T2.3 GRANITE IN NOVA SCOTIA

T2.3
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Nova Scotia

Granite is a hard, impermeable crystalline rock and is resistant to erosion. In consequence, in Nova Scotia it tends to form knolls and upland areas characterized by a hummocky, boulder-strewn surface; thin, acid soils; and large areas of exposed bedrock. Water can penetrate the body of granite only along the joints (fractures), which may be several metres apart. Most precipitation is therefore held on the irregular surface in numerous interconnected bogs, shallow lakes and streams.

Granite is found throughout mainland Nova Scotia and Cape Breton in plutons of various sizes and represents about 20–25 per cent of the bedrock across the province. The largest pluton is the South Mountain Batholith, which is the dominant feature in the landscape of southwestern Nova Scotia. It extends in an arc from Yarmouth to Halifax and outcrops over an area of 10 000 km^2 (see Figure T2.3.1).[1]

AGE AND GENESIS

Over the years, there has been much discussion about the formation of granitic rocks. The theories generally are variants on two themes: (1) separation from a basaltic melt, and (2) extreme recrystallization, or even melting, of pre-existing rocks. Combinations of these two are also possible. There is general agreement that most of the Nova Scotia granites were once molten (magma).

Age studies show that, since the Precambrian, granites have formed in Nova Scotia during at least two periods of intense crustal disturbance when

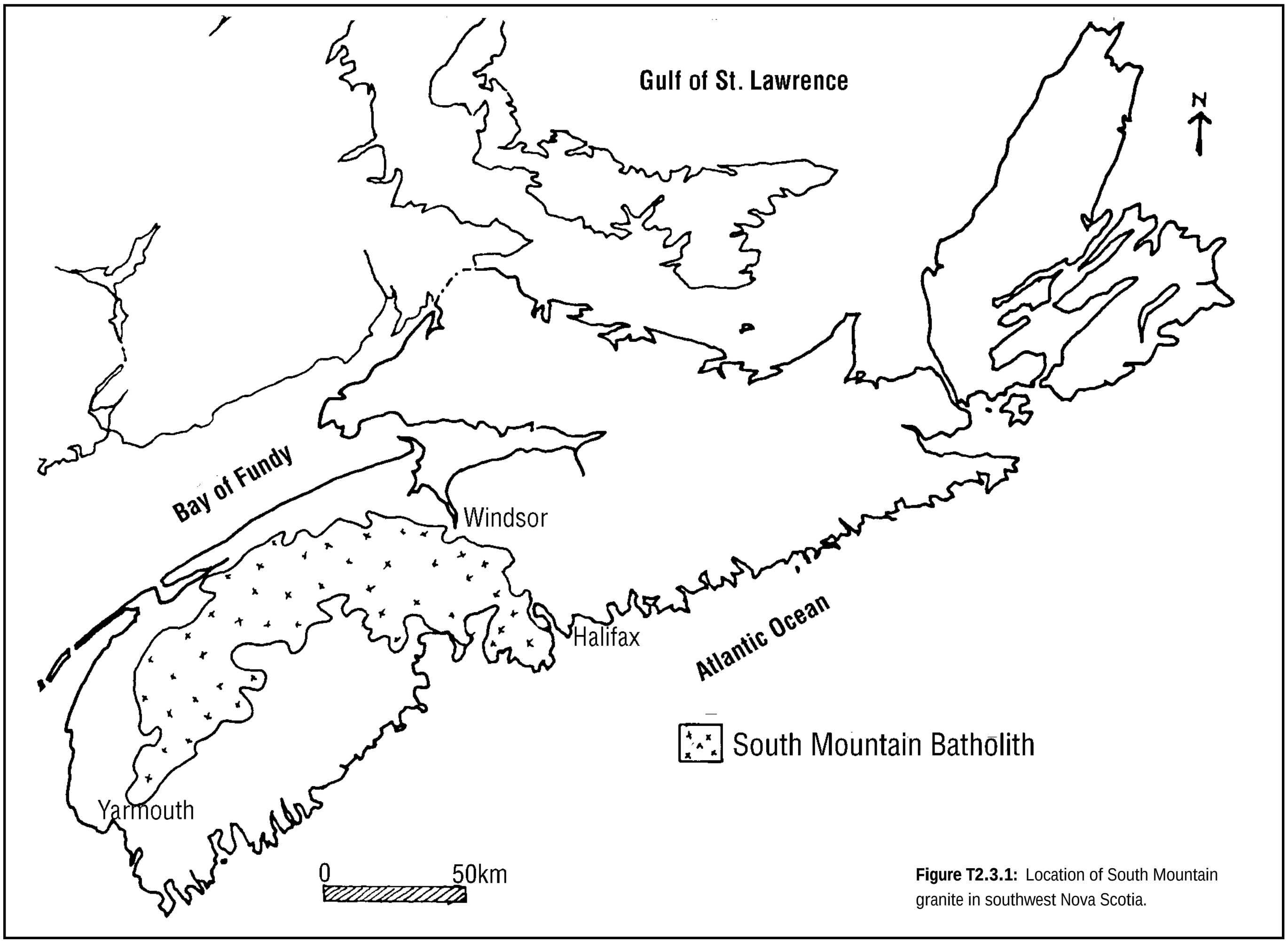

Figure T2.3.1: Location of South Mountain granite in southwest Nova Scotia.

sediments may have been thrust deep into the earth's crust and melted. These two major occasions were during the Cambrian and the Devonian periods.

The older group of granite plutons, around 550 to 500 million years old, is composed of relatively small bodies which are found exclusively north of the Cobequid-Chedabucto Fault in northern mainland Nova Scotia and Cape Breton. The younger group, roughly 370 million years old, is found throughout the province, but predominantly south of the Cobequid-Chedabucto Fault, within the sedimentary rocks of the Meguma Zone. These were generated during the Acadian Orogeny, when the thick Meguma sedimentary pile would have been squeezed against, and possibly over, the Avalon Zone. The South Mountain Batholith (Districts 440, 450), a very large body of granite which underlies about half of western Nova Scotia, falls within this younger group. It has been studied extensively during the past twenty years or so and is the best known of the granite bodies in the province. The description which follows is basically that of the South Mountain Batholith, although most other Devonian/Carboniferous plutons are likely to share similar characteristics.

The South Mountain Batholith is Late Devonian in age (ca. 370 million years) and is the largest body of granitoid rocks in the entire Appalachian system. The margin tends to be a granodiorite phase, but towards the centre of the batholith there are several other phases, including monzogranite and granite.

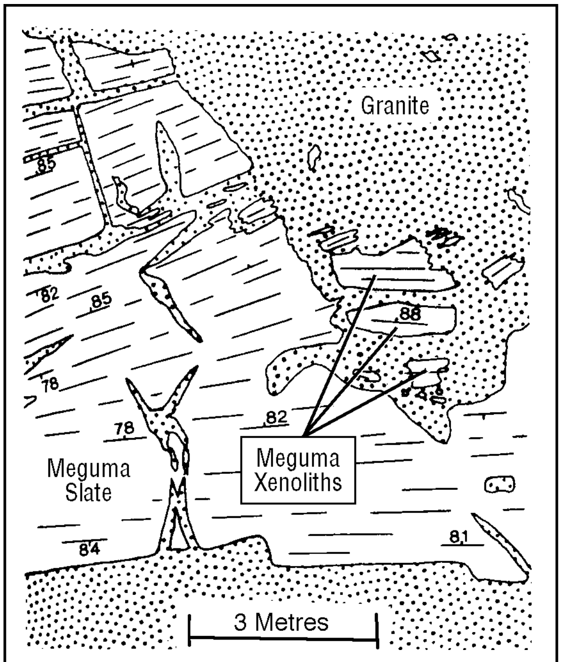

Figure T2.3.2[2]: Magmatic stoping. Arrested stoping at the margin of a large block of Meguma slates. Portuguese Cove (Unit 551).

Some of these rocks contain magmatic cordierite, andalusite or garnet. The Batholith as a whole is broadly concordant with the regional trends in the surrounding Meguma rocks, although locally, of course, it must cut across structures within them. Near its margin, it can contain screens of metamorphosed sedimentary rocks, or myriads of xenoliths (small fragments of the country rocks). Any foliation in the granite is due to movement in the viscous magma itself and was not imposed upon the rock by later tectonic stresses.

MODE OF EMPLACEMENT

Ascent of the Molten Rock

A hot magma which forms at a depth of 20–40 km in the earth's crust may rise either by forcing a path along lines of weakness or by breaking off and incorporating overlying rocks. There are no signs of strain within the sedimentary rocks surrounding the South Mountain Batholith, which might indicate forced passage, but several signs indicative of ascent by incorporation of blocks from the overlying strata (called country rock).

The contact with the surrounding Meguma country rock is generally steep, and in several places, blocks of sediment, some with obvious sedimentary banding, are incorporated into the granite mass. These blocks, or xenoliths, were gradually assimilated by the hot magma and can be found in various degrees of alteration in several localities near the margins of the granite; for example, at Portuguese Cove. The process of ascent by invasion and incorporation of country rock is called "stoping" (see Figure T2.3.2).

COOLING OF THE MAGMA

Foliation

As the magma cools, it develops crystals, which move in response to currents within it. Some remain in suspension, whereas others settle out into dense patches. Where there was relatively rapid movement of the viscous magma, rock fragments, blocky minerals (such as feldspars) and platy minerals (such as micas) reveal the flow pattern by alignment to produce a foliation in the granite.

Heating of the Surrounding Sediments

The heat that is given off by the liquid as it cools heats the surrounding sedimentary rocks for several kilometres. This is the thermal aureole of the granite. The physical change that takes place in the surrounding rocks is called thermal metamorphism. In general, this takes the form of hardening and recrystallization to form new minerals; the minerals so formed depend upon the temperature reached and upon the original composition of the country rocks. If the rock was a shale, then the most distant alteration will produce chlorite as a characteristic mineral. Closer to the batholith, biotite, garnet, staurolite and sillimanite appear in that order, with the sillimanite in a zone near the contact with the granite. This zoning is used to measure the intensity of the metamorphism (the metamorphic grade). For rocks of other compositions, the changes are recognized by comparing groups of minerals present in each rock type (metamorphic facies).

Mineral Deposits

In granitic rocks, crystals of quartz and feldspar form 80 per cent, or more, of the rock, and the balance is mainly micas and amphiboles. As the magma cools and the crystals form in it, any water present must collect in the still-fluid phase, because quartz and feldspars are anhydrous and the micas and amphiboles, which do contain some OH^- ions, are present only in small amounts. Because heat escapes only to the country rocks, the granite will generally freeze first at its margins and thence from the outside inward, with the still-fluid portion becoming increasingly enriched in water and in any elements that cannot be incorporated into the mineral crystals as they form. When the batholith is finally solid, the last remaining water-rich residue (the hydrothermal fluid) must be expelled. Fractures that developed in the solid shell due to contraction on cooling, to earlier movement of still-fluid portions, or to regional stresses provide channels through which the hydrothermal fluid can escape.

That fluid contains silica and many other elements in solution in small amounts. As it moves to regions of lower pressure on its journey through the fractures in the granite and the country rocks, the fluid will deposit its dissolved constituents in sequence as it cools and becomes saturated with one mineral compound after another. Within the solid, but still hot, part of the batholith, the deposits are quartz, feldspar and some rare minerals, as pegmatites, aplites and quartz veins. At lower temperatures, minerals containing tin, tungsten and molybdenum form, and at still lower temperatures, minerals containing copper, lead and zinc—and so on. In some cases, the concentration of the minerals may be sufficient to form ore. Commonly, the deposition of the low-temperature minerals is in the country rocks, many kilometres from the batholith. This will include the rocks of its roof, which now have been eroded away, along with any ore bodies they might have contained.

In Nova Scotia, the tin ore at East Kemptville formed in this way, and the gold ores were also formerly considered to have the same origin. Several deposits in Cape Breton, such as molybdenum at Eagle Head and zinc at Meat Cove, have a similar origin. As a different example, the copper-lead-zinc-silver-gold ore at Stirling is considered to have formed when the hydrothermal fluid flowed out onto the Precambrian sea floor.

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Associated Topics

T2.2 The Avalon and Meguma Zones, T12.3 Geology and Resources

References

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2 Milligan, G.C. (1977) *The Changing Earth*. McGraw-Hill Ryerson, Toronto.

Additional Reading

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