Nature and Origin of Microphenocrysts in a Basalt

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Abstract

In the upper 4 cm of a basaltic lava 2 kilometers from its source there is little or no significant change in the size, shape, number, and volume of plagioclase microphenocrysts. A maximum rate of elongation of 0.04 micrometers per second would be consistent with the data. These facts suggest that the microphenocrysts developed prior to extrusion, probably during ascent and effervescence.

Introduction

The abundance of microphenocrysts in glassy lavas appears to reflect the pre-eruption water content of the magma (ANDERSON, 1973). Unpublished studies of the texture and grain size of the glassy crusts and crystalline interiors of lavas suggest that the texture, grain size and even the crystallization sequence within lavas is rather strongly influenced by the microphenocryst population present in the lava at the time of extrusion. However, criteria are needed whereby to distinguish between crystals which grow after eruption (quench crystals, etc.), which grow during ascent (? microphenocrysts) and which grow before ascent (? megaphenocrysts). It is the aim of this work to outline some textural criteria which may be useful in this regard.

This paper is based on microscopic study of microphenocrysts in a Modoc basalt (POWERS, 1932) from Giant Crater, Medicine Lake, California (lat. 121° 38'; long. 41° 30' 30''; Medicine Lake quadrangle; scale of map 1 : 62.500). The samples were collected by A. T. Anderson, Jr. during the field season 1972.
The Modoc basalts are dark grey, aphanitic and variably vesicular and rarely visibly porphyritic. The principal constituents of these basalts are plagioclase, pyroxene (augite), olivine, glass and iron oxides (POWERS, 1932).

Method of Study

Polished sections at vertical intervals of 1 cm and up to 4 cm in depth were made from Sample No. M49-2 (see Fig. 1). Lengths and widths of plagioclase crystals were measured from photomicrographs of the polished sections.

Fig. 1 - Perspective sketch showing the positions of the sections (1, 2, 3, 4) relative to the glassy upper surface (0). Note variation in dimensions of vesicles suggested by irregular voids.

The term microphenocryst in this paper is used to describe crystals greater than 10 microns (but less than 1 mm) in length and width. The number of grains decreases in the size range 50 to 10 micrometers (see below) so that 10 microns is a natural as well as an effective operational limit to the size of measurable microphenocrysts.

Results and Discussion

The total number of plagioclase microphenocrysts per unit area at different depths is presented in Table 1. It is seen that the total number of plagioclase microphenocrysts per unit area is almost the same. Thus, we conclude that there is no significant addition of microphenocrysts in the first few cms of this flow. The histogram of grain size population (Fig. 2) and the data of Table 1 reveal that in the first 4 cm of the flow there is little or no significant growth of