

Table 2. Outline of calculation methods

| Step | Method 1: $X_{\text{Fe2O3}}^{\text{liq}}/X_{\text{FeO}}^{\text{liq}}$ is measured | Method 2: $X_{\text{Fe2O3}}^{\text{liq}}/X_{\text{FeO}}^{\text{liq}}$ is calculated | |
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| A | P is set to 0.0001 | P is set to 2.4 GPa at Hawaii, 1 GPa for MORB | |
| B | K_D is estimated using Eqn. 5b ¹ | K_D is estimated using Eqn. 5b | |
| C | $D_{\text{MgO}}^{\text{ol-liq}}$ obtained from bulk composition = D_{Mg1} (Beattie, 1993; Eqn. 12) and from K_D in $2 = D_{\text{Mg2}}$. | $D_{\text{MgO}}^{\text{ol-liq}}$ obtained from bulk composition = D_{Mg1} | |
| D | Calculate T from Eqn. 8 using D_{Mg1} , and from Putirka et al. (2007; Eqn. 4) using D_{Mg2} | Calculate T from Eqn. 8 using D_{Mg1} | |
| E | Calculate T and P by iteration from Putirka et al. (2007, Eqn. 4, D_{Mg2}), and Putirka (2008; Eqns. 41-42) | Hawaii ² : Establish $f\text{O}_2$ and $X_{\text{Fe2O3}}^{\text{liq}}/X_{\text{FeO}}^{\text{liq}}$ (for MORB, apply E3) | <ol style="list-style-type: none"> 1. Preserve low-T $f\text{O}_2$ conditions of Rhodes and Vollinger (2005) 2. Use $f\text{O}_2$ of Rhodes and Vollinger (2005) (near MW) but apply T-$f\text{O}_2$ relationship ($\log[f\text{O}_2] = 10.726 - 22151.8/T(^{\circ}\text{C})$) of MORB data (Cottrell and Kelley 2011) 3. Apply $f\text{O}_2$ of MORB-source mantle (as in 2., use MORB T-$f\text{O}_2$ slope) 4. Assume equilibrium with Fo90.5, and use $X_{\text{Fe2O3}}^{\text{liq}}/X_{\text{FeO}}^{\text{liq}} = f(\text{MgO})$ from Cottrell and Kelley (2011), where $X_{\text{Fe2O3}}^{\text{liq}}/X_{\text{FeO}}^{\text{liq}} = 0.2466 - 0.00728 [\text{MgO wt. \%}]^3$ 5. Increase $X_{\text{Fe2O3}}^{\text{liq}}/X_{\text{FeO}}^{\text{liq}}$ measured by Rhodes and Vollinger (2005), by 31.7%, i.e., the fractional increase in this ratio discovered by Cottrell and Kelley (2011) relative to Bezos and Humler (2005) 6. Preserve mean of $X_{\text{Fe2O3}}^{\text{liq}}/X_{\text{FeO}}^{\text{liq}}$ ratios of Rhodes and Vollinger (2005) with $f\text{O}_2$ calculated from Eqn. 4 7. Same as 6., except each liquid is matched with Fo91.3; no iterations required to obtain T and $f\text{O}_2$ |
| F | Calculate $f\text{O}_2$ from Eqn. 4 | MORB: Preserve mean $X_{\text{Fe2O3}}^{\text{liq}}/X_{\text{FeO}}^{\text{liq}}$ from Cottrell and Kelley (2011), and obtain $f\text{O}_2$ from T - $f\text{O}_2$ slope of the natural compositions of MORB at lower T : $\log[f\text{O}_2] = 10.726 - 22151.8/T(^{\circ}\text{C})$ | |
| G | | Olivine composition is calculated from steps B & E | |
| H | | D_{Mg2} is obtained from F and bulk composition | |
| I | | Calculate T and P by iteration from Putirka et al. (2007, Eqn. 4, D_{Mg2}), and Putirka (2008; Eqns. 41-42) | |
| J | Calculate T_D from Eqns. 8b, 10a, 10b; mean F is from Eqns. 12, and Putirka et al. (2007; Eqns. A1, A2); $F = 0.02$ (~1/2 of SEE) for any model that yields $F < 0$ | | |
| | <p>1. Cottrell and Kelley (2011) report atomic $\text{Fe}^{3+}/\Sigma\text{Fe}$ and so their compositions are converted to wt. % Fe_2O_3 and FeO (anhydrous), from which $X_{\text{Fe2O3}}^{\text{liq}}/X_{\text{FeO}}^{\text{liq}}$ are calculated.</p> <p>2. Plotted $T^{\text{ol-liq}}$-$f\text{O}_2$ results are those conditions that yield observed maximum Fo contents at Mauna Loa (90.5-91.3) when a value for K_D (calculated from 5b) is imposed. Exceptions are options 5 and 7, where an olivine composition is assumed. In these cases, the preferred $T^{\text{ol-liq}}$-$f\text{O}_2$ conditions are those where the K_D obtained from the assumed olivine composition matches the value calculated from Eqn. 5b.</p> <p>3. The motivation behind this reconstruction is that while Cottrell and Kelley (2011) present a convincing case that $X_{\text{Fe2O3}}^{\text{liq}}/X_{\text{FeO}}^{\text{liq}}$ varies with fractionation, MgO may act as a proxy for an intrinsic T effect on Eqn. 3a₃; since Fe^{2+} appears on the high entropy side of Eqn. 3a, $X_{\text{Fe2O3}}^{\text{liq}}/X_{\text{FeO}}^{\text{liq}}$ ratios should decrease with increased T, as Cottrell and Kelley (2011) observe.</p> | | |