GEOLOGIC MAP OF THE SILOAM GRANITE AND VICINITY, EASTERN GEORGIA

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GEOLOGIC ATLAS 1

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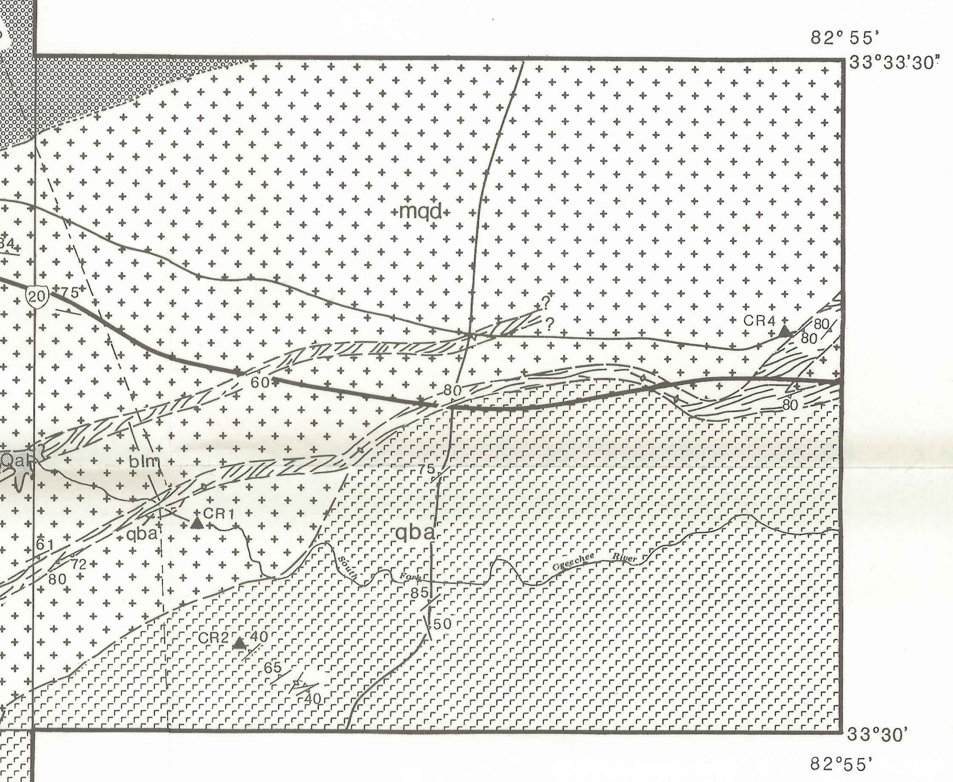

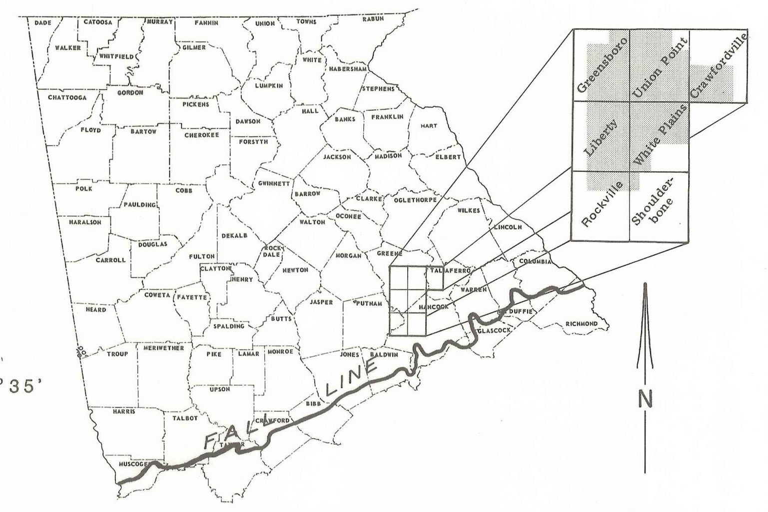

Index Map Showing Location of Map Area

INTRODUCTION

The Siloam Granite has been assigned a Rb-Sr whole-rock age of 269± 3 m.y. (Jones and Walker, 1973), making it the youngest intrusive body studied in the southern Appalachians. A granite of late Paleozoic (Permian) age significantly postdates the peak of dynamic metamorphism for this region proposed by Butler and Ragland (1969) as middle Paleozoic (Ordovician). The peak of post-metamorphic regional deformation has been interpreted as Pennsylvanian to Permian (?) by Butler and Ragland (1969) and Hatcher (1978). The lack of significant penetrative deformation of the Siloam Granite, therefore, places a minimum age of about 270 m.y. for Paleozoic tectonism in this region. Consequently, a thorough understanding of the Siloam and other Hercynian granites in terms of their overall structure and relation to enclosing lithologies is essential in understanding both the intrusive history and tectonic development of the southern Appalachian Piedmont.

The diversity of igneous rock classification systems remains an ever-present problem. The writer has chosen to adhere to the system of classification and nomenclature suggested by Streckeisen (1976).

PREVIOUS INVESTIGATIONS

An early descriptive study on parts of the Siloam Granite was performed by Watson (1902). Reconnaissance field and petrologic studies of the Siloam Granite and surrounding lithologies include the works of Humphrey (1970), Humphrey and Radcliffe (1970, 1971), and Radcliffe and Humphrey (1971).

The first descriptive study of the entire Siloam pluton was that of Speer (1977). Reconnaissance mapping of different phases of the Siloam and other granitoid bodies in the southern Appalachians has been performed and illustrated on a relatively small scale (approx. 1:500,000) by Speer and others (1979). Whitney and Wenner (1980) have examined the petrology and structural setting of post-metamorphic granites in Georgia, including the Siloam Granite.

DISCUSSION

The number and distribution of phases within the Siloam Granite indicate that it is a composite pluton with a complex intrusive history. Although detailed geochemical and radiometric-age data are currently unavailable on the individual phases, preliminary interpretations on the pluton's evolution can be made. The genetic history of the Siloam Granite is probably one of textural segregation as a result of differentiation within a magma chamber. There seems to be a sequential relation among the porphyritic megacrystic, porphyritic sparsely megacrystic, and porphyritic non-megacrystic phases (pm, psm, and pnm, respectively; see description of units below). In this regard, microcline megacrysts were an early siliceous component and tended to crystallize and concentrate in lower sections of the magma chamber. Considering the strong parallel alignment of the megacrysts and general random distribution of porphyritic phases (i.e. scarcity of concentric zonation), convection currents apparently were prevalent during nucleation/crystallization resulting in considerable mixing and redistribution of phases within the magma chamber. The equigranular phases (fme, ce, and cel) most likely represent earlier facies crystallizing in upper sections of the magma chamber. In some areas, fme and ce granite exist as autoliths within the porphyritic phases. Such a field relation suggests the fme and ce phases had sufficiently cooled/crystallized while the porphyritic phases existed as crystal "mush" in lower sections of the chamber. Considering that these equigranular rocks occur as both autoliths and border phases, it would seem that the porphyritic phases were emplaced as subsequent magma "pulses" into the earlier equigranular granite. Due to its similar texture and mineralogy to the fme phase, the gneissic phase (gn) is interpreted as a zone of ductile strain initiated either during the final crystallization stages of fme or the initial intrusion of pm. The gneissic phase as mapped includes one exposure of pm exhibiting a pronounced gneissic texture, suggesting a time affinity between the two phases.

The mylonitic rocks east of the Siloam Granite may represent an extension or splay of the Modoc zone. Data is inconclusive at present as to whether any significant displacement occurred along this possible extension/splay prior to emplacement of the Siloam pluton. Within the present study area, metasedimentary and metavolcanic units of comparable lithology and metamorphic grade can be mapped on both sides of the cataclastic zone. The mylonites terminate abruptly against the eastern edge of the Siloam Granite and could not be traced either into the pluton or across to the western side of the map area. Within the interior of the pluton, however, a flinty crush rock zone of limited areal extent occurs, indicating that at least some localized, post-crystallization, brittle shear occurred.

ACKNOWLEDGEMENTS

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EXPLANATION

The Siloam Granite intrudes granitic gneisses of unknown age and a regionally extensive sequence of interlayered Cambrian (?) metavolcanic and metasedimentary rocks. In the map area, the country rocks have been metamorphosed to the amphibolite facies. The following is a systematic description of lithologic units that comprise both the country rock and individual textural phases of the Siloam Granite. The phases of the Siloam Granite were mapped solely on the basis of variations in texture, mineralogy, and color as observed in the field. Actual contacts between phases are impossible to illustrate with extreme accuracy due to poor exposures and the gradational nature between most phases.

PHASES OF THE SILOAM GRANITE
(arranged in preliminary magmatic stratigraphic order)

The first six phases are arranged in preliminary magmatic stratigraphic order. This order is based on both the occurrence of equigranular granite (fme and ce) as autoliths within porphyritic granite and on the assumption that magmatic differentiation resulted in textural segregation within the chamber. For porphyritic phases, the writer has chosen a system of nomenclature based on the length of microcline phenocrysts in a particular exposure. For example, phenocrysts of at least 3 centimeters in length are referred to as "megacrysts". Otherwise, they are referred to simply as phenocrysts.

pm Porphyritic, megacrystic, biotite granite. Grey to greyish-pink, coarse-grained biotite granite that, in addition to regular porphyritic texture, contains tabular microcline phenocrysts of at least 3 centimeters in length that comprise at least 20 percent of a one meter^2 section of any given exposure.

Thin-section analyses (samples SL1 and L16) reveal that plagioclase grains commonly exhibit albite and pericline twinning with oscillatory zoning and moderate alteration to saussurite and sericite. Heaviest alteration occurs either near the center of the grains or is confined to one set of lamella. Microcline megacrysts show partial to complete exsolution. Biotite flakes exhibit slight alteration to chlorite and exhibit crude local alignment parallel to the orientation of microcline megacrysts. An approximate average modal composition for the two samples is as follows: microcline, 47 percent; plagioclase (optically positive and negative), 25 percent; quartz, 20 percent, perthite; 3 percent; biotite, 5 percent.

psm Porphyritic, sparsely megacrystic, biotite granite. Very similar in texture and color to pm except megacrysts comprise less than 20 percent of a one meter^2 section of any given exposure.

pnm Porphyritic, non-megacrystic, biotite granite. Grey to pink granite consisting of a coarse-grained porphyritic texture containing no megacrysts.

Three thin-section analyses from this phase indicate widely varying mineralogies. In sample L8, nearly all of the original microcline has exsolved to perthite (approximately 5 percent modal microcline and 62 percent modal perthite). In addition, the sample consists of only 2 percent plagioclase and is therefore classified as an alkali-feldspar granite. Plagioclase occurs as unzoned grains in both the groundmass and as subgrains within perthite. Sample L8a also exhibits extensive exsolution of microcline (approximately 4 percent modal microcline and 35 percent modal perthite), but consists approximately of 20 percent plagioclase that exhibits oscillatory zoning and indistinct albite twinning. Biotite flakes are crudely aligned in both L8 and L8a and form approximately 10 and 15 percent, respectively, of each. In sample WP3, all but a very few grains of microcline have exsolved to perthite. Plagioclase exhibits heavy saussuritization and contains clouding inclusions of epidote. A few plagioclase grains exhibit pericline twinning and/or oscillatory zoning, with clouding generally confined either to one set of lamella or a single crystal zone. Biotite is distinctly concentrated along a microshear where alignment between individual flakes and sphene is pronounced. All three samples from the pnm phase contain a small percentage of sphene, ranging from a trace amount in sample L8 to approximately 2 percent in sample WP3. An approximate modal composition for sample WP3 is as follows: plagioclase (optically negative), 25 percent; microcline, 1 percent; perthite, 36 percent; quartz, 25 percent; biotite, 10 percent; sphene, 2 percent; trace amounts of apatite, opaques, zircon, and chlorite.

espm Equigranular, sparsely porphyritic, biotite granite. Bluish to grey-pink granite consisting of a fine- to medium-grained, equigranular groundmass containing sparse, widely scattered megacrysts and phenocrysts of microcline. Considerable overlap occurs between this phase and the fme phase. Consequently, the phase "boundary" between the two is much more gradational and difficult to accurately illustrate than boundaries between other phases within the Siloam Granite.

ce Coarse-grained, equigranular, biotite granite. Light to bluish-grey granite with a non-porphyritic, equigranular texture.

A thin-section analysis of a sample (UP7) taken near the exposed center of the pluton reveals that exsolution of microcline ranges from near absent to complete. Some microcline grains contain inclusions of heavily sericitized plagioclase. Oscillatory zoning within plagioclase is common but not as widespread as in the more porphyritic phases. An approximate modal composition of the rock is as follows: plagioclase (optically positive), 32 percent; microcline, 25 percent; perthite, 20 percent; quartz, 20 percent; biotite, 2 percent; trace amounts of muscovite, opaques, zircon, and chlorite.

Sample UP5 was taken very near the contact of the Siloam Granite and mqd. This sample is classified as a quartz monzodiorite due to its high plagioclase content (approximately 59 percent, as compared to 24 percent microcline and 3 percent perthite) and low quartz content (approximately 10 percent). Note that this lithology is somewhat intermediate in composition between other phases of the Siloam Granite and the later described metadiorite (mqd). Of interest is the relatively low biotite content in both samples and UP5 and UP7 which is approximately 3 percent and 2 percent, respectively.

fme Fine- to medium-grained, equigranular, biotite granite. Very similar to ce except for a finer-grained texture that appears to be both mineralogically and texturally equivalent to the groundmass fraction of the espm phase. Where the fme phase occurs within the interior of the pluton, a sharp, pronounced contact between it and the more porphyritic phases can be seen in a few outcrops, suggesting there may be notable age differences between some phases. Along Pierce Creek, in the White Plains 7.5-minute quadrangle, extensive pavement exposures reveal what appear to be autoliths of fme within the pm phase.

A thin-section analysis from ths phase, sample WP8, reveals oscillatory zoning and moderate to heavy sericitization of plagioclase. Exsolution of microcline to perthite ranges from absent to complete, with partial exsolution apparent in a few grains. Biotite flakes are in random orientation and slightly chloritized. Due to a relatively low quartz content (approximately 15 percent), this sample from the fme phase is classified as a quartz monzonite. An approximate modal composition for the rock is as follows: plagioclase (optically negative), 26 percent; microcline, 34 percent; perthite, 13 percent; quartz, 15 percent; biotite, 10 percent; sphene, 2 percent.

(stratigraphic order and relation to other phases unclear)

gn Gneissic biotite granite. Similar to fme in most exposures except for a pronounced foliation defined by alignment of biotite. In the more porphyritic phases, foliation is locally marked by exceptionally close alignment of feldspar megacrysts in addition to biotite. The gneissic phase is poorly exposed and very difficult to trace laterally. Consequently, the actual regional width of this phase is conjectural at best.

cel Leucocratic, coarse-grained, equigranular granite. Light-grey to cream-colored granite that is very similar texturally to ce but contains trace amounts of fine-grained garnet and only minor biotite. This phase is most likely a facies of ce.

A thin-section analysis from this phase, sample L10, indicates that nearly all of the original microcline has exsolved to perthite. Plagioclase is slightly to moderately altered to sericite and saussurite with most grains exhibiting strained albite twins. Myrmekitic intergrowths are common in both plagioclase and quartz. Of note here is the exceptional degree of strain within all the light-colored minerals as evidenced by pronounced undulose extinction. In spite of this high degree of strain, no gneissic texture is discernible in outcrop. An approximate modal composition of the rock is as follows: plagioclase, 29 percent; perthite, 48 percent; microcline, 1 percent; quartz, 20 percent; biotite, 1 percent; trace amounts of opaques and zircon.

OTHER LITHOLOGIES
(no stratigraphic order implied)

Qal Alluvium (Quaternary). Unconsolidated sand, silt, and clay in flood plains and low terraces along major streams.

Trd Diabase dikes (Triassic). Outcrops scarce, occurring generally as spheroidally weathered boulder trains.

qba Micaceous quartzo-feldspathic gneiss, amphibole-biotite schist, and biotite-muscovite schist. An interlayered sequence of light- to yellowish-brown, fine- to medium-grained biotitic quartz-plagioclase-sericite gneiss; dark-brown to green, medium-grained amphibole-biotite schist; and dark-brown, medium-grained biotite-muscovite schist. The individual lithologies in this unit vary widely in thickness from approximately 0.3 meter to over one meter. At some localities, the micaceous quartzo-feldspathic gneisses and mafic schists are sharply discordant to each other, with angles between them ranging from 23 degrees to 70 degrees throughout the study area. Within the Crawfordville 7.5-minute quadrangle, a few localities occur where the felsic gneisses are crosscut at a very slight angle by other felsic gneisses of near identical megascopic mineralogy and texture. These field relations suggest that some of the lithologies in this unit may be intrusive in origin. However, considering the intense degree of deformation in the region, the writer prefers a structural/tectonic control on the crosscutting relations.

Thin-section analyses of micaceous quartzo-felspathic gneiss (samples GR1, CR2, and CR1) reveal a pronounced metamorphic fabric defined by strong alignment of sericite and/or biotite with quartz and plagioclase. Although the relative percentage of quartz is fairly consistent, ranging from approximately 40 percent in sample GR1 to approximately 45 percent in sample CR2, the ratio of sericite to plagioclase varies considerably. For example, sample CR2 contains approximately 10 percent sericite occurring as continuous bands alternating with layers of quartz and plagioclase. Plagioclase in sample CR2 constitutes approximately 20 percent of the whole rock. Sample GR1, however, contains only trace amounts of sericite occurring as an obvious secondary alteration of plagioclase. Plagioclase in sample GR1 constitutes approximately 55 percent of the whole rock. In addition, sample CR2 is comprised of approximately 20 percent microcline, whereas microcline is virtually absent in sample GR1. These mineralogical inconsistencies are probably a response to either varying degrees of shear and subsequent alteration within the unit or to metasomatic reactions from the nearby intrusive rocks. Variations in shear are most likely responsible for the relatively anomalous modal composition of sample CR1 (approximately 52 percent quartz, 46 percent sericite, and only 1 percent plagioclase). The locale of this sample is a small but conspicuous exposure that abuts against the mylonitic zone (blm) within the mqd unit. Such a field relation suggests that the locale of sample CR1 may be a minor tectonic slice.

bsa Amphibolite and biotite-muscovite schist. An interlayered sequence of dark-green to black, fine- to medium-grained amphibolite and dark-brown, medium-grained biotite-muscovite schist. Thicknesses of individual lithologies approximate those of qba, although poor exposures inhibit accurate measurements. This unit is distinguishable from qba by the absence of micaceous quartzo-feldspathic gneiss, although fine-grained granitic dikes and pods occur at some localities near the contact with the Siloam Granite. The amphibolite ranges from a salt-and-pepper textured, weakly foliated, hornblende-plagioclase bearing rock to a dense, amphibole gneiss with a foliation defined by strong alignment of prismatic hornblende.

mqd Metamorphosed rocks predominately dioritic in composition. Light- to greenish-brown, fine- to coarse-grained biotite granitoid to biotite granitic gneiss. Where the unit crops out on the eastern side of the Siloam Granite, foliation is locally well developed but as a whole is very weakly defined megascopically. Except for a greater percentage of micaceous minerals in this unit, saprolite exposures are difficult to distinguish from equigranular phases of the Siloam Granite. At some locales, particularly at or near the margins of mqd, biotite content is quite high and the rock could be classified megascopically as a porphyroblastic biotite-plagioclase schist. Where this occurs, the unit is often interlayered with the qba unit, suggestive of a lit-par-lit sequence.

On the western side of the Siloam Granite, the body does not crop out as a regionally homogenous granitoid but instead appears to consist almost entirely of a lit-par-lit screen formed with lithologies of the qba unit. These field relations on either side of the Siloam Granite, together with an overall granitic texture, suggest that mqd is intrusive in origin.

Thin-section analyses of samples from the body reveal a metamorphic fabric defined by crude alignment of biotite. Potassium feldspar is generally sparse to absent, except as exsolution (antiperthitic) intergrowths in plagioclase. Determination of anorthite content of plagioclase by the Michel-Levy method is hindered considerably by heavy clouding and strain. It can be said, however, that plagioclase is consistently optically positive for samples taken throughout the body.

As suggested by current petrographic data, the body has a more or less consistent dioritic composition within and outside of the map areas on both sides of the Siloam Granite. However, the approximate proportions of the major rock forming minerals tend to vary slightly from a quartz diorite in sample L2 (plagioclase, 52 percent; biotite, 25 percent; quartz, 14 percent; epidote, 8 percent; trace amounts of sphene and zircon) to tonalite in samples L14 (plagioclase, 67 percent; quartz, 20 percent; biotite, 10 percent; muscovite, 1 percent; trace amounts of sphene, epidote, and opaques), CR4 (plagioclase, 62 percent; quartz, 28 percent; biotite, 6 percent; epidote, 3 percent; muscovite, 1 percent), and GR8 (plagioclase, 57 percent; quartz, 20 percent; biotite, 15 percent; epidote, 7 percent; trace amounts of sphene, clinozoisite, and opaques). Sample GR5, taken near the inferred western margin of the body, has the mineralogical composition of a granite (plagioclase, 35 percent; microcline, 33 percent; quartz, 20 percent; biotite, 10 percent; epidote, 1 percent; trace amounts of clinozoisite, muscovite, and opaques), suggesting mqd is a composite body.

Along most of its southern margin to the east of the Siloam Granite, the dioritic body exhibits a pronounced mylonitic fabric (blm) of unknown regional width. This apparent structural control suggests that either mqd was intruded prior to a period of movement along a regional fault zone (Modoc zone or splay?) or was preferentially emplaced along such a zone which experienced later ductile shear following the intrusive event.

blm Blastomylonite. Light-pink to bluish-grey, medium-grained gneiss with a pronounced mylonitic fabric. This unit generally forms good, traceable exposures. A thin-section analysis from the map area (sample UP4) reveals a laminated texture defined by bands of strongly aligned sericite and fine-grained quartz stringers. The matrix of the rock is composed predominately of very fine-grained quartz and feldspar. Scattered throughout the matrix are relatively unaltered, rotated porphyroclasts of strained plagioclase and microcline. The porphyroclasts generally range from 0.25 to 0.5 centimeters in diameter, commonly occurring as augen with a long axis up to 1.5 centimeters.

The blastomylonitic zone extends from the interior of mqd to eventually form its southern margin east of the Siloam Granite. Although the lateral extent of the zone remains speculative, its total width along the southern border of mqd is estimated to be approximately 250 meters. This estimated width includes approximately 100 meters of mylonitic rocks that extend from the mqd contact into the country rock.

fcr Flinty crush rock, including microbreccia. A light-colored, generally aphanitic, cherty-textured, cataclastic rock that forms distinct linear ridges.

gsc Lit-par-lit sequence of coarse-grained granite and bsa lithologies interpreted as representing a screen of the Siloam Granite. This screen was found to occur only within the bsa unit on part of the western and extreme southeastern borders of the Siloam pluton.

Contact; observed, approximate, inferred

Strike and dip of foliation.
45 inclined
vertical

85 Strike and dip of penetrative surface within flinty crush rock.

Strike and dip of jointing.
65 inclined
vertical

Bearing and plunge of minor fold axis.
40 antiform
40 synform

5 Bearing and plunge of primary crystal lineation. Within the Siloam Granite, this refers to parallelism of the long axes of feldspar megacrysts.

WP8 Sample locale.

Cartography by Jeane S. Barrett

Geologic Map of the Siloam Granite and Vicinity, Eastern Georgia

Harold R. Vincent

1984