INTRODUCTION

In most geochemical environments, even in Ca-rich rocks with coexisting plagioclase and clinopyroxene, olivine contains only very limited amounts of Ca, although unlimited solubility between Fe₂SiO₄ and CaFeSiO₄ (kirschsteinite) and between CaMgSiO₄ (monticellite) and CaFeSiO₄ has been confirmed experimentally (Bowen et al. 1933; Schairer and Osborn 1950). An extensive miscibility gap even at high temperatures has only been found to exist between Mg₂SiO₄ and CaMgSiO₄ (Ricker and Osborn 1954). It has been argued that the inability of Fe-Mg olivine to incorporate appreciable amounts of Ca, even in Ca-saturated systems, is presumably due to the large ionic size of Ca compared to Fe, Mg, or Mn (Brown 1980). Hence, crystal-chemical reasons may be responsible at least in part for high distribution coefficients of Ca between Ca-rich phases and olivine. Köhler and Brey (1990) experimentally investigated the influence of pressure and temperature on olivine composition, but also in their work, even at high P and T, no olivine contained more than a few hundred parts per million of Ca. New experimental work of Libourel (1999) proves that Ca in olivine is strongly dependent upon melt composition—high Na₂O and CaO contents and high XFe are positively correlated with Ca in olivine. However, the detailed effect of any single compositional variable may be hard to isolate in natural systems and it may be more feasible to use the silica activity of the melt as a variable to model and interpret olivine-dependent phase equilibria (e.g., Stormer 1973). In this approach, silica activity would reflect the combined effect of the activities of all chemical components on melt structure.

Up to now, members of the monticellite-kirschsteinite series have only been described from high-temperatures marbles (monticellite-dominated, Tracy et al. 1978), from carbonatites (monticellite-dominated, Tuttle and Gittins 1966, p. 517), from an angrite meteorite (kirschsteinite-dominated, Mikouchi et al. 1995), and from ultrapotassic nepheline melilitites of the