The Influence of Major Faults in Retrograde Metamorphism and Talc Formation in the Ruby Range, Southwestern Montana

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The Archean Wyoming province lies in north-western Wyoming and south-western Montana. The Wyoming province is characterized by a variety of metamorphic and structural styles. In the western part of the province, high-grade metasedimentary sequences comprise most of the rocks. These have undergone isoclinal folding, nappe emplacement, and metamorphism to granulite facies at 2.75 Ga (Mogk, Henry, 1986).

Archean plutons of calc-alkaline granitoid dominate the eastern Wyoming province. Emplaced at about 2.75 b.y. ago, these plutons contain older, supracrustal xenoliths, which were metamorphosed to granulite grade 3.4- 3.2 b.y. ago. (Mogk, Henry, 1986)

The discontinuity between these distinct geologic regions appears in the western Beartooths as a mobile belt. The mobile belt consists of lithologic sequences of different metamorphic grades, structural types, and isotopic ages. These sequences have been juxtaposed by transverse and thrust faults (Mogk, Henry, 1986).

The Ruby Range occupies the north-west portion of the Archean Wyoming Province. The structural makeup of the Ruby Range varies between the central one-third of the range and the outer terrain. In the middle of the range, one finds two or three fold generations on a mesoscopic and macroscopic scale. Outside of this region, the rocks exhibit four fold generations. Karasevich et al. interpret this discrepancy as evidence that the rocks of the central Ruby Range originated in the Cherry Creek area, and were emplaced as nappes in their present locale. The emplacement would have occurred between 2750 my and 1450 my ago. (Karasevich et al., 1981)

Granulite-facies rocks in the north of the Ruby Range give dates of 2.75 Ga. Temperatures associated with this 2.75 Ga. event range from 745 degrees C in the north of the range to 675 degrees C in the central range. Anomalously low temperature conditions measured by oxygen isotope data may result from retrograde metamorphism, or later, low grade metamorphic events, such as the 1800 my emplacement of granitic dikes. (Karasevich et al.) James (1990) proposes another low grade, regional thermal rise at 1650 m.y., as well as a later (post 1.425 Ga.) hydrothermally driven event associated with the emplacement of mafic dikes. This last hydrothermal event is cited as the probable formative source of the talc reserves in the Ruby Range, which are valued for their large bodies of pit-minable, tremolite free talc (Olson, 1976).

The Ruby Range talc deposits have formed in dolomitic marbles. The structure of the host rocks seems to have influenced the location of formation of talc bodies. Talc occurs discontinuously along layer parallel fractures (Anderson et al., 1990). The maximum conditions for formation of the talc have been calculated as 2 kbar and 400 degrees C. (Anderson et al., 1990)

Okuma (1971), Garihan (1973), and Berg (1979) have suggested that talc formation resulted from fluid movement along the major North-west trending faults in the Ruby Range area. (Anderson et al., 1990). The volume of fluid required to produce this talc would be more than 600 times the volume of the talc. Because talc reserves in the Ruby Range have been estimated at a hefty, one million tons, formation of the ore requires enormous quantities of fluid (Anderson et al., 1990). If the major faults served as the main conduit for the circulation for a vast volume of hot fluids, rocks on or near the faults should display the effects of hydrothermal retrograde metamorphism and of metasomatism.

The identification of the talc forming event is complicated by the effects of several other low grade events; however, talc producing activity was widespread and significant, and, if the faults acted as conduits, retrograde effects beyond the scope of later hydrothermal events should be preserved. I have begun to distinguish non-fluid related, retrograde events. This distinction has helped to clarify the relationship between metasomatic, talc related alteration minerals, and other, regional, retrograde assemblages. They may have resulted from two separate events, or the same event.

In undertaking this project I compared of fluid altered rocks adjacent to major faults to the background metamorphic rocks collected near faults, as well as samples of the same rock types, collected at locations distant from major faults. I collected 160 samples from the northern, southern, and central parts of the Ruby Range according to the above criterion. 48 samples have been thin-sectioned and examined under a petrographic microscope. In addition to petrographic examination, the Amherst College scanning electron microscope has supplied chemical composition data, useful for mineral identification, and geothermometry and barometry.

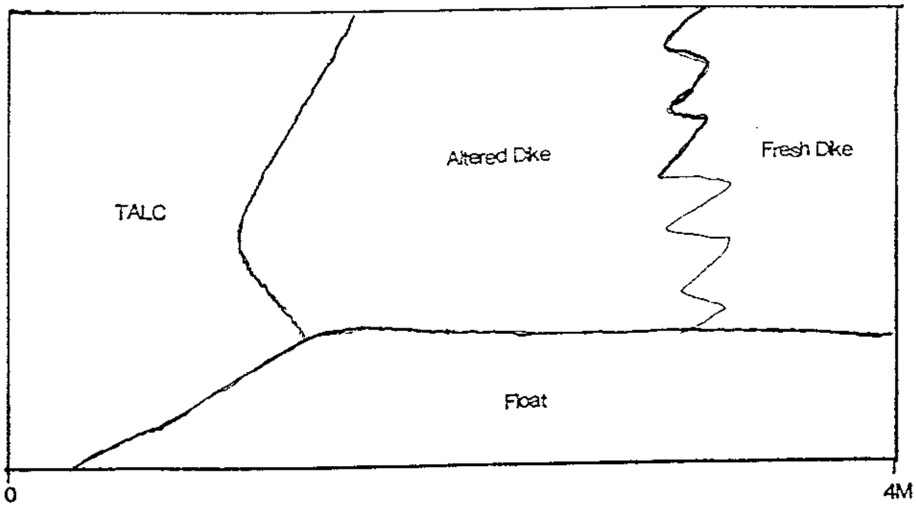

Figure 5. Field sketch showing the area of alteration in q dikes near the talc deposits.

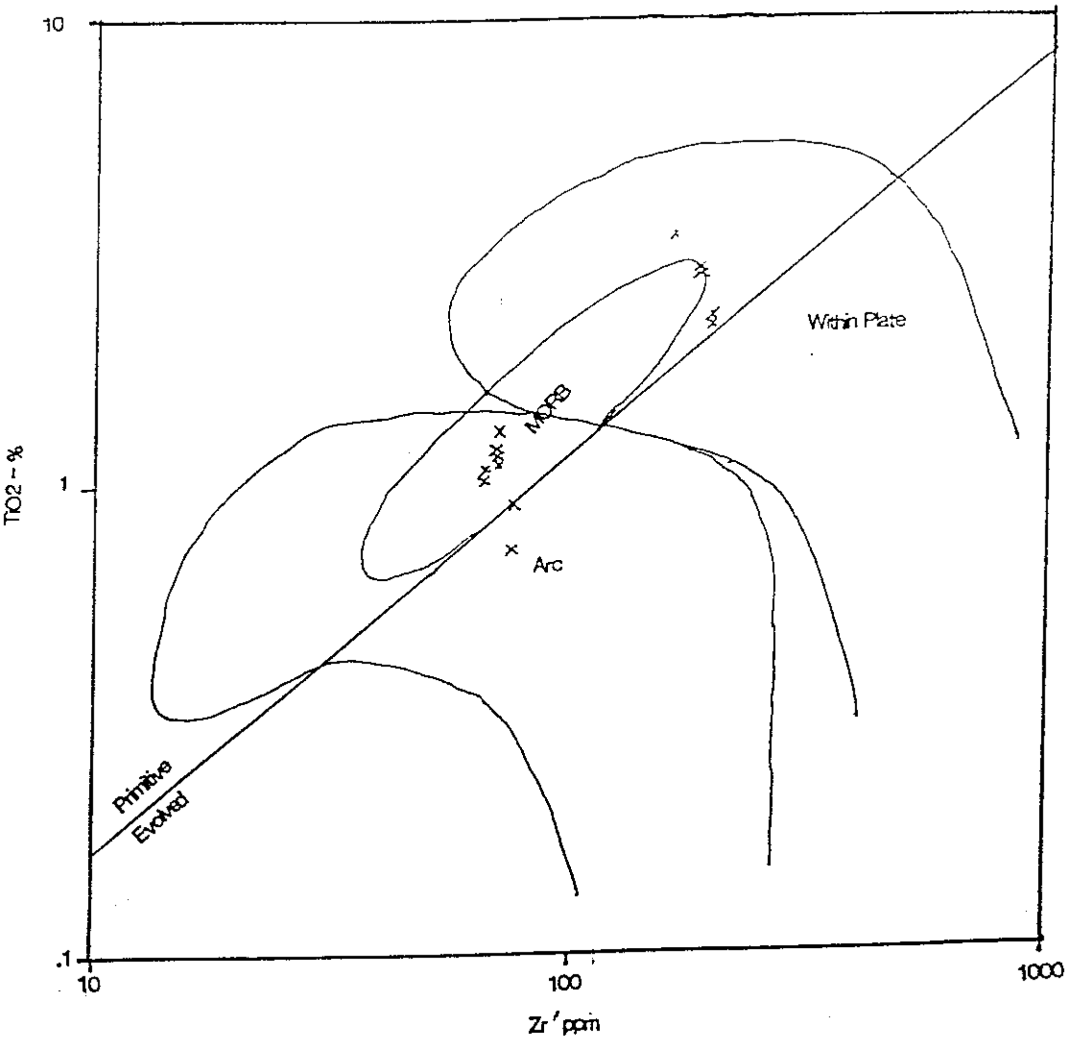

Figure 6. Discriminant diagram showing the two groups of Proterozoic dikes. One plots as a rift and the other as a back arc basin.

Preliminary examinations have not established a clear relationship between fault proximity and alteration. Located one mile from any major fault, an amphibolite (CC17) shows complete alteration of plagioclase feldspar to sericite, as well as the alteration mineral zoisite, petrographically associated with the seracitization. Another amphibolite (SW5) lies within 10 meters of a major north-west trending strike slip fault and shows only 50% alteration of plagioclase to sericite.

The lack of an initial correlation does not contradict the initial hypothesis of fault controlled fluid movement. I hope to clarify the relationship by examining the influence of factors other than fault proximity. Fluid passage might be influenced by rock type and composition, fabric, grain size, macroscopic folding, or unrecognized faults.

I will devote special attention to the interpretation of the age of metamorphism of altered rocks. Greenschist facies minerals may have originated during a thermal rise at 1.4 Ga., or they may have appeared during retrograde metamorphism at 3 Ga (Anderson et al., 1990). Using the argon release method at the Universisty of Maine at Orono I hope to obtain geochronology and thermochronology data in order to correlate the alteration in my rocks with distinct events of low grade metamorphism, and to establish an age for the hydrothermal emplacement of talc.

Argon release data gives the age at which the closure temperature for a specific mineral type was exceeded and argon was released. The closure temperature varies from mineral to mineral, allowing a single rock to give ages on several events. Thus by selecting biotite (300-350 degrees C closure) and hornblende (500 degrees C closure) (McDougal, Harrison, 1988) from near a talc deposit, I can characterize the talc forming event by age and temperature, in addition to establishing temperature constraints for older, higher grade metamorphism. Argon release data on my other samples from throughout the Ruby Range will reveal if the alteration therein corresponds to the talc metasomatism and, also, will clarify the post 3.2 billion year thermal history of the region. Establishing a thermochronologic history of the region will be essential to constraining the origin of the talc deposits.

References:

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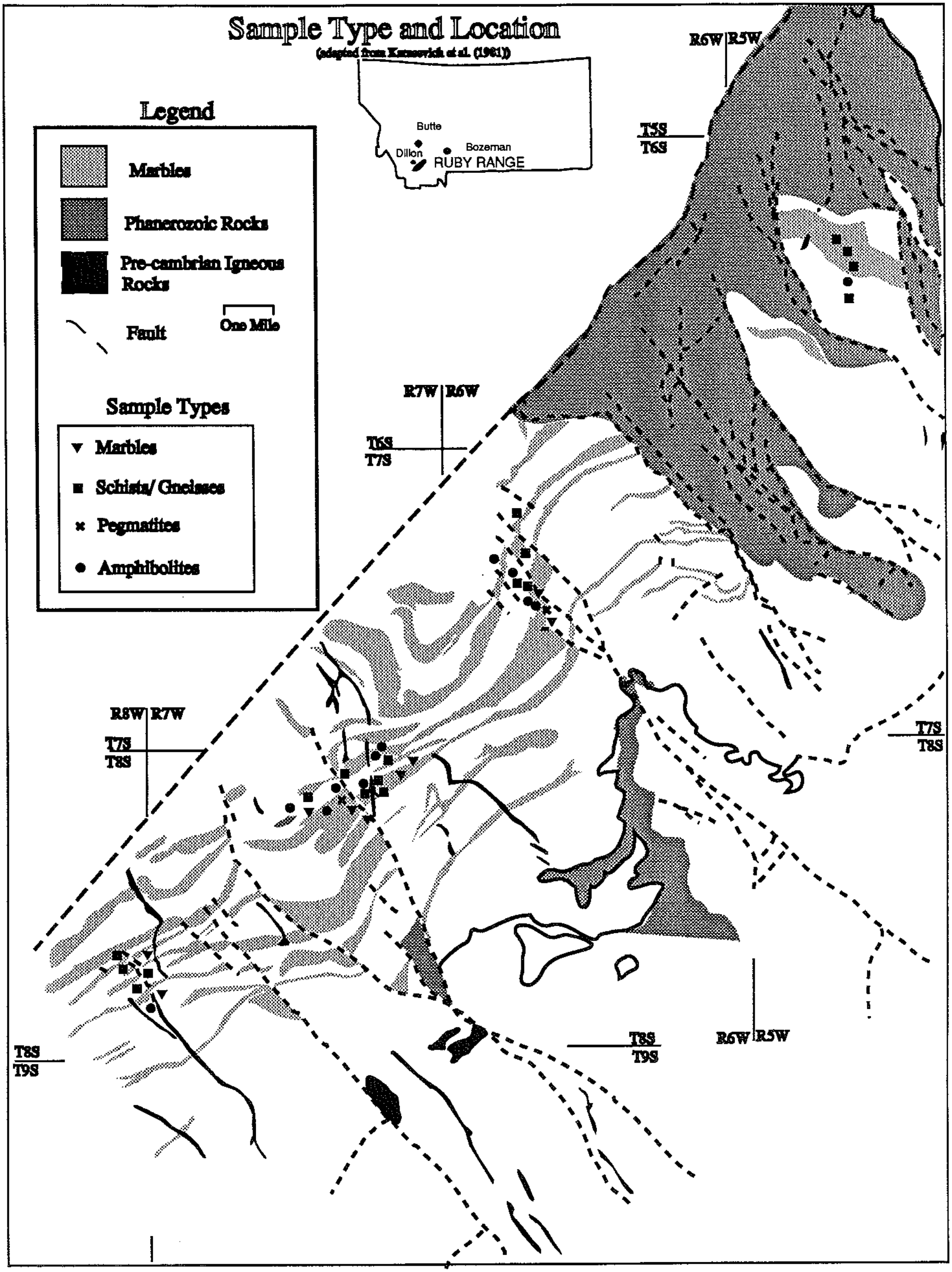
Sample Type and Location
Butte
Dillon
Bozeman
RUBY RANGE
Legend
Marbles
Phanerozoic Rocks
Pre-cambrian Igneous Rocks
Fault
One Mile
Sample Types
Marbles
Schists/ Gneisses
Pegmatites
Amphibolites
R6W R5W
T5S T6S
R7W R6W
T6S T7S
R8W R7W
T7S T8S
T7S T8S
T8S T9S
T8S T9S
R6W R5W