QUARTZ PARAMORPHS AFTER TRIDYMITE FROM COLORADO*

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Abstract

Tabular quartz phenocrysts as much as 17 mm. in diameter, paramorphs after tridymite, occur in a small intrusive body of quartz latite porphyry at Home, Colorado. Studies of the quartz phenocrysts show that the optic axis tends to make an angle of 61° to the normal to the plates.

Introduction

Approximately 500 feet north of Colorado State Highway 14, at Home, Colorado, on the north wall of the Cache la Poudre Valley (Home Quadrangle), a small body of quartz latite porphyry has been intruded into the pre-Cambrian basement complex. Although similar intrusive bodies are common throughout the Southern Rocky Mountains, that at Home is of especial interest because of the unusually large tabular phenocrysts of quartz which are paramorphs after tridymite. Studies of the phenocrysts indicate a lack of a simple, systematic orientation of the optic axis with respect to the tabular form of the paramorphs.

Specimens were first studied in the laboratories of Prof. E. S. Larsen at Harvard University. His continued interest and direction have resulted in this report; his aid is gratefully acknowledged.

Character of Intrusive Rock

In the hand specimen the quartz latite porphyry of the Home intrusive has a well-developed porphyritic texture (Fig. 1) with a micro-granular, light bluish-gray groundmass and coarse phenocrysts of quartz, feldspar, and hornblende. Near the contact with the country rock the phenocrysts are small and predominantly pink feldspar with an average length of about 2 mm. Towards the center of the intrusion the feldspar phenocrysts are larger and are associated with tabular quartz crystals which show a tendency toward a parallel vertical orientation, indicative of upward movement (Fig. 1). No attempt has been made to map the intrusive body or plot flow structures shown by crystal orientation.

The groundmass, composed of micro-granular quartz and feldspar, with a few scattered opaque minerals, and some chlorite, constitutes approximately 60 per cent of the rock. Some of the feldspar, having an index of refraction lower than Canada balsam, appears to be orthoclase. Rare, euhedral crystals of apatite and zircon are scattered through the matrix.

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Phenocrysts of feldspar, hornblende, and quartz (described separately) constitute about 40 per cent of the rock. The euhedral pink feldspar crystals with a maximum observed length of approximately 12 mm. have a composition near $Ab_{78}An_{27}$, or oligoclase-andesine. The sharp crystal borders are somewhat blurred by a reaction which has produced a brownish aureole about the crystals. Euhedral hornblende phenocrysts with a maximum observed length of approximately 7 mm. have also been attacked and almost completely altered to biotite, with a rim of opaque minerals and calcite. A few euhedral sphene crystals have borders which are partly resorbed and altered.

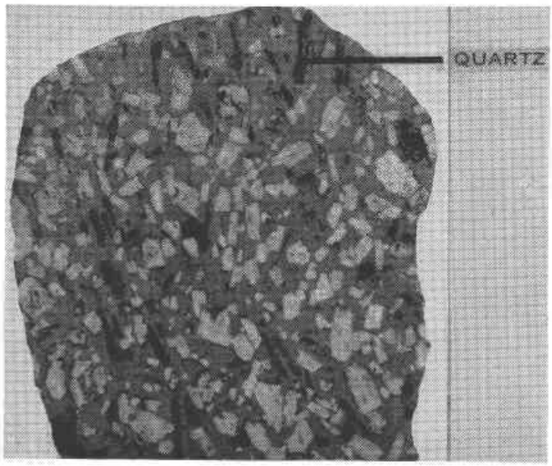

FIG. 1. Polished surface of quartz latite porphyry cut transverse to disc-like quartz phenocrysts (dark elongate areas). Note selective orientation of quartz and feldspar phenocrysts. Natural size.

QUARTZ PHENOCRYSTS

The tabular quartz phenocrysts are in large part concentrated in a zone intermediate between the contact of the intrusive with the country rock and the central part of the intrusive body. In the central mass the few crystals are generally unoriented and are not uniformly distributed. The phenocrysts occur as flattened and rounded discs (Figs. 1 and 2) with a maximum observed diameter of approximately 17 mm. and thickness of about 3 mm.; average diameter is somewhat less than 10 mm. All crystals lack measurable faces and edges because of strong resorption. At first they were believed to be quartz of unusual crystal form, showing either a remarkable development of basal or rhombohedral faces. However, their crystal habit and petrographic occurrence are such that the

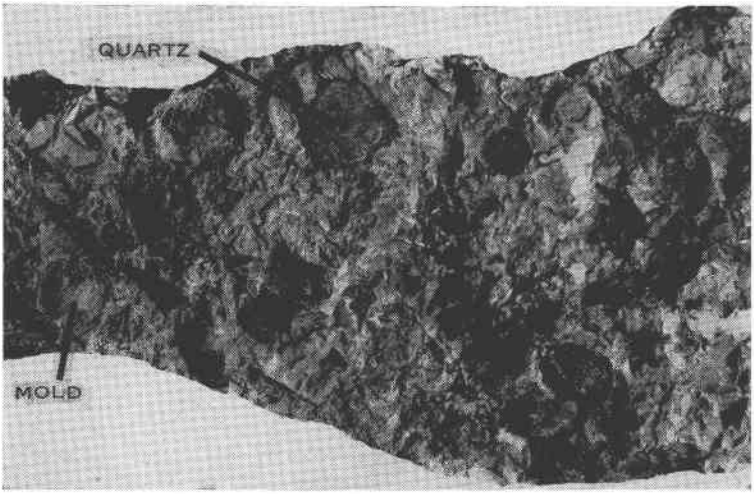

FIG. 2. Quartz latite porphyry showing disc-like phenocrysts and molds from which they have weathered. Resorption patterns of quartz show in molds. Natural size.

crystals can only be attributed to the common tabular form of tridymite. X-ray powder patterns show that the phenocrysts are quartz.* Each phenocryst is a single crystal and not an aggregate of quartz granules.

Numerous disc-like crystals were found weathered free from the matrix at the outcrop. Molds in the groundmass (Fig. 2) show definite patterns caused by the resorptive etching of the crystals. Similar patterns are easily visible on the crystals themselves and their development is well shown in thin section (Fig. 3).

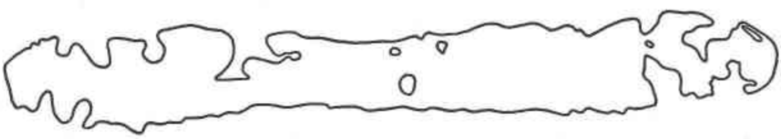

FIG. 3. Section through disc-like quartz phenocryst showing marked reentrants resulting from resorption. ×10.

It was first assumed that the optic axis of the quartz would be normal to the basal faces of the tridymite crystals. Sections of fifteen crystals were cut as nearly parallel as possible (probably within a few degrees) to the basal faces and examined petrographically by means of the Fedorov stage to determine the position of the optic axis. Deviations of the optic

* X-ray powder patterns by Mrs. Ursula Chaisson, Dept. of Mineralogy and Petrography, Harvard University.

axis from a direction normal to the basal face of the crystals varied from 14° to 83°, with an average of about 61°. Readings were: 14°, 52°, 55°, 56°, 57°, 60°, 61°, 62°, 64°, 65°, 66°, 67°, 72°, 78°, and 83°.

These data show that a preferred orientation of the *c*-axis of quartz at an angle of 61° ± 5° to the *c*-axis of tridymite is highly probable. This might mean that the $(10\bar{1}1)$ face of tridymite has become the (0001) of quartz.

Quartz paramorphs after trydymite are not uncommon and have been previously described by Mallard (1) from the Euganean Hills of Italy and by Rogers (2) from California. None, however, has considered the crystallographic orientation of the quartz. Van Valkenburg and Buie (3) have pointed out that quartz paramorphs of octahedral cristobalite have a scattered orientation of the optic axis with respect to the octahedral axis.

Larsen (4) has pointed out that "should quartz be found that had crystallized from the magma as tridymite or cristobalite and inverted to quartz in the solid state, the crystallization from the magma might have taken place either above or below 870° C."** Thus, the presence of tridymite phenocrysts does not necessarily indicate an unusually high temperature of crystallization. However, the large size of the phenocrysts in this rock suggests a leisurely crystallization under stable conditions rather than the hurried crystallization leading to most metastable forms. If this is true, the silica crystallized from this magma at temperatures above 870° C. At some stage the crystals were not in complete equilibrium with the fluid magma, as shown by their resorption.

Upward movement, shown by the orientation of the tabular phenocrysts, indicates considerable fluidity of the magma and a rapid chilling in the new environment.

It is suggested that detailed study of this interesting rock in both the field and laboratory may reveal considerable data on its paragenesis and the temperature of the magma.

References

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** This temperature is for a pressure of one atmosphere, and will be higher for higher pressures.