

### **Appendix 3**

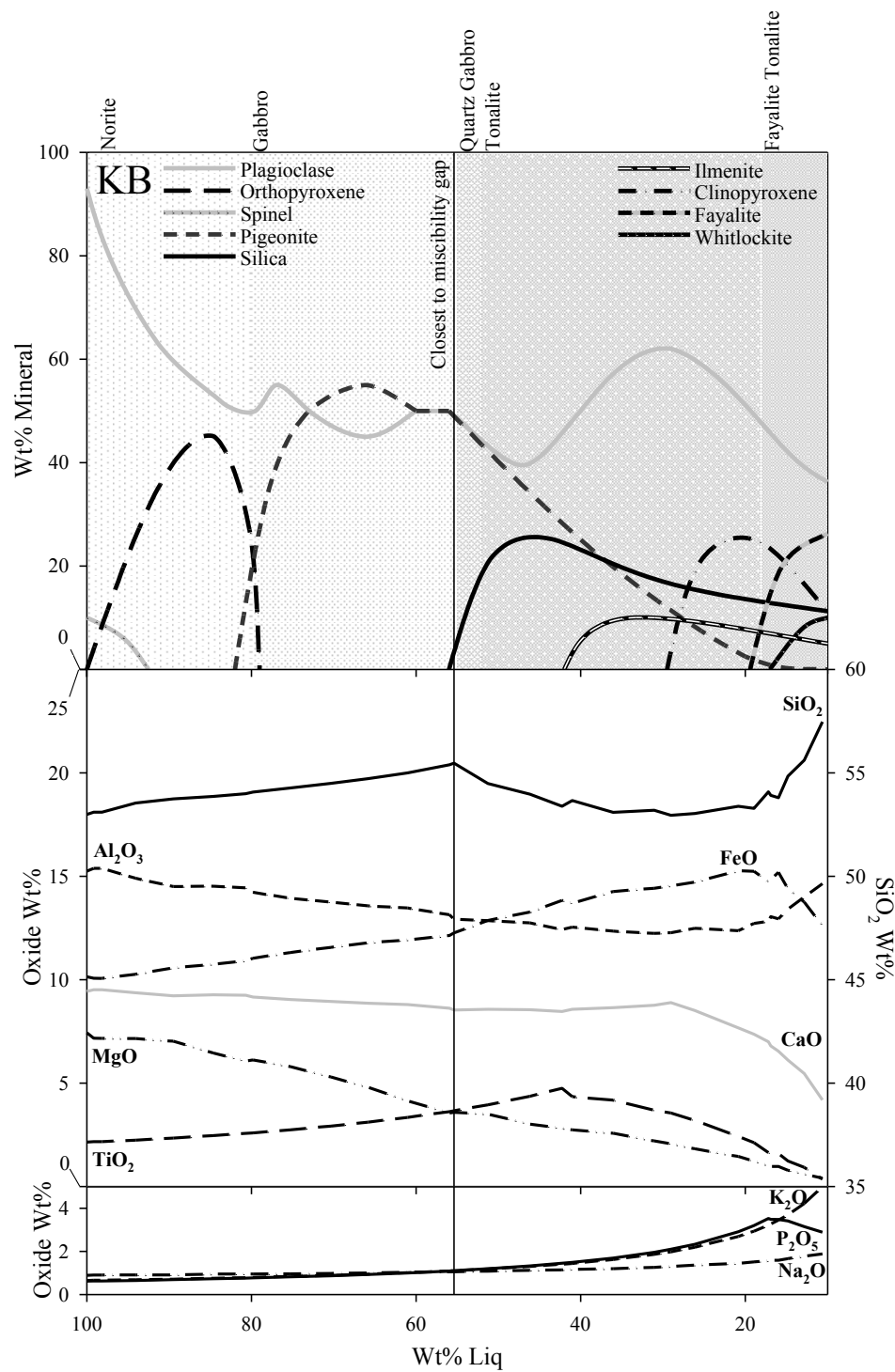
The following is a detailed description on the residual liquids in the KB and BAG models as referenced from the Petrogenetic Modeling section of the text. We also compare the results of experimental fractional crystallization on a 15386 composition done by Holmberg and Rutherford (1994).

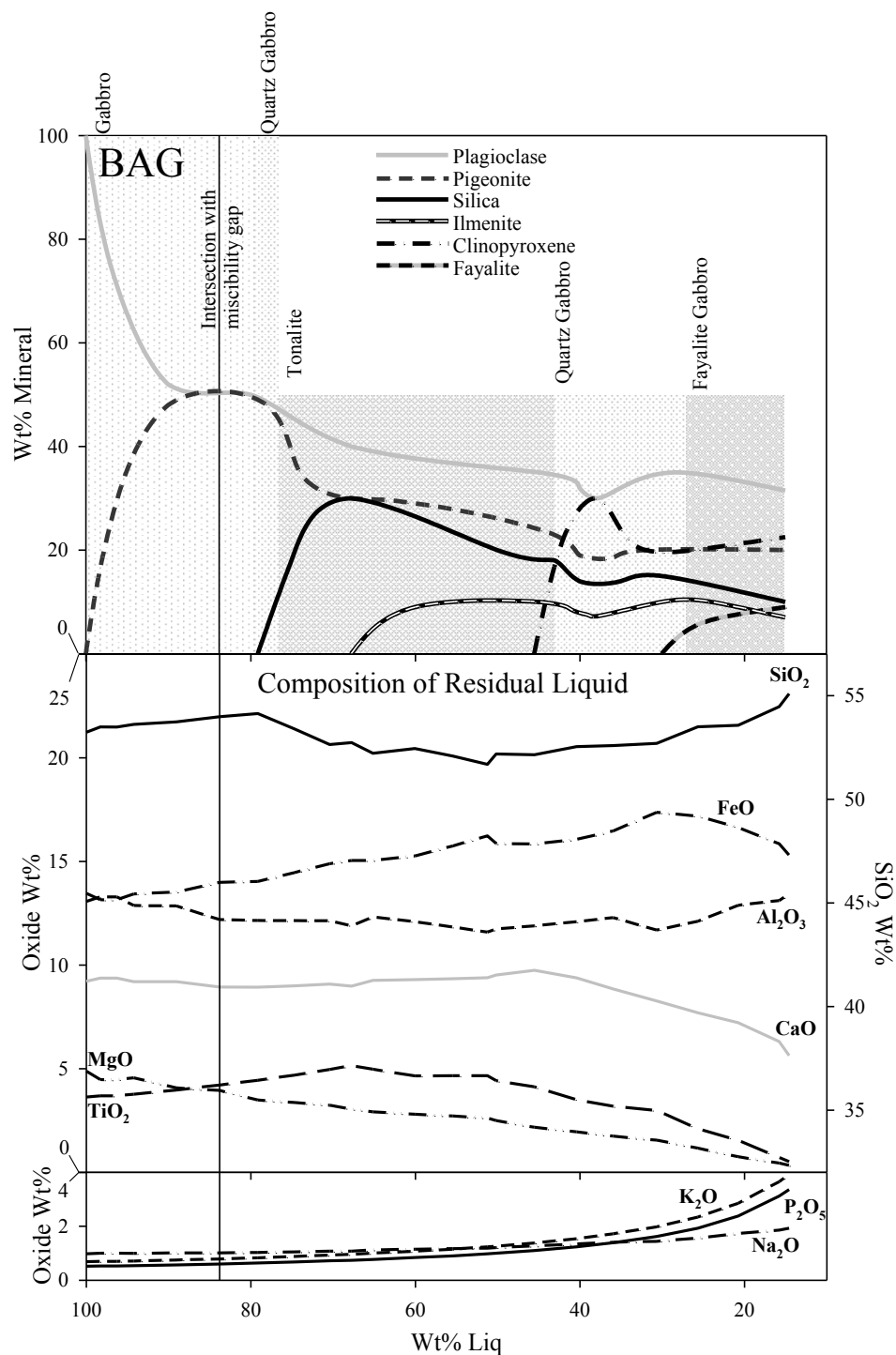
For the fractional crystallization of the KB melt, SiO<sub>2</sub> increases from ~53 to 55.4 wt% at 44 wt% crystallization when quartz begins to crystallize and then decreases back to 53 wt% at 71 wt% crystallization. Then SiO<sub>2</sub> increases to 57.5 wt% at 89.4 wt% crystallized. K<sub>2</sub>O increases to 5 wt% at 89.4 wt% crystallization. Initially, Al<sub>2</sub>O<sub>3</sub> decreases from ~16 to 12 wt% at 69 wt% crystallization and then increases to 14.6 wt%. FeO increases from 10 to 12 wt% until quartz begins to crystallize at 44 wt% crystallization, after which FeO increases more markedly, reaching a maximum of 15.3 wt% at 79 wt% crystallized. From there, FeO decreases to 12.6 wt% owing to crystallization of fayalitic olivine, ferropyrroxene (Fo<sub>12</sub> and En<sub>10</sub>Wo<sub>47</sub>, respectively), and ilmenite. P<sub>2</sub>O<sub>5</sub> increases from 0.6 wt% to 3.5 wt% at 83 wt% crystallization. At that point, whitlockite (merrillite) begins to crystallize and drives the P<sub>2</sub>O<sub>5</sub> down to 2.9 wt%. The KB residual liquid is closest to the field of immiscibility (Roedder 1951) at 44 wt% crystallization (Figs. 1, 2 of this Appendix).

For the fractional crystallization of the BAG melt, SiO<sub>2</sub> initially increases slightly to 54 wt% at 21 wt% crystallization and then decreases to ~52 wt% at 49 wt% crystallization owing to the crystallization of quartz. SiO<sub>2</sub> then finally increases to 55 wt%. K<sub>2</sub>O increases from 0.7 wt% to around 4% at 85.4 wt% crystallized. Plagioclase (An<sub>86</sub>Ab<sub>13</sub>) forms early and keeps Al<sub>2</sub>O<sub>3</sub> relatively constant at around 13.2 wt%. FeO increases to 17.4 wt% at ~69 wt% crystallized, at which point fayalitic olivine saturates. The FeO increase is relatively gradual—a result of the saturation of pigeonite, ilmenite, and ferroaugite. The co-crystallization of fayalitic olivine, pigeonite, ferroaugite, and ilmenite drive FeO to a concentration of 15.3 wt% in the residual melt. The P<sub>2</sub>O<sub>5</sub> concentration increases from 0.52 wt% to 3.4 wt% at 85.4 wt% crystallization without a phosphate saturating. The BAG residual liquid enters the field of immiscibility (Roedder 1951) at 16.2 wt% crystallization (Figs. 1, 2 of this Appendix).

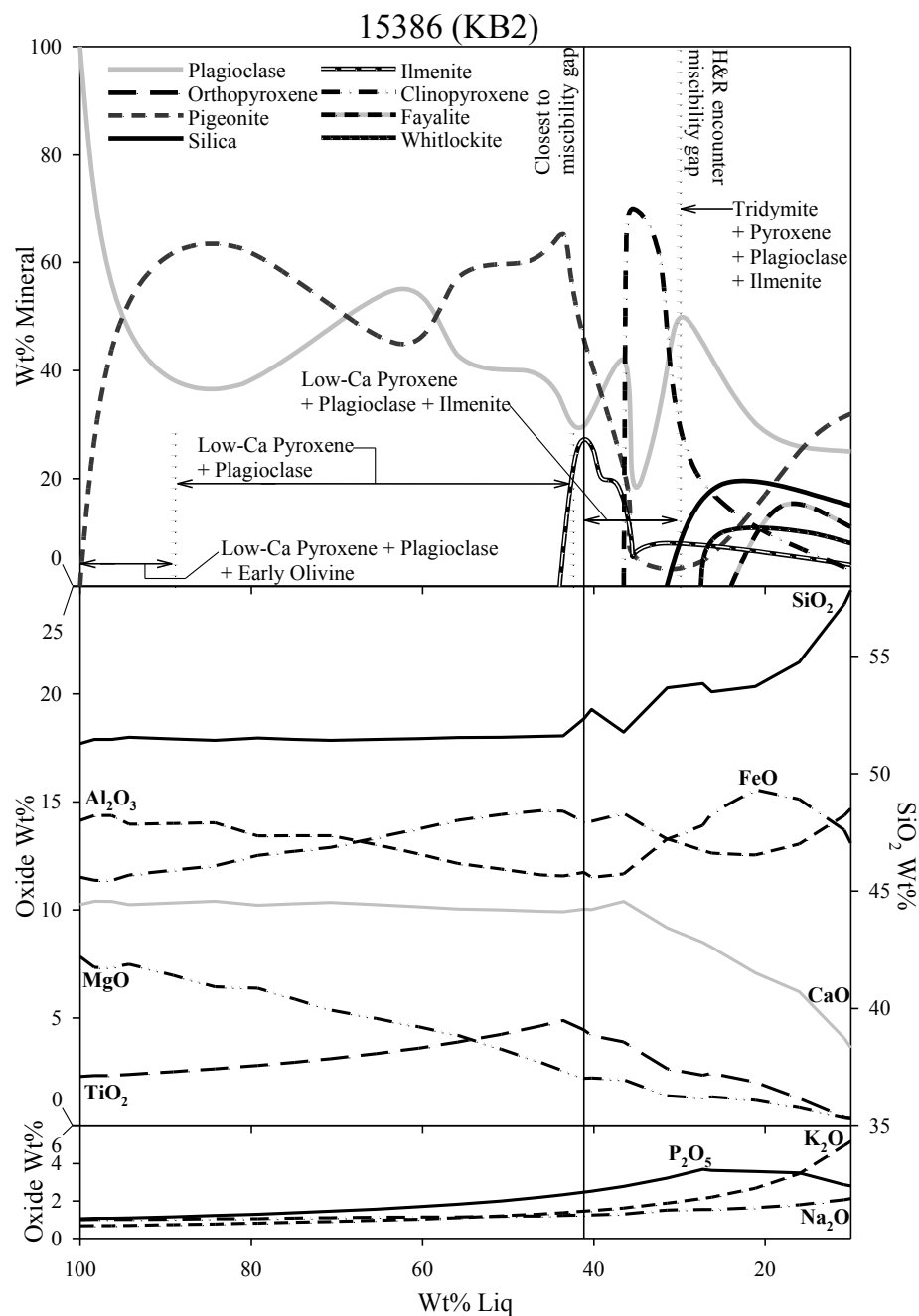
The results of experimental fractional crystallization of KREEP basalt 15386 by Holmberg and Rutherford (1994; hereafter, “the experiment”) are well-reproduced by modeling using the MAGFOX program (Longhi 1991; Fig. 3 of this Appendix) using KREEP basalt 15386 as the starting composition (hereafter, “KB2”). The first phases to crystallize in the experiment were low-Ca pyroxene, plagioclase, and olivine, and once crystallization reaches 11%, only low-Ca pyroxene and plagioclase have crystallized. At 55-60% crystallization, ilmenite begins to crystallize with low-Ca pyroxene and plagioclase. The KB2 model predicts that only low-Ca pyroxene and plagioclase crystallize from 0-56% crystallization after which ilmenite begins to crystallize. In the KB2 model, the composition of the residual liquid is closest to SLI field of Roedder (1951) at 59% crystallization. In the experiment, low-Ca pyroxene, plagioclase, and ilmenite continue to crystallize until ~70% crystallization at which point the residual liquid separated into two immiscible components and silica (tridymite) begins to crystallize. A phosphate crystallizes soon after. Though it cannot account for SLI, the KB2 model predicts that silica would begin to crystallize at 69% crystallization and is joined by phosphate at 72% crystallization. Aside from the onset of SLI (which cannot be directly predicted by MAGFOX),

the only notable difference between the experiment and KB2 is that KB2 predicts that augite will begin to crystallize at 63% crystallization.





**Appendix Figure 1.**  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{FeO}$ ,  $\text{CaO}$ ,  $\text{MgO}$ ,  $\text{TiO}_2$ ,  $\text{K}_2\text{O}$ ,  $\text{P}_2\text{O}_5$ , and  $\text{Na}_2\text{O}$  plotted vs. residual liquid along with the crystallizing mineral assemblage plotted vs. residual liquid (all in wt%) for the KB and BAG models. The plotted lines representing the wt% minerals crystallizing are qualitatively smoothed representations of the output of the MAGFOX program (Longhi 1991). Rock names of the crystallizing mineral assemblages (based on the QAPF diagram) and indicated by the background shade.



**Appendix Figure 2.** SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, FeO, CaO, MgO, TiO<sub>2</sub>, K<sub>2</sub>O, P<sub>2</sub>O<sub>5</sub>, and Na<sub>2</sub>O plotted vs. residual liquid along with the crystallizing mineral assemblage plotted vs. residual liquid (all in wt%) for the KB2 model. The plotted lines representing the wt% minerals crystallizing are qualitatively smoothed representations of the output of the MAGFOX program (Longhi 1991). Dotted, vertical lines represent data from the fractional crystallization experiments of Holmberg and Rutherford (1994; “H&R” in the figure). Arrows indicate the phases reported to have crystallized.