TECTONO-METAMORPHIC EVOLUTION OF THE DEVIL'S DEN AREA, VERMONT

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The Cambrian Hoosac Formation of the Devil's Den area in south-central Vermont (Fig.1) consists of pelitic schists surrounded by Proterozoic basement of the Green Mountain massif. The structure of the Devil's Den area has been interpreted by Slack and Sabin (1983) as a doubly plunging recumbent nappe broken by thrust faults. The rocks considered in this study are correlative with the Hoosac Formation on the eastern flank of the Green Mountains near Jamaica studied by Karabinos (1984), and the Gassetts schist of the Chester Dome studied by Thompson (1977), Downie (1982), and Crowley (1989).

Southern Vermont was subjected to two major Paleozoic deformations, the Ordovician Taconic orogeny and the Devonian Acadian orogeny, that produced multiple generations of mineral growth and fabrics in the Cambro-Ordovician rocks.

The purpose of this study is to use chemical data obtained from the electron microprobe as well as petrographic analysis of textures and fabrics to examine the evolution of the rocks with respect to the Taconic and Acadian orogenies. An understanding of the evolution of rocks from the Devil's Den area will allow comparison with similar rocks to the east that were metamorphosed to similar or higher grade and that contain evidence of polymetamorphic histories.

The Hoosac Formation in the Devil's Den area consists of a high-alumina schist containing the AFM assemblages garnet-chlorite-chloritoid and garnet-chloritoid as well as a low-alumina schist containing the AFM assemblages garnet-biotite-chlorite and garnet-biotite. Additional phases include white mica (muscovite and paragonite), quartz, plagioclase, and ilmenite or rutile, tourmaline, and epidote.

The Hoosac rocks in the Devil's Den area have a prominent schistocity defined by white mica, chlorite, and chloritoid that is folded in tight isoclinal folds. The minerals in the fold noses are bent and sheared. As there is no evidence of a cross cutting axial planar cleavage, the formation of schistocity and folding could have been concurrent. The fabrics are consistent with the westward transport of rocks by tractor-tread folding and may have been produced by prolonged simple shear.

Karabinos (1984) studied Hoosac Formation rocks from Jamaica (Fig.1) with the same assemblage as the high-alumina rocks considered here that contain garnets that have textural unconformities as well as reversals in their chemical zoning that Karabinos (1984) interprets as polymetamorphic growth separated by retrogression. The garnet in the high-alumina rock from the Devil's Den contains no textural unconformity or zoning reversals (Fig.2), suggesting that the high-alumina Hoosac experienced different tectono-metamorphic evolution in the Devil's Den area from Jamaica consistent with the interpretation of fabrics presented here.

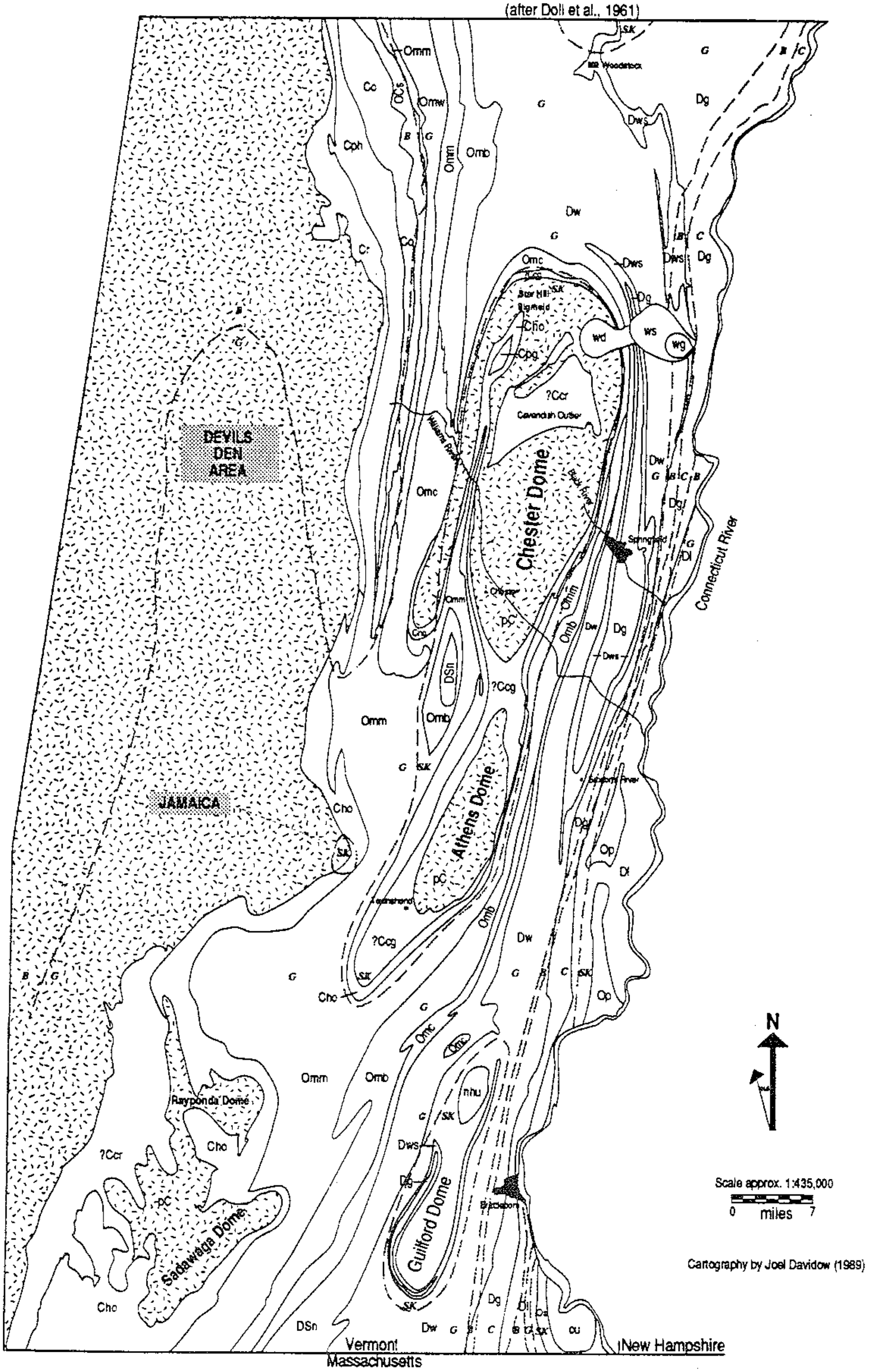
The existence of chloritoid as inclusions in garnet that coexists with groundmass chlorite and biotite is consistent with the prograde facing of the reaction biotite + quartz + H20 = garnet + chlorite + muscovite proposed by Spear and Cheney (1989). The non-AFM components Mn, Ca, and Na present in these rocks probably stabilize the observed assemblages over a wide range of pressures and temperature.

Additional work will include the analysis of garnet zoning profiles and inclusion compositions to trace the chemical evolution of the rock as well as an analysis of the

TABLE I

Reactions for the assemblage quartz + muscovite + albite + chlorite + garnet + chloritoid + biotite + water

Number	Reaction	Invariance
(1)	2bio + 3tk + 6qtz = gar + 2mus	<ctd, chl, ab>
(2)	2ctd + tk + 4ab = gar + 4mus	<bio, chl, qtz, wt>
(3)	2chl + 9tk + 8ab + 4qtz = gar + 8mus	<bio, ctd, wt>
(4)	4ctd = gar + 2chl + 7tk + 4qtz	<bio, ab, mus, wt>
(5)	9ctd + 14ab = 4gar + 14mus + chl + 2qtz	<bio, tk, wt>
(6)	ctd + 2mus = 4tk + ab + chl + 2qtz	<bio, gar, wt>
(7)	3bio + 7qtz + mus = chl + 4ab + gar	<ctd, tk, wt>
(8)	6chl + 24ab + 21tk = 4bio + gar + 20mus	<ctd, qtz, wt>
(9)	bio + qtz + 3mus = chl + 4ab + 3tk	<ctd, gar, wt>
(10)	8bio + 20qtz + 3tk = 2chl + 8ab + 3gar	<ctd, mus, wt>
(11)	4bio + 5tk +12qtz = gar + 2ctd + 4ab	<chl, mus, wt>
(12)	3ctd + 4ab = bio + 3gar + 5mus + 3qtz	<chl, tk, wt>
(13)	bio + tk + mus + 3qtz = ctd + 2ab	<chl, gar, wt>
(14)	2chl + 4qtz + 3tk = 3gar + 8wt	<bio, ctd, ab, mus>
(15)	4mus = gar + 4ab +3tk + 4wt	<bio, ctd, chl, qtz>
(16)	ctd = tk + gar + 2wt	<bio, chl, ab, mus, qtz>
(17)	4bio + 3tk + 12qtz = 3gar + 4ab + 4wt	<ctd, chl, mus>
(18)	2bio + 3tk + 6qtz + wt = 2mus + gar	<ctd, chl, ab>
(19)	3chl + 3tk + 2ab = 3gar + 2bio + 11wt	<ctd, mus, qtz>
(20)	6mus = 6ab + chl + 6tk + 2qtz + 2wt	<bio, ctd, gar>
(21)	2chl + 4qtz + 6tk = 3ctd + 2wt	<bio, gar, ab, mus>
(22)	2bio + 4qtz + 2wt = chl + 2ab	<ctd, gar, mus, tk>
(23)	4mus = ctd + 4ab + 2tk + 2wt	<bio, gar, chl, qtz>
(24)	3mus = bio + 2ab + 3tk + 3qtz + 2wt	<ctd, gar, chl>
(25)	4bio + 6tk + 12qtz + 2wt = 3ctd + 4ab	<gar, chl, mus>
(26)	chl + 2mus + 2qtz = 2gar + 2ab + 6wt	<bio, ctd, tk>
(27)	3ctd + 2chl + 4qtz = 6gar + 14wt	<bio, ab, mus, tk>
(28)	3ctd + 4ab = 4mus + 2gar + 2wt	<bio, chl, qtz, tk>
(29)	bio + mus + 3qtz = gar + 2ab + 2wt	<ctd, chl, tk>
(30)	3ctd + 4bio + 12qtz = 6gar + 4ab + 10wt	<chl, mus, tk>


Generalized Geologic Map of the Chester Dome Region, Southern Vermont

(after Doll et al., 1961)

Figure 1: Generalized Geologic Map of Southern Vermont showing the Devil's Den Area (from Davidow, 1989)

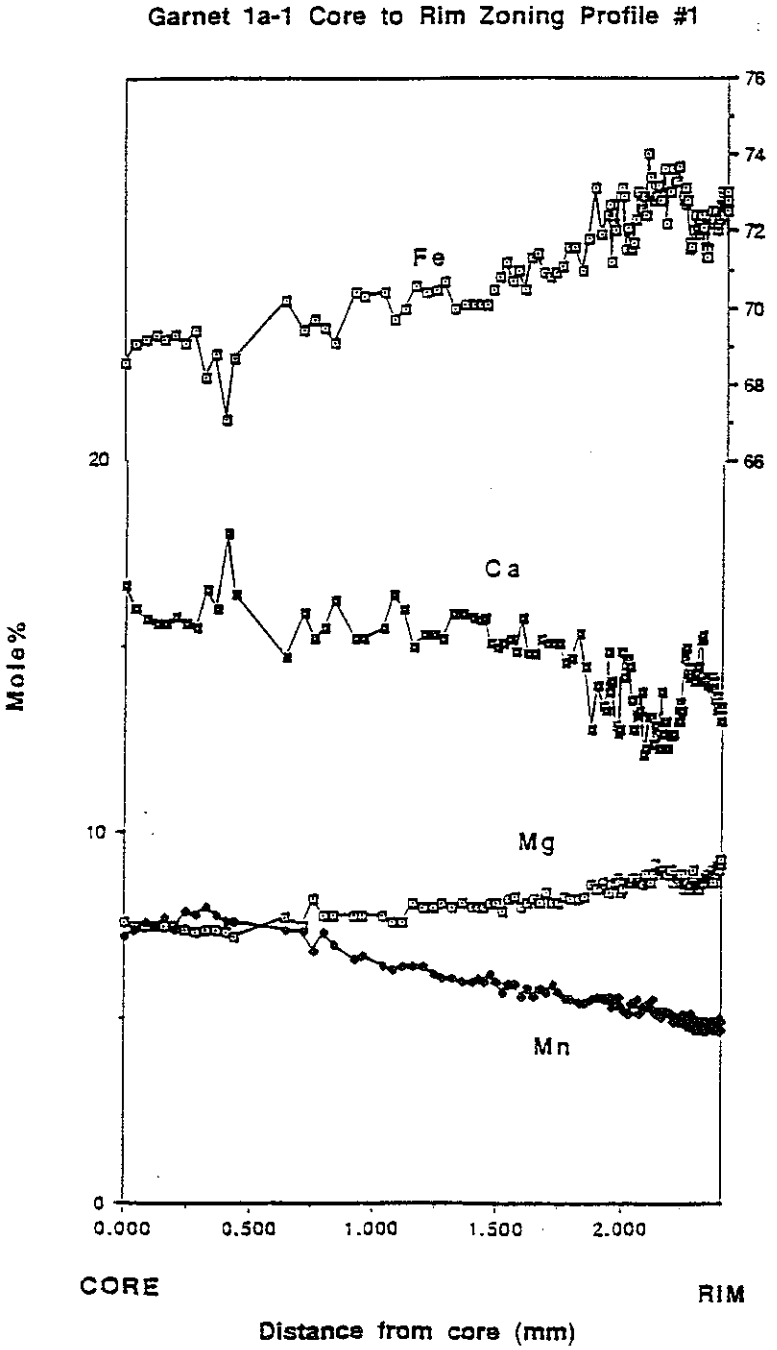


Figure 2: Zoning profile of a garnet from the high-alumina member of the Hoosac Fm. in the Devil's Den area

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

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PETROGRAPHIC AND GEOCHEMICAL ANALYSIS OF FIVE SE VERMONT GRANITES

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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.