The dependence of Fe-Mg partitioning between orthopyroxene and rhyolite melt on dissolved melt H_2O concentration

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Results of H_2O-saturated phase equilibrium experiments on two rhyolite liquids that are buffered at the Ni-NiO buffer demonstrate an effect of dissolved melt H_2O concentrations on Fe-Mg partitioning between orthopyroxene and low-MgO liquids. Experimental conditions range from 825-900°C, 40-250 MPa(P_{H2O}), and 1-5 wt% H_2O. The results of the experiments show that at high melt H_2O contents, $^{Fe\text{-}Mg}K_D$ values increase, resulting in Fe-rich orthopyroxene, whereas at low melt H_2O contents, $^{Fe\text{-}Mg}K_D$ values decrease, resulting in Mg-rich orthopyroxene. Previous H_2O-saturated phase equilibrium studies on basalts (e.g., Gaetani & Grove, 1998), where fO_2 is buffered, show that dissolved melt H_2O contents exert no resolvable effect on $^{Fe\text{-}Mg}K_D$ values. However, the results of H_2O-saturated, fO_2 buffered phase equilibrium experiments on rhyolite liquids (e.g., Tomiya *et al*., 2010) are consistent with the results of this study, which show that dissolved melt H_2O has a strong effect on orthopyroxene-liquid $^{Fe\text{-}Mg}K_D$ values in liquids with low concentrations of MgO (e.g., rhyolites). It is proposed that the effect of dissolved melt water concentration on the composition of orthopyroxene is analogous to that for plagioclase; in the latter case, dissolved hydroxyl groups preferentially speciate with Na+ vs. Ca2+, which reduces the activity of albite relative to anorthite at high melt water concentrations. Similarly, it is proposed that dissolved hydroxyl groups preferentially speciate with Mg^{2+} vs. Fe^{2+}, thus reducing the activity of the enstatite component at high melt water concentrations. It is further proposed that the effect of dissolved water on orthopyroxene-liquid $^{Fe\text{-}Mg}K_D$ values is strongest in rhyolite melts because of their relatively low MgO concentrations, where the speciation of dissolved hydroxyl groups with Mg^{2+} affects a relatively large proportion of the total Mg^{2+} in the melt. The results of this study demonstrate that reversely zoned pyroxene (i.e., Mg-rich rims) observed in dacites and rhyolites (low MgO liquids) may be the result of degassing of dissolved melt H_2O and is not always a sign of mafic magma recharge.