# TRITIUM ANALYSES OF WATER IN THE MISSISSIPPI RIVER ALLUVIAL AQUIFER IN NORTHWESTERN MISSISSIPPI, AUGUST 1991

By Larry J. Slack and William T. Oakley

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## CONTENTS



## ILLUSTRATION



## TABLES

## CONVERSION FACTORS AND VERTICAL DATUM

| Multiply | By | To obtain |
|---|---|---|
| foot | 25.4 | millimeter |
| square mile | 2.590 | square kilometer |

To convert degrees Celsius (°C) to Fahrenheit (°F), use the following:

$$°C = 5/9 (°F-32)$$

**Sea level:** In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "Sea Level Datum of 1929."

# TRITIUM ANALYSES OF WATER IN THE MISSISSIPPI RIVER ALLUVIAL AQUIFER IN NORTHWESTERN MISSISSIPPI, AUGUST 1991

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ABSTRACT

In August 1991, the U.S. Geological Survey collected water samples from 34 shallow (less than 160 feet deep) wells for tritium analyses; the wells are completed in the Mississippi River alluvial aquifer in northwestern Mississippi. Tritium concentrations ranged from less than 0.3 to 52 picocuries per liter. Tritium concentrations in water from 26 wells (about 76 percent) were greater than 1 picocurie per liter, indicating modern (post-1953) water. The median tritium concentration was about 4 picocuries per liter; the mean, about 9 picocuries per liter.

# INTRODUCTION

As part of the Federal-State Cooperative Program, the U.S. Geological Survey (USGS) collects, 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 appraises 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 Mississippi Department of Environmental Quality, Office of Pollution Control (OPC), is the principal agency responsible for the management and protection of ground water in Mississippi. The OPC administers programs and policies to secure, protect, and preserve the right of citizens to unpolluted waters. Together with the Mississippi Department of Agriculture and Commerce, the OPC is developing a comprehensive program to protect aquifers from surface and shallow-source contamination. The USGS, in cooperation with these agencies, is conducting an investigation to describe the relative susceptibility of major aquifers in Mississippi to surface and shallow-source contamination.

## Purpose and Scope

One of the objectives of the OPC's ground-water protection programs is to investigate the relative age of ground water in the principal aquifers in Mississippi that are associated with the Well Head Protection Program. In 1991, in cooperation with the OPC, the USGS used radioisotope (tritium) dating techniques to assess the relative age of shallow ground water in the Mississippi River alluvial aquifer in the northwestern part of the State. This report summarizes the site information, methods of sampling and analysis, and results of the tritium analyses and other selected water-quality data collected as part of that study.

## Use of Tritium as a Tracer

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 (pre- or post-1953). 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 and occurs in a small but nearly constant concentration in the atmosphere (Lal and Peters, 1967). 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 Units or 1 to 5 tritium atoms per $10^{18}$ normal hydrogen atoms (Thatcher, 1962, p. 48). In the 1950's and 1960's, tritium concentrations in precipitation in the northern hemisphere increased substantially and resulted in values of about 50 Tritium Units for surface ocean water and 100's or 1000's of Tritium Units for some continental water (Michel, 1989, p. 2).

## SITE SELECTION CRITERIA AND SITE INFORMATION

In August 1991, the USGS collected water samples from 34 shallow (less than 160 feet deep) wells for tritium analyses; the wells are completed in the Mississippi River alluvial aquifer in northwestern Mississippi, a 7,000-square-mile area (Sumner and Wasson, 1990) known locally as the "Delta" (see fig. 1 and table 1). First preference in site selection was given to irrigation wells for which driller's logs are available. Other selection criteria included wells that were in use or recently had been in use.

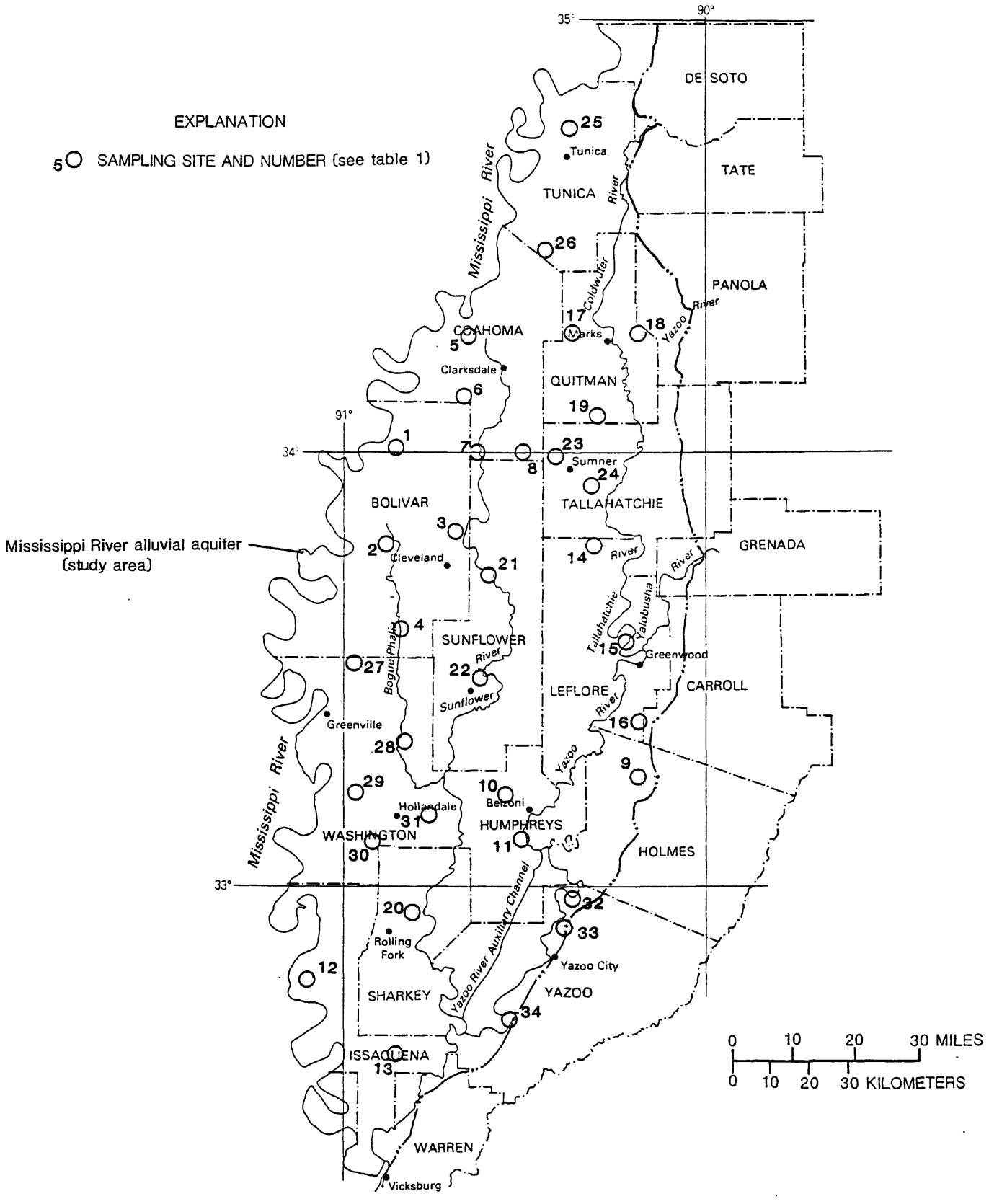


**Figure 1. Location of ground-water sites with tritium analyses.**

## Table 1. Summary of site information

| Site number of well (see fig. 1) | County | Local well number and name of owner | | Latitude | Longitude | Depth (feet) |
|---|---|---|---|---|---|---|
| 1 | Bolivar | A070 | KBH Corp | 34°00'52" | 90°52'24" | 105 |
| 2 | Bolivar | F029 | T Russell | 33°47'42" | 90°53'37" | 29 |
| 3 | Bolivar | H006 | Ed Hill | 33°49'42" | 90°42'24" | 135 |
| 4 | Bolivar | T145 | Session Pleasant | 33°35'55" | 90°51'27" | 107 |
| 5 | Coahoma | D014 | Stovall Farris | 34°16'49" | 90°40'02" | 125 |
| 6 | Coahoma | H020 | Graham Bramlett | 34°08'33" | 90°40'54" | 108 |
| 7 | Coahoma | N003 | L F Foreman | 34°00'06" | 90°39'20" | 54 |
| 8 | Coahoma | O018 | Floy Haney | 34°00'01" | 90°30'33" | 104 |
| 9 | Holmes | H031 | Henry Fleming | 33°15'57" | 90°12'24" | 96 |
| 10 | Humphreys | B160 | A B Evans | 33°13'19" | 90°33'39" | 116 |
| 11 | Humphreys | F155 | B L B Farms | 33°07'06" | 90°30'52" | 116 |
| 12 | Issaquena | C042 | Franklin Farms | 32°47'50" | 91°06'24" | 122 |
| 13 | Issaquena | F023 | Miss Grain Service | 32°36'56" | 90°51'36" | 140 |
| 14 | Leflore | B032 | Equen and McBee | 33°47'40" | 90°19'08" | 112 |
| 15 | Leflore | H105 | Prudential | 33°34'12" | 90°13'52" | 120 |
| 16 | Leflore | O026 | Leflore Flying | 33°23'35" | 90°12'22" | 100 |
| 17 | Quitman | D016 | Carr Planting Co. | 34°17'40" | 90°22'13" | 110 |
| 18 | Quitman | F016 | Unknown | 34°17'03" | 90°11'33" | 120 |
| 19 | Quitman | L034 | Frank Melton | 34°04'49" | 90°18'42" | 110 |
| 20 | Sharkey | C051 | Sunflower Farm | 32°56'36" | 90°49'02" | 110 |
| 21 | Sunflower | E063 | Mrs Quinn | 33°43'50" | 90°36'15" | 120 |
| 22 | Sunflower | N046 | Hiram Hill | 33°29'59" | 90°38'31" | 110 |
| 23 | Tallahatchie | C030 | B Williams | 34°00'26" | 90°25'30" | 105 |
| 24 | Tallahatchie | J039 | Smith Murphey | 33°56'02" | 90°19'08" | 126 |
| 25 | Tunica | D029 | Jack Day Perry | 34°45'40" | 90°23'08" | 125 |
| 26 | Tunica | M012 | Roger Johnson | 34°28'52" | 90°26'42" | 110 |
| 27 | Washington | A127 | Keith Mitchell | 33°31'37" | 90°59'17" | 105 |
| 28 | Washington | J050 | Mike Payne | 33°20'09" | 90°50'47" | 108 |
| 29 | Washington | K067 | Charles Hobart | 33°13'20" | 90°58'52" | 110 |
| 30 | Washington | O064 | Rusty Willis | 33°06'24" | 90°56'25" | 100 |
| 31 | Washington | P080 | Billy R Harris | 33°10'20" | 90°46'58" | 130 |
| 32 | Yazoo | A058 | Eden Fisheries | 32°58'48" | 90°22'20" | 105 |
| 33 | Yazoo | G002 | Miss Chemical | 32°54'32" | 90°23'22" | 158 |
| 34 | Yazoo | Q023 | J J Peaster | 32°42'32" | 90°32'50" | 96 |

## METHODS OF SAMPLING AND ANALYSIS

To assure that samples were representative of water from the water-bearing unit, most of the wells were pumped long enough prior to sampling to evacuate at least twice the volume of water standing in the casing. Water samples for tritium analysis were collected in a narrow-mouth flint glass bottle with a polyseal cap. The bottle was completely filled, 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 USGS Water Resources Division National Water Quality Laboratory in Denver, Colorado, where they were recorded, repackaged, and forwarded to the University of Miami Tritium Laboratory. At the 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 of tritium analysis available through the National Water Quality Laboratory. The lower detection limit is 0.3 picocurie per liter.

## RESULTS

Tritium concentrations for the 34 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. Laboratory values for specific conductance, pH, alkalinity, chloride, nitrite plus nitrate, and residue on evaporation (dissolved solids) for water from the 34 wells are also included in table 2.

## Table 2. Values for tritium and selected properties and constituents of water from the Mississippi River alluvial aquifer in northwestern Mississippi

[pCi/L, picocuries per liter; TU, tritium units; µS/cm, microsiemens per centimeter at 25 °C (degrees Celsius); mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; N, as nitrogen; ROE, residue on evaporation at 180 °C; <, less than]

| Site number (see fig. 1) | Date | Tritium concentration (pCi/L) | Tritium concentration (TU) | Specific conductance (µS/cm) | pH (units) | Alkalinity (mg/L as $CaCO_3$) | Chloride (mg/L) | Nitrite plus nitrate-N (mg/L) | ROE (mg/L) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 08-27-91 | 52 | 16 | 497 | 7.9 | 226 | 7.3 | <0.02 | 289 |
| 2 | 08-27-91 | 1.9 | 0.6 | 798 | 7.5 | 342 | 12 | <0.02 | 496 |
| 3 | 08-27-91 | 3.5 | 1.1 | 676 | 7.5 | 340 | 10 | <0.02 | 400 |
| 4 | 08-27-91 | 15 | 4.7 | 601 | 7.8 | 254 | 5.1 | <0.02 | 361 |
| 5 | 08-26-91 | <0.3 | <0.1 | 597 | 7.5 | 324 | 5.3 | <0.02 | 347 |
| 6 | 08-26-91 | 11 | 3.4 | 508 | 7.5 | 239 | 4.3 | <0.02 | 303 |
| 7 | 08-26-91 | 1.6 | 0.5 | 640 | 7.5 | 327 | 8.6 | <0.02 | 368 |
| 8 | 08-26-91 | 1.7 | 0.5 | 543 | 7.4 | 285 | 7.0 | <0.02 | 309 |
| 9 | 08-29-91 | 17 | 5.3 | 182 | 7.2 | 84 | 4.7 | <0.02 | 95 |
| 10 | 08-28-91 | 3.6 | 1.1 | 545 | 7.3 | 254 | 21 | <0.02 | 318 |
| 11 | 08-28-91 | 41 | 12 | 420 | 7.3 | 226 | 2.0 | <0.02 | 250 |
| 12 | 08-29-91 | 6.0 | 1.9 | 720 | 7.3 | 397 | 6.1 | <0.02 | 419 |
| 13 | 08-29-91 | 12 | 3.8 | 632 | 7.5 | 338 | 2.0 | <0.02 | 385 |
| 14 | 08-27-91 | 9.0 | 2.8 | 531 | 7.3 | 279 | 5.8 | <0.02 | 325 |
| 15 | 08-27-91 | 0.7 | 0.2 | 471 | 7.3 | 251 | 3.6 | <0.02 | 280 |
| 16 | 08-27-91 | <0.3 | <0.1 | 490 | 7.4 | 264 | 3.5 | <0.02 | 283 |
| 17 | 08-26-91 | <0.3 | <0.1 | 454 | 7.3 | 243 | 3.8 | <0.02 | 275 |
| 18 | 08-26-91 | 2.0 | 0.6 | 330 | 7.3 | 161 | 3.9 | <0.02 | 206 |
| 19 | 08-26-91 | <0.3 | <0.1 | 547 | 7.4 | 285 | 6.9 | <0.02 | 323 |
| 20 | 08-29-91 | 1.4 | 0.4 | 752 | 7.4 | 387 | 4.5 | <0.02 | 449 |
| 21 | 08-27-91 | 13 | 4.1 | 344 | 7.5 | 170 | 3.1 | <0.02 | 201 |
| 22 | 08-27-91 | 6.0 | 1.9 | 496 | 7.3 | 257 | 6.5 | <0.02 | 287 |
| 23 | 08-26-91 | 0.6 | 0.2 | 529 | 7.3 | 267 | 5.3 | <0.02 | 322 |
| 24 | 08-26-91 | 3.5 | 1.1 | 427 | 8.4 | 232 | 3.1 | <0.02 | 259 |
| 25 | 08-26-91 | 3.7 | 1.2 | 732 | 7.4 | 413 | 2.5 | <0.02 | 421 |
| 26 | 08-26-91 | 22 | 6.9 | 424 | 6.9 | 218 | 3.0 | <0.02 | 260 |
| 27 | 08-27-91 | 4.8 | 1.5 | 730 | 7.3 | 407 | 5.4 | <0.02 | 415 |
| 28 | 08-28-91 | 21 | 6.6 | 543 | 7.6 | 258 | 2.8 | 0.03 | 330 |
| 29 | 08-28-91 | 0.5 | 0.2 | 653 | 7.4 | 343 | 9.1 | <0.02 | 379 |
| 30 | 08-28-91 | <0.3 | <0.1 | 806 | 7.7 | 379 | 10 | <0.02 | 487 |
| 31 | 08-28-91 | 8.3 | 2.6 | 945 | 7.3 | 448 | 7.4 | <0.02 | 587 |
| 32 | 08-28-91 | 7.2 | 2.2 | 612 | 7.2 | 283 | 11 | <0.02 | 361 |
| 33 | 08-28-91 | 17 | 5.3 | 538 | 7.5 | 272 | 5.8 | <0.02 | 317 |
| 34 | 08-28-91 | 30 | 9.4 | 666 | 7.1 | 336 | 11 | <0.02 | 405 |

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."

Tritium concentrations ranged from less than 0.3 (the lower detection limit) to 52 picocuries per liter (table 2). Tritium concentrations in water from five of the wells were less than the lower detection limit. In 26 of the 34 wells (about 76 percent), tritium concentrations were greater than 1 picocurie per liter, indicating modern (post-1953) water. The median tritium concentration was 4.2 picocuries per liter; the mean, 9.4 picocuries per liter.

## SUMMARY

In August 1991, the U.S. Geological Survey collected water samples from 34 shallow wells (less than 200 feet deep) for tritium analyses; the wells are completed in the 7,000-square-mile Mississippi River alluvial aquifer in northwestern Mississippi. Tritium concentrations ranged from less than 0.3 to 52 picocuries per liter. Tritium concentrations in water from about 76 percent of the wells were greater than 1 picocurie per liter, indicating modern (post-1953) water.

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