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VOLUME XXXV (1949)

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PAPERS OF THE MICHIGAN ACADEMY OF SCIENCE ARTS AND LETTERS

EDITORS

EUGENE S. MCCARTNEY
FREDERICK K. SPARROW

VOLUME XXXV (1949)

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

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THE FUTURE OF IRON MINING ON THE MARQUETTE RANGE, MARQUETTE COUNTY, MICHIGAN

ROBERT J. GOODMAN

HOW long will the iron ore last?" is one of the questions paramount in the minds of residents on the Marquette Range (Fig. 1). A satisfactory answer to this query involves the consideration of variable factors: (1) cost of production; (2) cost of marketing; (3) iron content of the ore; (4) actual and potential reserves; and (5) variation of market demands.

Recent costs of production of iron ore have reduced the profit in mining (Fig. 2). As a result of increasing wages and a disproportionate increase in retail price, the theoretical profit on ore dropped from ninety cents per ton in 1939 to three tenths of a cent in 1944.[1] Such a drop is not conducive to sustained maximum production. Profits are high in prosperous years if wages and other prices are near average (1937), but profits are low in years of recession (1938) and in periods of inflation. This decrease in profit discourages a mining company from risking capital in the discovery and development of new reserves. As a consequence, these conditions tend to conserve the amounts of ore available.

Ore taken from the underground mines of the Marquette Range must compete with the open-pit ore of the Minnesota ranges (Table I). The latter is cheaper to mine, but position with respect to market, land ownership, state taxes, and marketing techniques allow

the mines of the Marquette Range to operate at a profit within the margin of difference.

The Marquette Range has an advantage over the ranges of Minnesota and Wisconsin in position with respect to market. Not only is it closer to the nation's ore markets than the other ranges, but the mines in it are the closest to ore-shipping ports. These positional advantages explain why the lower rates of transportation of ore are in effect for the ports of Marquette and Escanaba (Table II). It may be noted that the all-rail rates from the Upper Lakes to Granite City, Illinois, is $2.50 per gross ton.

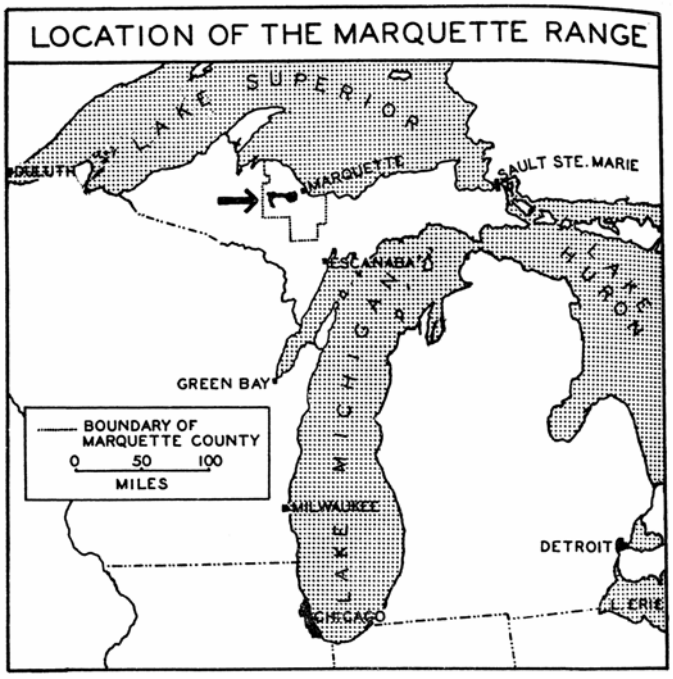

FIGURE 1

The mines on the Marquette Range are for the most part on lands owned by the companies which operate them. This ownership enables the operators to save royalties of forty cents to a dollar on each ton of ore. State taxes on the production of underground ore are consistently lower in Michigan than in Minnesota (Fig. 3). This difference in favor of Michigan has been as high as twenty-three cents per ton,[2] and the tax policy of Michigan acts as a conservation measure. Michigan allows a period of ten years to elapse after the discovery of ore before the new reserve is subject to full taxation. This policy encourages exploration for and rapid development of, new reserves. Minnesota, in contrast, taxes such reserves of ore soon after discovery.

TABLE I

CRUDE IRON ORE MINED IN THE UNITED STATES, 1945*

Area of production	Method of production		Total production
	Open pit	Underground	
All of United States	78,935,218†	27,377,181	106,312,399
Michigan	564,278	11,301,346	11,865,624
Minnesota	68,022,925	4,194,928	72,217,853

* Source: *Skilling's Mining Review*, 35, No. 29 (1946): 1.
† All figures are given in gross tons.

TABLE II

RAIL AND LAKE FREIGHT RATES ON IRON ORE*

Port	Rate per gross ton		
	By rail from Range to port†	By Lake from port to Lower Lakes‡	Total cost
Marquette	$0.685	$0.955	$1.64
Escanaba	0.925	0.685§ 0.820‖	1.61§ 1.74‖
Ashland	0.925	1.045	1.97
Minnesota ports and Superior, Wis.	0.955	1.045	2.00

* Source: *Skilling's Mining Review*, 35, No. 20 (1945): 11.
† Includes dock-handling charge, $0.115 per ton.
‡ Includes unloading charge, $0.145 per ton.
§ Lower Lake Michigan. ‖ Lake Erie.

In marketing techniques the Cleveland-Cliffs Iron Company, largest operator on the Marquette Range, has its own railroad,[3] ore boats, and by-products plants. These measures effectively reduce the cost of ore from the Marquette Range at the lower lake ports and tend to haste exploitation of the ore reserves.

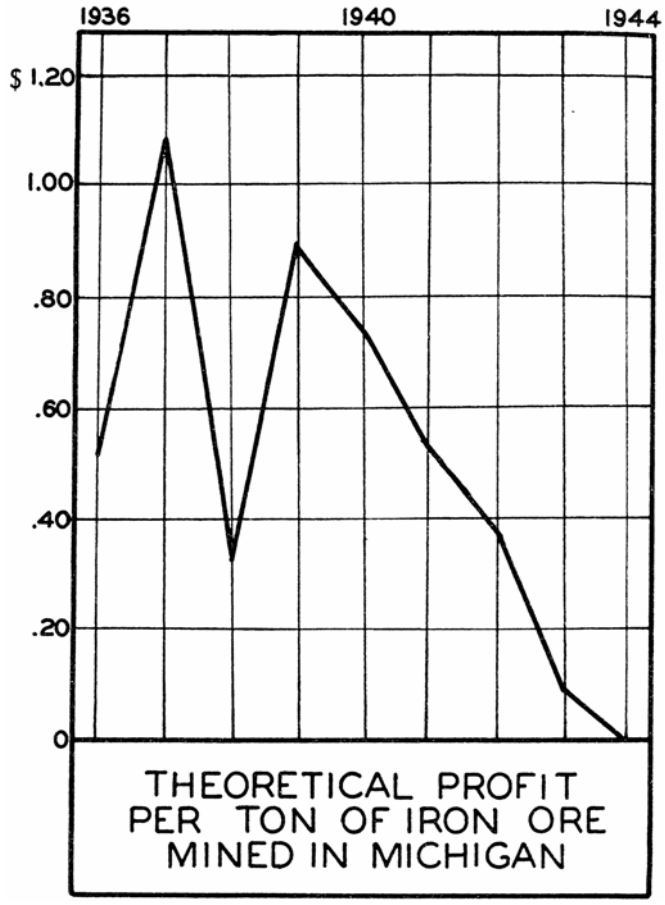

FIGURE 2

The iron ore of the Marquette Range has a high ferric content. Ore must have an iron content of at least 57 per cent to be mined economically for the present-day market. If the content falls below this figure the companies cannot market the ore at a profit. Fortunately the ore of the Marquette Range of the spicular hematite and magnetite varieties assays well over 60 per cent,

and some of it is mixed with poorer grades of ore to improve the latter's content.

Large reserves of potential[4] and actual[5] iron ore exist on the Marquette Range, but at the present rate of consumption the proved reserves will be exhausted in twenty years if new discoveries are not made. The rate of depletion of reserves on the Mesabi Range was accentuated noticeably during the recent war years (Fig. 4), whereas during the same period estimated reserves on the Marquette Range increased slightly.

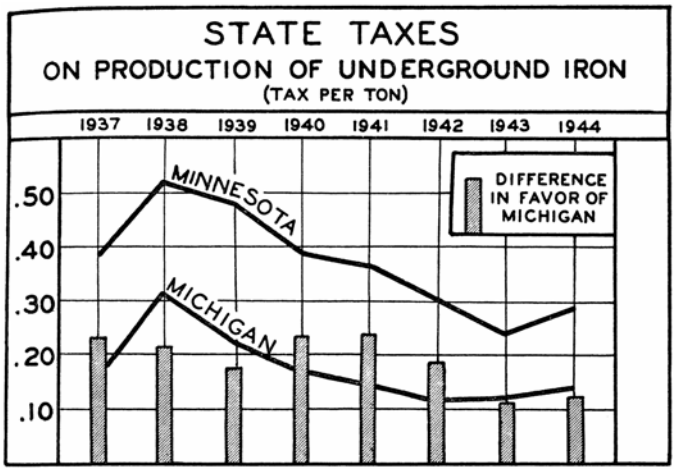

FIGURE 3

An estimated world reserve of 35.2 billion tons of actual ore and 164.8 billion tons of potential ore[6] in 1944 indicates that potential ore will become increasingly more important in the future. The Marquette Range, which has mined only rich ore, in the future must draw heavily on ores with lower iron content. Potential ore can undergo "beneficiation"[7] before shipment. Research is being conducted with a view to improving it and "the next few years promise steady advances in the beneficiation of iron ores."[8] The supply of exploitable ore depends, in large measure upon the progress which is made in beneficiation.[9]

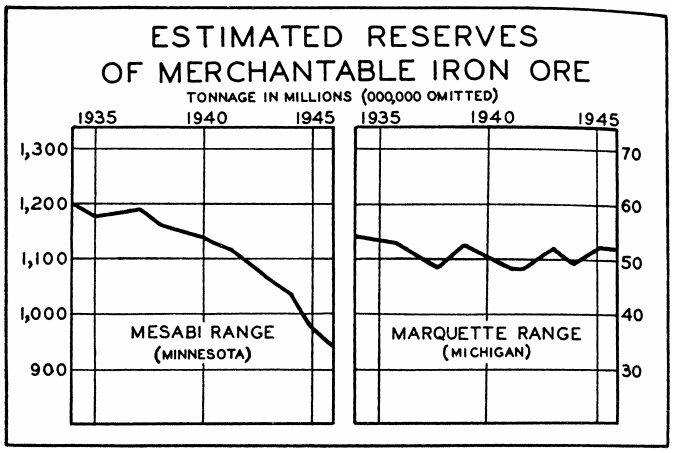

FIGURE 4

Market demands directly affect the production of iron ore on the Marquette Range, and therefore enter into calculations bearing on the life expectancy of ore reserves. In years of national prosperity, when the demand for steel is high, the mines of the Marquette Range produce enormous amounts of ore. Conversely, in periods of national depression relatively small tonnage is produced. It has been estimated that we in the United States are today (1947) using 1,250,000,000 tons of iron and steel to operate our present economy.[10] We are adding to that figure 65,800,000 net tons of steel annually, and would have produced 80,000,000 tons in 1946, had it not been for strikes.[11] This present great demand hastens the depletion of the known reserves.

Thirteen mines are active on the Marquette Range (Fig. 5). This number represents a consolidation of operations, for although total production figures remain relatively constant, each decade sees the closing of several mines. One new shaft is being sunk to tap extensive proved reserves. Such consolidation effects advantages in marketing ore, and indirectly acts as a conservation measure.

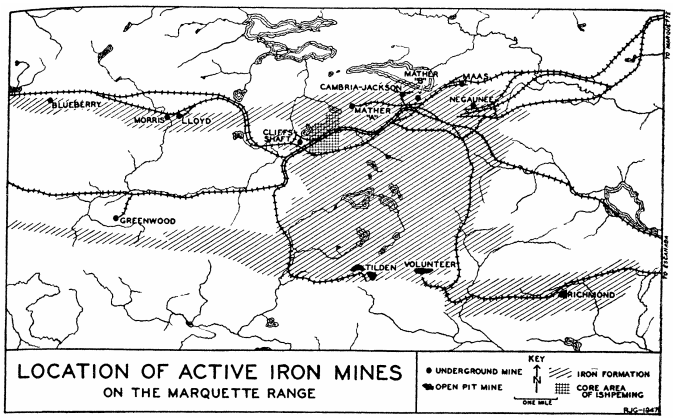

FIGURE 5

Demand for iron ore is variable. Primmer suggested that substitutes and the use of scrap tend to decrease demand, and thereby "substitutions and re-use patently tend to prolong producing life of the ore areas."[18] Perhaps development of the Brazilian or Cuban reserves will materially affect the demand for the ore of the Marquette Range. If the mines continue to yield ore of high iron content, however, and if other conditions continue generally as they are, the Marquette Range will be in a relatively safe production position for at least fifty years.

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[1] Wolff, J. F., "The Economics of Underground Mining," *Skilling's Mining Review*, 34, No. 51 (1946): 14.

[2] *Ibid*., p. 14.

[3] Lake Superior and Ishpeming Railroad, built in 1896.

[4] Ore which the mining companies are unable to utilize today in competition with ores now supplying the market. Potential ore can be too low in iron content, too high in undesirable constituents, or inaccessible to steel plants or markets by reason of distance. White, C. M., *Iron Ore and the Steel Industry* (New York: Re public Steel Corporation, 1947), p. 12.

[5] Ore which is mined and fed into the furnace of the world today; ores from which steel is now being made in plants operating in successful competition with one another. *Ibid*., p. 13.

[6] *Ibid*.

[7] A term used in mining to embrace all types of concentration of low-content ores.

[8] Maxson, Walter L., "Quality and Characteristics of Future Iron Ore Supply," *Skilling's Mining Review*, 35, No. 6 (1946): 4.

[9] For a discussion of beneficiation and its relationship to reserves on the Marquette range see George H. Primmer, "Future of Lake Superior Iron Ore Supply," *Economic Geography*, 10(1934): 397-398.

[10] White, *op. cit*., p. 27.

[11] Tower, Walter S., "Steel Production," *Skilling's Mining Review*, 35, No. 21 (1946) : 1.

[12] Primmer, *op. cit*., p. 400.

THE BEAVER ISLAND-WAUGOSHANCE POINT AREA OF MICHIGAN
A STUDY IN UNPLANNED RECREATIONAL DEVELOPMENT

JOHN H. McMURRY

INTRODUCTION

THE State of Michigan, with its thousands of inland lakes, small streams, rivers, and extensive forest tracts, has become a recreational mecca. It is among the nation's leaders in the number of hunting and fishing licenses sold and also in the number of tourists that visit it. One of its great attractions is its position with reference to the Great Lakes, all but one of which touch its shores. It has more miles of shoreline than any other state in the nation, and there is also the lure of numerous islands that belong to the state.

It is true that isolation and inaccessibility have hampered the recreational use of some areas, but when it is shown that a resource exists, development may follow in spectacular fashion. Such a development, together with a consideration of some problems involved in it, may be illustrated by a study of the Beaver Island-Waugoshance Point area (Fig. 1).

THE SETTING

Waugoshance Point is at the extreme northwest tip of Michigan's Lower Peninsula. It extends westward into Lake Michigan for twelve miles, and is composed of a series of long, narrow islands, culminating in a larger one called Crane or Waugoshance Island. Continuing westward some fifteen miles over a shallow rock shelf one reaches Hog Island, the most easterly of the Beaver Island group. This group of eight islands spreads over nearly 525 square miles of northern Lake Michigan.

Beaver Island, the largest of the group, is thirteen miles long and six in width. Garden Island, the next largest, is five miles long and three in width. Hog and High islands are approximately the same size — roughly ten miles in circumference. Gull, Whiskey, Squaw, and Trout islands are all much smaller, ranging from one-half to one mile in circumference. The entire region is underlain by limestone, which has been slightly tilted and dips gently to the east. Outcropping at the surface and under water has caused the formation of numerous shoals and reefs over much of the water surface of the area. The shorelines of the islands and Waugoshance Point are rough and broken, being everywhere characterized by numerous bays, channels, and inlets, and small offshore islands. The generally shallow water and the nature of the lake bottom, a heterogeneous mixture of sand, pebbles, rocks, and huge boulders, necessitates extreme caution in the handling of even the smallest boats.

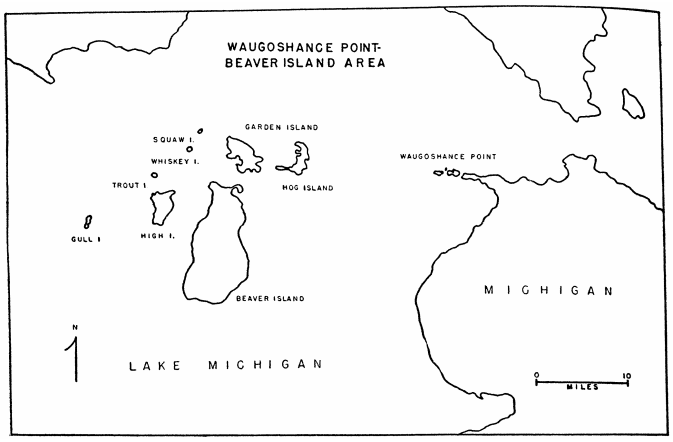

FIGURE 1

Such, then, is the locale of our present discussion. Until recently it was an area of extreme isolation. With the exception of limited agriculture and tourist trade on Beaver Island, it has been almost exclusively devoted to commercial fishing and scattered lumbering operations. It is now, however, the scene of a rapidly developing situation without parallel in the history of recreational use in Michigan.

THE DEVELOPMENT OF BASS FISHING

In the past commercial fishermen operating in the area were concerned mainly with such valuable species as whitefish, lake trout, herring, and perch. They looked upon the large numbers of bass taken in their nets as a nuisance. During the depression of the thirties, however, a program set up by the Michigan Conservation Department attached considerable importance to these fish. Fishermen were paid ten cents a piece for bass. They were caught in trap nets, kept in live boxes, and ultimately picked up by the Department and transferred to inland lakes. With returning prosperity fishermen again found it more profitable to concentrate on market fishing. Thus the program was abandoned in 1937.

Since there is ample evidence that large numbers of game fish are present, it is difficult to understand why the area was not speedily utilized by sportsmen anxious to tap the supply. The combination of public unawareness of the resource, isolation, and difficulty of access, together with the war, seem to have effectively blocked any large-scale opening up of the region.

During the summer of 1946 conditions changed. Returning veterans and others on extended vacations "discovered" Waugoshance Point. Tales of huge fish and limit catches spread, and by the end of the summer word had been passed around that here was indeed a sportsman's paradise. The next two years witnessed a remarkable transformation that at the outset would have seemed almost fantastic. Through the summers of 1947 and 1948 cars bearing license plates of practically every state in the Union parked at the base of the Point. Informal spot checks showed that from 25 to 150 cars were present on every day of the week. Small boats manned mostly by navigators unacquainted with the hazards of the area jockeyed for the best fishing sites. Charter plane services from Petoskey, Charlevoix, Harbor Springs, and as far distant as Traverse City filled the airlanes. Passengers were discharged carrying equipment ranging from bathing suits to rubber boats. This beehive of activity was not confined to Waugoshance Point alone. Yachts, planes, outboard motorboats — every available facility was used in exploiting the fishing grounds of the Beaver Island group as well. Beaver Island itself served as a base of operations. Its two hotels, one restaurant, and tavern (which shortly ran into competition with another tavern opened up next door), were taxed to the utmost in servicing the hordes of sportsmen descending upon them. The two neighboring islands of Garden and Hog were speedily overrun, and commercial fishermen in the vicinity were hampered by fishing parties fouling nets and shearing off net stakes. Landing and taxying airplanes further disrupted operations, while adventurous individuals explored the islands, peeling birch bark and often creating fire hazards. Small boats got into difficulty during bad weather, and the Coast Guard Station at Beaver Island called for additional personnel. A small lake on High Island teeming with pike, perch, and pickerel was located and emptied of everything but bullheads. Within a short time the more remote islands had been investigated, but shoreline and bottom conditions there are different, and few bass were taken. As the 1948 season closed, hundreds of fishermen declared that the following year would see even greater activity.

THE PROBLEM

Numerous questions have been posed by this large-scale occupation of a region which formerly made up one of the few essentially virgin outposts left in the state. Aside from the destruction of certain esthetic values attached to it by many people, other problems of a more concrete nature have arisen.

The only land route leading to Waugoshance Point is a twisting one-lane dirt road which passes through the heavily forested western extension of Wilderness State Park. Having been designed to handle only limited traffic, it was quickly reduced to an almost impassable state by the heavy flow of sportsmen anxious to reach the fishing grounds in the shortest possible time. Thus the establishment of transportation facilities was one of the first problems met. To date (March, 1949) this situation has not changed.

Enforcement of fishing laws and regulations, as well as general supervision of the region, is impossible under present conditions. It is certain that inadequacy of personnel for patrol work and disregard of bag limits have combined to allow an enormous seasonal catch. Whether it is possible to overfish such an area is but one of the many questions that arise. And a noticeable decline in the take toward the end of the 1948 season leads to considerations of cycles of abundance in the fish population. Food habits, the effect of fluctuating lake levels, and the increased incidence of lamprey-scarred bass are only a few of the many other problems that confront the specialists in fish management.

Fire control is particularly difficult because of the almost complete lack of equipment and an organized fire-prevention plan. The fortunate circumstance of comparatively wet summers during the last three seasons has precluded any disastrous fires. A dry summer, however, could very well result in extensive damage.

CONCLUSION

In view of the income that has accrued to the state through the use of the Beaver Island-Waugoshance Point area, its importance as a recreational asset should be obvious. It would therefore appear to warrant far greater attention on the part of those Michigan agencies concerned with such matters.

UNIVERSITY OF MICHIGAN

SETTLEMENT EXPANSION ACROSS DETROIT'S NORTHERN METROPOLITAN RIM INTO SOUTHWEST MACOMB COUNTY*

FLOYD A. STILGENBAUER

THE landscape adjacent to Detroit, geographically known as the umland, is passing through definite stages in changing from rural to urban use. A map showing the occupance patterns of a district extending across the northern metropolitan rim into southwest Macomb County presents conclusive evidence concerning the extent and manner of expansion of the morphological structure within this large metropolitan city. Urban impacts during the growth of Detroit on the rural umland resulted in high land values, increased tax levies on property, loosely managed speculation, and easy credit on loans. Forced improvement of properties made at the owners' expense, incomes augmented by supplemental activities, agreements with management to pay more lucrative wages and grant greater labor benefits were coetaneous elements involved in the process of settlement. This field study reveals how general farming is disintegrating inwardly where the soil will no longer yield an adequate income without a more intensive use of the better land for market gardening, fruit raising, and the cultivation of flowers and nursery stock, or some added form of industry like poultry husbandry, rhubarb producing, and the raising of rabbits, dogs, and mink. Lands less suitable for agricultural improvement and those occupying the more advantageous positions in the transportation form are taken over or reserved for industrial development, which is the major force producing urban growth. Forest remnants and natural beauty spots are frequently utilized for recreation or for home-building sites.

On the outer margin of the district about Utica — formerly called McDougell, Hog Hollow, and Harlow —a strong rural impact on a weaker urban influence results in the retention of more nearly normal farm activities. The only manufacturing in the village is done in two old water-power mills that use raw materials produced on the land. In one, wheat is rolled to make Gold Lace pastry flour for the nearby market, and in the other, grain is ground into feed for the livestock on local farms.

This study is also concerned with the manner of increase in the urban population. Detroit's growth is accomplished (1) by additions in areas within the central nucleus, where settlement is already far advanced but where potential capacity has not been exhausted, and (2) by the rise of small inhabitation clusters within the contiguous umland, which becomes part of the metropolitan area on sufficient assemblage of occupance. When factories are built, demands for housing mount, and the vacant spaces within the inner confines of the city gradually disappear. Homes, civic buildings, commercial establishments, service shops, and public institutions are placed on lands with natural conditions most favorable to their needs in the urbanization plan. It is the ingathering of dwellers on community sites having physical and cultural advantages for business assemblage that causes population to grow upward and outward, increasing the density and adding to the size of the metropolitan center as a whole. From the pressure of growth about the core stems a definite movement of people toward the periphery or to the surrounding suburban, suburban-rural, and rural districts in search of more satisfactory living conditions.

The 1940 census enumerated a tremendous increase of habitation throughout the inner metropolitan rim of Detroit. To judge from more than a decade of observation and study of urban chorography, it is presumed that the 1950 census will show an even greater settlement expansion outside the central city than did the previous one. It is difficult to estimate how much of this growth has been due to migration within, or what percentage of it has been accomplished through additions from outside. Outward expansion of the population has been most rapid and hence nearly complete along such major arterial highways as Lake Shore Drive, Gratiot, Woodward, Grand River, Michigan, and Jefferson avenues. Here the metropolitan rim juts outward from twenty-four to forty miles from the city hall. The interareas where subarteries lead to the main trunkline highways or to the central core of Detroit present a noteworthy increase in the number of inhabitants. This is a typical example of the outward urban growth during the past ten years.

A detailed chorographical survey and a thorough geographical study of a strip of landscape crossing Detroit's northern metropolitan rim along the inner umland were made in the summer of 1948 (Fig. 1). The area consists of the western half of the townships of Warren and Sterling in southwest Macomb County, which lies astride the Michigan Central Railroad and includes the incorporated communities of Center Line, Warren, and Utica. This area of approximately thirty-nine square miles is three miles wide and thirteen miles long. It reaches eastward from Dequindre to Van Dyke Road and extends northward from Detroit's upper border, Eight Mile Road, to Twenty-one Mile Road above Utica. This tract was chosen because the district avoids the direct influence of major trunk-line highways and depicts the more natural relationship of Detroit to its northern environs, where settlement appears to be expanding most rapidly.

In the Macomb district transportation lines are generally good, with each north-south road surfaced with concrete and with each east-we mile road similarly paved or otherwise improved and graded. Highway improvement was stimulated by (1) cheap gravel from the glacial out-wash immediately west of Utica, (2) by abundant cement from limestone and iron-furnace slag produced in Wayne County, and (3) by the rise of the motor-vehicle industry in Detroit. On the interior of the square-mile sections the roads vary from bad to good, depending upon the stage and standard of subdivision development.

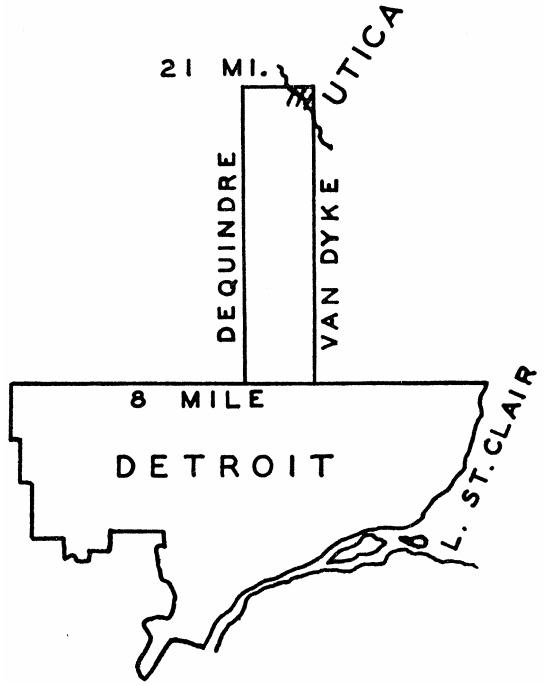

FIG. 1. The area across Detroit's northern metropolitan rim, bounded by Eight Mile, Twenty-one Mile, Dequindre, and Van Dyke roads

Natural landscape conditions are suitable for urban expansion in this area. The land surface, with remnants of ancient sandy beaches of the Pleistocene epoch, is flat to gently undulating and is traversed by the more youthful Red Run, Bear, and Plum creeks, which are tributaries of the older intrenched Clinton River. This gentle slope of the land, together with the argillaceous sediments in the subsoil of lacustrine origin, slows up the movement of ground water to such an extent that pools remain in the hollows for a considerable time after heavy rains.

Natural drainage in many places becomes sluggish because of a high water table in the broad shallow depressions. This condition necessitates construction of artificial ditches with county financial aid. The retarded movement of water appears to be the chief factor impeding efficient use of the land for production and building. On the other hand, intrenchment of the Clinton River with retreat of the glacial ice provided a lower outlet for the artificial drainage needed to improve the moisture condition of the land.

The soils fall into two main types: (1) sandy, silty loams and (2) clays and clayey loams. The former are general throughout the western two thirds of the district as far north as Red Run and also in the extreme northeast along the Clinton Valley. Fertility varies according to the amount of silt and loam present, and the lands that are well drained are suitable for agriculture and subdivision development. Heavier clayey lands predominate in a belt about one mile wide extending along the southeast border, across the north-central portion, and thence northward beside the western boundary. Although the heavier soils, when drained, are more adapted to general farming and industrial development, both types are well suited to market gardening in areas where a loose loamy texture exists in the presence of gravel, sand, and silt.

The climate of the district is typical of the glaciolacustrine plain between Lake Huron and western Lake Erie, where the temperature averages 48.5°F., and the annual rainfall is 32 inches. Since the area is situated in the Great Lakes trough, the atmosphere is humid, and the summers are generally moist, with cyclonic rains, thunderstorms, and squalls alternating with fair-weather sunshine. Winters are variable, with days of snow, sleet, rain, slush, glaze, and occasional high winds interspersed with days of bright sun. Tempering influences from the lake waters provide some protection from late frosts. Paper nightcaps are used extensively over plants by truck farmers during the danger period of early spring.

Originally forested with broadleaved deciduous hardwoods, the district now has only remnants of them in the woodlots toward the center of many of the sections. Such woodlands are used today for grazing, firewood, recreational parks, tourist camps, and residential subdivisions. Some of the hollows, which were rather swampy, contained scattered conifers among a dense stand of other trees. Cutting of the timber followed the founding of Detroit in 1701. In the decades after the turn of^ the nineteenth century there was vigorous activity for emigration to Michigan. Widespread settlement and development preceding a later intensive trend made the removal of the merchantable timber necessary for use in the construction industry and for clearing the land for sustenance agriculture.

The settlement of the Macomb district started as early as 1820; it began from Base Line Road and the right-angle roads of Dequindre, Ryan, Mound, and Van Dyke, which were laid out after the Northwest Territorial surveys divided the land into square-mile sections. East-west as well as north-south roads were cut through the forest along the section lines. Families purchased the timberland for a few dollars per acre and settled along the roadways. In the early days of development there were frequent building bees in which pioneers, with the aid of kind neighbors, constructed houses and barns with lumber and timber cut from the forest. Frequently settlers established their homes near a school, church, or store, located at the cross roads or at attractive sites on the higher and drier ground. During the past three decades many subdivisions have been developed in such locations and have spread to the interior of the square-mile sections, with strong expansion pressure from the south.

The growth of population was slow until about 1920. In 1870 there were 3,487 inhabitants, almost equally divided between Warren and Sterling townships. The Macomb district has about half of them. A slow but gradual increase took place up to 1920, when the census enumerated 5,293 persons. By 1930 the population had risen to 16,731 individuals, of whom

14,269 were in Warren Township because of its proximity to Detroit. The 1940 census recorded 25,774 people, with 22,126 in Warren Township, 3,198 in the incorporated communities of Center Line, and 1,022 in Utica. Stimulated by World War II and the industrial expansion northward along the Michigan Central Railroad, occupance has shown a further marked advance during the past ten years.

The rural impact on the virgin timber area caused grazing and general agriculture to increase as lumbering operations, extending over more than a century, gradually dissected the forest into small woodlots. Lumbering and subsequent agriculture brought only a limited prosperity and growth to Center Line, Warren, and Utica. When the more intensive urban impact of expanding Detroit set in with the turn of the twentieth century, southwestern Macomb County was a district of general agriculture, emphasizing the raising of hay, grains, roots, and livestock. The tempo of the recent northward industrial impact is increasing. Strong demands for urban expansion are being placed on the Macomb district. A geographic inventory of the present landscape conditions in this area will serve to show the direction, nature, and extent of settlement expansion across Detroit's northern metropolitan rim, and will reveal the accompanying adjustments of cultural activities to the changing environment.

In presenting the geographic complex the metropolitan rim is divided into inner, middle, and outer portions. The inner division extends from Eight Mile Road to slightly beyond Twelve Mile Road (Fig. 2). Here Detroit's influence was first felt and has been of the greatest proportions. Through site selection, decentralization, and the need for symbiotic relationship between factories of the motor-vehicle business the industrial form has spread miles beyond the limits of the central city. A major arm of the Detroit factory pattern containing several heavy basic manufacturing concerns, together with scores of scattered symbiotic industries, has penetrated the inner section of the Macomb district along Mound Road and the Michigan Central Railroad. Among these heavy industries and adjacent to the railroad right-of-way a transformer station was constructed by the Detroit Edison Company. The station receives 120,000 volts of electricity from the Marysville Power Plant near Port Huron over high-tension lines paralleling the Michigan Central Railroad. This electric power is divided and sent to numerous substations of 4,000 volts each for consumption in the surrounding area.

Heavy production began with the building of the Rotary Electric Company plant in 1933. There are over 15,000 people employed in the large plants of this locality at the present time. The division of employment is as follows: (1) the Dodge Motor Truck Company, with 5,200 employees, builders of a large line of trucks and trailers used in transporting goods; (2) the Ford Motor Company, with 4,290 workers, engaged in the machining and forging of certain parts used in the assembly of motorcars; (3) the Rotary Electric Company, with 550 laborers, manufacturers of stainless rim steel by means of electric-furnace processing; (4) the Chrysler Corporation Press Plant, employing 1,000 workers in the stamping of steel into motor-vehicle parts (Pl. I, Fig. 1); and (5) the Detroit Arsenal, north of Eleven Mile off Van Dyke, with 4,200 employees, where tanks are manufactured for the United States Army. Among a large number of symbiotic plants with varied employment are the Canfield Mounting Service Company, the Galion Hydraulic Hoist and Bodies Company, the Roadway Mounting and Equipment Company, the Schaller Tool and Die Company, and the Model Broach Company (Pl. I, Fig. 2). The names of the latter companies reflect the ties with the motorcar and truck industries.

Along with these establishments came thousands of factory workers and their families, who wanted to be near their place of employment or outside the central city, where they could be close to rural surroundings. Some worked in the local plants, which also drew laborers from the city; others were employed in Detroit. Factory and subdivision development forced general agriculture to decline and disintegrate. Land was first subdivided along the main highways, and later plotting progressed toward the center of most of the square-mile sections.

The largest subdivisions are around the heavy industries. Small poorly constructed houses predominate. Even former dumps were leveled, covered with a thin layer of earth, and converted into subdivisions. Many homes are build on land containing a mixture of earth, tin cans, broken bottles, fragments of cement, and other débris. One small dump still remains on swamp land between Nine and Ten Mile roads off Dequindre. Habitation has pushed dumping operations farther north. Commercials concentrate along the major highways to serve the people more conveniently. Mixed commercials and light industries flank Eight Mile Road on the north; their position outside Detroit enables them to enjoy lower taxes and still have city advantages. Small property holdings adjoining the south side are mostly vacant. Commercials monopolize Van Dyke frontage to Center Line, except for three sizable vacant spots waiting a greater concentration of homes.

Center Line was founded in 1878. The settlement grew slowly, and for a long time was dependent on Warren for its telephone connection and rural free delivery. When incorporated in 1925, the village had a population of only 300 people. Banking was done in Detroit, and produce was taken to Warren for shipment. By 1930 the population had grown to 2,605, and the community became more independent. Center Line was incorporated as a city in 1931. Favored by close proximity to Detroit, it has grown to be the second largest city of Macomb County, with 3,198 inhabitants in 1940. During World War II the establishment of large factories in the Mound Road district greatly increased the population. Migrants built houses with their own hands because of rising costs. Added housing was

provided by the Federal Government Aid, so that a large area of rural land was converted into a thriving community. Serving the Mound Road industrial section, this city will prosper in the future.

High land values, increased taxation for extensive public improvements, and the difficulty of securing farm labor in competition with the highly paid factory workers made profitable general farming impossible. The general farmer was faced with the problem of choosing one of five alternatives. He could (1) intensify the agricultural process through the use of gardening methods if the soils were suitable; (2) turn the farm wholly or in part to other uses, such as cow and goat dairying, poultry and pig raising, horse renting, and providing land for campers; (3) supplement his activities by adding a greenhouse, rhubarb shed, mushroom barn, dog kennel, rabbit hutch, supply depot, roadhouse, and the like; (4) seek other, more lucrative, jobs, such as trucking service, house moving, excavating, and garden plowing; or (5) sell out to a subdivider at a low price after the property had badly deteriorated. If lucky enough to have the right location, he might sell his land for a good price for a factory site.

The impact of industry is being felt severely, and many of the farmers of the inner section have withdrawn from agriculture, although the old farmhouse and the barn may still be occupied. Barns are sometimes converted into stores or shops (Pl. II, Fig. 1). There are a few farmers operating at a loss, but their number declines toward the industrial center and adjacent subdivisions, where the pressure for removal is great. In the extreme southeast the rural influence has all but disappeared.

Away from the industrial center, intensive farming and supplemental activities are quite well developed. There is an excellent market for garden produce, early shed-grown rhubarb, flowers, rabbits, poultry, and other quick turnover products. Horticulture has disappeared from the southern part of the inner section. Since farm orchards declined with general agriculture, this industry could not be reestablished on account of the long period before the first sizable crop. Even to the north orchards are neglected unless associated with the more intensive activities. Much undeveloped subdivision land is covered with grass, weeds, and brush and is unsightly. Most factory workers do not engage in home gardening to any great extent unless a depression or a manufacturing concern forces it. High wages and long hours of confining work require a less strenuous diversion. Rhubarb sheds become numerous to the west and northwest, and scattered poultry ranches appear. Here one also encounters most of the remaining woodlots, which are sometimes taken over for recreation grounds like the Ryan Park at Eleven Mile Road.

Demands for low-cost housing exceed the supply, and some families find it necessary to live in trailer homes. Six such parks are located in the inner section. The Shady Lane Camp off Nine Mile Road east of Dequindre, which covers three and one-half acres, contains 120 trailers, with an estimated population of 350 people. The proprietor lives in a trailer among his patrons, for this is a lucrative business and requires long hours of personal attention. Rent for a lot is $20 per month, and electricity is charged to the tenant. Water from Detroit reaches each trailer through a pipe with an electrically heated jacket to prevent freezing in winter. Special buildings provide supply, mail, bath, toilet, and laundry services. Meter washing machines are rented to the tenants by the owner. This site is newly developed, and only about thirty to forty per cent of its inhabitants are permanent, but some camps of long standing reach sixty to seventy per cent permanency. The turnover occurs mostly in the fall, when some campers move south to avoid the cold weather, but they return again in the spring to work in the factories nearby.

In the chorography of the middle section of the Macomb district one sees a growing urban influence less advanced, but with high potentiality (Fig. 3). The heavy industries will continue northward along the Michigan Central Railroad, where most of the land is already held by industrial concerns as far north as Chicago Road, paralleling Red Run. On a 360-acre site extending from Eleven Mile Road to Warren village the General Motors Corporation is building a technical center consisting of five large buildings for experimental purposes. The work was halted by World War II, but construction is now progressing satisfactorily since more plentiful material and labor in the building trades are available.

Warren is in large measure the village it was at an earlier day, except for the means of transportation, but is beginning to reflect the new urban impact (Pl. II, Fig. 2). Selection of the site was made in the 1820's at a point where Mound Road crossed Red Run, and was settled by English, French, Dutch, Belgian, and German families. This incorporated village (580 people in 1940) covers one square mile, much of which is rural territory. A steam feed mill and foundry were the industries around which the town thrived in its early years. Eventually the gristmill and the foundry passed out of existence, and the village sought new industries to give the residents employment. A small factory making welding equipment and a new parts plant, together with a few other light industries outside the limits in the direction of the heavy industrial center, gives the inhabitants ample means of employment. Only one small plant exists in the middle section to the north of Red Run. Warren is beginning to experience some growth and prosperity from the General Motors project.

The only decadent manufacturing industry in the district is the old Trombley Brick Company plant northeast of Warren along the Michigan Central Railroad to the south of Fourteen Mile Road. It operated several years on impure subsoil lacustrine clay of a 160-acre tract, but the bricks became soft and gradually crumbled with age. Competition of better brick from Dearborn and elsewhere caused the concern to go out of business. The pitted land became an idle waste of little value until the urban influence arrived. When dumping areas to the south had

been overrun with more valuable types of utilization, Detroit needed a new site for such operations farther out. The city rented the old brickyard property for a small sum and converted it into the largest dump in the metropolitan area. One can readily see how the urban impact converts even waste land to valuable use. In three years after dumping operations are completed the land can be taken over for a building site. Some day homes or factories will rise on this dump, as they have done on numerous others. To the west off Dequindre at Chicago Road, Hamtramck has about eighty acres of dump on the lowlands along Red Run.

General farming is more important in the middle section, where it occupies about two thirds of the available agricultural area. Some farms have a decadent appearance, especially where drainage is sluggish and high taxes for subdivision development are reducing farmers to poverty. Farmers are still making money by feeding ensilage to dairy cows and selling milk at the high prices prevailing in Detroit.

Intensive farming continues from the inner section of Red Run, from where the trend is toward the eastern half of the middle section. Gardening acreage is generally smaller, and all but disappears to the northwest, where soil is heavier and poorly drained. Orchards are numerous, but many are sadly neglected. Outside the intensive area horticulture has vanished through decadence. Similar conditions have been noted in the southern two thirds of the outer section. For the most part the land is too flat, the soil too wet, and too compact because of a heavy subsoil, which retards root growth. Another repellent factor is the presence of maximum frost danger, due to lack of air drainage on these flat lands and the prevailing adverse westerly winds that tend to nullify any tempering influence of Lake St. Clair.

Shed-cultivated winter rhubarb is found throughout the intensive farm areas of all three sections. Around Warren and Utica and toward Royal Oak more winter rhubarb is grown than at any other place in the world. Airplanes and Michigan Central express cars come to pick up some of the supply. In a single season a 300-foot shed may yield a crop that increases income by $3,000.

The accidental dumping of a load of barnyard manure on some rhubarb by a farmer at Seven Mile Road in Wayne County led to the creation of indoor cultivation, which has greatly bolstered a declining general agriculture. The fertilizer had remained on the plants during the winter, and when the farmer returned to remove it in early spring he was surprised to find red stalks of rhubarb growing through a late snow. It was noted by several farmers that the heat generated by rich decomposing manure caused an earlier growth of tender red stems. They set out to establish a new industry inside heated sheds, which were insulated with earth, straw, and manure. Expansion of Detroit forced the industry to retreat northward across Eight Mile Road into Oakland and Macomb counties.

Rhubarb roots are planted outside on good land and allowed to grow two years without any stems being pulled. Then they are plowed up and allowed to remain outdoors under protection until the ground is frozen to a depth of about two inches. They are then placed inside long insulated sheds in earth enriched with a heavy application of manure. The sheds are ventilated and equipped with heating apparatus and watering system, but are carefully guarded from light. Even light from electric bulbs or stoves will cause the stalks to turn green and the leaves to grow large. After six weeks the stalks are ready for harvesting, which begins at Christmas and continues until May. Good timing is necessary to prevent flooding the market.

In the middle section subdivisions are expanding rapidly from the four corners and are numerous throughout the district. They are poor to medium in quality. About one third of the land is idle, which indicates that the owner is planning to subdivide when the time is ripe to reap a fancy profit.

Recreational development is more important where the rural influence predominates and with greater distance from Detroit. Some of the recreational needs of an industrial urban population are met by Carpathia and Magnolia Grove parks, Bar M Ranch, Farmer Jim's Riding Club surrounding an artificial lake in an old clay pit beside the Michigan Central Railroad north of Fifteen Mile Road, Beverly Hills Golf Club in the southeast, and the Warren Aero School on Fourteen Mile off Ryan Road.

Two farms have been taken over for mortuary purposes. Detroit Memorial Park is a Negro cemetery at Ryan Road and Thirteen Mile Road. The Orthodox Greeks have a burial ground at Dequindre and Fifteen Mile Road.

The outer portion of the rim shows the weaker urban impact and, conversely, the stronger rural influence (Fig. 4). The urban relationship is reflected in the rather even distribution of intensive market gardening, poultry husbandry, and dairy farming; also in the more specialized activities such as fattening pigs, raising mink, and the growing of mushrooms, rhubarb, and horticultural products. Fruit is frequently sold along the highway or at a corner market. The better orchards are found in the extreme northwest on the outwash plain, where gravel is an important product. Extensive pits are located along Twenty-one Mile at Ryan Road near the Clinton River. Larger, but less numerous, wooded tracts occur in the west and northwest. General and dairy farms occupy about two thirds of the cultivated land (Pl. III, Fig. 1). Much less land is idle in this part of the district. Only three small industrial plants exist between Red Run and Utica. An airport that uses an old barn for a hanger is situated on Eighteen Mile Road near Mound Road.

One of the outstanding industrial features of this outer section is the petroleum pumping station beside the Michigan Central just south of Utica. It is operated by

the Transit and Storage Company, the Ohio-Michigan Pipe Line Division, a subsidiary of Standard Oil. The station assists in moving crude petroleum from the main pipe lines at Cygnet, Ohio, about thirty-five miles south of Toledo, to the Imperial Oil Company at Sarnia, Canada. Other stations on this branch line are at Sylvania, Ohio, and Wayne, Michigan. The company moves crude oil from any field in the eastern half of the United States, and some is also imported from Venezuela, South America. The stations are about thirty-seven miles apart and are linked by three pipes (two 6-inch and one 8-inch) under 1,000 pounds of pressure. In summer crude oil normally moves at the rate of about 45,000 barrels per day. In cold wintry weather the oil gets so thick that on some days the net movement is only 8,000 barrels in 24 hours. The lines are inspected daily for leaks by men walking the routes in search of oil spots on the surface. Plunger-like reamers are sent through the pipe lines every two days to cut paraffin from the inner surface and prevent clogging. Pumping equipment consists of five Diesels of 100 hp. and two 5-cylinder Diesels of 400 hp. Each engine operates a 17-inch pump by direct drive through a fire wall which separates them for safety because leakage is unavoidable. Engine fuel is derived from the raw crude oil as it passes through the station. About twenty-six barrels are used per day. A machine takes dirt, paraffin and other impurities from the crude oil by centrifugation. Soft water from the roof is retained for use in the Diesels. There are three reserve storage tanks two of 35,000 barrels capacity and one of 80,000, to take care of the variation in flow of the crude oil. In case of fire in a tank the oil is pumped out and water is forced in until there is nothing left to burn. The water flows from a deep well and is stored in a large pool made on the premises for such emergency.

In the northwest square mile of the outer section a thriving mushroom industry is located in barns at five different points. Another barn is in the south-central extreme near Seventeen Mile Road. Mushrooms are grown in darkened beds of specially prepared soil mixed with manure, straw or other materials, and inoculated with spawn. The dirt, manure and other ingredients are thoroughly sterilized by live steam for several days in order to prevent the invasion of species of fungi which might be poisonous or otherwise injurious to the mushroom crop. The mushroom mycelium grows abundantly under heat, moisture, and darkness until the nourishment of the soil mixture is used up. The produce is plucked each day and finds a ready market in Detroit and New York. This industry is expanding to meet an increasing demand.

Another highly specialized activity is the raising of mink. The Sherlock Mink Ranch containing over a thousand animals is about a mile west of Utica on the Auburn Road (Pl. III, Fig. 2). Mr. Sherlock has attained great skill in the crossbreeding of mink in order to develop strains of rare color and quality of fur. It takes three or more years of careful selection in breeding to obtain a new strain that will remain true to color. Jet black, silver black, patch black and white, pure white, platinum, blue platinum, and blue are some of the select colors. A few animals are worth as much as $1,000 apiece for breeding purposes when the color strain is of a rare variety. Mink are fed on a formula of ground horse meat, codliver oil, cereal, and medical ingredients. Being carnivores, they are very untrustworthy, and they bite at the least provocation. A mink bite bleeds profusely, but never becomes infected. Pelting is done in the late winter, when the fur is prime. The animals are kept in rectangular wire cages about two feet off the ground, each containing a wooden den of uniform shape placed on the upper side and adjacent to the alleyways. All manure drops to the ground through the wire bottom, and the animals keep themselves unusually clean. Mink ranching is very profitable in the hands of an expert, though it is not pleasant, since the animal has a scent gland on the order of a skunk, but the odor is less disagreeable.

Two piggeries are in the central part of the outer portion to the south of Plum Creek. The owners purchase pigs from the neighboring farmers and confine them in small enclosures, where they fatten them on garbage and grains for the Detroit market. Also typical of a suburban region are the numerous poultry houses in which chickens and turkeys are raised in large numbers for the city market. Producers enjoy the advantage of fancy prices through direct deliveries to the markets or to the consumer. The rural influence of the outer section is best distinguished by the background and present activities within the village of Utica. This site was settled in 1817, when three families arrived by way of Canada to establish homes. Advantageously located on the Clinton River for power and transportation, the settlement grew slowly as a lumbering and distilling center. By 1880 there were 490 inhabitants, the number increased to 562 in 1900, 588 in 1920, and 1,022 in 1940. Commercial and industrial activities reflect the rural surroundings. It is estimated that about half of the laboring population finds employment in factories outside the community nearer Detroit. These people choose to remain here because of the quiet rural environment.

When the era of canal building reached the United States in the 1820's, Michigan attempted to keep pace with other states by starting the construction of a water connection between Lake St. Clair and Lake Michigan (Pl. IV, Fig. 1). It was begun in 1830, and with pick, shovel, wheelbarrow, and scraper a canal was dug from Harlow (now Utica) to Rochester. The channel was built high along the north side of the valley with a sluiceway at the upper end to control the amount of water entering it from the Clinton River. At the time of incorporation Harlow was renamed Utica after the city on the Erie Canal in New York State. Small horse-drawn barges were used to transport goods and produce from Rochester to Utica and thence by river to Mt. Clemens.

In 1846 a flour and a gristmill, now operated by the Utica Milling Company, were built at the lower end of the canal, which served as a source of waterpower (Pl. IV,

Fig. 2). Huge timbers and thick planks cut from the forests of that time were joined together with wooden pegs to form the frames of these mills, which are still in good condition after more than a century of continuous operation. The mills are equipped with electric motors to meet emergencies. The chief emergencies occur when muskrats burrow through the banks of the canal, which is higher than the Clinton River, and thus cause the water to run out into the stream. Millers have been granted special permission by the State Department of Conservation to carry on out-of-season trapping of the rats so as to minimize this difficulty. About fifty barrels of Gold Lace pastry flour are manufactured per day, and it finds a ready market in Detroit and New York. The gristmill grinds large quantities of animal feed for the farmers, some of which is marketed in Detroit.

The village has an interesting monument since they have preserved one of the wildcat banks which was built in 1836. This building, having brick walls two feet thick, stands on Auburn Road just west of the Michigan Central Railroad and is used today as a dwelling. A wildcat bank had insufficient specie backing, yet issued huge amounts of paper money which it could not redeem. When a banking inspector came for the annual check up, the wildcatters would pool their specie and rush it from one to another just ahead of him so as to make the issues of paper money look legal. This bank failed as a result of the general recession which followed the Panic of 1837. Five years later its corporate rights were annulled by the Michigan legislature. Until recent years its occupants discovered in the recesses of the building bundles of the old paper money issued by the institution. This money is worthless, but makes a valuable memento of an exciting era of the past.

Utica's commercial and social life is typically rural. Farmers bring their grain to the mills and obtain their needed supplies from the commercial establishments. The tempo of this rural life has been hastened by the almost universal use of the motor vehicle for transportation. Visitors come to view the old mill, bank, canal, and printing office or to enjoy an hour in a rural village where life is still somewhat representative of an earlier period.

The growth of Detroit's northern metropolitan rim has been phenomenal since 1935. Migrants from the central city, from other parts of Michigan, and from other states have contributed the bulk of the settlers. Each of the three subdistricts of this Macomb County area represents a stage in the intensity of the urban impact of Detroit as the cultural landscape changes from rural to suburban-rural, to suburban, and, ultimately, to urban. Warren Township on the inner side of the rim shows the strong city influence and ranks third in population in the state. Many houses in the district are poorly constructed, and because of a shortage some people are forced to live in trailers. Some families get water from a common well, unsanitary outhouses are not uncommon, fire protection, sewers, and school facilities are inadequate, and street improvements lag behind the building of homes. The impact of a great industrial city has produced a growth and an expansion too rapidly for living conveniences to keep abreast of the times. These conditions are apt to continue for many years, but as the inhabitants accumulate capital, costly readjustments have to be made in order to establish a more modern American way of life,

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* The cartographic work for this paper was done by George Kaston, Wayne University. Noreen Barton, Robert Basal, Robert Brodowicz, Ann Chikos, George Kaston, Robert Kelley, Sidney Rose, and Alphonse Trawinski assisted in the collection and presentation of field data.

STILGENBAUER PLATE I

FIG. 1. Carnegie Steel Corporation Plant while under construction for the Chrysler Corporation on Mound Road

FIG. 2. Symbiotic light industries on Mound Road near Nine Mile Road

FIG. 1. An old farmstead barn converted into a store and shop dealing in building supplies

FIG. 2. Warren Village, on Mound Road at Chicago Road, experiencing a little of the urban impact

FIG. 1. Dairy cattle grazing on the lush pastures of the outer portion of the district near Utica

FIG. 2. Sherlock Mink Ranch, containing about one thousand animals of high-quality fur and in rare color strains, located on Auburn Road to the west of Utica

FIG. 1. The old Utica-Rochester ship canal, constructed by hand and team labor in 1830, now supplying water power to the Utica Milling Company

FIG. 2. Utica Milling Company flour mill constructed in 1846 of heavy pegged plank and timber from the forests of that day; it rolled the wheat from the rural community into Gold Lace pastry flour at the rate of fifty barrels a day

A SURVEY OF LAND USE AND LAND OWNERSHIP ON BOIS BLANC ISLAND

BURKE VANDERHILL

INTRODUCTION

IN THE extreme northwestern portion of Lake Huron, between the upper and the lower peninsulas of Michigan, lie a number of islands which have been significant in varying degrees to the Indian, French, British, and American occupants of this region. The largest of these is Bois Blanc[1] Island, which is at the eastern entrance to the Straits of Mackinac (Fig. 1).

Despite its size, the island has played a minor role in the affairs of the Straits of Mackinac region. For the Indians it was primarily a source of maple sugar, and only an occasional camping place. Since the coming of the white man it has been overshadowed by Mackinac Island, a much smaller island less than three miles to the northwest, which it long served as an auxiliary supply base. Having experienced a short boom period of lumbering and land speculation, the island today is a quiet summer resort area, with a few clusters of cottages along its southern and eastern shores. It remains an outpost, which travelers by-pass and is little known outside the immediate vicinity.

It is the purpose of this study to evaluate Bois Blanc Island in terms of its utility to the various peoples who have occupied the Straits region.

PHYSICAL CHARACTERISTICS

Roughly pear-shaped, Bois Blanc Island is twelve miles long and has a maximum width of six miles, and thus comprises an area of about thirty-four square miles. Viewed from the mainland, the island appears low and featureless, for its elevation seldom exceeds fifty feet above the level of Lake Huron.[2] Upon closer examination, however, surface irregularities become apparent.

Trending roughly parallel to the longer axis of the island is a succession of irregular north-facing cliffs or scarps which range between ten and thirty feet in height above their bases. These scarps, carved in dolomitic rocks whose strata dip gently southward, are evidence of the cuesta-form nature of the island. Most of the surface consists of a series of nearly level benchlands which extend southward from the crest of each scarp to the base of the next. They vary in width from a few hundred feet to over a mile, and have many low, gravelly ridges meandering across their surfaces. The benchlands are composed of unconsolidated glacial till deposited by the continental ice masses of the Pleistocene. This material was reworked by wave action during the successive lake stages which followed the withdrawal of the glacier, and

thus was produced a complex of lake benches and beach ridges.

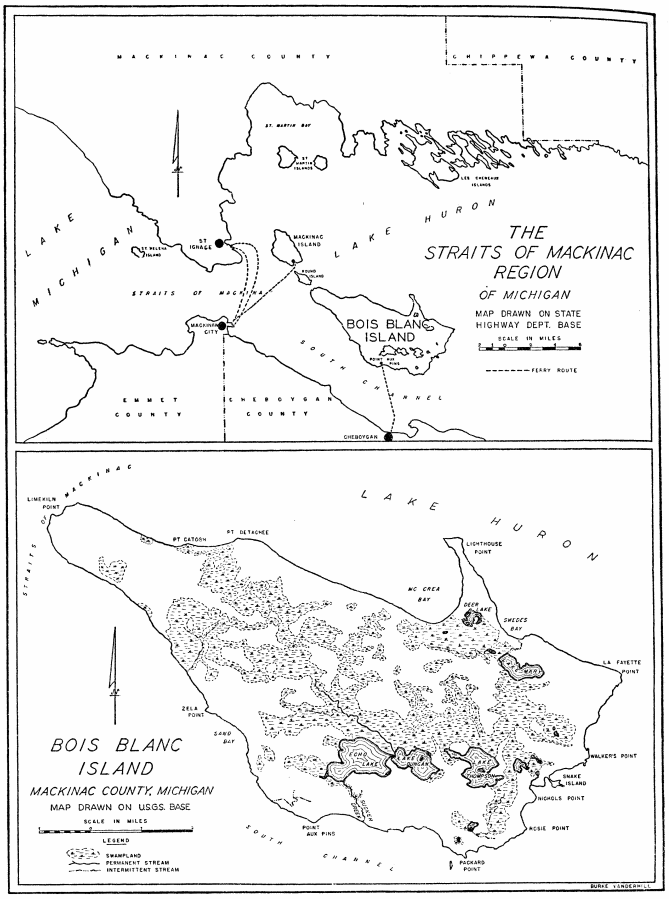

FIGURE 1

The present shorelines of the island resemble their predecessors in being predominantly gravelly or stony. There are, however, a number of coves along the southern and eastern shores which have sandy beaches. The water is shallow for some distance offshore, and no natural harbor exists.

The drainage pattern on Bois Blanc Island is an irregular one (Fig. 1). In the southeastern two thirds of the island there are about a dozen shallow lakes and several extensive areas of swamp, which, in view of the dip of the bedrock and the porosity of the till overlying it, seem to be maintained by underdrainage from the north and northwest. Only two permanent streams are found. One arises in the central part and flows southeastward into Lake Duncan. Since Lake Duncan and Echo Lake are joined, the second stream, Sucker Creek, which connects Echo Lake with Lake Huron, is really a continuation of the first. A few short creeks, intermittent in flow, are found along the southern and eastern shores.

Bois Blanc Island lies in a region of long, cold winters and short, mild summers, in which precipitation is well distributed throughout the year.[3] The winds of winter sweep across the ice-covered expanses of the lake without hindrance, frequently causing sensible temperatures to be bitterly cold. In summer the encircling waters usually keep temperatures comfortably mild.

The island's podzolic soils are well supplied with lime and are, therefore, inherently rather fertile, but their coarse texture and high content of stone and gravel make them generally unsuited to agriculture. Swamp soils, largely acid mucks and peats, comprise nearly one quarter of the total. Only a few scattered patches of good agricultural soil are found,[4] principally in the western portions of the island (Fig. 2).

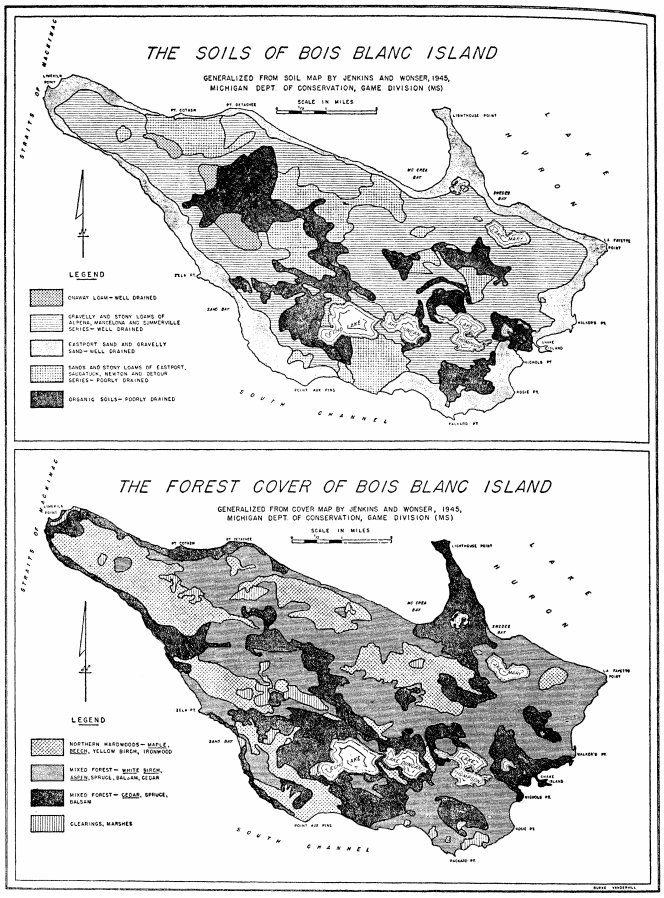

FIGURE 2

Bois Blanc Island was originally densely forested. A mixed growth off white and yellow birch, sugar maple, hemlock, and various conifers occupied the well-drained lands, while cedar occurred on the swampy lands.[5] The island today is 95 per cent wooded, but the composition of the forest has changed. Except for the mature timber on Lighthouse Point, long held by the Government, the forest is second growth and is coming back in thick stands (Fig. 2). Northern hardwoods occupy about 23 per cent of the area of the island,[6] occurring most commonly on the heavier well-drained soils. The species represented include sugar maple, beech, yellow birch, and ironwood. The remainder of the forest consists of admixtures of hardwoods and softwoods in varying proportions. On light, generally well-drained soils white birch and aspen predominate, associated with spruce, balsam, and cedar. This type covers about 38 per cent of the total area. A mixed forest in which

spruce, balsam, and cedar are dominant covers the remaining 2 5 per cent of the island, mostly poorly drained. Solid stands of cedar, formerly widespread on such lands, now occur only in a few small patches near some of the inland lakes. Most of the second-growth timber ranges between six and nine inches in diameter, although some areas have older stands which are already merchantable.

Wildlife is fairly plentiful on the island, but is limited in variety. Deer, snowshoe rabbits, beaver, and duck are the principal game species, though individuals of others are occasionally reported. Fish are found in the larger inland lakes, but apparently not in abundance, and the shore waters are not well stocked. Owing to the large areas of swampland, insect life is abundant on the island, and during the early summer mosquitoes, black flies,[7] and "no-seeums"[8] are particularly numerous and annoying.

In summary, the basic resources of Bois Blanc Island seem to be its timber, the dolomitic rock available at the surface, its wildlife population, a mild summer climate and some stretches of sandy beach — resources in which, however, it is equaled or surpassed by much of northern Michigan. On the other hand, its poor soils, large areas of swamp and the seasonal swarms of insects associated with them, and the lack of harbors and fishing grounds would seem to be major disadvantages.

Let us see how man has made use of the island through the various periods in its history.

EARLY HISTORY AND SIGNIFICANCE

While the Straits of Mackinac region was comparatively well populated before the coming of the white man, there is no evidence that permanent camps or villages ever existed on Bois Blanc Island.[9] The Indians of the region chose to establish their villages on Mackinac Island Round Island, St. Martin's Islands, or on the neighboring mainlands (Fig. 1), which were adjacent to their principal fishing grounds and which had better soil for growing corn.[10] The Straits formed a constriction in both the land and the water routes followed by the Indians, but Bois Blanc Island lay several miles east of the junction, and was usually by-passed. Their principal interest in the island was in its groves of sugar maple, the finest in the region, and they came here across the ice, in late February or early March, to make maple sugar. They called the big island Mi-ko-bi-min-iss — "White Wood Island" — because paper birch and aspen were common along its shores.[11]

The French missionaries and fur traders, in the course of westward expansion from the St. Lawrence Valley, came into the Straits region in the late seventeenth century. Since their interests were in converting the Indians as well as in trading with them, they established themselves in or near the Indian villages of the region.[12] The French at various times had forts on Mackinac Island and the northern and southern mainlands, in each case taking advantage of defensible positions and harbors located on the main routes of travel. The big island, whose name they translated into French as lie aux Bois Blanc, served them, as it did the Indians, as a source of maple sugar.[13] Because of the proximity of its western end to Mackinac Island, the settlers began to come to Bois Blanc Island to cut wood, walking over the ice in the winter, and later they established here a scattered plantings of apple trees.[14] Some woodcutters' huts were erected on the island, but there seems to have been no permanent settlement.

The British, having wrested Canada from the French in the middle of the eighteenth century,[15] came into the Straits region not as settlers but as soldiers and merchants, and after preliminary surveys they chose Mackinac Island as the site of their fort and fur posts because of its defensible heights, its excellent harbor, and its strategic location.[16] Bois Blanc Island had little significance to them except as a source of firewood for their garrison and their warships.

The island came into American hands in 1795 as the direct gift of the Chippewa nation, at about the time Mackinac Island was relinquished by the British,[17] and under early American control it remained a supply base for Mackinac Island. The army constructed a kiln at the western end of Bois Blanc Island (Fig. 3), in which dolomite was burned to secure lime for use in Fort Michilimackinac, and also utilized the island as a fuel reserve for the fort.[18] Some small gardens were established near the south shore (see Missionaries' Wharf, Fig. 3) by the Presbyterian Mission at Mackinac Island to satisfy their needs for vegetables and at the same time to train the older Indian boys in methods of cultivation.[19] With the closing of the mission in 1825 the gardens were abandoned.

Residence on Bois Blanc Island was sporadic or, at best, seasonal, and was generally restricted to the well-drained western and northwestern margins, facing Mackinac Island. The first landholding on the island for which a record exists was the private claim of Michael Dousman, approximately 640 acres on Limekiln Point (Fig. 3), which was privately surveyed in 1810. Dousman was a leading businessman of Mackinac Island and also owned timber property and sawmills on the mainland adjacent to Limekiln Point. By the time of the General Land Office survey of Bois Blanc Island in 1827 he had cut timber from much of the northern part of his claim, shipping it to his mainland mills from Missionaries' Wharf.[20] Although there is evidence that he grazed cattle on the island at one time, apparently he was not doing so at the time of the survey. The survey recorded two occupied dwellings and several clearings along the northern shore and, in addition, there were on the island at this time a house belonging to the Government, two abandoned dwellings, and a number of sugar camps (Fig. 3).

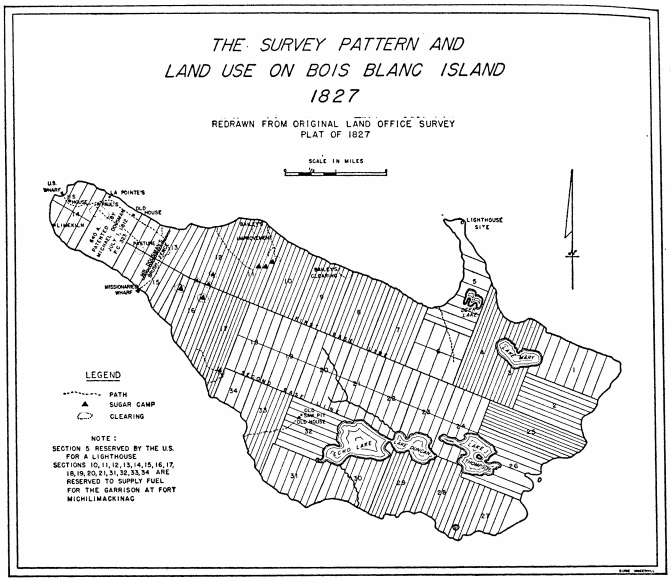

FIGURE 3

Because of its shape and the fact that its area approximated that of a township, Bois Blanc Island was surveyed in an unusual manner (Fig. 3). Two base lines were laid off parallel to the longer axis, and from them, 34 odd-shaped sections were surveyed, each comprising as close to 640 acres as possible. Then, since the usual land descriptions would not apply here, each section was subdivided into Government lots of approximately 80 acres, surveyed in such a way that 80 per cent of them were given water frontage. Dousman's claim was acknowledged and was not incorporated into the survey grid. As soon as the survey plat was recorded, the Government withdrew from entry 16 sections in the western half of the island as a fuel reservation for Fort Michilimackinac, and set aside section 5 as a reserve for a proposed lighthouse (Fig. 3).

THE PERIOD OF REORIENTATION

In the years following the survey the lighthouse was built, and the land open to entry passed gradually into private hands. There were desultory attempts to settle on the island and to farm its rocky soil, but most owners were interested only in the timber on their lands. Cutting on a small scale was carried on, mainly for firewood, poles, posts, and shingles.

Since most of the western half of the island was a Government reservation, land acquisition was largely in the southeastern portion, by people from the mainland rather than from Mackinac Island. Thus Bois Blanc Island began to face southward, toward Cheboygan, instead of northwestward, as it had done for so many years.

THE BOOM ERA OF LUMBERING AND LAND SPECULATION

The withdrawal of the Mackinac Island garrison in 1895 and the relinquishment of its fuel reservations on Blois Blanc Island coincided with the peak of lumbering activities on the neighboring mainland, and the lumber interests began to acquire land on the island in the hope of extending their operations for a few years. Landholdings were consolidated as well as possible by three companies, sometimes by the leasing of timber rights, sometimes by outright purchase (Fig. 4).

Lumbering operations on the island began at about the turn of the century. A steam sawmill to handle hardwood logs was erected at Sand Bay by the largest company, and a railroad was built into the interior to bring the logs to the mill. The other timber operators seem to have transported their logs to Cheboygan for milling. Cutting proceeded rapidly, and by 1908 most of the merchantable timber had been exhausted.[21] The mill was dismantled, the railroad was torn up, and only the scars of lumbering remained.

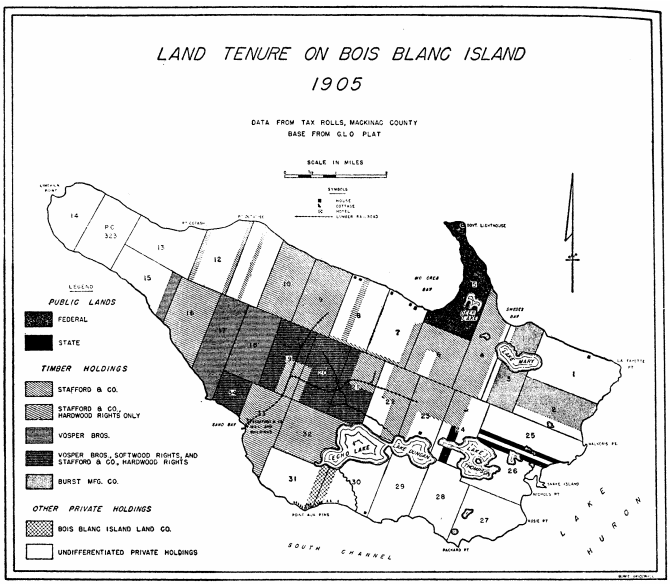

FIGURE 4

In 1898 an organization known as the “Bois Blanc Island Land Company” purchased two Government lots in sections 30 and 31, and by 1900 a hotel and nine cottages had been built at Point Aux Pins. By 1905 several more cottages had been built nearby along the Lake Huron shore (Fig. 4). Thus the first evidences of the present pattern of land use began to emerge.

After the fire which swept over the island in 1908 in the wake of lumbering, destroying some of the cottages, the land company was bought out by a group of Detroit people who were incorporated as the “Point Aux Pins Association,” and their shore holdings were platted as the first resort subdivision on the island. Interest in resort property here grew, especially among Detroiters, and nine more subdivisions were established in succeeding years, primarily as speculative ventures (Fig.

5). By 1927 most of the property that could be acquired along the southeastern and eastern shores was platted.

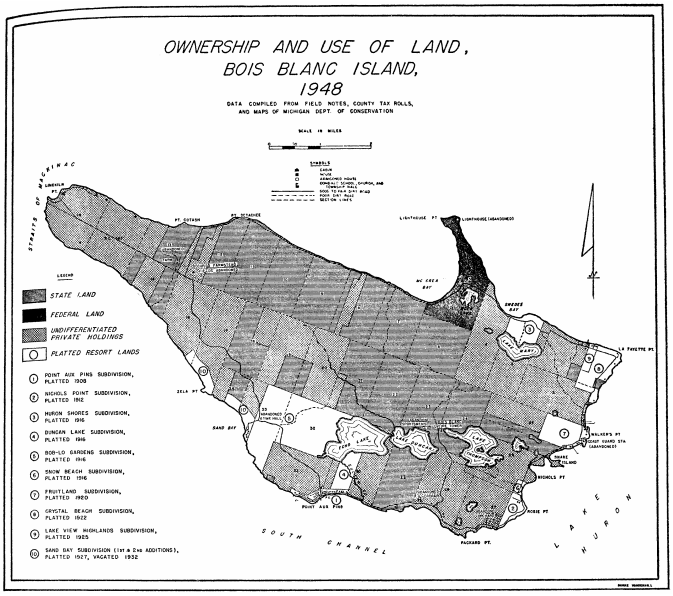

FIGURE 5

The plats were drawn on the basis of the Government survey grid with little regard for surface features. As a result, many of the interior lots were swampy, and in one area several were actually under the waters of Echo Lake. A total of 11,000 lots were platted on the island. Promotional schemes were successful in disposing of most lots sight unseen both to local people and to outsiders. It is estimated that four to five thousand were eventually sold, though only about three thousand deeds were actually recorded.

Though most of the lots were held by their owners as investments, about a hundred cottages were constructed, mainly along the shore. A sportsmen's club was established northeast of Lake Duncan, and ambitious plans were made to build an airplane landing field on the bench-lands east of Lake Mary. Deer hunters were beginning to come to the island in increasing numbers.

Several families settled along the shore near Point Aux Pins, and served as caretakers for the cottages. At least two attempts at farming were made on small patches of fairly good soil in the western part of the island, and two apple orchards were established near Packard Point, one a twenty-acre commercial orchard. A Coast Guard station was placed at Walker's Point, and a small post office and a summer church were built at Point Aux Pins. Meanwhile the cutover lands of the interior were still in the hands of the lumber companies, lying idle, in the hope that they could be disposed of profitably. Gradual reforestation by volunteer growth led to the establishment of a fire tower on a ridge near Lake Thompson, and during very dry periods a towerman was in residence. The island's prospects looked good, and then came the crash of 1929.

THE PERIOD OF RETRENCHMENT AND READJUSTMENT

The depression caused a rapid collapse in the promotional bubble on Bois Blanc Island. Sand Bay subdivision, the last to be platted, had disposed of only a few lots by this time, and was vacated in 1932. After the tax moratorium of the lean years tax delinquency mounted rapidly, and soon land began to revert to the state. While most of the better shore lots remained in private hands, and some of those in the interior were retained by local owners as woodlots, a large proportion of the interior platted lands and the former timber holdings eventually were allowed to revert, and the sportsmen's club was abandoned (Fig. 5).

The abandonment of permanent residences was not as rapid. During the depression years there was a measure of security on the land, where at least a subsistence economy was possible. It was during the more prosperous years that followed, therefore, that the permanent residents began to leave the island. The commercial orchard was among the first to succumb (see PI. I, Figs. 1-2), owing to a combination of low commodity prices, the inability to compete with mainland producers with better transportation facilities, and, it is said, poor management practices. Farming was eventually abandoned entirely, and some of the residents of Point Aux Pins also left the island.

The depression years caused an increase in hunting out of season, and sometimes the illegal use of dogs in hunting deer, on the part of both the islanders and the mainlanders. The reduction of the deer herd to near extinction, coupled with the increasing acreages of land in state ownership, led to the appointment, in 1936, of a resident conservation officer and towerman. Under protection the deer population increased rapidly, and each year more hunters came to the island, at first mainly from the nearby mainland, later predominantly from downstate areas.[22]

With the general return of prosperity there was no new resort boom on the island, but additional summer cottages were built from time to time. An attempt was made to establish a girls' wilderness camp on Lighthouse Point, the lighthouse having been abandoned for some time, but this was not successful, possibly because of the difficulty of access. In this period of readjustment the dominantly recreational function of the island was accentuated.

THE PRESENT PATTERN

Bois Blanc Island today is essentially a quiet summer colony for those who enjoy comparative isolation during their vacation months. About 120 cottages are located along the tree-lined southern and eastern shores, with concentrations at Point Aux Pins and Walker's Point (PI. I, Fig. 3; PI. II, Fig. 1). In addition, there are a few cabins on Limekiln Point (Fig. 5). Permanent residence is limited to seven or eight families, most of whom live in

Point Aux Pins, the only settlement on the island. Some serve as caretakers around the cottages, and occasionally accept employment on the mainland during the winter, while a few are living in retirement. There is one occupied farmstead, but the land is no longer farmed. No agriculture exists on the island at the present time.

The only service establishments on the island are in Point Aux Pins; they consist of a small summer hotel, a post office, and a summer church which doubles as the township school in winter and also serves as the township hall. There are no stores, and supplies must be brought in from Cheboygan. A mailboat service is operated by an island family (Pl. II, Fig. 2), the schedule varying with the needs of the season. During the winter months, when South Channel is frozen over, mail and supplies are brought over the ice by truck or automobile, and in the periods when the ice is unsafe an airplane is chartered to maintain the connections.[23]

Bois Blanc Island is a part of Mackinac County,[24] whose county seat is St. Ignace, on the Upper Peninsula mainland. Since all communication is with Cheboygan, the county has not maintained the roads on the island and they are little more than trails through the forest. The widespread occurrence of gravel at the surface has provided a substantial base for these roads, however, and has made it possible to improve, to some extent, the shore road from Point Aux Pins to Walker's Point (PI. Ill, Figs. 1-2). The typical mode of conveyance, among islanders and resorters alike, is an ancient automobile or truck, operated without the formality of license plates.

The island has not experienced a postwar building boom as have many northern Michigan resort areas, and in 1948 only six cottages were under construction. There has been some effort to sell lots in the subdivisions at La Fayette Point, but the poor service and transportation facilities have discouraged sales.

About 10,000 acres, or nearly 50 per cent of the island, are now state-owned, and the reversion of tax-delinquent lands, especially in the interior, is continuing. These lands are administered as a part of Black Lake State Forest, most of which lies on the mainland to the south. About 700 acres are still in Government ownership, and they include the lighthouse reserve, section 5, and the buildings and grounds of the Coast Guard station, recently abandoned.

Hunting is increasing, although its main benefits are felt in Cheboygan rather than on the island itself. The deer herd is estimated to contain nearly 300 animals and is growing, but it may soon reach the limit of its browse, for the second-growth forest is increasing in density, and the clearings are being reclaimed by aspen and fire cherry.

In general, the second-growth timber is not yet being used, although inlanders continue to cut firewood on their land during winter months, when it can be hauled across the ice. Some of the older second growth on the western end of the island has reached merchantable size, however, and in 1948 a Petoskey interest purchased 160 acres of timberland at the base of Limekiln Point, estimated to contain 600,000 board feet of hardwood. Lumbering was begun on the contract basis, and 350,000 board feet of logs were brought to the beach on the south side of the point. There they lie today. The cost of transporting them from the island to the mainland was so high that the terms of the contract could not be met, and logging came to a halt. The land and logs are now for sale. The recreational function of the island remains dominant.

CONCLUSIONS

Man has been attracted to Bois Blanc Island for many reasons, but throughout the fabric of its history one thread has been discernible — his primary purpose has been to take something from the island. Sugar, fuel, lime timber, and game have all served to bring him here, and m each case his stay was brief. This is understandable, for there was no good reason to tarry. None of these resources alone or in combination would have been sufficient to support a permanent settlement. Cheap land also has drawn man to the island from time to time, but each attempt to farm the stony soil has been abortive.

Only within the last sixty years has the principal resource of the island, the recreational one, been developed. It has been developed slowly, by trial and error, and has survived fire, speculation, and depression. The disadvantages of the site and situation of the island have been selective factors in the growth of the resort colony, for its members have come here expressly for the quiet privacy that isolation affords.

A further gradual increase in the number of cottages seems probable, for there are a number of sandy beaches as yet undeveloped (Pl. II, Fig. 3), and there are possible cottage sites on the low bluffs along the northern and northwestern shorelines. In the interior, where insects are bothersome, it seems likely that property will continue to revert to state ownership to be administered as hunting land and potential timberland. By-passed by the multitudes, the island will continue to perform a useful service for the few.

UNIVERSITY OF MICHIGAN

[1] Most commonly pronounced “Bob-lo.”

[2] No point exceeds one hundred feet above lake level.

[3] This is the Dfb climate of the Koeppen system. The January mean temperature is 18° F., the July mean temperature is 65° F., and the mean annual precipitation is twenty-seven inches. Data were secured by interpolation from those of nearby stations.

[4] Onaway loam.

[5] Data were secured from field notes of the General Land Office survey of 1827.

[6] These percentages were estimated on the basis of “Report 908” (unpublished) of the Game Division, Michigan Department of Conservation, prepared by B. C Jenkins and C. H. Wonser, 1946.

[7] Genus *Simulium*.

[8] Genus *Ceratopogon*.

[9] Hinsdale, Wilbert B., *Archeological Atlas of Michigan* (Michigan Handbook Series, No. 4, Ann Arbor, University of Michigan Press, 1931), p 27

[10] Van Fleet, Rev. James A., *Old and New Mackinaw* (Ann Arbor, Courier Steam Press, 1870), p. 8.

[11] Davis, Marion M., "Three Islands," *Michigan History Magazine*, 12(1928): 513.

[12] Father Marquette arrived at Mackinac Island in 1670 and built a mission there the following year. Van Fleet, *op. cit*., p. 6.

[13] Maple sugar was a prized item in the days when cane sugar was difficult or impossible to secure.

[14] Most of these French settlers were from northern France, where apples were commonly grown, and they continued the Old World practice here

[15] The British defeated the French in the battle of Quebec in 1759. They took actual possession of the Straits region in 1761. Van Fleet, *op. cit*., p. 31.

[16] "In the report of the British Governor, Major Sinclair, in 1779, the superiority of Mackinac Island as a strong position against Indian attacks . . . was pointed out; also its advantage as having one of the best harbors in the upper country, and as respects the fishing interests likewise." Meade C. Williams, *Early Mackinac, A Sketch*, Third Edition (St. Louis, Mo.: Buschart Bros., 1901) pp. 34-35.

[17] Mackinac Island was ceded to the United States under the terms of the Treaty of Paris, 1783, and transfer was implemented by the Treaty of Amity Commerce and Navigation, 1795. The approval of the Indian tribes for this transfer was secured by General Anthony Wayne in the Treaty of Greenville, 1795.

[18] Lawler, W. F., "Michigan Islands," *Michigan History Magazine*, 22 (1938): 296.

[19] Davis, *op. cit*., p. 514.

[20] This information was included in the field notes of the survey.

[21] Except for that in section 5, still held as a lighthouse reserve by the Government, and the timber in scattered private holdings.

[22] Information secured from "Report 891" (unpublished), Game Division, Michigan Department of Conservation, by I. H. Bartlett, 1945.

[23] There is a telephone cable connecting Point Aux Pins with Cheboygan.

[24] In 1818 most of northern Michigan Territory was placed in newly organized Mackinac County, with the county seat then at Mackinac Island. Bois Blanc Island has remained within that county, in spite of its present ties with Cheboygan.

FIG. 1. A portion of the abandoned orchard near Packard Point; looking northwest

FIG. 2. The abandoned farmstead connected with the orchard

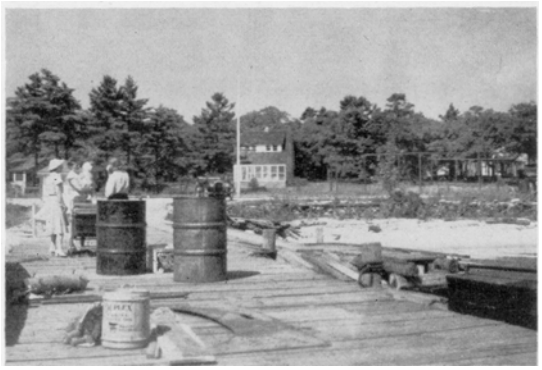

FIG. 3. Point Aux Pins, looking north from the dock. The vehicle is typical

FIG. 1. Point Aux Pins, looking west from the dock. The cottages are hidden in the trees. Conifers predominate in the shoreline complex

FIG. 2. The dock and the mailboat at Point Aux Pins; looking southeast

FIG. 3. Former sawmill site at Sand Bay, one of several stretches of beach as yet undeveloped. The island's low silhouette is evident in the background

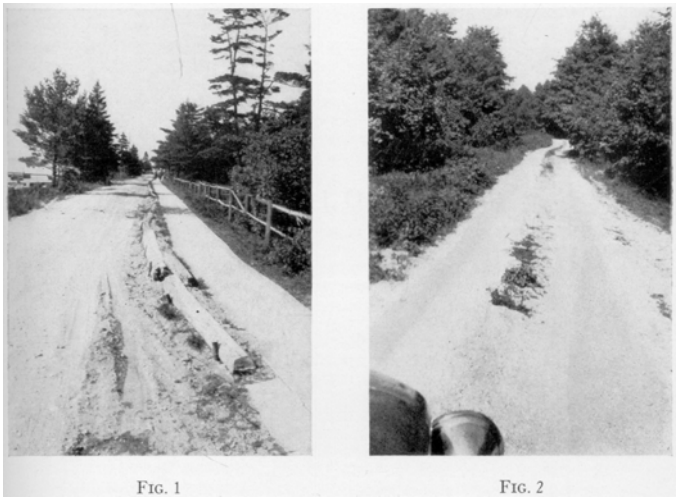

FIG. 1. The shore road at Point Aux Pins; looking west. This is the best road on the island

FIG. 2. A better part of the road between Point Aux Pins and Limekiln Point. The second-growth timber on this well-drained land is hardwood

GRAVITATIONAL DISTORTION AND FISSION

HOWARD B. BAKER

THE EARTH AS A PART OF THE SOLAR SYSTEM

CONCERNING the past of this earth there is a self-evident truth that geologists will do well never to forget or ignore. The earth is one member of an isolated mechanical cluster of bodies, the solar system. It has participated in the evolution of that system and the story of that participation must of necessity be included in the geologic record.

The present study has resulted from the application of methods developed some forty years ago. Large-scale continental movements in the earth's past have been investigated by the aid of a globe with movable continents. Such a globe was first demonstrated before the geologic section of this academy in 1911. There are several forms of the device, the simplest and also the best being easily made by anyone who is interested. The globe is greased to prevent the parts from sticking together, and tissue paper for tracings is applied to it with gelatin dissolved in water. After drying, tracings are made, lifted off, and trimmed. The results obtained by the use of such globes have been tested and amply verified by all sorts of collateral evidence afforded by stratigraphy, tectonics, petrology, mechanics, geographical distribution of plants and animals, and even by astronomy and other sciences. Fascinating as the details are, they cannot at this moment be adequately reviewed. It is time, rather, for us to summarize, taking the whole subject in one comprehensive view, realizing what it is that we are talking about, looking at big mechanical effects in a big mechanical way.

OBVERSE AND REVERSE OF THE GLOBE

Although the earth is a spheroid, it, like a medal, has an obverse and a reverse side. These opposite sides present contrasting sets of surface features. The Pacific hemisphere is here regarded as the obverse (Fig. I). There has been convergent movement of crustal fragments, a great pulling from every direction toward a focus in the Australian region. The travel has been greatest in the most forward fragments and less and less in those farther back. This alone is conclusive evidence that the cause was a gravitational attraction outside the earth and not a forward pushing or propulsion from the rear.

The *reverse* of the spheroid is the opposite hemisphere, the Atlantic (Fig. 2). Here, extending almost from pole to pole, is a widened crack or rift, a vast parting line on the two sides of which the fragments moved away, each and every one on a great circle path toward the Pacific focus. Here again are seen the effects of extraterrestrial gravitation, lagging of the rearmost fragments, and the progressive forward hastening of the more advanced. Here is also seen a progressive widening of the Atlantic rift toward the south, which clearly means that the tractive causal force was more effective in the southern part of the Pacific side.

ASTRONOMICAL IMPLICATIONS

It is futile to deal with effects of such magnitude in narrow terms and to ignore their astronomical implications. The facts under consideration are of such scope and significance that they tell of the earth's participation in the evolution of the solar system. The concept begins to take shape that the past of the system and of the earth as a part of it may have been different from what has been supposed and may not be impossible to discover.

Geology and astronomy should both share the credit for first inferring that the moon probably was formed by terrestrial fission. The mathematical researches of Sir George Darwin (1879) which led to that inference have naturally appealed to astronomers. His theory of fission caused by cumulative solar-tidal oscillation of the earth at an early epoch, assuming its rotation to have been rapid, appears to have had at least tentative approval in astronomical circles. Sir George, nevertheless, was not the first to suggest an origin of the moon from the earth, having been anticipated by Richard Owen in 1857.

Today another approach is possible. We may agree with Owen and Darwin that fission has occurred, but differ in regard to the cause and also the time when it took place.

Practically all the discussion of so-called “continental drift” during the past three decades has dealt with the crustal movements, in Wegenerian terms, as a slow continuous process. This is surely a serious misconception that arises in the first place out of inadequate methods and in the second place from failure to develop such evidence as is now available all over the globe. Any concept of gravitational terrestrial fission involves rapid action. The earth could not possibly be torn in two in any slow, gentle, uniformitarian way.

Although the evidence shows that the separation cannot have been a slow one, there is nothing against possible recurrence of similar events in the earth's past. Evidence which has been awaiting publication for several years proves that at the end of the Paleozoic era there was Atlantic rifting from the Atlas mountain region southward when Appalachia disappeared and the Mesozoic Tethys depression began in the same area. Still, because post-Mesozoic foldings and Cenozoic formations are divided by the rifts, the principal rearrangement of continental fragments cannot be dated earlier than late Cenozoic time. It is highly significant that the post-Paleozoic events were characterized by two phases, a traction phase with rifting and, later, a compression orogenic phase of recovery from a deformation less than fission.

GRAVITATIONAL ENCOUNTER

Two bodies in space may be infinitely far apart or may actually collide. Between these two extremes three grades of gravitational effect are known to astronomers as follows:

Grade 1, orbital perturbation;
Grade 2, tidal distortion followed by recovery;
Grade 3, fission.

All these grades come under the general term "gravitational encounter." Thus it is gravitational encounter, not the Wegener theory, that may be most profitably considered today. It is now possible to cite from earth history evidence of all three grades, but it cannot be done in this brief review.

Perturbation of the orbit of one body by the gravitation of another is a familiar occurrence in the solar system. Such variations in the orbit of the earth are always occurring, but their effects, of a climatic nature, can hardly be directly recognizable in the geologic record.

Tidal distortion is exemplified by the effect of the earth's gravitation on the shape of the moon and, conversely, by the lunar tidal changes in the shape of the earth. A larger moon mass would cause a proportionally greater distortion of the earth. Still greater would be the effect of lessened distance, for the tide-raising power varies inversely as the cube of the separating distance.

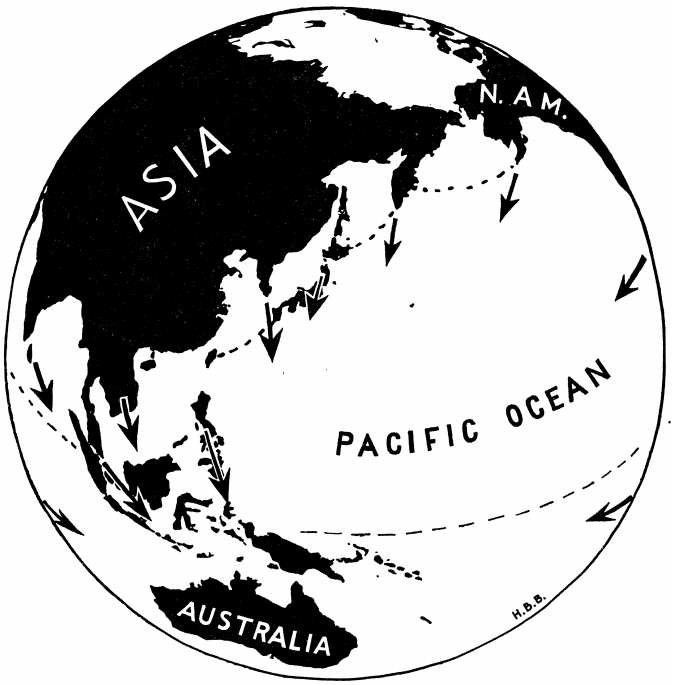

FIG. 1. The Pacific Hemisphere (the obverse of the spheroid), showing convergence of crustal fragments toward a common center of attraction

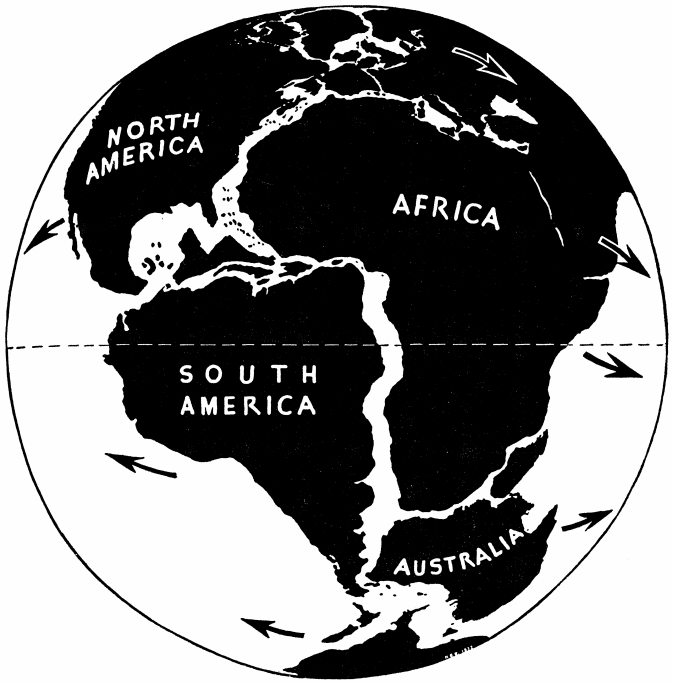

FIG. 2. The Atlantic Hemisphere (the reverse of the spheroid), showing rifting and separation

Any distortion of the earth's form away from the spherical must increase the area to be covered by the enclosing crustal shell, thus producing the phenomena of crustal deficiency, such as rifting and normal faulting, and any resumption of the preceding figure must result in crustal excess with thrusting and folding. The geologic record offers abundant evidence of such alternating effects which have never been satisfactorily explained by the theory of a cooling and therefore contracting earth. That theory never was anything more than a convenient assumption to explain crustal excess. Even if contraction did occur, it could never produce crustal deficiency, and its adequacy as an explanation of the known localized crustal excesses (folded mountain ranges) is far from being proved. Nor is it sure that the earth is even a cooling body; radioactive substances may be causing the subcrustal temperature to rise.

INFERENCE OF THE ABSENT

Fission results when one body is so close to a greater one that it is within the Roche limit of disruption. It has been thought by some that the planets came into being by such a biparental encounter of the maternal sun with some other body which cannot now be found. The rings of Saturn may be fragments of satellites within the Roche limit of the planet. When we find on the earth evidence that there has been a gravitational encounter at such close quarters that the earth was distorted beyond recovery and that a satellite was born, it may be inferred that the earth was within the Roche limit of some large mass. The visitor must presumably have been more massive than the earth, possibly comparable in that respect to one of the larger planets. Jupiter's mass is 318 times that of the earth; Saturn's, 95; Uranus's, 14.

There has to be an inference of something which is now absent. A hunter who found bear tracks and a scratched tree would look for a bear. Even if he failed to find the bear, he would know that one had been present, and so would his dog. A planetary mass with a cometary orbit, with an aphelion distance of 5,000 astronomical units, would not return for about 125,000 years. An aphelion distance of 10,000 units would mean a period of more than 353,000 years. The inference of the former presence of a body which is now absent will apparently have to suffice for a long while. There will be plenty of time to go on collecting the evidence which the geologic record offers of numerous epochs of tidal change of earth form. It will always be possible to recognize Grade 2 distortions by their second phase, crustal excess due to recovery, whereas the one occurrence of Grade 3, with fission, left only crustal deficiency, and that now mostly submerged beneath the oceans, practically without any following second phase and therefore without folded mountain ranges for geologists to climb to find out what had happened.

Examination of the earth and the finding upon it of signs of gravitational encounter, not just once but possibly many times, prompt further inquiry into the mechanics of the solar system. What light can earth history throw on the past of the system of which it is a member? Did other planets give birth to satellites by similar biparental encounters and mission? Would not that mode of origin explain the excess angular momentum which keeps them at their present distances? The satellites are presumably younger than the planets, and Jeans (1924) says they are too small to have been built up out of gas and hence must have begun as liquid or solid bodies. These problems, hopeless as they may appear, may not be beyond solving.

DISTORTION AND FISSION ILLUSTRATED

A mechanical model has been constructed to assist in visualizing gravitational distortion and fission, without claiming for it any particular value as evidence. The aim is merely to make plain what the evidence indicates has happened. Figure 3 shows a small tank containing a mixture of alcohol and water in which is suspended a metallic skeleton globe. A cork ball floats attached by a thread to a windlass, the ball being about the appropriate size to represent the moon in relation to the earth. On the skeleton is placed a globule of black oil of the same specific gravity as the alcohol and water. Surface tension causes the perfectly balanced globule to take a spheroidal form. Traction on the cork ball produces successive distortion figures in equilibrium, simulating gravitation. When the limit is passed beyond which recovery is impossible, fission occurs, and both the parent globule and the separated part become spheroidal

Figure 4 shows successive equilibrium forms obtained in this way. Figure 5 is one such form adapted to illustrate the inferred fission of the moon from the southern part of the Pacific hemisphere.

DIFFICULTIES CONSIDERED

Reasonable consideration of this subject — major crustal movements and their causes — has been delayed by difficulties that should not be minimized. First comes prejudice based upon orthodox geologic uniformitarianism, which insists that only causes currently known can have acted on the earth in times past. This attitude shows too much confidence in the completeness of geologic knowledge and leaves little possibility of revising our ideas of the past of the earth or of the solar system in conformity with unexpected discoveries. Not all of the ideas that were held a hundred years ago are tenable today. If Sir Charles Lyell had possessed the facts that are now demonstrable he would, we may presume, have altered his views concerning possible catastrophic gravitational effects upon the earth.

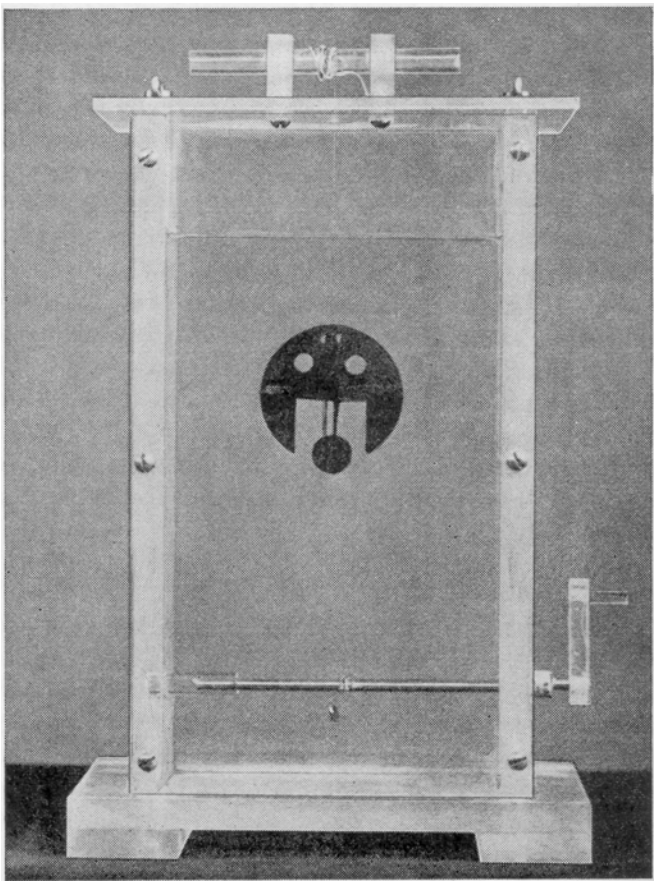

FIG. 3. Apparatus made in 1910 to simulate gravitational distortion and fission. A globule of oil is placed on a metallic skeleton globe in alcohol and water. A cork ball inside is attached by a thread to a windlass

FIG. 4. Successive equilibrium forms made by an apparatus similar to that shown in Figure 3

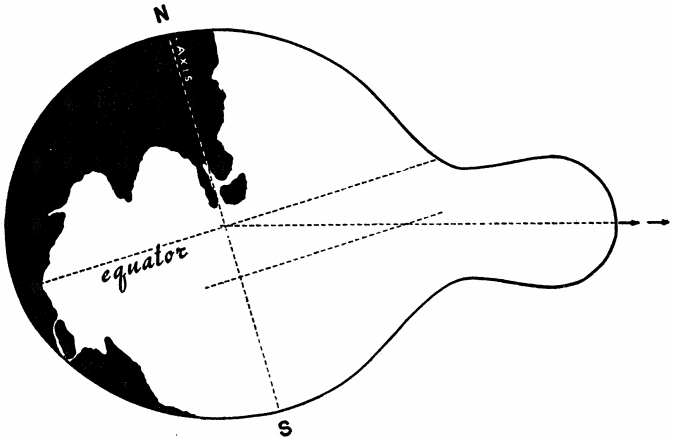

FIG. 5. Equilibrium form adapted to illustrate the inferred fission of the moon from the southern part of the Pacific Hemisphere

Secondly, and much more important, is the question concerning the volume of the ocean water. If the oceans occupy areas denuded of granitic crust which was similar to the continental sheets, and which has been lost, how could the same waters have found a place on the earlier holocrustal globe? They would have been distributed over the whole spheroidal area with an average depth of 8,000 or 9,000 feet. Geology proves that there was no such universal ocean. Throughout the geologic record the surface level of the waters of the globe was not far below the surface of the land. At the present day the same is true. The one question may be met with another: Where was the bottom of those early waters? Were they comparable in depth to the present oceans? Was their total volume the same? They were not! All the seas that are known from the early periods were of the epicontinental type and do not show signs of great depth. Nor did they cover the whole surface. Geology possesses no evidence whatever of such abyssal waters anywhere as now prevail over most of the earth's surface. Zoologists report that the fishes that are now adapted for life in the depths are not archaic forms but have recently been evolved from inhabitants of relatively shoal waters. The North Atlantic floor is reported to be liberally sprinkled with shallow-water shells. In 1911 geologists of this academy were inclined to ridicule the idea that prior to the Atlantic rifting the Atlantic Ocean did not exist. Today their objections are adequately met by the Veatch-Smith charts (1939). The slopes of the continental shelves of Mesozoic rocks are eroded in gullies as great as or greater than the Grand Canyon of the Colorado. There rivers flowed 10,000 feet below the present surface of the sea. There was a time, geologically not long ago, when the surface of the sea was approximately two miles lower than the present surface of the land. On the Pacific side the evidence is of the same purport. Some scientists go as far as they can to account for the changed volume of the oceans by postulating excessive glacial accumulation on the land, and they fail before they get well started. Submarine currents have been invoked to explain away the drowned gorges, with no better success. There has been a vast accession of water upon the earth since the late Cenozoic terrestrial fission. It is now only the surface of the water that is near the level of the land; no longer is it the bottom also. The acquisition of all that water is another, and later, chapter in the story of the earth's participation in the evolution of the solar system.

Man and all the other land-dwelling creatures depend for their continued existence upon the unevenness of the surface of the lithosphere. That unevenness has resulted principally from gravitational distortion and fission. Only the simplest of arithmetic is required to disclose that, if there had been no fission, what are now the continents would be at the bottom of a world-embracing ocean. Fission saved this world from subsequent total inundation.

DETROIT, MICHIGAN

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THE VOLCANIC ROCKS OF THE GROS VENTRE BUTTES, JACKSON HOLE, WYOMING

LOUIS J. SCOPEL

THIS study deals with the structure, origin, petrography, and age relationships of the volcanic rocks of the East and West Gros Ventre buttes in the southern part of Jackson Hole just northwest of the town of Jackson, Wyoming. The Teton Range lies to the west of the buttes and the Gros Ventre Range to the east. The buttes trend north-northeast and are approximately four and one-half miles long, one mile wide, and three fourths of a mile apart.

Field work was done in the summer of 1948 as part of the summer program of the University of Michigan at Camp Davis. Thanks are due to Professor A. J. Eardley, of the University of Michigan, for suggesting the problem. The writer is especially indebted to Professor W. H. Parsons, of Wayne University, for many profitable discussions and suggestions in both the field and the laboratory.

GENERAL GEOLOGIC SETTING

The East and West Gros Ventre buttes have been mapped by Horberg[1] and Bergren[2] as eroded fault blocks. The faulting has been considered contemporaneous with the great Teton block fault. The buttes are composed of Paleozoic rocks, which have a general westward dip and are partially covered, especially toward the north, by Tertiary volcanic rocks and Pleistocene glacial deposits. In the present study the buttes were mapped in detail, and the volcanic rocks were subdivided into seven map units (Fig. 1).

The volcanic rocks of the Gros Ventre buttes consist of basic lava flows and small amounts of breccia and tuff. Flow structure is apparent in most of the lavas, which range in appearance from light-gray felsites to dark-colored porphyries. These flows are cut by a few intrusive rocks, which are probably vent fillings.

THE EXTRUSIVE ROCKS

The oldest volcanic rock on the buttes is a pink to white friable tuff, which is represented by three small remnants that lie directly on Paleozoic sediments (Fig. 1). The tuff is composed of felsitic and glassy igneous rock fragments in a groundmass of volcanic dust, clay, and fine-grained calcite.

The earliest recognizable lavas are dense andesites, which are characterized by a pronounced sheetlike to subconchoidal fracture parallel to a prominent flow structure. These flows are light gray, with reddish to brownish weathered surfaces. The rock shows trachitic texture and consists of andesine laths, colorless interstitial glass, and a few microphenocrysts of hypersthene and andesine.

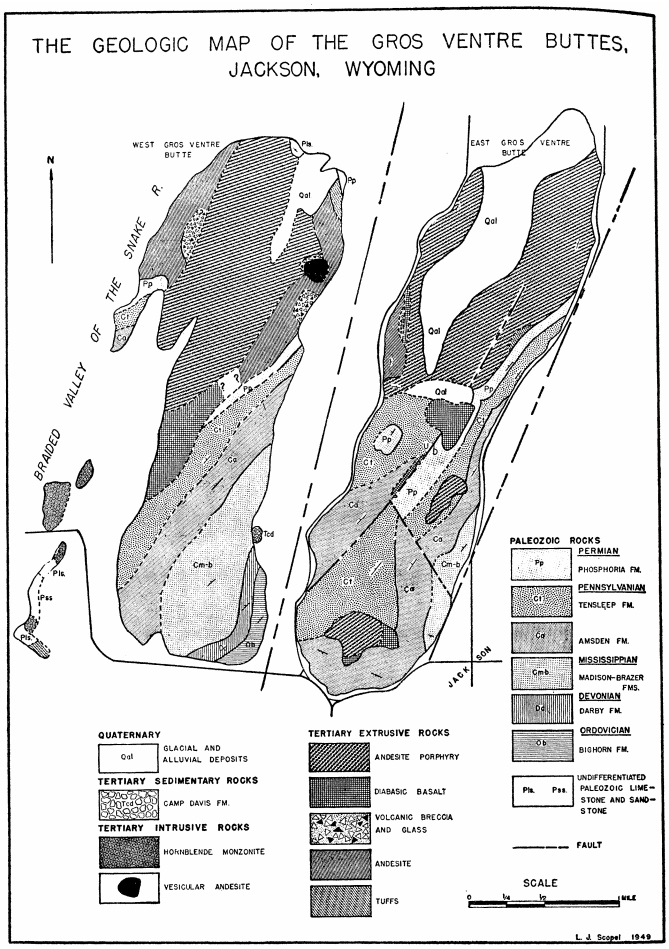

FIGURE 1

Several small areas of flow breccia and interbedded glassy lavas are associated with the andesite flows. The breccias are composed of small angular gray, brown, and black fragments (one-half to two inches) in a matrix of glass, which shows flow structure and weathers red. The fragments consist of trachitic andesite, various glasses, and vitrophyres with a few microlites of plagioclase. In the vicinity of the vents the glasses are devitrified and have a mottled light- and dark-gray appearance.

A few dense whitish-gray to purple flows occur which have a granular appearance and only a suggestion of flow structure. Microscopically these rocks reveal a diabasic texture of interlocking labradorite laths and pyroxene, with a small percentage of dark-brown interstitial glass. The pyroxene is a mixture of augite and hypersthene. The extrusives are diabasic basalt and contain more femic minerals than any of the other flows.

Andesite porphyry is the most abundant volcanic rock on the East and West Gros Ventre buttes (Fig. 1). It is the youngest lava of the area and has a thickness of at least six hundred feet. The thickness apparently represents many separate flows, but contacts between flows are hard to locate. Columnar, vertical, and horizontal joints are apparent, and the material has a pronounced flow structure. The weathered surface is predominantly

black- and red-streaked; the fresh fracture is dark-colored, and contains prominent plagioclase phenocrysts. Petrographically the rock is composed of large corroded phenocrysts of andesine, a few hypersthene crystals, minor amounts of augite in a glassy groundmass, and plagioclase crystallites.

THE INTRUSIVE ROCKS

The igneous rock which fills a vent on the eastern side of West Butte is a whitish-gray vesicular andesite with a vitreous luster. The vesicular rock contains inclusions which range in size from about one-half inch to over twenty feet. These inclusions are composed primarily of hypersthene andesite, volcanic breccias, and glass identical with that of the flows near by. The intrusive andesite is coarser-grained than the andesite and basalt flows and consists of interlocking andesine laths, and a small amount of colorless interstitial glass. Femic minerals are scarce and highly altered, but a few crystals of hypersthene were identified.

Several small outcrops of hornblende monzonite are present along the Snake River near the main highway, southwest of West Butte (Fig. 1). The intrusive is a light-gray, fine-grained, phaneritic rock with noticeable hornblende and feldspar crystals. The monzonite contains many inclusions of hornblende, biotite, and chlorite schists, quartzites and pegmatites, all apparently of pre-Cambrian age, since these rock types are all found today in the pre-Cambrian core of the Teton Range. Monzonite is used locally as a road filler. Petrographically the rock consists of a groundmass of orthoclase and plagioclase (albite or oligoclase), and plagioclase phenocrysts, which are highly altered to calcite and sericite. Many hornblende crystals and a few augite crystals are dispersed throughout.

STRUCTURE AND ORIGIN OF THE VOLCANIC ROCKS

The lava flows and pyroclastics of the Gros Ventre buttes lie on a very uneven erosional surface, developed on Paleozoic rocks, which has a relief of at least seven hundred feet. The lavas lap down the steep eastern sides of the buttes as well as the more gentle western slopes. The relief is also apparent from north to south within each butte.

Horberg[3] has assumed that the prevolcanic surface was relatively smooth and that after vulcanism the lavas and the underlying surface were tilted by block faulting. The author believes, however, that the lavas came out on a surface of considerable relief, which was not tilted after vulcanism.

Some of the lava flows originated from a volcanic vent on the northeastern side of West Butte. The vent is filled with vesicular andesite, which contains numerous large inclusions of the adjacent extrusive rocks. A possible volcanic plug exists southwest of the same butte and is composed of hornblende monzonite. Because of its more acidic composition the writer feels that this was probably the last active vent.

The andesite porphyry tic lavas at the highest part of the northern half of East Butte have vertical or very steep flow structure in a rather narrow belt extending over a linear distance of approximately a mile. This zone of steep-flow structure trends northeast, roughly parallel to the eastern front of the butte. In the southern part of the butte there is evident a small fault with the same northeastern trend and in line with the zone of steep flow structure to the north. At one point on this fault a small mass of diabasic basalt has an essentially vertical flow structure. Apparently the lavas have come up as fissure eruptions along this fault and its probable extension to the north.

Several small cross faults, one of which is mapped, are present on the buttes. Relationships at other localities were too obscure to permit mapping of such faults. However, the rather sudden change of the strike and dip of the flow structure of the lavas adjacent to possible cross faults might be explained as movements of the lavas up such fissures. The eruptions must have postdated the faulting of the buttes, since the lavas used some of these faults as avenues of escape. The fault blocks were not only uplifted but were also deeply eroded, as previously stated, before the first volcanic activity.

The flows on West Butte dip, in general, to the west away from the known vent and the fissures from which the eruptions originated. The dip of these lavas is, therefore, a normal dip away from the centers of extrusions and are not necessarily due to faulting or tilting.

AGE OF THE VOLCANIC ROCKS

Colbert[4] and Love[5] have dated the volcanic rocks in the northern part of Jackson Hole as Lower or Middle Miocene because of fossils found in basic volcanic tuffs. Foster[6] has correlated the basic volcanic rocks along the eastern margin of Jackson Hole with those to the north, dated by Love, and with those on East Butte. Foster describes andesitic breccias near Elk and along Ditch Creek (east side of Jackson Hole) and hypersthene andesite and basalt flows on Flat Creek. At these places the volcanic rocks are apparent beneath the Camp Davis formation.[7] The lavas on Flat Creek are approximately five miles east of the northern end of East Butte and might possibly have originated from the buttes.

The author found a small patch of material, presumably Camp Davis conglomerate, against the base of West Butte near its southern end. The conglomerate lies in the valley which has been cut between the buttes across the volcanic material, implying considerable erosion after the igneous activity and before deposition of the conglomerate. Therefore, it may be, as suggested by Bergren,[8] that the faulting of the buttes took place before the main Teton fault, since downwarping by the latter apparently initiated deposition of the Camp Davis

formation.[9] Such a sequence of events would allow time, after the faulting of the buttes, for volcanic activity and a great deal of erosion before Camp Davis time. Horberg,[10] Foster,[11] and Eardley[12] believe that the Camp Davis formation is late Miocene or Early Pliocene in age.

CONCLUSIONS

The sequence of events in the Gros Ventre buttes area may be summarized as follows:

1. Formation of the Gros Ventre buttes by block faulting.

2. Erosion of the fault blocks to a surface of at least seven hundred feet relief.

3. Vulcanism, with lavas and pyroclastics issuing from a few small vents and fissures, probably simultaneously with similar activity in the northern part of Jackson Hole in early or middle Miocene time.

4. Partial erosion of the volcanic rock.

5. Deposition of the Camp Davis formation initiated by the Teton fault in late Miocene or early Pliocene time.

6. Erosion to present-day topography.

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HALF HOUSE: A PITHOUSE IN CHACO CANYON, NEW MEXICO*

RICHARD N. ADAMS

THIS report is concerned with the excavation and the materials of a pithouse in Chaco Canyon, New Mexico. The house rests in the arroyo of the Chaco River, about thirty-five feet from the southern boundary of the Chaco Canyon National Monument boundary line, nine miles east and up the Canyon from the National Park Service headquarters (Fig. 1).[1] The floor of the house is some sixteen feet below the surface of the present valley floor, in the face of the arroyo below the mesa on which Shabik'eshchee is located (Pl. I). The site was first seen when it had nearly been cut in half by the erosion of the arroyo. Brand (p. 42, n. 4) mentions a bisected pithouse which was exposed in the arroyo below Shabik'eshchee when a part of the bank fell away in August of 1936. It was not until the early part of 1947, however, that any interest in the site was manifest. At that time Mr. Gorden Vivian[2] of the National Park Service removed the contents of the fire pit and sent the charcoal to Dr. Florence Hawley for dating. Dr. Hawley judged, however that the specimens were too short for dating; she thought they were juniper twigs, and hence they could not be relied upon for dendrochronological information.

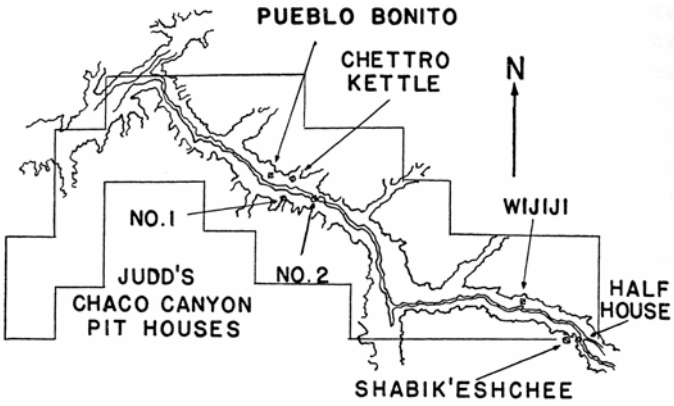

FIG. 1. A map of Chaco Canyon, New Mexico, showing the location of Half House with respect to other sites

In June of 1947, upon my request for a special project at the University of New Mexico Field Session, Dr. Paul Reiter suggested the task of excavating the site. Since it offered the possibility of self-instruction in archaeological techniques and since its depth indicated that the fill above would provide a sequence, the work was undertaken.

By way of introduction I should review briefly other pithouse excavations in the canyon. In 1924 Neil Judd's report on two pithouses appeared, consisting of descriptions of one surface house and one located in the face of the arroyo (13, 399-413). While the former produced few artifacts, the latter provided materials for the main body of the report. Roberts (21) in 1929 published his findings at Shabik'eshchee village, a group of pithouses on the mesa top overlooking the site of Half

House. The pottery complex from this village differs from that described by Judd for his Pit House 2, and the evidence points to later date of occupation for the house. During the 1936-37 excavation of Bc 50-51 a pithouse was discovered and excavated under the direction of Wesley L. Bliss; a brief description of it by Clyde Kluckholm is included in the general report (15, pp. 26-29, Fig. 4). Since Mr. Bliss's notes were not available, little more can be said of this report than that the excavation received attention. Though other pit dwellings have been located in Chaco Canyon, no other publications have appeared which give information on systematic investigations and descriptions of artifacts and floor plans.

The excavation of Half House was carried out on the basis of a simple scheme (Fig. 2). The face of the arroyo presented what appeared to be natural strata. Digging commenced in an area eleven by eighteen feet, directly above the house and on the edge of the arroyo bank. All cultural materials were removed according to the natural strata as delineated early in the excavation. When the floor of the house was reached at a depth of sixteen feet, the horizontal area of the pit had narrowed to the approximate diameter of the floor, fourteen feet. The hardness of the adobe and sand made the work slower than was anticipated; when a depth of seven feet below the valley floor was reached, two columns of earth four feet square were left in the inboard corners of the pit in order to lessen the amount of dirt to be removed. Upon nearing the floor we removed the earth from beneath the columns in order to reach the edge of the floor of the house.

Artifacts were placed in sacks differentiating types of material and the strata in which specimens were found. For reasons explained later, artifacts in the layer one foot above the floor were included with those taken from the floor itself. I did the laboratory work in the Museum of Anthropology at the University of Michigan, where facilities were offered by Drs. James B, Griffin and Albert C. Spaulding.

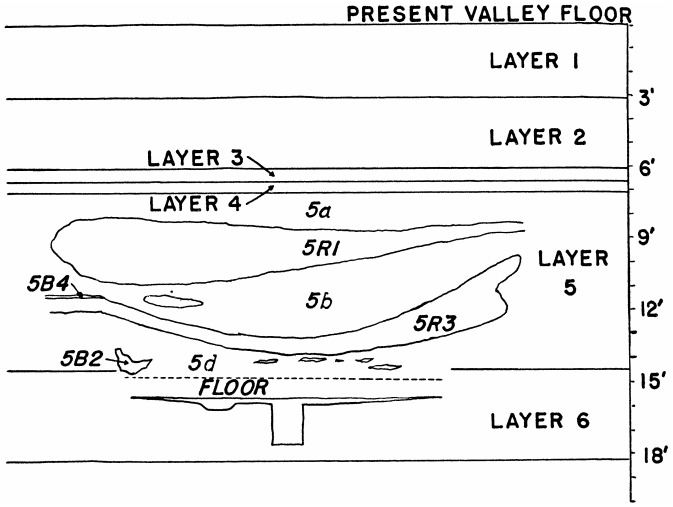

FIG. 2. The stratigraphy at the site of Half House. See text for explanation

STRATIGRAPHY

As has been noted, the arroyo face provided a natural series of layers and lenses according to which the materials were removed. Each layer described here was excavated as a whole. It should be remembered that Layers 1-4 extended across the whole face of the arroyo bank, whereas the various members of Layer 5 were peculiar to the area immediately above the pithouse. Hence the division of Layer 5 into its various components was made with a view to convenience in the removal of cultural materials. Thus 5d of Layer 5 is actually partly in Layer 6 in the regular stratigraphy of the arroyo face; and the Floor Layer is entirely in Layer 6 (cf, Fig. 2 and Pl. II). The composition of the various layers was as follows:

Layer 1. — Light-colored clay and sand. No cultural materials.

Layer 2. — Darker clay and sand. No cultural materials.

Layer 3. — Sand; sporadic pieces of charcoal, some as large as 1 cm.; occasional sandstone blocks. Cultural materials found in this layer and all lower layers to the house itself.

Layer 4. — Clay; sporadic pieces of charcoal as in Layer 3.

Layer *5*. — A composite layer, primarily clay, with a series of distinct yellow and red sand lenses containing pieces of charcoal and lignite, occasional deposits of almost pure clay and a considerable number of sandstone blocks. There were, in addition, a few lenses which were predominantly charcoal and lignite. The lenses of Layer 5 are labeled by a number, a letter, and a number. The initial number is 5, referring to Layer 5; the letter *R* indicates that the lens was predominantly red sand; the letter *B*, that it was predominantly sand and clay with a considerable amount of lignite mixed with it. The numbers following *R* or *B* designate lenses of each type. Other lenses of Layer 5, namely, 5*a*, 5*b*, and 5*d*, are mixed yellow sand and clay, the material of which Layer 5 is composed beyond the areas of the pithouse.

The lenses described below are those which were excavated separately for the removal of cultural materials:

Lens 5a. — Sand and clay mixture.

Lens 5R1. — Predominantly red sand mixed with charcoal and lignite; small lenses of yellow sand throughout.

Lens 5b. — Same as 5*a*; throughout this lens are a series of small red sand and charcoal lenses, the same material as that found in 5R1 and 5R3, and numerous sandstone blocks, mostly red, some yellow. There was no discernible regularity in the position of these blocks.

Lens 5R3.— The right half of the exposed surface of this lens is similar to 5R1, but the left or southern half is thoroughly mixed with clay so as to become almost indistinguishable from the rest of Layer 5 in color, but the outline is still distinct. On the far left is the lignite lens, 5B4.

Lens 5d. — Same as 5*a*. There is no visible distinction between 5*d* and the Floor Layer, but the dividing line was placed arbitrarily with the first appearance of roofing and walling clay at one foot above the floor.

Floor lens. — The terms “Floor,” “Floor Level,” and “Floor Layer” designate a depth of one foot from the floor itself up to 5*d*. Throughout this fill walling and roofing clay was found.

The body of the noncultural material in the Floor Level was of the same type as that found in 5*a*, 5*b*, and 5*d*. Covering the floor itself, for a depth of 4 cm. at the center of the house to 1 cm. or virtually none at the periphery, was a layer of sand (mixed with small pieces of charcoal), usually yellow but red in the vicinity of the fire pit and the upright stones (Figs. 3-4, items *M* and *L*). The presence of this thin layer made it quite easy to trace the entire area of the floor.

The removal of the overburden according to the strata outlined seemed originally to be superior to the use of regular, arbitrarily defined strata. The curve of the lenses directly above the pithouse suggested that the fill was wind-blown. Upon excavating it developed that the same curve which appears on the face of the arroyo also occurred in a plane perpendicular to the exposed face. Hence if one were to imagine himself present when the valley floor was nine to twelve feet below its present level, the ground surface would show a depression very similar to those observed above pithouses found nearer to the surface of the ground today. During the excavation every attempt was made to follow carefully these curved surfaces, but some difficulty was encountered in doing it. Were the work to be done over, I believe that arbitrarily defined levels would be more satisfactory both for digging and for the allocation of cultural remains.

ARTIFACTS

The artifacts from Half House and the fill above it provide us with nothing strikingly new. Similar types of almost all finds have been described or illustrated in other publications on excavations in the Southwest. For this reason it seems neither necessary nor profitable to give detailed explanations and descriptions concerning the materials. Instead the data are presented primarily according to the distribution by strata with descriptive notes added only for the sake of clarity. Each list is prefaced with a summary note, together with other relevant information. With the exception of the pottery data, no differential comparative notes have been made about the various layers, since there is such uniformity and since the paucity of the remains does not suggest the need for this treatment in a cultural period which is better known from other sites.

The materials from Half House are described in the following categories: pottery, unfired clay objects, stone, bone and shell, other bone remains, and walling and roofing clay. Besides the objects listed here, a number of pieces of charcoal were found and sent to Dr. Deric O'Bryan for dating. His findings are discussed in the section on chronology.

Pottery

Sherds from Half House and the fill above it were classified without the benefit of a comparative sherd collection. Mr. Stanley Stubbs went over all the pottery remains and introduced order into what had hitherto been chaos. Dr. J. O. Brew examined the orange ware, and I have followed substantially his suggestions. I am grateful for their assistance, but, of course, accept responsibility for opinions expressed here. Use was made of a number of publications, and I have employed only nomenclature which seemed to me to be generally accepted or adequately descriptive. If the sherds fitted into no standard type, I have used a generally descriptive label. All sherds of this last category were badly battered, and no space has been devoted to them in the report. Both the manuals on Southwest pottery (5, 11) and various monographs (2, 7-10, 15-19) were employed in the examination.

Instead of giving a detailed description of the pottery from Half House I have presented the information in tabular form. The comments which follow are made with reference to Table I. The data from Layer 3, though included in the table for completeness, will be excluded from consideration in the discussion, since so few sherds were found in it.

TABLE I

PERCENTAGE OF POTTERY BY TYPE IN EACH LAYER

Pottery	Floor	5*d*	5R3	5*b*	5R1	4-5*a*	3
Plain Gray	84.3	78.1	72.2	76.1	72.2	49.2	71.5
Fugitive Red	0.7 *	8.6	14.3	11.1	14.0	2.0	..
Corrugated †	..	..	..	1.6	2.6	14.8	14.3
Lino B/G	0.7	..	..	1.6	..	1.2	..
La Plata B/W	5.9	8.6	11.8	7.1	1.4	..	..
White Mound B/W	..	..	..	..	2.6	..	..
Red Mesa or Escavada B/W	..	0.9 ‡	0.4 ‡	..	..	..	..
Kiatuthlanna B/W	..	..	0.4 ‡	..	1.7	18.5	14.3
Unidentified slipped ware	..	..	..	1.6	0.9	9.9	..
Orange Ware	6.7 §	3.8	0.8	0.8	2.0	3.7	..
Smudged Ware	1.5	..	..	..	2.6	..	..
Total number of sherds per layer	134	105	245	126	349	81	7

* Fifty-four red sherds coming from a single olla are counted here as one sherd (Pl. VI). The paste of all this ware was the same as that of the Plain Gray.

† All corrugated sherds were of the band type. Whether they are to be classed as Kana'a Gray or full-body corrugation cannot be determined in the majority of the sherds since they are too fragmentary. For the same reason it is impossible to say whether they are predominantly continuous-coil or ring-coil (Pl. VIII, 3, 6, 10).

§ Four of the twelve sherds found in this layer formed a portion of an Abajo R/O bowl which had secondary working as a scraper. This makes the total count of sherds for this layer nine instead of twelve (Pl. IX, 5).

‡ Twelve sherds from 5*d* and ten from 5R3 were all part of a single bowl. Hence in calculating the percentage for these layers I have counted these sherds as one for each layer.

It will be noted that in the bottom five layers the combined Plain Gray ware and Fugitive Red ware amount to about 75 per cent of the pottery present. The two early forms of Anasazi painted wares, La Plata Black-on-white and the Orange ware, appear consistently from the Floor up through 5R1. It is only in 4-5*a* that slipped black-on-white ware and corrugated ware really make their appearance; there is over 25 per cent of the former, the majority of which is Kiatuthlanna Black-on-white. The Escavada or Red Mesa Black-on-white bowl which appears in 5*d* and 5R3 presents something of a problem. Since there is nothing comparable to it elsewhere in the site and since the sherds occur within a relatively clearly limited area, it seems apparent that it is intrusive. Both these pottery types are common in the lower portion of Chaco Canyon, but here, in this stratum, they are definitely out of context.

The Orange ware itself displays an evolutionary sequence, beginning with the bowl fragment (Pl. IX, 5)

from the floor, an Abajo Red-on-orange piece, and developing into a type very similar to if not the same as Morris's La Plata Black-on-red.[3] There seems little doubt that this ware is intrusive in the Chaco area, very probably having come in from the north or northwest, either in a few pots or as a technique employed by some migrant potters.[4]

The most significant thing about the pottery complexes of the various strata of the Half House site are the correlations they make possible with the pottery of Shabik'eshchee and Judd's Chaco Canyon Pit House 2 (Pis. VII-VIII). Both Shabik'eshchee and the bottom three strata of the Half House site have the following in common: predominance of Plain Gray ware, some Orange ware,[5] and an unslipped black-on-white ware. If I interpret Roberts correctly, Shabik'eshchee village has relatively more of the unslipped black-on-white ware than do the strata at Half House. In neither place are there corrugated sherds or slipped black-on-white pottery. Common to both the 4-5*a* strata of Half House and Judd's Pit House 2 are: Plain Gray ware, corrugated ware, and a slipped black-on-white ware. Gladwin believes that the black-on-white ware described in Judd's report is very similar to that which Roberts calls Kiatuthlana Black-on-white, the same ware as that found by Gladwin (7, pp. 41-48) at White Mound and Wingate. In the Half House strata as a whole the Kiatuthlanna Black-on-white overlaps only slightly La Plata Black-on-white and is roughly correlated in appearance with the corrugated ware. Lenses 5*b* and 5R1 seem to represent a transitional stage between the Shabik'eshchee pottery complex and that of Judd's Pit House 2. The disappearance of La Plata Black-on-white and the emergence of slipped wares and corrugated wares represent a distinct change in pottery decoration and technology. A more accurate comparison between these three sites is impossible without sherd counts from Shabik'eshchee and Judd's site.

Unfired Clay Objects

From 5R1 were taken two small rolls of slightly fired clay, apparently coils intended for use in the construction of a vessel (Pl. X, 6). One was 4 mm. long, the diameter varying between 6.7 and 7.6 mm. The other was 30 mm. long, with a diameter of 8.8 mm. The paste of both is the same, being gray and fine, and with any temper in it invisible with the aid of a small magnifying glass.

From 5*d* was taken an unfired brown object with a punctate design (Pl. X, 2). It is not unlike the clay pipes and effigies which Kidder (14, Figs. 110a, 150a) shows in his collection of artifacts from Pecos. The Gleeson site produced a number of clay figurines, one of which is similar to this specimen from Half House (6, p. 50; Pl. XVIh).

Stone

There is little that is unique about the stone remains from the Half House excavation. With the exception of a few objects on the floor, everything found was in the nature of waste material such as manos and a piece of metate, irregular flakes, and waterworn pebbles. It is evident that the stone items from the floor comprise for the most part things either too clumsy to transport or easily replaceable items picked up locally, namely, metates, manos, hammerstones, polishing stones, scrapers, odd cores and flakes, concretions that had been variously employed, and a fragment of a point. By far the largest number of the artifacts are of quartz or sandstone. The almost complete absence of projectile points, knives, and other small stone objects does not mean that they were not used.

Floor (Pl. III). — The most prominent stone implements from the floor were the three metates, the first of which was supported by three small piles of slabs, evidently in the position in which it had been used. The other two were placed on end against what had been the wall of the house. All three were of the open trough, open-at-one-end, type, and were roughly triangular. Their dimensions are: No. 1, 1.65' X 1.35' X 0.3'; No. 2, 1.7' X 1.7' X 0.4'; No. 3, 1.8' X 1.75' X 0.3'. There were also three manos, the first of which was well worn (No. 1,0.72' X 0.4' X 0.08'; No. 2,0.7' X 0.4' X 0.22'; No. 3,0.75' X 0.45' X0.15'). Other stone artifacts included a waterworn pebble used as a hammer stone (125 X 66 X 48 mm.); a bowl-shaped sandstone concretion (120 mm. in diameter, 58 deep, 22 thick), thoroughly reddened, found directly above the fire pit on the level of the floor; a concretion shaped like two soft balls which had been pressed together and had stuck, with one end pecked, and evidently it had been used as a hammerstone; a small polishing stone- core and four flakes.

Layer 5d. — The inventory of stone artifacts from this layer includes: three flakes; three hammerstones (66 X 58 X 55 mm.; 77 X 75 X 68 mm.; 75 X 67 X 54 mm.); amano (182 X 105 X 23 mm.); a portion of a flaked knife or projectile point (29 mm. wide, 5 thick, and 54 long between the two broken ends); and a flat grinding stone with a pecked surface. The use to which this stone was put is problematic. Though one surface is flat and pecked, the other is convex and smooth. Its size (140 mm. in diameter and 26 thick at the center) indicates that it had not been used for grinding any large quantity of material.

Layer 5R3. — The stone artifacts from this stratum include five flakes, a polishing stone, a hammerstone (59 X 70 X 64 mm.), and a broken metate of the same type as that found on the floor.

Layer 5b.—- Three flakes, a core, a scraper with a small concretion and a mano (200 X 94 X 50 mm.) occurred in this stratum.

Layer 5R1. — Here were found thirteen flakes, four cores, a hammerstone (65 X 48 X 39 mm.), and four small scrapers. The scrapers, taken together with that found in Layer 5*b*, present something of a problem. They average 34 X 39 mm., with thicknesses ranging from 10 to 23 mm. (the scraper from 5*b*). The long edge

of each one is sharp, the other rough; they are convenient for grasping in one hand and may have been used for cutting, smoothing, or scraping small wood, bone, or shell implements. In view of the evidence for the rather good flaking among the Anasazi, the crudeness of these tools suggests that they may not represent any type at all. There is little evidence of secondary flaking, and I have not seen any reference made to them by other writers.

There were also in this stratum two manos (192 X 105 X 34 mm.; 171 X 102 X 29 mm.) and perhaps a third, a large stone (225 X 95 X 40 mm.), which had one surface pecked and which may represent the initial stage of preparing a mano for use.

Layer 5a. — One stone flake was found in this stratum.

Bone and Shell Artifacts

Worked bone and shell items were few; among them were bone awls, a bodkin, and a fragment of a shell bracelet.

Floor. — Three bone awls: two of the type described by Kidder (14, p. 217) as *Class a*; one probably worked from the humerus of a dog, the second, from the radius of a jack rabbit, shows marks of gnawing. The third is in Kidder's *Class c*; it is a particularly fine piece, with the head partially worked and the entire body well smoothed and polished.

Layer 5d. — Two broken femurs of a jack rabbit: one highly polished, with teeth marks; the other displaying a number of scratches.

Layer 5b. —Three fragments of a long, flat awl or bodkin, 8 mm. wide at the broad end, probably about 150 mm. long originally, and approximately 1.5 mm. thick at the center. It is pierced by a hole, 1.5 mm. in diameter, located on the center line, 5 mm. from the broad end.[6]

Layer 5R1. — Fragment of a shell bracelet, 61 mm. long, 5 X 2 mm. thick. It has been identified as a marine pelecypod, but both Mr. Robert Drake, formerly of the University of New Mexico, and Mr. Aurele La-Rocque, formerly of the University of Michigan, say that it is too fragmentary to permit of further identification. It is rather typical of many such bracelets found in a number of sites in the Southwest, including one similar fragment from Shabik'eshchee.[7]

Other Bone Remains

The following is an inventory of the bones found at the Half House site, as identified by Dr. Burt:

Floor. — *Lepus californicus*: 1 femur head, 1 femur, distal end, 1 humerus head, 1 ulna head, 1 femur, 1 astragalis, 3 calcanei, 4 tibiae; *Sylvilagus*: 1 lumbar vertebra, 1 distal end of humerus, 1 radius, 1 ulna, 1 mandible; *Cynomys*: 1 radius; *Neotoma*: 2 mandibles.

Layer 5R3. — *Cynomys*: 1 humerus, 1 mandible, 1 distal end of humerus, 1 head of a femur, 1 radius, 2 ulnae. Dr. Burt suggested that all except the first listed humerus very likely came from the same young animal.

Layer 5b. — *Lepus californicus*: upper right row of teeth; *Cynomys*: 1 mandible.

Layer 5R1. — Three fragments of bird bones, unidentified.

Walling and Roofing Clay

As has been mentioned, the distinction between 5*d* and the Floor Layer was made on the basis of the presence of pieces of walling and roofing clay in the fill up to one foot above the floor. These specimens were found irregularly throughout this fill. Sixty pieces were recovered in sufficiently good condition to warrant preservation.

Description (Pl. X, 7). — The pieces showed one or two parallel impressions of branches or logs. The clay ranged from 15 to 60 mm. in length, and the calculated diameter of the wood which made the impressions ranged from 20 to 140 mm. The pieces were roughly triangular in cross section. All wood impressions were smooth, but some showed lines in relief running parallel to the length of the branch. Whenever two adjacent impressions were on the same piece of clay, they were approximately parallel. No impressions appeared at definite angles to each other. Most of the remains showed evidence of having been stained with smoke on the area exposed between adjacent impressions. There are no finger impressions on the smoked areas, but they are not uncommon on the opposite side. The smoked area invariably appears on one corner of a piece that would approximate a triangle in cross section. The clay was full of small pieces of charcoal, lignite, and other impurities. It is apparently the same as that used in the plastering between the slabs and in the corners of the fire pit.

Inference. — The framework was composed, to judge from the evidence given above, of a series of parallel stripped branches, some of which were dried, and so left longitudinal cracks. There was no evidence of a cross framework. Most of the branches were between 20 and 80 mm. thick; a few approached 140 mm. thick. With almost no exceptions there was a space of 4 to 15 mm. between branches. It appears that the moist clay was pressed against the outside face of this frame, especially between the cracks, possibly also on the outside surface of the branches. The clay was seldom pressed more than halfway through the cracks, and the inside was left unfinished. It is this small inside area of each piece that is smoked. There was little evidence that these pieces had been exposed to considerable heat or that the branches on which they were pressed had been burned. Some have a slight yellow coloration toward the smoked portion, but an equal number do not. Several pieces have been smoothed on the outside, though most are broken and show only that the clay was applied heavily.

After examining the remains Mr. Volney Jones of the University of Michigan said they were not clear enough to permit identification of the wood and that they have little botanical significance. The sizes of a few pieces over 100 mm. in diameter indicate that the branches were cotton-wood or pine, both of which grew in the Chaco area during this general era.

DESCRIPTION OF HALF HOUSE

The description of the pithouse which follows will be easier to follow if figures 3 and 4 and Plates III-V are kept in mind.

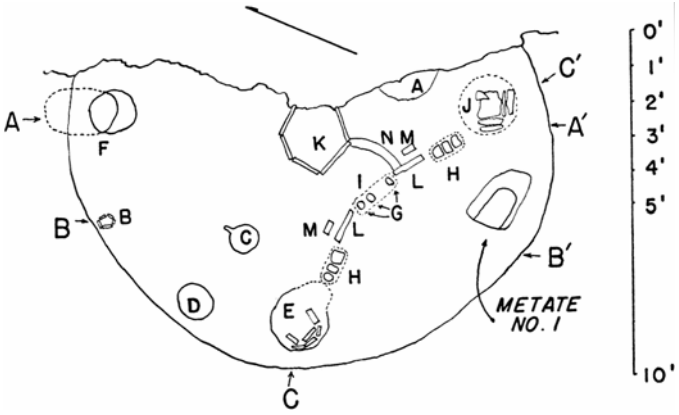

FIG. 3. Floor plan of Half House. (See text for explanation.)

Half House was circular, roughly 14 feet in diameter. Its depth is uncertain. Though the floor was clearly outlined on the arroyo face, there were no external indications of walls such as are shown clearly in the photograph of Judd's Pit House 2 (13, Pl. 2, photograph 2). There is evidence that the house was at least 1.2 and not more than 2.5 feet deep. First, metates 2 and 3 were found leaning against what must have been the wall, with their point of contact 1.2 feet above the floor. Secondly, when the pit was being dug for the construction of the house, the stratum which I have designated Layer 5 had begun to form, for the line distinguishing Layer 5 from Layer 6 occurs on both sides of the house, but not in the area directly above the house. This line of division is also 1.2 feet above the floor. Further, the even line of the bottom of 5R3 over the northern part of the house (to the right of the fire pit in Fig. 2) makes it clear that the walls could not have been more than 2.5 feet high above the floor. And, lastly, the rather sharp angle formed by the left side and the bottom of 5B2 indicates that at the time this lens was deposited the angle made by the wall with the horizontal still remained. The top point of 5B2 is about 2 feet above the floor. A reasonable estimate for the depth of the house, in the light of these data, is 1.5 to 2.0 feet. The lack of any indication of a ventilator would tend to support this conclusion of a shallow pit.

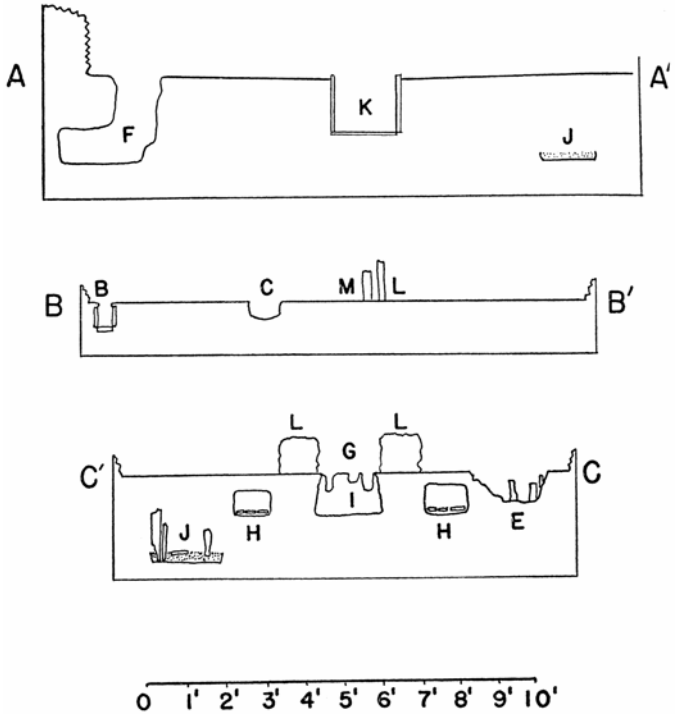

FIG. 4. Cross sections of floor plan of Half House. (See text for explanation.)

The architectural features of the floor of the house are as follows:

1. Floor depression: 1.7' in diameter, 0.4' deep; clay thoroughly reddened, indicative of exposure to heat; filled with same layer of sand which covered the floor. (Fig. 4*A*; Fig. 2.)

2. Small slab-lined pit: greatest diameter, 0.5', smallest diameter, 0.33'; depth, 0.6'; filled with lignite and sand. (Figs. 3*B* and 4*B*.)

3. Floor depression: 0.7' in diameter, 0.4' deep, with slot extending north for 0.2'. (Figs. ZC and AC.)

4. Floor depression: 1.2' in diameter, 0.33' deep; four sherds from a broken Abajo Red-on-orange bowl worked into a scraper found in it. Like depression C, this one was filled with the sand layer which covered the floor. (Fig. 3*D*.)

5. Rough slab-lined pit; maximum length, 2.5', maximum width, 1.75', depth, 0.75'; major area enclosed on three sides by a series of crude slabs; filled with lignite and clap; rim of a plain gray culinary jar found in this pit. (Figs. 3*E* and 4*E*.)

6. Large lignite-filled pit: plastered bottom and sides up to 2" above the bottom; diameter of aperture on the floor, 1.35', at a depth of 2.1' the bottom is 2.15' X 1.35'. To what use this pit was put is not clear; no artifacts were found in it, nor was anything buried beneath it. (Figs. 3*F* and 4*F*; Pl.V.)

7. Three small postholes dug into lignite fill in pit *I* (see No. 9, below); filled with red sand, the same as that which covered the floor in this area. (Figs. 3*G* and 4*G*.)

8. Two cavities under the floor: slab bottoms, lignite fill; dimensions: west cavity, 1.25' X 0.55' X 0.75'; east cavity, 1.2' X 0.55' X 0.6'; the slab bottoms of both these cavities are 1.0' below the floor of the house. (Figs. 3*H* and 4*H*; PL. IV.)

9. Rectangular pit 0.4' wide, 1.0' deep, 1.7' long at the bottom, 1.45' long at the floor level; same type of fill and same depth as the two sub- floor cavities (*H*); in this lignite fill were placed three posts, as evidenced by the postholes (*G*). (Figs. 3*I* and 4*I*.)

10. Subfloor fire pit: 2.2' below the pithouse floor, set in circular depression 1.75' in diameter, packed with lignite and charcoal; highest up right slab 1.3' high; no artifacts found in association. (Figs. 3*J* and 4*J*; Pl. 4.)

11. Main fire pit: six-sided, slab sides and bottom; approximate diameter, 1.85', depth 1.35'; well constructed of tight-fitting slabs, plastered corners and cracks; stone thoroughly reddened. (Figs. 3*K* and 4*K*; Pl. III.)

12. Two large upright slabs; crudely formed, each approximately 1.18' X 0.1' X 1.0'. (Figs. 3*L* and 4*L*; Pl. III.)

13. Two smaller upright slabs; well-shaped rectangular blocks, each approximately 0.5' X 0.2' X 0.75'; each is paired with one of the larger slabs (*L*). (Figs. 3*M* and 4*M*; Pl. III.)

14. Clay lip or ridge extending from crude eastern upright slab (*L*) to southern point of fire pit (*K*); 0.3' wide, 0.2' high. This ridge of clay separated easily from the floor, indicating that it had been placed there after the floor had been well packed by use; there were no indications of a symmetrically placed mate to this ridge running from the fire pit to the large west slab (*L*). (Fig. 3*N*; Pl. III.)

The possible significance of certain of these floor features will be discussed separately later on.

Before concluding this section on Half House it should be noted that the house has the same internal division as is found in some other Anasazi pithouses. The northern part, in which one metate is placed ready for use and two others are set against the wall, served domestic needs. Apparently the southern part was devoted to other purposes. The paucity of artifacts on the floor indicates that the last inhabitants carried away everything worth taking. Metates and manos, which are not readily portable, broken pottery, odds and ends of stone pieces, and a few bone awls were the only materials left. The excavation revealed footprints in the northern half of the floor; these will be discussed later.

The construction of the roof of the house and the walls above the ground must, of course, be inferential, but there are certain things which should be noted. Apparently there were no postholes in the floor for roof supports.[8] It has been suggested[9] that the three large features, the sub-floor fire pit (*J*),[10] the rough slab-lined pit (*E*), and the lignite-filled pit (*F*), all stand in the relative positions of three of the four postholes one would expect to find in a pithouse of this nature. The objection to this explanation is the fact that, even if they had at one time been used for postholes, their later functions obviously varied; hence we are still left with the problem of a house with no visible means of support in its later history. The most likely answer is that the major post supports were outside the house proper. If we do not accept this solution, we must turn to the evidence provided by our study of the walling and roofing clay. It suggests that the covering was of parallel branches or logs, which would have had to be either uprights or parallel horizontals leaning against a series of uprights. Both Roberts (22, Fig. 3) and Smiley (23, Fig. 40) postulate this latter type in their reconstructions of pithouse superstructures. In such a type, however, a series of heavier supports really should be present for the framework, and the evidence from Half House does not indicate that it was.

The evidence does not seem sufficient to enable us to accept one of these possibilities with certainty, but in view of the locus of the site and the fact that we did not excavate around it, and hence did not find a possible series of upright supports, the type of reconstructions of Roberts and Smiley, made on better data than were available at Half House, seems likely.

CHRONOLOGY

All the specimens of charcoal examined for help in dating are from pinon trees. Since none have outside rings, there is no way of determining dates of cutting. The only one that contains the core of a branch is No. 6599. Six pieces (Nos. 6598, 6600-6602, 6605, and 6606) could not be dated owing to their small size or the unsuitability of the wood for such work.

Table II gives Dr. Deric O'Bryan's findings on the charcoal specimens sent to him.

Since no piece of charcoal provides an outside date, we have hardly an indication of the date when this wood was cut, if indeed it ever was. The dates of the charcoal from 5R3 suggest that the fill from which they were taken accumulated during or after the 740's. This would tend to show that the outer date of the specimen from the Floor Level, No. 6599, may not be far off, probably not more than twenty or thirty years. The rate of deposition in this region is very irregular and is unreliable for calculations, but the maximum depth of 5R3 above the floor of the house is four feet, the minimum a little under two feet. Under the circumstances it would be reasonable to estimate the time of the beginning of the fill over the house to be between 700 and 740 after Christ. The end of the last occupation of the house would presumably be not too far from this date. Consequently, the occupations of Half House can be placed earlier than that of Judd's Pit House 2, to which the date of 777 is usually assigned.

TABLE II*

DATA ON CHARCOAL SPECIMENS FOUND AT GILA PUEBLO

Catalogue No.	Stratum	Dates		Correlation
		Inside	Outside	
6599	Floor	⊙— 614	691 (doubtful)	. .
6603A	5R3	— 599	653+ —	Good
6603B	5R3	— 599	644+	Fair
6603C	5R3	— 597	653+	Good
6604A	5R3	— 634	741+	Fair
6604B	5R3	— 623	701+	Poor
6604C	5R3	— 651	748+	Fair
6604D	5R3	— 629	699+	Good

* In a letter dated October 20, 1947, Dr. O'Bryan made the following additional notes: "Catalogue Numbers 6603 A and C and 6604 D show very good correlations with our Chaco and neighboring Lukachucai master charts, and specimens 6604 A and C furnish fairly reliable dates. Number 6599 had extremely tight rings and showed some distortion; however, I am quite sure that the date is within a year or two of being right (allowing for missing rings, etc.)."

All dates are after Christ. The symbol ⊙ preceding the 614 in Column 3 means that the piece of charcoal in question contains the core of the branch; the rest of the specimens do not.

After the floor of the house had been cleared, a test trench 2 feet deep and 0.8 foot wide was cut from the exposed southeastern corner of the floor across to the center of the back. It revealed the subfloor fire pit (Figs. 3*J* and 4*J*) and the eastern subfloor cavity (Figs. 3*H* and 4*H*). The photograph shown in Plate IV gives a view directly down this trench. No artifacts were found in the trench, however. Lack of time prohibited further excavation below the floor, but certain tentative conclusions may be based on the information at hand.

It seems certain that the deposit of earth in which Half House is situated may be classed as Bryan's Deposition II (3; 4: 226-229). The lack of artifacts below the house, as compared with their consistent appearance in the fill above the house in Layers 5, 4, and 3 and in the continuation of those layers along the arroyo face, indicates that Half House was either contemporaneous with Shabik'eshchee village or earlier than it. For it will be remembered that Shabik'eshchee is located on the mesa immediately above Half House; and to imagine that a population of any size could live on the edge of a mesa without availing themselves of the opportunity to dispose of waste and refuse over the side would be difficult. We would expect that, if Shabik'eshchee preceded Half House in time and if any deposition was going on, the sand and clay under the pithouse would reveal Shabik'eshchee materials. Since they do not, if we take into account the similarity in pottery complexes between the two, we would conclude that Half House was very nearly contemporaneous with the village, if not slightly earlier.

Against this conclusion, however, is the fact that the lack of materials beneath the floor is purely negative evidence, and there are certain indications that Half House does not represent the same culture as Shabik'eshchee. In view of their proximity certain differences which will presently be noted in detail suggest a difference in time; the alternative view is that Half House represents a separate social group with some distinct cultural elements not present in the village.

SUMMARY AND INTERPRETATION

Half House is a pithouse in Chaco Canyon, located in the valley below Shabik'eshchee village about nine miles up the canyon from Pueblo Bonito. It was exposed in the side of the arroyo, sixteen feet below the present valley floor, when the wash cut away the bank. The collection of artifacts, and particularly the pottery complex, indicates that the house represents a culture similar to that of Shabik'eshchee. It was probably occupied sometime between 700 and 740 after Christ. The architecture of the house manifests some characteristics which have not heretofore been reported from any other pithouse excavation in the southwest. Among them are subfloor cavities placed symmetrically with regard to certain floor features and the use of two pairs of parallel stones in the north-south division of the house instead of the single row frequently found elsewhere. In other respects the house obviously belongs to the cultural era called Basket Maker III, or Modified Basket Maker, in the Anasazi culture area. The discovery of a fireplace below the floor with apparently little connection with the house itself suggests an earlier but probably unrelated occupation.

Though the artifacts found at the site are too few to enable us to improve our understanding of the late Basket Maker culture, the variation in architectural features suggests a local diversity in this region which has yet to be adequately delineated. The pottery complexes in the several strata of the fill above the house provide a sequence which is in accordance with that usually attributed to the Anasazi culture. The slight, but consistent, appearance of Orange ware indicates a constant contact with other phases of this culture.

Turning to an interpretation of our Half House material, I shall first consider indications concerning the course of events during its occupation, and finally touch on some problems presented by the data.

At the site of Half House two separate and distinct occupations can be postulated. The first is based on the remains of the single subfloor fire pit (Figs. 3*J* and 4*J*). This hearth, if I am correct in my estimate of the ground level at the time of occupation of the house itself, was constructed at a time when the valley floor was about four feet lower than it was during the actual occupation of the house. No artifacts, besides the hearthstones themselves, were found in association with this fireplace or in the test trench across the pithouse. It is possible that it was constructed as part of the house, but the composition of the fill above it could not be distinguished from that around it, though that of the other subfloor features could be differentiated.

If this subfloor pit is earlier than the house, then the house could not have been dug until about four feet of deposition had covered the area (Figs. 2-4). In any case, there are suggestions of two separate occupations of the house itself. The three subfloor cavities (*H, H, I*) have no obvious function. The rectangular pit (*I*) need not have been dug for the placing of three posts, and the

two subfloor cavities (*H, H*) were well covered and trampled on. There seems no other conclusion than that these were originally dug for some reason now unknown and were later filled, and that the house was used without them. It is possible that the same people that dug them filled them, and that a separate occupation is not a necessary postulate, but there is no evidence of similar changes from other pithouses in the Southwest.

The footprints mentioned earlier throw an amusing sidelight on the final occupation of the house. At least twelve of these prints were found on the floor between the fire pit (*K*) and the wall of the house between *D* and *F* (Fig. 3). They were made when the floor was muddy and had been allowed to dry undisturbed. Later on a series of cracks had formed over the floor of the whole northern section of the house. Neither the footprints nor the floor cracks were further worn by occupants. In the southern end of the house there were no real cracks in the floor, probably because of its different composition, which resulted from an accumulation of meal and other foodstuffs soaking into the floor with an occasional flooding. The footprints are evidently those of the last person to visit the house on or after its final abandonment. Whether this prehistoric wanderer was just leaving or was engaged in some outrageous looting, he apparently favored one foot, for there are ten prints of the right foot and only two or three of the left.

A number of problems are suggested by the nature of the site and the present interpretation of its features. The variation in pottery types as one goes up through the layers above the house shows, with the exception of one odd piece (see last note to Table I), a relatively regular evolution of techniques. It is suggested that the upper cultural layers, 5R1 and 4-5*a*, are probably close in time to Judd's Pit House 2. If I am correct in my estimate of the date of Half House, then this indicates a relatively rapid deposition of between seven and eight feet during the eighth century and, perhaps, the ninth. It should be noted that this date is later than the period 500 to 700 after Christ that Bryan assigns to his Deposition II on the basis of sherd evidence given by Bryan (4). Whether this situation would indicate that an alteration in my estimated dates is in order or merely that this part of Chaco Canyon provides a variation in Bryan's conclusions I cannot say.

In the pithouse we are faced with a number of problematical phenomena. Aside from the subfloor cavities discussed earlier (Figs. 3*HI* and 4*HI*), we have the large L-shaped lignite-filled pit with a plastered bottom (Figs. 3*F* and 4*F*; Pl. V). What possible purpose it could have served has thus far escaped everyone familiar with the site. After cleaning it out, we cut through the bottom on the possibility that something might be buried beneath it, but nothing was found.

Though we have speculated on the possible affiliations of Half House with Shabik'eshchee village, the precise relationships, both cultural and historical, remain uncertain. It would not be difficult, however, to determine them if further excavations were carried on in this section of the canyon.

In conclusion, let us return to the question of the correlation between the estimated date of the house and the sequence of pottery types. If my date for Half House, between 700 and 740 after Christ, and that usually assigned to Judd's Pit House 2, A.D. 777, are correct, it means that definite changes in pottery technique and design, namely, the application of a slip and the use of corrugation on culinary wares, took place sometime between those dates in the region of Chaco Canyon. These changes in pottery, coupled with the evident architectural differences between these two sites, reflect the beginnings of the elaboration of culture in Chaco Canyon which developed into the great pueblos of Chettro Kettle and Pueblo Bonito. Since Chaco Canyon was one of the major centers of population of the Pueblo peoples in prehistoric times and since the Southwest has always been a popular area of investigation for archaeologists, it is not a little surprising that our picture of the culture and history of this region remains as spotty as it is. The present paper is offered as a small increment to the knowledge of this important area in the hope that someday we shall at least have available all information on the excavations which have been carried out.

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* The excavation upon which this report is based was carried on during the summer of 1947 by Mr. Malcolm Raphael, Miss Lucille Knudson, and myself, together with a crew of two to four Navaho Indians, in connection with the Field Session of the University of New Mexico; various students of the University gave help during the excavation. I want to thank Mr. Raphael especially for his suggestions and assistance during the entire period. Dr. Paul Reiter, director of the University of New Mexico 1947 Field Session, initiated the project and aided materially in its progress. For advice and criticism I am indebted to a number of people, but particularly to Dr. J. O. Brew, Harvard University, Dr. Irving Rouse, Yale University, and Mr. Stanley Stubbs of the Laboratory of Anthropology in Santa Fe. Dr. William H. Burt, University of Michigan, identified the animal remains and Dr. Deric O'Bryan of Gila Pueblo did the dendrochronology. Dr. James B. Griffin of the University of Michigan was very helpful in the preparation of the manuscript. To these and many others I owe thanks.

The work was undertaken with the permission of the Department of the Interior. The materials from the site are deposited in the Museum of Anthropology, University of Michigan.

This essay was presented in slightly different form to the faculty of the Graduate School of Yale University in candidacy for the degree of Master of Arts.

[1] This map was prepared from one in the National Park Service circular for Chaco Canyon.

[2] I am indebted to Mr. Vivian for information concerning the site prior to my work and for the interest he showed during the excavation.

[3] I am indebted to Dr. Brew for pointing out this sequence.

[4] Brew (2) and Morris (19) provide descriptions of these two red or orange wares. The term “Orange ware” used here includes both.

[5] Roberts (21, p. 117) refers to some of his sherds as “red”; Dr. Brew has suggested— and it seems reasonable under the circumstances — that they are in fact the same general type as my “Orange ware.”

[6] See Roberts (21), Pl. 25d, for a similar tool.

[7] Roberts (21), p. 142; Pl. 30a.

[8] Cf. Hurt (12). In a brief description of the site of a Modified Basket Maker house in the Canyon de Chelley he states that a superficial examination revealed no postholes. Brew (2, pp. 187-188) found at his site, Ab:7:13, only one pithouse, Pit House *N*, which has no evidence of postholes. According to Roberts (21), four postholes were standard at Shabik'eshchee, but House *J* had twenty-two. This situation would be intermediate between the use of primary roof supports and a whole series, as may have been true of Half House.

[9] By Dr. Brew in conversation.

[10] Italicized letters in this section refer to Figures 3 and 4.

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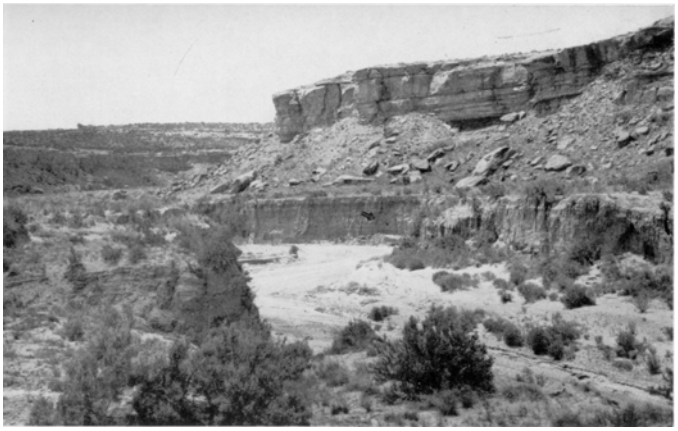
ADAMS PLATE I



View of the site of Half House from the north prior to excavation. The arrow indicates the location of the exposed fire pit. Shabik'eshchee village is on the top of the mesa to the right

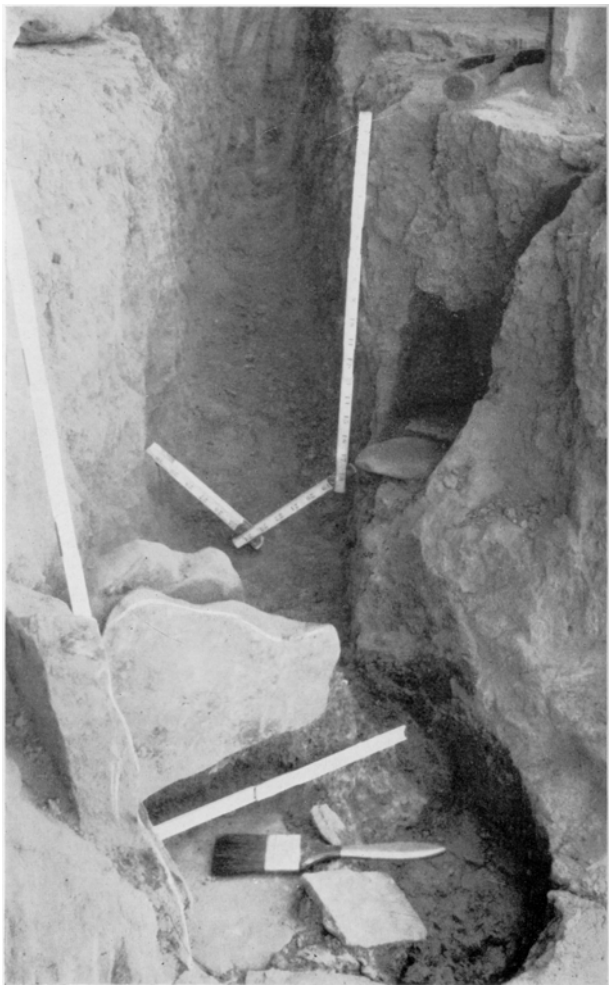
ADAMS PLATE II

Arroyo face at site of Half House prior to the removal of the materials from the fire pit. The sand lens over the house floor is clearly discernible. Compare this view with Figure 2. (Photograph by Gordon Vivian)

ADAMS PLATE III

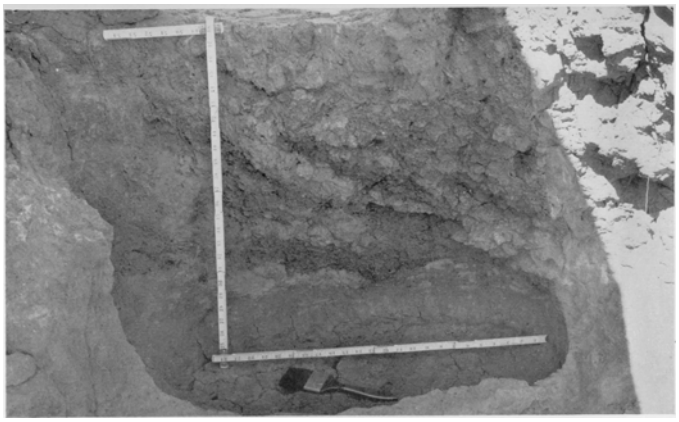
View of the northern portion of the house floor taken from the valley floor. The metates and the upright slabs are *in situ;* the smaller stones are not, but were taken from the immediate vicinity. The six-foot rule lies in a shallow test trench which is not a part of the house construction. Perpendicular to the rule is the test trench which exposed the subfloor fireplace. Compare the photograph with Figure 3. (Photograph by Boyd Wettlaufer)

ADAMS PLATE IV



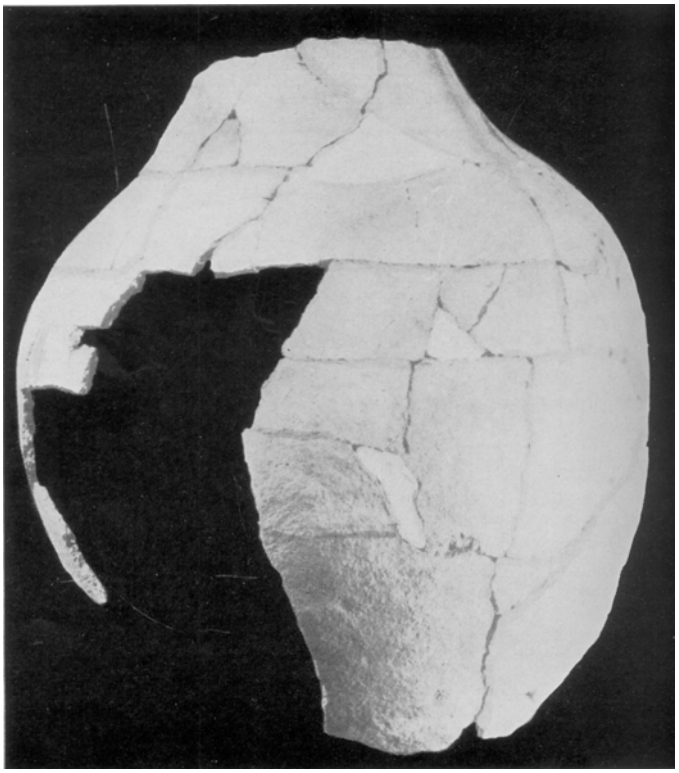
Close-up of the subfloor fireplace, looking west. Just to the right of the center of the photograph is exposed the west subfloor cavity. (Photograph by Boyd Wettlaufer)

ADAMS PLATE V



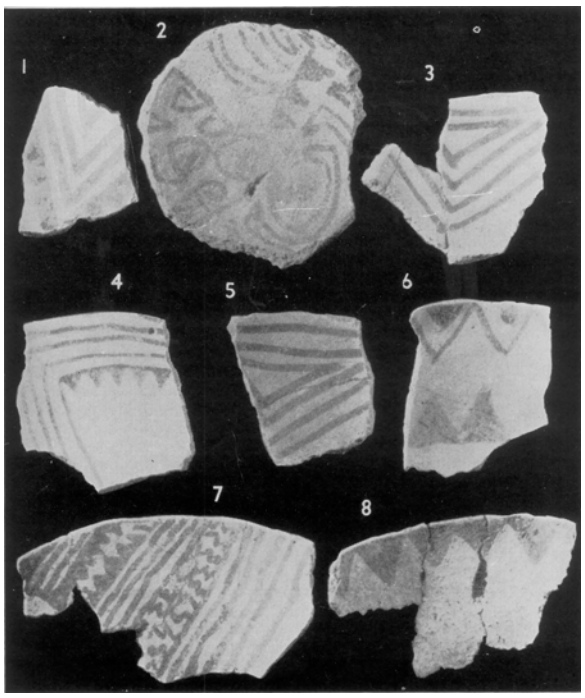
Pit filled with lignite and having a plastered bottom. Here the arroyo bank has been cut away to expose the entire pit. The upper horizontal section of the rule is at the floor level. (Photography by Boyd Wettlaufer)

ADAMS PLATE VI



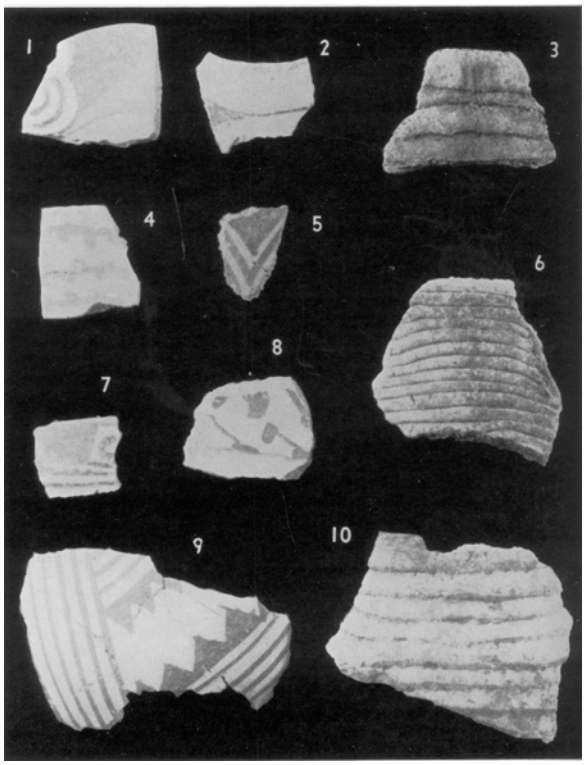
Fugitive red olla taken from the floor of the house. The maximum diameter is 37.6 cm.

ADAMS PLATE VII



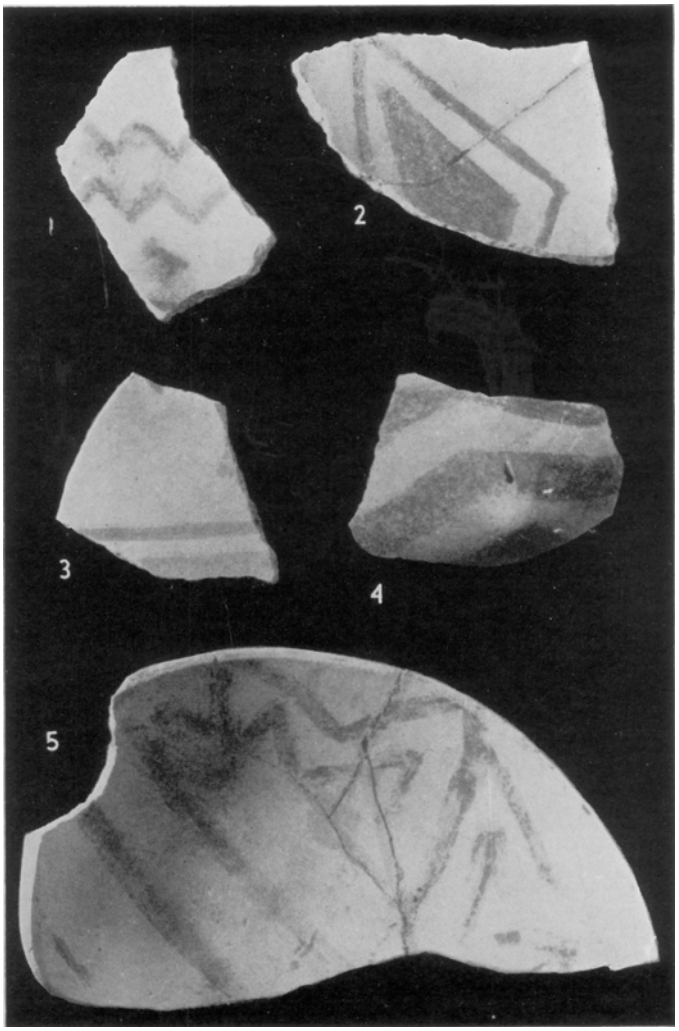
La Plata Black-on-white from the stratigraphy above Half House. Nos. 1, 3, 7, and 8 are from 5R3; No. 2 is from 5d; Nos. 4, 5, and 6 are from 5b. Scale: No. 7 is 12.7 cm. across

ADAMS PLATE VIII



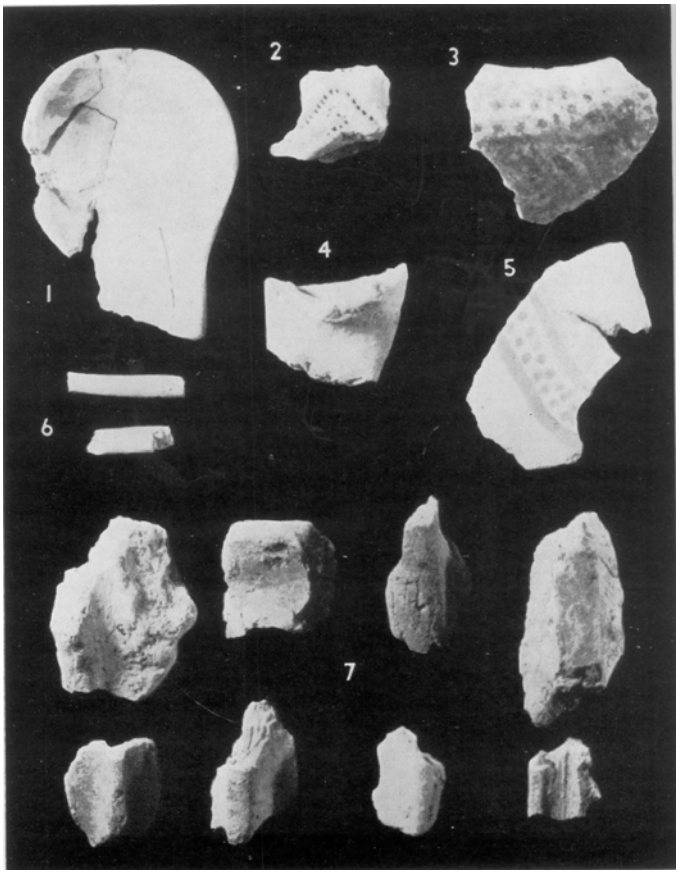
Sherds from the higher levels in the stratigraphy of the site. Kiatuthlanna Black-on-white: Nos. 1 and 2 are from 4-5*a*; No. 4 is from 3; Nos. 7 and 8 are from 5R1. Whitemound Black-on-white: No. 9 is from 5R1. Corrugated Ware: No. 3 is from 5b; No. 6 from 5R1; No. 10 from 4-5*a*. Scale: No. 6 is 10.1 cm. across

ADAMS PLATE IX



Orange ware from the Half House excavation. No. 1 is from 5*b*; No. 2 from 5R1; No. 3 from 4-5*a*; No. 4 from 5R3; No. 5 from the floor of the house. Scale: No. 2 is 8.5 cm. across

ADAMS PLATE X



Miscellaneous artifacts. No. 1 is a plain gray scoop from layer 5*d*. No. 2 is an unbaked clay object with punctate design, from 5*d*. Nos. 3 and 5 are Lino Black-on-gray, from 5*b* and the floor level, respectively. No. 4 is a Fugitive Red effigy foot, from 5*d*. The two items of No. 6 are partially baked clay rolls from 5R1. The eight items composing No. 7 are specimens of the walling and roofing clay found in the fill immediately above the floor. Scale: diameter of No. 1, the scoop, is 7.2 cm.