

STATE OF CONNECTICUT

THIRTY-SECOND

BIENNIAL REPORT

OF THE COMMISSIONERS

OF THE

STATE GEOLOGICAL AND
NATURAL HISTORY
SURVEY

1965-1967



STATE GEOLOGICAL AND NATURAL HISTORY SURVEY
OF CONNECTICUT
A DIVISION OF THE DEPARTMENT OF AGRICULTURE AND
NATURAL RESOURCES

1967

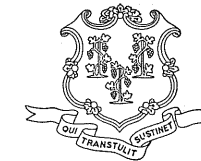
BULLETIN 100

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A DIVISION OF THE DEPARTMENT OF AGRICULTURE
AND NATURAL RESOURCES

HONORABLE JOHN N. DEMPSEY, *Governor of Connecticut*
JOSEPH N. GILL, *Commissioner of the Department of Agriculture and
Natural Resources*

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LETTER OF TRANSMITTAL

February 23, 1967

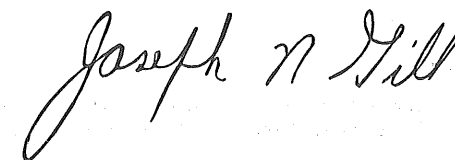
Honorable John N. Dempsey
Governor of Connecticut
State Capitol
Hartford, Connecticut

Dear Governor Dempsey:

I have the honor to transmit to you, herewith, on behalf of the Commissioners of the State Geological and Natural History Survey, in compliance with past custom, the Thirty-second Biennial Report of the Survey, covering the two years ending December 31, 1966.

This report which has been prepared by Dr. Joe Webb Peoples for the Commissioners, summarizes the progress made by the Survey in its continued geologic mapping and natural history programs. It also summarizes the part played by the Survey in the events leading to the establishment of the Dinosaur State Park.

Sincerely yours,



Joseph N. Gill
Commissioner of Agriculture
and Natural Resources

THIRTY-SECOND BIENNIAL REPORT
OF THE COMMISSIONERS
OF THE
STATE GEOLOGICAL AND NATURAL
HISTORY SURVEY
1965-1967

HISTORY AND ORGANIZATION

The State Geological and Natural History Survey was created by the 1903 statutes of the General Assembly (Chapter 133, Public Acts of 1903) as amended in 1915 (Chapter 185) and 1945 (H.B. No. 1145, P.A. No. 301, Sect. 2227). These statutes set up a board of Commissioners to be in general charge of the Survey. This Commission includes the Governor of the State, and five active scientists, appointed by the presidents of Connecticut College, Trinity College, University of Connecticut, Wesleyan University, and Yale University. (Currently the scientific members of the Commission include two geologists, two biologists, and a botanist.) Each Commissioner serves "without further appointment until his removal from the state, death, or resignation, unless sooner removed for cause." The Commissioners choose as Director of the Survey one of the appointed members of the Commission. (Pertinent portions of the statutes are quoted in the Appendix, which also includes a list of the Superintendents or Directors of the Survey since its inception.)

Public Act No. 637 of the January 1959 Assembly placed the Geological and Natural History Survey in the newly organized Department of Agriculture and Natural Resources.

The 48 state geological surveys differ widely in scope as well as in appropriation. Very few have, as that of Connecticut does, a natural-history function as well as a geological one. A majority have groundwater studies and many cooperate with the U. S. Geological Survey in topographic mapping. Studies and administration of mining and petroleum operations in their states are important functions of many surveys.

The aims of the Connecticut Geological and Natural History Survey were set forth in the first Biennial Report in 1904 as follows:

The Survey is styled, in the Act for its establishment, a Geological and Natural History Survey. This title, and the still more explicit

Cover

A close-up, reversed print of tracks of a dinosaur (*Eubrontes giganteus*) at Dinosaur State Park. Photo by John Howard, Peabody Museum.

The price of this Bulletin is 25c. Additional copies may be ordered from the State Librarian, Hartford, Connecticut 06115 (postpaid; Connecticut residents must add 3½ percent sales tax). Like all publications of the Connecticut Geological and Natural History Survey, one copy is available, free of charge, to public officials, exchange libraries, scientists, and teachers, who indicate to the State Librarian, under their official letterhead, that it is required for professional work. A List of Publications of the State Survey is also available from the State Librarian on request.

language of Section 2, we have understood as requiring that attention should be given both to the rocky framework of the state and to its vegetable and animal life—both to the Geology of the state and to its Botany and Zoology. The language of that section further implies that three distinct aims should be regarded in the work of the Survey: first, the advancement of our knowledge of the geology, botany, and zoology of the state as a matter of pure science; second, the acquisition and publication of such knowledge of the resources and products of the state as will serve its industrial and economic interests; third, the presentation of the results of investigations in such form as to be useful in the educational work carried on in the various schools of the state. These three aims, the purely scientific, the economic, and the educational, we have endeavored constantly to keep in mind in all plans which have been made.

It is appropriate to continually reconsider these aims in the light of changing state needs. After a review of the accomplishments of the past biennium, the aims will be reviewed and plans for the future will be discussed.

During the past two years the Survey's activities were administered by the Director, Dr. Peoples, acting on a part time basis. From June to September he was assisted by William Crowley as special assistant. In addition the following have served on a part time basis: Mrs. Louise Henney, secretary; Dr. Lou W. Page, general editor; Dr. C. L. Remington of Yale University, editor and planner of the entomological publications; Dr. Henry Aldrich, map editor; Dr. Bernice Wheeler, consultant on the natural history program.

ACCOMPLISHMENTS SINCE JANUARY 1965

The biennium 1965-67 has been an active one for the Geological and Natural History Survey. During that period the quadrangle mapping program has been prosecuted vigorously by the Survey and by the U.S. Geological Survey in its cooperative program. In addition aeromagnetic surveys have been completed of all the quadrangles in the state, a number of aeromagnetic maps have been published, and others are in various stages of compilation and editing. The topographic map of the state (scale 1:125,000), authorized by the last assembly, has been compiled and is in the proof stage.

The natural history program has also progressed. Dr. Bernice Wheeler is serving as consultant in this field. Two reports of the new series on the vegetation of natural areas have been published, one manuscript has been submitted for review, and others are in various stages of preparation. A bulletin on the molluscs of Connecticut is nearing completion and several papers for the entomological series are planned or are in preparation. Plans are being made to publish bulletins in other areas of natural history for which up to date information is badly needed.

Probably the most exciting development came from a most unexpected source, the finding of dinosaur tracks in an excavation for the basement of a Highway Department testing laboratory in Rocky Hill and

the whole chain of events thereby initiated which led to the Dinosaur State Park. 1966 could be appropriately called the Year of the Dinosaur.

The individual programs are summarized in the following sections.

DINOSAUR STATE PARK

The story of the finding of dinosaur tracks in Rocky Hill and the subsequent creation of Dinosaur State Park has been much publicized in newspapers and on radio and television. However, the efficient and swift cooperation and coordination of scientists and various departments of the State government is worthy of note.

On a site on the south side of West Street in Rocky Hill excavation was underway on August 24, 1966, for the foundations and basement of a Highway Department testing laboratory. Edward McCarthy, a bulldozer operator, recognized dinosaur tracks in the rocks at a level about 12 ft below the natural surface of the ground. He pointed out the tracks to Thomas Jeffreys, Engineer for the Public Works Department and to Thomas Perry, the architect for the new laboratory, who happened to be at the excavation. Jeffreys and Perry called the Peabody Museum at Yale University, the University of Connecticut, and the newspapers. That evening a large number of people who had heard news of the find came to the pit to collect specimens. One man is said to have started up the contractor's bulldozer in order to do so more efficiently.

The next morning, August 25, Commissioner of Public Works Timothy Murphy asked the Connecticut Geological and Natural History Survey to appraise the importance of the find. That afternoon Survey Director Joe Webb Peoples and his assistant, William Crowley, met Deputy Commissioner of Public Works S. A. McGann, members of his staff, and representatives of the Highway Department at the site. Dr. Larry Frankel and Dr. Hugo Thomas of the University of Connecticut and Dr. Henry Roos of Willimantic State College were also there with a few of their students, investigating and collecting, on the assumption that a concrete floor would soon cover the tracks and that anything which could be salvaged for teaching purposes should be saved. Later, Mrs. Jane Cheney, Director of the Children's Museum in West Hartford, arrived. She had visited the excavation the previous evening and again that morning and reported that there had been tracks exposed on the east side of the excavation which, by this time, were covered up.

The scientists present quickly discussed the find. It seemed apparent that the tracks probably were to be found across the 120-ft width of the excavation, that they continued down-dip underneath the overlying sandstone, and also probably to the west under the rock and soil there for an unknown distance. It was the consensus of the group that an open-air exhibit of dinosaur tracks left in place would have great public appeal and would be very valuable for public education. Dr. John Ostrom and Dr. Elwyn Simons, paleontologists from Yale University, who also visited the site that afternoon, strongly supported this viewpoint. In the meantime, Dr. Peoples had conferred with Commissioner Gill of the Department of Agriculture and Natural Resources,

and had his approval to make a written recommendation to Commissioner Murphy that an effort should be made, in the interests of public education, to save an area where the tracks could be exhibited in place.

The various State officials then acted with great speed to stop excavation in the area of the tracks that day, to put up a temporary fence around the excavation, and to have State Police guard the site on a 24-hour basis.

On August 29, Commissioner Conkling called a conference in Col. Beckwith's office at the State Veterans' Hospital to consider what should be done about the find. The following, among others, were at the conference:

- George J. Conkling, Commissioner of Finance and Control
- Joseph N. Gill, Commissioner of Agriculture and Natural Resources
- Howard S. Ives, Commissioner of the Highway Department
- S. A. McGann, Deputy Commissioner of the Public Works Department
- Donald Mathews, Director of Parks and Forests
- Joe Webb Peoples, Director of the Geological and Natural History Survey
- John Ostrom, Associate Professor of Vertebrate Paleontology at Yale University
- Larry Frankel, Associate Professor of Geology at University of Connecticut
- Henry Roos, Willimantic State College

The four scientists present were asked to appraise the importance of the tracks and to consider what, if anything, could be done about their preservation. Their recommendations were to preserve the tracks *in situ* if possible. It was then decided by the State officials present to consider other possible sites for the Highway Department building, to authorize additional excavation to the west, and to uncover the tracks down dip. Peabody Museum of Yale University agreed to furnish their chief preparator, Grant Meyer, with two assistants, to direct the work of uncovering and preserving the tracks. On August 31 this additional excavation was begun. Two members of the staff of the University of Connecticut and several graduate students from that institution joined the Peabody Museum men.

At the August 29 meeting, Commissioner Conkling had requested a written report from the four scientists present. Under the date of September 7, John Ostrom wrote as follows:

The scientific value of the features at Rocky Hill is not extraordinary, because similar features occur at several other sites in the Northeast. However, only one or two of these sites receive any degree of protection or maintenance and none that I know of have any potential for future development. This is the only site found in the last several decades that might reasonably be developed into a significant public display. To date, no new information or new kinds of prints have been discovered at Rocky Hill, but it is always possible that this may result



Plate 1. Aerial view of Dinosaur State Park, looking south, with West Street in foreground. Photo by J. T. Rummel, Jr., Connecticut State Highway Department.

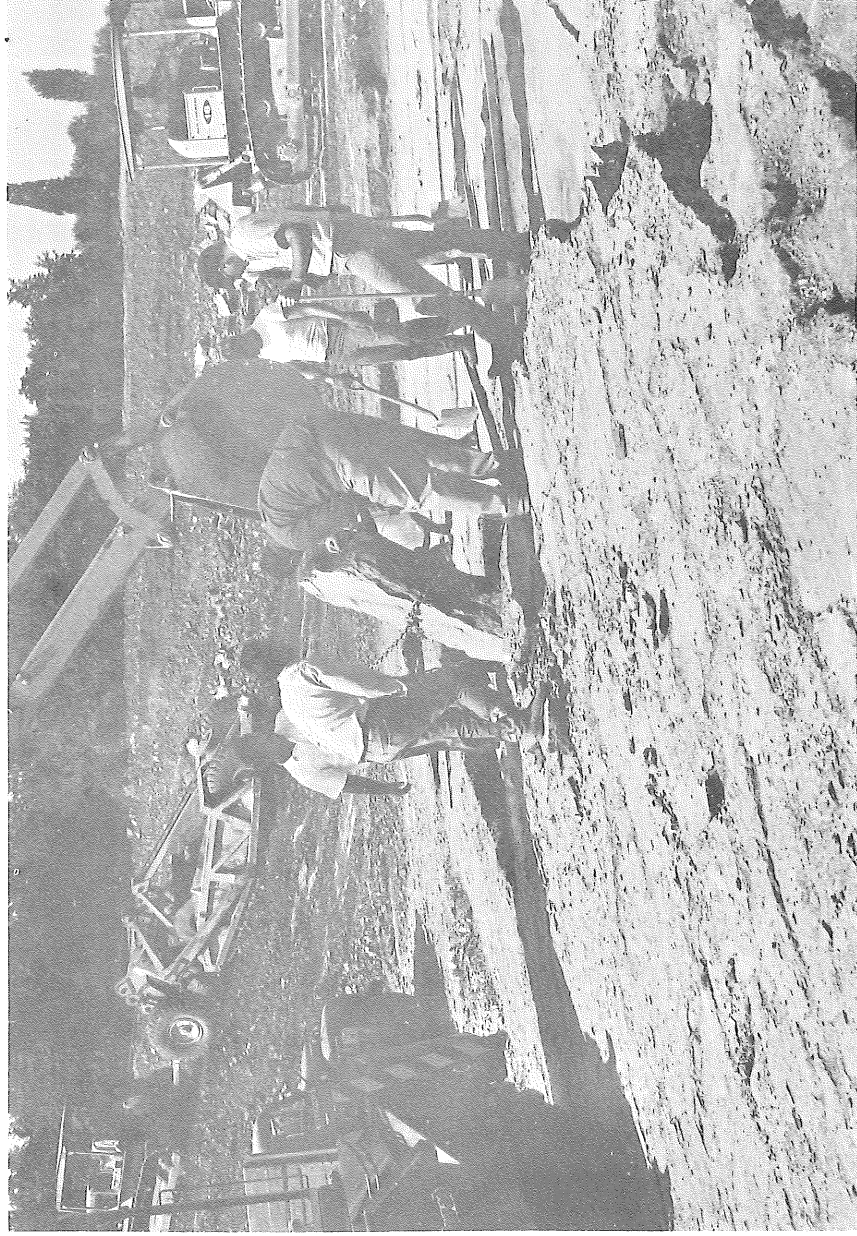


Plate 2. Back hoe excavator, under direction of Grant Meyer of Peabody Museum, removing 6-10" layer of mudstone overlying footprint horizon. In foreground principal footprint bearing stratum. Note that machine does not rest on uncovered footprint surface. Photo by J. F. Chipps, Jr., Connecticut State Highway Department.

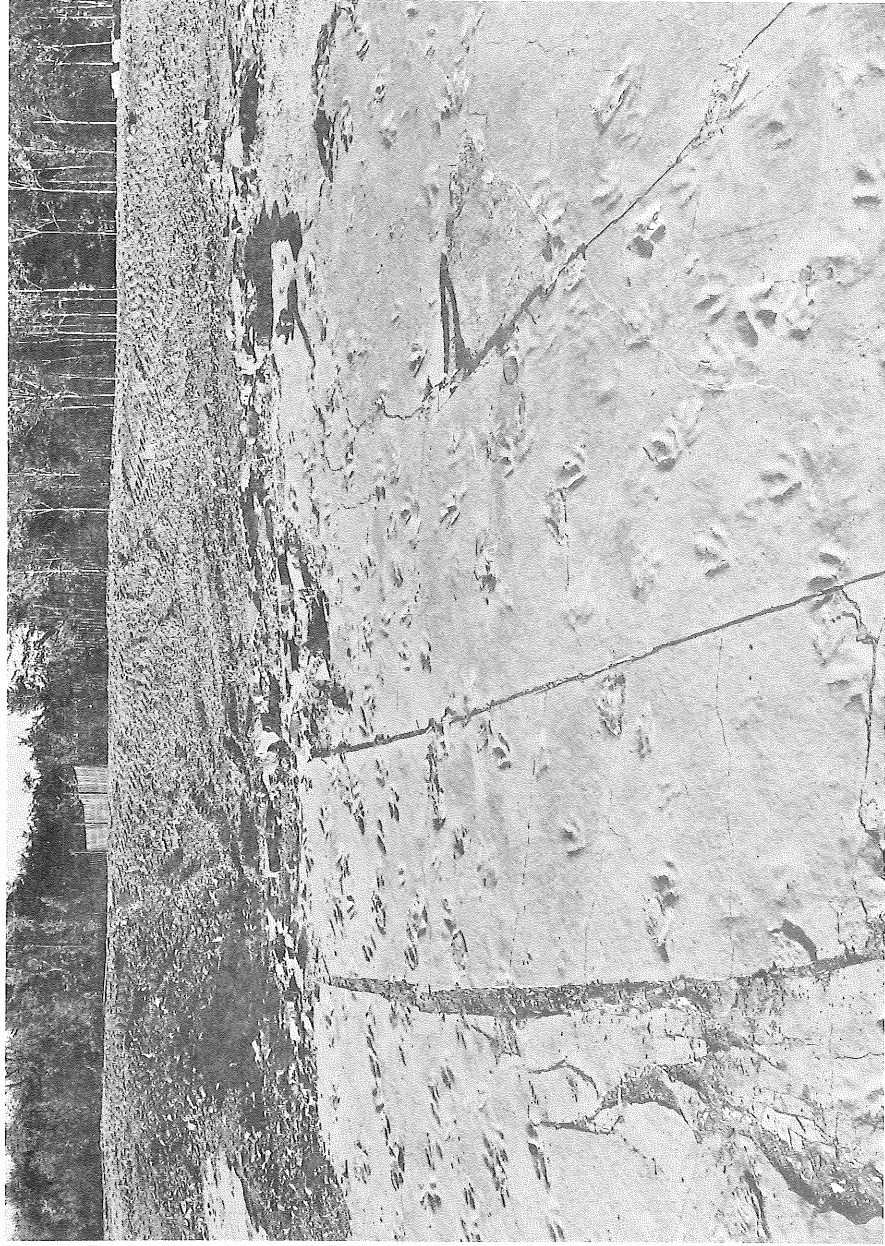


Plate 3. Tracks of the dinosaur *Eubrontes* on the main horizon. Note at upper right ripple marks show on a lower horizon which contains *Anchisauripus* footprints shown on plate 4. Photo by John Howard, Peabody Museum.



Plate 4. Tracks of the dinosaur *Anchisauripus*. The large tracks from left to right, center, show that it stepped first on firm mud on the bank of a stream or pond, then on softer mud as it came to the edge of the water, and on very soft bottom-mud (right side footprint). The ripple marks show clearly the edge of the water, from upper left diagonally to lower center. Smaller tracks proceed from right foreground to upper left. Photo by John Howard, Peabody Museum.

when final preparation has been completed and detailed studies can be made.

The principal value of the Rocky Hill site is an educational one, in my opinion. If properly developed and maintained, this locale could be a spectacular and valuable outdoor instructional display available to the general public and tourist and to all the public and private schools in the central Connecticut area. In addition to the dinosaur footprints, there are a variety of geologic features which, if properly developed and labeled, could add greatly to the scope of topics. Still more scope might be added by supplementary displays coordinated with specific school programs in natural science.

For these reasons, I urge that the State proceed with a program to develop the Rocky Hill site into an outdoor nature preserve, primarily as an unusual instructional facility for Connecticut schools. I suggest that an advisory committee be appointed as soon as possible to insure the best possible planning and development of the site.

The following is quoted from Larry Frankel's letter:

My recent examinations of the West Street excavation where dinosaur tracks were uncovered, have convinced me even more than before, that this site should be preserved for the present and future citizens of Connecticut. The purely scientific value of the site will not be fully known until it is studied in detail, but its educational value to young and old is immense because of the many geological phenomena, in addition to the tracks, preserved there. Because of its central location and easy access, the site would make an ideal and valuable outdoor classroom for the teaching of earth science. For this reason, I strongly urge that every effort be made to preserve the site.

Grant Meyer, on September 7 wrote as follows:

On August 31, 1966, excavation was continued at the site of the State Highway Department's testing laboratory to determine the areal extent of a stratum which had been found to contain fossil dinosaur footprints. At that time there existed at the site an excavation of approximately 120 feet by 120 feet to a depth of 12 feet. The stratum which contained the fossil footprints was exposed along an east-west line thirty feet south of the north border of the proposed building and 37 footprints were exposed in the excavation, and 5 footprints on slabs of rock which had been carried out of the excavation.

It was decided by Dr. Joe Webb Peoples, Dr. John Ostrom and myself to continue the excavation along two fronts. First, to uncover the stratum exposed in the existing excavation in a southerly direction until it was terminated by a fault, and secondly, to extend the excavation 50 feet to the west and uncover the same stratum throughout that area.

At the present time, 6600 square feet of stratum have been uncovered in the existing excavation site except for the final 9 inches of rock. At the eastern end of this stratum seventy footprints have been

uncovered in an area of 400 square feet. Along the northern margin 37 footprints have been uncovered and prints are found at the south west corner next to the fault. The remainder of this bed should be uncovered by Friday, September 9, 1966 and there is every indication that footprints should be found in similar abundance throughout this area.

We are also planning to expose a small fault along the southern end of the excavation which could easily be viewed by visitors to the area. Two 20 ft. by 20 ft. extensions to the excavation have been made at the southern corners of the existing excavation. These have exhibited the fault in three perpendicular planes and will give visitors a marvelous chance to walk over and around a fault and see what it looks like. Explanations and educational diagrams can be made at Peabody Museum to be placed at the site and a display of any fossil fish and fossil plants found in the black shales located at the southern end of the site can be added.

It is my opinion that this site should be preserved *in situ* for it is, I believe, without equal in the United States. Nowhere, to my knowledge, are so many dinosaur footprints found in such a small area. The value of this site lies in the fact that we have such an amazing density of footprints. This value would be lost if the blocks of prints were carried out to museums.

On September 8, Dr. Peoples sent these reports to Commissioner Conkling; in addition he made the following summarizing recommendations:

1. We recommend uncovering of the track horizon in the present excavation including the 60' section west of the original pit but no more stripping beyond that until plans for landscaping and development can be made.
2. We recommend that cleaning and treating the tracks with epoxy under the direction of Mr. Meyer be carried out as outlined in his letter.
3. We recommend that plans be prepared for the development of the site and that an advisory committee be appointed to aid in planning.

On September 13, Governor Dempsey announced that the 7.7-acre site which contained the tracks would be set aside as a State Park, and appointed a committee to advise the Commissioner of Agriculture and Natural Resources on the planning and development of this park.

At the time of the September 8 recommendations, about 6,600 sq ft of stratum was excavated down to 9 in. above the track-bearing horizon. The actual fossil horizon, however, was exposed over less than 1,000 sq ft, showing about a hundred tracks. By the end of October, at the close of excavation, Mr. Meyer reported that an area of 9,200 sq ft of the fossil horizon, with about a thousand footprints, was exposed, and that the major overburden had been removed from about 34,000 sq ft.

By Governor Dempsey's order the 7.7-acre plot of land in Rocky Hill was transferred to the Department of Parks and Forests, and (1) plans were immediately made for a security guard; (2) the firm of Morton Fine and Associates were engaged to (a) plan for protection of the site over the winter, (b) to plan and construct an exhibit near the road, and (c) to prepare a proposal for the long range development of the site. Mr. Fine and his associates met with the Governor's Advisory Committee on September 28 and on December 6. They have sought the advice of various scientists, engineers, and other experts in the state. At one conference in Middletown various methods of protecting the site for the winter were discussed. After further studies the following steps were taken: (1) Two sumps were dug and pumps installed. (2) The surface of the principal footprint bearing layer was painted with a new plastic sealing material. Students from Yale, Wesleyan and the University of Connecticut assisted in this part of the project. (3) A sheet of vinyl plastic was put over the walkway, on top of which came thousands of feet of electric heating cables, several inches of sand, a layer of mulch, another cover of vinyl plastic weighed down by old automobile tires. The plastic sheeting will prevent surface water from reaching the trackway, the pumps will lower the ground water level, and the heating cables will prevent moisture in the fractures from freezing and breaking up the track bearing layers.

At the meeting of the Geological Society of America in San Francisco in November an exhibit of photographs of the dinosaur-track site received many favorable comments and expressions of admiration and surprise that the State could move so fast to preserve a natural feature of this kind. The Society of Vertebrate Paleontologists, meeting at Berkeley, California, discussed the find, and sent the following communication addressed to Governor Dempsey, State Commissioners and Officials:

The Society of Vertebrate Paleontology has become aware of your extensive and laudable efforts to preserve the magnificent series of dinosaur footprints recently exposed at Rocky Hill, Connecticut. At its annual meeting held in Berkeley, California, on November 17, 1966, the Society voted unanimously to hail the actions already taken by the State of Connecticut and to encourage the officers of that State to take whatever further steps are necessary to maintain that site as an invaluable heritage for all citizens.

Many people have asked many questions about this find. Is it an important one? Why is it important, since dinosaur tracks have been found in the Connecticut Valley since 1802 in large numbers at several places. Dr. Donald Baird of Princeton University, one of the world's experts on such tracks, visited the site and also took part in a TV panel discussion on a Channel 3 program. Dr. Peoples asked him for his appraisal of the find and he replied as follows:

I'm delighted to hear that the Dinosaur Track State Park project has lost none of its momentum, that all the right things are being done, and that everyone involved is cooperating heartily to realize the site's potential as one of the great natural showplaces of the country. There

are equally fine exposures of dinosaur tracks *in situ* in Arizona, Texas and British Columbia, but they have been minimally developed at best and are too far off the beaten track to have much significance in terms of public education and recreation. Your Rocky Hill site, on the other hand, could hardly be better situated for accessibility to the public of the northeastern states. It is already a tourist attraction, and when properly developed it will be in the same class with such outdoor education-recreation centers as Mystic Seaport and Old Sturbridge Village.

The scientific and educational aspects of the site should, I think, be appraised separately. A scientific study of the site will certainly be rewarding, though on preliminary examination I do not feel that it will add a great deal to our knowledge of life in the Triassic Period. That this is so is, of course, a tribute to the monumental work that has already been done by Professor Hitchcock at Amherst and Professor Lull at Yale. The chief advantage of the Rocky Hill site over previous finds is that it affords one of the largest known exposures of dinosaur tracks on a single bedding plane — tracks made in a single moment of time, geologically speaking — and thus gives us the opportunity to study an ancient community of reptiles *as living animals*. Accumulations of buried bones, such as that at Dinosaur National Monument, cannot provide as reliable information about the natural association of different species, the size range within a species, and the habits of the animals.

So far I have identified three types of reptiles among the Rocky Hill trackmakers: *Eubrontes giganteus*, a coelurosaurian dinosaur about 25 feet long which appears to be related to *Halticosaurus* from the Triassic of Germany (at least their body proportions and foot structure are very similar); a species of *Anchisauripus*, probably *Anchisauripus sillimani*, a smaller coelurosaurian about 12 feet long; and *Batrachopus dispar*, a quadrupedal thecodont reptile that appears to be a member of the group that gave rise to the crocodiles. These are listed in order of frequency. More detailed study of the occurrence may reveal additional types of reptiles.

The education opportunity provided by the Rocky Hill find is simply outstanding. This will be almost the only outdoor exhibit in the eastern United States (aside from commercial displays of dubious educational value) where school classes, family groups, and out-of-state tourists can see a spectacular display of fossils as they occur, along with interpretative labels and reconstructions. (I don't know whether present plans for the site include life-sized restorations of the dinosaurs, but reasonably accurate fiberglass sculptures, either in the round or in high relief, are certainly feasible.)

To go a step further, it doesn't seem at all visionary to think of the track exhibit as the nucleus of a popular scientific and educational center, a field station for displays and activities dealing with the natural history resources of the State.

Probably nothing need be added about the potential (indeed, the actual) economic spin-off from such a project. "Our free and enlight-

ened citizenry," as Sam Slick would say, need no prompting to realize the benefit which the new State Park will have on the economy of their area.

In closing, let me congratulate you and the people of Connecticut, first for having uncovered this spectacular natural treasure, and second for having moved so wisely and expeditiously to make the most of its scientific and educational potential. The Rocky Hill park will unquestionably be an outstanding attraction and a credit to all who have made it possible.

The interest of the public has been high since the first announcement of the discovery; as the State Park continues to develop, interest and enjoyment will no doubt become even greater. The importance of the discovery and its preservation in place is recognized by scientists who have come to study the site.

The Dinosaur State Park is part of the State Park system and is under the control and jurisdiction of the Department of Parks and Forests. The Geological and Natural History will assist with scientific studies and will advise on the scientific exhibits. It will also plan a geologic report on the area with the aid of scientists from Yale, University of Connecticut, Willimantic State College, and Wesleyan University.

The Survey has two bulletins in print which describe Triassic life in Connecticut. They are: Bulletin 81, "The Triassic Life of the Connecticut Valley," by R. S. Lull, 1953, and Bulletin 96, "Fossils of the Connecticut Valley," by E. H. Colbert, 1963. Both are available from the State Library.

GEOLOGIC PROGRAM

Quadrangle mapping

For several years the major geologic activity of the Survey has been the making of geologic quadrangle maps. Much of this work has been done by university personnel working part time for the Survey. In addition, U.S. Geological Survey personnel have been engaged in mapping under a cost-sharing cooperative program. Index maps (figs. 1, 2) show the status of quadrangle mapping in the state as of Jan. 1, 1967.

An effort has been made to complete the mapping already begun and to publish the completed manuscripts as fast as they are edited. In 1966, with the increase in funds made available to the Survey, it was possible to increase the tempo of field mapping. Work done since January 1965 is shown in table 1. Field work was completed in this period in the Colchester, Old Lyme, Bridgeport, Hampden, Monson, and Long Hill quadrangles. Field work will be continued in the remaining quadrangles in 1967.

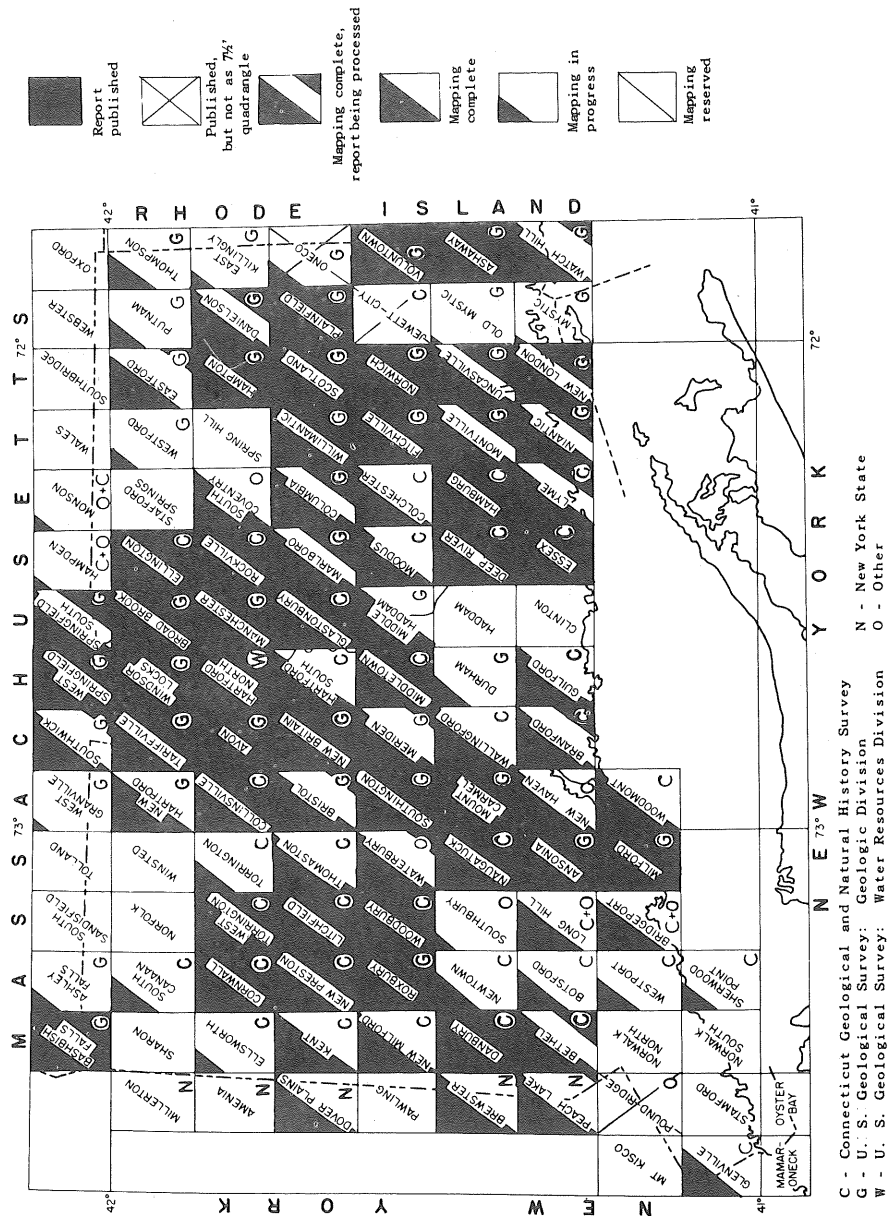


Fig. 1. Status of bedrock geologic mapping as of Jan. 1, 1967.

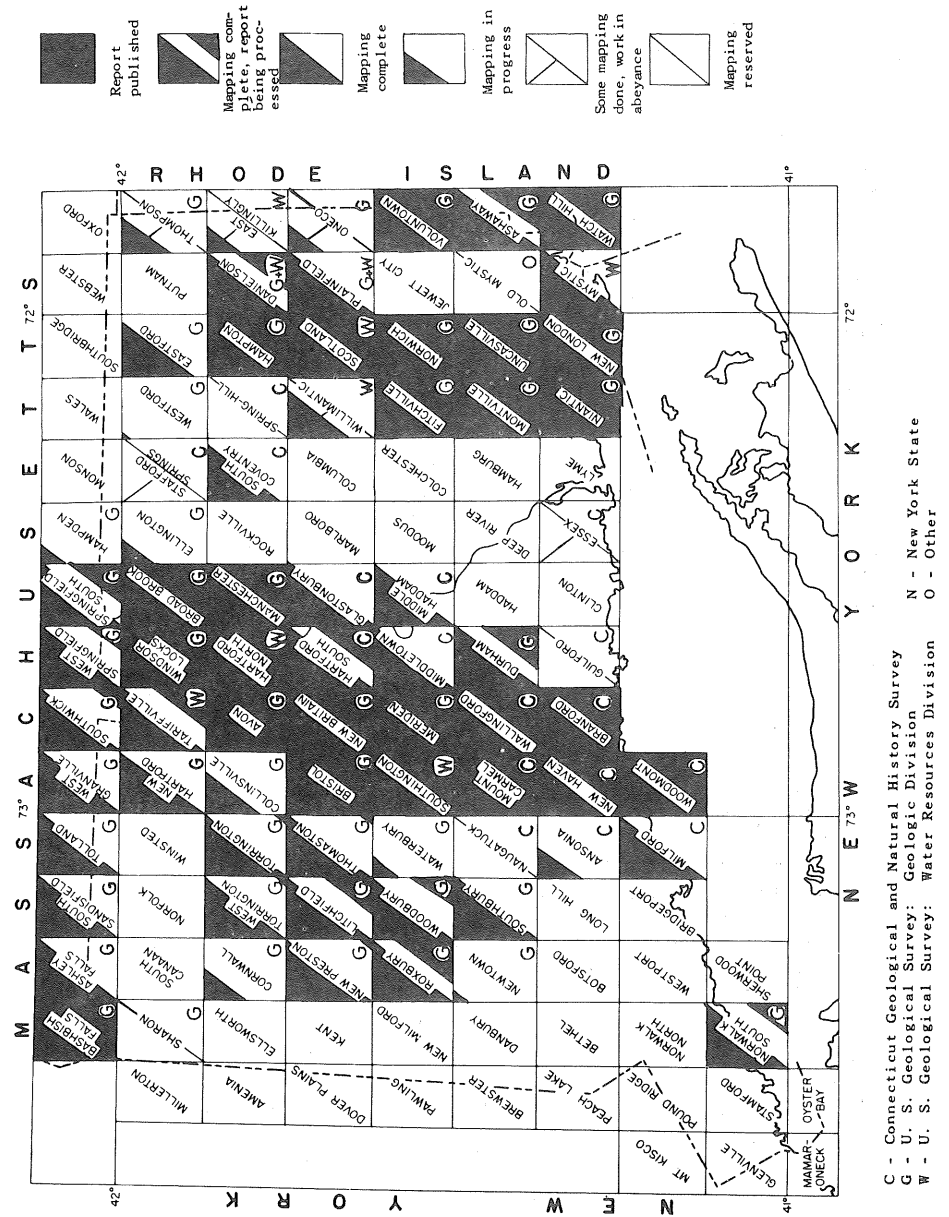


Fig. 2. Status of surficial geologic mapping as of Jan. 1, 1967.

Table 1.—Geologic field activity, 1965-67, Connecticut Geological and Natural History Survey

Quadrangle	Type of Map	Geologist	University
Ansonia	Surficial	Flint	Yale
*Botsford	Bedrock	Stanley	Vermont
†*Colchester	Bedrock	Lundgren	Rochester
Milford	Surficial	Flint	Yale
†Bridgeport	Bedrock	Crowley	Yale
†Long Hill	Bedrock	Crowley	Yale
*Newtown	Bedrock	Heyl	Univ. of N.Y. at New Paltz
Torrington	Bedrock	Martin	Earlham
South Canaan	Bedrock	Gates	Wisconsin
*Glenville	Bedrock	Hall	Union
*Durham	Bedrock	deBoer	Wesleyan
†Old Lyme	Bedrock	Lundgren	Rochester
*Westport	Bedrock	Dieterich	Yale
*Sherwood Point	Bedrock	Dieterich	Yale
†Hampden	Bedrock	Peper	Rochester
†Monson	Bedrock	Peper	Rochester

*Field work started since Jan. 1, 1965

†Field work completed

The increase in funds made available in this biennium for the cooperative mapping program with the U.S. Geological Survey has made it possible to accelerate the field mapping. A great effort was made to get surficial mapping completed in those areas being studied in the Water Inventory Program of the Water Resources Commission. To this end, surficial mapping was done during the period under review in the Cornwall, West Torrington, Torrington, Collinsville, New Preston, Litchfield, Thomaston, Roxbury, Woodbury, Waterbury, Southbury, Newtown, and Norwalk South quadrangles. The map of the Roxbury will be published very soon. Although maps of several other quadrangles pertinent to water-supply investigations are still being prepared for publication, the field results of all are available to the geologists making the water-inventory studies. Work in the Housatonic Valley will be pressed in the coming field season, since this is one of the regions under study by the Water Resources Commission. Because surficial maps are already available for most of the region in which ground-water studies will be started in 1967 and 1968, the focus of the surficial mapping can be shifted to Southern Connecticut in 1968.

U.S.G.S. geologists continued the bedrock mapping of northeastern Connecticut in Eastford, Westford, Putnam, Danielson, and East Killingly quadrangles; on the Massachusetts border in the Southwick, West Granville, and New Hartford quadrangles; and in the Marlborough and Middle Haddam quadrangles in central Connecticut.

Table 2 shows the status of quadrangle maps and manuscripts as of January 1, 1967. The numbers and percentages of quadrangles in various stages are summarized in table 3.

Table 2.—Status of geologic quadrangle maps and manuscripts as of January 1, 1967

U.S. GEOLOGICAL SURVEY		CONNECTICUT GEOLOGICAL AND NATURAL HISTORY SURVEY	
Bedrock	Surficial	Bedrock	Surficial
<i>Published</i>			
(22)	(20)	(15)	(5)
GQ121 Roxbury	GQ119 New Britain	MS3 Litchfield	QR10 Wallingford
GQ134 Avon	GQ137 Windsor Locks	MS5 New Preston	QR12 Mt. Carmel
GQ144 Norwich	GQ138 Uncasville	QR3 Woodbury	QR14 Branford
GQ199 Mt. Carmel	GQ145 Bristol	QR4 Ellington	*QR18 New Haven and Woodmont
GQ200 Southington	GQ148 Montville	QR5 Glastonbury	
GQ223 Hartford North	GQ146 Southington	QR6 Rockville	
GQ335 Willimantic	GQ147 Avon	QR7 Danbury	
Bull. 1161-I	GQ150 Meriden	QR8 Middletown	
Fitchville	GQ165 Norwich	QR9 Naugatuck	
GQ388 Windsor Locks	GQ176 New London	QR11 Cornwall	
*GQ370 Tariffville	GQ223 Hartford North	QR13 Deep River	
*GQ392 Scotland	GQ329 Niantic	QR15 Essex	
*GQ403 Ashaway	*GQ392 Scotland	QR16 Collinsville	
*GQ475 Ansonia	*GQ433 Manchester	*QR17 West Torrington	
*GQ426 Milford	*GQ410 Watch Hill	*QR18 Hamburg	
*GQ433 Manchester	*GQ434 Broad Brook		
*GQ434 Broad Brook	*GQ468 Hampton		
*GQ436 Voluntown	*GQ469 Voluntown		
*GQ468 Hampton	*GQ485 Fitchville		
*GQ494 New Britain	*GQ507 Bashbish Falls		
*GQ481 Plainfield			
*GQ507 Bashbish Falls			
*GQ537 West Springfield			
<i>In press</i>			
(9)	(3)	(4)	(1)
New London	Roxbury	Old Lyme	Hartford South
Niantic	Danielson	Waterbury	
Uncasville	Springfield South	Peach Lake ¹	
Columbia		Brewster ¹	
Montville			
Watch Hill			
Springfield South			
Danielson			
Meriden			
<i>In review</i>			
(2)	(11)		
Bristol	West Springfield		
Marlborough	Tariffville		
	Ashaway		
	Southwick		
	Durham		
	West Torrington		
	Litchfield		
	Eastford		
	Norwalk South		
	New Preston		
	Torrington		

¹To be published by the State of New York

*Published in years 1965 and 1966

Table 3.—Summary of quadrangle geologic mapping in Connecticut as of January 1967 (Connecticut Geological and Natural History Survey and U. S. Geological Survey)

	Bedrock	Surficial
Number of quadrangles covering the state	111	111
Quadrangle maps published	37 (33%)	25 (22.5%)
Quadrangle maps in press	13	4
Quadrangle maps in review	2	11
Quadrangle maps for which field work is completed	15	7
Quadrangles partly mapped	16	15
Total number of unpublished quadrangle maps completed at least through the field-work stage	68 (61%)	47 (42%)

Aeromagnetic maps

In the last Biennial Report the plan for completing the flights necessary to obtain data for aeromagnetic maps of Connecticut quadrangles was presented. As was previously pointed out, the U.S.G.S. had already published several aeromagnetic quadrangle maps in the state and were preparing maps of two tiers of quadrangles across the northern part of the state. During the past two years a number of these maps have been published and others are in press (see Appendix for list of maps). All of this work has been done with Federal funds and at no cost to the State. In 1965 and 1966, however, under the cooperative mapping program, the U.S.G.S. made flights across the remaining quadrangles of the state and the aeromagnetic maps of this area are in process of compilation. The status of aeromagnetic mapping in the state is shown in the index map, fig. 3. It is now planned to prepare for publication an aeromagnetic map of the whole state, probably at the scale of the proposed new state base map, 1:125,000.

The aeromagnetic surveys were made to aid the geological mapping program in the state. Results to date clearly indicate that the aeromagnetic maps will provide information useful to geologists. These aeromagnetic data give the field geologist another set of physical measurements which, when properly interpreted, can aid greatly in a better understanding of the complex geology of much of Connecticut. At the last two annual Conferences on Connecticut Geology, R. W. Bromery discussed preliminary interpretations of the aeromagnetic maps of Eastern Connecticut and has shown that some of the major rock units can be correlated with characteristic magnetic anomaly patterns. A study of these patterns indicates structural and/or lithologic changes which are important in the areas of scarce outcrop information. A very surprising series of aeromagnetic anomalies has been shown to trend east across Southern Connecticut, in part paralleling the Honey Hill fault previously mapped by Goldsmith, Snyder, Lundgren, Dixon, Eaton and others. This very interesting feature is still under study.

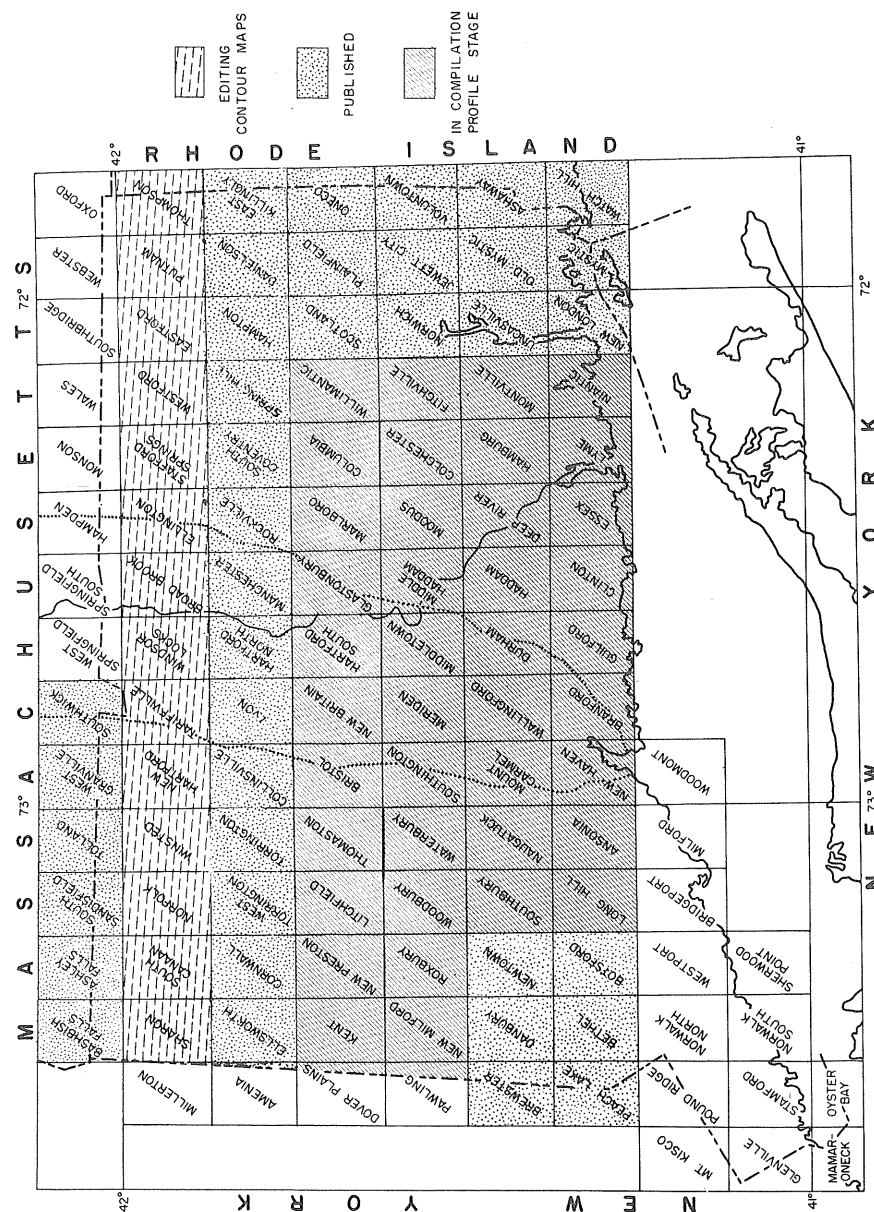


Fig. 3. Status of aeromagnetic surveys as of Jan. 1, 1967.

At other places in the world, study of aeromagnetic maps has led to the discovery of important ore deposits. It is possible that these Connecticut aeromagnetic maps may directly or indirectly lead to mineral discoveries, although it is too early at this time to indicate particular areas favorable for further geophysical and geological exploration.

State topographic map

The 1965 Assembly appropriated \$30,000 to be matched by the U.S. Geological Survey and to be used by the Federal Survey to make a topographic map of the state of Connecticut on a scale of 1:125,000 (one inch to about two miles). At the beginning of the present biennium the compilation of the map was started. Progress was rapid and preliminary proof was available in the fall of 1966. At every stage, various interested State agencies have been consulted; they have furnished valuable information, made corrections, and discussed various cartographic problems with the Federal engineers. It is expected that the map will be published by June 30, 1967.

Two editions will be printed to be sold to the general public. One will show contours (in brown), drainage (in blue), names of towns, rivers, lakes, and so on (in black), cultural features such as roads, railroads, and buildings (also in black); built-up areas will be tinted, and State Parks and Forests shown in separate colors. The second edition will have a woodland overprint. The possibility of a third edition, with shaded relief, also to be available to the public, is being discussed and will be printed if there are sufficient funds.

The state topographic map will be a handsome wall map and will be useful in many ways—in schools, as a base for a variety of special maps, for planning of many kinds. It is of especial importance to the Survey since it will serve as a base for two new geologic maps of the state.

State geologic maps

Now that the state topographic map is nearing completion, and the program of geologic mapping by quadrangles has progressed so far, it is time to press for the completion of two geologic maps of the state, one showing the bedrock geology and the other the surficial geology. The former map will be prepared by Dr. John Rodgers and the latter by Dr. R. F. Flint, both of Yale University. Both men, however, will need help and advice from the various field workers. It is hoped to have preliminary compilations of the quadrangle mapping done to date ready by the 1967 Summer Conference on Connecticut Geology. Discussion of these compilations will point up some of the problems which need to be ironed out and will help in planning future work. By the end of the next biennium it should be possible to set a target date for the completion of the two maps and to estimate the funds needed for completion and publication.

The glacial map of the state published with Bulletin 47 in 1931 was of great value for many years in highway planning and construction work. The two new maps should be of even greater use for future

engineering work of all kinds, for planning, for exploration for mineral raw materials, and for educational use, not only in schools and colleges, but also for the general public.

Mineral resources

Sand and gravel and stone products account for more than 90 percent of the value of the mineral production of the state. In 1964 and 1965 the value of the mineral production declined slightly from the all time high in 1963. (See table 4.) This is attributed to a decline in residential and industrial construction.

Table 4.—Value of mineral production in Connecticut (in thousands of constant 1957-1959 dollars)¹

Year	Value	Year	Value
1949	\$5,617	1958	\$13,245
1950	6,526	1959	12,738
1951	6,802	1960	15,243
1952	7,891	1961	16,601
1953	8,266	1962	19,835
1954	9,973	1963	20,937
1955	10,718	1964	22,013
1956	11,495	1965	21,400
1957	16,316	1966	20,700

¹This table appeared as table 2 of the U.S. Bureau of Mines *Minerals Yearbook*, 1964.

Although Connecticut is not a large mineral producer, this is largely a function of size. On a square mile basis the value of the mineral production exclusive of fossil fuels was exceeded in 1963 by only 9 states. Table 5 shows the values per square mile of minerals less fuels and total value for a number of states ranked on the basis of value less fuels. These figures are adapted from a table furnished by James Calver, State Geologist of Virginia.

As aeromagnetic maps are published they should be examined as clues to possible mineral deposits. Economic deposits of metallic minerals in Connecticut should not be ruled out without consideration of the geologic and geophysical data.

In the Annual Review volume of the U.S. Geological Survey for 1966 (Prof. Paper 550-A) it is reported that vein quartz of the type mined at Lantern Hill in North Stonington, has been found along a steeply dipping fault in southern Plainfield. It is suggested that this may provide a new source for silica. The location of the fault and vein is shown on GQ 481, "The Bedrock Geology of the Plainfield Quadrangle," by H. Roberta Dixon.

Donald Spalding of the Highway Department has prepared a summary report for his department on Construction Aggregate Availability in Highway District IV. In this study full use of published and unpublished maps of surficial geology were used as well as field investigation. This report shows that the physical resources are large but that availability is limited by socio-economic factors.

Table 5.—Value of mineral production per square mile in 1963

Rank		Value less fuels	Total Value
1	New Jersey	\$9,351	\$9,351
2	Michigan	7,517	8,452
3	Pennsylvania	6,758	18,902
4	Maryland	6,191	6,642
5	Ohio	6,184	10,174
6	Minnesota	5,395	5,395
7	New York	5,047	5,249
8	Arizona	4,225	4,226
9	Connecticut	4,115	4,115
10	Massachusetts	3,956	3,956
11	Florida	3,426	3,443
12	California	3,268	9,612
13	Tennessee	3,267	3,804
14	Indiana	3,074	5,581
15	Utah	3,035	4,540
16	Louisiana	2,680	54,862
17	Illinois	2,669	10,354
18	Virginia	2,636	5,612
19	Vermont	2,538	2,538
20	Rhode Island	2,312	2,312
23	West Virginia	1,865	31,753
30	Texas	1,327	16,507
37	Oklahoma	853	12,479
47	Montana	376	1,237

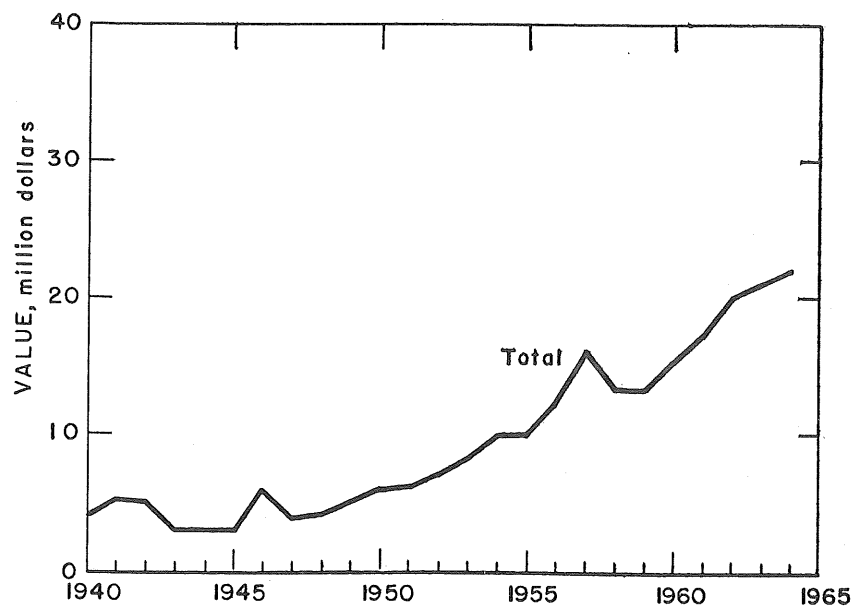


Fig. 4. Value of mineral production in Connecticut, 1940-1964.

The surficial mapping now underway will make possible a detailed study of the sand and gravel resources of the state. L. R. Page of the U.S.G.S. has estimated that the mapping in Connecticut in 1965 outlined about 2 billion cubic yards of sand and gravel resources.

Cooperation with other agencies and with universities

The Survey has maintained a close cooperation with the geologists working on the groundwater problems of the state in the cooperative program between the State Water Resources Commission and the Federal Geological Survey. Ideally the ground water geologists should have in advance of their work the bedrock and surficial maps of the river basins for which water inventory studies are to be made. This was not possible in the first projects started but in 1966 a strenuous effort was made to get surficial mapping done in the Housatonic River basin for use in the studies now under way. Surficial and bedrock mapping has been completed in most of the Connecticut River valley where studies will begin this summer.

CONFERENCE ON CONNECTICUT GEOLOGY

An annual Conference on Connecticut Geology has been held every summer for several years. This has been an opportunity for field workers to discuss problems and to exchange views with those working in adjacent states, and with interested teachers, engineers, geologists and students. At the meeting held on July 18 and 19, 1966 at Wesleyan University in Middletown 113 were registered. On July 18 reports of progress were given of work on bedrock mapping by both the State Survey and the Federal Survey, on geologic work in the Highway Department, soils mapping by the Soil Conservation Service, geologic work on water resources, and geologic research in the universities. In the afternoon of the same day the problems of glacial geology in Connecticut were discussed by a number of field workers. In particular the problem of mapping the deposits and boundaries of old glacial lakes was discussed at some length. The morning session on July 19 was devoted to the geology of western Connecticut. About a dozen geologists participated in an active discussion. Notable progress has been made in recent years in the subdivision of the Stockbridge Formation and of the New York City group. Progress has also been made in subdividing the Hartland Formation but many problems of correlation still remain. Dr. R. M. Gates of the University of Wisconsin acted as moderator for this part of the program. He emphasized the wide area of agreement of the various geologists in western Connecticut but also pointed out many unsolved problems. In the afternoon Dr. Gordon Eaton of the U.S.G.S. and the University of California at Riverside acted as moderator for a discussion of problems in the Eastern Highlands. Of particular interest was the report of R. W. Bromery on the east-west magnetic anomaly found in southern Connecticut and which he reported continues across Rhode Island. A number of geologists discussed the related geologic problems.

The Conference has served a very useful purpose in keeping the workers informed about related studies and in keeping various agencies

in Connecticut appraised of the wide range of current activity. It was particularly good to have a number of soil scientists present since they and the glacial geologists have many problems in common.

WORK ON CONNECTICUT GEOLOGY IN UNIVERSITIES

In addition to the university personnel engaged in mapping for the Survey, other research on geologic problems in Connecticut is being carried on at a number of places. Our information is far from complete; however, some of the projects known are as follows:

University of Connecticut staff:

Rumney, G., Study of interaction of atmosphere and shallow water temperature experience in tidal estuaries.

Frankel, L., Experimental drive point well development.

Frankel, L. and Thomas, H.

- 1) Concretion-bearing clay from Block Island Sound. (To be published in March Jour. of Geology.)
- 2) Effect of induced infiltration on water supply.
- 3) Three-dimensional sedimentological investigation of Block Island and eastern Long Island sounds.

Liese, H.

- 1) Trace elements of ground water and aquifers (with special reference to area of NE Conn. being studied by Aitken of below).
- 2) Petrologic interpretations of geochemical characteristics of minerals from selected igneous and metamorphic rocks.

Thomas, H., Sedimentation study of the shallow marine water environment in the vicinity of Noank, Conn.

Kasperson, R., Planning for public management of water resources (with special reference to the Farmington River valley).

Rahn, P., Hydrology of the University of Connecticut well-field (with particular attention to induced infiltration).

Aitken, J.

- 1) Bedrock geology of South Coventry quadrangle.
- 2) Relation of bedrock fracture systems to underground water supplies (with special reference to Ellington, Rockville, Stafford Springs, South Coventry, Spring Hill and Westford quads).
- 3) Small scale fold structures in NE Conn. (with special reference to area as above).

University of Connecticut graduate students:

Earl—Preliminary survey of hydrologic conditions and seismic profiles of Lee Farm experimental well field.

Giddings—Geology of Fenton River valley in vicinity of the university well field.

Hubbard—Petrology and structure in the west central portion of the Spring Hill quadrangle.

Mazzaferro—Geology of the eastern section of the Spring Hill quadrangle.

Noska—Petrology and structure of the central section of the Spring Hill quadrangle.

Osgood—Application of sedimentation to stratigraphic interpretation (with special reference to the Triassic exposed along Stoney Brook, Suffield).

Szabo—1) Sampling procedures in glacial contact features (with special reference to the SE section of the South Coventry quadrangle).

- 2) Special project on petrology and structure of a portion of the central 9th of the Spring Hill quadrangle.

Vitali—Geology of the upper Skungamaug drainage basin (with special reference to surficial deposits and hydrogeologic considerations).

Yale University undergraduates

Sam Carmalt—Whole rock Rb—Sr age determinations on the Reynolds Bridge Formation, Prospect Gneiss and Woodbridge Granite of Ansonia, Bridgeport and Long Hill quadrangles.

Yale University graduate students:

David A. Hewitt—Experimental studies of calc-silicate equilibria and their application to determination of pressure-temperature conditions in metamorphosed areas. This project includes a study of quartz-mica-carbonate reactions which have occurred in the Wepawaug Schist during regional metamorphism.

Rosemary Vidale—Mobility of ions as determined by experimental cation exchange reactions in calc-silicate systems. This study has been related to calc-silicate banding in western Connecticut and elsewhere.

Dr. Richard Armstrong is building up the geochronology laboratory at Yale and is planning a continuing program on dating problems in Connecticut. He is presently working on rocks of the Waterbury dome and will start, in cooperation with Lawrence Lundgren, on a study of dating problems in the Honey Hill fault area.

Wesleyan University

For several years students have been working with Drs. Balsley and deBoer on problems of magnetism of rocks and of paleomagnetism. Dr. deBoer has prepared a paper summarizing the results he and three of his students—Peter Shive, Roger Young, and David Kingwill, have obtained. He finds that the Triassic lava flows can be distinguished paleomagnetically; that the layer intrusions were intruded contemporaneously with the Holyoke sheet, and that the NE-SW dikes are probably Jurassic and are not related to the late Triassic tectogenesis.

DeBoer has also been carrying on structural studies in central Connecticut in addition to his mapping in the Durham quadrangle.

Earlham College

Two students from Earlham College have worked in Connecticut in 1965 and 1966 with Dr. C. W. Martin, supported by funds from the National Science Foundation. The student papers prepared on this work are as follows:

1965, John Hill and Grimsley Hobbs: Unit 4 of the Hartland Formation.

1966, John Hill: A Possible Structural Setting for the Northwestern Thomaston Quadrangle Area, Connecticut.

Craig White: Lithology and Possible Structure of Hartland Rocks in the Northwest Quarter of the Thomaston and Southern Half of the West Torrington Quadrangles, Connecticut.

University of Massachusetts

Joseph Gaffney has completed a Master's thesis, "Surficial Geology of the Old Mystic Quadrangle, Connecticut." Richard Kroll is now completing a thesis, "Structure and Petrology of the Northern Part of the Barndoor Intrusion, North-Central Connecticut."

University of Rochester

In recent years several graduate students at the University of Rochester have done Master's theses on problems of Connecticut geology. Professor Lundgren has recently received a Natural Science Foundation grant for the study of the Honey Hill Fault in eastern Connecticut.

University of Wisconsin

The work by Dr. R. M. Gates of Wisconsin and of Dr. Charles Martin of Earlham College on the Waterbury Dome has been financed by a grant from the National Science Foundation. QR 22 which is in press is a by-product of this study. Dr. Gates has in press a paper which is another result of his work in Connecticut: "Amphibolites: Syntectonic Intrusives." This will be published by the *American Journal of Science*.

There is at the present time a Master's thesis in progress on the geology of part of the South Canaan quadrangle.

A thesis by R. M. Cassie, "Evolution of a Domal Granitic Gneiss and Its Relation to the Geology of the Thomaston Quadrangle," has been accepted in partial fulfillment of the requirements for the Ph.D. degree by the University of Wisconsin. The field work in this thesis was supported by the Connecticut Geological and Natural History Survey and Cassie has in preparation a Quadrangle Report on the Thomaston quadrangle.

Two unpublished Master's theses at the University of Wisconsin are: "A Structural Interpretation of Some Deformed Metasediments in Northern Waterbury Quadrangle, Connecticut" by D. J. Dewees, and "The Origin of the Hitchcock Lake Banded Gneiss, Northern Waterbury Quadrangle, Connecticut," by D. M. Howe.

Kansas State University

For several years Dr. Douglas G. Brookins of Kansas State University has carried on geochronological studies in Connecticut. He has summarized his plans for continuing this work as follows:

The Department of Geology, Kansas State University intends to continue geochronological research in Connecticut as part of its broad geochemical program. The studies will be carried out under the direction of Dr. D. G. Brookins (whose Ph.D. thesis deals with geochronological problems in the Middle Haddam and Glastonbury quadrangles, Connecticut), and it is anticipated that numerous graduate students both from Kansas State University and sister universities will participate in the program. Specifically, problems of geologic correlation and rock genesis (including mantled gneiss domes) will be attacked. Previous work in Connecticut (Brookins and Hurley, 1965; Zartman et al, 1965) have demonstrated that geochronological methods are a very valuable aid in interpreting complex geological problems in areas of regional metamorphism.

It would not be possible to carry out a comprehensive geochronological study in any area without a thorough appreciation of the geologic problems involved. The Connecticut area has been chosen because of the previous excellent work and current keen interest of both the United States and Connecticut Geological Surveys; and their cooperation has made possible the work completed to date. The National Science Foundation has recently awarded a Grant to Kansas State University for the acquisition of a mass spectrometer for age studies, and the original proposal emphasized the necessity and potential of geochronological research in New England (particularly Connecticut and Massachusetts). Future proposals will continue to place emphasis on this area as long as the current geologic interest prevails. In short, both the geological and geochronological programs complement each other, and both are necessary to insure meaningful results.

Geological Society of America meeting

The program to be presented in March 1967 at the meeting of the Northeastern Section of the Geological Society of America at Boston, Mass. includes the following papers of interest to Connecticut geologists:

*R. W. Bromery: Geophysical Evidence of a Pronounced East-West Lineament in Southern New England

Homer C. Liese: Composition of Minerals from Selected Granites and Gneisses of New England

*John D. Peper: Stratigraphy and Structure of the Monson Area, Massachusetts-Connecticut

*E-an Zen: Stratigraphic-Structural Contrasts in Thrust Slices of the Taconic Allochthon

R. W. Schnabel: Post-Metamorphic Diorite and Pegmatite in Western Massachusetts

V. J. Murphy and T. F. Sexton: Seismic Studies of Deep Buried Valleys in the Northeast

Grover H. Emrich: Ground Water Pollution and Waste Disposal Practices

Robert B. Ryder: The Determination of Aquifer Coefficients of the Stratified Drift Aquifer in Southwestern Connecticut

Walter S. Newman, et al: Late Wisconsin Lacustrine and Marine Episodes in Long Island Sound

*John P. Schafer: Retreat of the Last Ice Sheet in New England

*J. H. Hartshorn and Carl Koteff: Lake-Level Changes in Southern Lake Hitchcock, Connecticut-Massachusetts

* Papers which presumably will be based in part on work for the Geological and Natural History Survey or the U.S. Geological Survey cooperative program with Connecticut.

Paul D. Krynine

Paul D. Krynine who wrote "Petrology, Stratigraphy and Origin of the Triassic Sedimentary Rocks of Connecticut," published as Bulletin 73, 1950, died in 1964. A recent article in the *Journal of Sedimentary Petrology* describes Krynine's career and appraises his work. The following quotation is taken from this article:

Krynine undertook thesis work on the Triassic New Haven arkose, his second great piece of field work (1933-1935). He applied classic mineralogic methods to this series of redbeds and arkoses, which so resembled the modern arkoses he had seen forming in Mexico. He was struck by the similarity between the two masses of sediment, and this led him to believe that most redbeds were formed under similar conditions of tropical climate with markedly seasonal rainfall. His dissertation was completed in 1936, but because of the depression and war the Connecticut Geological Survey could not publish it until 1950. This paper remains a classic in the field of sedimentary petrography, in paleoclimatology, and in the redbed controversy. As much as any other, this paper is typical of Krynine at his best, — his careful assembly of data, often from diverse sources, drawn together in an exciting and forceful style, all directed toward support of his argument on a controversial issue.

R. E. Deane

Dr. R. E. Deane of the University of Toronto, together with several of his students, was tragically drowned on October 23, 1965, while conducting underwater research in Lake Ontario. For some time Dr. Deane had carried on for the Great Lakes Institute subsurface studies of sedimentation in the Great Lakes. He met his death on the last trip of the season.

Dr. Deane came to Connecticut in 1953 and started the first surficial mapping on a quadrangle basis done in the state. He started with the Middletown quadrangle but delayed publication until he could map some of the adjacent quadrangles. By the time the field work was completed he had moved to the University of Toronto, had a heavy

teaching program, and had started new research activity in Canada. The completion of the reports was so delayed that he returned to Connecticut in 1962 and spent three months reviewing the field work, examining the many new road cuts and excavations, and gathering much subsurface data. His manuscript and map of the Hartford South quadrangle had been edited and returned to him for final check shortly before his death, but he had not opened the package. Mrs. Deane shipped all of his notes, maps, and manuscripts for four quadrangles. The Hartford South report and map is in press. The other quadrangles do not have a suitable text. A final decision has not been made on the best way to handle the material on the Middletown and Glastonbury quadrangles but Dr. J. C. Tharin of Wesleyan University will review the Middle Haddam map, bring it up to date, and prepare a report on it.

NATURAL HISTORY PROGRAM

There is a strong need to expand the natural history program beyond the entomology and ecology projects presently underway. To this end Dr. Bernice Wheeler of Connecticut College has been engaged as a consultant to advise on a long range program and to help the Director administer the continuing projects. She has consulted with other biologists and expects to broaden this consultation in the next year. She has had correspondence about possible new bulletins on fishes and flora of Connecticut.

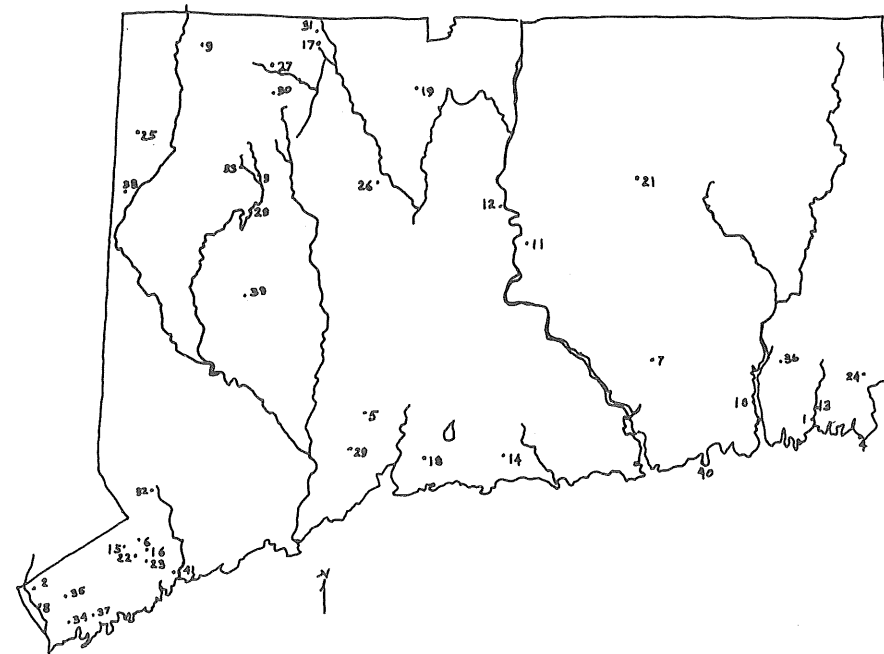


Fig. 5. The Natural Areas of Connecticut (identified in table 6)

Table 6.—Status of Connecticut natural-area studies

Area no. ¹	Name	Owner	Quadrangle	Status
1	Akeley Tract Nature Reserve	The Nature Conservancy	Mystic	Preliminary manuscript
2	Audubon Center of Greenwich	National Audubon Soc.	Glenville	Published 1966
3	Bantam River Preserve	The Nature Conservancy	Litchfield and West Torrington	Field work incomplete
4	Barn Island Peninsula	State of Connecticut	Watch Hill	Field work incomplete
5	Bethany Bog	Yale University	Mount Carmel	Preliminary manuscript
6	Browning Wildlife Sanctuary	New Canaan Audubon Soc.	Norwalk North	Field work incomplete
7	Burnham Brook Preserve	The Nature Conservancy	Hamburg	Field studies complete
8	Byram River Gorge Preserve	The Nature Conservancy	Glenville	Field work incomplete
9	Canaan Mountain	State of Connecticut	South Canaan & Ashley Falls	Preliminary manuscript
10	Connecticut Arboretum	Connecticut College	Uncasville	Field studies complete
11	Cotton Hollow Preserve	The Nature Conservancy	Glastonbury	Field studies complete
12	Folly Brook	City of Hartford and The Nature Conservancy	Hartford South	Preliminary manuscript
13	Gallup Salt Water Marsh Preserve	Private ²	Mystic	Field studies complete
14	Guilford Salt Meadows Sanctuary	National Audubon Soc.	Guilford	Field work incomplete
15	Kelley Lowlands Sanctuary	New Canaan Audubon Soc.	Pound Ridge	Preliminary manuscript
16	Kelley Uplands Sanctuary	New Canaan Audubon Soc.	Norwalk North	Preliminary manuscript
17	Kitchel Wilderness Preserve	State of Connecticut	Tolland & Winsted	Field studies complete
18	Lydia Hytt's Pond	Yale University	Branford	Field work incomplete
19	McLean Game Refuge	—	Tariffville	In press
20	Miles Sanctuary	National Audubon Soc.	Sharon	Field work incomplete
21	Nathan Hale Natural Area	State of Connecticut	South Coventry	Field studies complete
22	New Canaan Nature Center	—	Pound Ridge	Field work incomplete
23	Old Stamford Road Sanctuary	Town of New Canaan	Norwalk North	Field work incomplete
24	Pequot-sepos Wildlife Sanctuary	—	Ashaway	Field studies complete
25	Sharon Audubon Center	National Audubon Soc.	Ellsworth	Field work incomplete
26	Taine Mountain Preserve	The Nature Conservancy	Collinsville	Field studies complete
27	Walcott Preserve	The Nature Conservancy	Norfolk	Field studies complete
28	White Memorial Foundation Natural Areas	—	Litchfield	Manuscript in preparation
29	Yale Natural Preserve	Yale University	New Haven	Published 1966
30	Site Hall Pond	The Nature Conservancy	Norfolk	Field work incomplete
31	John Girdler Tract	The Nature Conservancy	Tolland	Field work incomplete
32	Devil's Den	The Nature Conservancy	Bethel & Norwalk North	Field work incomplete
33	Wm. Buell Natural Area	The Nature Conservancy	West Torrington	Field work incomplete
34	Bond Tract	The Nature Conservancy	Stamford	Field work incomplete
35	Mianus River Gorge Preserve	The Nature Conservancy	Stamford	Field work incomplete
36	Barrett Tract	The Nature Conservancy	Uncasville	Field work incomplete
37	Lange Tract	The Nature Conservancy	Stamford	Field work incomplete
38	Pond Mountain Trust	Pond Mountain Trust	Ellsworth	Field work incomplete
39	Flanders Nature Center	Flanders Nature Center	Woodbury	Field work incomplete
40	Pataganset Marshes	The Nature Conservancy	Niantic	Field work incomplete
41	Mid-Fairfield County Youth Museum	Mid-Fairfield County Youth Museum	Norwalk	Field work incomplete

¹For location by number see figure 5

²Easement owned by The Nature Conservancy

Entomology

Dr. Charles Remington of Yale University has for some years planned and edited the distinguished series of publications in the field of entomology. This series is widely known over the world. No manuscripts have been available for publication in the last two years but a manuscript on stoneflies and one on centipedes are expected in the near future.

Ecology

The program of studying the vegetation pattern in the natural areas of the state was described in the Thirty-first Biennial Report. Since that time reports have been published in two natural areas (see Appendix), a third is ready for editing and a fourth report is nearing completion. In the meantime, new natural areas have been set up in the state. These are shown on the index map, fig. 5 and identified in table 6, which indicates the status of mapping and report preparation on all of the areas. Publication at the rate of at least two per year is expected to continue.

FINANCES

For the biennium 1965-67 appropriations for the Survey were increased both for direct work by part time staff and for cooperative work with the U. S. Geological Survey. The item of \$30,000 which was appropriated for making a topographic base map of the state is a non-recurring item as the work will be completed in the present biennium. The appropriations for fiscal years 1956 to 1967 inclusive are shown in table 7. A financial statement covering the period from July 1, 1964 to June 30, 1966 is given in table 8.

Table 7.—Appropriations 1956-1967 (Fiscal Years)

Year ¹	Appropriation	Cooperative State Funds	Cooperative Federal Funds
1956	\$23,930	\$20,000	\$20,000
1957	16,535	20,000	20,000
1958	30,250	40,000	40,000
1959	32,250	40,000	40,000
1960	30,208	40,000	40,000
1961	27,513	40,000	40,000
1962	22,012	40,000	40,000
1963	22,114	40,000	40,000
1964	30,520	40,000	40,000
1965	28,645	40,800	40,800
1966	56,130	76,000	76,000
		30,000 ²	30,000 ²
1967	63,401	75,000	75,000

¹Ending July 1

²Appropriation for state topographic base map

Table 8.—Financial statement, biennial period, July 1, 1964, to June 30, 1966

<i>Income</i>		<i>Expenditures</i>	
1964-1965			
Appropriation, \$28,645		Salaries	\$ 5,853
Cooperative with U.S. Geological Survey, \$40,800		Field workers	1,403
		Editors	3,299
		Printing	13,712
		Dues	30
		Fees	220
		Travel	1,250
		Sundry	50
		Office expenses	284
		Total	\$26,101
1965-1966			
Appropriation, \$56,130		Salaries	\$ 5,860
Cooperative with U.S. Geological Survey, \$76,000		Field workers	5,951
Topographic base map		Editors	2,220
Cooperative with U.S. Geological Survey, \$30,000		Printing	11,288
		Dues	40
		Fees	301
		Travel	5,671
		Sundry	992
		Office expenses	280
		Maps	348
		Total	\$32,951
1966-1967			
Appropriation, \$63,401			
Cooperative with U.S. Geological Survey, \$75,000			

LONG RANGE PLANS

It will take a number of years to complete the quadrangle mapping of the state. However, at the present rate of activity maps of all quadrangles should be started by July 1971 and projecting present curves of publication at a somewhat accelerated rate should result in published maps by 1975 of virtually all quadrangles of the state. By the same date a series of Connecticut maps on the scale of 1:125,000 should be prepared as follows: (1) bedrock geologic map; (2) surficial geologic map; (3) gravity map; (4) aeromagnetic map. All four of these will be cooperative projects with the U.S. Geological Survey.

When the cooperative mapping program was planned with the U.S. Geological Survey it was expected that the first product would be quadrangle maps in the GQ series with a text for each of some 3,000 words, and that later there might be fuller reports on a group of quadrangles. Most of the quadrangle maps recently published have had no text. This

represents a serious deficiency in the program which has been discussed with the Federal Survey officials. Several longer reports are planned and should begin to appear in a year or so.

The quadrangle maps and reports are not ends in themselves and to realize their full potential other studies and publications will be necessary. The Water Resources Commission is finding the surficial maps invaluable in the inventory studies of water resources in which they are engaged with the U.S.G.S. The maps should also serve as basic data in studies of economic mineral deposits, in publications useful in education, and in studies of geologic problems of urban development.

Some of the economic studies needed are: (1) limestone, lime and cement materials; (2) clays; (3) material for lightweight aggregates; (4) ceramic materials; (5) sand and gravel; (6) possible underground storage for gas.

For use by schools and colleges the needs are: (1) a bulletin on the general geology of the state; (2) a series of field guidebooks; (3) guidebooks of the state parks; (4) a bulletin on the minerals of Connecticut.

In a highly populated area such as Connecticut resource problems are intimately tied up with competing uses of land. Special studies of urban geology would help resolve some of these problems in the metropolitan areas. A number of other states are active in such studies now. Connecticut is not a major producer of minerals but its small size conceals the importance of what it does produce. The value per square mile of mineral resources excluding the fossil fuels was compiled for each state in 1963, and Connecticut ranked 9th of all the states. (See table 5.) It ranked ahead of California, Texas, Oklahoma, Montana, Illinois and many other large producers of raw materials. The chief products are sand, gravel, and stone. This means that in such a small state with a large population Connecticut has greater problems in zoning and in factors of interference with other land uses.

In the last ten years the geological program of the Survey has been more active than the natural history program. Under the leadership of Dr. Remington the preparation and publication of bulletins in the entomological series has moved forward and has maintained the high reputation of this distinguished series. Also, the new series of reports on natural areas is a notable new development. There is clearly a need for more up to date bulletins in the field of natural history. A bulletin on molluscs due to appear in 1967 will fill one niche. It is hoped that a bulletin on fishes and one on flora will be published in the near future. Others are in the discussion stage. Although in general the programs on geology and natural history move in separate but parallel paths, in some areas they come together. The proposed guidebooks of state parks should bring them together. Dr. Egler has recently suggested cooperation in the study of vegetation changes in highway road cuts.

APPENDIX

Statutes creating the Connecticut Geological and Natural History Survey, and amendments thereto

Sec. 24-1. Appointment and duties of commission. The State Geological and Natural History Survey shall continue to be under the direction of a commission composed of the governor and a member of each of the faculties of Yale University, Wesleyan University, Trinity College, The University of Connecticut and the Connecticut College for Women. Each appointed commission member shall be designated by the president or other administrative head of the institution from whose faculty the member is drawn. Each person so designated, upon acceptance of such office, shall serve as such commissioner without further appointment until his removal from the state, death or resignation, unless sooner removed for cause. Any vacancy occurring in the membership of the commission shall be filled by a new designation by the president or other administrative head of the institution from whose faculty the vacated membership was originally drawn. Said commissioners shall have general charge of the survey, and shall choose as superintendent of the same one of the appointed members of the commission, and may appoint such assistants as may be necessary. The compensation to be paid such superintendent and such assistants shall be determined pursuant to the provision of section 4-40. Each member of the commission shall serve without compensation, but shall be reimbursed for expenses incurred in the performance of official duties, except that the superintendent of said commission shall be compensated in the manner hereinabove prescribed. (1949 Rev., S. 3542.)

Sec. 24-2. Objects of survey. Said survey shall have for its objects: (1) An examination of the geological formation of the state, with special reference to such economic products as building stones, clays, ores and other mineral substances; (2) an examination of the animal and plant life of the state, with special reference to its economic and educational value; (3) the preparation of special maps to illustrate the resources of the state; (4) the preparation of special reports, with necessary illustrations and maps, which shall embrace both a general and detailed description of the geology and natural history of the state. (1949 Rev., S. 3543.)

Sec. 24-3. Reports; distribution and sale. Said commissioners shall cause to be prepared a report to the general assembly before each regular session of the same, showing the progress and condition of the survey, together with such other information as they deem useful or as the general assembly requires. The regular and special reports of the survey, with illustrations and maps, shall be prepared for publication, and, when printed, the reports shall be distributed or sold by the commissioners as the interests of the state and of science may demand, and all moneys obtained by the sale of the reports shall be paid into the state treasury. (1949 Rev., S. 3544.)

Sec. 24-4. Disposition of material collected. All material collected, after having served the purposes of the survey, shall be distributed by the commissioners to the educational institutions of the state in such manner as to be of the greatest advantage to the educational interests of the state, or, if deemed advisable by said commissioners, the whole or any part of such material shall be put on permanent exhibition. (1949 Rev., S. 3545.)

*Superintendents and Directors of the Connecticut
Geological and Natural History Survey*

Superintendent or Director	Location of Survey Office	Dates
William North Rice	Wesleyan University	1903-16
Herbert Ernest Gregory	Yale University	1916-21
Henry Hollister Robinson	Yale University	1921-25
Wilton Everett Britton	Connecticut Agricultural Experiment Station	1925-39
Edward Leffinwell Troxell	Trinity College	1939-54
John Becker Lucke	University of Connecticut	1954-60
Joe Webb Peoples	Wesleyan University	1960-

*Publications of the Connecticut Geological and Natural
History Survey, Jan. 1, 1965 to Jan. 1, 1967*

PUBLISHED

Bulletin series

- Bulletin 98. Thirty-first Biennial Report of the Commissioners of the State Geological and Natural History Survey
- Bulletin 99. The Climate of Connecticut, by Joseph J. Brumbach
- Bulletin 64. (Reprint) Guide to the Insects of Connecticut. Part VI. The Diptera or True Flies of Connecticut. First Fascicle

Report of Investigations series

- RI 3. Petrology and Stratigraphy of the Hampden Basalt, by Randolph W. Chapman

Quadrangle maps and reports

- QR 17. The Bedrock Geology of the West Torrington Quadrangle, by Robert M. Gates
- QR 18. The Surficial Geology of the New Haven and Woodmont Quadrangles, by Richard F. Flint
- QR 19. The Bedrock Geology of the Hamburg Quadrangle, by Lawrence Lundgren, Jr.

Guidebooks

1. Postglacial Stratigraphy and Morphology of Coastal Connecticut, by Arthur L. Bloom and Charles W. Ellis, Jr.

The Vegetation of Connecticut Natural Areas

1. Yale Natural Preserve, New Haven, by Frank E. Egler and William A. Niering
2. The Natural Area of the Audubon Center of Greenwich, by William A. Niering and Frank E. Egler

List of Publications, 1966

IN PRESS

Bulletin series

- Bulletin 100. Thirty-second Biennial Report of the Commissioners of the State Geological and Natural History Survey

Quadrangle Maps and Reports

- QR 20. Surficial Geology of the Hartford South Quadrangle, by R. E. Deane
- QR 21. Bedrock Geology of the Old Lyme Quadrangle, by Lawrence Lundgren, Jr.
- QR 22. Bedrock Geology of the Waterbury Quadrangle, by Robert M. Gates and Charles W. Martin

Report of Investigations series

- RI 4. Stratigraphy and Structure of the Western Part of the New Haven Quadrangle, by Henry Robert Burger, III

*Publications of the U. S. Geological Survey in Cooperative
Program with the Connecticut Geological and Natural
History Survey, Jan. 1, 1965 to Jan. 1, 1967*

PUBLISHED

Geologic Quadrangle series

- GQ-370. The Bedrock Geology of the Tariffville Quadrangle, by Robert W. Schnabel
- GQ-392. The Geology of the Scotland Quadrangle, by H. Roberta Dixon and Charles E. Shaw
- GQ-403. The Bedrock Geology of the Ashaway Quadrangle, by Tomas Feininger
- GQ-410. The Surficial Geology of the Watch Hill Quadrangle, by John P. Schafer
- GQ-426. The Bedrock Geology of the Ansonia Quadrangle, by Crawford E. Fritts
- GQ-427. The Bedrock Geology of the Milford Quadrangle, by Crawford E. Fritts
- GQ-433. The Geologic Map of the Manchester Quadrangle, by R. B. Colton
- GQ-434. The Geologic Map of the Broad Brook Quadrangle, by R. B. Colton
- GQ-436. The Bedrock Geology of the Voluntown Quadrangle, Connecticut and Rhode Island, by Tomas Feininger
- GQ-468. The Geologic Map of the Hampton Quadrangle, by H. Roberta Dixon and Fred Pessl
- GQ-469. The Surficial Geology of the Voluntown Quadrangle, Connecticut and Rhode Island, by Tomas Feininger
- GQ-481. The Bedrock Geology of the Plainfield Quadrangle, by H. Roberta Dixon
- GQ-485. The Surficial Geology of the Fitchville Quadrangle, by Fred Pessl, Jr.
- GQ-494. The Bedrock Geology of the New Britain Quadrangle, by Howard E. Simpson
- GQ-507. The Geology of the Bashbish Falls Quadrangle, by E-an Zen and J. H. Hartshorn
- GQ-537. The Bedrock Geology of the West Springfield Quadrangle, by Roger B. Colton and J. H. Hartshorn

Bulletin series

- Bulletin 1224-A. Nomenclature and Age of Formation in the Ansonia Quadrangle, Fairfield and New Haven Counties, Connecticut, by Crawford E. Fritts
- Bulletin 1224-J. Stratigraphic Names in the New London Area, Connecticut, by Richard Goldsmith
- Bulletin 1244-A. Stockbridge Formation; Walloomsac Formation; Egremont Phyllite; Everett Formation, by E-an Zen

Professional Paper series

- Prof. Paper 550-D. A Two-Till Locality in Northeastern Connecticut, by Fred Pessl, Jr.

IN PRESS

Geologic Quadrangle series

- GQ-574. The Bedrock Geology of the New London Quadrangle, by Richard Goldsmith
- GQ-575. The Bedrock Geology of the Niantic Quadrangle, by Richard Goldsmith
- GQ-576. The Bedrock Geology of the Uncasville Quadrangle, by Richard Goldsmith
- GQ-592. The Bedrock Geology of the Columbia Quadrangle, by George E. Snyder
- GQ-609. The Bedrock Geology of the Montville Quadrangle, by Richard Goldsmith
- GQ-611. The Surficial Geology of the Roxbury Quadrangle, by H. E. Malde
- GQ-655. The Bedrock Geology of the Watch Hill Quadrangle, by George Moore
- GQ-660. The Surficial Geology of the Danielson Quadrangle, by Allan D. Randall and Fred Pessl, Jr.
- GQ-678. The Geology of the Springfield South Quadrangle, by J. H. Hartshorn and Carl Kotteff
- GQ- The Bedrock Geology of the Danielson Quadrangle, by H. Roberta Dixon
- GQ- The Bedrock Geology of the Meriden Quadrangle, by Penelope M. Hanshaw

*U. S. Geological Survey publications not part of the
Cooperative Program, but dealing with Connecticut
geology, Jan. 1, 1965 to Jan. 1, 1967*

PUBLISHED

Professional Paper series

- Prof. Paper 525-D. Implications of New Radiometric Ages in Eastern Connecticut and Massachusetts, by R. E. Zartman, G. L. Snyder, T. W. Stern, and R. G. Marvin
- Prof. Paper 550-B. Effect of Glacial Geology Upon the Time Distribution of Streamflow in Eastern and Southern Connecticut, by M. P. Thomas

Water Supply Paper series

- Water Supply Paper 1599-J. Water Resources of the Waterbury-Bristol Area, Connecticut, by R. V. Cushman

Geophysical Investigations

- GP-526. Aeromagnetic Map of Part of the Ashley Falls Quadrangle, by G. R. Boynton, Peter Popenoe, and G. L. Zandle, 1965.
- GP-527. Aeromagnetic Map of Part of the Bashbish Falls Quadrangle, by G. R. Boynton, Peter Popenoe, and G. L. Zandle, 1965.
- GP-533. Aeromagnetic Map of Part of the South Sandisfield Quadrangle, by G. R. Boynton, Peter Popenoe, and G. L. Zandle, 1965.
- GP-534. Aeromagnetic Map of Part of the Southwick Quadrangle, by G. R. Boynton, Peter Popenoe, and G. L. Zandle, 1965.
- GP-535. Aeromagnetic Map of Part of the Tolland Center Quadrangle, by G. R. Boynton, Peter Popenoe, and G. L. Zandle, 1965.
- GP-536. Aeromagnetic Map of Part of the West Granville Quadrangle, by G. R. Boynton, Peter Popenoe, and G. L. Zandle, 1965.
- GP-539. Aeromagnetic Map of the Jewett City Quadrangle, by G. R. Boynton and C. W. Smith, 1965.
- GP-540. Aeromagnetic Map of the Scotland Quadrangle, by G. R. Boynton and C. W. Smith, 1965.
- GP-541. Aeromagnetic Map of the Plainfield Quadrangle, by G. R. Boynton and C. W. Smith, 1965.
- GP-542. Aeromagnetic Map of the Oneco Quadrangle, by G. R. Boynton and C. W. Smith, 1965.
- GP-543. Aeromagnetic Map of the Norwich Quadrangle, by G. R. Boynton and C. W. Smith, 1965.
- GP-544. Aeromagnetic Map of the Old Mystic Quadrangle and Part of the Mystic Quadrangle, by G. R. Boynton and C. W. Smith, 1965.
- GP-545. Aeromagnetic Map of the Voluntown Quadrangle, by G. R. Boynton and C. W. Smith, 1965.
- GP-546. Aeromagnetic Map of the Uncasville Quadrangle and Part of the New London Quadrangle, by G. R. Boynton and C. W. Smith, 1965.
- GP-547. Aeromagnetic Map of the Ashaway Quadrangle and Part of the Watch Hill Quadrangle, by G. R. Boynton and C. W. Smith, 1965.
- GP-583. Aeromagnetic Map of the Ellsworth Quadrangle, by P. W. Philbin and C. W. Smith
- GP-584. Aeromagnetic Map of the Cornwall Quadrangle, by P. W. Philbin and C. W. Smith
- GP-585. Aeromagnetic Map of the Spring Hill Quadrangle, by P. W. Philbin, and C. W. Smith
- GP-586. Aeromagnetic Map of the South Coventry Quadrangle, by P. W. Philbin and C. W. Smith
- GP-587. Aeromagnetic Map of the Rockville Quadrangle, by P. W. Philbin
- GP-588. Aeromagnetic Map of the Collinsville Quadrangle, by P. W. Philbin
- GP-589. Aeromagnetic Map of the Torrington Quadrangle, by P. W. Philbin and C. W. Smith

- GP-590. Aeromagnetic Map of the West Torrington Quadrangle, by P. W. Philbin and C. W. Smith
- GP-591. Aeromagnetic Map of the East Killingly and part of the Oneco Quadrangles, by P. W. Philbin and C. W. Smith
- GP-592. Aeromagnetic Map of the Danielson and part of the Plainfield Quadrangles, by P. W. Philbin and C. W. Smith
- GP-593. Aeromagnetic Map of the Hampton and part of the Scotland Quadrangles by P. W. Philbin and C. W. Smith
- GP-594. Aeromagnetic Map of the Avon Quadrangle, by P. W. Philbin and C. W. Smith
- GP-595. Aeromagnetic Map of the Hartford North Quadrangle, by P. W. Philbin and C. W. Smith
- GP-596. Aeromagnetic Map of the Manchester Quadrangle, by P. W. Philbin and C. W. Smith
- GP-359. Aeroradioactivity and Generalized Geologic Maps of Parts of New York, Connecticut, Rhode Island, and Massachusetts, by Peter Popenoe

Other Publications on Connecticut Geology

- Brookins, Douglas C., 1965, Some Rb-Sr Aspects of the Genesis of Large Granitic Pegmatites in Areas of Regional Metamorphism: Kansas Academy of Science Transactions, v. 68, no. 2.
- Lundgren, Lawrence L., Jr., 1966, Muscovite Reactions and Partial Melting in South-eastern Connecticut: Journal of Petrology, v. 7, no. 3.