soils; (2) level clay soils; (3) predominantly rolling loamy sand and sandy loam soils; and (4) sand plains, sand hills, and swamps (Table I).

FIG. 1. Map of Michigan showing Ogemaw County in black

TABLE I

<table>
<thead>
<tr>
<th>Broad soil division</th>
<th>Soil types</th>
<th>Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rolling clay</td>
<td>Nester loam</td>
<td>50,944</td>
</tr>
<tr>
<td>Level clay</td>
<td>Selkirk loam</td>
<td>33,756</td>
</tr>
<tr>
<td>Rolling sandy loam. Predominantly hilly loamy sands and sandy loams underlain by reddish sandy clay</td>
<td>Rosecliff gravelly sandy loam, Ogemaw sandy loam, Ottawa loamy sand, Ogemaw gravelly sandy loam, and Rubicon gravelly sand</td>
<td>53,760</td>
</tr>
<tr>
<td>Sand-swamp. Sand hills, sand plains, and swamps</td>
<td>Grayling sand, Ottawa sand, Rose-lawn sand, Saugatuck sand, Newton loamy sand, Griffin loam, Genesee fine sandy loam, and organic soils</td>
<td>216,880</td>
</tr>
</tbody>
</table>

The rolling clay soils division represents the well-drained productive, durable agricultural land of the county. The soils of the level clay division have naturally poorer drainage and warm up more slowly in the spring, and for this reason are not so adapted to field crops as the soils of the rolling clay group. This level land, however, is considered excellent for use as pasture. The agricultural value of the predominantly hilly loamy sand and sandy loam soils divisions is depreciated by low to fair natural fertility, cobbles and stones on the surface, a high percentage of steep slopes, and low natural moisture-holding capacity. The sandy soils have a low natural fertility, high acidity, and low moisture-holding capacity. The organic soils are naturally exceedingly wet.

LAND USE

The real-estate transfers were divided into three land-use categories: agricultural, recreational, and other. This classification was based on probable use of the land by the purchaser rather than upon intent in ownership. The probable land use was interpreted from data obtained on the real-estate transfer records; from replies to questionnaires; and from information secured from the following maps: Land Economic Survey soil and farm-forest maps; ownership plats and cover maps prepared by the Works Progress Administration as part of a study sponsored by the State Tax Commission; privately owned areas of cutover land enclosed by fence from Michigan Department of Conservation maps; and state-ownership maps, also from the Department of Conservation, which showed the boundaries of dedicated conservation units.

NUMBER OF TRANSFERS

The number of real-estate transfers increased steadily from 1942 to 1947, reaching a peak of 249 transfers in 1945 (Fig. 2). The sale of agricultural land accounted for approximately 50 per cent of the real-estate transfers (Fig. 3; Table II).

FIG. 2. Number of real-estate transfers in Ogemaw County, 1942-46

FIG. 3. Number of real-estate transfers by years according to land use

TABLE II

<table>
<thead>
<tr>
<th>Land use</th>
<th>1942</th>
<th>1943</th>
<th>1944</th>
<th>1945</th>
<th>1946</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural</td>
<td>79</td>
<td>106</td>
<td>102</td>
<td>136</td>
<td>96</td>
<td>519</td>
</tr>
<tr>
<td>Recreational</td>
<td>47</td>
<td>50</td>
<td>68</td>
<td>78</td>
<td>56</td>
<td>299</td>
</tr>
<tr>
<td>Other</td>
<td>18</td>
<td>29</td>
<td>34</td>
<td>35</td>
<td>42</td>
<td>138</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>144</td>
<td>185</td>
<td>204</td>
<td>249</td>
<td>194</td>
<td>976</td>
</tr>
</tbody>
</table>

LAND CHARACTER AND LAND USE

When the real-estate transfers were compared with the broad soil divisions of the county, it was found that over 90 per cent of the property sales in rolling clay soils division and in the level clay soils division were classified as agricultural land (Figs. 4-5). It was noted that fewer than 10 per cent of the transfers made in the sand-swamp soils division were designated as agricultural.
land (Fig. 7). The largest acreage transferred in the sand-swamp soils division was classified as recreational land. These data show a marked trend to select land for an intended use, whether it be of an agricultural or a recreational quality. A definite trend exists toward use of land for the purpose for which it is best suited in all three of these soil divisions.

In the rolling sandy loam soils division, however, the relationship is not so good as that in the rolling clay and level clay soils divisions, since forty to fifty transfers of agricultural land were recorded annually during the five-year period (Fig. 6). These sales represented the lowest-priced agricultural land in the county, and the purchasers will be the first to feel the effects of lower farm prices.

As Atchley has pointed out, "The quality of the land does make a difference. Farmers on the poorest lands who received neither pay for their labor nor interest on their investment in a year like 1946 will have 'tough sledding' if farming conditions return to pre-war levels. Farmers on the poorer lands will have to do a better job of managing."8

An average of twelve transfers of recreational land per year was recorded in the rolling sandy loam soils division.

**RESIDENCE OF PURCHASERS**

Purchasers of land were segregated geographically into four groups, based on their residence at the time of purchase: (1) from Ogemaw and adjoining counties; (2) from industrial counties (Bay, Saginaw, Genesee, Oakland, Wayne, Washtenaw, and Macomb); (3) from other counties in Michigan; and (4) from other states.

Eighty per cent of the agricultural land sold was acquired by local buyers (Fig. 8). An average of 65 per cent of the recreational land (75 per cent in 1944 and 55 per cent in 1946) was purchased by residents of Michigan's industrial areas (Fig. 9). Approximately 60 per cent of the buyers of the third land-use group were local residents (Fig. 10).

Information obtained from questionnaires show that recreational land was purchased for use as hunting or fishing grounds or as sites for summer cottages. This increase of recreational holdings in private ownership should strengthen the tax base of the county.

It is noteworthy that agricultural land continues to be owned by local residents. Returns from the questionnaires indicate that many of those disposing of their holdings were pioneers who were seventy to eighty years of age. This is particularly true of the transfers made in 1945 and 1946.

**PRICE TRENDS IN RECREATIONAL LAND**

The price of Ogemaw County recreational land more than doubled between the years 1942 and 1947 (Fig. 11). The average price of all recreational real estate transferred, including state sales, climbed from $6.41 per acre in 1942 to $13.90 in 1946. The number of transfers...
of private recreational land exceeded state sales by two or three times (Fig. 12). Although the price paid per acre doubled between 1942 and 1946, state sales of recreational land showed a gradual decrease annually during this period. The price per acre of privately owned recreational land with and without water frontage exceeded the price received on similar land sold by the state at public auction (Figs. 13-14). Less desirable water frontage, retention of mineral rights, and retention of access rights to streams tended to lower the price paid for state land. The average prices per acre of recreational property sold, both state and private and with and without water frontage, are shown in Table III.

![Fig. 10](image1.png)  
**Fig. 10.** Percentage of real-estate transfers other than agricultural or recreational according to residence of purchaser

![Fig. 11](image2.png)  
**Fig. 11.** Average price per acre of all recreational land by private sales and by state land sales

![Fig. 12](image3.png)  
**Fig. 12.** Number of real-estate transfers of recreational land by private sales and by state land sales

![Fig. 13](image4.png)  
**Fig. 13.** Average price per acre of recreational land without water frontage by private sales and by state land sales

![Fig. 14](image5.png)  
**Fig. 14.** Average price per acre of recreational land with water frontage by private sales and by state land sales

<table>
<thead>
<tr>
<th>Table III</th>
<th>Average Recreational Land Prices per Acre by Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>All sales</td>
</tr>
<tr>
<td></td>
<td>Without water frontage</td>
</tr>
<tr>
<td>1942</td>
<td>$6.31</td>
</tr>
<tr>
<td>1943</td>
<td>11.50</td>
</tr>
<tr>
<td>1944</td>
<td>11.80</td>
</tr>
<tr>
<td>1945</td>
<td>15.53</td>
</tr>
<tr>
<td>1946</td>
<td>13.90</td>
</tr>
</tbody>
</table>

**SUMMARY**

1. During the five-year period from 1942 to 1947 the number of real-estate transfers in Ogemaw County increased gradually, reaching a peak in 1945.

2. Agricultural land represented approximately 52 per cent of the transfers; recreational land, about 32 per cent.

3. The price of all recreational land more than doubled between 1942 and 1945.

4. Although the number of sales of state land showed a gradual decrease in the period studied, the price paid per acre doubled between 1942 and 1946.

5. The price paid per acre for privately owned recreational land was more than three times the price paid per acre for state-owned recreational land.

6. Over 95 per cent of the transfers in the rolling clay soils division and over 90 per cent in the level clay soils division were for agricultural purposes.

7. In the sand-swamp soils division approximately 65 per cent of the land transfers were for recreational use; fewer than 8 per cent were for agricultural use.

8. Over 66 per cent of the land sold in the rolling sandy loam soils division was for agricultural use; less than 12 per cent was for recreational use.

9. Almost 66 per cent of the purchasers of recreational land resided in the industrial counties of Michigan. Over
80 per cent of the buyers of farm land lived in Ogemaw or adjoining counties.

**THE PRINCIPAL FARMING TYPES OF ANTRIM COUNTY, MICHIGAN**

BURKE G. VANDERHILL

The counties of western Michigan bordering Lake Michigan present many striking contrasts in agricultural land use primarily associated with local differences in topography, soils, and climate. The influence of ethnic groups has also been a factor of significance in some localities. Antrim County, located in the northern part of this coastal strip (Fig. 1), offers an opportunity to study such relationships.

The surface features of the area are the result of the erosional and de-positional activities of the Pleistocene ice mass, and most of the common glacial landforms are represented. These are reflected in a great variety of topography and soils. Owing to differences in elevation and distance from Lake Michigan, climatic conditions within the county also show considerable contrast, the higher eastern portions having greater average diurnal and annual ranges in temperature, shorter frost-free seasons, greater snowfall, and lighter summer precipitation.

Agriculture is the major activity of Antrim County, although only one half of the land is in farms and about one third of that amount is cultivated land. The areas of first-class soil are limited in extent and arable surface. General farms outnumber all others in the county, but there are many which are distinctly specialized. Of these, there are three types, fruit farms, dairy farms, and potato farms, which show striking areal concentration.

Fruit farms dominate a small area in the southwestern corner of the county, where well-drained sandy loam soils, a gently rolling till-plain surface, and a lake-modified climate combine to make this type of farming profitable. Dairy farms are most common in the northwestern townships, where the agricultural population is predominantly Dutch or of Dutch extraction. Specialized potato growing is the leading activity of the outwash plain of eastern Antrim County, where Polish immigrants and their descendants have concentrated.

The remainder of the county is characterized by either general or subsistence farming. The latter is most common in the hilly, morainic sections and in the dry, sandy outwash plains of the southeast, where land is marginal or submarginal for agriculture.

The areas in which each of these five farming types is dominant are portrayed on Figure 2. The boundary lines are approximate, since statistical data upon which they are chiefly based are not available for units smaller than townships. Field observation and aerial photographs indicated that the areas outlined conform rather closely to actual conditions.

In order to examine some of the characteristics of the principal farming types of the county, aerial
photographs covering the county were secured. With these as a guide, sample areas representative of each of the types were chosen (Fig. 2). Individual farms could not be distinguished on the photographs, and therefore the surveyor's section was selected as the basic unit for consideration. Maps were then constructed to show patterns of land use within each type area.

**TYPE I — FRUIT SPECIALIZATION**

Fruit is grown in some quantities on nearly every farm in Antrim County, but most of the farms specializing in fruit production are concentrated in the two southwestern townships. A section bordering the east shore of Elk Lake (Fig. 3) is representative of the fruit-farming area in general.

![Figure 2](image)

Commercial orchards occupy approximately 135 acres in the sample area, showing especial concentration on the till-plain upland of the northeast. Two of the six farms appear to be based almost entirely on commercial fruit production, two have commercial orchards with some supplemental crops, and two have no land in orchards. Thus two thirds of the farms in the section are fruit farms. The amount of pasture occupying the slope land of the western half may indicate that small-scale dairying is carried on as a means of supplemental income.

The field pattern in the section is rectangular, except in the more steeply sloping portions. Fields in crops average about five acres in area, while the orchards tend to be considerably larger. Woodlots comprise only about 10 per cent of the land in farms, which is considerably lower than the county average.

![Figure 3](image)

Type I areas are in general the most prosperous in the county, for, though a considerable outlay of capital is required, in most years the fruit crop brings large returns.

**TYPE II — DAIRY SPECIALIZATION**

Farms deriving the major part of their incomes from dairy products are rare outside the northwestern portion of Antrim County. The localization of dairying here is due in part to the predominantly Dutch rural population and in part to the proximity of these areas to the market afforded by the creamery in East Jordan, in neighboring Charlevoix County. This type of agriculture is exemplified by a section located in central Banks Township (Fig. 4).

The drumlin topography of this part of the county is reflected in the arrangement of the fields, many of which are elongated and parallel the axes of the drumlin ridges. This alignment varies a few degrees from a north-south direction. Pasture land and hay fields occupy a large part of the section. The pastures are commonly located along the borders of the woodlands, which cover much of the lower lands or swales between...
the ridges; hay is produced along their flanks. Cultivated cropland is found along the broad crests of the drumlins, where there is less danger of erosion. Each of the five farmsteads within, the section has a small orchard and a number of garden plots nearby.

Dairy products constitute the main source of income in Type II areas, but many subsidiary crops are important. Market potatoes, cannery crops, and small amounts of fruit are produced, and there are many farms which specialize in such products rather than in dairying. This portion of Antrim County is noted for the general excellence of its farms, and is second only to the fruit-specialty area in the quality of its farmsteads.

**TYPE III — POTATO SPECIALIZATION**

The potato is almost a universal crop in Antrim County, and its distribution closely resembles that of farm population, with one striking exception — a crescent-shaped area in the eastern part of the county. Here potato acreages are very high, especially in relation to the total land in crops. On nearly level outwash plains farmers who are chiefly Polish or of Polish extraction are engaged in producing market and seed potatoes on a large scale. This specialized potato growing is represented by a section in eastern Warner Township (Fig. 5).
Although specialized agriculture is very important in Antrim County, general farming is most common. Such farms produce a variety of sustenance and cash crops, and numerous livestock activities are carried on, but no single product dominates the economy. This type is prevalent in the west-central and north-central parts of the county near the chain of lakes and is usual in the vicinity of Mancelona. As a sample area a section in Forest Home Township was chosen (Fig. 6).

Over one half of the section consists of a gently rolling morainic upland, which descends to lake benchlands bordering Lake Bellaire to the east and Clam Lake to the south. The steeper slopes and sandy lake benches are largely wooded. Fields show little uniformity in size or shape, and the number in crops is indicative of a variety of products.

General farming is characterized by a balanced economy which affords a considerable amount of security, though the returns are not ordinarily as high as in the case of specialized agriculture. There is a tendency toward some specialization in certain cash crops on many of the general farms, but always in connection with a variety of subsidiary crops which comprise the solid foundation for the farm economy.

There are many farms in Antrim County which produce practically no salable surplus, making use of their products largely at home, while work off the farm provides most of the cash income. This type of farming is particularly common in the central morainic belt and in the sandy lands of the southeastern corner of the county. Occupying the valley bottoms or more gentle slopes, most of the farms are distinctly marginal in character. A section in eastern Kearney Township serves as an example of Type V lands (Fig. 7).

Rolling to hilly in the central part of the section, the land slopes toward a broad valley bottom in the northwest corner. The soils of the area are predominantly Emmet sands, which are low in organic matter and are easily depleted. Approximately one half of the section is in second-growth forest, and many acres of cleared land are idle or abandoned. There are five farmsteads in the section, each with a small orchard adjacent. These were originally commercial orchards, but have not been maintained and have deteriorated badly. Only about 60 per cent of the trees remain, and one orchard has been abandoned entirely. The field pattern is roughly rectangular where the surface permits, but the fields vary greatly in size.

Agriculture is rarely profitable in Type V areas, and sources of supplemental income must be found.
Abandoned farms are common throughout the morainic belt, testimonials to the marginal or submarginal nature of the lands for agriculture. Many of the farms were fairly productive when first established, but it was found that new ground had to be cleared and broken every two or three years if production was to be maintained at a profitable level, owing to the rapid depletion of the cropped lands. Farming could not prove successful on this insecure basis. As a result, much land was allowed to revert to the state as tax-delinquent, and it is now being administered on a long-term basis as forest or recreational land.

SUMMARY

The pattern of agriculture in Antrim County is largely a product of evolution. In a century of settlement man, the dynamic factor, has developed, by inclination, trial and error, or by trained reasoning, an agricultural economy which seems to him best suited to his local physical and economic environment. In response to no one set of stimuli, therefore, but to the interplay of many factors, a diversity of farm types has emerged exhibiting definite areal concentration.

Though maladjustments have not been eliminated entirely, the present over-all pattern of agricultural land use in the county seems a mature one, and it is probable that it will persist.

MICHIGAN STATE COLLEGE
EAST LANSING, MICHIGAN

INTRODUCTION

Location of Area and Purpose of Study

THE Snake River Plains (Russell, 1902, p. 13), which extend in a broad crescent across southern Idaho from Yellowstone National Park to Oregon, are formed principally of lava sheets. They are generally bordered on the north, east, and south by rugged mountains. The area of this report (Fig. 1) is the southeast margin of the Snake River Plains and, in terms of topographic landmarks, embraces the northern ends of the Big Hole and Snake River ranges and the adjacent Teton River, Henrys Fork, and Snake River. The back slope of the Teton Range at the Idaho-Wyoming state line bounds...
the area to the east, and the Market Lake playa marks the western boundary. The Snake River, with its major tributaries, the Henrys Fork and Teton River, drains the area. The south fork of the Snake River passes through a broad intermontane valley before reaching the Snake River Plains at Heise. The headwaters of the Teton River rise in Teton Basin. The Henrys Fork rises near Yellowstone National Park, northeast of the map area, and flows southwestward, marking the easternmost edge of the lava flows in the Market Lake area. The Big Hole and Snake River ranges contain the highest peaks in the area of the reconnaissance.

The purpose of this report is to offer some preliminary views on the post-Laramide stratigraphy and structure of the area and to relate them in time and space to the regional geology. The data here presented are derived from a preliminary survey of the Big Hole and Snake River ranges and the adjacent Snake River Plains.

This area is of importance because of the phosphate reserves (Blackwelder, 1911; Schultz, 1918; Gardner, 1944) and coal deposits (Woodruff, 1914; Schultz, 1918; Mansfield, 1920). Petroleum geologists have become interested in the oil and gas possibilities west of Driggs. The correlation of the Paleozoic, Mesozoic, and Cenozoic history of western Wyoming and southern Idaho may be furthered by a detailed study of this region.

Acknowledgments

Included in the report are certain observations made by the writer during the summer of 1946 while mapping the Snake River Range near Alpine, Idaho (Bayless, 1947). Field work continued through the summer of 1947 in the Big Hole Range and the adjacent Snake River Plains. The writer was assisted for two weeks of this period by Fred Houser, then a student at Michigan State College. B. T. Sandefur, Michigan State College, gave counsel in the description of several thin sections. A. J. Eardley, University of Michigan, spent two days in the field with the author and made helpful suggestions during the preparation of the manuscript. Financial assistance for this work came from the All College Research Fund of Michigan State College.

PRE-TERTIARY ROCKS

The Snake River Plains are surfaced with Tertiary and Quaternary continental deposits and lavas which conceal all underlying rocks (Table I). Older strata, ranging from Cambrian to Cretaceous in age, crop out in the surrounding mountains and are presumed to underlie the Snake River Plains (Fig. 1). Descriptions of the formations in the Snake River Range may be found in reports by Schultz (1918, pp. 12-35) and Gardner (1944, pp. 5-12). The same formations, with some differences in thickness and lithology, are also present in the adjacent Big Hole, Caribou, and Teton ranges.

<table>
<thead>
<tr>
<th>Age</th>
<th>Name</th>
<th>Lithology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recent</td>
<td>Younger alluvium</td>
<td>Sand and gravel deposited on recent flood plains</td>
</tr>
<tr>
<td></td>
<td>Black basalt</td>
<td>Fresh black basalt flows and associated fragmental deposits</td>
</tr>
<tr>
<td></td>
<td>Older alluvium</td>
<td>Sand, gravel, and, locally, boulders deposited in pediment alluvial fans</td>
</tr>
<tr>
<td></td>
<td>Buffalo and Bull Lake glacal deposits</td>
<td>Sand and gravel, bedded, overlain by clay; some volcanics and rounded quartzite cobbles</td>
</tr>
<tr>
<td></td>
<td>Lake beds</td>
<td>Clay and silt, locally sandy; locally interbedded with basalt and tuff</td>
</tr>
<tr>
<td></td>
<td>Snake River lava</td>
<td>Basaltic lava, gray to black, fine-grained and vesicular</td>
</tr>
<tr>
<td></td>
<td>Menan tuff</td>
<td>Tuff and unconsolidated lapilli; contains blocks of older basalt, gravel, and sand</td>
</tr>
<tr>
<td>Micro (T)</td>
<td>Flows and related volcanic rocks</td>
<td>Basalt, andesite, latite, and trachyte flows with pyroclastic material and a few lake beds</td>
</tr>
<tr>
<td>Miocene</td>
<td>Rhyolitic rocks</td>
<td>Silicic flows (mostly); some basalt and pyroclastics</td>
</tr>
<tr>
<td></td>
<td>Camp Davis formation</td>
<td>Conglomerate, fanglomerate, and sandstone, calcareous; fresh water limestone and interbedded volcanic ash</td>
</tr>
<tr>
<td>Pre-Tertiary</td>
<td>(Mesozoic and Paleozoic)</td>
<td>Sedimentary rocks that compose the mountains and doubtless underlie the Snake River Plains beneath the Tertiary rocks</td>
</tr>
</tbody>
</table>
MIOCENE (?) PLIOCENE SERIES

Camp Davis Formation

Character and distribution. — The name “Camp Davis formation” is applied to intermontane beds in the map area and adjacent areas in western Wyoming. It includes several thousand feet of calcareous conglomerates, fanglomerates, sandstones, and fresh-water limestones (Pl. I, Fig. 1). It rests unconformably upon underlying Paleozoic and Mesozoic formations. At places on the north end of the Caribou Range it is interbedded or overlain by rhyolitic flows (Kirkham, 1924, p. 61; 1931a, p. 581). Near Alpine, Idaho, the formation contains beds of tuff, and in the Calamity Point area fifteen miles northwest of Alpine, it is cut by two andesite sills (Enyert, 1947, pp. 16-17) 1,200 and 300-1,000 feet thick. Enyert describes the sills as zeolitic hypersthene augite andesites containing microphenocrysts of hypersthene, augite, and labradorite in a groundmass of microcrystalline labradorite, augite, and magnetite with glass and chabazite. The sills indurated the overlying sediments to a maximum distance of eight feet and transgressed the bedding planes.

The Camp Davis formation is well exposed along the valley of the Snake River south of Swan Valley, where it forms the foothills of the Snake River Range. It is also found in the eastern and northern foothills of the Caribou Range. At places it is masked by flows of lava and by alluvium.

Correlation and age. — This great piedmont series has been referred by the writer (1947, p. 24) and by A. J. Eardley (personal communication) to the Camp Davis formation of western Wyoming, after comparison with the type area along the west flank of the Hoback Range. Similarity of composition, environment of deposition, and structural setting is the basis of comparison. The Camp Davis formation in the Hoback Range was described by members of the Field Station staff of the University of Michigan at Camp Davis, Jackson, Wyoming (Eardley, 1942, p. 1800; Eardley and Others, 1944).

The Camp Davis formation in the Hoback Range and in the area of this report was deposited after the Laramide folding and thrusting and accompanied middle Tertiary high-angle faulting. Accumulation was typically against the fault escarpments, which were eroded and finally buried during subsequent deposition. A Pliocene horse tooth, which was found in the fresh-water limestone in the lower part of the type section, proves all beds above to be at least lower Pliocene in age.

Structure. — Deposition in the area of the Big Hole and Snake River ranges was in the Grand Valley fault trough and around the Miocene highlands. At one time the Camp Davis formation probably mantled much of the region, but erosion has removed most of the strata from the later elevated parts.

In the Grand Valley fault trough the strata dip toward the Grand Valley normal fault bordering the Snake River Range. The dips of the strata are progressively less toward the fault plane, where they become practically horizontal. Enyert (1947, p. 24) has suggested that the Camp Davis strata have been tilted and dragged by the displacements of the fault block.

On the north end of the Caribou Range the Camp Davis strata dip at an angle of 2 to 10 degrees toward the axis of the Snake River downwarp. These beds were tilted by an uplift of the Caribou Range complementary to the subsidence of the Snake River downwarp (see “Snake River Downwarp,” p.223).

Relation to the Salt Lake formation. — The Salt Lake group is a widely distributed series of sands, sandstones, tuffs, and marls in Weber Valley and Salt Lake Valley, Utah. It was first described by Hayden (1869, p. 92). Mansfield (1920, pp. 402-406) gave the name “Salt Lake formation” to beds he believed of equivalent formational rank in southeastern Idaho, where the strata most commonly consist of light-gray to buff conglomerates, with rather angular pebbles and some interbedded sandstone, clay, and marl. He assigned the strata to the Pliocene chiefly on physiographic evidence, now questioned. Eardley (personal communication) later found uppermost Eocene fossils (Duchesene River) in the type locality of Hayden, but he believes units of younger age may exist elsewhere.

Kirkham has mapped the conglomerates of the map area and referred them to the Salt Lake formation (1924, p. 29). He reported them to be interbedded with or overlain by rhyolitic flows, which he correlated with the upper Miocene Owyhee rhyolite in southwestern Idaho (1931c, p. 580). These field relationships suggest that the conglomerates belong to the upper Miocene or lower Pliocene and, therefore, correlate in age with the Camp Davis formation. It is felt by the writer that the name “Salt Lake formation” should be abandoned in this area until such time as the type section can be reconsidered. These beds have therefore been assigned by the writer to the Camp Davis formation.

Relation to the Payette formation. — In southwestern Idaho there is a series of lake deposits to which Lindgren (1898, pp. 625-736) gave the name “Payette formation.” On paleobotanical evidence he referred them to the Miocene epoch. In a review of the Payette formation Kirkham (1931a, p. 232) has defined this formation in southwestern Idaho and adjacent areas in Oregon as intermontane beds; they crop out only in intermontane valleys about the edges of the Snake River downwarp. The beds consist chiefly of well-consolidated ash, carbonateous or coaly shale, and sandstone. Plant and mammalian fossils indicate a middle or an upper Miocene, and possibly a Pliocene, age. It may therefore be equivalent to the Camp Davis formation in eastern Idaho and western Wyoming. At several places the Payette formation is overlain by the Owyhee rhyolitic flows, but in general it is overlain by the upper series of the Columbia River basalt and usually overlies the lower series of the Columbia River basalt.
The Payette formation was probably deposited during a period of quiescence between extrusions of the Columbia River lava. The strata were laid down in lakes and swamps, which may have been caused by the damming of old drainage lines by lava flows (Kirkham, 1931a, p. 234). There were times of widespread ash showers, since both the Payette formation and the Camp Davis formation in southeastern Idaho contain extensive ash deposits.

The conglomerates of the map area probably correlate in age with the Payette formation, and this name for the formation has priority over the name “Camp Davis formation.” However, the conglomerates of the map area are lithologically similar to the Camp Davis formation of western Wyoming, and that name is retained by the writer.

**Rhyolitic Rocks**

*Character and distribution.* — Along the borders of the Snake River Plains and in scattered exposures within the plains area are large quantities of dominantly silicic flow rocks and associated pyroclastic rocks that are more silicic than the basaltic flows which surface the plains. A considerable part of this lava is a rhyolite, however; much of it is actually quartz latite, trachyte, andesite, and basalt (Kirkham, 1931c, p. 581; 1927, pp. 33-38; Anderson, 1931, pp. 60-66). For convenience these lavas have been grouped as rhyolitic rocks.

The rhyolitic rocks in the map area are erosional remnants on the north end of the Big Hole and Caribou ranges bordering the plains (Pl. I, Fig. 2; Pl. II, Fig. 1) and are mesalike crests in the Caribou Range. The characteristic dips of the strata on the ranges are 2 to 10 degrees toward the axis of the Snake River downwarp. This dip is often the surface slope.

Lava of this character now appears as a fringe bordering the eastern third of the Snake River Plains, where it either was never buried or has been exposed by erosion in stream canyons. At the Continental Divide on the Centennial Range, Montana, the same flows are elevated along the divide to 10,000 feet but pass under the Snake River Plains at 6,000 feet (Kirkham, 1931c, p. 581). Similar lavas appear in Juniper Buttes, an arched-up area near St. Anthony. The dips of these lavas in the mountains on the north and south sides of the Snake River Plains, together with the exposures in the plains area, offer evidence of a continuous sheet of lava now extending or formerly extending under the Pleistocene basalt and lake beds which fill the present basin.

*Correlation and age.* — Most geologists who have described portions of the region have referred to these rocks as “rhyolite.” Kirkham has applied the local names “Owyhee rhyolite” (1931c, p. 579) and “Tertiary late lavas” (1927, pp. 33-38). The writer follows Stearns (1938, p. 34) in referring to these lavas as “rhyolitic rocks.”

No direct evidence of the age of the rhyolitic rocks has been found in the area shown on the map. Interbedded with them or underlying them in the Caribou Range are conformable beds of the Camp Davis formation. Kirkham (1931c, pp. 564-591) regards the rhyolitic rocks in southern and southwestern Idaho as Miocene or Pliocene in age.

**PLEISTOCENE AND RECENT DEPOSITS**

*Flow and Associated Pyroclastic Rocks*

*Character and distribution.* — The ancient valley of the Snake River above Heise was carved in the Camp Davis formation and associated rhyolitic rocks, and at a later time it was partly filled with volcanic flows and associated pyroclastics. The Snake River, on returning to its former course, carved new canyons (Pl. II, Fig. 2), which in turn were filled by later volcanics, and the cycle was repeated. At least one lava flow coursed down the canyon of the Snake River, partly filling the canyon. The river reestablished its meandering course on the lava fill, remnants of which are now found here and there as benches (Pl. III, Fig. 1) along the canyon. Since this area is topographically higher than the Snake River Plains, the flows were not inundations from the plains, but had a source in the valley and moved toward the plains.

The basal lavas rest unconformably upon the Camp Davis formation, and remnants of the uppermost flows form high benches 250 to 300 feet above the present stream level. Individual flows are 10 to 75 feet thick, but where a flow filled a preexisting drainage channel its thickness increased abruptly. A columnar structure is well developed in many of the lavas exposed in the walls of the canyon (Pl. III, Fig. 2). Lake beds were deposited locally when the river was ponded. Tuff and breccia were laid down during times of explosive eruptions or steam explosions, when flows entered bodies of water (Pl. IV, Fig. 1).

North of Swan Valley pink and white rhyolitic glass tuff, breccia, and andesite overlie the Camp Davis calcareous conglomerate. The tuffs are composed of fine glass dust containing crystal fragments of quartz, magnetite, feldspar (probably orthoclase), and plagioclase (probably oligoclase). In places the white tuff is underlain by a tan pumicelike tuff composed of glass shards drawn out in parallel or wavy lines and bent around the rare crystal fragments of labradorite, oligoclase, quartz, and magnetite. These tuffs may have formed as a consequence of local steam explosions which occurred when the advancing lava flows entered dammed streams. The andesite bears hypersthene and contains lathlike andesine phenocrysts with augite and magnetite. The magnetite is altered in places to hematite, which gives a local red color to the andesite. Pine Creek was inundated by a flow of vesicular dark-gray basalt (Pl. IV, Fig. 2). In thin section this basalt appears to be holocrystalline-porphyrity containing...
near Heise (Pl. V, Fig. 1). The volcanic rock fill is thus extruded was eroded partly in the tilted rhyolitic rocks valley. The valley into which the volcanic rocks were Camp Davis formation and the volcanic rocks that fill the Valley there is an angular unconformity between the these volcanic rocks has been found. North of Swan downwarp (see "Snake River Downwarp," p. 223). The extruded after the major subsidence of Snake River the volcanic rocks near Heise indicates they were younger than the Camp Davis formation and the rhyolitic rocks. The thick mantle of soil and loess on the volcanic valley fill indicates an age older than the barren Pleistocene black basalt, which surfaces part of the nearby Snake River Plains. The horizontal position of the volcanic rocks near Heise indicates they were extruded after the major subsidence of Snake River downwarp (see "Snake River Downwarp," p. 223). The writer has therefore tentatively assigned the volcanic rock fill of the Snake River valley to Pleistocene time.

Kirkham (1924, pp. 42-43) mapped a volcanic group along the west side of the Snake River south of Swan Valley (PI. VI). He reported Camp Davis age conglomerates to be overlain by flows of andesite, basalt, trachyte, and rhyolite with tuffs and agglomerates. Kirkham believes this volcanic group to be a continuation of the rhyolitic rocks, but, after considering their field relationships and similarity to the volcanics south of Heise, the writer is of the opinion that this group is Pleistocene in age.

**Menan Tuff**

Five tuff cones of explosive character are recognized (Stearns, 1939, p. 32) in the map area. The largest mass of tuff is in the two weathered cones known as Menan Buttes, near the confluence of the Henrys Fork and the Snake River (Pl. V, Fig. 2). A much smaller cone is situated a quarter of a mile to the northwest of the buttes, and remnants of two much-eroded cones are a similar distance to the southeast.

The Menan Buttes cover eight square miles and rise 500 feet above the plain. They are partly covered with grass and sagebrush, and contain craters about half a mile in diameter and 100 to 150 feet deep. The lower slopes are covered with weathered tuff and loess, beyond which black volcanic sand predominates. Snake River lava laps on the west and north sides of the Menan Buttes and entirely surrounds the tuff cone to the north.

Large portions of the cones are evenly bedded black to brown basic ash, in part pisolithic. The beds dip away from the craters and become nearly horizontal near the bases. The tuff is partly indurated. Extraneous material is included in the tuff and increases in amount from the north to the south cones. The foreign material consists of weathered basalt blocks, quartzite pebbles, fragments of sedimentary rocks, and angular quartz grains. The tuff weathers, so that the heavier blocks and pebbles are concentrated to form a protective surface.

No lava is known to have issued from these vents. Stearns (1939, p. 35) suggests that the rapid heating of ground water by the rising magmatic gases caused steam explosions which built the cones. The cones are older than anything else exposed on the surface in their vicinity, but the basalt blocks and the gravel show that basalt flows and alluvium underlie them. They are aligned along a northwest-southeast line seven miles long suggesting fissure eruption and a possible continuation of the Snake River fault (Fig. 1).

**Snake River Lava**

The name "Snake River basalt" was proposed by Russell (1902, p. 59) to designate the basaltic flows which surface or underlie the greater part of the Snake River Plains. The writer prefers to designate flows of this age as the Snake River Lava. In the map area the lava flows are the products of numerous eruptions, but available data do not allow differentiation. The youngest flows tend to conceal the older flows where erosion has not dissected the plains. Stearns (1938, p. 56) has distinguished eleven local Pleistocene lava formations along the Snake River canyon west of the area of the map.

Stearns (1938, p. 63) reports that the basaltic flows in the Mud Lake region are as young as late Pleistocene and that some are possibly Recent in age, as is shown by relations to glacial and other deposits and by the degree of weathering. The Pleistocene flows in general are distinguished from older flows by their fresh appearance. The zone of weathering usually extends less than one inch beneath the surface of the Pleistocene lavas.

The Snake River lava is mostly gray to black, fine-grained, and vesicular. It commonly has small feldspar and olivine phenocrysts visible to the unaided eye. Northwest of St. Anthony a well 1,050 feet deep failed to reach the base of these lavas.

The principal vents from which the Snake River lava issued in the map area are shown on Figure 1. Most of the vents, however, lie to the west of this area. A few cones that are older and stand like islands in younger lavas indicate younger and older groups of flows. Over most of the plain the greater number of vents are broad lava domes, each about one hundred feet high, with related flows covering about thirty square miles. The lava rose to the surface through fissures or tubular vents and welled out quietly and profusely. Nearly all these cones had only one period of activity.

The present channel of the Snake River through the map area lies close to the southeastern margin of the Pleistocene lava plains. It appears that many of the vents were so situated that eruptions from them forced
the river to shift to the south away from the median portion of the plain, where, presumably, it originally flowed (Pl. V, Fig. 2).

Lake Beds

Masses of horizontal clay beds containing lesser amounts of silt, sand, and poorly bedded tuffs are found associated with the volcanic rocks in the Snake River Valley south of Heise. These beds accumulated in lakes formed when the Snake River was dammed by Pleistocene lava flows. Remnants of this sedimentary fill are now found in the valley as detached masses (Pl. IV, Fig. 1).

Lake beds occupy depressions in the Snake River basalt in the Mud, Rays, and Hamer lakes area, and near Market Lake. In most places the lake beds are covered by loess and small sand dunes. Northward they interfinger with alluvial deposits and in places they intercalate with surrounding lava flows. The Market Lake beds occupy a basin hemmed in by lava flows, most of which are older than the lake deposits. The scanty fossil evidence and the relations to other rocks (Stearns, 1938, p. 38) indicate that the beds in both areas began to accumulate early in Pleistocene time and continued into Recent time.

Glacial Deposits

Glaciers of the Buffalo and Bull Lake stages moved from the Yellowstone Park plateaus and the Teton Range into the Teton Basin. Deposits of these stages are now found in the map area on interstream areas on the back slope of the Teton Range and on the plains north of the Teton River. The outwash plains are chiefly bedded sand and gravel, and the till contains igneous and sedimentary rocks from the Teton Range, with some volcanics and rounded quartzite cobbles.

Pinedale (late Wisconsin) stage glaciation was widespread in the mountains, where glaciers existed at the heads of most major streams. These glaciers did not move far from their cirques, since few moraines are much lower. Cirques are well developed in the Teton, Big Hole, and Snake River ranges, where they appear on most of the major peaks. Much of the valley development in evidence today was accomplished during times when stream activity was greatly increased by melting glaciers. Pinedale-stage deposits are not included on the geologic map (Fig. 1).

Alluvium

Most of the stream valleys tributary to the Snake River Plains are floored by large quantities of alluvium. Great piedmont alluvial fans reach out from the bordering mountains and spread over the plains (Pl. II, Fig. 2). Older (Pleistocene) alluvium is not differentiated from the younger (Recent) alluvium on the geologic map. The younger differs from the older only in being confined to the Recent flood plains along present streams.

Much of the older alluvium is coarse gravel and sand, with thin beds of clay. Some of the gravels form a hardpan cemented with calcium carbonate. In places along the Snake River the cemented gravel is extensive and has been eroded into hills.

The Snake River has built a large fan above Heise, and gravel deposits cover a considerable area along the river.

Black Basalt

A short distance west of Idaho Falls there is an area covered with dense black basalt that appears to be so young that it is regarded as Recent in age (Stearns, 1938, p. 94). Other areas, including the Craters of the Moon National Monument, are also covered with this black basalt. The freshness of these flows is emphasized by the scantiness of soil and vegetation.

STRUCTURE

General Features

Three stages of deformation are recognized in the region of this report. Extensive low-angled, imbricate thrust faults and parallel folds were formed in Laramide times; block faults in mid-Tertiary time; and, finally, the great cross fold of the Snake River downwarp in Pliocene and Pleistocene time.

During the stages of crustal deformations uplifted areas were eroded, with subsequent deposition in adjacent basins. The basin deposits were in turn deformed and eroded. Parts of the older structures are now covered by less-deformed younger deposits.

The great Laramide folds, developed mostly as parts of anticlinoria or synclinoria, are usually overturned to the east. The Caribou Range consists of long and persistent open folds of this type. Great thrust faults developed toward the end of the period of folding. The thrust faults are low-angled, and of great displacement along nearly horizontal planes, which later were warped and folded. The trend of the Snake River and Big Hole ranges generally conforms with that of these imbricate thrusts.

A common basis for structural correlation exists between the major ranges of pre-Tertiary rocks in the region, even though they are separated by younger formations. The major ranges in which pre-Tertiary rocks are exposed have been involved in the Laramide Revolution and, although they differ slightly in direction of trend and magnitude of deformation, each is closely related to the other in character, origin, and time of development.

Normal Faults

A zone of north-south-trending intermontane valleys and associated normal faults, described as belonging to the epoch of block faulting of the basin and range structure, extends from northern Arizona through the High Plateaus of Utah and the Wasatch Range to
The great structural depression of the Snake River downwarp extends as a crescent across southern Idaho from Yellowstone National Park, through the area of the map to Oregon, and is superimposed on all previous structures. The length of the depression from the base of the Teton Range to the Weiser River is over 400 miles, and its width ranges from 50 to 125 miles.

The formations which visibly take part in the downwarp in southeastern Idaho are the Camp Davis formation, the rhyolitic rocks, and the Snake River lava. Evidences of the downwarping in the map area are the tilted Camp Davis formation and rhyolitic rocks, and the plunging of the Big Hole and Caribou ranges beneath the structural Snake River Plains.

Originally the rhyolitic rocks had a widespread occurrence, as is indicated by outcrops which ring the plains and appear in uplifted areas in the plains. The Big Hole and Caribou ranges have been notably warped since the extrusions of these flows, for the lavas and the erosion surfaces now dip toward the downwarp axis and the ranges plunge beneath the Snake River lavas. That the dip of the rhyolitic rocks is not an angle of flow is indicated by the tilted interbedded sediments.

Kirkham (1927, p. 26) was the first to show that the warping in the eastern Snake River Plains was later than the formation of the rhyolitic rocks. He found in later studies (1931b, pp. 471-482) that the downwarping was subsequent to the deposition of the basal strata of the Pliocene Idaho formation in the western part of the Plains. Thousands of feet of sediment collected as subsidence continued. In the eastern part and in the map area great thicknesses of Pleistocene Snake River basalt partly filled the depression. Subsidence thus generally began in Pliocene time and continued through the Pleistocene epoch. The time interval between the tilting of the rhyolitic rocks and the extrusion of the Pleistocene volcanic rocks south of Heise is indicated by an angular unconformity (Pl. V, Fig. 1).

The Snake River downwarp is especially significant because it does not parallel the regional structure or those of the Rocky Mountain system, but crosses their axes. Complementary movements produced broad antilinal ranges farther south which parallel the downwarp (Anderson, 1931, p. 85) and which arched the Centennial Range to the north (Kirkham, 1927, p. 34). The downwarp probably has faults and rifts along its bottom and sides, but no faults approaching the magnitude of the basin-and-range faults bound the Plains area. The suggestion made by Kirkham (1931c, pp. 456-482) that the down warp is a result of the withdrawal or migration of magma is the most suitable explanation at present. The Snake River basalt may have come to the surface through fractures and so have partly filled the basin.

**Teton Basin**

The Teton Basin is one of the interesting features of the region. Before the uplift of the lofty Teton, Snake River, and Big Hole ranges which border it on the east, south, and west, the surface of this area was inundated by Mid-Tertiary lavas. These volcanics are now found as tilted remnants on the back slopes of the Teton Range and in the foothills of the Big Hole Range.

Warping seems to have been the important factor in the formation of the basin. The present Teton River eroded canyons where the slopes were steep. Tuffs and lavas were deposited during late Tertiary time, as we know from the presence of volcanics in the stream valleys and on the foothills along the southern terminus of the basin.

The alluvial filling of the Teton Basin is of unknown depth since there are no exposures of the underlying rock in the floor of the basin. During the glacial period, when
precipitation was greater, thick alluvials fans were formed at the mouths of the major canyons. That the gravel is somewhat thicker in the Teton Basin than elsewhere may be due to the fact that the glacial waters from the Buffalo and Bull Lake stages poured a large volume of outwash southward into the basin.

**SUMMARY**

The post-Laramide geology of the southeastern Snake River Plains and adjacent mountain ranges in Idaho is one of erosion and deposition, interrupted by crustal movements and effusion of lavas. Near the middle of the Tertiary period the region was uplifted and broken by normal faults. Deep valleys were eroded and immediately filled with the coarse conglomerates of the Camp Davis formation. Deposition continued until the lower hills and fault scarps were buried. Volcanism began, and rhyolitic flows were spread over an area greatly exceeding the present Snake River Plains.

The eruption of rhyolitic rocks was followed in Pliocene and Pleistocene times by subsidence of the Snake River downwarp accompanied by uplift and moderate folding in adjacent regions. Erosion became dominant once more, and the pre-Camp Davis valleys were partly re-excavated.

The Quaternary history of the region shows continued subsidence of the Snake River downwarp and the erosion of adjacent areas. Floods of Snake River lava built up the Snake River Plains. The South Fork Valley of the Snake River was partly filled by Pleistocene flows and pyroclastics while lake beds were deposited in the ponded waters behind lava dams.

Pleistocene glaciation took place, and extensive piedmont glaciers from Yellowstone Park and the Teton Range left deposits on the back slope of the Teton Range and north of the Teton River and poured a large volume of outwash into the Teton Basin. Mountain glaciation occurred later in the Pleistocene, but the deposits are less extensive. These glaciers carved cirques on the higher peaks of the Snake River, Big Hole, and Teton ranges.

Filling of the basins and valleys is continuing today, and vast piedmont deposits are forming about the borders of the mountains.

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**LITERATURE CITED**


Fig. 1. Conglomerate of the Camp Davis formation

Fig. 2. Pine Creek entrenched in Pleistocene lava. 1, Pleistocene lava; 2, Snake River Canyon; 3, Caribou Range; 4, Miocene (?) Pliocene rhyolitic rocks dipping northwest

Fig. 1. Snake River Plains, looking northwest. 1, Big Hole Range; 2, Snake River Plains; 3, Caribou Range and Miocene (?) Pliocene rhyolitic rocks dipping northwest

Fig. 2. Snake River Canyon north of Swan Valley. 1, Big Hole Range; 2, Pleistocene alluvium; 3, Snake River cutting through Pleistocene lava
**Plate III**

**Fig. 1.** Lava bench, Snake River Canyon. 1, Snake River; 2, lava bench; 3, Caribou Range; 4, Pleistocene lava valley fill

**Fig. 2.** Pleistocene lavas along Snake River showing columnar structure in the several flows

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**Plate IV**

**Fig. 1.** Pleistocene deposits. 1, capping lava; 2, lake beds; 3, tuff and breccia

**Fig. 2.** Swan Valley at Pine Creek. 1, Pine Creek lava embayment; 2, Grand Valley fault trough; 3, Snake River fault scarp; 4, Caribou Range
THE BIBLIOGRAPHY OF PARÍCUTIN VOLCANO

ROBERT T. HATT

The birth of the volcano Paricutin in the Mexican state of Michoacán, on February 20, 1943, gave unprecedented opportunity to study varied aspects of volcanology and the biological and sociological consequences of volcanic activity. Investigators from both Mexican and United States agencies and institutions were soon in the field, as were journalists, photographers, and tourists by the thousand. Their published accounts, scientific and literary, have made this volcano the best-known one of our times. Under the auspices of the National Research Council the United States Committee for the Study of Paricutin Volcano was formed in July, 1944, at the invitation of the Comisión Impulsora y Coordinadora de la Investigación Científica de Mexico to work in cooperation with the Mexican scientists. It has served to stimulate and correlate studies at El Paricutin, and all investigators at the volcano are in debt to the Committee for the excellent facilities it has provided there.

The following bibliography was prepared for the convenience of other investigators working on problems of this volcano and on related studies. It includes all printed accounts to the end of 1947 which the compiler finds contributing to knowledge of this volcano or of the country in its immediate vicinity, through either text or photographs. Certain strictly literary contributions are also included, as are a few curiosa. A few mimeographed reports and several of the more substantial newspaper accounts are listed.

A mimeographed bulletin, “Information for Scientific Visitors to the Mexican Volcano, Paricutin,” was issued in December, 1945, by the United States Committee for the Study of Paricutin Volcano and will prove useful, although outdated by the end of 1947.

Persons interested in the scientific literature on Paricutin Volcano after 1947 should watch particularly for papers in the following sources:

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THE Fort Wayne Mound, located at the Fort Wayne Ordnance Depot, Detroit, Michigan, first aroused archaeological interest in 1875, when the Detroit Scientific Association, under the direction of Mr. Henry Gillman, received permission to excavate. The report on this work states (1, p. 312) that a trench was cut east and west through the long axis of the mound. It was supplemented by trenches running north and south nearly at right angles to the original one and cutting nearly at right angles to the original one and cutting nearly at right angles to the original one and cutting nearly at right angles to the original one and cutting nearly at right angles to the original one and cutting nearly at right angles to the original one and cutting nearly at right angles to the original one and cutting. It was this work states (1, p. 312) that a trench was cut east and west through the long axis of the mound. It was supplemented by trenches running north and south nearly at right angles to the original one and cutting nearly at right angles to the original one and cutting nearly at right angles to the original one and cutting nearly at right angles to the original one and cutting nearly at right angles to the original one and cutting nearly at right angles to the original one and cutting.

Gillman records (1, p. 315) that at least sixteen burials were removed, together with some pottery and other artifacts. Most of them were flexed or bundle burials, to judge from the report, but one cremated burial, in a pottery vessel, was located at the central point in the mound. Since the major portion of Gillman's report deals with the measurements and descriptions of the skeletal material, details on the artifacts are meager.

In 1944 the commandant of the post became interested in the mound and, with the members of the Aboriginal Club of Detroit, under the direction of Mr. Carl E. Holmquist, secured permission to investigate it. The Aboriginal Club started work with no knowledge of the previous excavation, but, finding evidence of disturbance, later secured the Gillman report, and was thus able to explain the features which had been peculiar (3, p. 1).

The excavating by the Aboriginal Club covered two seasons of work, 1944 and 1945. The field notes and specimens were later deposited as a loan in the Museum of Anthropology of the University of Michigan. During the first season a trench was opened at the north side of the mound and carried toward the center. The base of the mound was found to rest on beach sand, eleven inches below the present sidewalk grade. It was taken at the datum plane, which was found to be 596.3 feet above sea level. Below the datum plane there was a fourteen-inch layer of beach sand resting on a six- to eight-inch layer of a compact mixture of reddish clay and gravel, with several feet of fine gravel below that.

The compact layer under most of the mound was smooth and level, but at the western end there was found a series of pits containing refuse material, including a large number of potsherds. In all, seven subbase pits were excavated.

**BURIAL COMPLEX**

A description of the skeletal material must wait until a complete report is presented, but the burial complex is well defined. Twenty-three burials were discovered, most of which were in the mound itself; the remainder were in the subbase sands, except one which was below the compact layer.

In the subbase material the burials were flexed and primary, but in the mound proper they were usually bundles of disarticulated skeletons. Individual exceptions to this general classification that were found will be discussed in detail later.

Though artifacts were associated with twelve of the burials, they were not abundant in most of them, and the remaining eleven burials are listed as having nothing in association. Red ocher, which was used in four, seems to have been confined to males.

Three burials are distinctive enough to warrant more detailed description. Burial 10 was found below the base of the mound, in flexed position, with the face up and the hands over the mouth. The small bones of the hands were in place, a position that indicates a flesh burial. Associated with this individual was a deer-bone beaming tool, with one end notched to secure the end scraper with it. There were also two flint flakes and a crushed pot.

Burial 21, which proved to be a flesh burial, the only one discovered within the mound proper, was in a prone position, with the legs widely spread and flexed, and the right hand over the pubic region. There were no grave goods.

Burial 22 was a subbase primary burial in a seated position, with the head upright and facing northwest. The arms were crossed over the breast, with the left hand at the right shoulder. This burial had a large assemblage of slate and flint artifacts, all in a red ocher deposit behind the right hip. A pot, ceremonially killed, was also with the burial. It is difficult to say what is the significance of any of these special burials, but more light may possibly be shed on the problem when the skeletal study is completed.

**POTTERY**

Fort Wayne Mound yielded 1,672 pieces of pottery, which include 8 complete pots, 110 rim sherds, 34 decorated body sherds, 1,515 underrated body sherds, 3 pipe bowls, and 2 clay "marbles."

Crushed granitic rock is the principal tempering material, although in a few sherds sand or sand and grit are found. The texture is medium to coarse, but the sand-tempered material usually ranks as fine. Often the material is crumbly and laminated, scaling off in layers.

Some of the sherds are scratched by gypsum (2.0 on the hardness scale); others, by cryolite (2.5).

The surface of the vessels is either smoothed or roughened by a cord-wrapped paddle, and the rims of the vessels are parallel-sided or collared. There is a direct correlation between surface finish and rim form, for the collared sherds are usually smooth-surfaced, and the parallel-sided ones, whether straight or outflaring, are predominantly roughened. This correlation goes...
even further. The collared-smooth-surfaced vessels are normally softer than the others. On this basis, then, the collared ware will hereafter be referred to as Ware I, and the parallel-sided ware will be called Ware II.

A third ware, which is distinct from the other two, is represented by eight small body sherds, taken from various places in the mound fill. They lack any association with other materials. These eight sherds are thicker than those in either of the other wares, and are tempered abundantly with very coarse grit. The most striking characteristic is cord-wrapped paddle markings on both exterior and interior surfaces. The material has been identified as Vinette I, which has been described by Ritchie (4, p. 164).

When the sherds were arranged according to the levels in which they were found, it developed that the greater number of Ware I sherds came from below the base of the mound, and primarily from the pits. Ware II sherds were largely from the mound fill.

The complete pots have parallel-sided walls, with either straight or outflaring rims (Ware II), and they bear out the statements made above, for though three of them were found below the base of the mound, they were within the first foot of subbase material. The other five vessels were found well up in the mound.

The vessels for which body form could be determined are subconical and incapable of standing upright without support. All belong to Ware II, however, and there is no information on the vessel forms of Ware I.

Nothing has been said as yet about decorative technique or designs. In this respect there seem to be no striking differences between Wares I and II. Impression was by far the favored technique, but incision was used, either by itself or in combination with impression.

There is some slight difference in the placement of the decoration. Both wares have the larger proportion of the decoration either on the exterior rim, lip, and interior rim surfaces, or on the exterior rim and lip surfaces, but Ware I has a slightly greater number of examples in which decoration is on all three of the surfaces, whereas Ware II is more likely to have it upon the exterior rim and lip only. The difference is not large enough to be significant in itself, but, added to the other characteristics of the two wares, it points up the distinction.

The predominant motif or design element is a short cord-wrapped stick impression applied vertically or obliquely, or so as to form overlapping and crosshatched designs. Punctates, alone or in combination with the cord-wrapped stick, are used freely, and from the form of the punctates it is possible to infer the instrument used. Small hollow reeds or grasses and twigs with an irregular broken end surface seem to have been the most popular devices, but smooth-ended round and square sticks were also used. The vessels decorated by incision most frequently bear a cross-hatched diamond pattern, though triangular designs are also found, especially on the collars of Ware I vessels.

Fragments of three clay pipe bowls are included in the count of the pottery specimens. One of these has a sharply defined shoulder angle. It is constricted toward the base and flares at the junction of stem and bowl. The paste is black and is tempered with finely crushed shell and sand. It is probable that a separate pipestem was used with this bowl.

Another pipe fragment consists of the major portion of a straight-sided, smooth-surfaced bowl. The texture of the paste is coarser than that of the preceding example, and the temper consists of coarsely crushed granitic rock. There is no indication of the stem form, or of the point where the stem entered the bowl.

Only one example of a pipe came from below the mound. This is a fragment of a decorated bowl with straight sides and smooth surface. The decoration consists of semicircular punctates, arranged in a band on the upper portion of the bowl. This decorative form is reminiscent of the decoration on the collars of some of the pots.

Two small "marbles" of baked clay were found during the excavating. One of these bore small indentations which may have been made by roulette. The other was unmarked.

STONE

Besides the pottery described above, the Fort Wayne Mound yielded a small but varied series of stone artifacts, both chipped and polished.

Seven triangular projectile points, chipped from gray flint, with corner notches, comprise the most important and distinctive items of stone. These points are small, being about 3.5 centimeters in length and less than 3.0 centimeters wide at the base. The bases are straight, or very slightly convex, and have been thinned by secondary chipping. In addition to these complete points, an unfinished one and four fragments are in the collection. To judge from the shapes of the incomplete specimens, they are of the same general character as the unbroken examples.

There are three flint drills in the chipped stone series— all small and all of somewhat different styles. The largest is triangular in outline; one is square-shouldered; and the third has side-notched shoulders.

The third class of chipped stone artifacts is composed of seven slate discs, roughly circular in outline. Although four of them were definitely associated with burials, their purpose is unknown.

One small end scraper was found with a bone beaming tool, fitted into a notch in one end of the bone.

Polished stone artifacts include a slate birdstone with a perforated base, two celts of gray slate, and a tabular piece of slate resembling an unperforated gorget. The birdstone was found with Burial 5, that of a female, and may have had ceremonial significance.
A fragment of very fine black slate showing a remnant of a polished edge may have come from a slate celt, although the small size of the specimen makes it difficult to say with certainty.

One polished white quartzite “marble” and the basal portion of a sandstone pipe bowl were recovered, but no information concerning them is available.

Large ground stone implements are represented by a granite pestle and a fragment of a grooved sandstone ax. The pestle is irregular on the upper end, but shows signs of use, for the base is slightly concave.

Three sandstone abraders with grooves resulting from use and numerous small unworked flint chips complete the list of stone artifacts.

Some of the artifacts were found in direct association with burials, but the majority seemed to have no relationship with either burials or other artifacts. This, together with the relative scarcity, would seem to preclude satisfactory reconstruction of the cultural complex so far as the stone materials are concerned.

### BONE AND SHELL

The stone artifacts are scanty, but the bone implements are even more so. Three bone awls, a beaming tool, and a thin bone band comprise the total. The awls are well preserved, and two of them are very sharp and well made. It is impossible to tell from what kind of bone they were made, because the articular surface has been removed in the process of manufacture. The third awl is more stubbed, and the surface is rough.

The curved band of thin bone which was found with Burial I is probably an ornament. Both ends are missing, but traces of an incised design are evident upon careful examination.

Shell beads were found with three burials. The small shells seem to have been utilized without shaping, but some larger beads appear to have been cut from thick shell. All are extremely fragile and are scarcely identifiable.

### CONCLUSIONS

Obviously Fort Wayne Mound was built for burial purposes, but Holmquist (3, p. 17) states his conviction that the compact layer, described previously, represents a premound village floor, which may extend under a large part of the present parade ground of the post. The mound may have been constructed after the village was abandoned and the area had been covered with sand.

Laboratory examination of the pottery from the various levels showed that some Ware I sherds known to have come from subbase pits were matched by others recovered from upper levels. This fact suggests that intrusive pits were dug into the mound and were clearly evident to excavators only when the base of the mound was reached. If the pits were intrusive, Ware I is a later product than Ware II.

All materials, particularly the pottery, point to a relationship between this site and the Gibraltar site, excavated earlier (2), but more study and continued careful excavation of similar sites are necessary before any decision in regard to detailed cultural connections can be reached.

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**LITERATURE CITED**


3. **Holmquist, Carl E.** Fort Wayne Mound. (Unpublished field notes, on file with the Aboriginal Club of Detroit and in the Museum of Anthropology, University of Michigan.)