



Experiments on the effect of CaO, MgO, TiO₂ and P₂O₅ on liquid immiscibility in the system KAlSiO₃-FeSiO₄-SiO₂ : implications for Fe-Ti-P rich magmas.

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Silicate liquid immiscibility has been proposed for many magmatic systems (Fe-gabbros-plagiogranites, lunar basalts, alkaline complexes,...) but mainly investigated by experiments in the KAlSiO₃-FeSiO₄-SiO₂ system (KFaS). However, both CaO and MgO drastically suppress liquid immiscibility making it difficult to step from the KFaS-system to natural magmas, although TiO₂ and P₂O₅ expand the immiscibility field. In previous experimental work, the two groups of oxides were not added together and therefore extrapolation to natural magmas remains hazardous. We performed experiments in the KFaS-system with 0.8-2 wt % P₂O₅ and variable amount of CaO, MgO and TiO₂. Experiments were performed at 3-4 kbar, 1060-1150 °C in a piston-cylinder mounted onto a centrifuge to segregate the coexisting liquids (24 h equilibration in static position and then segregation for ~ 8 h at 700 g). For each run, two starting material were filled in a two-chamber Mo capsule, which in turn was sealed in a Pt capsule.

The addition of CaO lowers the consolute temperature and the width of the miscibility gap. Nevertheless, two liquids are observed at 1100 °C even with 10 wt% CaO in the bulk, contrasting with experiments without P₂O₅. At 1150 °C, the addition of 5 wt% MgO in the bulk, by lowering the FeO_t component, produces two liquids (LF: 26 wt% SiO₂, rich in Fe-Ti-P and LG: 74 wt% SiO₂) in equilibrium with olivine. MgO strongly influences the distribution coefficient of P between the two liquids. For the same difference in polymerization between conjugate liquids (Si/O^{LG}-Si/O^{LF}), D_P is < 12 in the KFaS system (Visser & Koster van Groos, 1979) while it is more than twice as large when MgO is present (D_P between 24-36). The same observation holds

also for D_{Ti} ($D_{Ti}=5.19$ with MgO and < 4.4 in the KFaS system).

The preliminary experiments have some interesting applications for Fe-Ti-P rich magmas. One of the proposed models for these ore-forming magmas consider that they formed through immiscibility, the conjugate liquid being of dacitic-rhyolitic composition. A major drawback of this theory was the low experimental D_P and D_{Ti} , i.e. Naslund et al. (2002) argued that a dacitic magma cannot coexist with a Ti-P rich magma. Our data suggest the contrary. More precisely, our experimental Fe-Ti-P rich liquids are very close to natural ore magmas observed as dykes in the alkaline complex of Kodal (Norway: Bergstol, 1972).

References

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