GEOLOGY ALONG THE TRAIL ACROSS MOUNT PAUL MEMORIAL COUNTY PARK, CHESTER, NEW JERSEY

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ABSTRACT

The Mt Paul Trail offers a rare opportunity to observe good exposures of a wide range of rock types (granite, gneiss, slate, conglomerate, and mylonite) of widely varying age (Precambrian, Ordovician, and Triassic) and a wide range of geologic structures (The Flemington Fault, The Peapack - Ralston Fault, The Peapack Klippe, and some plunging folds) along about 3 miles of gentle hill slope.

INTRODUCTION

The Mt Paul trail is a small part of the rather extensive trail system of Chester, New Jersey. The trail system is currently being upgraded and several trail plans are about to be implemented. The Conservation Resources Inc. serves as a consultant for this project. According to Conservation Resources "The Chester Trails Plan is a collaborative effort by Chester Township and Chester Borough to develop a plan for a trail ecosystem that will connect significant open space, environmental, cultural and historic features in the Chesters." This year (2012) Conservation Resources published a 36 page plan on their web site that includes a "geology trail" with 47 points of interest. Several of these points will have QR codes on posts along the trail that will describe the rock exposures.

One of the more interesting of the Chester trails is a proposed "blue" or secondary spur of Patriots Path that will cross through the Mount Paul Memorial County Park. An important step in the development of the Mt. Paul trail was the recent purchase of the "Shale Pits Property" by the Schiff Natural Lands Trust. This purchase has connected State Route 24 (510) or Mendham Rd. W to Mt Paul Memorial Park. The Shale Pits include several acres of excellent exposure of Ordovician shale.

GEOLOGIC SETTING

An easy way to think of the geologic development of the earth over the last couple of billion years is to think of two supercontinents (**Rodinia and Pangea**) that existed by themselves, one after the other, in a huge global ocean. **Rodinia** formed first during Precambrian time. Most of Chester is located on rocks that formed during the assembly of **Rodinia** about one billion years ago. Then about 550 million years ago at the end of Precambrian time **Rodinia** broke up and slid away from a huge hot-spot to form smaller continents (Puffer, 2002). Sediments that eroded off of one of these continents (Laurentia) were deposited in the ocean as sand and mud about 480 million years ago during early Paleozoic time (specifically the Cambrian and Ordovician periods). Some of the mud lithified into the slates exposed in the quarry north of Mt. Paul. Then Laurentia and the other continents slowly drifted together and gradually merged into the second continent (**Pangea**) about 300 Million years ago. When **Pangea** started to break apart about 200 Million years ago, volcanic rocks extruded out of the fissures (Puffer et al. 1909); and rift valleys formed that later widened to form the Atlantic Ocean. Some of the sand that was deposited in one of the rift valleys lithified into the red sandstone found at the top of Mt. Paul. Therefore, Mt. Paul has participated in a large fraction of the geological development of the earth. It's actually that simple, although geologists are still working out the details.

We are, therefore, left with three kinds of rock exposed around Mt. Paul: 1. Late Precambrian granites and metamorphic rocks formed deep under Rodinian mountains; 2. Slates and sandstones formed from mud and sand deposited in Paleozoic oceans, and 3. Sandstone deposited in rift valleys formed during the break-up of Pangea.

1. Late Precambrian rocks

a. Losee Metamorphic Suite (Ylo) - is a volcanic rock that was metamorphosed about 1.1 billion years ago into gray gneiss composed of quartz and plagioclase feldspar (the two most abundant minerals in the earth's continental crust) together with minor quantities of biotite and magnetite. The volcanic rock was extruded onto a large island arc (a volcanic island chain such as Japan) and was metamorphosed during the assembly of Rodinia. The metamorphic activity was very intense and caused some of the rock to melt. The portion that melted became an igneous rock called a trondhjemite (Puffer and Volkert, 1991). The Losee is commonly veined with quartz and magnetite. Where the magnetite content exceeds about 15 percent it was mined as an iron ore at several locations throughout the Chester area (Puffer, 2001).

b. Byram Intrusive Suite (Ybh) - is a pink to tan granite that intruded into the Losee Metamorphic Suite about 0.8 billion years ago. The granite is composed of microcline feldspar, quartz, plagioclase feldspar, and hornblende with minor magnetite. A few abandoned magnetite (iron ore) mines in the Chester area are also found in the Byram granite. Most of the Chester area is underlain by Byram Granite and Losee Gneiss.

2. Paleozoic Rocks

a. Jutland klippe upper unit B (Ojtb) - is red and green shale that has been slightly metamophosed into a slate. The rock was deposited as shallow marine mud in an Ordovician ocean about 480 to 490 million years ago. The rock is interbedded with dolomite, siltstone, sandstone, and conglomerate. The rock contains conodont, graptolite, and brachiopod fossils (Volkert et al. 1990) supporting a marine environment. These Ordovician rocks are locally confined to a structure known as a Klippe which is an isolated block of rocks separated from underlying rocks by a fault (see accompanying cross section).

b. Beekmantown Group - are gray Ordovician dolomites and limestones (Obu and OBl) that contain conodont fossils (the teeth of extinct marine ell-like animals).

c. Allentown Dolomite - is a gray dolomitic mudstone (OCa) deposited in shallow water as indicated by mud cracks and algal stromatolites. The rock is of late Cambrian to early Ordovician age (about 490 million years).

d. Leithsville Formation - is gray dolomite (Cl) containing Archaeocyathid fossils (a horn coral animal that lived in shallow warm coral reefs). The rock was deposited during the late Cambrian Period (about 500 million years).

e. Hardyston Quartzite- is a Cambrian sandstone (Ch) that contains trilobite fossils.

3. Triassic rocks

A layer of dark red Quartz-pebble conglomerate that was deposited during the late Traissic period (about 200 to 210 million years ago) is exposed at the top of Mt. Paul. The rock is sandstone containing abundant pebbles composed of quartz. The red color is due to iron oxide (rust). The rock layers are not exposed at the surface but provide evidence of their existence as common pebbles and cobbles in the soil. The red Triassic sandstones of New Jersey contain common dinosaur and alligator footprint fossils together with mud-cracks, raindrop impressions, and ripple-marks providing evidence of nonmarine deposition. Some vegetation is also preserved in the sandstone as thin layers of coal-like material. Most of the Triassic dinosaurs including those that lived in the Chester area were small, about the size of a person. Most of these dinosaurs became extinct during the eruption of volcanic basalt flows that suddenly covered eastern North America, eastern South America, northwestern Africa, and southern Europe at the beginning of the Jurassic period (Puffer et al., 2009). But a few species survived and evolved into larger Jurassic and Cretaceous dinosaurs.

THE MT. PAUL TRAIL

The Mt. Paul trail is currently (as of July 2012) under development and is still not blazed. However, most of the trail, particularly the northern half, is easy to follow and is shared by both hikers and horses. It is about 3 miles long and hilly.

From the parking area about 1/8th mile south of Rt. 24 hike west into the abandoned shale/slate quarry area. The quarrying activity has resulted in excellent exposures of the Ordovician Jutland klippe upper unit B. The area has been mapped by Volkert et al, (1990) who have measured the strike and dip at several locations around the quarry. The dip measurements average about 70° to the south-east and strike about 45° to the north-east. The beds have formed folds that plunge at low angles (about 6 to 16 degrees to the northeast and the southwest. The composition of the red slate and the green slate is the same except for the oxidation state of the iron in the red slate that has oxidized to rust.

Continue west across the clearing and climb the ridge. The trail along the ridge-crest leads south-west. The base of the steep slope to the north is a major New Jersey fault known as the Flemington Fault. About 1/3 mile south-west along the ridge-crest where the trail flattens out, a narrow side trail can be taken down to the stream at the bottom of the hill. The stream has exposed some Precambrian Byram Granite. Most of the large boulders are Precambrian granite eroded off of the north-west side of the Flemington Fault. Very little Ordovician rock is exposed along this part of the trail.

As the summit of Mt Paul is approached within about ¼ mile in any direction pebbles and cobbles of red conglomerate are exposed in gullies and in eroded soil exposures. This red Triassic rock is about 300 million years younger than the Ordovician rocks. The pebbles in the conglomerate are composed of quartz and are cemented together with silt enriched in red iron.

As the trail from the summit descends toward the southwest more Ordovician rock is encountered until Gladstone Brook is reached. Gladstone Brook marks the fault contact with Byram granite that is exposed on the valley wall to the west. The Flemington Fault follows along the brook (as is typical of faults). The younger Ordovician rocks on the east side of the fault dropped down while the much older Byram Granite on the west side lifted up as indicated by the arrows on the cross section along the line A'-A. Therefore, the relative motion makes this portion of the fault a normal-type fault. The contact at Gladstone Brook is a contact between rock deposited about 480 million years ago and granite intruded about 800 million years ago. The granite and the adjacent Losee Gneiss were therefore uplifted several miles from their original sites of intrusion or metamorphism to reach their current position. This also means that the several miles of rock overlying the Byram and Losee have eroded away resulting in countless cubic miles of sediments, most of which were deposited as sand and mud in shallow marine environments.

It can also be observed that the Byram Granite has experienced the effects of crushing and grinding during movement along the Flemington Fault and has become finer grained and foliated. The sheared, fine-grained portion of the granite has become a rock type known as mylonite.

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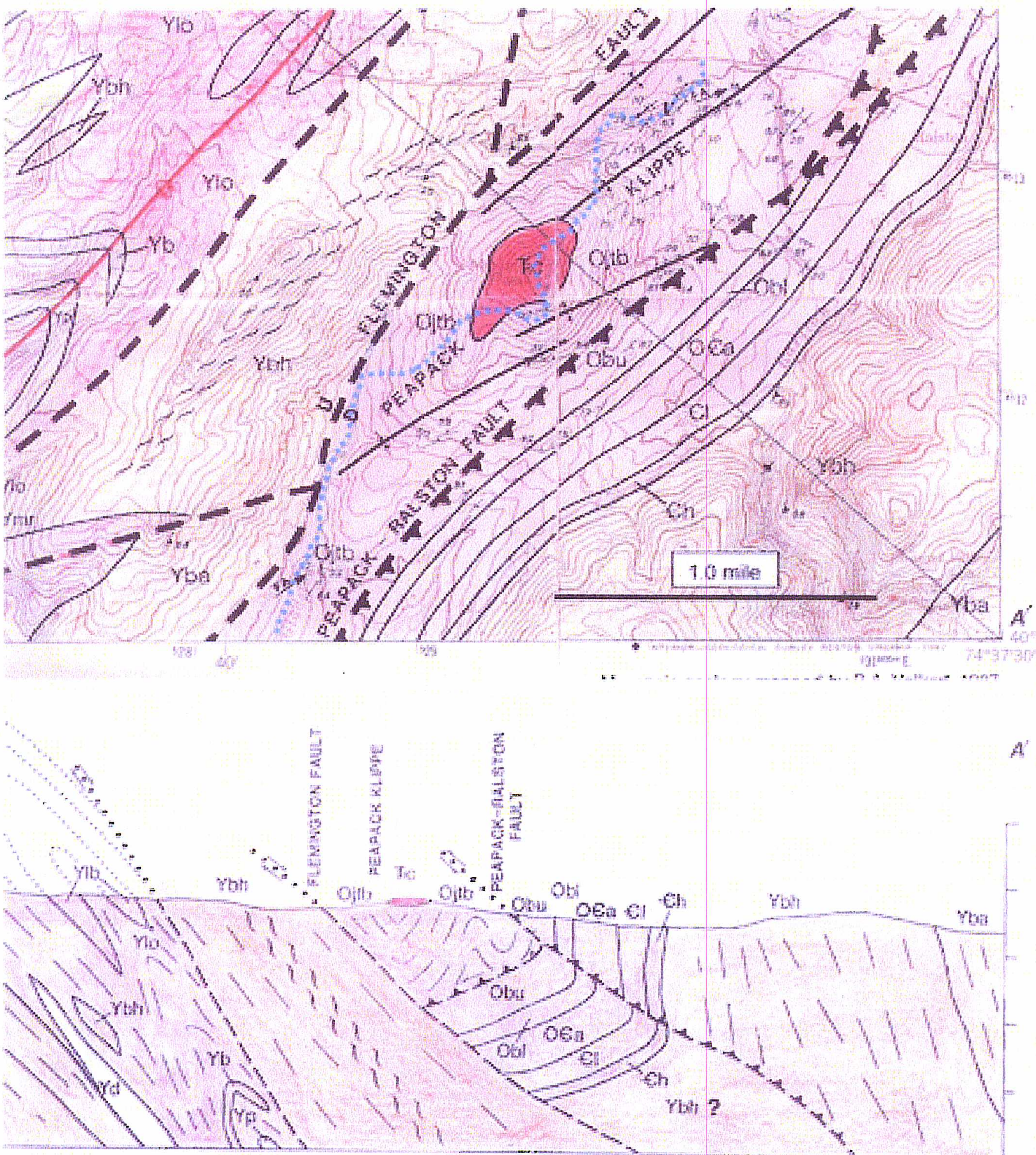

Geologic map and cross section after Volkert et al. (1990). Mt. Paul is located near the center of the Peapack Klippe. The peak of Mt. Paul is Triassic sandstone (TrC) mapped in dark red and the base is Ordovician slate (Otjb) mapped in light red. The Precambrian Byram Granite (Ybh) west of the Flemington Fault is mapped in orange and the Precambrian Losee Gneiss (Ylo) is mapped in pink. The trail mapped as a blue line.