TRITIUM ANALYSES OF SHALLOW GROUND WATER IN MISSISSIPPI, APRIL 1989

By Larry J. Slack and William T. Oakley

U.S. GEOLOGICAL SURVEY
Open-File Report 89-418

Prepared in cooperation with the

MISSISSIPPI DEPARTMENT OF ENVIRONMENTAL QUALITY,
BUREAU OF POLLUTION CONTROL

Jackson, Mississippi
1989

DEPARTMENT OF THE INTERIOR
MANUEL LUJAN, JR., Secretary

GEOLOGICAL SURVEY
Dallas L. Peck, Director

For additional information write to:

District Chief
U.S. Geological Survey
Suite 710, Federal Building
100 W. Capitol Street
Jackson, Mississippi 39269

Copies of this report can be purchased from:

U.S. Geological Survey
Books and Open-File Reports
Building 810
Box 25425, Federal Center
Denver, Colorado 80225

CONTENTS

ILLUSTRATIONS

TABLES

CONVERSION FACTORS

For readers who may prefer to use the metric (International System) of units rather than the inch-pound units used herein, the conversion factors are listed below:

Multiply inch-pound unit	by	To obtain metric unit
foot (ft)	25.4	millimeter (mm)
gallon per minute (gal/min)	0.06308	liter per second (L/s)
degree Fahrenheit (°F)	°C=5/9x(°F-32)	degree Celsius (°C)

ABBREVIATIONS

mg/L	milligram per liter
pCi/L	picocurie per liter
TU	tritium unit
µS/cm	microsiemens per centimeter at 25 °C

TRITIUM ANALYSES OF SHALLOW GROUND WATER IN MISSISSIPPI, APRIL 1989

by Larry J. Slack and William T. Oakley

ABSTRACT

In April 1989, the U.S. Geological Survey collected water samples from 22 shallow wells (less than 400 feet deep) for tritium analyses; the wells are completed in 11 of the principal aquifers in Mississippi. Tritium concentrations ranged from less than 0.3 to 42 picocuries per liter. Tritium concentrations in water from 50 percent of the wells were greater than 1 picocurie per liter, indicating modern (post-1953) water.

INTRODUCTION

This study is part of the Federal-State Cooperative Program, conducted by the U.S. Geological Survey and State and local agencies. The principal program objectives are: (1) to collect, on a systematic basis, data needed for the continuing determination and evaluation of the quantity, quality, and use of water resources in the United States, and (2) to appraise the availability of ground and surface water through analytical and interpretive investigations. The resulting information forms the foundation for many of the Nation's water-resources management and planning activities and allows for the detection of emerging water problems.

The principal State agencies in Mississippi responsible for ground-water management and protection are the Bureau of Pollution Control (BPC), the Bureau of Land and Water Resources, and the Bureau of Geology of the Mississippi Department of Environmental Quality.

The Groundwater Planning Section, Groundwater Protection Division of the BPC, is responsible for the development of ground-water protection programs. The long-term objective of those programs is both to develop and to administer the regulatory activities necessary to protect the State's ground-water resources; short-term objectives include investigating ground-water recharge rates for selected aquifers in the State associated with the Well Head Evaluation Program (C. Smith, Mississippi Bureau of Pollution Control, written commun., July, 1989). This study was made to help meet the objectives of the USGS and the BPC.

Purpose of Tritium Analyses

Tritium has been used extensively as a hydrologic tracer since the early 1950's and can be used to indicate the relative age of water. Tritium is particularly useful in ground-water studies because it is relatively unaffected by reactions other than radioactive decay.

Tritium is a radioactive isotope of hydrogen with an atomic weight of 3 and a half-life of 12.43 years. Tritium is produced naturally, in a small but near steady-state concentration (Michel, 1989, p.3), in the atmosphere. Prior to the initiation of atmospheric testing of large thermonuclear weapons in 1953, the natural tritium content of rainwater was about 1 to 5 tritium atoms per 10^{18} normal hydrogen atoms (Thatcher, 1962, p. 48), or 1 to 5 tritium units (TU). In the 1950's and 1960's, tritium concentrations in precipitation in the northern hemisphere increased 2 or 3 orders of magnitude--to about 50 TU for surface ocean water and 100's or 1000's of TU for some continental water.

SITE SELECTION CRITERIA

In April 1989, the U.S. Geological Survey collected water samples from 22 shallow wells (less than 400 feet deep) (fig. 1) for tritium analyses; the wells are completed in 11 of the principal aquifers in Mississippi. It is essential that complete and accurate well-construction information be available for each site; consequently, first preference was given to public-supply wells for which geophysical logs are available. Wells were selected that were in use, had turbine or submersible pumps, and had a yield of at least 50 gallons per minute (table 1).

METHODS OF SAMPLING AND ANALYSIS

To assure that samples were representative of water from the water-bearing unit, the wells were pumped long enough prior to sampling to evacuate at least twice the volume of water in the casing. Most of the wells sampled were in daily operation, and some were in continuous operation.

Water samples for tritium analysis were collected in a narrow-mouth flint glass bottle with a polyseal cap. Water was pumped into the bottle until it reached near the top, with care taken not to entrain air. The bottle was capped, and the cap was taped to prevent it from loosening during transit.

The samples were shipped to the Water Resources Division National Water Quality Laboratory (NWQL) in Denver, Colorado, where they were recorded, repackaged, and forwarded to the University of Miami Tritium Laboratory. The samples were analyzed by an electrolytic enrichment with gas counting method developed by Ostlund and Werner (1961). It is the most sensitive method available through the NWQL. The lower detection limit is 0.3 picocurie per liter. [One TU = 3.2 picocuries per liter of water.]

RESULTS OF TRITIUM ANALYSES

Tritium concentrations for the 22 wells (table 2) are in picocuries per liter; for the convenience of the reader, tritium units (which were obtained by dividing picocuries per liter by a conversion factor of 3.2) are also shown. Temperature, specific conductance, pH, and alkalinity data for water from the 22 wells are also included in table 2.

Tritium concentrations less than about 1 picocurie per liter are considered to represent water with natural or background levels of tritium for ground water in Mississippi (R.L. Michel, USGS, oral commun., September 13, 1989). Values greater than 1 picocurie per liter are considered to represent post-1953 water, which is commonly referred to as "modern water" or "bomb tritium water." The limited amount of tritium data obtained during this study precludes drawing conclusions about the typical concentrations for any given aquifer.

Tritium concentrations ranged from less than 0.3 (the lower detection limit) to 42 picocuries per liter. Tritium concentrations in water from 10 of the wells were less than the lower detection limit. In 50 percent of the wells, tritium concentrations were greater than 1 picocurie per liter, indicating modern (post-1953) water.

SUMMARY

In April 1989, the U.S. Geological Survey collected water samples from 22 shallow wells (less than 400 feet deep) for tritium analyses; the wells are completed in 11 of the principal aquifers in Mississippi. Tritium concentrations ranged from less than 0.3 to 42 picocuries per liter. Tritium concentrations in water from 50 percent of the wells were greater than 1 picocurie per liter, indicating modern (post-1953) water.

REFERENCES

Michel, R.L., 1989, Tritium deposition in the continental United States, 1953-83: U.S. Geological Survey Water-Resources Investigations Report 89-4072, 51 p.

Ostlund, H.G., and Werner, E., 1961, The electrolytic enrichment of tritium and deuterium for natural tritium measurements: Tritium in the Physical and Biological Sciences, Proceedings, vol. 1, p. 95-105.

Thatcher, L.L., 1962, The distribution of tritium fallout in precipitation over North America: International Association of Science Hydrology Bulletin, vol. 7, no. 2, p. 48.

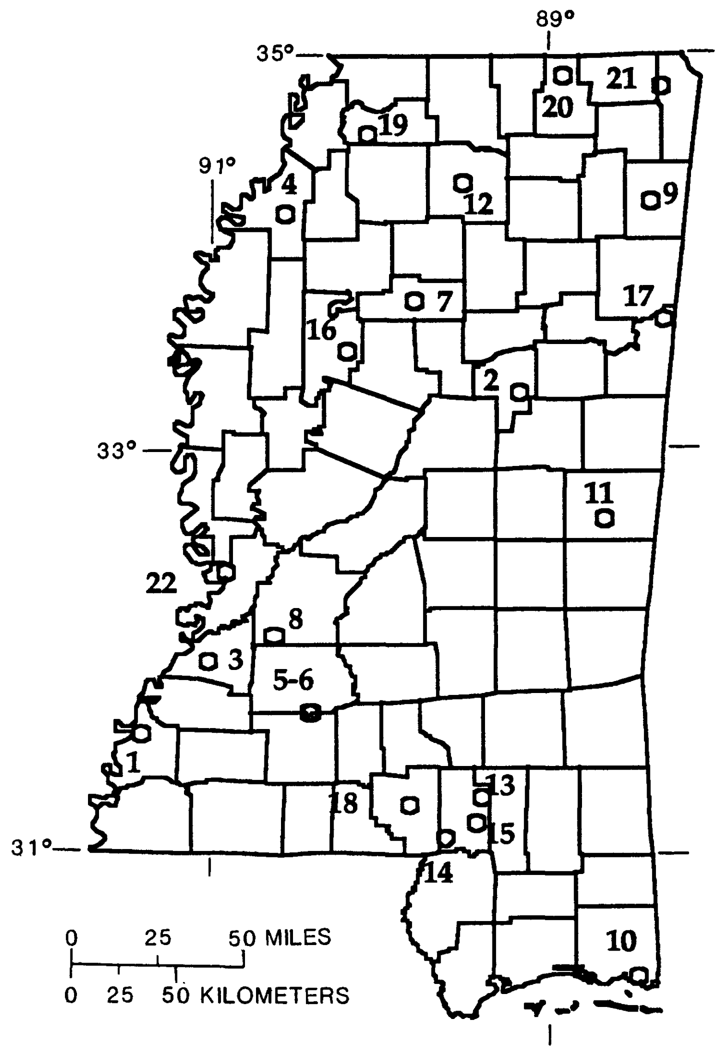

Figure 1.--Location of ground-water sites for tritium analyses.

Table 1. *Summary of site information*
[ft, feet; gal/min, gallons per minute; Util, Utilities; W A, Water Association]

Site no. (see fig.1)	County	Local well number and name of owner or city	Depth of well (ft)	Top, open interval (ft)	Well yield (gal/min)	Aquifer or aquifer system
1	Adams	D045 Broadmoore Util	150	135	250	Miocene
2	Choctaw	H030 Ackerman	101	64	360	Middle Wilcox
3	Claiborne	L079 Port Gibson	170	110	140	Catahoula
4	Coahoma	J009 Clarksdale	357	307	2,000	Sparta
5	Copiah	V019 Wesson	332	292	340	Catahoula
6	Copiah	V025 Wesson	360	320	380	Catahoula
7	Grenada	H013 Grenada	170	145	600	Meridian-Upper Wilcox
8	Hinds	S016 Utica	298	258	240	Catahoula
9	Itawamba	H021 Fulton	274	223	350	Gordo
10	Jackson	Q420 Pascagoula	346	266	600	Graham Ferry
11	Kemper	N016 Kipling W A	178	138	200	Lower Wilcox
12	Lafayette	F023 Oxford	96	71	600	Meridian-Upper Wilcox
13	Lamar	E209 N Lamar W A	187	147	200	Miocene
14	Lamar	J276 N Lumberton W A	202	160	220	Miocene
15	Lamar	L093 Progress W A	264	222	200	Miocene
16	Leflore	L154 Greenwood	220	160	1,900	Sparta
17	Lowndes	B030 Caledonia	323	283	110	Gordo
18	Marion	L002 Columbia	140	110	1,200	Miocene
19	Tate	F048 Strayhorn W A	316	276	220	Sparta
20	Tippah	D014 Tipplersville W A	190	130	120	Ripley
21	Tishomingo	D052 Burnsville	280	230	350	Paleozoic
22	Warren	E023 Vicksburg	122	82	1,000	Miss. River Valley alluvium

Table 2. ***Values for tritium and selected water-quality properties and constituents for ground water at selected sites in Mississippi***

[pCi/L, picocuries per liter; TU, tritium units; °C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter]

Site no. (see fig. 1)	Date	Tritium concentration (pCi/L)	Tritium concentration (TU)	Temperature (°C)	Specific conductance (µS/cm)	pH (units)	Alkalinity (mg/L as $CaCO_3$)
1	04-20-89	41	12.8	19.5	540	6.7	288
2	04-18-89	20	6.2	18.0	110	5.2	8
3	04-20-89	4.3	1.3	20.0	498	6.8	246
4	04-26-89	<0.3	<0.1	17.0	450	7.1	251
5	04-19-89	34	10.6	20.0	65	5.2	7
6	04-19-89	38	11.8	20.0	45	5.3	6
7	04-25-89	<0.3	<0.1	19.0	340	7.6	148
8	04-20-89	<0.3	<0.1	21.0	580	7.4	179
9	04-19-89	<0.3	<0.1	17.0	100	6.6	24
10	04-18-89	<0.3	<0.1	23.0	920	7.7	299
11	04-21-89	31	9.7	18.5	38	5.1	2
12	04-25-89	42	13.1	17.0	80	5.6	13
13	04-19-89	14	4.4	20.5	24	5.6	5
14	04-19-89	31	9.7	20.5	22	5.1	3
15	04-19-89	<0.3	<0.1	21.0	30	5.6	11
16	04-25-89	0.9	0.3	19.0	420	7.2	234
17	04-20-89	<0.3	<0.1	18.0	110	6.4	25
18	04-19-89	12	3.8	21.0	46	5.6	9
19	04-25-89	<0.3	<0.1	18.0	80	6.5	38
20	04-18-89	<0.3	<0.1	17.0	380	7.4	192
21	04-19-89	<0.3	<0.1	16.5	100	6.6	20
22	04-20-89	17	5.3	18.5	525	6.7	258