DEFORMATIONAL HISTORY WITHIN THE ROCKFISH VALLEY DEFORMATION ZONE, BLUE RIDGE MOUNTAINS, CENTRAL VIRGINIA

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INTRODUCTION

The Rockfish Valley deformation zone is a feature which extends from Northern Virginia as far south as the Grandfather Mountain Window in North Carolina. Distinctive of this deformation zone are its greatly varying width (1-10 km) and the high degree of shearing and mylonitization present within the zone. This deformation zone has been interpreted as being formed during a period of Paleozoic deformationwhen it was activated as a thrust fault, carrying the Lovingston massif westward into contact with the Pedlar massif (Bartholomew, 1977; Bartholomew, Gathright, and Henika, 1981). Simpson and Kalaghan (1989) have suggested, however, that in southwestern Virginia the Rockfish Valley deformation zone formed first as an extensional fault during the late Proterozoic, and was later reactivated as a thrust fault.

In this study, a single outcrop was examined in great detail in order to work out the sequence of deformational events which have affected the rocks, and to identify characteristic fabrics which may be associated with these events.

OBSERVATIONS

The outcrop studied is a roadcut located along Virginia Rt. 60 approximately 15 miles east of Buena Vista, VA. The rock at this location has been named the Stage-Road Layered Gneiss by Sinha and Bartholomew (1984). Although it is a part of the Lovingston Massif, it is well within the Rockfish Valley deformation zone. It is a dark augen gneiss, with a strong, steeply dipping foliation (s_1) defined by augens of potassium feldspar 1-5 cm in length. This primary foliation trends roughly northeast, and dips 50 to 70° to the southeast. The augens are contained in a fine-grained matrix of biotite, chlorite, quartz, and epidote, with minor zircon, ilmenite, magnetite, and rare garnet.

At the study location, ten felsic dikes within the augen gneiss range in thickness from two inches to ten feet. The mineralogy of the dikes is primarily coarse-grained and highly fractured potassium feldspar, with blue quartz and plagioclase also present. Five of the smaller dikes show evidence of post-cooling plastic deformation, as evidenced by the irregular and curvy nature of their contacts. The dikes larger than about twelve inches, however, consistently retain their planar shape, and the wall rocks are in one instance deformed in narrow bands along the dike-wall rock contact.

A later fabric (s_2) is present which cuts both the primary foliation in the wall rocks and the dikes. The strike of this fabric is roughly parallel to the s_1 foliation, but it dips more shallowly at 25-35° to the southeast. The s_2 fabric is weakly developed in the rocks, and is visible in the augen gneiss as dark, mica-rich bands about 1-3 cm thick and up to 20 cm long cutting across the s_1 foliation. These bands do not appear in the dikes, but the dikes are fractured and offset along planes parallel to the s_2 foliation. In all cases, the offset of the dikes by this fabric is in a top-to-the-northwest sense; the amount of actual offset ranges from 5 to 20 cm.

METHODS

At the study location twenty-five oriented samples were collected from the augen gneiss and felsic dikes. From these samples, fifteen oriented thin sections of the augen gneiss were cut perpendicular to the s_1 foliation, and parallel to the elongate augens in order to show the maximum rotation of grains, as suggested by Passchier and Simpson (1986). These slides were examined for kinematic indicators, including asymmetric porphyroclasts, fractured and offset grains, and S-C type fabrics, to determine the sense of shear in the rocks.

Five unoriented thin sections of the felsic dike lithology were cut. These were examined both for mineralogy and for evidence of deformational fabrics. In particular, numerous fractures and crack-seal veins within the dikes were examined for cross-cutting relationships. Two thin sections were viewed using a scanning electron microscope equipped with a backscatter detector; an X-ray analyzer was used to determine compositions of veins.

RESULTS

Thin sections of the augen gneiss lithology reveal numerous kinematic indicators. By themselves very few of these indicators are entirely convincing as to the sense of shear, and often indicators in the same thin section will suggest opposite senses of shear. However, taken together these kinematic indicators may be viewed with a high level of confidence; the great majority of them indicate a top-to-the-southwest sense of displacement in the rocks. The one exception is a distinct zone, approximately three feet thick, of very high shearing which cuts across the s_1 foliation. Within this zone all indicators showed a top-to-the-northwest sense of shearing. The most abundant and useful indicators were asymmetric feldspar and quartz porphyroclasts with tails of mica and/or recrystallized porphyroclast material. Figure 1 shows a quartz porphyroclast with assymetric tails indicating a top-to-southeast sense of shear. These asymmetric porphyroclasts are all of the σ-type in the classification scheme of Passchier and Simpson (1986). Also useful were grains which showed fractures and offsets, and S-C type fabrics. Figure 2 shows two seperate biotite grains which have been fractured and offset, indicating a top-to-southeast sense of shear. The lower grain is fractured parallel to the s_1 foliation, while the upper grain is fractured antithetically.

Within the felsic dikes, two generations of veins were distinguished. The first are quartz veins which are generally found extending only within a single vein and with irregular and curved walls. The quartz within these veins is almost always recrystallized to a very fine grain size, and in several instances shows undulous extinction. These veins are clearly cut in several places by later plagioclase veins. These typically extend up to 10-15 mm across a slide, cut through multiple grains, and have fairly regular, straight boundaries. They are generally narrower than the quartz veins, and do not show recrystallization of vein material. Examples of both types of these veins are also observed in large feldspar grains within the augen gneiss.

Figure 1. Assymetric quartz porphyroclast showing top-to-southeast sense of shear.

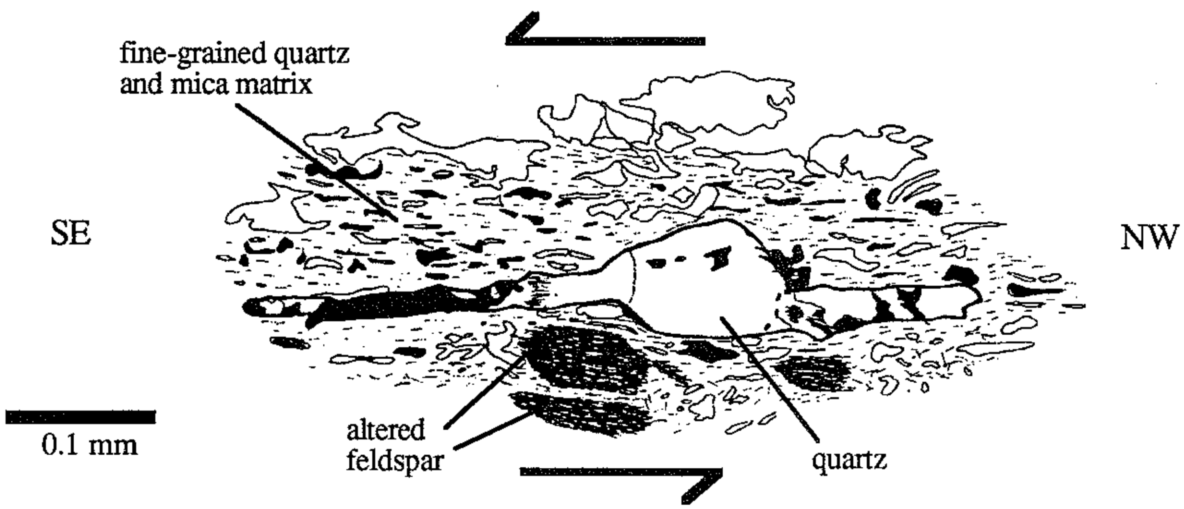
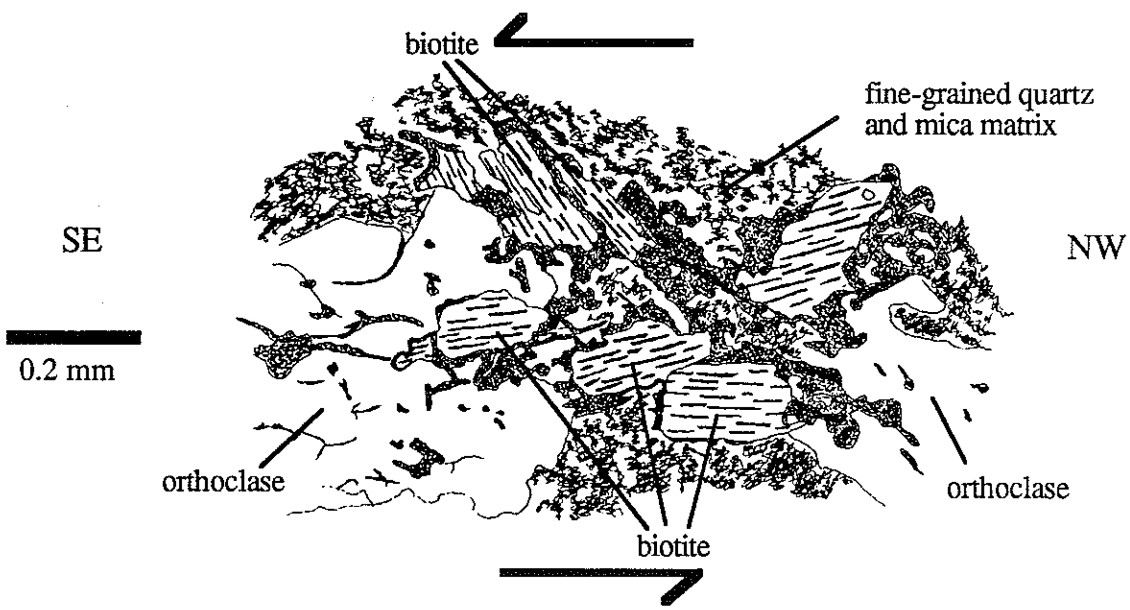


Figure 2. Fractured and offset biotite grains showing top-to-southeast sense of shear.



DISCUSSION

From the data collected, we can establish four distinct stages in the development of the outcrop. First is the formation of the augen gneiss, assumed to be during some metamorphic event of Grenville age. Second is the emplacement of the felsic dikes in the rock, probably concurrent with the emplacement of several late Proterozoic plutons in the area, such as the Roses Mill and Turkey Mountain Plutons. Third is the formation of the steeply-dipping s_1 foliation in the augen gneiss. Based on cross-cutting relations it is younger than the dikes, and based on kinematic indicators it is older than the Paleozoic deformational events. I therefore assign a late Proterozoic age to it. Finally, the development of the shallowly-dipping, more brittle s_2 foliation occurred. This is probably related to regional thrusting during the Paleozoic which has been recognized by several workers in the area (Bartholomew, 1977; Bartholmew, Gathright, and Henika, 1981).

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