DESERICITIZATION: A PROCESS OPERATIVE DURING HIGH TEMPERATURE MINERALIZATION

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INTRODUCTION

The alteration of orthoclase and other feldspars to sericite is a well-known and well-understood phenomenon. The feldspars of granitic rocks are commonly found altered to white mica, or sericite, in the vicinity of veins or fractured zones through which have passed more or less high-temperature solutions. The reverse change, that is from sericite to orthoclase, is not nearly so common nor so well understood. The alteration of muscovite or white mica to orthoclase has been recognized by Butler and Vanderwilt[1] in their study of more or less high-temperature mineralization in the molybdenum deposit at Climax, Colorado, and more recently a paper by Butler[2] treats of the same general topic. Butler[3] refers to the replacement of sericite by orthoclase as "orthoclasization." In this paper the writer describes the case of the mineralization of a previously sericitized granodiorite in which it seems conclusively evident that a similar change has taken place. The process is named "desericitization." The term refers to the destruction of sericite without regard to the nature of the mineral causing the destruction. In this respect the term differs from "orthoclasization" of Butler.

In the granodiorite stock at Santa Rita, New Mexico,[4] there occurs a brecciated zone in which intense mineralization has taken place. The minerals which were introduced are chiefly magnetite, quartz, orthoclase, and some copper mineral, now entirely oxidized. This locally brecciated granodiorite is known as the Whim Hill breccia. It is only in the Whim Hill breccia that the phenomenon to be described has been noted, all other specimens of the granodiorite examined having been found to be more or less completely sericitized.

[1] Butler, B. S., and Vanderwilt, John W., The Climax Molybdenum Deposit of Colorado: *Colo. Sci. Soc. Proc.*, vol. **12**, pp. 36–37, 1931.

[2] Butler, B. S., Influence of the Replaced Rock on Replacement Minerals Associated with Ore Deposits: *Econ. Geol.*, vol. **27**, pp. 1–24, 1932.

[3] *Loc. cit.*, p. 20.

[4] Paige, Sidney, *U. S. Geol. Survey Atlas, Silver City folio*, No. **199**, 1916.

Petrography of the Whim Hill Breccia

The structure of the breccia is illustrated in Fig. 1. The large fragment in the center of the photograph is about 1.5 inches across. Other fragments are somewhat larger but most measure about 1 inch in greatest dimension. The fragments are cemented by quartz, magnetite, oxidized copper minerals and orthoclase. In places open spaces exist between the fragments, although in such cases the fragments are generally covered with a film or crust of minerals similar to those which occur in the cement.

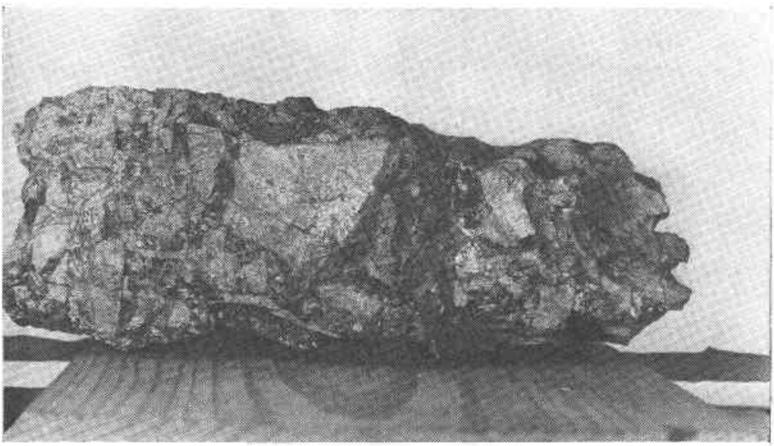

Fig. 1. Handspecimen of Whim Hill breccia.

A microscopic examination of the breccia discloses the texture of the original unaltered granodiorite to have been porphyritic granular. The phenocrysts presumably were orthoclase because there is no vestige of plagioclase twinning. The groundmass was probably quartz, orthoclase, plagioclase, and biotite.

The present mineral assemblage is illustrated in Fig. 2. The field shows two fragments of altered granodiorite separated by a mineralized fracture. Mineralization in the fracture consists of quartz, magnetite, and a small amount of orthoclase. The porous nature of the veinlet is shown by the presence of open spaces in the thin section. The fragments of granodiorite consist largely of sericite bordered by fresh, unaltered orthoclase in the vicnity of the fractures.

Other specimens under the microscope show that the interior of the granodiorite fragments carry bleached chlorite whereas the peripheral portions carry instead green biotite.

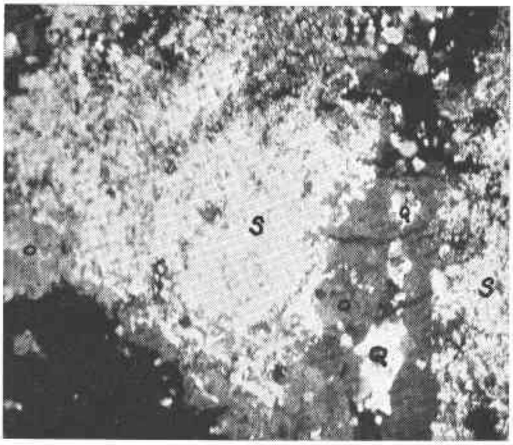

FIG. 2. Photomicrograph showing desericitization in Whim Hill breccia. *S*, white areas to both sides of veinlet, sericite. *O*, gray areas bordering sericite areas, orthoclase. *Q* in center of fracture, quartz. The dark areas in the fracture consist of quartz in extinction, opaque magnetite, and open space. Nicols, crossed. Magnification, about 12×.

Theory of Mineralization

Three explanations of these facts are possible. The first suggests that after the fracturing of the fresh granodiorite hot magnetite-bearing solutions were introduced. In the open spaces between the rock fragments temperatures were too high for the formation of sericite and chlorite, but in the interior of the fragments these minerals could form. Under this hypothesis magnetite deposition and sericitization went on contemporaneously.

The second hypothesis states that after the solidification and crystallization of the granodiorite fracturing took place. During this process the rock was cooling, and exerted a cooling influence on the first of the mineralizing solutions to arrive. At this time the rock was sericitized. As mineralization progressed, temperatures increased, so that some of the sericite and chlorite previously produced was destroyed. Sericitization and chloritization were thus a prelude to the main magnetite mineralization, during which fresh orthoclase both filled fractures and replaced sericite.

The third hypothesis is as follows: The rock was sericitized and chloritized during one period, and in a distinctly later period was desericitized and dechloritized. Additional fresh orthoclase, quartz, and magnetite were deposited in the open spaces between the fragments. Both desericitization and dechloritization were most effective near the margins of the fragments and along the borders of the orthoclase phenocrysts.

The principal objection to the first hypothesis which attributed the change from sericitized to non-sericitized areas to differences of temperature in the mineralizing solutions, is found in the small scale in which these variations occur; they being well shown in the field of view of the microscope. It is hardly reasonable to assume that the temperature differences in such small scale distances would be large enough to account for the very marked mineralogical contrasts.

If sericitization constituted the prelude to magnetite mineralization it might be expected that a second stage of sericitization would follow the magnetite mineralization as the solutions cooled. Such, however, was not the case.

On the whole it seems probable that sericitization was an early and perhaps protracted process which effected the entire granodiorite intrusive. This period of alteration was distinct from the later process of metallic mineralization, which in the Whim Hill breccia was of such a nature as to produce orthoclase, quartz, and magnetite. The thermal and chemical nature of the solutions attending the two stages were apparently quite different.

The retention of outlines of phenocrysts and brecciated fragments proves the constancy of volume during mineralogical change, both from orthoclase to sericite and the reverse. Table 1 shows

TABLE 1. LOSSES AND GAINS IN ALTERATION OF ORTHOCLASE TO SERICITE, BASED ON THE ASSUMPTION THAT VOLUME REMAINS CONSTANT

Specific gravities: orthoclase, 2.57; sericite, 2.76. Data from "Dana's Textbook of Mineralogy" 3rd ed., by W. E. Ford, John Wiley and Sons, Inc., New York, 1922, pp. 458 and 561.

Oxides	Composition		Weight of 1cc.		Gain in grams	Loss in grams
	Orthoclase	Sericite	Orthoclase	Sericite		
SiO_2	64.7%	45.2%	1.66g	1.25g		0.41g
Al_2O_3	18.4	38.5	0.47	1.06	0.59g	
K_2O	16.9	11.8	0.44	0.33		0.11
H_2O		4.5		0.12	0.12	
Total	100.0%	100.0%	2.57g	2.76g	0.71g	0.52g

losses and gains during the alteration of 1 cubic centimeter of orthoclase to sericite, based on the assumption that the volume remains constant.

Table 1 may also be used to show the gains and losses in the alteration of sericite to orthoclase by merely reading the gains as losses, and the losses as gains. During this stage some of the sericite which formed during the first stage was destroyed by the orthoclase-bearing solutions. The new orthoclase deposited in the veinlets together with quartz and magnetite, and some of it worked its way into the fragments replacing sericite. Much of this replacement appears to have followed the crystallographic lines of the primary orthoclase of the granodiorite since restored phenocrysts show simultaneous extinction of all areas. It was also during this stage that bleached chlorite to a minor extent altered to green biotite.

Summary

The observations may be summarized as follows:

(1) Whim Hill breccia consists of sericitized granodiorite fragments. Some fragments contain bleached chlorite in their centers.

(2) Fresh orthoclase, quartz, magnetite, and copper minerals partially fill the interstices between the fragments. Fresh orthoclase also replaces sericite within the brecciated fragments along their margins.

(3) The replacing orthoclase restored the original feldspar structure as indicated by the simultaneous extinction of all areas within the outlines of a phenocryst.

(4) Small shreds of bleached chlorite occur in the centers of the granodiorite fragments, but near their borders in the vicinity of the fresh orthoclase, green biotite is present.

Conclusion

These facts lead to the conclusion that high-temperature solutions carrying the chemical constituents of orthoclase can replace sericite, and that the replacing orthoclase can assume a crystallographic orientation and structure similar to that of the first generation.

Acknowledgments

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NOTES AND NEWS

NOMINATIONS FOR OFFICERS OF THE MINERALOGICAL SOCIETY OF AMERICA FOR 1933

The Council has nominated the following for officers of the Mineralogical Society of America for the year 1933:

PRESIDENT: Herbert P. Whitlock, American Museum of Natural History, New York City.

VICE-PRESIDENT: Frank N. Guild, University of Arizona, Tucson, Arizona.

SECRETARY: Frank R. Van Horn, Case School of Applied Science, Cleveland, Ohio.

TREASURER: Waldemar T. Schaller, United States Geological Survey, Washington, D.C.

EDITOR: Walter F. Hunt, University of Michigan, Ann Arbor, Michigan.

COUNCILOR (1933–1936): Kenneth K. Landes, University of Kansas, Lawrence, Kansas.

The thirteenth annual meeting of the Society will be held December 28–30, 1932, at Harvard University, Cambridge, Massachusetts. It is planned to publish in the December issue of the Journal a *preliminary* list of titles of papers to be presented before the Society at its annual meeting. In order to appear on the advance program, titles of papers should be in the hands of the Secretary by *November 10.*

FRANK R. VAN HORN, *Secretary*

REPORT OF THE COMMITTEE ON NOMENCLATURE MINERALOGICAL SOCIETY OF AMERICA, 1932

TO THE FELLOWS AND MEMBERS OF THE MINERALOGICAL SOCIETY OF AMERICA:

The report of the Committee on Nomenclature has been mailed to all fellows and members. Please read it carefully and preserve your copy. If you have any suggestions to make, please send them to the Chairman, Dr. W. T. Schaller, U. S. Geological Survey, Washington, D.C., before November 1, 1932. The report, with any comments by the membership, will be presented to the Society at the annual meeting to be held in Cambridge, Mass., this coming December, 1932. Please be prepared to vote on its acceptance or amendment or rejection, without a full reading of the report at the meeting.

WALDEMAR T. SCHALLER, *Chairman*