# GEOLOGY

## INTRODUCTION

The Borough of Hawthorne is situated within a unique geologic terrain, the Newark basin, a group of rocks that have played a significant role in the evolution of the Earth sciences known as Plate Tectonics. The rocks of Hawthorne Heights, basaltic lavas that poured out over the earth in vast lava lakes, and the softer sandstones of the Goffle Brook Valley, both are evidence of a time when the continent of North America was being torn apart and the Atlantic Ocean was just being born, when dinosaurs were coming into their own, and when this part of North America was as close to the equator as Mexico is today.

By examining the bedrock geology of an area, we can determine surface stream paths, ground-water capabilities, slope, vegetation cover, and the nature of the soils present. All of the bedrock formations in the Borough date from the Late Triassic and Early Jurassic age approximately 230 to 190 million years ago (NJDEP 1999) (**Fig. 1**).

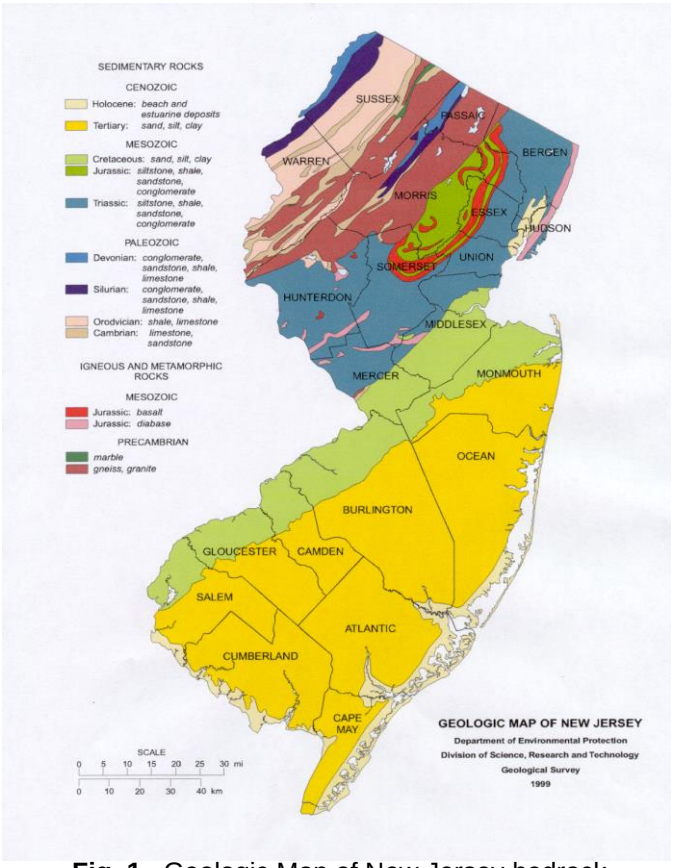


**Fig. 1**. Geologic Map of New Jersey bedrock geology showing sedimentary rocks.

## BEDROCK GEOLOGY HISTORY

Hawthorne is located in the Newark Basin and the Piedmont Physiographic Province (**Fig. 2**) Hawthorne borders on the first (from east to west) of the three Watchung Mountains, Orange Mountain. The Watchungs were lava flows of which Orange Mountain is the oldest. The first Watchung Mountain stretches from Paterson southwest to Millburn and then to Bound Brook where it curves northwest to Pluckemin (Wolfe 1977). North of Hawthorne the mountain bends sharply to the west through Franklin Lakes and Oakland where it terminates against the Ramapo Mountains.

## BEDROCK GEOLOGY

The two major geologic classes found in the Hawthorne area (**Fig. 3**.) are Triassic/Jurassic arkosic (red) sandstone and basalt (lava). The majority of Hawthorne's bedrock is comprised of two different types of this Triassic/Jurassic arkosic sandstone, labeled by geologist as **JTrpcq** and **JTrpsc**.

**JTrpcq** is a reddish-brown pebble conglomerate, pebble sandstone, and sandstone in upward-fining sequences 1 to 2 m thick. **JTrpsc** is brownish-red pebble conglomerate, medium – to fine-grained feldspathic sandstone, and micaceous siltstone; the unit is planar to a low-angle trough cross laminated, burrowed, and contains local pebble layers. The unit forms upward-fining sequences 0.5 to 2.5 m thick. These types of rock are generally known to be good ground water producers (NJDEP 1999).

The Triassic/Jurassic basalt is located on the western boundary of the town. It is part of the first Watchung Mountain, known to geologists as the Orange Mountain basalt. The Mountain was formed from fissure eruptions. The basalt from this mountain is medium gray in color. It is dense, fine-textured igneous rock composed of glass, submicroscopic to barely visible crystals. These crystals are generally plagioclase feldspar, pyroxene, and some magnetite as well as occasional olivine (Wolfe 1977). The basalt in this area has a maximum thickness of 155 m. Unlike sandstone, basalt is not generally known to be a good ground water producer.

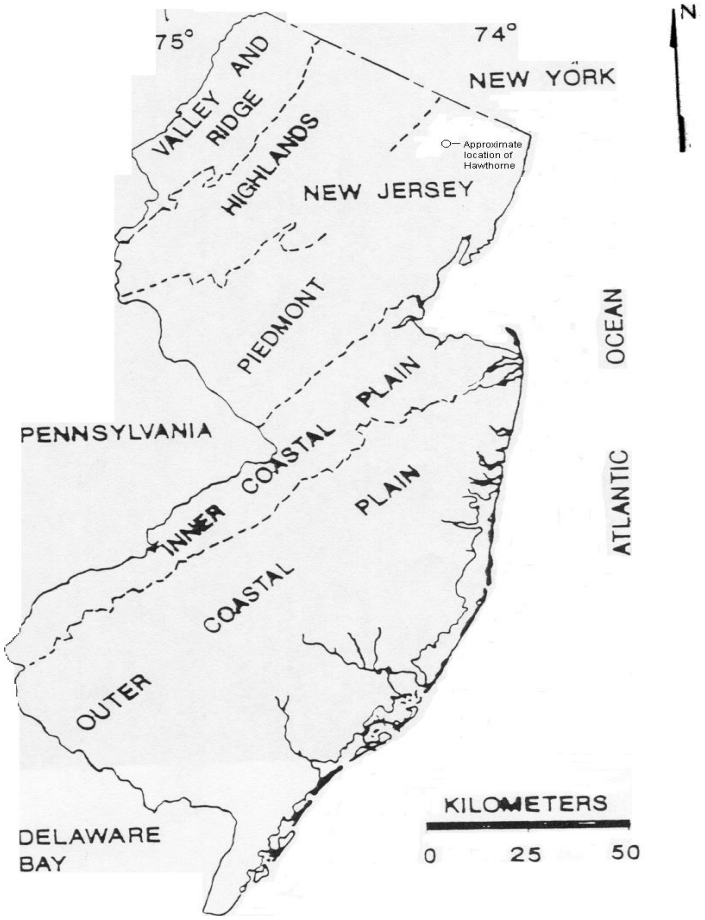


**Fig. 2**. Physiographic Provinces of New Jersey.

Although there are no rocks exposed on the surface within the Borough that are older than about 200 million years, Hawthorne lies between two much older geologic terrains - the very ancient, highly distorted metamorphic rocks of the Highlands to the west (roughly west of Route 287), at least 1.1 billion years old, and the somewhat less ancient metamorphic rocks of Staten Island, Manhattan, and the Bronx to the east, between 300 and 500 million years old.

These rocks record a complex history of a region that for much of the Earth's history lie along the margin of colliding and splitting continents. Over most of the Earth, the oldest rocks of the continents lie toward the continental centers while the youngest rocks lie along the edges. Sometimes, though, pieces of one continent are left "stuck" on another as the continents collide and then split apart, while at other times pieces of continents split off, drift around by themselves (like Madagascar today) and then rejoin the same or

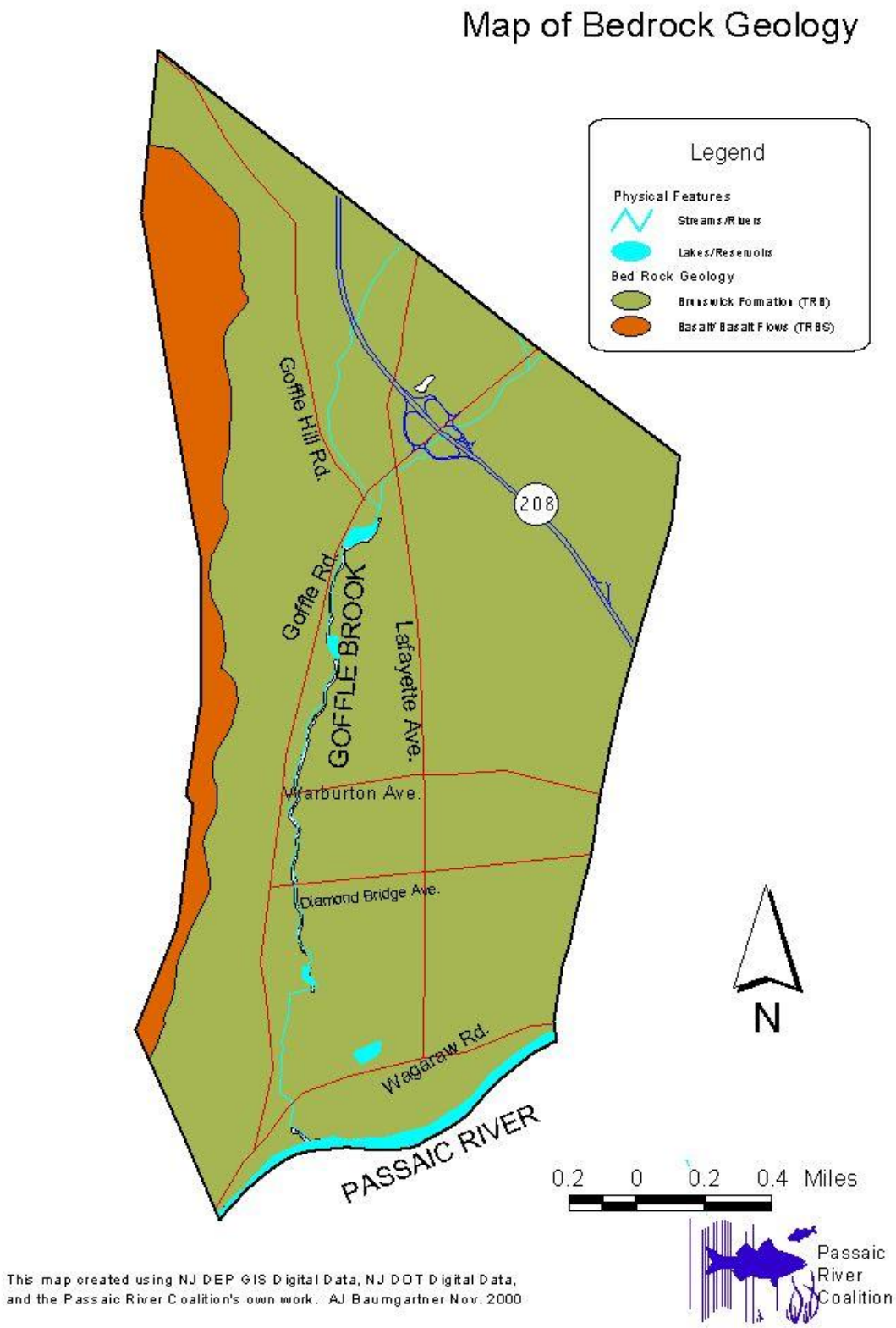


**Fig. 3**. Map of Bedrock Geology, Borough of Hawthorne

another continent at a very different place. The rocks of the Highlands most closely resemble the rocks of Ontario and Quebec in Canada far to the northwest, while the rocks of Manhattan and the Bronx are closely related to the rocks of the British Isles now an ocean away in Europe.

During the age of the reptiles and dinosaurs (241 to 65 million years ago), the great, single continent of Pangaea began to crack, rift, opening first as a valley and then as a long, narrow sea that would eventually become the Atlantic Ocean. The tension that ripped the valley rocks apart caused the floor of the valley to drop, into which vast amounts of sediment poured from the surrounding mountains. The tensional forces continued until these cracks grew deep enough to become conduits for molten basalt to flow up and over the valley floors in vast lava lakes. Several pauses and renewals created the inter-layering of lava and sediment that is characteristic of the Newark Basin. As the rift valley unzipped starting in the north and proceeding to the south, the Atlantic Ocean began to fill the gap, and volcanism on land finally stopped to be resumed on the new ocean floor. At some time after the entire sequence, sandstone and lava was tilted slightly (15°) back to the west, an orientation it has retained until the present time. If the area was overlain by rocks younger than Jurassic and older than the ice ages of the last 2-3 million years, no record is found in northern New Jersey.

## SURFICIAL ROCKS

Unconsolidated surficial sediments are not significant in Hawthorne. Those sediments that are found in this area are **ct**: (continuous till), **dt**: (thin till and rock outcrop), **d**: (deltaic and lacustrine-fan deposits), and **fl**: (fluvian over lacustrine deposits) (**Fig. 4**). Although there are several different types of sediment, none of them have appreciable depth except for the small deltaic and lacustrine-fan deposits (**d**), which are located in the uppermost northeast corner of the town along the border with Ridgewood.

These unconsolidated, surficial sediments can be traced to one (and probably the last) advance of Pleistocene ice over the region. The ice ages of the Pleistocene consisted of several alternating cold (glacial) and warm (interglacial) periods. During glacial periods in North America, vast continental ice sheets moved down from centers in Quebec and Ontario and overrode most of what is now the northern United States, including most of northern New Jersey. Most of these ice advances crossed completely over the Hawthorne area and moved on south toward central New Jersey. The last ice advance (known as the Wisconsin) had its southern most point in this area at the southern tip of Staten Island. It covered the First Watchung Mountain as far south as Summit and crossed the Delaware River just south of the Water Gap.

The advancing continental ice sheets carved and subdued the landscape, planing down the mountains and filling the valleys. As these huge sheets of ice retreated, they left behind vast quantities of rock debris (till or drift) that underlay or form most the area's soils today. In the valleys the melt water of these glaciers filled many glacial lakes. In this area, glacial Lake Passaic filled the upper Passaic River valley to the southwest, while glacial Lake Hackensack filled the lower Passaic and Hackensack valleys to the south and east. On the floors of these lakes, tens to hundreds of feet of glacial clays accumulated, which today retard the infiltration of water into the bedrock below.

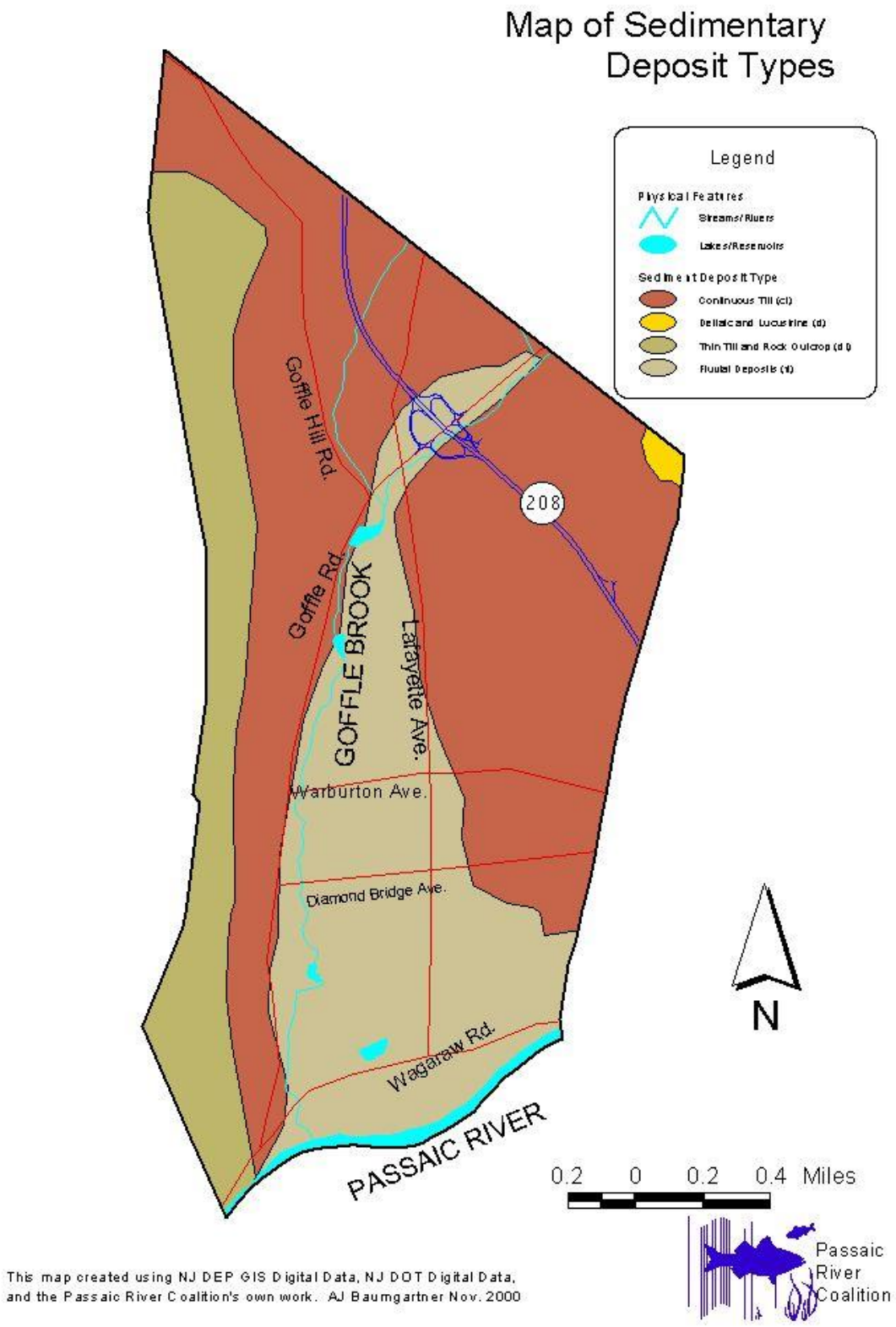


**Fig. 4**. Map of Sedimentary Deposits, Borough of Hawthorne

## EARTH RESOURCES AND MINERALS

Trap rock mining was and still is a major industry in the Hawthorne area although there are no mines operating within the Borough today. The former North Haledon quarry along the western boundary with North Haledon is now filled with water. The Haledon trap rock quarry near the southwest border of Haledon/Prospect Park and Hawthorne is still operational.

View of North Haledon Quarry showing trap rock.

Zeolites are a rare group of minerals that are, however, fairly common in the trap rock quarries of the Paterson area. The minerals associated with the Watchung Mountains (many of which were removed from nearby Paterson quarries) are amethyst, smoky quartz, heulandite, stilbite, chabazite, prehnite, pectolite, and several zeolite minerals. (Wolfe 1977). A special exhibit of the minerals of the Paterson area can be seen in the Hall of Minerals at the American Museum of Natural History in New York City.

## EARTHQUAKES

Earthquakes are recorded every year in New Jersey and the surrounding region, with many of these originating from near the boundary between the Newark basin and the New Jersey Highlands along the former Ramapo fault line (approximately Route 287). Most of these earthquakes have Richter magnitudes of less than 2 and are felt only by sensitive instruments, but as recently as October 1985, many area residents felt a magnitude 4 earthquake that originated just across the Hudson River in Westchester.