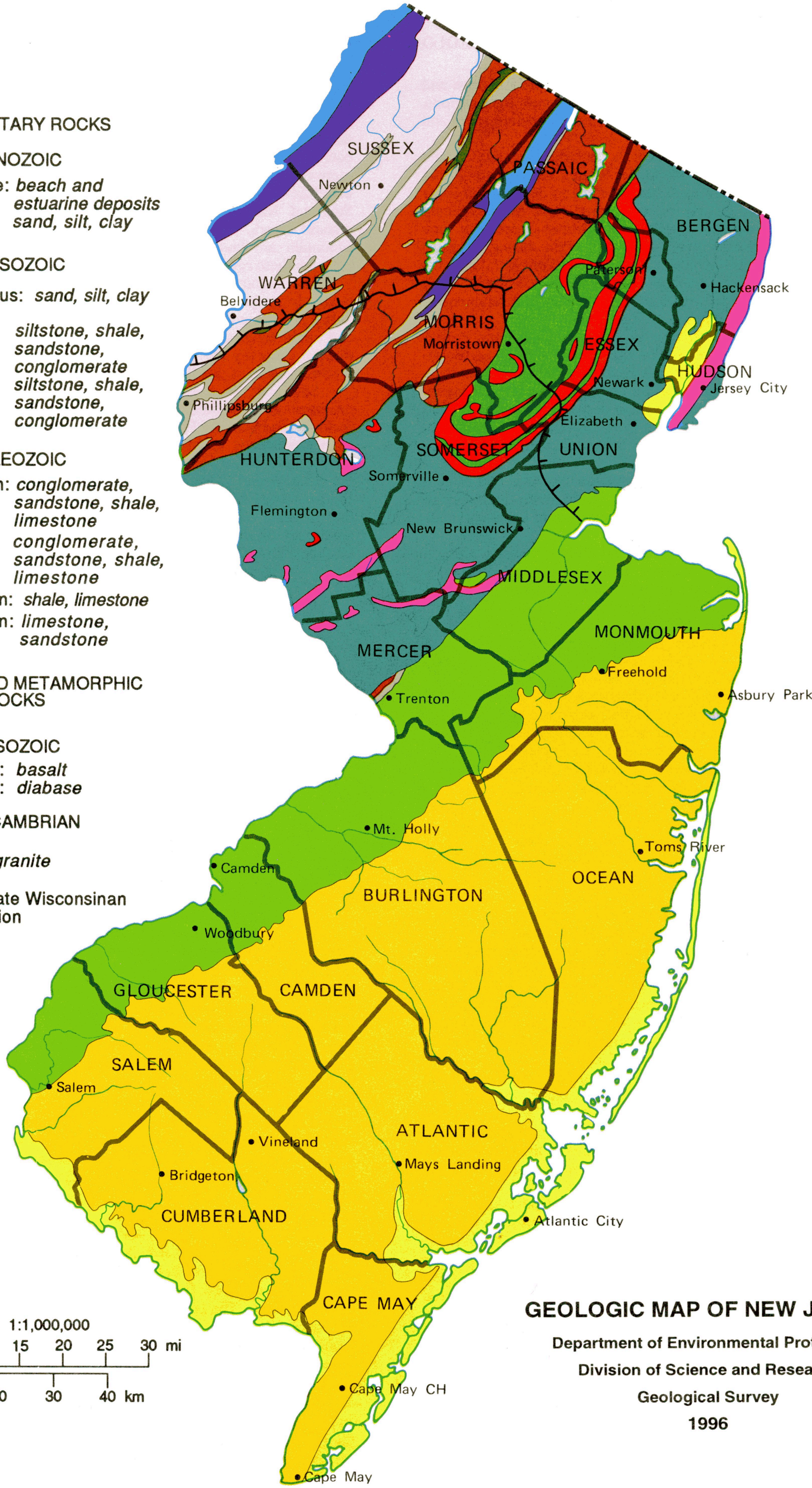


SEDIMENTARY ROCKS

CENOZOIC

- Holocene: *beach and estuarine deposits*
- Tertiary: *sand, silt, clay*

MESOZOIC

- Cretaceous: *sand, silt, clay*
- Jurassic: *siltstone, shale, sandstone, conglomerate*
- Triassic: *siltstone, shale, sandstone, conglomerate*

PALEOZOIC

- Devonian: *conglomerate, sandstone, shale, limestone*
- Silurian: *conglomerate, sandstone, shale, limestone*
- Ordovician: *shale, limestone*
- Cambrian: *limestone, sandstone*

IGNEOUS AND METAMORPHIC ROCKS

MESOZOIC

- Jurassic: *basalt*
- Jurassic: *diabase*

PRECAMBRIAN

- *marble*
- *gneiss, granite*

Limit of late Wisconsinan glaciation

SCALE 1:1,000,000

0 5 10 15 20 25 30 mi

0 10 20 30 40 km

GEOLOGIC MAP OF NEW JERSEY

Department of Environmental Protection

Division of Science and Research

Geological Survey

1996

THE GEOLOGY OF NEW JERSEY

For an area of its size, New Jersey has a uniquely diverse and interesting geology. The state can be divided into four regions, known as physiographic provinces, which have distinctive rocks and landforms.

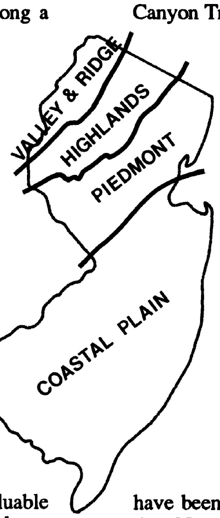
The **Valley and Ridge** Province is underlain by faulted and folded sedimentary layers of sandstone, shale, and limestone that range in age from Cambrian to Devonian (570 to 345 million years old). These rocks originated as sand, mud, and lime sediment deposited in former seas and floodplains. During Ordovician time (approximately 450 million years ago) and again during Pennsylvanian and Permian time (approximately 300 million years ago) the rocks were deformed by compression into folds and thrust along faults. As a result of the deformation, the originally flat sedimentary layers were tilted and now outcrop as linear belts.

Alternation of belts of erosion-resistant sandstone and easily-eroded shale and limestone creates the long, parallel northeast-southwest trending ridges and valleys characteristic of this province. Resistant sandstone and siltstone layers underlie Kittatinny Mountain and Walpack Ridge; shale and limestone underlie the valley of Flat Brook, the Delaware Valley upstream from the Delaware Water Gap, and the broad valley between Kittatinny Mountain and the Highlands to the east.

The limestone is quarried for construction material and cement aggregate. Some of the limestone units yield large quantities of ground water. The shales and sandstones and some limestone units are generally less productive aquifers.

On the eastern edge of the Valley and Ridge Province, along a line from Franklin through Andover to the Delaware River just north of Phillipsburg, an irregular escarpment averaging 500 feet in height marks the boundary of the **Highlands** Province. The Highlands are underlain predominantly by granite, gneiss, and small amounts of marble of Precambrian age. These rocks, the oldest in New Jersey, were formed between 1.3 billion and 750 million years ago by melting and recrystallization of sedimentary rocks that were deeply buried, subjected to high pressure and temperature, and intensely deformed. The Precambrian rocks are interrupted by several elongate northeast-southwest trending belts of folded Paleozoic sedimentary rocks equivalent to the rocks of the Valley and Ridge Province.

The granites and gneisses are resistant to erosion and create a hilly upland dissected by the deep, steep-sided valleys of major streams. The belts of sedimentary rock form long, parallel ridges and valleys (for example, Bearfort Mountain, Long Valley, and the Musconetcong Valley) that extend through the province.



The Highlands contain magnetite iron ore deposits that formerly supplied an industry of national importance. A valuable and mineralogically unique zinc ore in the Franklin Marble at Ogdensburg was also mined. In places the rocks of the Highlands are quarried for crushed stone. The Precambrian rocks are generally unproductive aquifers except where they are fractured or weathered. The more productive aquifers of the region are the glacial deposits and some of the Paleozoic sedimentary rocks.

Rocks of the **Piedmont** Province are separated from the rocks of the Highlands Province by a series of major faults, including the Ramapo Fault. The more resistant gneisses and granites on the upthrown northwest side of the faults make a prominent escarpment, 200 to 800 feet in height, extending from Mahwah through Boonton and Morristown to Gladstone, and from there westward in an irregular line to the Delaware River near Milford.

South and east of this escarpment, interbedded sandstone, shale, conglomerate, basalt, and diabase of the Piedmont Province underlie a broad lowland interrupted by long, generally northeast-southwest trending ridges and uplands. The rocks of the Piedmont are of Late Triassic and Early Jurassic age (230 to 190 million years old). They rest on a large, elongate crustal block that dropped downward in the initial stages of the opening of the Atlantic Ocean — one of a series of such blocks in eastern North America. These down-dropped blocks formed valleys known as rift basins. Sediment eroded from adjacent uplands was deposited along rivers and in lakes within the basins. These sediments became compacted and cemented to form conglomerate, sandstone, siltstone, and shale. They commonly have a distinctive reddish-brown color.

In the course of rifting, the rock layers of the Piedmont became tilted northwestward, gently folded, and cut by several major faults. Volcanic activity was also associated with the rifting, as indicated by the basalt and diabase interlayered with the sandstone and shale. Diabase is a rock formed by the cooling of magma at some depth in the crust; basalt is formed by cooling of an identical magma that has been extruded onto the surface as lava. Both basalt and diabase are more resistant to erosion than the enclosing sandstone and shale and therefore they form ridges and uplands. The Palisades, Rocky Hill, Sourland Mountain, and Cushetunk Mountain are underlain by diabase layers. The Watchung Mountains, Long Hill, and Hook Mountain are underlain by basalt layers. Valleys and lowlands between these ridges are underlain by shale and sandstone.

The basalt and diabase are extensively quarried for crushed stone. In the past, "brownstone" was widely quarried from sandstone units. Also, minor quantities of copper were extracted from sandstone and shale associated with the diabase and basalt. The basalt and diabase generally are poor aquifers but the sedimentary rocks are, in places, capable of yielding large quantities of water.

Southeast of a line roughly between Carteret and Trenton, unconsolidated sediments of the **Coastal Plain** Province overlap rocks of the Piedmont Province. These sediments, which range in age from Cretaceous to Miocene (135 to 5.3 million years old), dip toward the coast and extend beneath the Atlantic Ocean to the edge of the Continental Shelf. The Coastal Plain sediments thicken southeastward from a featheredge along the northwestern margin of the province to approximately 4,500 feet near Atlantic City to a maximum of more than 40,000 feet in the area of the Baltimore Canyon Trough, 50 miles offshore from Atlantic City. The sediments consist of layers of sand, silt and clay deposited alternately in deltaic and marine environments as sea level fluctuated during Cretaceous and Tertiary time. These layers of sediment outcrop in irregular bands that trend northeast-southwest. Wide areas of the Coastal Plain are covered by a thin veneer of Late Tertiary and Quaternary sand and gravel deposited by rivers.

The topography of the Coastal Plain generally is flat to very gently undulating. However, erosion-resistant gravel or iron-cemented sediment underlie upland areas and isolated hills, such as the Atlantic Highlands, Telegraph Hill, Mount Holly, and Arneys Mount.

Coastal Plain sediments have been mined in the past for bog iron, glass sand, foundry sand, ceramic and brick clay, the mineral glauconite for use in fertilizer, and titanium from the mineral ilmenite in sand deposits. Today the Coastal Plain sediments continue to supply glass sand and are extensively mined for sand and gravel construction material. The sand formations are productive aquifers and important ground water reservoirs.

Within each of these physiographic provinces there have been major changes during the past two million years. In this time New Jersey has undergone three glaciations. The last glacier (the late Wiconsinan advance) began to melt back from its maximum extent approximately 20,000 years ago. North of the limit of the last glaciation much of the surface is covered by glacial deposits. Upland areas in this region are thinly draped with till, an unsorted mixture of sand, clay and boulders deposited directly from the glacier. Valleys and lowlands are filled with up to 350 feet of sand and gravel deposited from glacial meltwater and silt and clay that settled in glacial lakes. The sand and gravel deposits are important sources of construction material, and productive aquifers are found where sand and gravel occur in buried or filled valleys. South of the limit of Wisconsinan glaciation, there are discontinuous patches of till from older glaciations. These deposits occur on uplands and are found as far south as the Somerville area.

During each glaciation, sea level dropped as water from the oceans was transferred to ice sheets. Rivers extended and deepened their valleys to conform to the lower sea levels. When the ice sheets melted, sea level rose, flooding the deepened valleys and establishing new shorelines. The present configuration of the coast is the result of the rapid post-glacial rise in sea level, which slowed approximately 6,000 years ago. Many of the estuaries along the coast are the drowned lower reaches of former river valleys. To the east of the mainland, barrier islands were formed, and continue to be shaped, by erosion and deposition of beach sand by waves and currents. Mud and sand transported by rivers and from offshore is gradually filling the bays and estuaries between the mainland and the barrier islands, creating extensive wetlands.