PETROGRAPHIC AND GEOCHEMICAL ANALYSIS OF FIVE SE VERMONT GRANITES

Tamir Klaff
Department of Geology
Franklin and Marshall College
Lancaster, PA 17604-3003

Introduction

The geology of south-eastern Vermont is typified by metamorphic rocks produced by the Taconic and Acadian orogenies. There are, however, several plutonic granitic bodies scattered througout the area. Due to a lack of geochemical data on these plutons I sampled five scattered bodies for petrographic and geochemical analysis.

Areas of Study:

I collected samples from five different granitic intrusions. The first intrusion, which I call the Plymouth Church granite, was collected in a quarry 2 miles north of Plymouth, Vermont. The body intrudes into and has sharp cross-cutting contacts with the Ordovician Pinney Hollow Formation, a rusty carbonaceous schist which dips to the northeast.(Doll, 1961) The intrusion is about 500 feet long and 100 feet wide and is mapped about 1/8 of a mile from the garnet isograd, on the garnet grade side (Chang et al., 1965). The granite appears homogeneous throughout the main body and has dikes with varying thickness protruding off into the country rock. There are no apparent signs of deformation within the body. The granite has previously been called a granodiorite. Chang et al. (1965) interpret the emplacement of the body as having been coincident with the waning stages of deformation and metamorphism of the Acadian orogeny.

The second set of samples was collected from a small granite outcrop just to the west of Proctorsville, Vermont. I called this the Castle granite. The body is mapped as 800 feet long by 200 feet wide. It intrudes at an elevation of around 1080 feet on the western slope of a hill close to the contact between serpentinite and the Barnard Formation which consists of metamorphosed, interbedded light-and dark-colored metavolcanic rocks with a small amount of schist and phyllite of sedimentary origin.(Chang et al., 1965) The granite has a light foliation and contains large flattened mica nodules up to 9cm long and 3cm high.

I collected the third set of samples from a granitic intrusion three miles east of North Springfield . The intrusion crops out along a ridge and has quartz veins and large xenoliths of up to 8 inches in diameter. I sampled several dikes which ran off of the main body.

The fourth group of samples were collected from Black Mountain about 51/2 miles northwest of Brattleboro along the West River. A body of leucogranodiorite crops out on both sides of the river and trends in a north-south direction. The northern portion of the intrusion forms what is called Black Mountain (elevation 1,269 feet). The exposed area of the intrusion is approximately 2 miles long and 11/2 miles wide. The leucogranodiorite intrudes into a series of interbedded, somewhat gneissoid schists which vary greatly in texture and composition.

partitioning of components between phases to constrain the pressure-temperature evolution of these rocks.

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The last sample location was from an intrusion 1 mile north of North Vernon, Vermont. There was limited outcrop at this site and it was difficult to sample. The granite from this intrusion seems very different from the other locations. There is a relatively strong foliation of the micas and feldspars.

Petrography:

Some of the samples which were taken from each of the sites were made into thin sections and analyzed petrographically. The main minerals in all of the sections are quartz, plagioclase, microcline, and muscovite. Accessory minerals consist of apatite, epidote, chlorite, and biotite. The average plagioclase composition for all of the suites, determined by extinction angles, is in the albite-oligoclase range. The plagioclase in the Plymouth Church sections was highly sericitic indicating a strong possibility of retrograde metamorphism. All of the muscovite crystals appear to be of a secondary nature, filling in fracture zones between plagioclase and quartz crystals. In hand sample the samples vary from white to tan depending on the location and they are all medium to coarse grained. The Vernon section was the only one which appeared to have a strong foliation to it.

Geochemical Analyses:

Major and trace element analyses of the rocks were done on a Diano-XRD 8000. Trace elements were also analyzed on a Jarell Ash IACP 61. Sample analyses most indicative of the average rocks are shown in table 1.

Based on the major element analyses, I have determined that the samples from the Plymouth Church, Castle, and Town Line intrusions are trondjhemites. I used F. Barker's (1979) major element characteristics of trondhjemite which are as follows:

1. SiO_2 > ca. 68%, usually < 75%;
2. Al_2O_3 typically > 15% @ 70% SiO_2 and < 14% @ 75% SiO_2;
3. (FeO*+MgO) < 3.4%, and FeO*:MgO commony is 2-3;
4. CaO ranges from 4.4-4.5% in calcic trondhjemites to typical values of 1.5-3.0%;
5. Na_2O typically is 4.0-5.5%; and
6. K_2O <ca. 2.5 %, and typically < 2%.

The IUGS classification of a trondhjemite (Streckeisen, 1976, pp 181-185) defines it as a leucotonalite with plagioclase in the oligoclase-andesine range. The definition also includes a quartz content of 20 percent or more of the leucocratic minerals, that alkali feldspar constitute less than 10 percent of the total feldspar, and that the color index be 10 or less. My classification is based on the petrography observed, the geochemistry of the main body samples, and Barker's (1979) suggestion that albite-bearing as well as oligoclase bearing leucotonalites be termed trondhjemite.

The Black Mountain samples were too high in K_2O and contained too great of a percentage of alkali feldspar for them to come under the definition of a trondhjemite. Their petrography and whole rock chemistry place them under the classification of leucogranodiorite.

TABLE 1

Weight Percent for Indicative Main Body Samples - Major Elements

	PLYMOUTH CHURCH		CASTLE	TOWNLINE	BLACK MOUNTAIN	VERNON
Sample:	2L2	2S1		2Y2	2AB2	2AK3
SiO_2	72.55	72.90		67.95	74.27	72.50
TiO_2	0.05	0.06		0.08	0.09	0.24
Al_2O_3	16.13	15.76		19.09	15.35	16.07
Fe_2O_3	0.16	0.15		0.30	0.57	0.78
FeO	0.22	0.32		0.23	0.50	0.92
MnO	0.02	0.01		0.08	0.02	0.03
MgO	0.11	0.15		0.20	0.18	0.59
CaO	1.79	1.30		2.49	1.11	2.53
Na_2O	5.58	6.08		6.17	4.08	4.37
K_2O	2.02	1.59		1.56	4.09	2.19
LOI	0.88	0.46		.070	0.60	1.60
P_2O_5	0.05	0.07		0.09	0.10	0.11
Total	99.56	98.85		98.94	100.96	101.93

CIPW WEIGHT % NORM

	2L2	2S1	2Y2	2AB2	2AK3
Ap	.1166	.1632	.2099	.2332	.2565
Il	.0952	.1142	.1524	.1714	.4570
Mt	.2325	.2180	.4361	.8785	1.13
Or	11.93	9.39	9.22	24.16	12.94
Ab	47.21	51.45	52.22	34.53	36.98
An	8.55	5.99	11.77	4.85	11.83
Hy	.4999	.7562	.6882	.7833	2.17
C	1.60	1.81	2.89	2.39	2.14
Q	28.43	28.50	20.65	32.41	32.42
Total	98.68	98.39	98.24	100.36	100.33

Origin

A granitic rock is said to be peraluminous if it has the ratio:

$ASI = Al_2O_3/(CaO+K_2O+Na_2O) > 1.0$

All five of the analyzed intrusions are highly peraluminous with ASI values much greater than 1.0.

The CIPW normative mineral calculation shows a corundum normative in all of the samples (see table 1). The presence of greater than 1% corundum in the norms for all five intrusions strongly suggests that they are S-type peraluminous granites originating from partial melting of a sedimentary source.

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STRUCTURAL CHARACTERISTICS OF THE MORETOWN AND BARNARD MEMBERS OF THE MISSISQUOI FORMATION, CHESTER AND ATHENS DOMES, VERMONT

Thomas J. Powers
Department of Geology
Whitman College
Walla Walla, WA 99362

INTRODUCTION

The rocks of the Moretown and Barnard Members of the Ordovician Missisquoi Formation have been multiply deformed around the Chester and Athens Domes. This deformation has occurred in several stages, with the last two major stages transpiring during the Acadian orogeny. Structural data from the Moretown and Barnard could provide clues to the nature of these deformations.

PETROGRAPHIC DESCRIPTION

The Ordovician Moretown Member is predominantly composed of alternating thin (one to twenty centimeter thick) layers of quartz-rich and biotite-muscovite-chlorite-epidote-quartz-garnet schist (Doll, at al., 1961). The resulting "pinstripe" effect is highly distinctive of this formation. The parent material of the Moretown is thought to be volcanic material from an island arc situated off-shore during the Ordovician interbedded with sediment from the continent. These eugeosynclinal deposits were sutured onto the continent during the Taconic orogeny (Stanley and Ratcliffe, 1985).

The Ordovician Barnard Member is composed of thick (30 centimeter to several meter) layers of mafic schists separated by thin (several centimeters) layers of felsic schist. The mafic layers contain large amounts of hornblende with actinolite, plagioclase, and biotite. The felsic layers are mostly quartz with some plagioclase, hornblende, and actinolite (Carroll, 1989). It is lithologically very similar to the Ammonoosuc Volcanics present to the east and may have resulted from bimodal volcanic activity related to overthickening of the crust (Stanley and Ratcliffe, 1985).

REGIONAL GEOLOGY

The folding present in the Chester and Athens Domes is primarily a result of the Devonian Acadian orogeny (Karabinos, 1989). The Acadian orogeny appears to consist of two main deformational phases: an early nappe-building phase and a later gneiss doming phase (Thompson, et al, 1968). In most locations in the Chester and Athens Domes fabrics from the earlier phase of nappe building has been heavily overprinted by fabrics from the later phase, and is some locations the earlier fabric is missing completely.

PURPOSE AND METHODS

The purpose of this study is to survey the structural characteristics of the Moretown and Barnard around the Chester and Athens Domes and relate them to the different phases of the Acadian orogeny. Several localities were sampled, including areas near Townsend, Harmonyville, Springfield, Houghtonville, in Proctersville Gulf, and along the William's River (see figure 1). Sampling included hand samples for thin-section analysis and data on foliations, mineral lineations, fold axes, and axial planes.

RESULTS

Figures 1 and 2 present a summary of structural data recorded. It is fairly clear from this data that most of the minor structures sampled are fairly co-linear or co-planar and line up with the large-scale structures of the Chester and Athens Domes. This conclusion is supported by preliminary thin-section data. Certain structures, for example lineations and folds at stops 2 and 3 (see figure 2b and 2c), are not parallel to regional trends. The latter are often overprinted with the former, suggesting that the non-parallel fabrics are from an earlier stage of deformation.