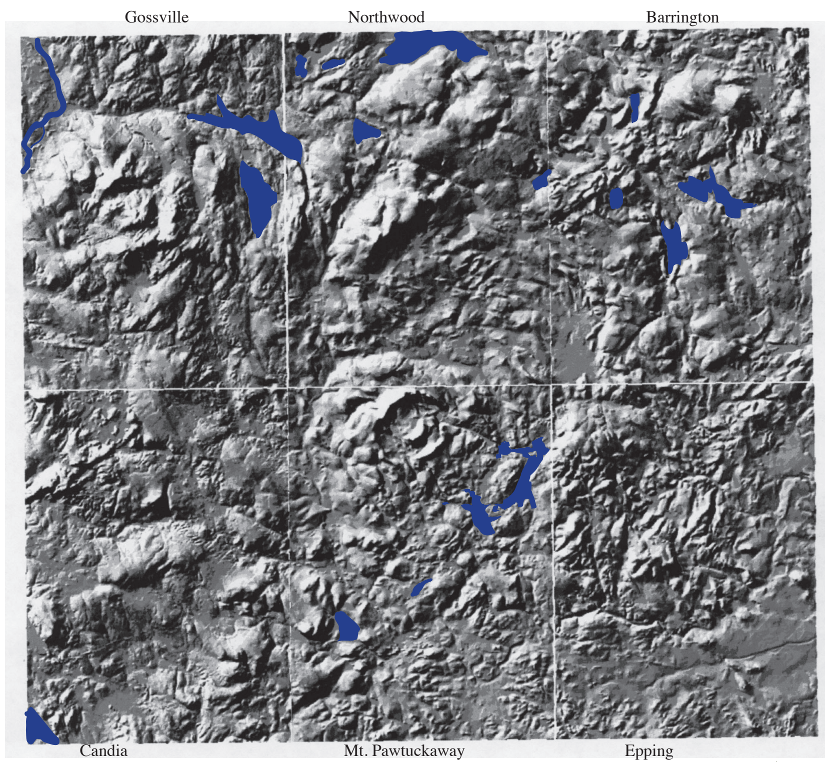
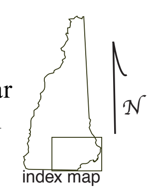
G.S.N.H.
Summer Field Trip

Pawtuckaway State Park Geology Tour
August 24, 2019



DEM of the Gossville, Northwood, Barrington, Candia, Mt. Pawtuckaway and Epping 7.5 minute quadrangles. The Pawtuckaway Ring Dike Complex can be seen as a set of circular hills just south of the center of the diagram. Taken from Kerwin (2007)



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Acknowledgments

The field trip details and geology information is largely taken and summarized from

Part 1
White Mountain Magma Series
G. Nelson Eby
Department of Earth Sciences
University of Massachusetts, Lowell, MA,U.S.A.
Third Hutton Symposium Pre-Conference Field Trip Guide, Lowell, August 1995.

It contains field trip and geology information for the White Mountain Batholith, the Ossipee Complex and the Mt. Pawtuckaway Ring dike complex. I would recommend obtaining a copy to any who are interested in more geologic and chemical details than will be presented on this trip.

Other information that will be shared comes from years of bedrock mapping, studying New Hampshire geology and personal communication with numerous geologists about the what, how and when all of the events of the White Mt. Magma Series. Some of the topics that we will discuss are still debated and may become part of conversations on this trip. All opinions and ideas are welcome, as some of the current conclusions remain controversial.

Also, we will be doing some short hikes. Please be aware that there are abundant ticks and flying insects that could possibly carry disease. Insect repellant is always a good idea.

Respectfully,

Charlie Kerwin

Introduction

The White Mountain Magma series is a linear NW trending igneous complexes (Fig. 1). They are largely granitic in nature but the Ossipee and Mt. Pawtuckaway expose various mafic and ultramafic rocks. They are thought to be part of a hotspot track that begins at the meteor hot spot in the Atlantic and continues NW into the Province of Quebec.

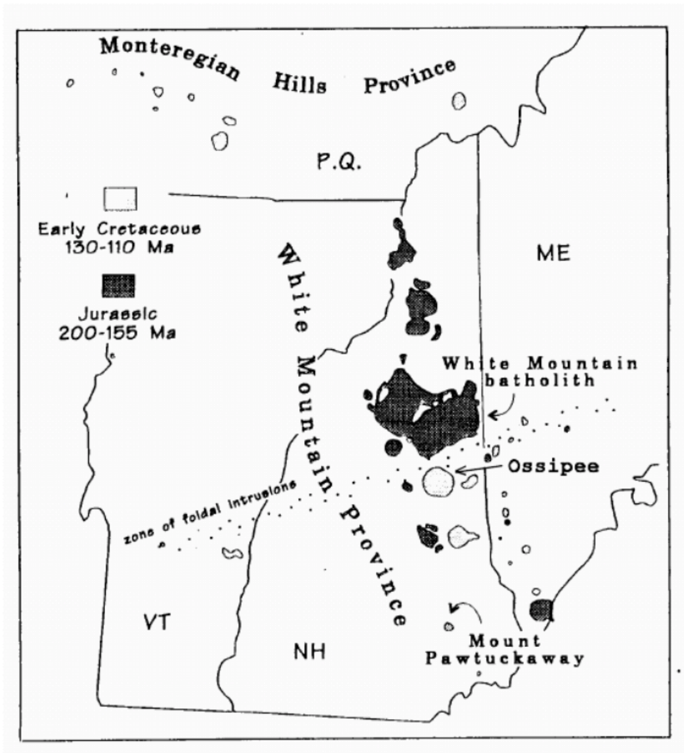


Figure 1. White Mountain and Monteregian Hills igneous provinces showing the location of the White Mountain batholith, Ossipee, and Mount Pawtuckaway (After Creasy and Eby, 1993).

The sub-aqueous section of the hot spot track is known as the New England Seamount chain, and it lines up quite neatly with the White Mountain magma Series locations (Fig. 2). The hot spot track idea becomes a bit problematic in that a hot spot track is expected to go from older rocks at one end and progressively become younger as the hot spot is approached. Figure 1 shows that there are 2 age groups of rocks consisting of an Early Cretaceous group (130-110 Ma) and an older group of Jurassic (200-155Ma) that somewhat overlap at the southeastern end of New Hampshire.

The White Mountain Magma rocks fall into the A type granites (Eby,1992). A, stands for anorogenic or anhydrous. Either way, they are thought to have originated without a mountain building event. They also tend to not have muscovite present as a hydrous phase. The older suite of rocks are mostly granitic and mafic rocks are scarce while the younger group have abundant mafic rocks.

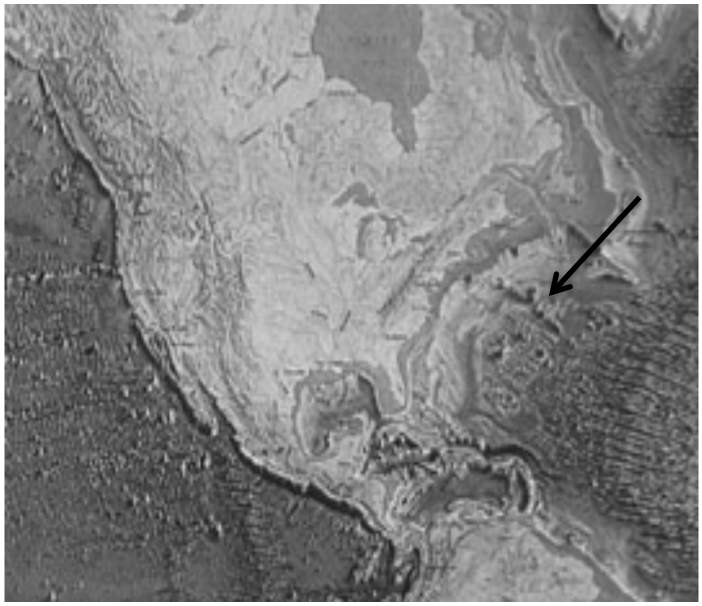


Figure 2. Map of the North American plate and New England Sea Mount chain (black Arrow) striking toward New Hampshire.

Mount Pawtuckaway

Mount Pawtuckaway is located in Rockingham County, New Hampshire. It lies in the northwestern corner of the Mt. Pawtuckaway 7.5 minute quadrangle within the Mt. Pawtuckaway State Park. The park is approximately 22 square kms (5500 sq acres) and the Mt Pawtuckaway complex is approximately 8 sq. kms of the total area. The maximum relief is approximately 200m (~656 ft) with the silica rich (felsic) rocks forming the ridges and the mafic rocks, which are more susceptible to erosion, underlie the lowlands (Fig. 3)

The Mt. Pawtuckaway complex has been studied in detail by Roy and Freedman (1944), Freedman (1950), Shearer (1976) and Richards (1990) as well as a few senior projects (J. Dadoly, M. Kick., M. Lambert and J. Plunkett) at the University of Massachusetts, Lowell. These studies have mapped the bedrock, looked at the structural geology, the geo-chemistry and geophysics of the complex and their data was used to construct the paper from which this trip was designed.

The Mt. Pawtuckaway complex is considered a "ring dike" complex most likely getting its circular shape as shown in Fig. 4. Geophysical work (Richards, 1990) indicates that it is a plug-like structure. Fission track work done by Doherty and Lyons (1980) estimates the depth of emplacement was 3-3.6 km. It intruded the Massabesic Gneiss Complex near the northeastern terminus of that belt of rocks.

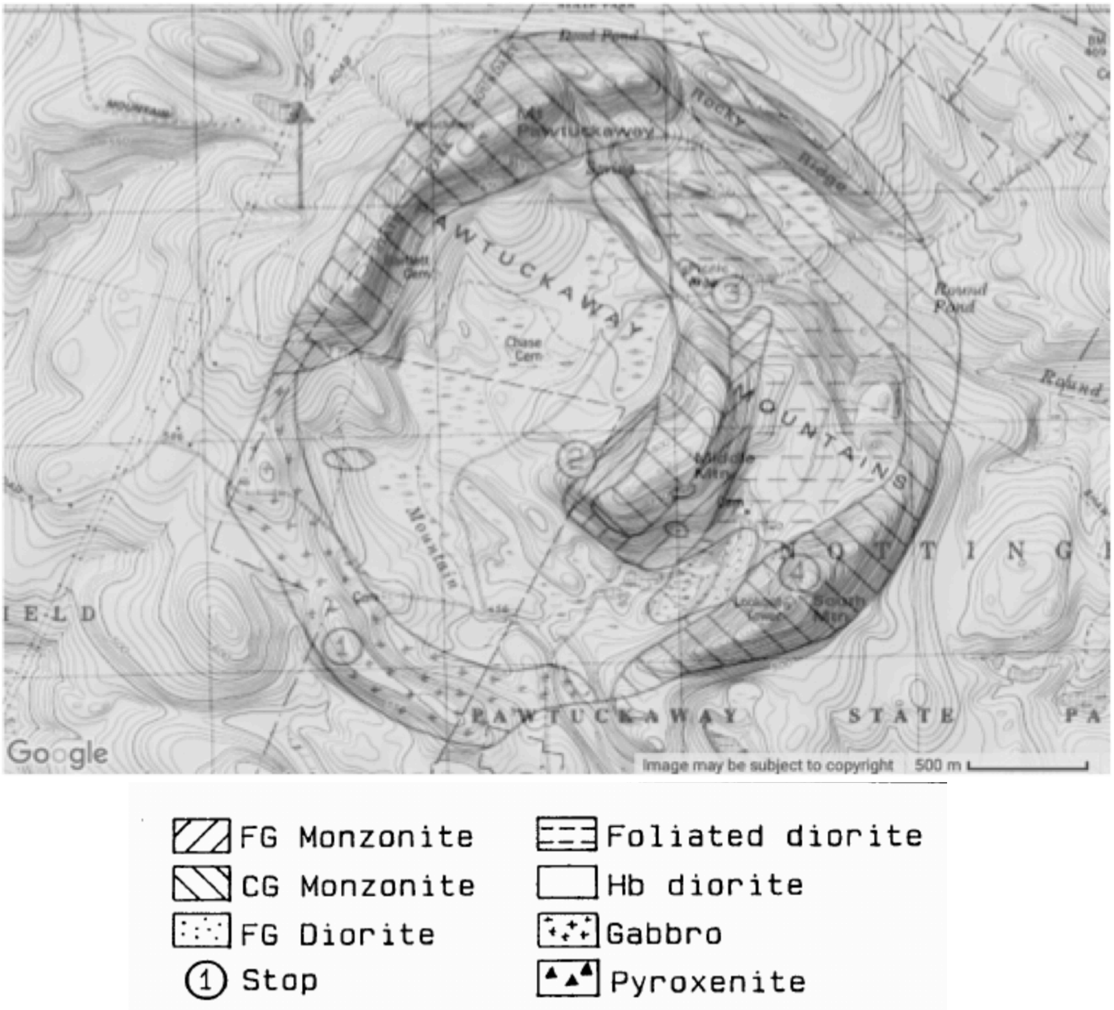
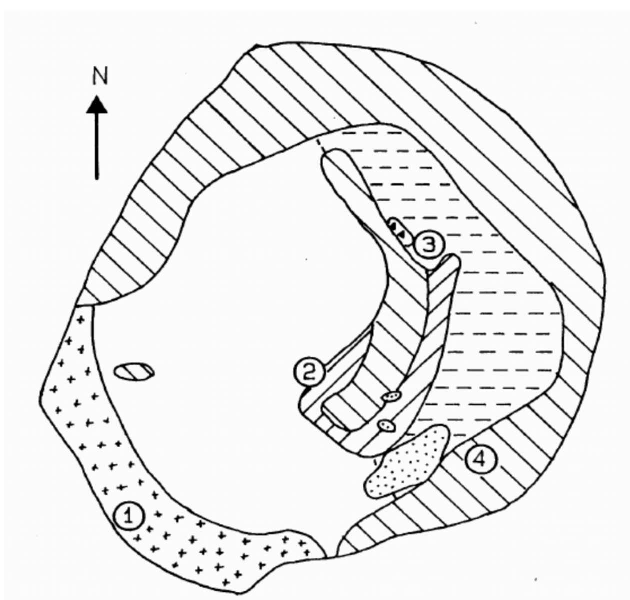


Figure 3. Rocks units (Eby, 1995) overlaid on a portion of the Mt. Pawtuckaway 7.5 minute quadrangle (above) Geologic map and field stops from Eby, (1995) below.



The mafic rocks are pyroxenites, gabbros, and diorites of various grain sizes. The felsic rocks consist of mainly monzonites and syenites. A Streckeisen (1976) diagram is included for your convenience (Fig. 5)

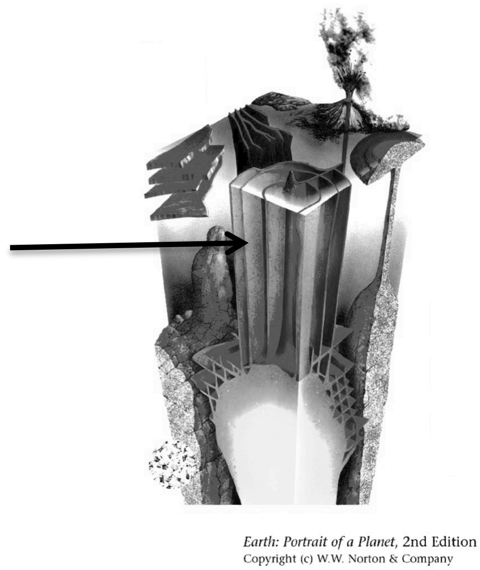


Figure 4. Artist rendition of the "ring dike" plumbing for a volcano above. Black arrow shows possible present day ground surface.

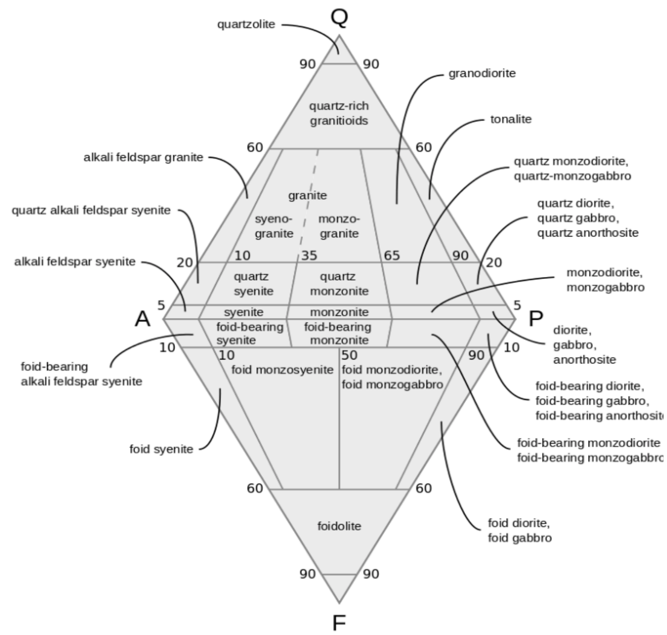


Figure 5. Streckeisen diagram showing the classification of rocks based on the normalization to Quartz (Q) Alkali Feldspar (A) and Plagioclase (P).

The oldest mafic rocks are the pyroxenites. They are thought to be pretty much in their original level of emplacement. The timing of gabbro emplacement is not known as it shows no intrusions or cross cutting relationships with any other units. The pyroxenites and gabbro are interpreted to be cumulates, most likely precipitating from the walls of a convecting magma chamber during the initial stages of magmatic activity.

The coarse and fine-grained diorites were the next units to be emplaced. The coarse grained diorites have a foliation that dips increasingly steeper as the center of the complex is approached suggesting a funnel-shaped intrusion (Kick, unpublished data) The fine-grained diorite has no foliation and is included within the monzonite and is considered to be the last of the mafic rocks to intrude but was emplaced prior to the monzonite unit

The last units to be emplaced were the felsic magmas. The first of these were the course-grained monzonites and later the fine-grained monzonites. The fine-grained monzonites may have vented at the surface based on textural indicators. The last to occurwere the central ring monzonites followed by a phase of mafic and felsic dikes that cross cut all other units.

Rock descriptions

Pyroxenite- coarse-grained, olivine, augite and labradorite with titano-magnetite and hercynite opaques.

Gabbro- Medium – coarse-grained with plagioclase laths (An_{60}-An_{46}) and light pink augite with local olivine.

Hornblende Diorite – Medium-coarse-grained, plagioclase, pyroxene, biotite and local olivine (altered).

Foliated Diorite – Fine to coarse –grained, plagioclase, light pink-light green pyroxenes, amphibole, biotie, apatite.

Fine-grained Diorite – Plagioclase, hornblende and minor biotite.

Coarse-grained monzonite and syenite – Medium-coarse-grained perthitic K feldspar and plag is usually oligoclase, pyroxene is colorless to light green and brown and dark green amphibole, interstitial quartz.

Fine-grained monzonite – Fine to very fine-grained, with phenocrysts of biotite and hornblende, oligoclase, quartz, minor occurences of apatite and pyrrhotite

Road log

Road log mileages and UTM coordinates (CONUS 1997) are approximate, close, but approximate...

> We will use the entrance to the Firetower off of route 107, 3.2 miles north of the route 27 and 107 intersection. Set odometer to 0. At 2.0 miles park near small cemetery on the south side of the road

Stop 1 Gabbro

Follow logging road on west side of the cemetery 300 feet to pavement outcrop of gabbro. UTM 0320779, 4774348. Gabbro is also exposed in abundance further up the trail and off to the southwest side of the hill.

> Return to vehicles. Continue on road and take the left hand turn onto loop road. At 2.9 miles UTM 0321540, 4775107, pull off to the right near the big log. Walk east (110˚) for 225 feet then turn NE (62˚) for 180 feet, outcrop is visible to the right (100˚).

Stop 2 Hornblende Diorite, monzodiorite and coarse and fine-grained monzonite.
UTM 0321668, 4775116

Return to vehicles, at 3.5 miles park at intersection of loop road and Round Pond Road. Walk back (west) along the road several hundred feet to a road leading to a primitive picnic area

Stop 3 Pyroxenites foliated Diorites and monzonites

Outcrops of coarse-grained monzonite are found on either side of the road. They belong to the inner arcuate coarse-grained monzonites (partial ring-dike?). On the east side of the road there are several outcrops of fine-grained monzonite.

Return to vehicles and continue walking down Round Pond Road aprrox 400 feet from the intersection.

Outcrops of pyroxenite along the road and along the edge of the ridgeline.

Return to vehicles. Continue down Round Pond Road until abandoned road on the left (3.6miles)with the WWII memorial bench can be seen UTM 0322281, 4775670

Stop 4 Outcrops of foliated diorite can be seen as pavement in the road and along the sides

Return to cars and continue down Round Pond RD until you reach a bridge (4.0 miles) over a little brook. UTM 0321959, 4776038

Stop 5 Outcrops of coarse-grained monzonite north of the road and just west of the brook carry inclusions of fine-grained biotite.

Return to vehicles and reverse direction until the Round Pond Road and Loop Rd intersection (Stop 3). Turn left towards parking area for the Fire tower trail (5.3 miles). There is an outhouse here. Proceed up the fire tower trail.

Stop 6 Coarse-grained monzonites and syenites of the outer ring-dike.

Excellent exposures of the coarse-grained monzonite are found along the upper portion of the trail. Towards the center of the ring dike the rock becomes a coarse-grained syenite cut by fine-grained monzonite. A number of mafic dikes are exposed around the fire tower and on a trail going southward from the tower is a small exposure showing mixing between felsic and mafic magmas.

Return to vehicles. Continue on loop road to juncture. Turn right at teh intersection and proceed back to route 107

References

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