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Kristallisation granitischer Schmelzen

Von

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Mit 11 Textabbildungen

(Eingegangen am 15. April 1965)

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Abstract. To elucidate the problem regarding the genesis of granites and migmatites, the influence of a) anorthite component, b) mafic components, and c) composition of the fluid phase on the crystallization of granitic melts has been experimentally studied. As starting material, an obsidian with an average granitic composition has been selected and mixtures of this obsidian with anorthite or biotite have been made. H₂O or diluted solutions of NH₃, HF or HCl have been used as a fluid phase. The experiments were conducted under 2000 bars gas pressure and under isochemical conditions. At the outset of each experiment obsidian and the mixtures have been melted under 2000 bars pressure and then the temperature has been brought down stepwise, in order to study the sequence and temperature of crystallization directly from the melt.

The results of these experiments are plotted on a series of quartz-orthoclase-albite (Q-Ab-Or) melt diagrams, so that a better comparison with the different granitic systems and with the simple Q-Ab-Or-H₂O system of TUTTLE and BOWEN (1958) can be achieved. The melt or crystallization diagrams of these complex granitic systems under study, represent projections of the Q-Ab-Or-An (An = anorthite) tetrahedron on to the base Q-Ab-Or. In all these triangular diagrams, there are three regions of crystallization: quartz, plagioclase and alkalifelspar. These three regions of crystallization are separated from each other by three
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cotectic lines, which meet at a point: the eutectic point. The sequence of crystallization of the leucocratic minerals, observed in the different granitic systems investigated experimentally here, can be understood with the help of such diagrams easily.

From these experiments the following petrogenetically interesting results have been obtained:

1. The order of crystallization of granitic melts is to a great extent influenced by the normative proportion of the Ab/An components and the composition of the fluid phase. (It is not the variation in the An content directly but the variation in the relative proportions of Ab/An, that causes a change in the order of crystallization.) In general, with decreasing Ab/An proportion in a rock or a melt, the amount of albite component in the eutectic melt decrease, while at the same time the amount of quartz and orthoclase components increase. When the Ab/An proportion of a rock is more than 3.5, then the corresponding eutectic melt is of granitic composition; and when the proportion is lesser than 3.5 the eutectic melt is quartz and orthoclase rich and has aplite composition. Calc-alkaligranites and alkali-granites have an average Ab/An proportion of 4.7 and 10.5, respectively.

2. Not only the sequence of crystallization, but also the temperature of crystallization of a granitic melt is influenced by the normative proportion of Ab/An and the composition of the fluid phase. With decreasing Ab/An proportion from co (An content = 0) to 1.8, the eutectic temperature increases by 40°C. This is valid in both the experiments, where YI2O or 0.05 m HCl is added.

The eutectic temperatures in the following experiments show the influence of the composition of the fluid phase on the crystallization temperatures:

- Obsidian + 0.5 m NH₃ at 690°C,
- Obsidian + H₂O at 675°C,
- Obsidian + 0.5 m HCl at 665°C, and
- Obsidian + 0.5 m HF at 640°C.

3. The acidity of the fluid phase also effects the crystallization of mafic minerals. As the acidity increases: (1) in the experiments where NH₃ has been added magnetite only crystallizes, (2) by the addition of H₂O magnetite forms at first and at lower temperatures reacts with