STRUCTURAL RELATIONSHIPS AMONG METAMORPHIC SUITES IN THE TOBACCO ROOT MOUNTAINS OF SOUTHWESTERN MONTANA.

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INTRODUCTION

Archean rocks exposed in the Tobacco Root Mountains of southwestern Montana include three metamorphic assemblages that may represent distinct accreted terranes. The Indian Creek Metamorphic Suite (ICMS) and the Pony Middle Mountain Metamorphic Suite (PMMMS) comprise thick sequences of quartzofeldspathic gneiss with interbeded amphibolite. The ICMS includes bands of marbles. These two suites are in contact with the Spuhler Peak Metamorphic Suite (SPMS) distinguished by an alternating sequence of quartz-garnet-biotite-gneiss, quartzites, and distinctive gedrite-bearing amphibolites. The purpose of the study was to analyze the contact relationship between the gneisses and the SPMS located along the western slope of the Tobacco Root Mountains and determine how they relate to each other structurally. The contact between the ICMS/PMMMS and the SPMS has been interpreted by Burger (1969) as a fault and as an unconformity by Gillmeister (1971). This distinction is critical to the tectonic and metamorphic history of the Tobacco Root Mountains.

FIELD OBSERVATIONS

The contact between the SPMS and the ICMS/PMMMS was mapped from Sunrise Cirque to Mustard Pass (Figure 1). The orientations of foliations were recorded at each sample stop. The contact was mapped at the base of the first quartzite layer below quartzofeldspathic gneiss with gedrite amphibolite and above quartzofeldspathic gneiss without gedrite amphibolite.

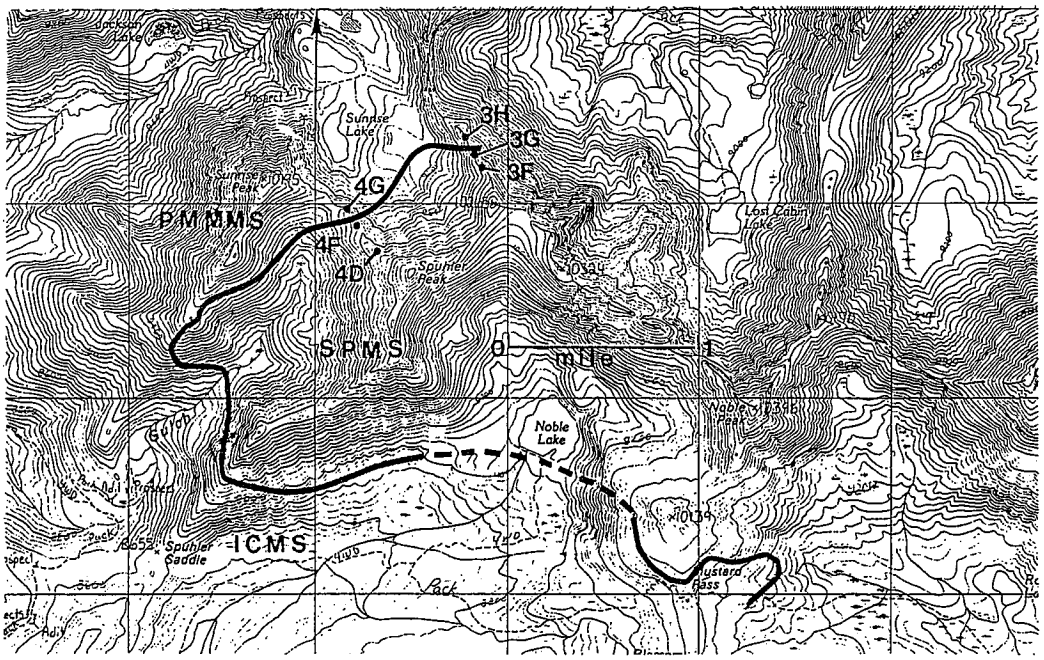

Figure 1. A portion of the Noble Peak Quadrangle, 7 1/2 minute topographic map showing the study area. The contact is shown by the heavy black line.

The quartzite at the contact varied in thickness from 15 to 100 cm. Oriented samples were collected at the contact and from the metamorphic suites on both sides of the contact. In the ICMS and the PMMMS samples were taken from quartz rich layers within the quartzofeldspathic gneiss that varied in thickness from 0.2 to 1.5 cm. Samples in the SPMS were taken from quartzite layers that varied in thickness from 0.15 to 10 meters. The foliations measured at the sample stops were found to be everywhere parallel to the contact surface.

THREE POINT PROBLEMS

In order to fully characterize the contact, three point problems were plotted in areas of different elevation and with consistent planar orientations along the contact. Plotting three point problems reveals that the contact is a broad synform. On a Schmidt net this surface is an isoclinal fold with a fold axis oriented 079 °,19 ° (Figure 2).

PETROFABRIC ANALYSIS

The oriented quartzite and quartzofeldspathic gneiss samples taken along two traverses perpendicular to the contact in the Sunrise lake area produced thin sections for this analysis. The samples contained at least 60% quartz. Four samples were from the quartzite layers in the SPMS: two at the contact and two ~60 feet away. The remaining two samples were taken from the PMMMS. Each sample was cut to produce two mutually perpendicular thin sections: one parallel to strike and the other parallel to the dip direction of foliation. The orientations of quartz c-axes were measured using a universal stage to determine if a lattice-preferred orientation (LPO) exists. LPO diagrams are presented from contoured Schmidt nets parallel to the XZ plane with the foliation oriented along the E-W axis.

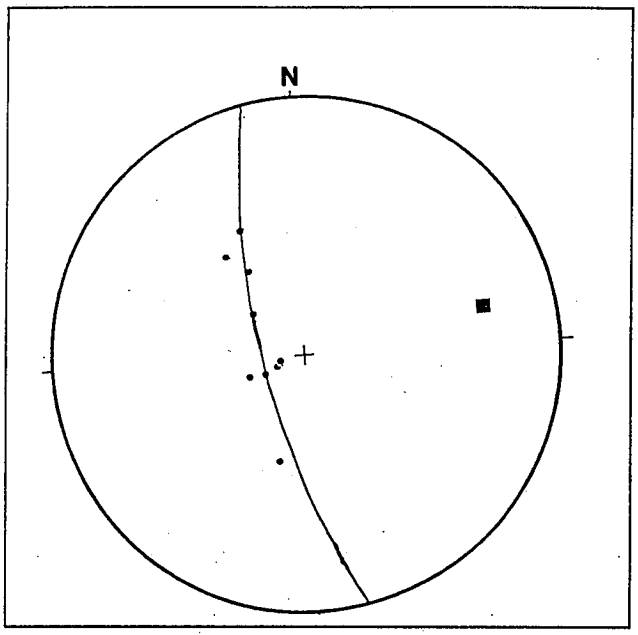

Figure 2. Contoured equal angle projection of poles to the contact. Fold axis is represented by the black square.

In thin section, foliation is typically expressed by the parallel alignment of micas and by the elongation direction of quartz grains. Grain boundaries in quartz and feldspar are straight, curved, or lobate (Figure3). Some quartz grains show mildly undulose to patchy extinction, whereas others appear to be strain free. In the PMMMS, smaller, polygonal grains of quartz or feldspar are interspersed with larger inequant grains. Deformation mechanisms probably include grain-boundary migration recrystallization, with secondary grain growth allowing readjustment of grain boundaries after deformation ceased.

Three of the six samples showed strong preferred orientations of quartz c-axes. C-axes were plotted according to Lister and Hobbs (1980). The fabric is Type 1 crossed girdle with a sharply defined outline. The pattern consists of a single straight girdle perpendicular to the shear plane, and oblique projecting legs. The features of the fabric can be defined by linking up peaks and crest lines on the contoured diagram. The result is the girdle that is approximately perpendicular to the foliation (Figure 4). This confirms that the microstructural fabric is related to the foliation according to Behrmann and Platt (1982). They also showed that if the central part of the girdle is oblique to the foliation, the obliquity indicates the degree of external asymmetry of the fabric with respect to the finite-strain reference frame.

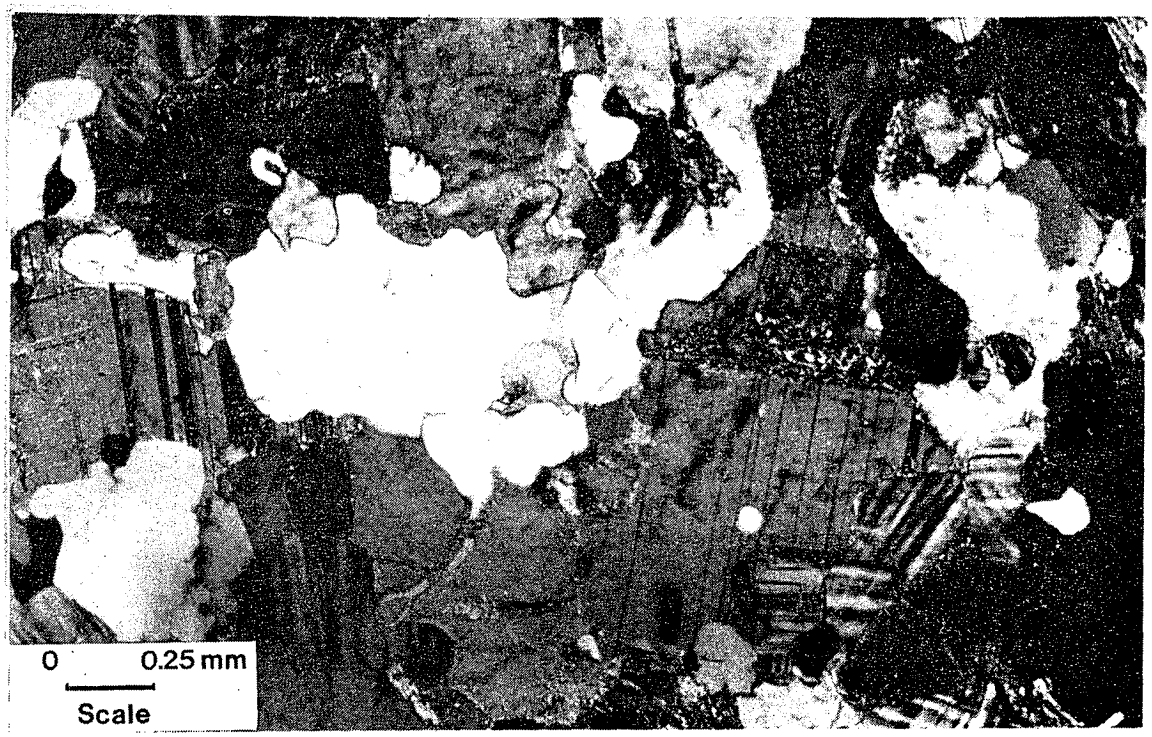

Figure 3. Photomicrograph showing the lobate and curved quartz crystal boundaries.

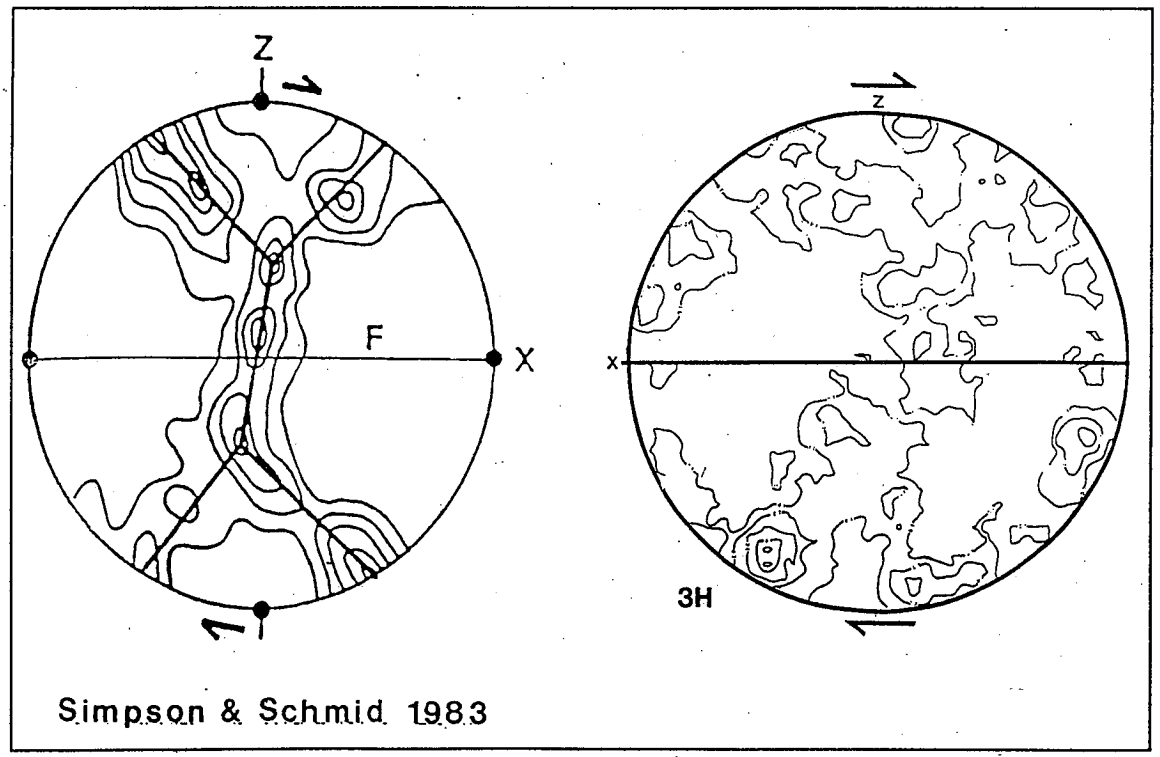

Figure 4. Type 1 crossed girdle reference and sample 3h.

Asymmetrical type 1 crossed girdles are indicative of noncoaxial plane strain, the sense of the asymmetry suggesting sense of shear. The comparison evaluating the spatial distributions is shown in figure 4.

DISCUSSION AND CONCLUSIONS

With the field data, the three point problems and the petrofabric analysis several conclusions can be derived. First, plotting the three point planes in several sections of the study on a Schmidt net revealed the contact not just as a horizontal contact but a folded plane, the nose of which was in Spuhler Gulch with a fold axis of 079°, 19°. Within this fold the PMMMS/ICMS wraps around the SPMS.This is corroborated by the foliation attitudes in both the SPMS and gneisses along the contact. The preferred crystallographic orientation patterns suggest the zone was a fault. Quartz c-axis fabrics on both sides of the contact zone indicates a large scale shear zone hanging wall up parallel to the dip of the contact. This leads to the the conclusion that the three packages must have undergone their most recent event together. This event would have to be the last deformation that retained the strain in the fabrics.

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