Insights Into the Formation of Rhyolite From the Searchlight Pluton: Evidence from Oriented Quartz Clusters

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Introduction

The Miocene Searchlight pluton (SLP) in the Colorado River extensional corridor of southern Nevada is well exposed and filled near-vertical walls exposing cross-sectional study of magma reservoir dynamics and crystal fractional crystallization processes. We used the crystallographic orientations of quartz clusters, as determined by Electron Backscattered Diffraction (EBSD), to test for crystal accumulation in the SLP. Clusters of quartz crystals with matched diffraction planes (parallel or EBSD twin orientation) may indicate a period of crystal accumulation. Using the EBSD results we identify variations in oriented clusters abundances within the section of the SLP and relate these to the dynamic processes that may have occurred during the magma fractional crystallization.

Objectives

• Phryolle fisses and streaks from the nearby Highland Range have been found to be the same age as the SLP and the rhyolite is similar in bulk composition to the SLP Middle zone (Cottontail et al., 2008). The SLP represents a rare, exposed pluton system that provides us with the unique opportunity to study the dynamic processes that occur within the upper crust that are potentially related to the locations and abundances of quartz clusters within each sample. After it was determined which clusters would be analyzed by EBSD, the thin sections were sent to Bowdoin College where polishing, EBSD scanning, and data analysis took place.

• The lower unit of the Searchlight pluton (SLP) is interpreted to be the cumulus equivalent to the overlying granite unit. This is evidenced by the low abundance and mostly interstitial nature of quartz clusters. We have determined that the use of EBSD with respect to these quartz clusters would not be useful for future examination and identification of intermediate cumulates due to the lack of abundant quartz clusters and the randomly oriented nature of the few clusters which are present.

• The upper unit is interpreted as the crystalization front in the chamber in which the initial surge of magma quickly cooled, allowing early contact with the surrounding rock. The coarse phenocrysts (angles oriented to upper-most portions cooled quickly, while the bottom of the upper unit the minerals had more time to slowly solidify and grow. The rhyolite in the lower unit, the upper unit would have been crystallizing before any substantial fractional crystallization had occurred to create the granite found in the Middle unit. While the lower portion of the upper unit does have a higher modal abundance of quartz and quartz clusters than the Lower unit of similar intermediate composition, the clusters have been shown to be completely random in their orientation.

• The high modal abundance of quartz and oriented quartz clusters within the lower Middle unit allows for a thorough analysis of crystal fractionation that occurred. The rhyolite in the lower Middle unit and the upper part of the SLP were exposed, rhyolite within the Highland Range (SLP), which has formed due to normal faulting and deformation, within the upper, prior to eruption. The relationships discovered here have the potential to create many new hypotheses, as well as provide much insight into the processes involved in the formation of rhyolite that are otherwise not accessible.

Methods

Multiple samples were collected from each section (Upper, Lower Middle, and Lower of the Searchlight pluton in southern Nevada. Thin sections of each were made and analyzed under petrographic microscope in order to determine the locations and abundances of quartz clusters within each sample. After it was determined which clusters would be analyzed by EBSD, the thin sections were sent to Bowdoin College where polishing, EBSD scanning, and data analysis took place.

Key Findings

• The lower unit of the Searchlight pluton (SLP) is interpreted to be the cumulus equivalent to the overlying granite unit. This is evidenced by the low abundance and mostly interstitial nature of quartz clusters. We have determined that the use of EBSD with respect to these quartz clusters would not be useful for future examination and identification of intermediate cumulates due to the lack of abundant quartz clusters and the randomly oriented nature of the few clusters which are present.

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• Future studies, close examination of oriented quartz clusters in rhyolite collected at the surface may indicate that some sort of upper-crustal fractionation has occurred. Because quartz crystallization at high pressure hinders the formation of melt from reaching silica-saturated, oriented quartz clusters are unlikely to form in magmas derived at such depths and temperatures. Therefore, rhyolite containing abundant diapiric quartz clusters would need to have had sufficient time to undergo crystal fractionation within the upper crust and form a cumulus before the clusters could be exhumed during chamber evacuation.

Future Work

We intend to examine more grains from the upper Middle, high-silica granite in the SLP and quartz clusters in the upper portion of the lower Middle unit in an attempt to determine whether any cumulus magma was in fact forming while also assessing whether the two magmas are genetically related. We will also continue our work with CL imaging (not shown) to confirm robust granulite grain growth histories within apparent quartz clusters.

*References*


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