CORRELATION AND STRAIGRAPHY OF STOPED BLOCKS IN THE VINALHAVEN PLUTON, MAINE TO THE SEAL COVE FORMATION

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INTRODUCTION

A Silurian (?) bimodal pluton, located on Vinalhaven Island, Maine, preserves clues to the history and dynamics of the once molten magma chamber (Smith, 1907, Gates, 2001, Wiebe, 2001). The island exposes a cross section through the pluton and its surrounding country rocks. Along the northern coastline, in contact with the intruded pluton, a bedded tuff sequence within the lower Seal Cove formation (Gates, 2001) is exposed along strike for over 150 meters. Field observation and petrographic analysis of the bedded tuffs are used to describe this member of the Seal Cove formation in more detail than has previously been recorded. Large, up to 20 meters in length, stoped blocks of bedded tuffs, found near the base of the pluton along the west side of the southern portion of Vinalhaven and on Greens Island to the west, are coherent and preserve much of their original layering. Using layer thickness and composition, we have determined that these blocks originated from the lower Seal Cove tuff exposed along the northern coastline. We interpret that during the process of emplacement, large blocks of the bedded were stoped and sank into the granite magma while the pluton was still fairly small.

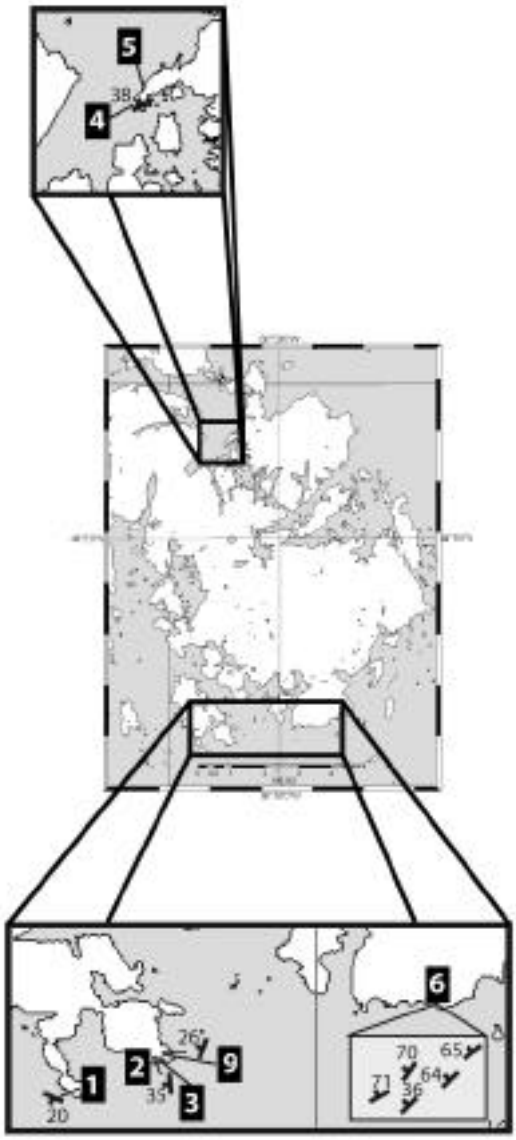


Fig. 1: Map of sites with attitudes of blocks and in situ lower Seal Cove tuff.

FIELD RELATIONS

At field sites 4 and 5 (Fig. 1, 2a, and 2b), on an unnamed peninsula protruding southwest

from the Calderwood Peninsula, the lower Seal Cove formation is exposed along strike for 169.3 meters, with an average dip of 38 ° W. The thickness of the layers varies from a few centimeters to over 14 meters thick. However, the majority of the layers are between 0.3 meters and 1.5 meters. Sedimentary features, such as cross and mud cracks are visible, although slight metamorphism obscures the details of these features. The beds within the sequence are composed of impure quartzites, impure quartzites with nodules of epidote and chlorite, calc-silicates, channel deposits, granite sills/dikes, and garnet-rich cherts. The presence of epidote and chlorite is likely a late stage alteration product resulting from metasomatism.

Fig. 2b: Outcrop picture of the partial stratigraphic column in Fig. 2a, site 4.

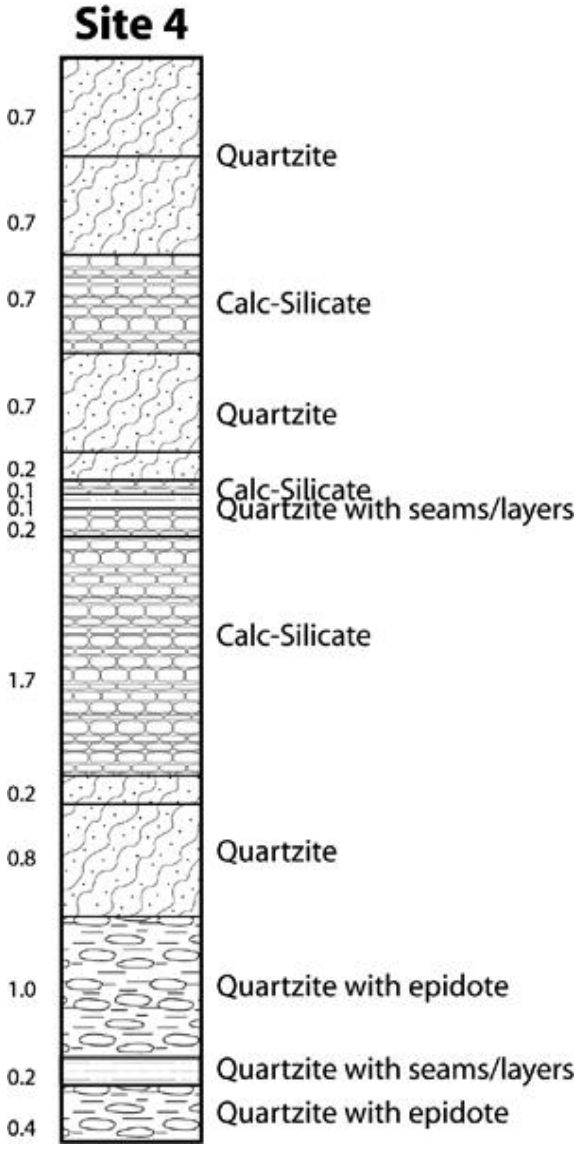


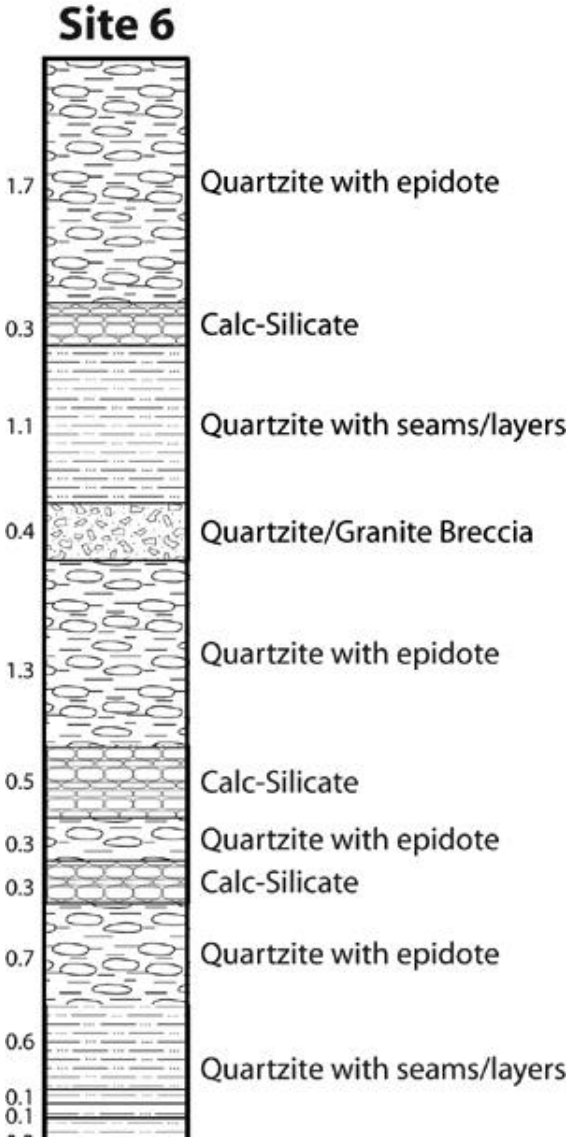
Fig 2a: Partial stratigraphic column (in meters) at site 4

Greens Island, located to the west of Vinalhaven, contains blocks of lower Seal Cove tuff at sites 1, 2, 3 and 9. Site 1 contains a 7 x 20 meter block surrounded by granite. Impure quartzite and epidote compose the majority of the 0.1 - 0.6 meter layering present. Crosscutting relationships of the mafic and felsic dikes with the medium grained granite suggest that the dikes were originally part of the source rock before stoping and subsidence of the block. A low coastal outcrop, site 2 exposes less than 2 meters of measurable quartzite and calc-silicate layers, varying in thickness from 0.1-0.2 meters; however it continues along strike for 8-10 meters. The outcrop appears to be the middle section of a larger block of bedded tuffs that was eroded away. Site 3 shows intense folding of rock layers similar to those at site 2. The eastern edge of site 3 is comprised of a block of breccia with epidote/chlorite clots up to 8 cm by 1 cm. The breccia portion of the block may be in fault contact with the folded section because the space between the units is heavily eroded. A large, open folded block comprises site 9 on Greens Island. The surrounding granite intrudes the edges of the blocks. Beds of quartzite, calc-silicate, and chert-like calc-silicate range from 0.1 - 0.4 meters in

thickness. Near the middle of the block, a mafic dike crosscutting the layers is found.

Round Neck, almost due south of the lower Seal Cove tuff at its type locality, exposes bedded tuff blocks at site 6 (Fig. 3a and 3b). Layers of impure quartzite and calc silicate, from 0.1 –1.7 meters thick, comprise the beds. The basal layer of quartzite contains sills of granite that originate in the surrounding granite.

The blocks of lower Seal Cove tuff found along the southern coast show a progression of strikes that radiate west from the strike of the in situ lower Seal Cove tuff found in the north (Fig. 1). All the blocks are emplaced in granite; however, the area immediately surrounding the block is bimodal containing granite, gabbro, and hybridized gabbro.



The blocks were also explored along the edges

Fig. 3b: Outcrop picture of stratigraphic column in Fig. 3a, site 6, Round Neck.

in order to ascertain any further relationships with the surrounding granite. The contacts, where clear of boulders, are relatively sharp and do not suggest melting of the blocks.

PETROGRAPHY

Thirty of the samples obtained from the measured sections were made into covered thin sections and one was made into a polished section for analysis with a Scanning Electron Microscope (SEM) with EDAX. After primary analysis, five additional polished thin sections were made.

The samples from the in situ lower Seal Cove tuff represent a number of distinct layers. While the samples vary slightly within a given layer, similar samples have been grouped together. The impure quartzite layer is characterized by a fine-grained polygonal matrix of quartz and plagioclase. Within the matrix, biotite, occurring in a wide range of altered and unaltered states is found. Epidote, chlorite, opaques, andalusite, and calcite are also found to a lesser degree in certain slides. The granite sill is composed of anhedral grains of perthite, quartz, plagioclase, microcline, muscovite, chlorite, and opaques in decreasing abundance. The calc-silicate layer contains garnet, plagioclase, potash feldspar, augite,

muscovite, and titanite (sphene). The garnet-rich layer is composed of garnet, plagioclase, feldspar, muscovite, and apatite.

The layers found in the blocks show similar minerals and distributions for the calc-silicate and impure quartzite layers. The dike sampled at site 9 contains plagioclase, biotite, hornblende, augite, opaques, and actinolite in decreasing abundance.

DISCUSSION AND CONCLUSIONS

Mineral analysis supported Gates' (2001) assertion that the lower Seal Cove tuff is composed of bedded tuffs, some of which contain relic glass shards. While the thin sections did not record many clues to their origin, the presence of an andradite component in garnet suggests that the rocks underwent metasomatism from thermal metamorphism of calcic igneous rocks (Deere, 1993).

Within the lower Seal Cove tuff, layers repeat themselves at random intervals and with varying thicknesses. While the main layers are composed of quartzite and calc-silicate, other layers occur within the sequence. The thickest of these, a 14-meter section of tuff breccia, is found near the top of the measured section. The presence of mud cracks and cross bedding in sedimentary interlayers suggests that the tuffs were reworked after sedimentation and also that the sequence was not continuously deposited. The epidote occurrences appear to range from nodules to burrows. The epidote itself appears to be a result of post-deposition hydrothermal alteration of the tuffs before intrusion of the granite.

Linking the blocks to the in situ country rock above the pluton helps in understanding the processes that occurred within the pluton. Unlike the blocks of Calderwood further to the east, which are used for P-T constraints (Porter, 1999, Brill, this volume), the bedding present in the lower Seal Cove tuff enables both the emplacement and rotation of the blocks to be examined.

The convection occurring within the Vinalhaven pluton during emplacement was not strong enough to randomly disperse the lower Seal Cove tuff blocks that fell into the intruding granite magma. The stoped blocks are found along the margins of the base of the magma chamber and have strikes that suggest they were emplaced through the convection currents with the chamber. If the blocks fell without regard to convection, it would have been likely that they would have fallen through the center of the magma chamber (Myers, 1985). Since the blocks show a rotation to the southwest, they were effected by convection.

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