GEOLOGY AND MINING HISTORY OF THE BARTON GARNET MINE, GORE MT. AND THE NL ILMENITE MINE, TAHAWUS, NY WITH A TEMPORAL EXCURSION TO THE MACINTYRE IRON PLANTATION OF 1857

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INTRODUCTION

This field trip examines the geology and history of mining at two types of ore deposits, one a metal and one an industrial mineral. Both are strongly identified with the Adirondack Mountains of New York and both have histories that extend for more than a century. While mining activities began at both in the nineteenth century, only the Barton garnet mining venture has remained in continuous operation. Attempts, successful and unsuccessful, to exploit the ore at Tahawus occurred sporadically through the nineteenth and twentieth century. During this time the minerals that were the target and gangue at Tahawus essentially reversed roles.

BARTON GARNET MINE, GORE MT.

The Barton Mines Corporation open pit mine is located at an elevation of about 800 m (2600 ft) on the north side of Gore Mountain. For 105 years, this was the site of the world's oldest continuously operating garnet mine and the country's second oldest continuously operating mine under one management. The community at the mine site is the highest self-sufficient community in New York State. It is 16 km (10 mi) from North Creek and 8 km (5 mi) from NY State Route 28 over a Company-built road that rises 91 m (300 ft) per mile. This road, like others in the vicinity, is surfaced with coarse mine tailings. About eleven families can live on the property. The community has its own water, power, and fire protection systems. On the property are the original mine buildings and Highwinds, built by Mr. C.R. Barton in 1933 as a family residence.

The garnet is used in coated abrasives, glass grinding, metal and glass polishing, and even to remove the red hulls from peanuts. Paint manufacturers add garnet to create non-skid surfaces and television makers use it to prepare the glass on the interior of color picture tubes prior to the application of the phosphors. Barton sells between 10,000 and 12,000 tons of technical-grade garnet abrasive annually. About 40% of the company's shipments are to foreign countries. All current U.S. production of technical-grade garnet is limited to the Barton Mines Corporation. The product is shipped world wide for use in coated abrasives and powder applications (Austin, 1993a,b).

Garnet has been designated as the official New York State gemstone. Barton produces no gem material but collectors are still able to find rough material of gem quality. Stones cut from Gore Mountain rough material generally fall into a one to five carat range. A small number of stones displaying asterism have been found. Garnets from this locality are a dark red color with a slight brownish tint. Special cutting schemes have been devised for this material in order to allow sufficient light into the stone.

HISTORY

The early history of the Barton garnet mine has been compiled by Moran (1956) and is paraphrased below. Mr. Henry Hudson Barton came to Boston from England in 1846 and worked as an apprentice to a Boston jeweler. While working there in the 1850's, Barton learned of a large supply of garnet located in the Adirondack Mountains. Subsequently, he moved to Philadelphia and married the daughter of a sandpaper manufacturer. Combining his knowledge of gem minerals and abrasives, he concluded that garnet would produce better quality sandpaper than that currently available. He was able to locate the source of the Adirondack garnet stones displayed at the Boston jewelry store years before. Barton procured samples of this garnet, which he pulverized and graded. He then produced his first

garnet-coated abrasive by hand. The sandpaper was tested in several woodworking shops near Philadelphia. It proved to be a superior product and Barton soon sold all he could produce.

H.H. Barton began mining at Gore Mountain in 1878 and in 1887, bought the entire mountain from the State of New York. Early mining operations were entirely manual. The garnet was hand cobbed *i.e.* separated from the waste rock by small picking hammers and chisels. Due to the obstacles in moving the ore, the garnet was mined during the summer and stored on the mountain until winter. It was then taken by sleds down to the railroad siding at North Creek whence it was shipped to the Barton Sandpaper plant in Philadelphia for processing. The "modern" plant at Gore Mountain was constructed in 1924. Crushing, milling, and coarse grading was done at the mine site. In 1983, the Gore Mountain operation was closed down and mining was relocated to the Ruby Mountain site, approximately 6 km (4 mi) northeast, were it continues at present.

MINING AND MILLING

The mine at Gore Mountain is approximately one mile in length in an ENE-WSW direction. The ore body varies from 15 m (50 ft) to 122 m (400 ft) and is roughly vertical. Mining was conducted in benches of 9 m (30 ft) using standard drilling and blasting techniques. Oversized material was reduced with a two and one-half ton drop ball. The ore was processed through jaw and gyratory crushers to liberate the garnet and then concentrated in the mill on Gore Mountain. Garnet concentrate was further processed in a separate mill in North River at the base of the mountain. Separation of garnet was and is accomplished by a combination of concentrating methods including heavy media, magnetic, flotation, screening, tabling and air and water separation. Processes are interconnected and continuous or semi-continuous until a concentrate of 98% minimum garnet for all grades is achieved (Hight, 1983). Finished product ranges from 0.6 cm to 0.25 micron in size.

CHARACTERISTICS OF GORE MOUNTAIN GARNET

The garnet mined at Gore Mountain is a very high-quality abrasive. The garnets display a well-developed tectonic parting that, in hand specimen, looks like a very good cleavage. This parting is present at the micron scale. Consequently, the garnets fracture with chisel-like edges yielding superior cutting qualities. The garnet crystals are commonly 30 cm in diameter and rarely up to 1 m with an average diameter of 9 cm (Hight, 1983) The composition of the garnet is roughly 43% pyrope, 40% almandine, 14% grossular, 2% andradite, and 1% spessartine (Levin, 1950; Harben and Bates, 1990). Chemical zoning, where present, is very weak and variable (Luther, 1976). The garnet has been so well analyzed isotopically that it is frequently used as an ^{18}O / ^{16}O standard (Valley et al., 1995). Typical chemical analyses of the garnet are presented in Table 1. Hardness of the garnet is between eight and nine and the average density is 3.95 gm/cm^3.

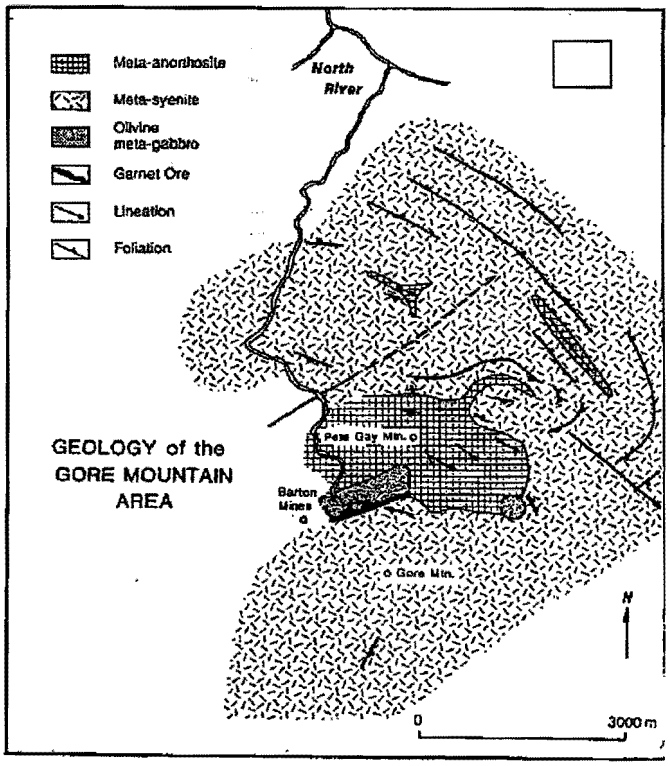
Table 1. Electron Microprobe analyses of Gore Mt. garnet (almandine-pyrope) normalized to 8 cations and 12 anions. * Calculated by charge balance (Kelly and Petersen, 1993).

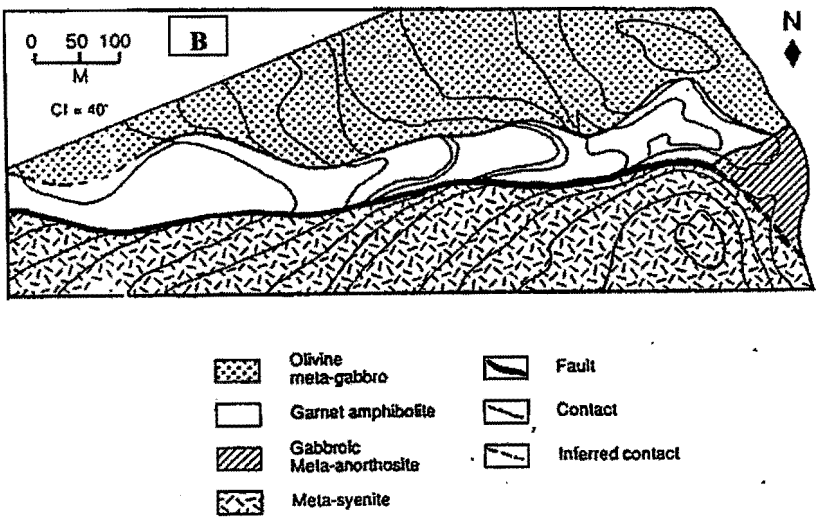
Oxide Weight Percent	#29	#41
SiO_2	39.43	39.58
Al_2O_3	21.40	21.20
TiO_2	0.05	0.10
FeO*	22.80	24.45
Fe_2O_3*	1.44	0.72
MgO	10.65	9.60
MnO	0.48	0.74
CaO	3.85	3.97
Na_2O	0.00	0.00
K_2O	0.00	0.00
Total	100.09	100.36

GEOLOGY

The garnet mine is entirely hosted by a hornblende-rich garnet amphibolite unit along the southern margin of an olivine meta-gabbro body (Fig. 1). The garnet amphibolite grades into garnet-bearing gabbroic meta-anorthosite to the east. To the south the garnet amphibolite is in contact with a meta-syenite; a fault occurs parallel to this contact in places.

Figure 1. Geologic maps of Barton garnet mine
(A. modified from Bartholome, 1956, B. Goldblun & Hill, 1992)





The olivine meta-gabbro bordering the ore zone is a granulite facies lithology with a relict subophitic texture. Preserved igneous features, faint igneous layering, and a xenolith of anorthosite have been reported in the meta-gabbro (Luther, 1976). Prior to metamorphism, the rock was composed of plagioclase, olivine, clinopyroxene and ilmenite. During metamorphism, coronas of orthopyroxene, clinopyroxene and garnet formed between the olivine and the plagioclase and coronas of biotite, hornblende and ilmenite formed between plagioclase and ilmenite (Whitney & McLelland, 1973, 1983). The contact between the olivine meta-gabbro and the garnet amphibolite ore zone is gradational through a narrow (1 to 3 m wide) transition zone. Garnet size increases dramatically across the transition zone from less than 1 mm in the olivine meta-gabbro, to 3 mm in the transition zone, to 50 to 350 mm in the amphibolite (Goldblum and Hill, 1992). This increase in garnet size coincides with a ten-fold increase in the size of hornblende and biotite, the disappearance of olivine, a decrease in modal clinopyroxene as it is replaced by hornblende, and a change from green spinel-included plagioclase to white inclusion-free plagioclase (Goldblum and Hill, 1992). Mineralogy in the garnet amphibolite ore zone is mainly hornblende, plagioclase and garnet with minor biotite, orthopyroxene, and various trace minerals. In both the olivine meta-gabbro and the garnet amphibolite, garnet content averages 13 modal percent, with a range of 5 to 20 modal percent (Luther, 1976; Hight, 1983; Goldblum, 1988). The garnet amphibolite unit is thought to be derived by metamorphism of the southern margin of the granulite facies olivine meta-gabbro. At the west end of the mine, a garnet hornblendite with little or no feldspar is locally present. This rock may represent original ultramafic layers in the gabbro (Whitney et al., 1989). In the more mafic portions of the ore body, the large garnet crystals are rimmed by hornblende up to several inches thick. Elsewhere, in less mafic ore, the rims contain plagioclase and orthopyroxene. Chemical analyses of the olivine meta-gabbro and garnet amphibolite show

Travel to end of Barton Mine Road	5	31.8

Note: the intersection of Barton Mine Road and Rt. 28 is marked by a small cluster of buildings. Among these are a Mom 'n' Pop general store with gas pumps and Jasco's mineral shop. On the east side of Rt. 28 facing south there is a sign opposite Barton Mine Road indicating the Barton Mine (Gore Mt.) mineral shop.

STOP 1. BARTON MINES, GORE MT. (1.5-2 hours) Note: there is a charge of $1.00 per pound of material collected, payable at the mineral shop.

Travel back to Rt. 28	5	36.8
Turn right at stop sign, go to Rt 28N at North Creek	6.6	43.4
Turn left on Rt 28N, go straight at 4-way stop	0.1	43.4
Turn right at Blue Ridge Road	21.5	64.9
Note: Sign for NL Ind., MacIntyre Development and sign for High Peaks Wilderness Area		
Turn left at Tahawus Road	1.1	66
Turn left at Upper Works Road	6.5	72.5
Proceed to dirt road to Cheney Pond	0.6	73.1
Boulders on right, gate on left		

STOP 2. KRONOS, INC., CHENEY POND DEPOSIT (1.5-2 hours)

Proceed north on Upper Works Road	2.0	75.1
Furnace stack is on the right, by the edge of the road, wheel house is close to the river.		

STOP 3. ADIRONDACK IRON AND STEEL CO. "NEW" FURNACE (1 hour)

Please take only photographs at this stop. Do not take artifacts as souvenirs.