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FOSSIL WOOD FROM THOMPSON CREEK, YAZOO COUNTY, MISSISSIPPI

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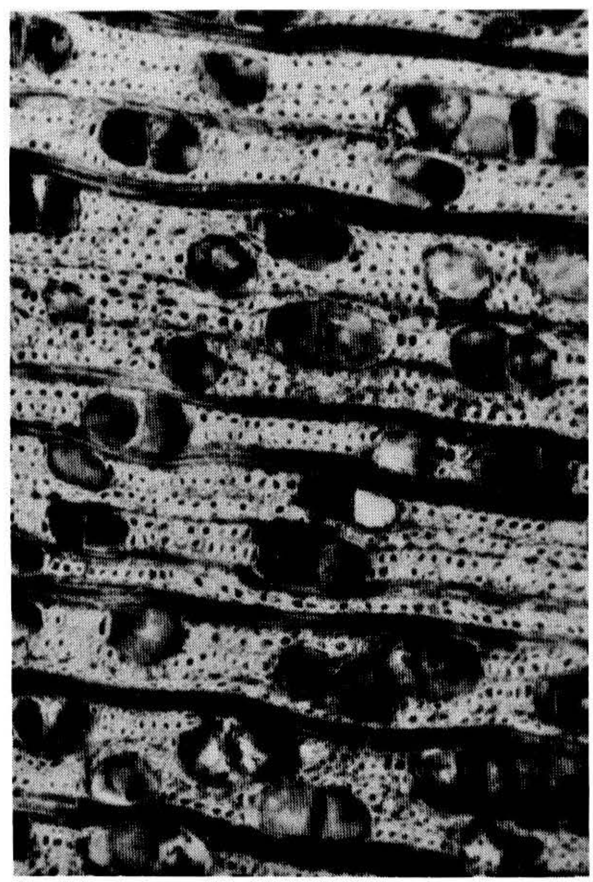
Introduction

Fossil wood is a common commodity in Mississippi, even to the point that it has been designated as the "state stone." There is interest in it commercially (e.g., jewelry), as a popular collector's item among "rockhounds," and scientifically. Yet, available information is all too often deficient in detail (and sometimes even accuracy). This is especially true when such "hardnosed" questions as the following are posed concerning a particular fossil wood specimen: 1) Exactly what kind of wood is it, botanically?, 2) Precisely where did it come from?, 3) How old is it, geologically?, and 4) What is the mechanism by which it became petrified? Certain identification, and literature providing other exact information, is typically lacking (or else not generally available) for collections of petrified wood from a given site (outstanding exceptions are the works of E. W. Berry many years ago, e.g., Berry, 1916, 1924). Fossil wood is without question one of Mississippi's rich natural treasures, and yet, sur-



Cross section of fossil red maple (x 68) from Thompson Creek.

prisingly, so very little is actually known about it. This is a fact which has bothered the authors of this paper for some time, especially since both of us grew up and received our college educations in Mississippi, and since both have maintained an interest in southeastern fossil plant material.

Among the unfortunate myths (or downright erroneous ideas) which have existed, and even prevailed, about fossil wood are these: 1) It is all the same, 2) It has no structure inside (no anatomical detail), 3) It is unidentifiable, 4) It is just old hickory or walnut which has simply "turned to stone" from staying in the creek too long. It can be said with some assurance that none of the preceding is generally true. It is hoped that this brief paper will serve to answer, to some extent at least, all of the first four questions (paragraph preceding) in the case of one specific locality (Thompson Creek), and at the same time debunk the second set of four statements (this paragraph). It is also hoped that this study will stimulate interest and encourage others, both in the state and out, to work in an effort to provide careful determinations of additional collections of fossil wood from various localities, leading ultimately to an improved understanding and a larger picture of the true nature of this rather common natural wonder in Mississippi. It is quite possibly the case that these particular types of fossils are among our most important links with the past, telling us, for example, something of what former vegetation was like, and how it evolved over geologic time into the vegetation of the present.

This particular project began in the summer of 1979 when one of us (Blackwell) made a rock collecting trip to the southern part of Yazoo County, and Thompson Creek in particular (Fig. 1). Thompson Creek is now a rather famous locality being as it is the site of a relatively recent discovery of a fossil whale (archaeocete) of Eocene Age (55 million years B.P., approximate), which has subsequently come to be referred to by some as the "state fossil." Write-ups of this (Frazier, 1980; Nagle, 1980) should prove of general interest to the reader. However, overlying the Eocene clays and muds in many places, and especially exposed and spread out in some creek beds, are the much younger, Pleistocene Age (no more than one million years B.P.) sand and gravel materials (Moore et al., 1965) referred to generally as "pre-loess terrace deposits." Westward toward the Mississippi River, and especially on hilltops, these deposits are in fact covered by an increasingly thick mantle of loess (Figs. 2, 3) -- fine eolian silt which apparently "blew in" during the declining phase of the most recent glacial episode in North America (say 15-20 thousand years ago). Regardless, it is the colorful (often reddish) pre-loess terrace gravels (Figs. 3, 4) which are pertinent to this particular study, because mixed in among the "non-biological" cherts and sands are abundant pieces of fossil wood (Fig. 4). Thompson Creek is literally "loaded" with fossil wood, containing as much as or more than these authors have encountered at any other locality. The petrified wood in most cases is totally silicified (silicious replacements), and generally quite well preserved. Specimens seen generally vary from about an inch to more than a foot in length. The first specimens, collected in the summer of 1979 as indicated in the preceding discussion, were transported to Miami University (Ohio) where work was done in geological laboratories. Additional collections were made by both authors in 1980 and 1981 and taken

Figure Legends

Figure 1. Thompson Creek, between Oil City and Tinsley, in southern Yazoo County, Mississippi.

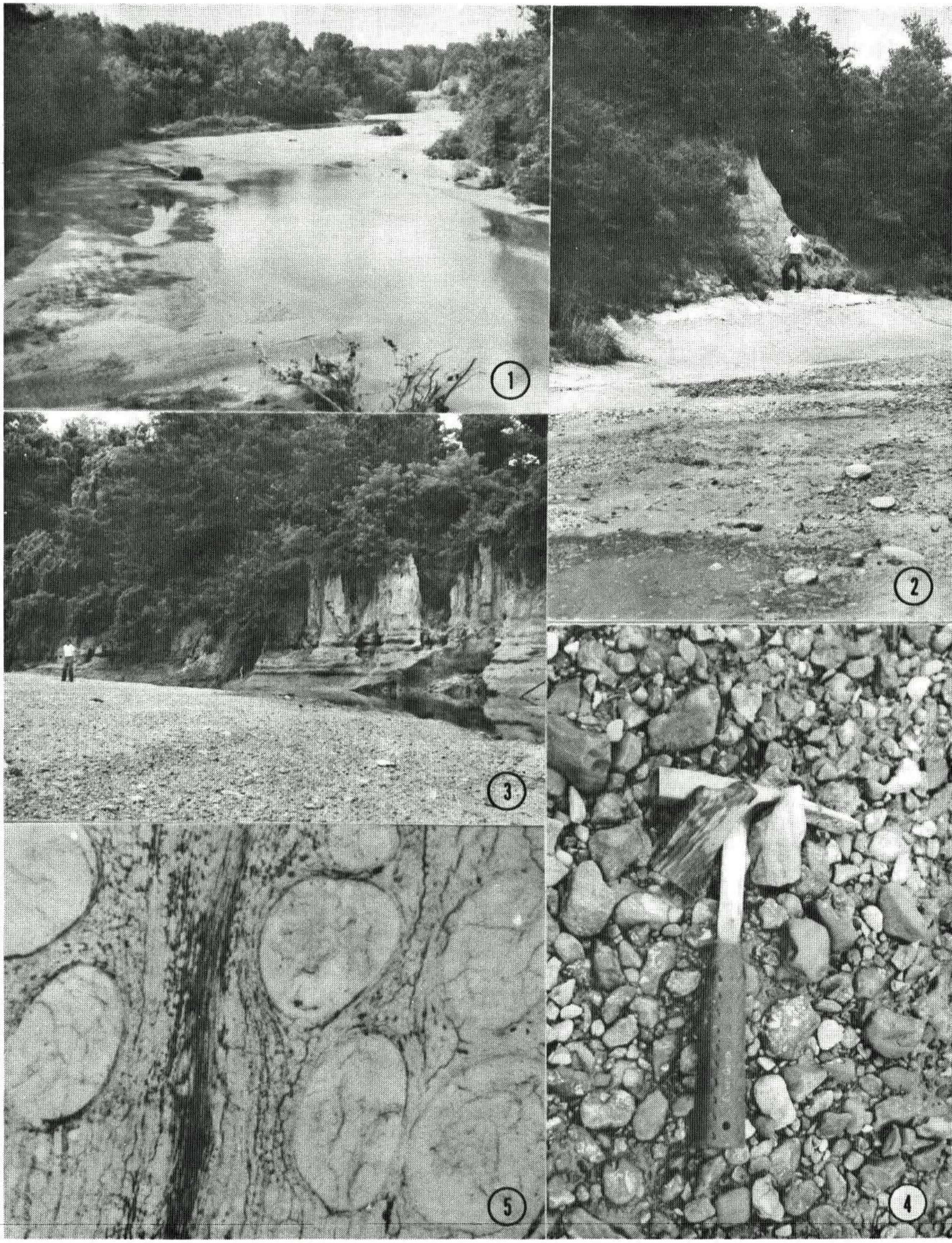
Figure 2. Different geological strata at Thompson Creek. Man is standing at level of Pleistocene terrace deposit. The younger loess mantle is above, and the older Yazoo Clay beneath. Some of the terrace gravels have washed out in stream bed below (foreground).

Figure 3. Pre-loess terrace gravels and sands common at Thompson Creek. Loess bank is seen in background.

Figure 4. Two small pieces of fossil wood (on top of rock hammer), common at Thompson Creek, found mixed in among the stream gravels.

Figure 5. Photomicrograph of cross section of fossil "Swamp White Oak" found at Thompson Creek. Note large vessels of the "early wood."

(Figures 5-11 are X68)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to Miami University to be "worked up." In all, approximately 20 different collections were prepared for microscopic examination by the method outlined in the following paragraph.

Materials and Methods

Each specimen of petrified wood was sectioned to appropriate size (to fit on petrographic slides) with a rock (trim) saw. Sections were cut (from each specimen) in three planes (cross section, radial-longitudinal section, and tangential-longitudinal section) to permit ultimate three-dimensional reconstruction (if needed) of the wood structure. These petrified wood slugs were then polished on a lapidary wheel through a graded grit (silicon carbide) series, fine-polished on a glass plate (using 1000 grit), and mounted with epoxy on glass slides. After hardening of the epoxy (at 50° C, overnight), each slug was thin-sectioned and polished down to virtual transparency, utilizing a thin-section machine and grinder combination. Specimens were then hand-polished on a fine-grained (15 um particle size) diamond lap head, and coverslips were mounted on them using epoxy. After hardening of the epoxy, slides could be examined for fine structural features under a compound light microscope. Photomicrographs were taken with a camera-back attached by adapter tube to the microscope. Thin-section slides of the silicified woods were subsequently compared with microscope slides of extant woods in the slide collection of the U. S. Forest Products Laboratory (Center for Wood Anatomy Research) at the University of Wisconsin, Madison, Wisconsin.

Results and Discussion

From the photomicrographic illustrations provided (Figs. 5-11) it can be seen that good "cell detail" is frequently encountered in these specimens. This is, in fact, saying that mineral infiltration preserved the outlines of the cells "the way they were." It should be reemphasized that this petrified wood is almost completely a silicious replacement, and that little or nothing remains of the original organic matter of the plant. Nonetheless, the pattern of the original structure was more or less exactly replaced by dissolved silica minerals which gradually infiltrated, and then hardened *in situ*. There exists thus internally, in each specimen, a natural "glass copy" of its original "cellular skeleton." This fortuitous circumstance makes the study of cell detail easily possible under a light microscope, even though, in fact, no cells actually remain. Such excellent replication of detail also permits comparison with extant woods, which are of course not mineral-replaced, but rather have (as most people are familiar) a basic cellulose framework to their cell structure. In all, five different types of petrified wood were found at Thompson Creek, with more no doubt awaiting discovery.

A significant aspect of this particular study was the comparison of the thin-section slides made from the different silicified woods in Thompson Creek with slides of "living" woods in the very outstanding wood slide collection of the U. S. Forest Products Laboratory at Madison, Wisconsin. The Wisconsin collection constitutes probably the outstanding wood slide assemblage in the United

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Figure 6. Fossil wood of Eastern Red Cedar (microscopic cross section) found at Thompson Creek. Unlike other woods shown, cells seen here are predominantly tracheids.

Figure 7. Radial-longitudinal section of fossil Red Cedar wood. Relatively large circular pits are visible on the walls of the tracheids.

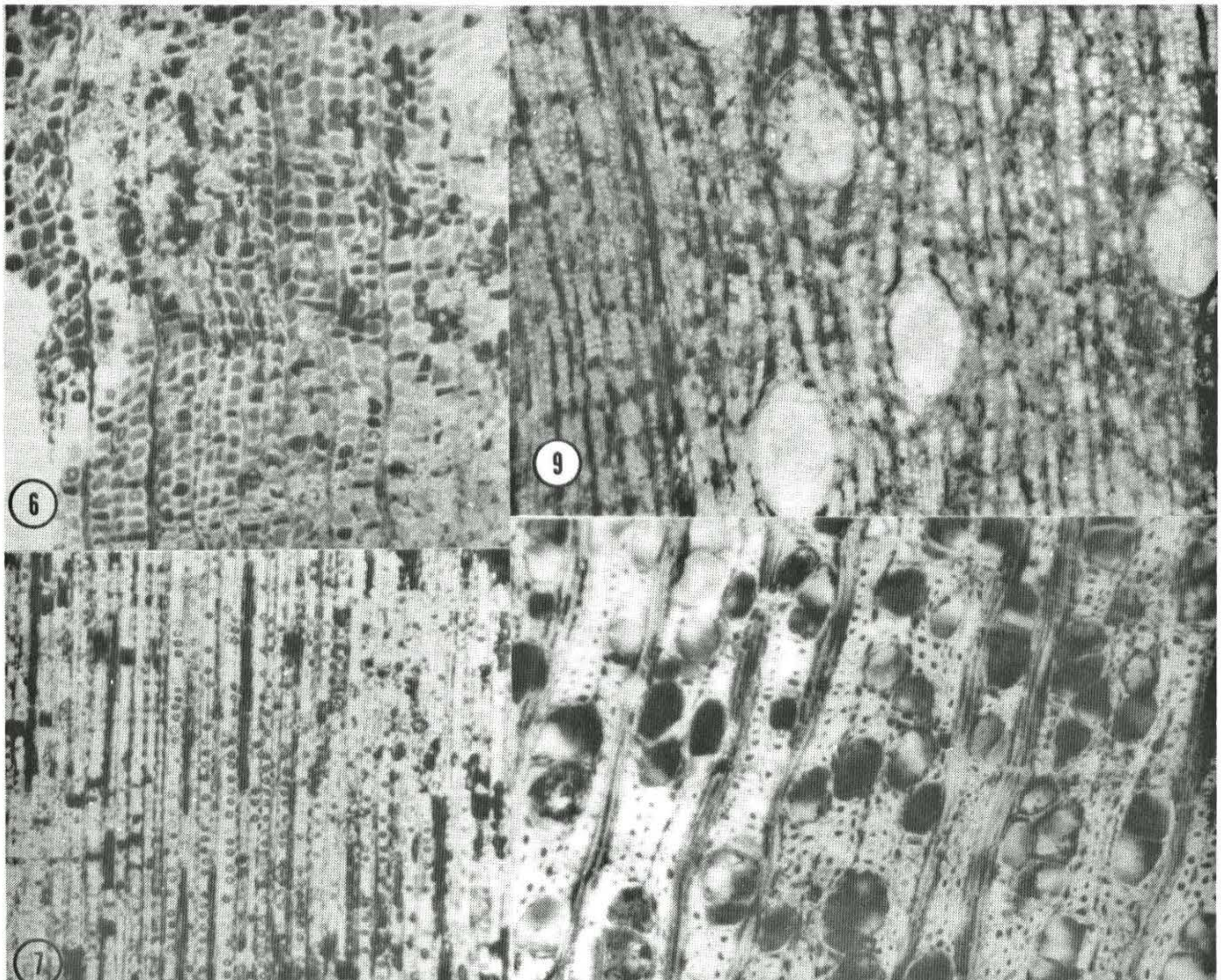
Figure 8. Cross section of fossil Hop-hornbeam, also known as "Ironwood." This was the most common petrified wood found at Thompson Creek during this study.

Figure 9. Probable fossil Live Oak (cross section). This petrifaction compared well with extant Live Oak wood, except for the paucity of large aggregate rays.

Figure 10. Petrified Red Maple in cross section. This wood was particularly well preserved. In the photomicrograph, vessels, fibers and wood rays can readily be seen.

Figure 11. Tangential-longitudinal section of silicified Red Maple wood. In this section plane, wood rays may be viewed transected.

(Figures 5-11 are X68)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States (incorporating as it has the Yale collection), comprising now over 100,000 microscope slides of woody plants. Using these slides as a basis for comparison, with the aid of published information on wood anatomy (e.g., Kukachka, 1960, Panshin and de Zeeuw, 1980; Sudworth and Mell, 1911), and with the assistance of Dr. B. Francis Kukachka of the Forest Products Laboratory (and his unparalleled knowledge of wood anatomy), specific identification proved possible for all five kinds of petrified wood found in Thompson Creek. These compare well, as indicated in the figure legends (Figs. 5-11), with the following five extant woods: Red Maple *(Acer rubrum)*, Hophornbeam *(Ostrya virginiana)*, Swamp White Oak *(Quercus bicolor)*, Live Oak *(Quercus virginiana)*, and Eastern Red Cedar *(Juniperus virginiana)*. Thus, four of the five types of fossil wood are angiospermous (dicot) wood, and the remaining one is gymnospermous (coniferous). The most abundant type, at least based on the specimens we sectioned, was *Ostrya virginiana*, the Hop-hornbeam (also known as "Ironwood"). All five types of fossil wood matched almost perfectly with their extant counterparts, with the possible exception of Live Oak *(Quercus virginiana)*. The fossil Live Oak possessed fewer large (aggregate) wood rays than did typical living representatives seen. However, only one fossil collection turned out to be this type of wood. Thus, sectioning of additional specimens, if they can be found, might well show the one already sectioned to be merely somewhat aberrant in this feature. In any event the difference was certainly not deemed great enough to lead to the description of a new taxon.

All of these types of woods occur in the living condition in Mississippi today, except possibly in the case of *Quercus bicolor* (Swamp White Oak) which is generally found farther to the north (as for example in parts of the Ohio Valley). The climate in Mississippi during the Pleistocene Epoch was probably similar to that of today, or perhaps slightly cooler. It is quite feasible that all five types of fossil wood once grew in the local vicinity of Thompson Creek. Equally plausible is the idea that they came in as driftwood from farther north. Such a "hydrologic highway" from the North was once present in the form of the combined, broad, and braided stream situation which existed between the ancestral Mississippi and Ohio Rivers. These two great rivers did not finally become separated and diverted into their present paths until relatively late in Pleistocene times (Fisk, 1944). Flooding and sediment deposition were no doubt common occurrences during peak glacial episodes of the Pleistocene. Trees growing locally, in adjacent valleys, could easily have been buried by the alluvium; or, they could just as easily have been drifted in from farther north prior to burial. It is not likely in the case of Thompson Creek that we will be able to say with certainty which origin had the greater importance. Probably, in truth, both phenomena occurred at various times. Regardless, following burial below water line (which would have slowed down the decay process), the sands and silicious gravels composing the pre-loess terraces provided, with little question, a good medium from which silicious waters leached out and gradually impregnated the various pieces of wood.

Although the identity, general age, general origin (or origins), and probable means of petrification of the fossil wood material in Thompson Creek is, we believe, rather clear, it should not be assumed that this knowledge necessarily applies in total to all "finds" of fossil wood in Mississippi and elsewhere in the Southeast. It is the opinion of these writers that fossil wood of different ages, and divergent sources or origin, is to be found at various localities (see for example Blackwell et al., in press). However, the unscrambling of these mysteries is a fascinating project, and one that the authors look forward to pursuing very much. It is our hope that others will join us in assembling the pieces of the puzzle, and the search for the truth regarding one of Mississippi's most valuable and beautiful natural assets.

Acknowledgments

The writers wish to express their appreciation to Dr. B. Francis Kukachka of the Forest Products Lab (Madison, Wisconsin) for his aid in confirming identifications of the fossil woods, to Ms. Audrey Chang, of Miami University, for her help with sectioning several of the collections, and to Dr. Martha J. Powell (Miami University) for her assistance with some of the photography.

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GEOHYDROLOGY OF THE LOCAL AQUIFER, TATUM DOME

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Mississippi Bureau of Geology

Introduction

The monitoring of nuclear detonations with seismic instruments began with the two Crossroads events of 1946. These two events, each with a yield of 20 kilotons, represent the fourth and fifth atomic explosions in history, and were designed to determine the impact of air and underwater bursts on naval vessels (Glasstone, 1957; see also Table 1).

In 1958 the Soviet Union accepted a United States offer for a moratorium on nuclear testing which lasted almost three years. The Soviet Union resumed atmospheric testing in September 1961 with over thirty events, including a 63 megaton "monster bomb." Finally, on October 10, 1963, the United States, the United Kingdom, and the Soviet Union signed the Moscow Treaty (the Partial Nuclear Test-Ban Treaty), prohibiting nuclear testing in the atmosphere, under water, and in outer space.

Since 1963 all nuclear detonations by these countries have been conducted underground to comply with the Partial Nuclear Test-Ban Treaty and to minimize the possibility of releasing fission products to the atmosphere.

Following the guidelines of the moratorium on nuclear testing, on September 14, 1960, Tatum Salt Dome was selected as the site for underground nuclear detonations as part of Project Dribble. Project Dribble consisted of the nuclear portion of the Vela Uniform Program explosion series which was conducted at locations off the Nevada Test Site (Table 2). The principal objective of the project was to study the seismic signals produced by a tamped nuclear explosion in salt and a decoupled nuclear explosion in a salt cavity (Werth and Randolph, 1966; Patterson, 1966, Springer, 1966). The first experimental verification of decoupling was accomplished by Project Cowboy at Winnfield, Louisiana, using high-energy chemical explosives in a salt medium.

Tatum Dome was the fourth shallow salt dome discovered in the state. The salt dome was named after W. S. F. Tatum, who "noted a peculiar drainage pattern surrounding an area in which pine seedlings would die after reaching a height of 2 or 3 feet" (Morgan, 1941).

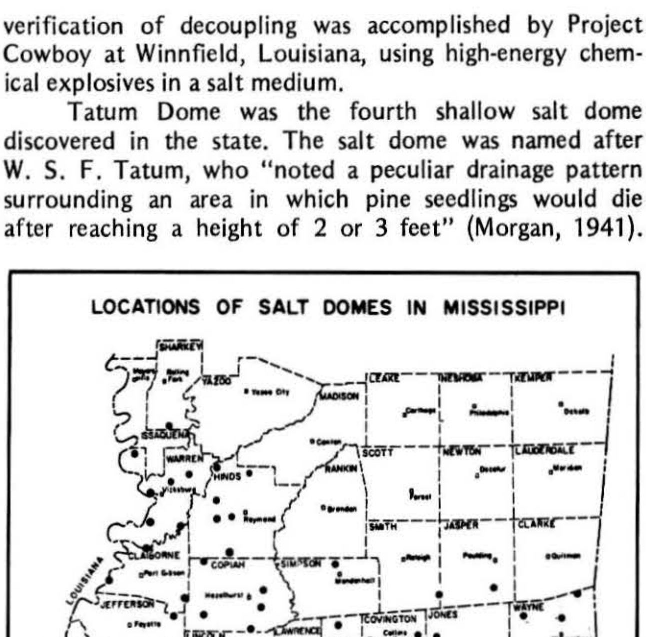


Figure 1

Table 1

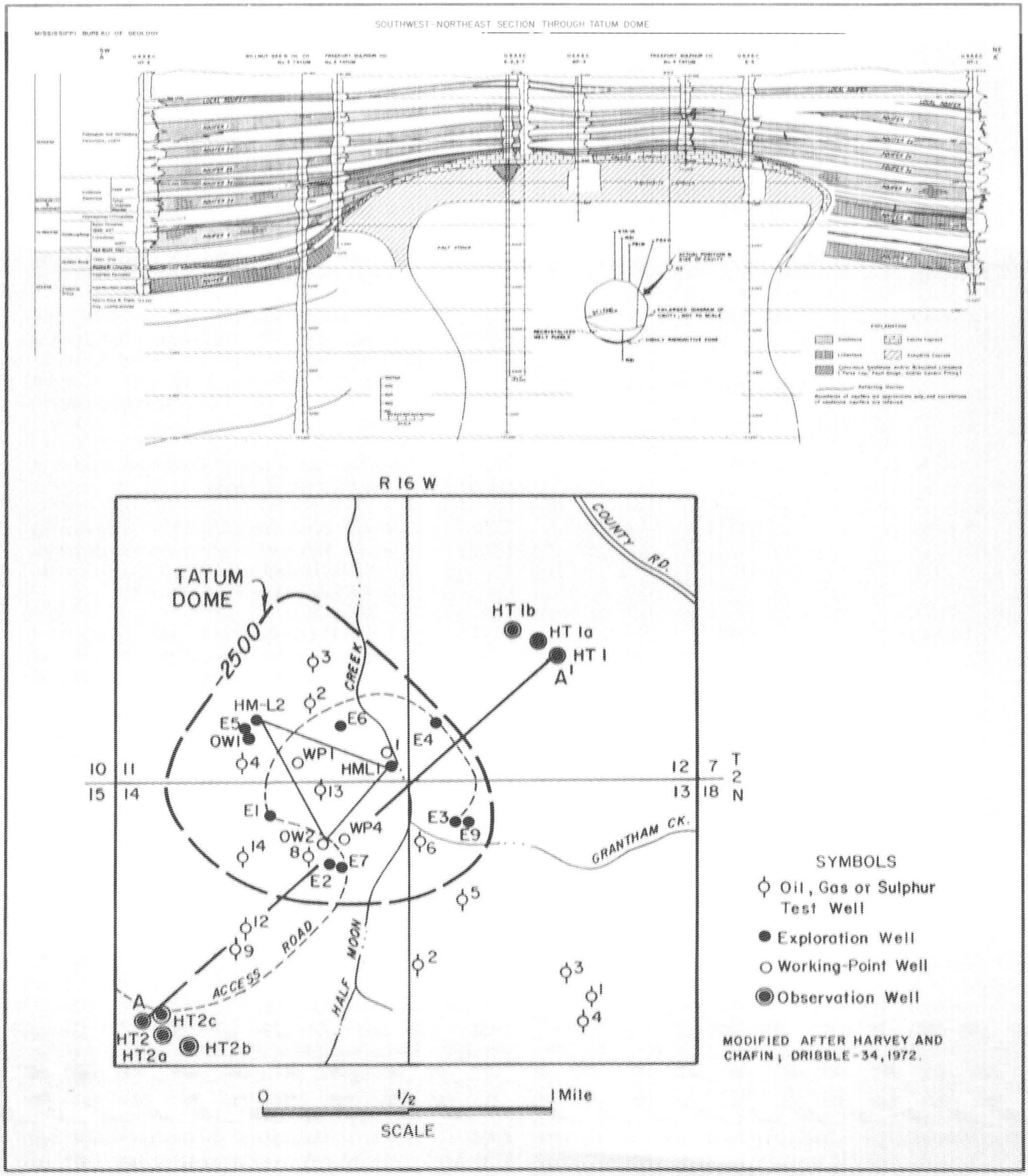
Summary of Atmospheric Nuclear Tests until 1956

(Modified after Glasstone 1957)

Date	Code Name	Remarks
1945	Trinity	First atomic explosion in history, located at Alamogordo, New Mexico, on July 16, 1945. Actual yield of bomb was 20 kilotons.
1945	Hiroshima	Second atomic explosion in history. An air burst of 20 kilotons at 1,850 feet above ground zero on August 6, 1945, resulted in 140,000 casualties.
1945	Nagasaki	Third atomic explosion in history. An air burst of 20 kilotons at 1,850 feet above ground zero on August 9, 1945. Primary target of Kokura was switched to Nagasaki due to bad weather over target area.
1946	Crossroads	These two events represent the fourth (Able) and fifth (Baker) atomic explosions in history. Able event was a moderately low air burst and Baker was an underwater burst. Both were designed to test the effects of an atomic explosion on surface vessels.
1948	Sandstone	Three tower blasts in the Pacific.
1951	Ranger	Five air bursts in Nevada.
1951	Greenhouse	Four tower blasts in the Pacific.
1951	Buster	Four air and one tower blast in Nevada.
1951	Jangle	One surface burst and one shallow underground burst in Nevada.
1952	Tumbler	Four air blasts in Nevada.
1952	Snapper	Four tower blasts in the Pacific.
1952	Ivy	One air blast and one surface blast in the Pacific.
1953	Knothole	Two air blasts in Nevada.
1954	Castle	High yield test in the Pacific.
1955	Teapot	Three air, ten tower and one shallow underground blast in Nevada.
1955	Wigwam	Detonated at sea.
1956	Redwind	A Pacific detonation.

Table 2. Summary of Underground Nuclear Tests
Conducted Off the Nevada Test Site (Modified after Grossman 1978)

Name of Test, Operation, Project, or Event	Date of Event	Yield (Kilotons)	Depth in feet (Meters)	Summary
Gnome/Coach	12/10/61	3.1	1184 (360 m)	A Project Plowshare event located 30 miles (48 kilometers) southeast of Carlsbad, New Mexico. This multipurpose experiment was the first nuclear detonation in a bedded salt medium.
Shoal	10/26/63	12	1200 (366 m)	A Vela Uniform Event detonated in granite 28 miles (45 kilometers) southeast of Fallon, Nevada. Object of event was a nuclear detection/research experiment.
Salmon	10/22/64	5.3	2700 (823 m)	First nuclear detonation in a salt dome. This event, a part of Project Dribble, was located at Tatum Dome 21 miles (34 kilometers) southwest of Hattiesburg, Mississippi. The event was a nuclear test detection/research experiment.
Long Shot	10/29/65	80	2350 (716 m)	Nuclear test detection experiment located at Amchitka Island, Alaska.
Sterling	12/03/66	0.38	2700 (823 m)	Nuclear detonation used to test the Decoupling theory. This nuclear detection/research experiment was located in the spherical cavity created by the Salmon Event in Tatum Dome.
Gasbuggy	12/10/67	29	4240 (1292 m)	A Project Plowshare Event. Joint Government/ Industry Gas Stimulation Experiment located 55 miles (88 kilometers) east of Farmington, New Mexico.
Faultless	1/19/68	200-1000	3000 (914 m)	Weapon Test located 60 miles (96 kilometers) east of Tonopah, Nevada.
Diode Tube	2/02/69	HE (High Explosives)	2700 (823 m)	High Explosive gas detonation in the Salmon/ Sterling cavity. Object of Miracle Play Series of Events was for seismic studies.
Rulison	9/10/69	40	8425 (2568m)	A Project Plowshare Gas Stimulation Experiment located 12 miles (19 kilometers) southwest of Rifle, Colorado.
Milrow	10/02/69	1000	4000 (1219 m)	Weapon Test located at Amchitka Island, Alaska.
Humid Water	4/19/70	HE	2700 (823 m)	High Explosive gas detonation in the Salmon/ Sterling/ Diode Tube Cavity. This Miracle Play Event was for seismic studies. The event was detonated prematurely by a lightning strike.
Cannikin	11/06/71	5000	6000 (1829 m)	Test of Warhead for the Spartan Missile. Test located at Amchitka Island, Alaska.
Rio Blanco	5/17/73	3 x 30	5840-6690 (1780-2039 m)	A Project Plowshare Gas Stimulation Experiment located 30 miles (48 kilometers) southwest of Meeker, Colorado.



SOUTHWEST-NORTHEAST SECTION THROUGH TATUM DOME
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SALT STOCK
LOCAL AQUIFER
R 16 W
COUNTY RD.
TATUM DOME
2500
CREEK
HT Ib
HT Ia
HT I
A'
HM-L2
E5
OWI
E6
E4
WPI
HMLI
10
11
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15
14
13
18
T 2 N
E1
E3
E9
OW2
WP4
GRANTHAM CK.
E2
E7
ACCESS ROAD
HALF MOON
A
HT2c
HT2
HT2a
HT2b
SYMBOLS
Oil, Gas or Sulphur Test Well
Exploration Well
Working-Point Well
Observation Well
MODIFIED AFTER HARVEY AND CHAFIN; DRIBBLE-34,1972.
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Figure 2

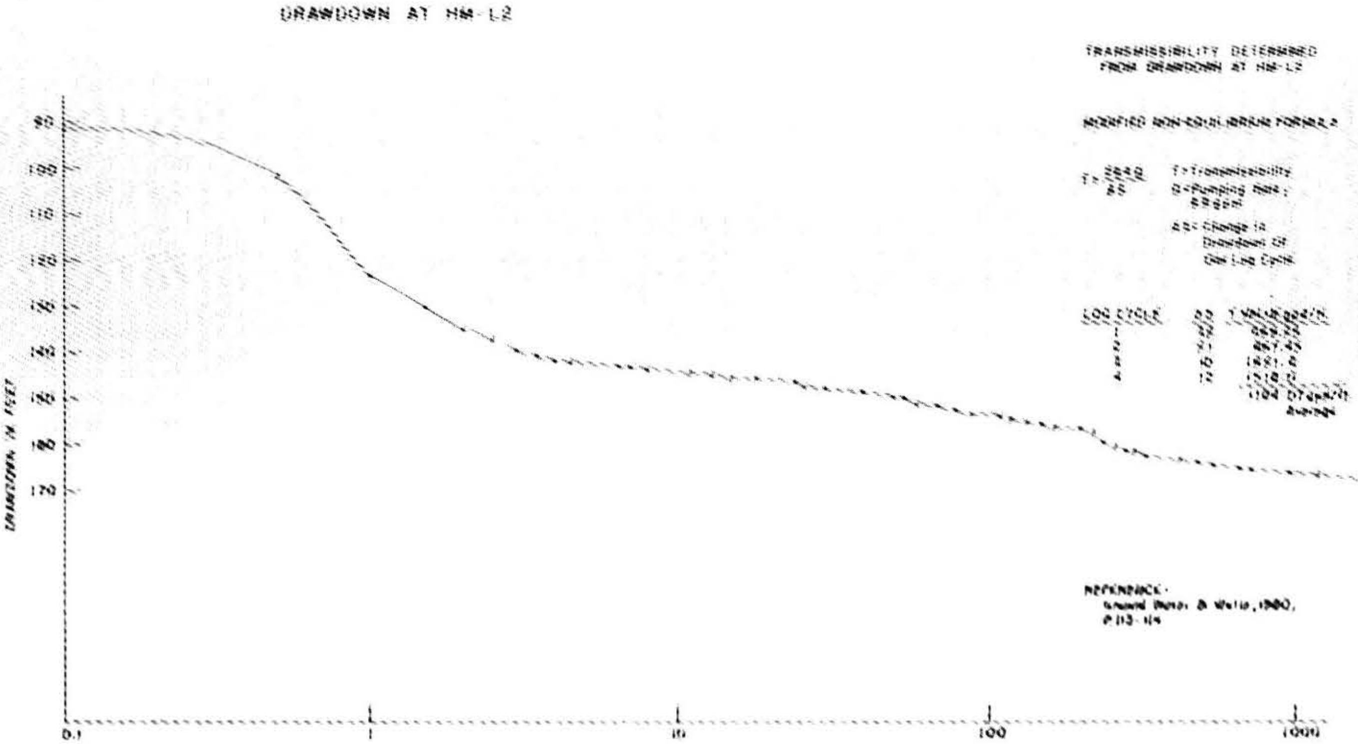

Figure 3

The Salmon nuclear event detonated in Tatum Dome on October 22, 1964, was the first nuclear detonation in a salt dome. Prior to this event, only two other underground nuclear blasts were conducted outside the Nevada Test Site. Project Gnome, near Carlsbad, New Mexico, was detonated in bedded salt, and Project Shoal, near Fallon, Nevada, was detonated in granite (Table 2).

There were two nuclear and two chemical explosions at Tatum Dome (Table 2). These explosions were located at a depth of 2700 feet (823 m) and approximately 1000 feet (305 m) from the nearest side of the salt dome. The first nuclear event, Salmon, with a yield of 5.3 kilotons, created a spherical cavity with a radius of 57.1 feet (17.4 m). The other three explosions, one of them nuclear, occurred within this cavity. A puddle of radioactive materials and recrystallized salt formed in the bottom of the cavity and cracks and microfractures were detected out to a distance of 300 feet (91 m) from the cavity. In addition there was some failure around the emplacement shaft (Rawson et al., 1966).

In April of 1972 a long-term hydrologic monitoring program was initiated by the U. S. Department of Energy. This program was designed to determine if significant levels of tritium and other radionuclides occur in the aquifers above the dome, and the rate and direction of ground-water movement in these aquifers. This investigation, which was published in 1980, indicated that only the "Local Aquifer" contained any tritium above background levels (Fenske and Humphrey, 1980). The hydrologic study described below was conducted by the State of Mississippi during March and April of 1981 to determine more accurately the rate and direction of ground-water flow in the Local Aquifer (Stover et al., 1981).

Geology

Tatum Salt Dome is similar to most Gulf Coastal salt domes in that it consists of a core of halite (NaCl) capped by a layer of calcite ($CaCO_3$) and anhydrite ($CaSO_4$) (Fig. 2). The dome is a diapir structure which originates in the Louann salt of Jurassic age. The dome pierces approximately 25,000 feet of sediments with the caprock 1,096 feet below land surface. The dome is overlain by a section of undifferentiated Miocene sediments which have a regional dip to the southwest of approximately 25 feet per mile (Warren et al., 1966). Sediments overlying the dome have been pushed up and appear to be "draped" over the flanks.

The Miocene section (undifferentiated) is composed of alternating beds of sands and clays. Overlying the dome the Miocene section contains five freshwater artesian aquifers (Fig. 2). The base of the shallowest aquifer, the Local Aquifer, is approximately 200 feet below the land surface. The aquifer is apparently a channel sand which

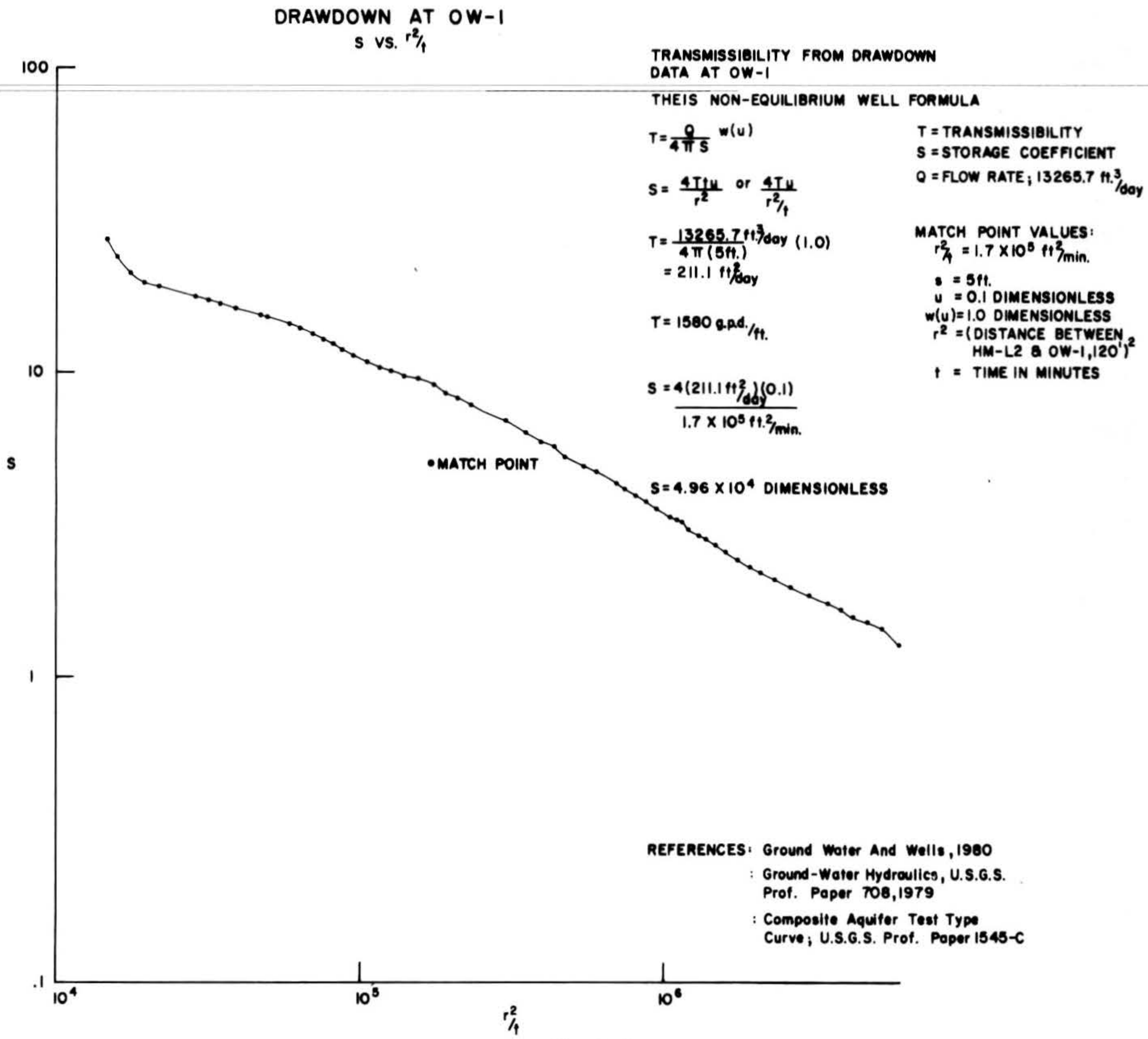

Figure 4

in the vicinity of HM-L and OW-2 bifurcates into two sands in hydrologic connection with each other (Fig. 2). The lower sand in the Local Aquifer is 10 to 15 feet thick and is composed of fine- to medium-grained, poorly sorted, quartz sand. The upper sand in the Local Aquifer is not continuous over the dome as indicated by electrical logs from OW-2 and HM-L2 (Stover et al., 1981).

Geohydrology of the Local Aquifer

Three wells were completed in the lower sand of the Local Aquifer to 1) provide data to calculate the velocity and direction of ground-water movement, and 2) provide additional monitor and observation wells to investigate the possible migration of any radionuclides present. Two other wells utilized in previous investigations were also used to provide additional hydrologic data. OW-1, OW-2, HM-L1, and HT-2C were used as observation wells to obtain water-level readings during the aquifer test. Water-level readings from the pumped well (HM-L2) were obtained by using a pressure transducer. An average discharge of 69 g.p.m. was maintained at HM-L2 during the pumping phase of the test. A 4-inch orifice pipe, piezometric tube, and 2 1/2-inch orifice plate were used to determine the rate of discharge and to maintain a constant yield. The drawdown and recovery portions of the aquifer test lasted a total of 48 hours. On April 6, 1981, the pumped well (HM-L2) was turned on and the water-level decline was recorded at the pumping and observation wells. After pumping for 24 hours, HM-L2 was shut off

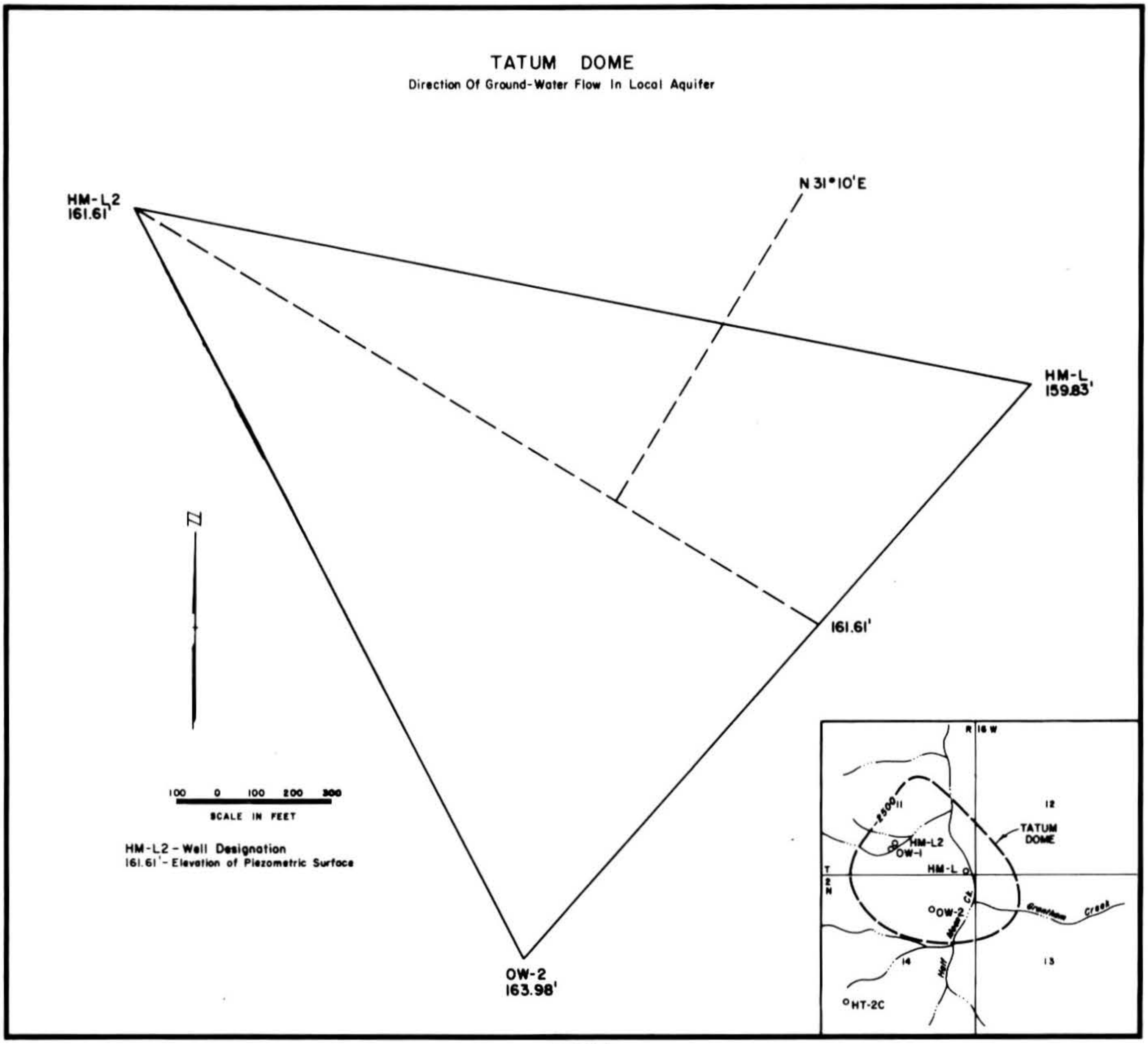

FIGURE 5

and recovery data were recorded.

Calculations

The data obtained from HM-L2 and OW-1 were used to calculate the coefficient of transmissibility in the Local Aquifer. Drawdown data obtained from HM-L2 are not as accurate as OW-1 data because within the immediate vicinity of the pumped well there can occur some fluctuations of the hydrostatic head. These fluctuations are smoothed out with distance from the pumped well (Ground Water and Wells, p. 93). Analysis of drawdown data obtained from HM-L2 by the modified non-equilibrium formula indicates an average transmissibility of 1194 g.p.d./ft. (Fig. 3). Slightly higher "T" values were obtained in the latter portion of the test after the rate of water-level decline had stabilized.

Observation well OW-1, located 120.25 feet (36.6 m) from HM-L2, is believed to be far enough away from the pumping well that hydrostatic head fluctuations will not interfere with the water-level readings. Analyzing the drawdown data obtained from OW-1 by Theis' non-equilibrium formula yields a transmissibility coefficient of 1580 g.p.d./ft. and a storage coefficient of 4.96×10^4 (Fig. 4).

Two months after the pumping test was completed an accurate survey of the well locations was completed by Mississippi State Board of Health personnel. The static water levels of all wells involved in the aquifer test were recorded, assuming the two-month delay allowed the wells to recover fully from the effects of pumping. This information was then used to calculate the hydraulic gradient and direction of ground-water flow. Analysis

Figure 6. Ground-Water Velocity Calculations

Method I. Permeability determined from transmissibility at OW-1

Reference: U. S. Geological Survey Professional Paper 708, 1979, p. 6.

$$P = \frac{T}{b}$$

P = Permeability

T = Transmissivity at OW-1, 210.93 $\frac{ft^3 pd}{ft}$; determined from transmissibility of 1580 gpd/ft

b = Thickness of aquifer, 10 ft.

$$P = \frac{210.93 \frac{ft^3 pd}{ft}}{10 \text{ ft}}$$

P = 21.093 ft/day

Darcy's Law V = PI and Q = AV

V = Velocity

P = Permeability, 21.093 ft/day

I = Hydraulic gradient; $\frac{11.46 \text{ ft}}{5280 \text{ ft}}$

Q = Volume of flow

A = Area of a 1 foot wide section of 10 foot thick aquifer; 10 ft^2

Velocity: $V = 21.093 \frac{ft}{day} \left(\frac{11.46 \text{ ft}}{5280 \text{ ft}}\right)$

$$V = .0458 \frac{ft}{day} \text{ or } 16.72 \frac{ft}{year}$$

Volume: $Q = 10 \text{ ft}^2 \; (.0458 \text{ ft/day})$

$$Q = .458 \frac{ft^3}{day} \text{ or } 3.41 \text{ g.p.d.}$$

Method II. Permeability determined from equilibrium formula

Reference: Ground Water and Wells, 1980, p. 106.

$$P = \frac{528\, Q \left(\log \frac{r_2}{r_1}\right)}{M\,(h_2 - h_1)}$$

P = Permeability

Q = Pumping rate, 69 g.p.m.

r_2 = Distance to OW-2 from HM-L2; 2,215.67 ft.

r_1 = Distance to OW-1 from HM-L2, 120.13 ft.

M = Thickness of aquifer, 10 ft.

h_2 = Head at OW-2, measured from bottom of aquifer, 84 ft.

h_1 = Head at OW-1, measured from bottom of aquifer, 60 ft. Head measurements were made after 24 hours of pumping.

$$P = \frac{528 \text{ (69 gpm)} \left(\text{Log} \frac{2215.67 \text{ ft}}{120.13 \text{ ft}}\right)}{10 \text{ ft } (84 \text{ ft} - 60 \text{ ft})}$$

$$P = 192.15 \frac{gpd}{ft^2} \text{ or } 25.65 \frac{ft}{day}$$

Darcy's Law V = PI and Q = AV

V = Velocity

P = Permeability, 25.65 ft/day

I = hydraulic gradient, $\frac{11.46 \text{ ft}}{5280 \text{ ft}}$

Q = Volume of flow

A = Area of a 1 foot wide section of 10 foot thick aquifer, 10 ft^2

Velocity: $V = 25.65 \frac{ft}{day} \left(\frac{11.46 \text{ ft}}{5280 \text{ ft}}\right)$

V = .05567 ft/day or 20.32 ft/year

Volume: $Q = 10 \text{ ft}^2$ (.05567 ft/day)

$$Q = .5567 \frac{ft^3}{day} \text{ or } 4.17 \text{ g.p.d.}$$

of these data by the three-point method indicates a hydraulic gradient of 11.46 ft./mile, and a direction of ground-water movement as N. 31° 10' E. (Fig. 5).

The direction of ground-water flow varies locally directly over and off of the dome because it is influenced not only by the local and regional dip of the aquifers, but also by large-scale ground-water withdrawal by industry to the northeast of Tatum Dome. Such effects on the regional ground-water movements were first noted in the early 1960's by Taylor et al. (1968).

In order to determine the velocity of water flow by Darcy's Law, the coefficient of permeability is multiplied by the hydraulic gradient. The permeability coefficient expressed in feet/day is determined by taking the transmissibility coefficient (expressed in gallons per day/foot), making the unit conversions, and then dividing by the aquifer thickness (10 feet). The transmissibility coefficient from OW-1 is 1580 g.p.d./foot and converts to a permeability of 21.093 feet/day. The permeability coefficient and hydraulic gradient of 11.46 feet/mile yields an average velocity of 16.72 feet/year. An alternative method for determining the permeability coefficient by using water-level data from two wells other than the pumped well yields a value of 25.65 feet/day (Fig. 6). Using this value an average velocity of 20.32 feet/year was calculated for ground-water movement in the Local Aquifer.

Conclusions

1. The ground-water velocities determined by this study are the average calculated travel time between two points. The path of water movement is not necessarily in a straight line, so the actual travel time between any two points can differ depending upon a number of variables. The velocity of ground-water movement in the Local Aquifer over Tatum Dome varies between 15 and 20 feet per year.

2. Large-scale ground-water withdrawal by the Hess Pipeline Company, the South Mississippi Electric Power Association, the Town of Purvis, and other wells located northeast of Tatum Dome influences the direction of ground-water movement. These high-capacity wells are completed in deeper Miocene aquifers, but these aquifers are thought to be in hydrologic connection with the Local Aquifer. This large-scale ground-water withdrawal has been interpreted as causing a reversal in the regional direction of ground-water movement in the Local Aquifer in the vicinity of Tatum Dome, resulting in a North 31° East direction of ground-water movement.

3. Water samples taken from the Local Aquifer throughout the duration of the aquifer test and analyzed by the Mississippi State Board of Health indicate tritium concentrations are less than the minimum detectable activity of 270 pCi/l (Dempsey, 1981). The U. S. Environmental Protection Agency has set a maximum drinking water standard of 20,000 pCi/l.

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CALENDAR OF EVENTS

1982 January - March

January 3-8 - American Association for the Advancement of Science, annual meeting, Washington, D. C. (AAAS headquarters, 1776 Massachusetts Ave. NW, Washington, D. C. 20036)

January 27-29 - Management, analysis, and display of geoscience data, meeting, Golden, Colorado. (Richard B. McCammon, U. S. Geological Survey, Reston, Virginia 22092)

March 25-27 - Northeastern and southeastern sections, Geological Society of America, joint annual meeting, Washington, D. C. (Jean M. Latulippe, GSA headquarters, Box 9140, Boulder, Colorado 80301, 303/447-2020)

March 29-30 - South-central section, Geological Society of America, annual meeting, Norman, Oklahoma. (Kenneth S. Johnson, Oklahoma Geological Survey, Norman, 73019, 405/325-6541)

"No generation holds fee simple title to the fertility of the soil, the wealth of the forests, the fish and game of the streams and woods, or the minerals and clays that lie buried in the earth. We hold these blessings of nature for our successors, and we have no moral right to rob our descendants by wastefully depleting or recklessly destroying them. It is the legitimate function and service, and the sacred duty of every government, to conserve these natural resources."

Governor M. S. Conner
1934

The race of man shall perish, but the eyes
Of trilobites eternal be in stone,
And seem to stare about in mild surprise
At changes greater than they have yet known.

T. A. CONRAD

PETROLEUM NEWS

MISSISSIPPI OIL AND GAS STATISTICS, SECOND QUARTER 1981

Oil

	Bbls. Produced	Severance Tax	Average Price Per Bbl.
April	2,798,451	$ 5,837,814.46	$ 34.77
May	1,701,113	3,619,795.71	35.47
June	4,197,902	8,133,045.89	32.29
Totals	8,697,466	$ 17,590,656.06	$ 34.18

Gas

	MCF Produced	Severance Tax	Average Price Per MCF
April	21,451,963	$ 4,144,549.94	$ 3.22
May	15,068,302	2,594,786.42	2.87
June	25,249,361	5,155,484.15	3.40
Totals	61,769,626	$ 11,894,820.51	$ 3.16

source: State Tax Commission

SPHAEROCYPRAEA JACKSONENSIS (JOHNSON) FROM THE MOODYS BRANCH FORMATION (EOCENE), MISSISSIPPI

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Universite de Paris VI
4 Place Jussieu
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Introduction

Our study of literature concerning the Mollusca of the Moodys Branch Formation led us to make comparisons between American and European faunas of the same age in search for possible connections. After examining incomplete specimens of *"Notoluponia" ampla* Dockery, 1977, sent to us by the author, we are convinced that this species is a synonym of *Cypraea jacksonensis* Johnson, 1899, and belongs to the genus *Sphaerocypraea*. The author himself after further study agrees to this determination. As we have an occasion to make an adjustment about this species, we will also briefly enter upon a discussion of related species.

Systematics

Family OVULIDAE Fleming, 1828

This family is characterized, in the adult specimens, by the absence of any visible coiling at the posterior end, a characteristic derived from the fact that the larval shell is embedded in the collumella at the posterior 2/3 of its axis. This is the main criterion for the family and is confirmed by our sections of Eocene specimens.

Genus *SPHAEROCYPRAEA* Schilder, 1927
(Genotype: *Cypraea bowerbankii* Sowerby, 1850)

Members of this genus show a gradual divergence from the Paleocene species of *Eocypraea*. This separation is partly justified taxonomically by the larger size and general bulbous appearance of the *Sphaerocypraea* species. However, the most distinctive generic criterion is the denticulation of the inner lip. The *Sphaerocypraea* denticulation is only found again in the related genus *Sulcocypraea* Conrad, 1865, though with a different form. As for *Notoluponia* Schilder, 1935, this genus includes Australian Cypraeidae with projecting protoconchs and consequently is not included in our Ovulidae.

Sphaerocypraea jacksonensis (Johnson)
Plate 1, figures 2a, 2b, 3, 4

1899. *Cypraea jacksonensis* Johnson, Acad. Nat. Sci. Philadelphia, Proc., v. 51, p. 77.
1942. *Cypraea jacksonensis* Johnson. Ingram, Bull. Amer. Paleont., v. 27, no. 104, p. 14, pl. 2, fig. 7-Holotype.
1947. *Cypraea jacksonensis* Johnson. Palmer, Bull. Amer. Paleont., v. 30, no. 117, pt. 2, p. 317, pl. 39, fig. 18.
1966. *Cypraea jacksonensis* Johnson. Palmer and Brann, Bull. Amer. Paleont., v. 48, no. 218, pt. 2, p. 623.
1977. *Notoluponia ampla* Dockery, Miss. Geol. Survey, Bull. 120, p. 60, pl. 6, fig. 6A, 6B, 6C (= *Cypraea jacksonensis* Johnson of p. 59).

The inner lip is decorated, on an average, by twenty out-stretched teeth and by a strong fold that is bifurcated on the base and clearly set apart from the first teeth. The teeth are thin and continue onto the anterior part. As is characteristic of the genus, they are extended into the aperture by a fine string which ends in a node. These nodes form a second row of teeth (Plate 1, fig. 2a-b).

Discussion

In our article on the Auversian of Baron (Oise, France), we noted without comment a *Sphaerocypraea* cf. *bowerbankii* Sowerby, 1850 (1878) (Dolin, Dolin, and LeRenard, 1980, p. 29). These broken pieces as well as the specimen represented here (Plate 1, fig. 1a-d), which comes from Mary-sur-Marne (Seine et Marne, France), did not seem to be notably different from the Lutetian type from Braklesham (Hampshire, England) in Edwards (1854, p. 129-130, pl. 17, fig. 1a-d). We have not been able to examine the English specimens to confirm this determination.

Up to now, two related forms have been reported in the Paris Basin; they are: (1) *Sphaerocypraea levesquei* (Deshayes, 1835, p. 722, pl. 94 bis, fig. 33-34), a juvenile specimen from the "Cuisian" of Retheuil (Oise, France); height 50 mm, width 29 mm [not *Cypraea levesquei* in Cossmann and Pissaro, 1911, pl. 33, fig. 162-10, from Cuise (Oise, France) = *Eocypraea* cf. *inflata* (Lamarck)]. (2) *Sphaerocypraea raspaili* (Chedeville, 1904, p. 86, pl. 4, fig. 2-2 bis), from the lower Lutetian of Boury (Oise, France); height 65 mm, width 44 mm; = *Sphaerocypraea obovata* (Schafhautl, 1863) (fide Schilder and Schilder, 1971).

If we believe the authors (who have seldom referenced the earlier works), about fifteen species or subspecies exist. These species are often based more or less on the appearance of denticles on the outer lip, a factor which is a consequence of different stages of maturity (Plate 1, fig. 3, 4). Therefore, one would have good reason to include under Deshayes' taxon the whole of the specimens found in all of Western Europe, from the middle Ypresian Stage (Cuisian) to the lower Bartonian Stage (Auversian). In fact, no sufficiently reliable criterion can be held forth (the species being stable, in its phylogenetic components as well as in its proportions) for scientifically setting up stratigraphical or geographical subspecies. From all the former points, it is evident that one must be careful when entering upon a study of the Cypraeacea.

The short diagnosis of Johnson for *"Cypraea" jacksonensis,* "Lip thick, reflected, teeth large, and occasionally bifurcate," and measurements he mentions allow no doubt about the classing of the Mississippi specimens: Dockery's taxon must then be given up (though more suitable and above all perfectly figured). Although Johnson's species most certainly belongs to the genus of *S. levesquei* (Deshayes, 1835) and *S. bowerbankii* (Sowerby, 1850), it notably differs in three unvarying points: (1) the width of the aperture (a characteristic point of the genus but here it is exceptional), (2) the larger size of the specimens, a factor that possibly indicates a particularly favorable environment, and (3) the spacing and lengthening of the denticles on the outer lip.

Sphaerocypraea jacksonensis (Johnson) constitutes an important link between the Eocene and Miocene series, as it foreshadows (though no related form has yet been reported in the Oligocene) the Central and South American Miocene species *Sphaerocypraea wegeneri* Schilder, 1939, and its synonyms, *"Marginocypraea" paraguana* Ingram, 1947, p. 3-4, pl. 1, fig. 1-2, and *"Eocypraea (Apiocypraea?)" keenae* Woodring, 1959, p. 196, pl. 32, fig. 8-10. Besides this it presents a rather rare case of migration from Western European basins toward those of the Southern United States and Central America, paired with a tangible adaptation.

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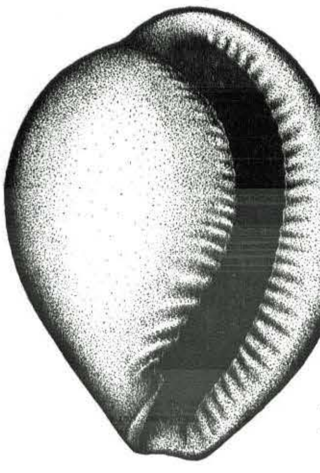
Plate 1

Figure

1 *Sphaerocypraea* cf. *bowerbankii* Sowerby, 1850. Natural size, height 59.5 mm (incomplete); Lower Bartonian (Auversian), Mary-sur-Marne, Seine et Marne, France; a. reconstruction, b. actual specimen, c-d. view of the fossula.

2,3,4 *Sphaerocypraea jacksonensis* Johnson, 1899. Natural size; Moodys Branch Formation, Town Creek, Jackson, Mississippi; 2. view of the fossula (incomplete), 3. height 86 mm, width 63 mm (incomplete), 4. height 83 mm, width 63 mm (juvenile, specimen is laterally compressed).



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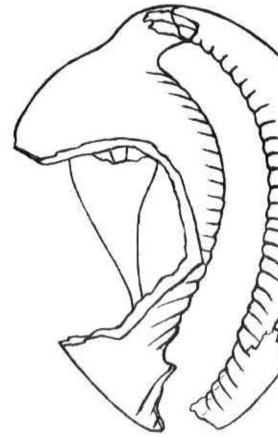

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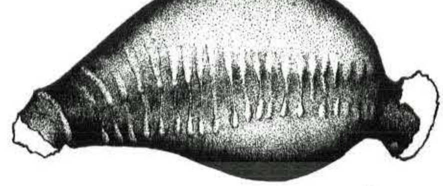

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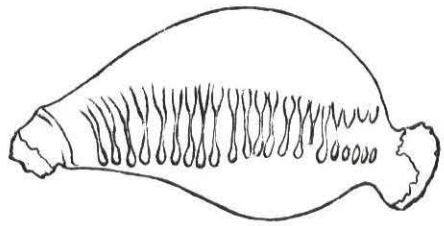

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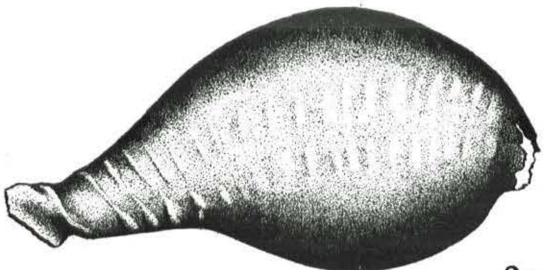

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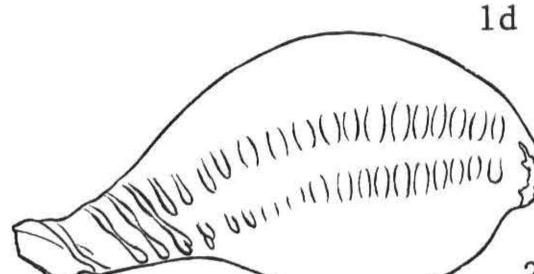

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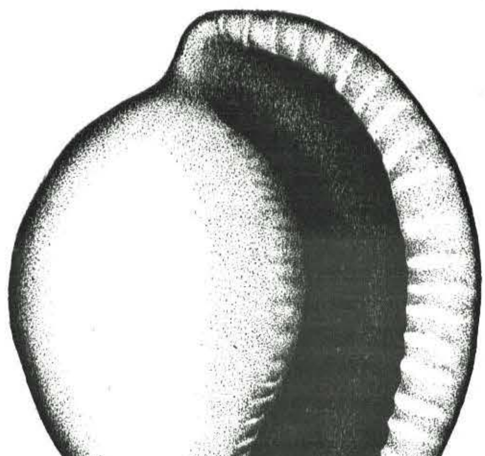

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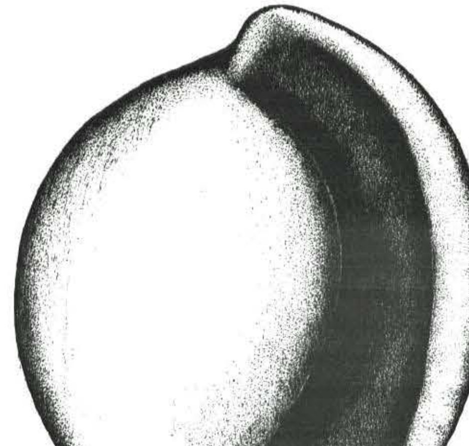

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