

Myrmekite in the Sherman Granite in Wyoming-Colorado

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September 15, 2019

Introduction

In the late 1940s Arthur Hagner (with W. H. Newhouse and G. W. Devore) mapped the Sherman Granite in the Laramie Range of Wyoming-Colorado (Newhouse and Hagner 1947; Newhouse, Hagner, and Devore 1949) (**Figures 1 and 2**).

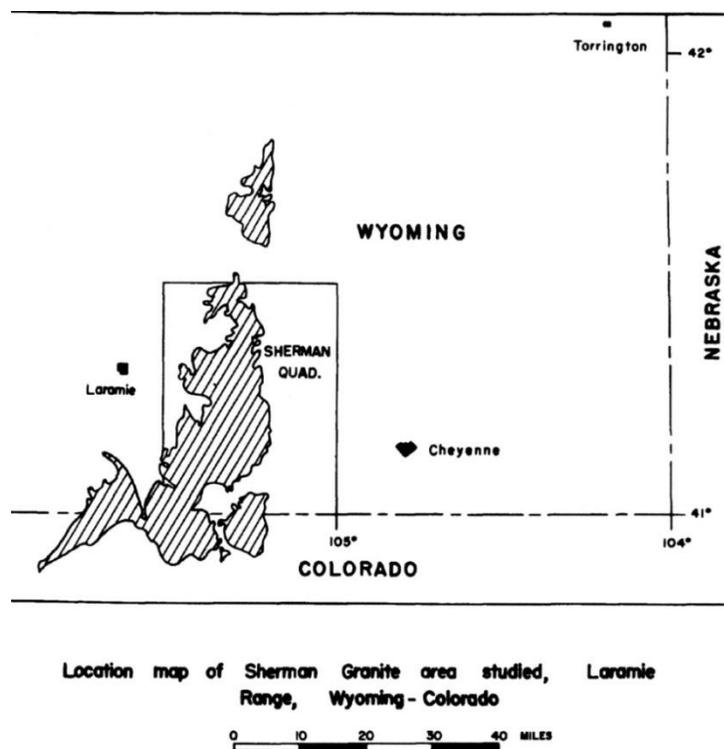


Figure 1

Figure 1. Location map of the Sherman Granite area (Harrison 1951).



Figure 2. Porphyroblastic Sherman Granite (Harrison 1951).

The Pole Mountain gneiss (**Figure 3**) occurs associated with the Sherman Granite (Harrison 1951).



Figure 3. Pole Mountain gneiss (Harrison 1951).

Discussion

In the course of his study Hagner found that the rocks in the Sherman granite area had regional changes in the foliation attitudes, bending into S-shapes (**Figure 4**).

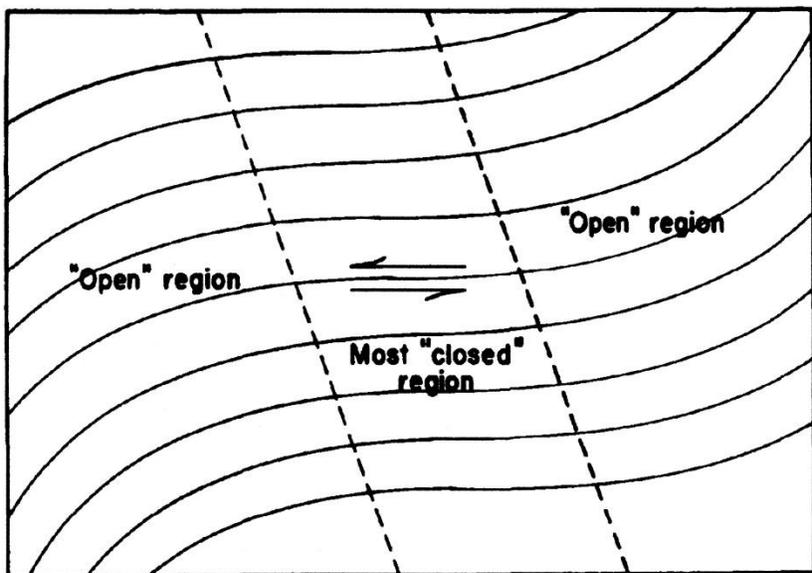


Figure 4. S-shaped structure. The flanks of the "S" are pulled apart during shear movements parallel to the foliation to produce low-pressure sites ("open" regions) into which fluids could migrate and bring in dissolved ions to replace primary micro-fractured minerals (Harrison 1951).

Hagner found that the granitic rocks changed composition depending on the degree of bending of the foliation. Un-bent rocks had the composition of quartz diorite. Where the regional foliation was slightly bent, the rock became granodiorite. With greater bending it became quartz monzonite, and with greatest bending it became granite (the Sherman Granite). The sliding along the foliation, opened low pressure sites through which fluids could move and extract Ca, Fe, and Mg as the volume of hornblende in the original rock was reduced. These same fluids introduced K and Si to form K-feldspar that replaced plagioclase feldspar and quartz that replaced hornblende. Some of the K that formed the K-feldspar came from biotite that was replaced by quartz and which was in former biotite schists. In this way the rock's mineralogical and chemical composition was

changed by chemical replacement process (metasomatism) at temperatures below melt conditions. The degree of bending controlled the composition. The more open the structure, the more K and Si were introduced.

These compositional changes also happened on an outcrop scale, and Hagner had to make sure that both sampling and attitude measurements had to be done in the same place on the outcrop for there to be a correlation.

Jack Harrison Ph.D Thesis

In 1951, Jack Harrison did a Ph.D. thesis under Hagner's guidance on these same rocks (Harrison 1951). However, Harrison did not know the importance of myrmekite, and he only mentioned its presence as part of his petrographic descriptions of the various rock types without any further discussion of it. But the deformation of the rocks and changes in mineralogical and chemical content were clear clues that myrmekite must be present in these rocks. As predicted in the following link, Harrison reported finding myrmekite in both granite and quartz monzonite (**Figure 5**). <http://www.csun.edu/~vcgeo005/Nr56Metaso.pdf>

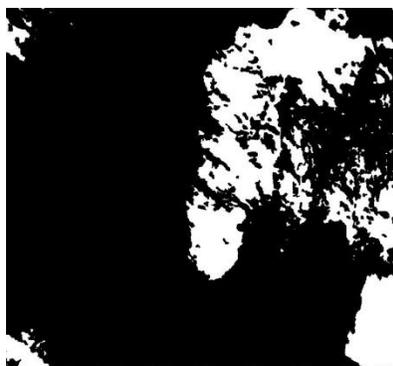


Figure 5. Myrmekite in granite in Wyoming (Harrison 1951).

In his discussion of the geology of the rocks, Harrison found that the Sherman granite in most places did not have sharp contacts with the adjacent more mafic rocks but was commonly gradational to these rocks and that the long dimensions of K-feldspar (microcline) megacrysts were aligned parallel to the foliation (**Figure 6**).

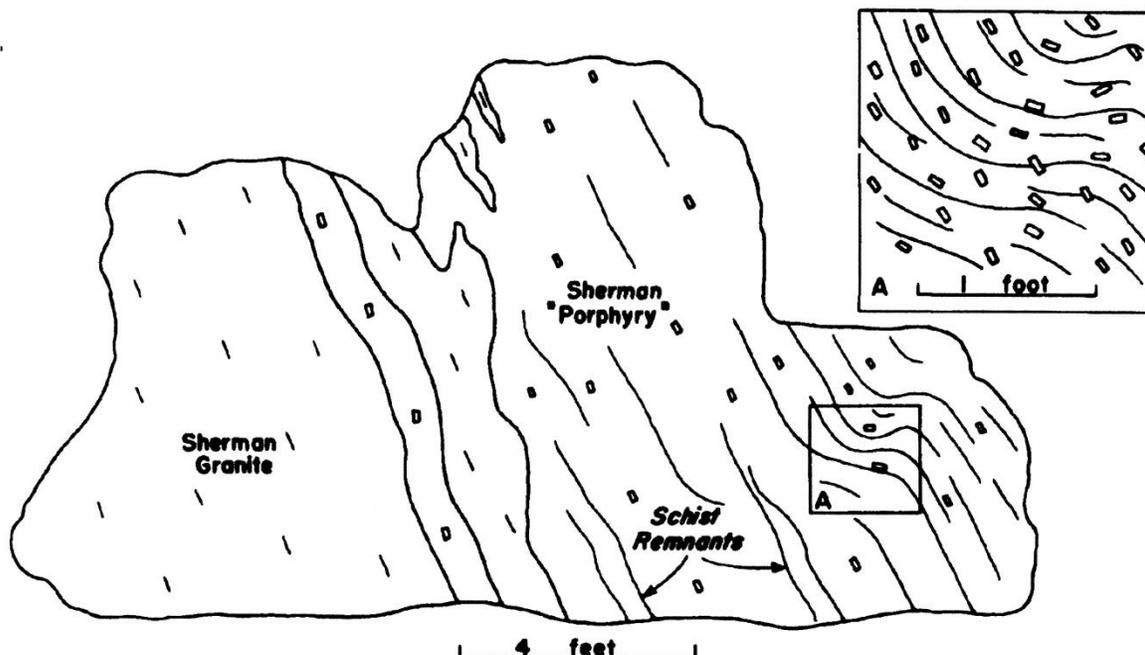


Figure 6. Sherman "porphyry" granite showing porphyroblastic megacrysts aligned parallel to foliation. Schist remnants in the granite also are parallel to the foliation. In some places the megacrysts cut across the foliation (inset) (Harrison 1951).

Harrison describes three types of Sherman granite. Type I is coarse granite with large porphyroblasts of K-feldspar (54%), and this rock is more massive than the other types, lacking a well-developed foliation, but commonly the porphyroblasts are aligned. Wispy traces of biotite schist (a source of K for the K-feldspar megacrysts) are also in parallel alignment (**Figure 6**). Type II is quartz monzonite that has lesser amounts of K-feldspar (41%) and has better foliation, and Type III is gneissic quartz monzonite with the best-developed foliation and lesser amounts of K-feldspar (35%).

Type III has the most myrmekite, Type II has intermediate amounts of myrmekite, and Type I has the least amount of myrmekite. These relative abundances of myrmekite make logical sense in that most myrmekite occurs where the plagioclase is less efficiently replaced by K-feldspar. Therefore, where K-feldspar is more efficient in replacing the plagioclase to make the large K-feldspar

porphyroblasts, the least amount of myrmekite is found. See: <http://www.csun.edu/~vcgeo005/Nr56Metaso.pdf> for more examples.

Evidence that K-feldspar replaces plagioclase can be seen in this image where microcline occurs in a fracture cutting a plagioclase crystal (**Figure 7**).



Figure 7. Microcline penetrating and replacing a reverse zoned plagioclase crystal along a fracture in the plagioclase (Harrison 1951).

In the field a person can walk along strike of the foliation of the Pole Mountain gneiss into Sherman Granite, and along this distance the change from gneiss into granite is completely gradational. No sharp contacts occur between the two rock types.

However, in some places sharp contacts occur against the Sherman Granite, but they do not necessarily indicate age relationships. For example, aplite dikes with sharp contacts give the appearance of being younger than the host rocks that they seem to cut through, but where the Sherman Granite encloses an aplite dike, K-feldspar megacrysts cut across the contact between the granite and the aplite, indicating that the granite is younger than the aplite dike (**Figure 8**).

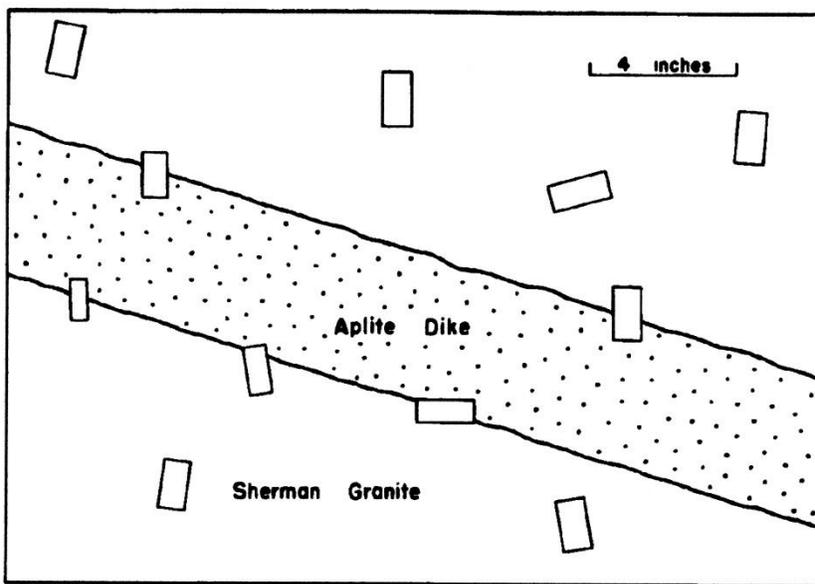


Figure 8. Field sketch of K-feldspar crystals cutting contact between granite and aplite (Harrison 1951).

In other places the aplite dike has a smaller volume in an irregular contact with the granite (**Figure 9**). In **Figure 9** the Sherman Granite is also shown to replace hornblende schist, leaving remnants of the schist in the granite. This replacement of the schist is volume-for-volume without any change in volume, indicating that the hornblende schist has been replaced by the Sherman Granite.

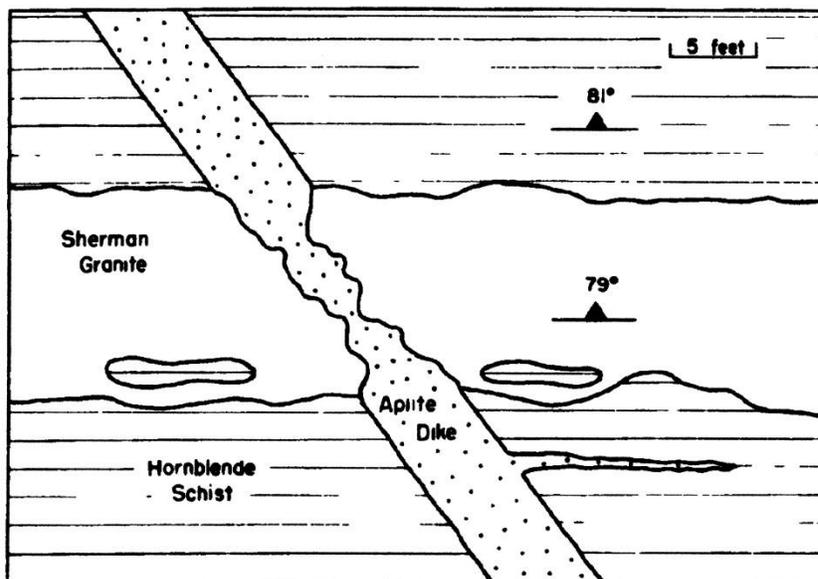


Figure 9. Field sketch showing aplite dike with irregular contact with the Sherman Granite. Remnant hornblende schist is enclosed in the granite. Aplite cuts the schist and penetrates the schist but is older than the Sherman granite (Harrison 1951).

In still other places the Sherman Granite locally also contains large lenticular masses of mixed rocks, e.g., hornblende gneiss, biotite schists, and quartzites. In these places these enclosed rock masses were not deformed so that the fluids carrying K and Si could penetrate and replace their silicate minerals. In other places small inclusions of these rock types occur with their foliations aligned parallel to the foliation in the adjacent Sherman Granite. In some places, the granite is gradational along strike to all three of these rock types.

It is also common for the K-feldspar megacrysts to have tiny inclusions of the ground mass minerals found in these rock types.

In some places megacrysts of plagioclase in gneiss are reverse-zoned with more calcic rims (An-33) and more sodic cores (averaging An-26). This reverse zoning could have resulted if the original rock was subjected to increasing temperatures of metamorphism. That is, because more calcic compositions of plagioclase are more stable at higher temperatures, as the plagioclase crystals

began to grow at higher temperatures, more calcic plagioclase formed on the borders of these crystals.

In other places Harrison reported that K-feldspar porphyroblasts have a rapakivi texture with rims of plagioclase (An-33). This rapakivi texture makes logical sense when it is known that myrmekite forms in such rocks where the cores of micro-fractured plagioclase crystals are replaced in their interiors to leave an outer rim of unreplaced plagioclase and that the rocks in the same Sherman Granite area also contain reversed zoned plagioclase with the same rim of plagioclase (An 33) as in the rapakivi K-feldspar. The plagioclase rim (An 33) gives evidence that the K-feldspar has replaced the interior of a former reverse-zoned plagioclase crystal. See the following link: <http://www.csun.edu/~vcgeo005/Nr56Metaso.pdf> where other examples of interior replacements of plagioclase crystals occur.

See also the following link where another rapakivi granite and myrmekite were formed in granitic rocks containing zoned plagioclase megacrysts in Norway. http://www.csun.edu/~vcgeo005/metasomatism_Collins.pdf

Conclusion

The granitic rocks in the Laramie Range clearly show strong evidence (a) that they were formed at temperatures below melt conditions in places where the rocks were deformed and micro-fractured so that K and Si could be introduced in hydrothermal fluids as these same fluids extracted Fe, Mg, and Ca to change the rocks into more granitic compositions, and (b) that their mineralogical compositions were determined by the degree in which the system was open to the fluids. What is significant is that myrmekite provides another clue that this replacement process occurred in these rocks that became the three types of Sherman Granite.

References

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Newhouse, W. H., and Hagner, A. F., 1947, Zoned metasomatic gneisses related to structure and temperature, Laramie Range, Wyoming, *Geological Society of America Bulletin*, v. 58, p. 1212-1213.

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