony series.

The pre-Cambrian rocks in the Yellowstone Valley north of Gardiner are definitely pre-Beltian. The biotite-garnet gneiss in Yankee Jim Canyon is very similar in appearance and composition to nearby rocks of Pony age (Heinrich, personal communication). Furthermore, the Cherry Creek invariably contains, along with abundant phyllites and schists, thick sections of quartzites, marbles, and quartz-magnetite taconites. Therefore, owing to the absence of such diagnostic Cherry Creek rocks, coupled with the fact that the rocks in Yankee Jim Canyon are of mixed sedimentary and igneous origin, the authors suggest a Pony age for the rocks in this area. These rocks were later intruded by granite and by postgranite diabase.

DISCUSSION OF OTHER BEARTOOTH LOCALITIES

The described occurrences of pre-Cambrian rocks in the Beartooth Mountains are few, but a brief review and a comparison of some of them with those in the area described in this paper may be fruitful, especially in aiding future investigations.

The Jardine district (Fig. 1, locality 2) lies about ten miles southeast of Yankee Jim Canyon and has been described in detail by Seager (1944). Metamorphic rocks in this district are mostly biotite quartzites, with some biotite and quartz-cummingtonite schists, usually rather dark. Seager has pointed out that these rocks are very similar to the Cherry Creek series. At first sight the Yankee Jim Canyon area and the Jardine district strike the observer as being very similar, especially because of the occurrence of the rather uncommon mineral cummingtonite in both places, but wide differences soon become apparent. The cummingtonite rock of the Yankee Jim Canyon area is much more massive and lighter-colored than that at Jardine. In thin section the cummingtonite shows none of the recrystallization or radial structure or alteration to hornblende so common at Jardine. In addition, the abundant migmatites described in this paper have no counterpart in the Jardine area. Seager's descriptions (1944) of the Jardine granite and of diabase dikes are, however, essentially the same as those given by the present writers for the rocks in Yankee Jim Canyon. The metamorphic rocks of Jardine and Yankee Jim Canyon cannot be correlated owing to differences of appearance and mineralogy, but, on the other hand, neither can they be declared positively to be of different ages. Unfortunately, in the few intervening miles between these areas the pre-Cambrian rocks are covered by Tertiary volcanic rocks, so that it is not possible to trace the metamorphic rocks from one district to the other.

Across the Boulder Plateau, about forty miles northeast, is the Stillwater ultramafic complex (Fig. 1, locality 3), which has been intruded into a series of dense gray hornfels, an iron formation, and light-colored quartzites (Peoples, 1940; Howland, 1949). No other age than pre-Cambrian is assigned to the rocks by either author; but the presence of an iron-rich rock and quartzites possibly suggests Cherry Creek. A coarse-grained gneissoid biotite granite and some fine-grained basic dikes are regarded as cutting the ultramafic complex and being of a distinctly later period of intrusion.

At Cooke City, Montana (Fig. 1, locality 4), Lovering (1929) has distinguished two granites which he considers to be of Archean age. The Goose Creek granite, which is the older, is remarkably like the granite found in the Yankee Jim area both in appearance and in mineral composition. It is a gray gneissic rock composed of feldspars, quartz, biotite, and accessory garnet. The younger granite, the Cooke City granite, is a pinkish rock with no gneissic structure. The only metamorphic rocks in this area are inclusions of various schist and hornblende-chlorite rocks in the older granite, which Lovering suggests represent metamorphosed sediments and basic igneous rocks respectively.

In the Red Lodge chromite district (Fig. 1, locality 5), seventy miles to the east, James (1946) has described the pre-Cambrian rocks in detail. The oldest rocks are partly sedimentary and partly igneous in origin and are all highly metamorphosed. They comprise quartzites, amphibolites, basic gneisses, with minor lenses of schist and magnetite-rich rock. This presence of quartzite and iron-rich rocks is suggestive of the Cherry Creek series. These ancient rocks were first intruded by ultramafic rocks—now serpentine—and then by small bodies of gabbro. All of these were then engulfed in gneissoid granite, which underlies the greater part of the Beartooth Range and in which the older rocks now form isolated roof pendants. James states that about one fourth of the area mapped is underlain with migmatites representing a mixture of the granitic material and the earlier metamorphic rocks. Granite and older rocks are cut by diabase dikes. In addition, James believes the granite types in the Red Lodge area to be correlative with those found in the Cooke City area, and his descriptions of the granites and pegmatites tend to bear out his beliefs.

CONCLUSION

By comparing these several districts in the pre-Cambrian core of the Beartooth uplift a similar sequence of events may be outlined for all as follows: an older series of metamorphosed sediments and basic igneous rocks (amphibolites), ultramafic and gabbroid intrusives in two districts, granites and pegmatites with two distinct ages of granite indicated in at least two districts, late injection of un-metamorphosed diabase dikes.

Dating of the old metamorphic rocks as Pony or Cherry Creek has not been possible. One writer (Seager, 1944) has suggested a Cherry Creek age for the schists and quartzites. In two other districts, the Stillwater complex and the Red Lodge chromite area, the presence of quartzites and iron-rich rocks might suggest Cherry Creek age. Using the absence of such rocks, the present authors have suggested that the rocks in and near Yankee Jim Canyon are most like the described Pony series to the west. But correlation is impossible between Jardine and Yankee Jim Canyon, districts only ten miles apart. Obviously, therefore, more extensive detailed mapping of the pre-Cambrian rocks of the Beartooth uplift is needed before it will be possible to differentiate Pony and Cherry Creek in this range.

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RADIOACTIVE DINOSAUR BONES FROM THE CAMP DAVIS REGION, WESTERN WYOMING

KENNETH G. SMITH AND DANIEL A. BRADLEY

DINOSAUR bones are frequently found in the Upper Jurassic and the Lower Cretaceous nonmarine sediments of Wyoming, and entire skeletons have been uncovered in a few places. The samples described in this paper were located in an outcrop of the Jurassic Morrison (?) formation near Lower Slide Lake, Teton County, Wyoming, approximately thirty-five miles north of Camp Davis, the University of Michigan Rocky Mountain Field Station.

Fragments of dinosaur bones occurring as float have often been picked up by students in this area, usually near the top of a cliff along the north side of Lower Slide Lake. The horizon from which they were derived was assumed to be at the top of the Jurassic section or the base of the Cretaceous section.

In July, 1950, a routine examination of several different specimens collected in the Camp Davis region was made with a Detectron Geiger counter. Bone fragments from the Slide Lake area were found to be radioactive. Further exploration led to the discovery of the bone-bearing layers, which were approximately six hundred feet above the level of Lower Slide Lake, along the southward-facing cliff.

Structurally the Gros Ventre Mountain Range is a broad asymmetrical anticline trending northwest-southeast, with a steep and locally faulted southwest limb and a broad, gently dipping northeast limb.[1] The bone-bearing bed is on the northern flank of the anticline and trends parallel to the regional structure. It strikes N73W and dips twenty degrees to the northeast.

Formations exposed in the area range in geologic age from the Pennsylvanian through the Cretaceous (Table I). A detailed description of the regional stratigraphy was published by Helen L. Foster in 1947.[2] Although her sections do not indicate the presence of the Morrison formation, she notes that the upper portion of what is described as the Jurassic Stump formation may be Morrison in part. It consists of 192 feet of alternating beds of sandstones, shaly sandstone, and shale of various colors-black, greenish black, gray and greenish gray.

The bone-bearing bed is a lenticular conglomerate approximately thirty feet long and two feet thick. It is associated with alternating beds of sandstone and greenish-gray silty sandstones and shales. A few layers are rich in carbonaceous plant material. The nature of the formation suggests deposition by a shifting stream that flowed across a swampy lowland area.

TABLE I

STRATIGRAPHIC SECTION IN THE NORTHERN GROS VENTRE MOUNTAINS, WYOMING (MODIFIED FROM FOSTER)

Age	Formation	Feet
Cretaceous	Mesa Verde formation	4076
	Cody shale	1365
	Frontier formation	2753
	Mowry shale	1067
	Thermopolis shale	318
	Cloverly formation	237
Jurassic	Morrison (?) formation	192
	Stump sandstone	155
	Twin Creek limestone	476
	Nugget sandstone	150
Triassic	Chugwater formation (Thaynes and Woodside)	950
	Dinwoody formation	235
Permian	Phosphoria formation	195
Pennsylvanian	Tensleep formation	298
	Amsden formation	350

Bone fragments, varying in size from one-fourth to one and one-half inches in diameter, are scattered throughout the conglomerate. Near the center of the lens there were obtained larger samples up to eighteen inches long and four to five inches in diameter; some of greater size remained in place. The material appears to have been deposited in a stream channel that extends to the north. J. D. Love recorded similar occurrences of dinosaur bones in subsurface sections of central Wyoming, where they were found in both the Morrison formation and in the overlying Cloverly formation.[3]

Both Love and Foster[4] placed the base of the Cloverly formation at a sparkly quartz sandstone, and as the bone-bearing conglomerate described in this paper is located below this horizon, it is assumed to be Morrison or equivalent.

Most of the bone fragments in the conglomerate are angular and indicate that the material was not transported a great distance by running water. Rounded bone pebbles occur in places, but are rare. It is not possible to identify the animal from which the bones came except to designate it as some type of dinosaur. This tentative identification is based on the large size of some of the bones and on the environment of deposition.

The lithologic setting of the bone deposit strikingly resembles the uranium-bearing sandstones in the Morrison formation of the Colorado Plateau, described by Fischer.[5] The Colorado Plateau deposits are lenticular bodies of sandstone interbedded with mudstone. Carnotite, the principal uranium mineral, is disseminated in the sandstone and replaces fossil plant material. Fischer believes that the deposits were formed in channels and on flood plains of streams that meandered across a surface of low relief and grade.

The bone fragments consist of a dense, black outer layer; dusky blue on weathered surfaces, and an olive-gray porous central part. Bone structure is well preserved in the central porous bone, which is commonly stained with limonite. Five typical samples from the deposit are illustrated on Plate I. The contact between the dense outer bone and the lighter-colored porous inner bone can be noted on bone number 3 of the photograph.

Thin sections of a selected bone were examined under a polarizing microscope. The original material of the dense outer bone has been replaced by amorphous collcphane. The Haversian canals contain calcite. In the inner porous bone the trabeculae are replaced by cellophane having a fibrous and pseudo-spherulitic structure similar to those described by Rogers.[6] The cavities of the inner porous bone are filled with caicite crystals and a fine caicite paste.

The contact between the dense bone and the porous bone is well illustrated in a photomicrograph of a thin section cut transverse to the bone structure (PI. II, Fig. 1). The contact crosses the center of the illustration from left to right, and the dense bone material is in the upper half of the photograph. The gray spherulitic areas are cellophane, and the white areas are calcite. Pyrite appears black m the photograph and fills two main fractures, but can also be observed in some of the cavities formerly occupied by bone cells. Pyrite probably came in after fossilization of the bone was complete.

The same contact between dense bone and porous bone is readily recognized in a longitudinal section also (PI. II, Fig. 2). The black areas m the lower half of the photomicrograph are cavities of the porous bone that have been filled with a fine calcite paste. The white angular particles in some of the cavities are clastic fragments. Evidently there were continuous channels available through which the clastic material moved into the bone. Minerals identified among the clastic grains are quartz, plagioclase feldspar, orthoclase, microcline, muscovite, amphibole, and zircon.

The five bone samples illustrated in Plate I were tested with a Detectron Geiger counter on February 9, 1951, at Ann Arbor, Michigan the average background count at the time of testing was forty-five radiations per minute.

Samples are numbered from 1 to 5 (PI. I), and the approximate radiation counts per minute are as follows: No. 1, 360; No. 2, 312; No. 3, 390; No. 4, 312; No. 5, 324. Sandstone and shaly sandstone from the deposit showed a slight degree of radioactivity when tested. Values for two such samples were 55 and 51 radiations per minute the bone sample from which the thin sections were made was tested on February 14, 1951. The average background count at the time of testing was 43 per minute. The sample gave a count of 234 radiations per minute.

Earlier tests for radioactivity were made in August, 1950, at Camp Davis, Wyoming, and similar results were obtained. The average background count on the day samples were tested was 48 radiations per minute. Nine bone fragments averaged 221 per minute, and six samples of associated sedimentary rocks averaged 60 per minute.

The fifteen samples examined in Wyoming were submitted to the Geochemical Branch of the Geological Survey for analysis, and it was determined that every specimen contained slight amounts of uranium, with a larger concentration in the fossil bones. The results correlate with the radioactive counts recorded for the bone fragments, which were considerably higher than those recorded for the associated sediments.

A tabulation of the uranium content for each of these samples (Table II) permits a comparison of the values for the bone fragments and those for the sediments in which they are found. The percentage of uranium in each sample correlates fairly well with the approximate radioactive counts for each, with possibly two or three exceptions. This fact may be useful as an aid for further field investigations in this area.

No uranium minerals could be identified with a microscope owing to the very small amounts present in the bone as compared with the rest of the mineral matter contained. It is suggested that the uranium is disseminated throughout the organic bone material, possibly associated with the collophane. Organic material appears to favor precipitation of greater concentrations of uranium minerals. Fischer states that in the Colorado Plateau deposits fossil plant material is richly mineralized in places and fossil wood is commonly replaced by carnotite.[7]

There is no evidence of Mesozoic igneous activity in the area, which rules out that source of mineralizing solutions. It is suggested by the authors that the uranium minerals were precipitated from ground-water solutions percolating through the formation at the time of fossilization of the bone fragments. Fischer concludes that the ore minerals of the Colorado Plateau deposits were precipitated from percolate ground waters shortly after deposition of the river sands.[8] Similar conditions may have occurred in this section of Wyoming

but the source of the uranium is unknown.

TABLE II

URANIUM CONTENT OF SAMPLES OF DINOSAUR BONES

(From analysis by the Geochemical Branch of the United States Geological Survey)

Sample no.	Description	Radiation count	Uranium percentage	
1	Medium-grained quartz sandstone with a carbonate cement; green clay nodules and chert; also woody black fragments	67	...	.005
2	Mineralized fossil bone material with a small amount of carbonate and some Fe stains	194	.135	.11
3	Fossil bone material with Fe stains	247	...	.12
4	Fossil bone material	314	...	.095
5	Fine-grained sandstone with a few chert nodules and Fe stains; carbonate cement	70	...	.005
6	Fossil bone material	208	...	.12
7	Fossil bone material	235	.085	.080
8	Fossil bone material	213	.12	.12
9	Fossil bone material	241	.12	.12
10	Fossil bone material	129	...	.040
11	Fossil bone material with quartz and Fe stains	234	...	.12
12	Cherty conglomerate with carbonate cement and some back woody material; also clay and Fe stains. Red and green chert pebbles visible	63	...	.002
13	Well-sorted fine-grained quartz sandstone with carbonate cement. Some black lustrous plant material with replaced veinlets of calcite on surface	48	...	.001
14	Fine-grained quartz sandstone with Fe stains and clay carbonate cement	52	...	.001
15	Very fine grained quartz sandstone with green clay and carbonate cement	60	...	.001

Further conclusions concerning the origin and extent of the uranium-bearing beds described cannot be drawn until additional investigations are carried on in the area. The occurrence of uranium may merely be a local phenomenon, or there may be several such deposits fairly near to the original one. Other deposits might be found by tracing the bone horizon along the strike, or deposits might be found at other horizons. It is felt by the authors that further exploration in the area may lead to the discovery of sandstone or conglomerate layers in which uranium has been concentrated in greater quantity.

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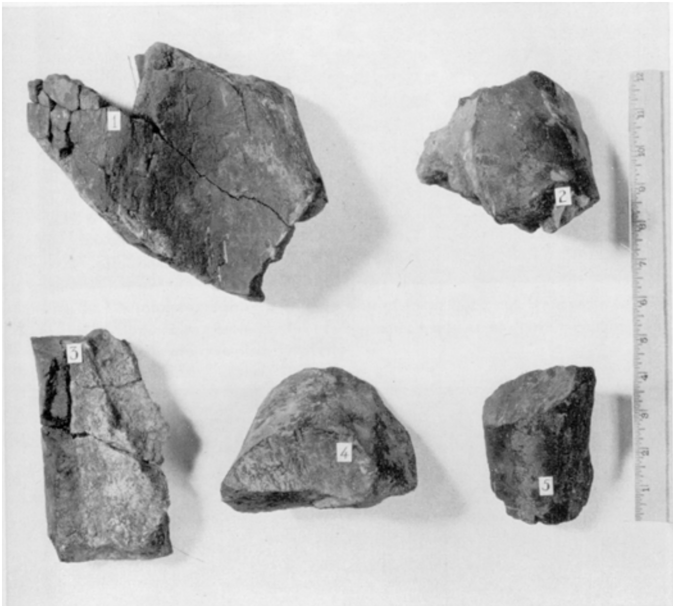

Typical samples of the larger fragments of fossil dinosaur bones from the Lower Slide Lake region

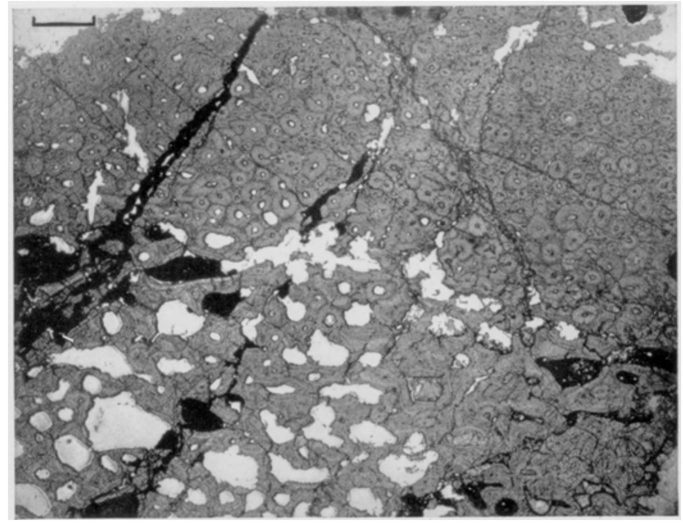

FIG. 1. Photomicrograph of a thin section of fossil bone cut transverse to the structure. Gray areas contain collophane; white areas contain calcite, and black areas are occupied by pyrite

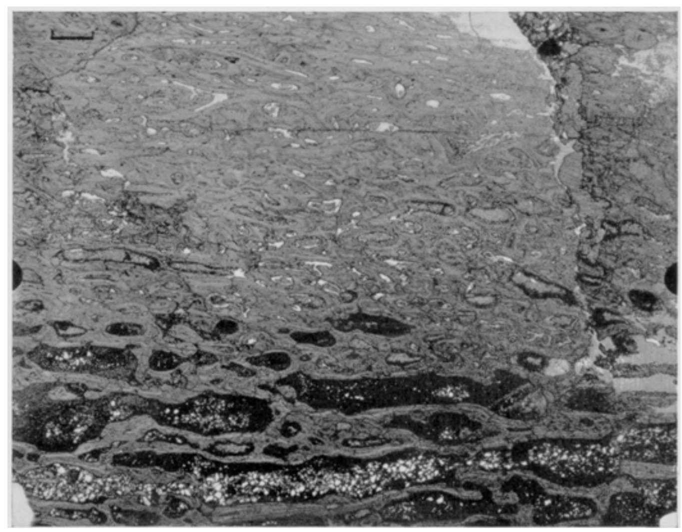

FIG. 2. Photomicrograph of longitudinal thin section of fossil bone structure. The presence of clastic grains in some of the cavities of the inner porous bone is shown

The scale in the upper left-hand corner of each figure represents one millimeter of original thin section