TIMING OF DEFORMATION ASSOCIATED WITH A MAJOR DUCTILE SHEAR ZONE, RUBY MOUNTAINS, SW MONTANA

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ABSTRACT

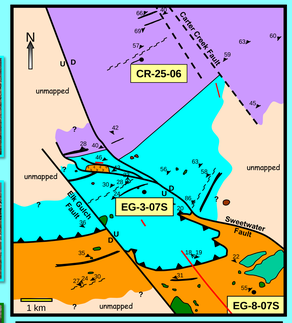
The Ruby Mountains in southwest Montana are one of several Archean-aged basement cored uplifts exposed during Cretaceous-Tertiary time. A high strain shear zone exposed across the southern portion of the Ruby Mountains separates two distinct lithostratigraphic terranes. The Archean terrane to the north consists of granitic gneiss, marble, amphibolite, pelitic gneiss, and quartzite, with minor, metaconglomerate, meta-banded iron formation, and calc-silicate schist. The terrane to the south is composed dominantly of granitic gneiss, locally migmatitic pelitic gneiss, and amphibolite, with minor quartzite. In addition, the southern terrane contains a narrow (~1 km) belt of ultramafic rocks, both peridotite and megacrystic metapyroxenite.

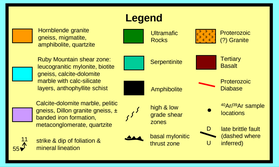
Separating the lithologically distinct terranes is a 5-10 meter thick shear zone of mylonitic leucogranite and granite gneisses. Foliations within the shear zone strike NE and dip moderately to the NW and mineral lineations are predominantly down dip. Kinematic indicators with mylonitic gneisses reveal a two-phase history of movement, with an earlier reverse stage overprinted by later normal motion. The timing of deformation is uncertain.

Age dating in the western part of the Ruby Mountains and the adjacent ranges has identified a long and complex history of deformation and metamorphism ranging in age from 1.7 to 2.5 billion years ago. However, the age of the deformation and shear zone formation in the southern Ruby Mountains is not well constrained. We have analyzed hornblende samples from amphibolite units above, within, and below one of these shear zones in an effort to establish the timing of deformation and the thermal history associated with the development of this shear zone.

Objectives

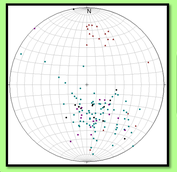
- Perform $^{40}Ar/^{39}Ar$ age dating of hornblende samples from amphibolites above, within, and below the Ruby Mountain shear zone
- Establish the timing of high-grade metamorphism and deformation associated with the tectonic evolution of this region
- Integrate new age data into existing models for the tectonic evolution of SW Montana during Precambrian time





Kinematic Analysis of Ruby Mountain 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

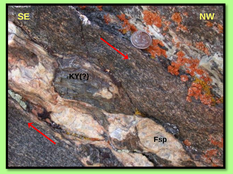


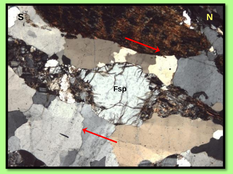
Structural Data

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

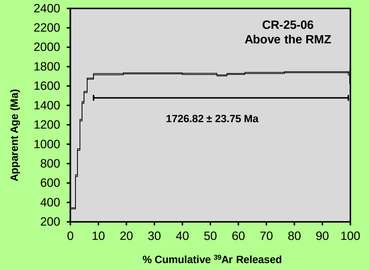
Phase I: Reverse Movement

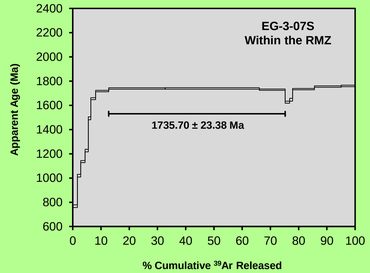
Phase II: Normal Movement

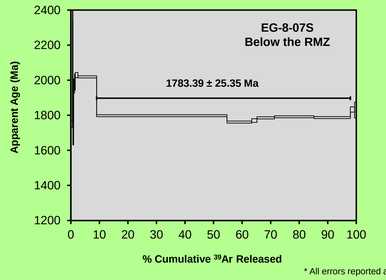




$^{40}Ar/^{39}Ar$ Results





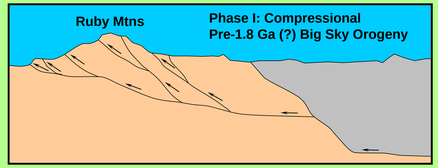


* All errors reported at ±2σ

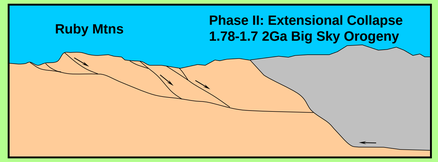
Tectonic Model

Quartzofeldspathic mylonites from several shear zones within the southern Ruby Mountains preserve evidence for a two-stage movement history.

The first phase is related to regional crustal shortening associated with high-grade metamorphism and collisional tectonism.



A second phase of extensional movement appears to post-date the compressional episode and is most likely related to post-orogenic collapse during the Big Sky Orogeny between 1.78 and 1.73 Ga.



Summary

- Kinematic analysis indicates a two-phase movement history within the Ruby Mountain Shear Zone (RMSZ)
- Phase I is associated with compressional tectonism and reverse movement
- Phase II is associated with extensional tectonism and normal movement, unroofing the footwall below the RMSZ
- Phase II possibly related to the gravitational/topographic collapse following crustal thickening during Phase I
- Preliminary $^{40}Ar/^{39}Ar$ results date Phase II extensional movement as initiating ~1785 Ma as recorded by rocks within the footwall of the RMSZ
- Tectonic unroofing continued until ~1726 Ma as recorded by rocks within the hanging wall of the RMSZ