Effect of excess aluminium on phase relations in the system Qz-Ab-Or: experimental investigation at 2 kbar and reduced H2O-activity

FRANÇOIS HOLTZ 1, 2, WILHELM JOHANNES 1 and MICHEL PICHAVANT 2

1 Institut für Mineralogie, Universität Hannover, Welfengarten 1, 3000 Hannover 1, Germany.
2 C.N.R.S.-C.R.S.C.M., IA TUé de la Ferollerie, 45071 Orléans Cedex 02, France.

Abstract: Liquidus phase relationships have been investigated in the peraluminous system Qz (SiO2) - Ab (NaAlSi3O8) - Or (KAlSi3O8) - Al2O3 - H2O - CO2. The experiments have been performed at 2 kbar, 750 to 850°C, and at H2O-undersaturated conditions (H2O-activity close to 0.5). An aluminosilicate phase (mullite) coexists with all melts of peraluminous compositions. Liquidus phase relationships determined in this system correspond therefore to liquidus temperatures of quartz or alkali feldspar in presence of mullite.

The comparison of the subaluminous (Qz-Ab-Or-H2O-CO2) and the peraluminous (Qz-Ab-Or-Al2O3-H2O-CO2) systems shows that all liquidus temperatures are lower in the peraluminous system. The minimum liquidus temperature is 20 ± 5°C lower in the peraluminous system. The position of the quartz-feldspar cotectic is slightly shifted towards more Qz-rich compositions (3 ± 1 wt% normative Qz content) in the peraluminous system. The projected composition of the thermal minimum is Q35Ab36Or29 in the subaluminous system and Q38Ab34Or25 in the peraluminous system. Peraluminous melts coexisting with mullite contain 1.2 to 2.4 % normative corundum at the investigated temperatures (750 to 850°C).

In contrast to the results obtained in liquidus experiments, different temperatures have not been observed for the beginning of melting of crystal mixtures composed of quartz + alkali feldspar and quartz + alkali feldspar + sillimanite. This may be due to kinetic problems and is discussed.

Key-words: granite, peraluminous, phase relations, solidus, liquidus.

Introduction

After silicon, aluminium is the most abundant element in silicate melts. Recently, the influence of Al on the solubility of minor and trace elements has been studied. Experiments on both natural and synthetic high-silica melts emphasized that highly charged cations (such as Fe3+, Ti4+, Zr4+ and Sn4+) have higher solubilities in peralkaline melts* than in metaluminous* and peraluminous melts* (Dickenson & Hess, 1981, 1986; Watson & Harrison, 1983; Naski & Hess, 1984). Other elements such as P have higher solubilities in peraluminous melts* than in sub-

* peraluminous melt: Mol Al2O3 > CaO+Na2O+K2O; A/CNK > 1; normative corundum > 0
subaluminous melt: Mol Al2O3 = CaO+Na2O+K2O; A/CNK = 1; normative corundum = 0
metaluminous melt: Mol Na2O+K2O > Al2O3 < CaO+Na2O+K2O; A/CNK < 1; normative corundum = 0
peralkaline melt: Mol Na2O+K2O > Al2O3; A/CNK < 1; normative corundum = 0