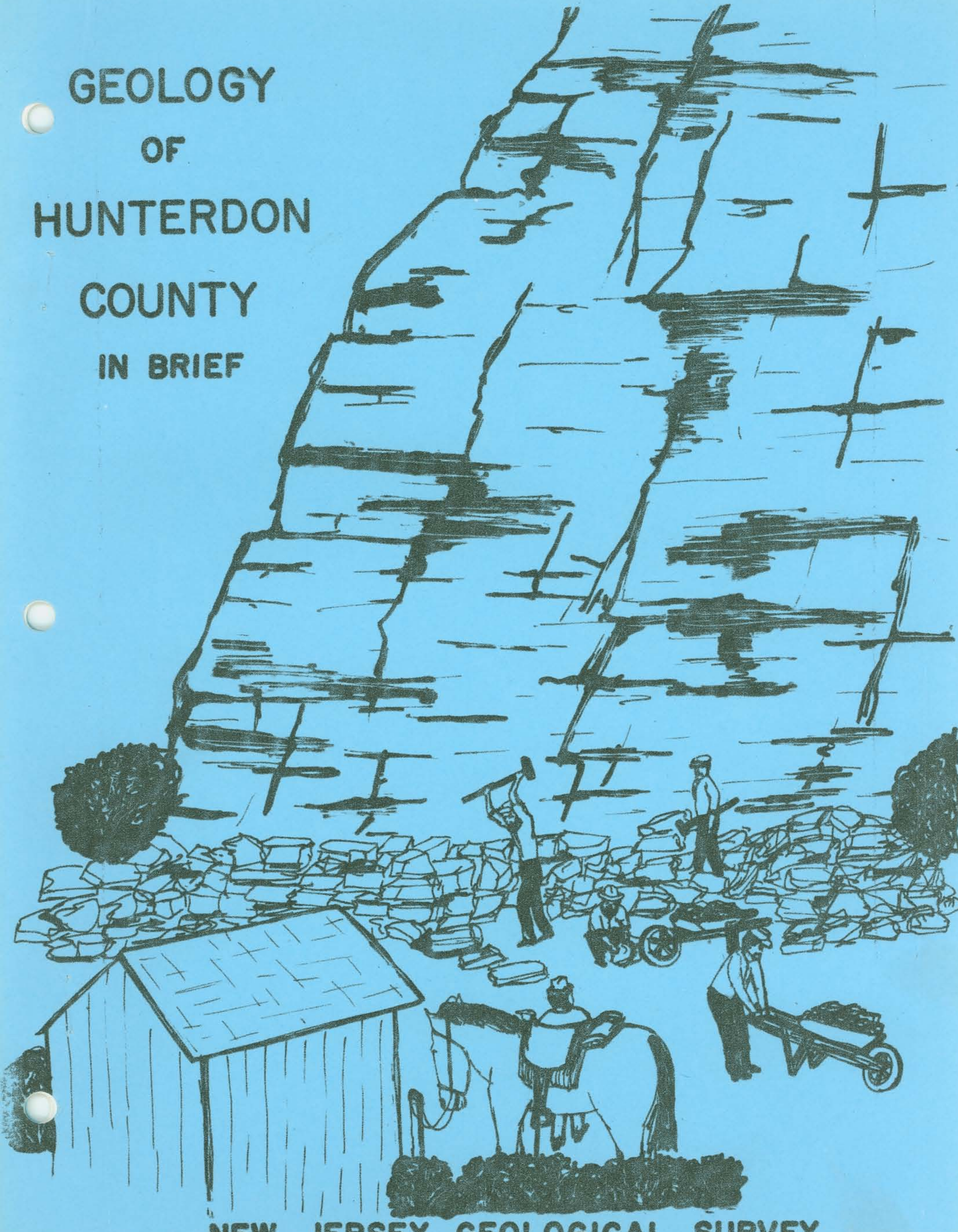
GEOLOGY OF HUNTERDON COUNTY IN BRIEF



NEW JERSEY GEOLOGICAL SURVEY

STATE OF NEW JERSEY

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GEOLOGY OF HUNTERDON COUNTY IN BRIEF

by

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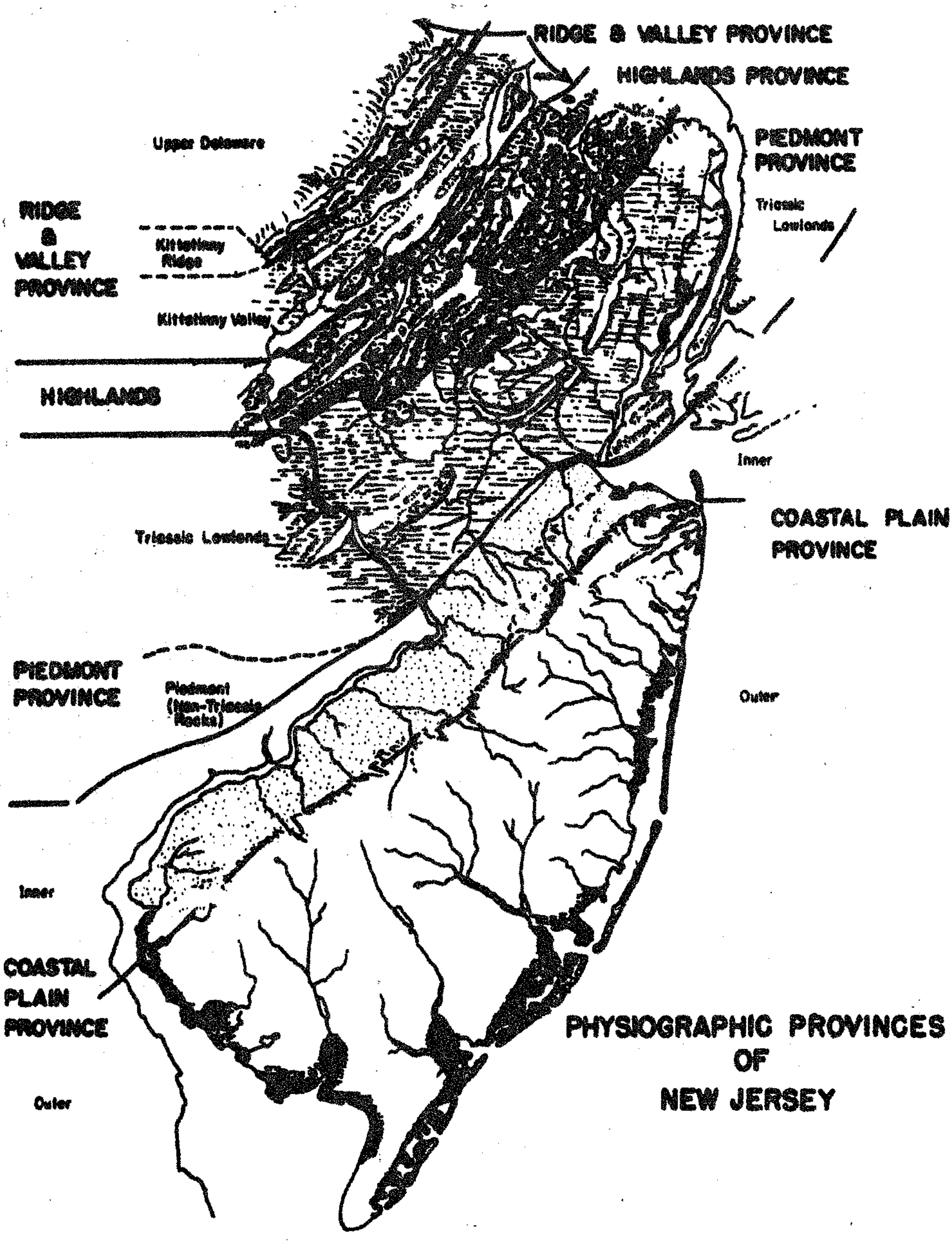

PHYSIOGRAPHIC PROVINCES OF NEW JERSEY

GEOLOGY OF HUNTERDON COUNTY IN BRIEF

Topography

Hunterdon County lies within two of the four major physiographic provinces in New Jersey, the Highlands and the Piedmont (see Plate I). The Piedmont is located in the southern two thirds of the county and has two main elements, including the Hunterdon Plateau and the Raritan Valley Lowland. The plateau is underlain primarily by dense argillite and hard shale, and reaches its greatest elevation, nearly 900 feet, about one mile south of Pattenburg, sloping gently southeastward from the Highlands.

The Raritan Valley is east of the Hunterdon Plateau. It is a low rolling plain, sloping gently southeastward from an elevation of 200-300 feet near the plateau to 150-200 feet near the Hunterdon-Somerset County boundary. A number of ridges and isolated hills, underlain by highly resistant igneous rock, rise several hundred feet above the softer shale and sandstone of the Raritan Valley Lowland. The highest of these ridges, Cushetunk Mountain, rises about 500 feet above the plain and 834 feet above sea level.

The New Jersey Highlands is a portion of the Reading Prong of the New England Province. This province consists of several flat-topped ridges separated by narrow deep valleys. Valleys within the Highlands are underlain by more easily eroded limestones and shales, while the ridges are composed of more resistant igneous and metamorphic rock. The average elevation of the ridges is between 800-1000 feet above sea level. Except where they merge with the Hunterdon Plateau in the western part of the county, the Highlands rise abruptly above the Piedmont.

Geologic History

Proterozoic Era

Precambrian Period - The oldest rocks in the county were originally sedimentary rocks deposited in a sea and later altered by a process called metamorphism. Deep beneath the earth's surface, heat and pressure caused the rock to be folded, faulted and metamorphosed. Subsequent intrusion of molten igneous rock into the metamorphosed sediments caused further alteration. The resulting coarse grained gneiss possess alternating bands caused by the concentration of dark and light minerals.

The Franklin Formation is a complex metamorphic rock consisting primarily of marble with occasional flakes of graphite. Exposure of this rock today is due to erosion of several miles of overlying Precambrian rock during the millions of years that followed its deposition.

Life during the Precambrian was probably plentiful, but primitive. Most forms were soft bodied so that preservation was almost impossible. In New Jersey there is no fossil evidence in the gneiss. However, it is possible that the graphite in the Franklin Formation is the metamorphosed carbon residue of organic remains.

Paleozoic Era

Paleozoic time began with the slow depression of parts of the continents and the invasion of a shallow sea over the surface from a southwesterly direction. Sediments gradually began accumulating in the northeast-southwest trending basin which extended from Newfoundland, through northwestern New Jersey and southward into Alabama. Sediments, derived from uplifted landmasses to the east and southeast, were continually being dumped, changing the size and shape and gradually filling the trough. Near the end of the Paleozoic the seas retreated and non-marine conditions prevailed.

In New Jersey, sediments were deposited during the Cambrian, Ordovician, Silurian and Devonian Periods. Although rocks of Silurian and Devonian age are not found in Hunterdon County, it is probable that they were deposited, and then later removed by erosion. Rocks from the last three periods of the era, the Mississippian, Pennsylvanian and Permian, are not present in New Jersey but are found in Pennsylvania to the northwest and west.

Cambrian Period - At the beginning of Cambrian time, sediments derived from the southeast were deposited in the basin by streams and reworked by the encroaching sea. Currents and wave action mechanically reduced the sediments to a uniform size, forming a well-sorted sandstone composed almost entirely of the minerals quartz and feldspar. At the base of the formation there is a conglomerate containing Precambrian grains and pebbles which were originally rock debris on the Precambrian surface. These sands and gravels constitute the Hardyston Quartzite.

Cambro-Ordovician Time - During the latter part of the Cambrian and the beginning of the Ordovician Periods, warm shallow seas prevailed throughout most of the basin. The abundant lime organisms and the conditions of the quiet seas resulted in the precipitation of calcium carbonate, which formed dolomitic limestones called the Kittatinny Formation.

Ordovician Period - Following uplift and a long period of erosion, a warm sea again invaded the area, depositing the Jacksonburg Limestone on top of the Kittatinny Formation. The variety and number of fossils found in this dark colored limestone indicate that favorable conditions existed at the time of Jacksonburg deposition.

Following this deposition, more and more silt was deposited, cutting off the deposition of calcium carbonate. The deepening of the basin cut off all deposition of the Jacksonburg limestone and the silt continued to be introduced. This created a gradational contact between the Jacksonburg Limestone and the Martinsburg Formation. The Martinsburg Formation includes a series of sandstone, shales and slates.

It is likely that life existed for 100 million years before the Paleozoic Era, but pre-Paleozoic rocks have preserved little or no evidence of life. In New Jersey, the first fossil evidence is worm tubes found in the Hardyston Quartzite. Although the New Jersey Cambrian fossil record is scant, over 500 species of invertebrate animals have been found in other North American rocks. The meager New Jersey record was caused by the prevailing type of deposition. Generally, the seas were shallow, very warm, and rather stagnant, producing an environment where most animals could not flourish. Only a few fossils are found in the Kittatinny Formation. Two of the more common are primitive types of algae and the scaphopod, *Hyolithellus micans*. When the Jacksonburg limestone was deposited, the environment had become very favorable for a variety of marine organisms to live. The limestone, therefore, contains abundant fossil brachiopods, crinoid stems, conodonts and bryozoa.

The types of fossils found in the Martinsburg Formation, combined with their relatively rare occurrence, indicate that this deposition was not favorable for abundant life. Graptolites, jellyfish-like animals with individuals living along hanging branches, are found in the formation. These animals lived in an open sea near the surface and are best preserved in a muddy bottom.

At the conclusion of Ordovician time there was a period of mountain building known as the Taconic Disturbance. Evidence of this disturbance in Hunterdon County can be seen by the folded and faulted Paleozoic sediments.

The Paleozoic Era came to a close with a period of uplift known as the Appalachian Revolution. During this time the Precambrian and Paleozoic rocks were gradually uplifted thousands of feet, creating a mountain range probably similar to the present day Swiss Alps. After increased uplift the seas may never again have invaded the area underlain by these Paleozoic rocks. Thus, the Hunterdon County area may have been undergoing erosion ever since the end of the Paleozoic Era.

Mesozoic Era

At the beginning of the Mesozoic Era a great fault, known as the Border Fault, formed southeast of the New Jersey Highlands. The fault formed several block mountains with basins on either side. These intermontane basins were filled with sediment from the uplifted blocks that bordered them. The mountains have long since been eroded away, and only parts of the sedimentary basins have been preserved. They occupy a belt extending from the Bay of Fundy along the eastern side of the Appalachian Mountains as far south as North Carolina.

Triassic Period - The sedimentary rocks of Middle and Late Triassic time that fill these intermontane basins are known as the Newark group. This group includes four sedimentary facies: arkose, red shales and associated pink sandstone, argillites, and coarse conglomerates. Arkose is a kind of sandstone in which more than a quarter of the grains are feldspar. Commonly, but not always, it is colored deep red by the reddish feldspars, orthoclase and microcline, and by the iron oxides staining the clayey matrix. This arkose is called the Stockton Formation. It was derived from the granite and gneiss of the Highlands. The minerals were not eroded to change them sufficiently because rapid stream erosion in the mountains and deposition occurred where the streams discharged into the basins. The red iron oxides indicate accumulation under oxidizing conditions.

The Triassic fault troughs were large alluvial valleys, into which streams and rivers discharged coarse sand in the wet season. Where drainage was interrupted, saline lakes were formed, and varicolored clays were laid down. These clays constitute the Lockatong Argillite, a well cemented, dense rock type, which may be black, dark green, gray, brown or red.

The third rock type is the Brunswick Formation. This was deposited when the Lockatong lakes were overwhelmed with red mud during wet weather cycles. It now is seen as a red shale and sandstone. Because of the changes in climate, causing changing deposition, all three formations interfinger with each other.

During the time these three Triassic units accumulated in the slowly subsiding basin, a fourth unit, the Triassic Conglomerates, was more or less continuously deposited near the fault margin. They represent indurated alluvial fan sediments dropped where fast flowing streams from the Highlands discharged on the valley floor. The conglomerates were deposited contemporaneously with the three other Triassic units and interfinger. Quartzite and limestone boulders up to three feet in diameter illustrate the tremendous capacity of the streams flowing from the high relief of the faulted mountains.

The deep reaching normal faults formed channels along which basic igneous magma from depth approached the surface to form dikes and sills or poured out on the surface as lava flows. Both basalt and diabase formed as a result of this activity. The basalt formed lava flows and the diabase cooled at depth, forming dikes and sills. Both of these rock types are commonly referred to as trap rock.

The basalt is exposed in the Watchung Mountains in adjacent Somerset County. The fine grained texture of the basalt shows that the lava cooled quickly on the ground surface. Exposures of diabase can be seen at Sourland and Cushetunk Mountains (Round Valley). The coarse texture of the diabase indicates that the rocks never reached the surface at the time of formation and their exposure today is the result of erosion.

Near the end of the Triassic period deposition of the Newark group was brought to a close by further uplifting and faulting. The sills, dikes, flows and sediments were shifted and tilted into their present position along a new set of normal faults.

The Mesozoic Era is known as the age of reptiles, but fossils in Hunterdon County are rare. Dinosaur footprints, plant, bird and fish imprints and valves of small mollusks and crustaceans have been found in the Triassic rocks of New Jersey, outside of Hunterdon County.

There are no rocks of Jurassic Age in New Jersey because erosion was the dominant geologic process. During the Cretaceous, seas from the southeast invaded southern New Jersey. The shoreline may have reached Hunterdon County, but subsequent erosion has removed any evidence of deposition that may have existed.

Cenozoic Era

Tertiary Period - Deposition of Coastal Plain sediments continued in southern New Jersey and erosion continued in what is now Hunterdon County, along portions of the Triassic Border Fault, exposing the underlying Paleozoic rocks.

Quaternary Period - Pleistocene Epoch - Commonly known as the Ice Age, the Pleistocene Epoch represents the last million years of geologic history. The epoch is divided into three glacial and four interglacial stages. Ice probably invaded New Jersey during each of the three glacial stages, but the Wisconsin, the most recent ice advance, apparently obliterated all but a few remnants of earlier glaciation.

The materials deposited during the earliest glaciations are so badly weathered that it is impossible to determine to which glacial stage they belong. In Hunterdon County, there are scattered patches of rock debris found on hilltops and in valleys around Clinton and east of Round Valley.

The ice of the last glacial epoch, the Wisconsin Stage, did not enter Hunterdon County. However, streams flowing away from the glacier deposited sediment in the river valleys of the Musconetcong, Raritan and Delaware Rivers. This material, left by the melting glacial waters, is called stratified drift. Stratified drift is composed of clay, sandstone and gravel in distinct rock layers, the larger rock fragments on the bottom gradually grading upward into particles of silt.

MINERAL PRODUCTION AND HISTORY

The abundant rock and mineral resources of Hunterdon County were more extensively quarried and mined in the past than they are today. Among the most profitable and important contributions of the county in the past were its numerous brownstone quarries from the sandstone and shales of the Triassic Stockton Formation along the Delaware River. Much of the building stone for the brownstone houses of the 18th, 19th and early 20th centuries was quarried from workings near Lambertville, Stockton and Raven Rock, giving Hunterdon County an important role in the Brownstone Era. Today the only building stone quarries which remain in operation in New Jersey are those near Stockton.

Granite gneiss has also been widely quarried in the county for use as building stone and road metal. The most important remaining operations are worked near Pattenburg by Somerset Crushed Stone, and at Glen Gardner by the new quarry opened in 1958 by the Glen Gardner Quarry Corporation. The state's most important source of road metal, concrete aggregate and crushed stone has been from the trap rock ridges of the Sourland Mountain, Raven Rock and Lambertville. Trap Rock Industries is still quarrying in the Oldwick and Lambertville localities.

Among the most important minerals which have been mined in the past are magnetite, hematite, and limonite in the crystalline gneisses of the Highlands. Minor copper deposits were mined at the base of the trap rock near Flemington and Copper Hill. Manganese has been mined from Triassic sandstone near Clinton, and barite has been worked near Lambertville. Graphite has also been extracted from the gneisses and limestones near High Bridge, where it is sparingly disseminated. Although economics make the present mining of these mineral resources less profitable than in the past, future discoveries may bring about renewed interest in the potential mineral deposits throughout the county.

GEOLOGIC TIME SCALE

Geologic time intervals are unequal subdivisions of the earth's history corresponding to earth's geologic events. Eras are the longest divisions of time and contain many periods which are further subdivided into epochs. Formations, which are mappable units of rock or sediments, usually have lithology or characteristic distinctions and are assigned to that period or epoch during which they are formed.

A formation's place within the stratigraphic column is determined by the predominant form of life preserved as fossils within the rocks or sediments. If fossils are lacking, a formation's location in the time scale may be determined by its relationship to previously dated units. Only recently have geologists been able to place an absolute date on these relative time units by radioactive methods.

The geologic column is used throughout the world, although some regional modifications may be used for greater clarity.

In the accompanying stratigraphic column, the rock type given after the name is the most common variety found in the county. There may be variation of lithology within the formation from place to place.

GEOLOGIC TIME SCALE OF HUNTERDON COUNTY

Era	Period	Formation or Rock (approx. thickness)	Approx. No. of Million Years Ago
CENOZOIC	Recent Quaternary	Soil and Alluvium	0-1
	Pleistocene	Glacial Outwash Deposits (0-460 ft.)	
	Tertiary	Not present in county	1-60
MESOZOIC	Cretaceous	Not present in county	60-130
	Jurassic	Not present in state	130-155
	Triassic	Brunswick Formation (6,000-8,000 ft.) Lockatong Formation (3,500 ft.) Stockton Formation (2,300-3,100 ft.) Diabase Basalt	155-185
PALEOZOIC	Permian	Not present in state	185-210
	Carboniferous	Not present in state	210-265
	Devonian	Not present in county	265-320
	Silurian	Not present in county	320-360
	Ordovician	Martinsburg Formation (3,000 ft.) Jacksonburg Formation (125-300 ft.)	360-440
	Cambro-Ordovician	Kittatinny Formation (2,500-3,000 ft.)	440-520
	Cambrian	Hardyston Quartzite (5-200 ft.)	
PRECAMBRIAN		Franklin Formation and assorted gneiss (? ft.)	520-2,100

Dashed lines indicate formation being deposited in two time periods.

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- Geology of Burlington County in Brief; K. Widmer and C. S. Lucey
- Geology of Essex & Union Counties in Brief; C. S. Lucey, Sr.Geologist
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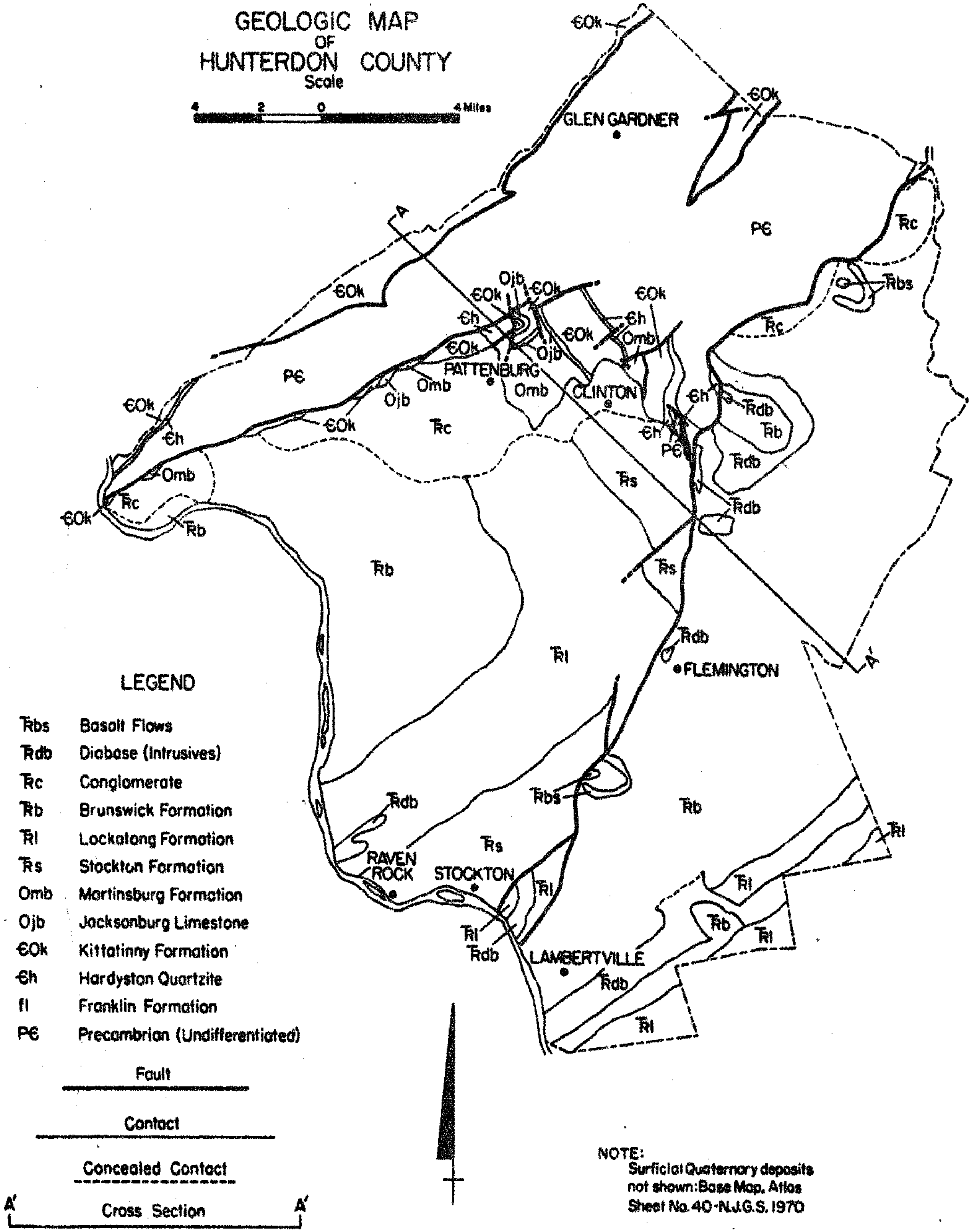
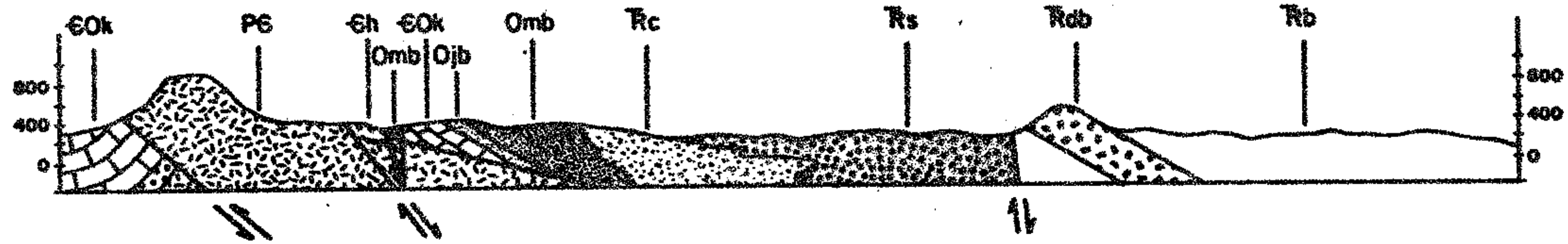

GEOLOGIC MAP OF HUNTERDON COUNTY
Scale
4 2 0 4 Miles
GLEN GARDNER
PATTENBURG
CLINTON
FLEMINGTON
RAVEN ROCK
STOCKTON
LAMBERTVILLE
A
A'
LEGEND
TRbs Basalt Flows
TRdb Diabase (Intrusives)
TRc Conglomerate
TRb Brunswick Formation
TRl Lockatong Formation
TRs Stockton Formation
Omb Martinsburg Formation
Ojb Jacksonburg Limestone
€Ok Kittatinny Formation
€h Hardyston Quartzite
fl Franklin Formation
P€ Precambrian (Undifferentiated)
Fault
Contact
Concealed Contact
A' Cross Section A'
NOTE:
Surficial Quaternary deposits not shown: Base Map, Atlas Sheet No. 40-N.J.G.S. 1970

GEOLOGIC CROSS-SECTIONS OF HUNTERDON COUNTY

New Jersey Geological Survey 1970



SECTION A-A'

LEGEND

TRdb	Diabase (Intrusives)
TRc	Conglomerate
TRb	Brunswick Formation
TRs	Stockton Formation
Omb	Martinsburg Formation
Ojb	Jacksonburg Limestone
ЄOk	Kittatinny Formation
Єh	Hardyston Quartzite
PЄ	Precambrian (Undifferentiated)

Vertical Scale .3cm = 100 Feet

Horizontal Scale 2cm = 1 Mile