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Stability and phase relations of $Ca[ZnSi_3]O_8$, a new phase with feldspar structure in the system $CaO\text{-}ZnO\text{-}SiO_2$

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ABSTRACT

Zinc feldspar [$Ca(ZnSi_3)O_8$] has been synthesized hydrothermally and its phase relations have been investigated in the system $CaO\text{-}ZnO\text{-}SiO_2$ up to pressures of 1.0 GPa. Single-phase Zn feldspar grew from an oxide mixture at 600 °C and 0.7 GPa within 6 days. It crystallizes in space group $P\bar{1}$ displaying lattice constants of a = 8.121(1) Å, b = 12.927(1) Å, c =7.206(1) Å, α = 93.76 (5)°, β = 116.120(7)°, γ = 84.368(7)°, V = 675.7 Å^3, Z = 2 (Heuer et al. 1998). In Zn feldspar, Zn and Si are ordered on the tetrahedral sites and the structure of Zn feldspar is more similar to the low albite structure than to that of anorthite due to the tetrahedral ordering scheme. Zinc feldspar does not melt congruently but decomposes at subsolidus conditions according to the reaction: 4 Zn feldspar = willemite + 2 hardystonite + 7 quartz (1). Reaction 1 was determined by means of reversed experiments and its negative P-T slope can be expressed by the equation P (GPa) = 2.797(0.325) – 0.0031 (0.0004) T (°C). Introducing the stability relations of the SiO_2 system, two invariant points, I_{qtz} and $I_{trid,}$ are generated at 720 °C, 0.57 GPa and 896 °C, 0.016 GPa projected on the low/high-quartz and high-quartz/tridymite phase transitions, respectively. The phase assemblage willemite+ hardystonite+quartz is not stable at pressures above 1.2 GPa where petedunnite is formed according to the reaction: willemite + 2 hardystonite + 3 quartz = 4 petedunnite (2) (Rothkopf and Fehr 1998). The stability field of Zn feldspar is restricted to pressures <1.2 GPa and temperatures <530 °C, where Zn feldspar decomposes according to the doubly degenerated reaction: Zn feldspar = petedunnite + quartz (3). The intersection of reactions 1 to 3 generates an invariant point at ca. 530 °C and 1.2 GPa. Zinc usually is not determined routinely in electron microprobe analyses of feldspars and therefore data on the Zn contents of natural feldspar are scarce. Nevertheless, some feldspars of Pb-Zn hydrothermal vein deposits and skarns display deficiencies of tetrahedral cations and contain up to 0.18 wt% ZnO in combination with appreciable BaO contents, implying the existence of a $Ba(ZnSi_3)O_8$ component in addition to $Ca(ZnSi_3)O_8$. We recommend inclusion of Zn in analysis of feldspars from such paragenesis.