Liquid-forsterite-anorthite-spinel assemblage at 1 bar in the CMAS system: implications for low-pressure evolution of high-Al and high-Mg magmas

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Abstract: New experiments on the assemblages liquid-forsterite-anorthite-spinel (liq-fo-an-sp) and liq-fo-an have been performed at one atmosphere in the system CaO-MgO-Al2O3-SiO2 (CMAS), in order to shed more light on the evolution of high-Mg to high-Al magmas, which often undergo olivine and/or plagioclase and/or spinel crystallisation during early stages of low-pressure differentiation.

In CMAS, the prior crystallisation of fo, an, sp, fo+sp or an+sp forces high-Mg to high-Al compositions to converge toward intermediate Mg- and Al-rich magmas with constant MgO/(MgO + Al2O3) ratio (= 2/3 in m mole). This first step also increases the CaO/Al2O3 ratio of liquids to produce Al-rich basalts in equilibrium with fo-an-sp. The odd univariant assemblage liq + sp = an + fo displays a similar evolution trend to liq-fo-an-di through the three main basaltic fields (alkali-basalts, ol- and qz-tholeiites) but, due to its odd character, liquids directly evolve from liq-fo-an-sp towards pyroxene-bearing parageneses, crystallising forsterite and anorthite (30:70 wt%). Then, increase of normative pyroxene content allows modal ortho- or clinopyroxene to appear along liq-fo-an boundaries. These new data yield to a simple model of parent/daughter relationships between high-Mg to high-Al compositions and basalts (s.l.).

In this part of the CMAS system, CaO solubility in forsterite seems to be mainly controlled by the degree of silica-saturation of the liquid. Silica-saturation seems to also control MgO solubility in anorthite as well as the CaO/Al2O3 ratio of the liquid.

Key-words: CMAS, basalt, differentiation, high-Al basalt, high-Mg basalt, experimentation, liq-fo-an-sp, thermal divide.

Introduction

The system CaO-MgO-Al2O3-SiO2 (CMAS, see section "Abbreviations and conventions") is the best simple model to understand more complex equilibria of basic magma genesis and evolution, providing quantitative information on phase stability fields, reaction relationships.