Appendix

Modeling Method

C isotope compositions of SiC formed by degassing of CO and CO_2 were modeled based on reaction formulas:

$$2C + SiO_2 \rightarrow SiC + CO_2 \text{ (Liu et al. 2015)} \quad \text{(S1)}$$

$$6C + 4MgSiO_3 \rightarrow 2SiC + 4CO + 2Mg_2SiO_4 \text{ (Shiryaev and Gaillard 2014)} \quad \text{(S2)}$$

Because the reactions involve three carbonaceous components, the $\delta^{13}C$ value of SiC cannot be simply calculated using the Rayleigh fractionation formula. Instead, numerical simulation was used to model the C isotope composition of SiC. We divided the reaction into sufficiently short reaction processes in which the C isotope composition of SiC can be readily calculated by

$$R^{SiC} = R^{C} \times \alpha_{SiC/C} \quad \text{(S3)}$$

Where R^{SiC} and R^{C} are the C isotope ratio of SiC and graphite, $\alpha_{SiC/C}$ is the C isotope fractionation factor between SiC and graphite. Thus, $\delta^{13}C$ of SiC at every increment i of instantaneous reaction with degassing of CO_2 can be calculated by

$$\begin{cases} \mathbf{R}_{i+1}^{SiC} = \mathbf{R}_{i}^{C} \times \alpha_{SiC/C} \\ \mathbf{R}_{i}^{C} = \dfrac{\mathbf{R}_{i-1}^{C} - \mathbf{R}_{i}^{SiC} \times \dfrac{\dfrac{X}{2}}{X_i^C} - \mathbf{R}_{i}^{CO_2} \times \dfrac{\dfrac{X}{2}}{X_i^C}}{1 - \dfrac{X}{X_i^C}} \\ \mathbf{R}_{i}^{CO_2} = \mathbf{R}_{i-1}^{C} \times \alpha_{\frac{CO_2}{C}} \\ \mathbf{R}_{i}^{SiC} = \mathbf{R}_{i-1}^{C} \times \alpha_{\frac{SiC}{C}} \end{cases} \quad \text{(S4)}$$

and degassing of CO can be calculated by

$$\begin{cases} \mathbf{R}_{i+1}^{SiC} = \mathbf{R}_{i}^{C} \times \alpha_{\frac{SiC}{C}} \\ \mathbf{R}_{i}^{C} = \dfrac{\mathbf{R}_{i-1}^{C} - \mathbf{R}_{i}^{SiC} \times \dfrac{\dfrac{X}{3}}{X_i^C} - \mathbf{R}_{i}^{CO} \times \dfrac{\dfrac{2X}{3}}{X_i^C}}{1 - \dfrac{X}{X_i^C}} \\ \mathbf{R}_{i}^{CO} = \mathbf{R}_{i-1}^{C} \times \alpha_{\frac{CO}{C}} \\ \mathbf{R}_{i}^{SiC} = \mathbf{R}_{i-1}^{C} \times \alpha_{\frac{SiC}{C}} \end{cases} \quad \text{(S5)}$$

where $\mathbf{R}_i^C$, $\mathbf{R}_i^{CO_2}$ RiCO, $\mathbf{R}_i^{CO}$, $\mathbf{R}_i^{SiC}$ RiCO are the C isotope ratio of graphite, CO_2, CO and SiC at stage *i,* respectively. *X* is the graphite consumption molar proportion relative to original graphite (we use $X = 0.001$ here), $\mathbf{X}_i^C$ is the remnant graphite proportion relative to original graphite at stage *i*. The $\alpha_{SiC/C}$ and $\alpha_{SiC/CO2}$ are the C isotope fractionation factors between SiC and graphite and between SiC and CO_2, respectively. There is no experimental data about $\alpha_{SiC/C}$ and $\alpha_{SiC/CO2}$, therefore, we calculated the fractionation factor through reduced partition function ratios (β-factors) by

$$10^3 ln\alpha_{\frac{A}{B}} = 10^3 ln\beta_A - 10^3 ln\beta_B \text{ (Horita and Polyakov 2015)} \quad \text{(S6)}$$

Thus $\alpha_{SiC/C}$, $\alpha_{SiC/CO2}$ and $\alpha_{SiC/CO}$ can be expressed by

$$10^3 ln\alpha_{\frac{CO_2}{C}} = 10^3 ln\beta_{CO_2} - 10^3 ln\beta_C \quad \text{(S7)}$$

$$10^3 ln\alpha_{\frac{sic}{c}} = 10^3 ln\beta_{sic} - 10^3 ln\beta_C \quad \text{(S8)}$$

$$10^3 ln\alpha_{\frac{CO}{C}} = 10^3 ln\beta_{CO} - 10^3 ln\beta_C \quad \text{(S9)}$$

β_{SiC} is from (Horita and Polyakov 2015), β_{CO2} and β_{CO} are from (Richet et al. 1977) and β_C is from (Polyakov and Kharlashina 1995), which are all temperature dependent. Assuming temperatures of 700, 900, 1100, and 1300 °C, C isotopic compositions of SiC were calculated (Fig. 7).