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MODERN HYDROCARBONS IN TWO WISCONSIN LAKES[1]

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Princeton, New Jersey, and Houston, Texas

GENERAL STATEMENT

The presence of hydrocarbons in modern sediments has been reported by Smith (1954), Swain and Prokopovich (1954), and Stevens (1956, p. 57). This brief report notes the presence of modern hydrocarbons in the recent sediments

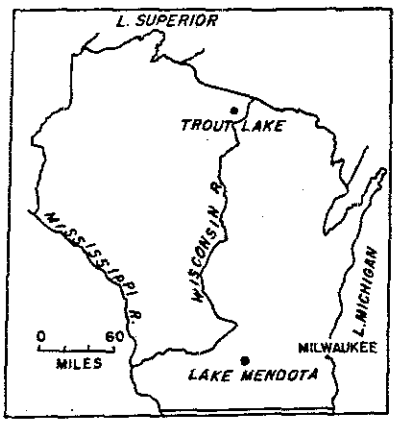

FIG. 1.—Map of Wisconsin to show location of Lake Mendota and Trout Lake.

of Lake Mendota in south-central Wisconsin, and Trout Lake, 250 miles north of Lake Mendota and just south of the Michigan-Wisconsin line (Fig. 1). These lakes differ in limnologic and sediment characteristics and thus offer unusual op-

[1] Manuscript received, December 23, 1955.

[2] Department of Geology, Princeton University.

[3] Technical Services Division, Shell Oil Company. Most of the data on which this paper is based were gathered while the writers were associated with the Department of Geology, University of Wisconsin.

The writers are indebted to the Research Department of the Carter Oil Company, Tulsa, Oklahoma, for extracting the hydrocarbons from the lake sediments; and especially to R. N. Meinert and W. A. Bruce of that department. Professor J. Laurence Kulp of the Lamont Geological Observatory, Columbia University, directed Carbon-14 analyses of the extracts. The lake studies were carried on as part of the work by the University of Wisconsin Lake and Streams Investigation Committee, of which Professor William B. Sarles is coordinator. The Wisconsin Department of Conservation provided facilities for work on Trout Lake. The Wisconsin Alumni Research Foundation provided funds for the general program of which this report is a part and also met, in part, the expense of the radio-carbon analytical work. We were led to the present investigation by observations made in 1951 of G. F. Hanson, Wisconsin State geologist. G. T. Philippi, Shell Development Company, has kindly provided critical reading of this report.

portunities for comparison of their hydrocarbon contents with environmental factors. The data here reported are a by-product of a more extensive study of the sedimentary processes and resulting sediments in the two lakes (Murray, *in press*).

DESCRIPTION OF SAMPLES

Method of collection.—The samples from each lake were taken from a single station. The Lake Mendota samples were taken on two dates, May 26 and June 2, 1954. The Trout Lake samples were taken on June 18, 1954. The sampling was conducted from a small boat.

A free-fall tube with a 1½-inch I.D., split plastic liner was used. The tube was weighted at the bottom. Each sample represents an accumulation of a section of each of approximately thirty cores from a definite stratigraphic level at a single station. In other words, a single sample such as #M-56-1 is the accumulation of thirty 10-inch sections 1½ inches in diameter extending from the surface of the lake bottom to 10 inches below this surface. The individual samples weighed 4–12 pounds of wet sediment. Details of sampling, sample location, lake environment, sediment petrography and petrology are reported by Murray (*in press*).

The samples were put under refrigeration at the time of collection and then put under deep freeze immediately after coming off the lake. Subsequently they were packed in dry ice and shipped air express to the Carter laboratories in Tulsa which reported the samples to be still partly frozen upon arrival.

Lake Mendota samples.—The samples were taken in 69 feet of water near the center of a flat-bottomed basin. Lake Mendota is a hard water, eutrophic lake, with a hardness of 35–40 cc. of fixed CO_2 per liter. The lake is subject to contamination from motor boats, farmland drainage, some drainage from city and village streets, but not from municipal sewage. The samples were as follows.

Sample Number	*Depth in Inches Below Surface of Lake Bottom*	*Type of Sediment*
M-56-1[1]	0–10	Black sludge
M-56-2	10–16	Buff marl
M-56-3	20–26	Buff marl

[1] The interface between M-56-1 and M-56-2 is knife sharp.

Trout Lake samples.—Trout Lake, about 250 miles north of Lake Mendota and 15–20 miles south of the Michigan-Wisconsin state line, is made up of two lakes connected by a narrow passage. Samples were taken in Southern Trout Lake which is the larger of the two. The sampling locality was in the north end of a large flat-bottomed basin and beneath 95 feet of water. Trout Lake is a medium-soft water, oligotrophic lake with a hardness of about 6.5–7 cc. fixed CO_2 per liter. The sources of lake contamination are negligible. Aside from a few motor boats and lakeside cottages the lake is about as free of contamination as one can currently find in northern Wisconsin.

The samples obtained were as follows.

Sample Number	*Depth in Inches Below Surface of Lake Bottom*	*Type of Sediment*
T-20-1	0–9	Olive green gyttja
T-20-2	9–18	Olive green gyttja
T-20-3	18–27	Olive green gyttja

No recognizable horizons existed although a uniform increase in plasticity from top to bottom was noted.

HYDROCARBON CONTENT

The samples contained hydrocarbons as follows.

	Hydrocarbon Content ppm	*Wt. Grams*	*Organic Matter %*
Lake Mendota			
M-56-1	120	0.06	10
M-56-2	350	0.1	10
M-56-3	225	0.04	12

Comment.—The reported hydrocarbon concentration is essentially free of elemental sulphur.

Trout Lake			
T-20-1	275	0.03	43
T-20-2	285	0.03	46
T-20-3	270	0.05	50

All samples contained paraffin-naphthene and aromatic hydrocarbons but the type and molecular weight of the hydrocarbons were not obtained.

The method of extraction used was similar to that reported by Smith (1954) but differed as follows according to W. A. Bruce of the Carter Research Department.[4]

The sample is dried at 80–90°C., ground to pass a 100-mesh sieve, and extracted for four hours with a refluxing mixture of benzene, methanol, and acetone. Following the benzene mixture extraction, a second extraction is carried out with a similar mixture of carbon disulfide, methanol and acetone. The atmosphere of nitrogen employed by Smith in his extractions is not used in our procedure. The combined extracts are filtered, allowed to evaporate at room temperature, and weighed. The chromatographic separation of the residue . . . used . . . is essentially that outlined by Smith except that we do not use acetone and methanol to elute the column. In addition, the benzene-insoluble portion of each extract is removed prior to chromatography.

CARBON-14 CONTENT

In order to determine whether the samples contained modern hydrocarbons or whether they were contaminated in some way by "dead" hydrocarbons, Carbon-14 analyses were undertaken by Kulp (1956) at Columbia. Because of the smallness of samples it was necessary to mix together the three samples from each lake to obtain a single sample for each lake which would be large enough to determine the C-14 content. Kulp stated that the difficulties involved were large and that the Sample No. L.#243B was the smallest that had yet been analyzed for C-14.[5] Total carbon in the Trout Lake sample was .025 gram. Because of technical difficulties the samples were not run until September and October, 1955.

The results for the samples follow.

Lake Mendota		
Lamont #243 A	Two runs	
(Our M-56-1,2,3)	5,400 ± 2,000. Best average	
Trout Lake		
Lamont #243 B	Four runs	
(Our T-20-1,2,3)	2,960 ± 2,400. Best average	

SIGNIFICANCE

From the foregoing data it is seen that the hydrocarbons from each lake have C-14 activity; therefore, they are not due to contamination by "dead" hydrocarbons, but represent the generation of hydrocarbon in the modern sedimentary environment of the lakes.

It is interesting to note that the most recent sediments in Trout Lake contain approximately 45 per cent organic matter and average 277 ppm. hydrocar-

[4] W. A. Bruce, personal communication to R. C. M., dated October 18, 1954.

[5] J. Laurence Kulp, personal communication to S. J., dated October 20, 1955.

bon. On the other hand, the most recent sediments in Lake Mendota have approximately 11 per cent organic matter and average 232 ppm. hydrocarbon. The organic content does not appear to reflect directly the hydrocarbon concentration. The organic content of the Trout Lake sediments is approximately four times that of the Mendota sediments, but the hydrocarbon contents are roughly of the same magnitude. Two suggestions may cast some light on this anomaly and offer a departure point for future investigations. 1. There may be a basic difference in type of organic matter being deposited in two lakes. Lake Mendota supports heavy green algal blooms in summer which undoubtedly contribute much of the organic sediment. Trout Lake undoubtedly receives much transported organic material from the near-by forest area. 2. Lake Mendota, being eutrophic, has oxygen deficient bottom waters during much of the year. This deficiency allows the generation of reducing conditions capable of permitting the formation of authogenic iron sulphides. Such reducing conditions should also favor the preservation of oxidizable hydrocarbons. Trout Lake, on the other hand, is oligotrophic and thus retains some of its oxygen throughout the year. Thus, Trout Lake offers a far more favorable environment for destruction of hydrocarbons by oxidation.

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