REMELTING OF THE VINALHAVEN GRANITE BY BASALTIC INJECTIONS, VINALHAVEN, MAINE

MATTHEW MANON
Department of Geosciences, Franklin and Marshall College
Sponsor: Bob Wiebe, Franklin and Marshall College

INTRODUCTION

The Vinalhaven intrusive complex, is one of several bimodal plutonic complexes located along the coast of Maine (Mitchell & Rhodes, 1989; Gates, 2000). The complex, about 10 km in diameter is made up of mostly biotite granite. Around the east and south margins of the island are many mafic layered sheets recording magmatic input. Volcanic deposits of comparable age to the chamber appear to the north west side of the island. These relationships indicate the pluton is tilted gently to the northwest.

My study focused on the youngest intrusive body found within the Vinalhaven complex, found in the central part of the pluton, surrounded by relatively homogeneous granite.

FIELD RELATIONS

The Vinal Cove intrusion (Figure 1) is an ENE-trending, 3 km long, sheet-like body of megacryst dominated mafic and hybrid intermediate rocks that locally grade upward to fine-grained granitic rocks (fgg) in sharp contact with a roof of coarse-grained granite (cgg). Along the western side of the body, crystal content appears to increase continuously from megacrystic hybrid rocks, grading continuously back to normal granite. Exposed in Vinal Cove (Figure 2), at the base of the intrusion is a thick body of coarse-grained mafic material with chilled margins, which appears to feed mafic and hybrid sheets within the lower part of the intrusion, dipping 15-20 NW. A bimodal dike (basalt chilled in a felsic matrix) cuts across these sheets trending roughly North-East. Upward in this

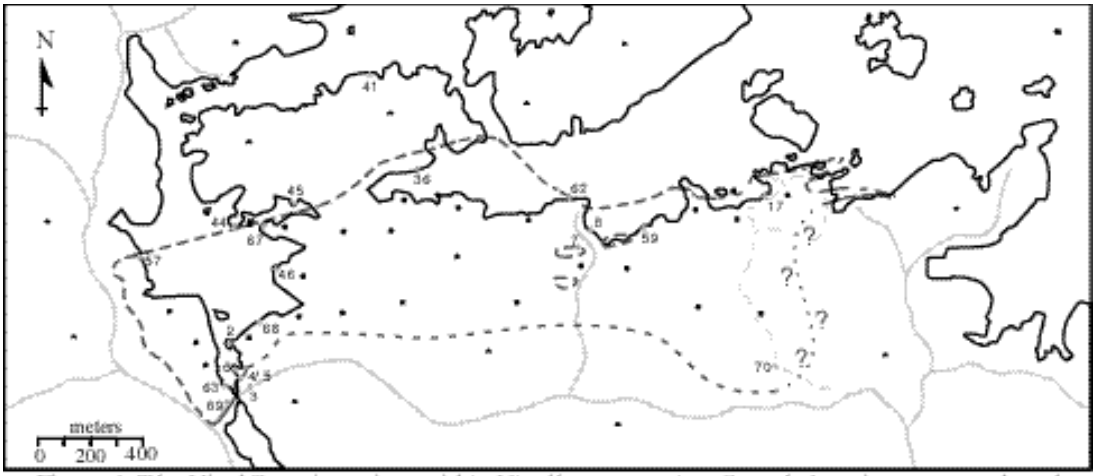

Figure 1. The VinalCove intrusion, within Vinalhaven granite. Sample locations are numbered.

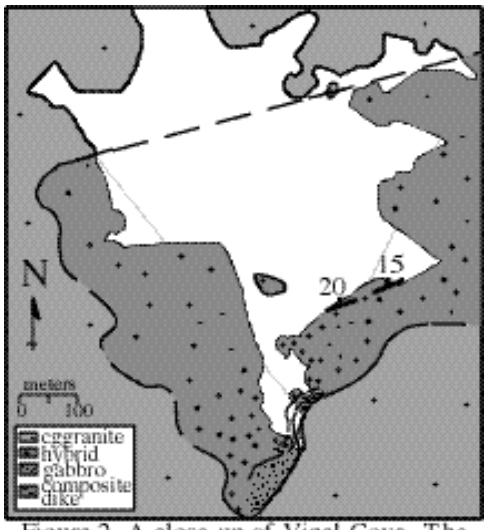

Figure 2. A close-up of Vinal Cove. The different characters of rock type can be seen towards the base of the intrusion.

body, the matrix becomes increasingly silicic and the proportions of megacrysts decrease and are locally absent. The sharp northern contact remains discrete for 2 km. It is hard to define the southern contact since everywhere East of Vinal Cove it is obcsure, due to a general lack of outcrop away from the coast.

The most distinctive feature consistently present in some proportion throughout the intrusion are the megacrysts. Though their distribution is the types of megacrysts are consistent. They include plagioclase feldspars alkali feldspars and quartz. Small clusters of relatively fine-grained mafic material are also within the matrix.

The cgg found to the north, near the roof of the intrusion, has generally smaller crystals than normal Vinalhaven granite, and in some areas it even has a fine grained matrix surrounding grains. Areas within the intrusion locally increase in crystallinity until they appear no different than cgg.

PETROGRAPHY

The coarse-grained granite cut by the Vinal Cove intrusion, contains plagioclase feldspar, alkali feldspar, quartz and biotite, with some hornblende. Plagioclase crystals often have rounded cores surrounded by a more calcic rim. Alkali feldspars are coarsely exsolved.

The most mafic rocks in the Vinal Cove intrusion are gabbros, ranging from coarse to fine grained. Minerals found in the gabbro include olivine, augite and plagioclase. Plagioclase and olivine tend to be euhedral. In the fine-grained samples, plagioclase occurs in an acicular radiating pattern.

The hybrid rocks from within the intrusion share many characteristics, despite their wide variation in the ratio of megacrysts to matrix (Figure 3). Megacrysts include plagioclase and alkali feldspar, quartz and some biotite. The megacrysts are commonly rounded and show irregularities and pits. The large plagioclase megacrysts are aggregates of smaller plagioclase crystals, accompanied by some interstitial biotite and quartz. Alkali feldspars show thick exsolution textures and are often surrounded by a rim of plagioclase. Some quartz crystals are surrounded by a concentration of mafic minerals, usually biotite and some hornblende, with rare augite. Other quartz crystals are often surrounded by a quartz-feldspar intergrowth, which is in optical continuity with the central quartz megacryst.

A quartz-feldspar intergrowth of irregularly shaped crystals which are often in optical continuity is present in the matrix of many samples. The amount of this granophyre

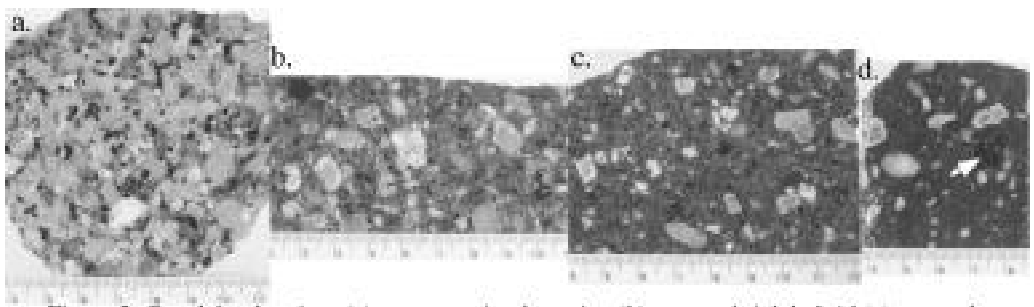

Figure 3. Cut slabs showing: (a) coarse-grained granite (b) a crystal rich hybrid (c) a sample containing fewer megacrysts (d) a sample with finer grained matrix, showing rounded very fine-grained mafic enclaves (arrow) and white rims of plagioclase around K-spar.

varies from sample to sample. In more megacryst-rich samples, this texture often fills the gaps between rounded crystals.

GEOCHEMISTRY

The samples from within the intrusion vary from 47 to 75 wt% SiO_2 (Table 1). The samples of cgg taken from just outside the intrusion range from to 73 to 74 wt% SiO_2. The chemistry of these granitic samples is similar to that of the most felsic rocks from within the intrusion. There is little chemical distinction between the coarse and fine grained mafic samples.

The chemistry of the hybrid samples taken from within the intrusion represent a variety of grain sizes and megacryst style and content. However, for almost all elements, the samples define a linear trend between the mafic and granitic end members (Figure 4).

ORIGIN OF HYBRID

The hybrid rock which characterizes the Vinal Cove intrusion is quite unusual in the Vinalhaven system. Many relationships indicate that intrusion's distinctive megacrysts are granitic rocks remobilized by mafic magma.

The diffuse, gradational contact of the intrusion with the cgg to the west of Vinal Cove is evidence of remelting granite. Local gradations within the intrusion between granite-like blocks and hybrid rocks also suggest cgg was disaggregating into the hybrid rocks. Substantial mafic input is suggested by the large body of coarse mafic rock present at the base of the intrusion, chilled on its edges. This high temperature input could have provided the energy necessary for melting. The distribution of chilled mafic enclaves within the hybrids indicates active mixing of this input (Figure 3).

The mineralogy of the hybrid megacrysts mirrors that of the large crystals in the granite. The preserved exsolution of many resorbed alkali feldspars is similar to that in the granite. Disequilibrium reactions such as the resorption of megacrysts and mafic rims on quartz suggest the megacrysts were unstable.

The linear trend between mafic input and cgg in the geochemical data is consistent with bulk mixing of the two end members, supporting the coarse granite origin of the hybrid megacrysts. Fractionation was unimportant in this intrusion, instead mechanical mixing on a large scale distributed elements without homogenizing the intrusion.

REFERENCES

Mitchell C. B., & Rhodes J. M., 1989, Geochemistry of the Granite-Gabbro Complex on Vinalhaven Island, Maine,

Table 1. Data from representative samples.

Rock Type	cg mafic	fg mafic	cgg	hybrid	hybrid	hybrid
Sample	69	6B	3.00	63.00	68C	68A
SiO2	47.24	49.91	74.14	73.63	67.01	57.75
TiO2	1.58	1.30	0.33	0.35	0.78	1.31
Al2O3	16.64	16.65	13.13	13.43	14.04	15.07
Fe2O3	11.39	9.95	2.27	2.26	4.91	8.46
FeO	0.00	0.00	0.00	0.00	0.00	0.00
MnO	0.19	0.17	0.06	0.05	0.10	0.14
MgO	8.77	7.98	0.48	0.54	2.37	5.21
CaO	11.08	10.38	1.14	1.29	3.65	6.72
Na2O	2.82	2.91	3.24	3.46	3.38	3.09
K2O	0.14	0.59	5.13	4.90	3.65	2.07
P2O5	0.16	0.16	0.08	0.08	0.12	0.17
Ni	140.5	127.5	3.80	3.90	27.40	74.10
Rb	4.00	26.90	199.7	204.1	171.2	91.50
Sr	225.2	201.8	48.90	52.80	91.80	165.4

Maine Geological Survey; Studies in Maine Geology, Volume 4,. p. 45-57

Gates, O., 2000, Geologic map of Vinalhaven Island. Maine Geological Survey, Department of Conservation.

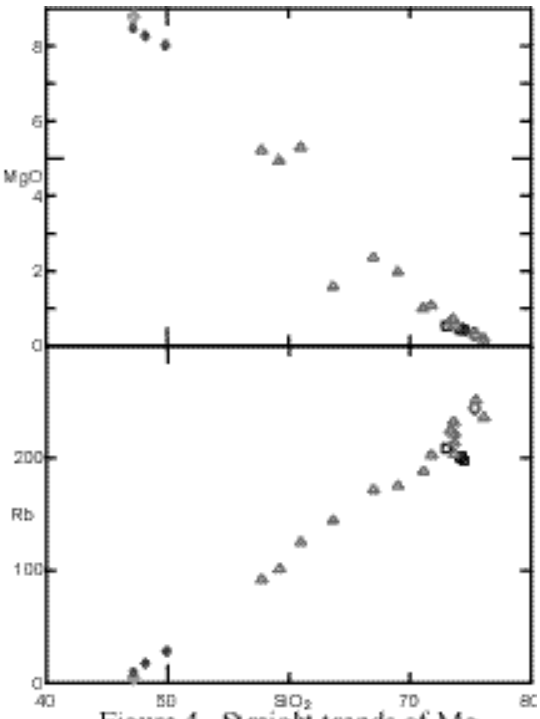

Figure 4. Straight trends of Mg and Rb vs. SiO_2