PETROLOGIC INVESTIGATION OF AMPHIBOLITES ACROSS A MAJOR DUCTILE SHEAR ZONE IN THE RUBY MOUNTAINS, SW MONTANA: IMPLICATIONS FOR THE NATURE OF EARLY PROTEROZOIC(?) MAFIC MAGMATISM

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ABSTRACT

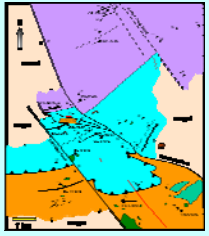
Geologic mapping in the southern portion of the Ruby Mountains reveals a highly variable metamorphic lithostratigraphy. An NE-striking high strain shear zone exposed in the divide between the Sweetwater and Timber Creek drainages forms the boundary between two distinct Archean/early Proterozoic metamorphic terranes. The terrane to the north is comprised dominantly of granitic gneiss, marble, amphibolite, pelitic gneiss, and quartzite, with minor, metaconglomerate, meta- banded iron formation, and calc-silicate schist. Highly deformed, well-layered calc-silicate marbles structurally underlie more massive dolomitic marbles and appear to form the base of the northern terrane. The terrane to the south is comprised dominantly of granitic gneiss, locally migmatitic pelitic gneiss, and amphibolite, with minor quartzite. It contains a narrow (~1 km) belt of ultramafic rocks, both peridotite and megacrystic metapyroxenite The shear zone and the southern terrane contain distinctive 1-10 m thick layers of white garnet leucogneiss which are absent from the northern terrane.

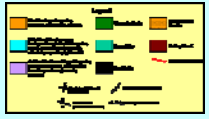
Amphibolites, which are widespread throughout both terranes and the shear zone, occur both as discontinuous and continuous mappable units several meters to tens of meters thick and thin (cm to m scale) bands interlayered within other lithologies. Amphibolites are dominated by the assemblage hornblende + plagioclase + quartz, with some containing relict skeletal garnet and minor biotite. They vary texturally from well-banded or laminated to more massive and granular. The abundance of quartz increases into the terrane north of the high strain ductile shear zone.

Geochemical analyses of amphibolites structurally above, below, and within the ductile shear were acquired in an effort to characterize chemical variations and to help understand the nature of mafic magmatism in the area. Chemical differences in major and trace element distributions can be seen in amphibolites from different structural positions possibly reflecting original variations in chemistry (and/or mineralogy). Tectonic discrimination diagrams are slightly more ambiguous but provide insight into tectonic setting prior to development of the high strain ductile shear zone.

Objectives

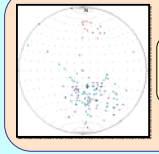
- Document mineralogy & kinematics within major ductile shear zone
- Characterize geochemistry of amphibolite units across shear zone
- Evaluate tectonic setting for amphibolite units
- Determine metamorphic P-T conditions during ductile shearing





Kinematic Analysis of Southern Ruby Shear Zone

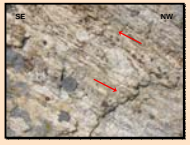
- Leucogranitic & granitic mylonitic gneisses
- Sheath folds in calc-silicate marbles
- Thickness ~250 meters
- NE-striking foliation — N-plunging mineral stretching lineation
- Dominantly σ-type of kinematic indicators
- Two phase of ductile shearing Phase I: Reverse/ Phase II Normal
- Sillimanite and Kyanite commonly define mineral lineation

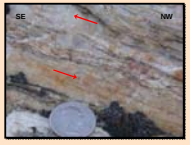


Structural Data

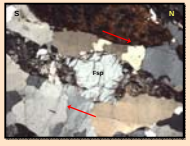
- Poles to Mylonite Foliation (n=40)
- Poles to Marble Foliation (n= 18)
- Poles to Amphibolite Foliation (n= 16)
- Mineral Lineations (n=19)

Phase I: Reverse Movement



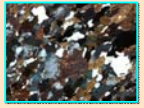


Phase II: Normal Movement

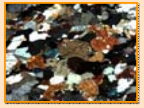


Amphibolite Petrography

Above shear zone
Hornblende+quartz+plagioclase±garnet



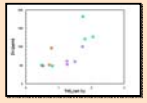
Within shear zone
Hornblende+plagioclase

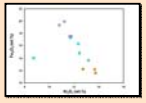


Below shear zone
Hornblende+plagioclase±garnet

*Magnification 4X for all photographs

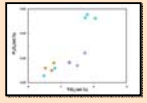
Amphibolite Geochemistry

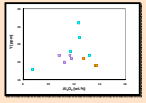


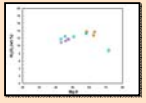


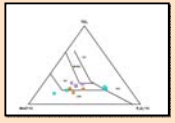
Legend

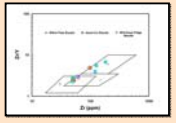
- Above shear zone
- Within shear zone
- Below shear zone





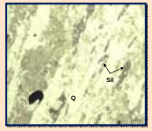


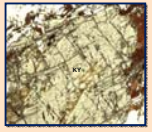


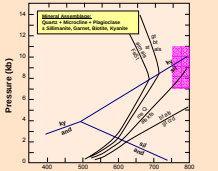


Metamorphic Conditions

Mineral assemblages & recrystallized microtextures in the mylonitic gneisses indicate high-grade P-T conditions associated with ductile deformation. Sillimanite define the mineral stretching lineation in shear zones and relict kyanite and muscovite suggest P-T conditions on the order of 7-11 kb & 750-800°C (purple box).







Summary

- Kinematic analysis indicates a two-phase movement history within the Southern Ruby Shear Zone (SRSZ)
- Phase I associated with compressional tectonism and reverse movement
- Phase II associated with extensional tectonism and normal movement
- Phase II possibly related to the gravitational/topographic collapse following crustal thickening during Phase I
- Metamorphism occurred at 7-11 kb and 750-800°C during phase II suggesting normal movement occurred contemporaneous with, or shortly following, phase I movement
- Geochemical results reveal amphibolites above the SRSZ are distinct from those below suggesting at least two distinct episodes of mafic magmatism
- Discrimination diagrams suggest amphibolite above the SRSZ represent tholeiitic magmatism formed in an island arc setting, whereas those below imply a more calc-alkaline affinity indicative of a continental arc environment
- Results are consistent with those found within the Tobacco Root Mountains to the north

Acknowledgements
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