Supporting Information for "Rate of Melt Ascent beneath Iceland from the Magmatic Response to Deglaciation"

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Introduction:

Figures S1 to S4 are produced by our model using the bi-lithological mantle source of *Rudge et al.* (2013). The results in these figures lead to the same conclusion as those produced from our simplified mantle source that the melt ascent velocity is of the order of 100 m/yr.

Tables S1 to S2 describe the column entries in Datasets S1 to S2.

Data Set S1. Data of whole-rock samples from Iceland. See Table S1 for the description of each column in the data table.

Data Set S2. The mean value of all the rock samples in each eruption. See Table S2 for the description of each column in the data table.

Movie S1. Animation showing the time evolution of the modelling-input ice load (top two panels) and the model outputs of the decompression rate in a vertical plane passing through the center of ice perpendicular to the ridge axis (bottom panel). The top view of the ice load (top-left panel in blue circle) is overlaid on top of the map of Iceland simply for the illustration purpose.

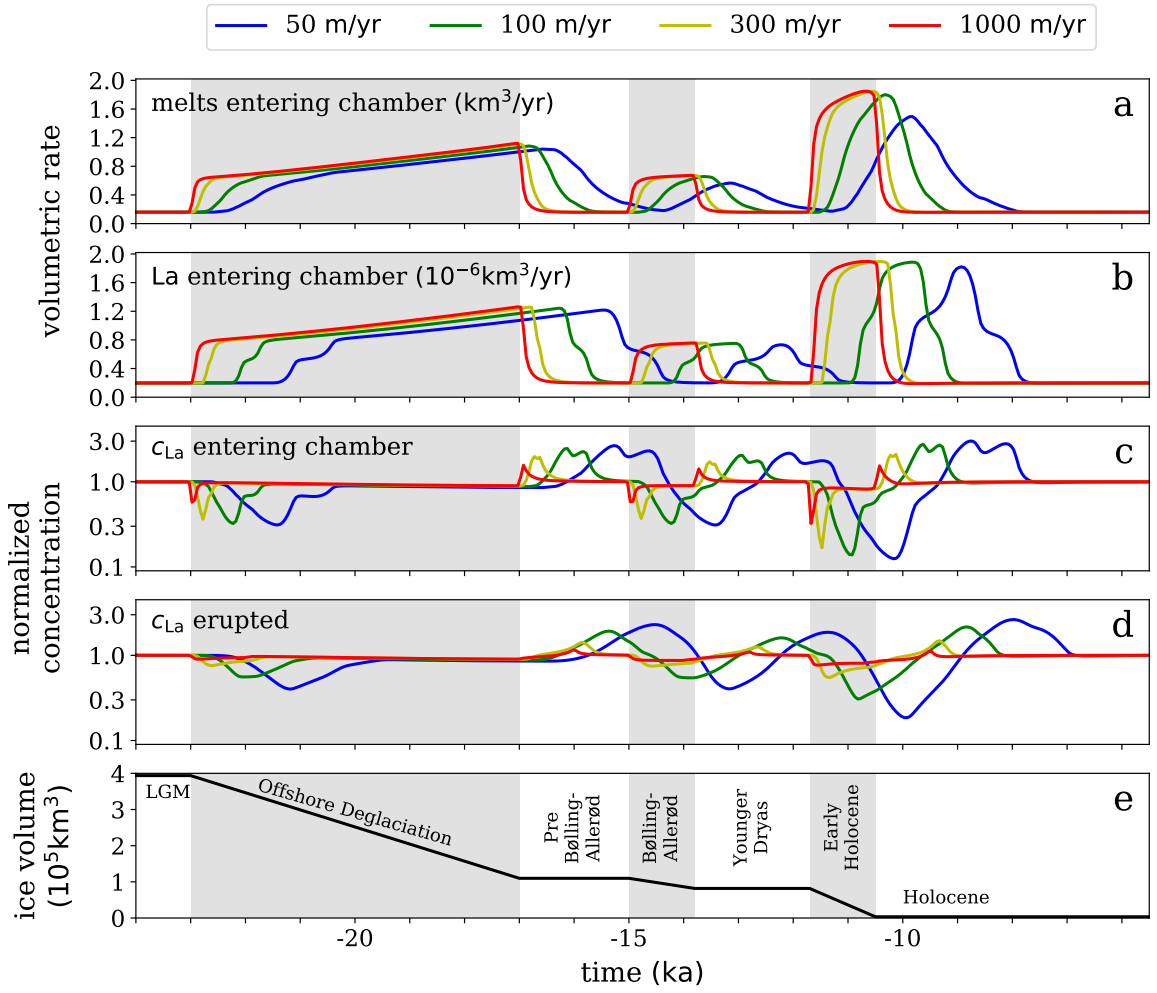


Figure S1: a) volumetric rate of melt supply to the crustal chamber. b) volumetric rate of La supply to the crustal chamber. c) concentration of La in melt supply to the crustal chamber normalized to the steady-state La concentration. d) concentration of La in erupted lavas normalized to the steady-state La concentration. e) modelling-input ice load volume. (c) is the ratio of the La volume (b) to the melt volume (a); whereas, (d) is the ratio of the 1000-year standard moving average (SMA) of the La volume (SMA of (b)) to the 1000-year SMA of the melt volume (SMA of (a)). Grey shaded regions indicate the time interval during which the ice is retreating. Different line colors correspond to different values of melt ascent velocity as labelled on top of the figure in m/yr. The melt and La volumetric supply rates to the crustal chamber are the sum along the ridge axis between 45 and 270 km from the center of ice.

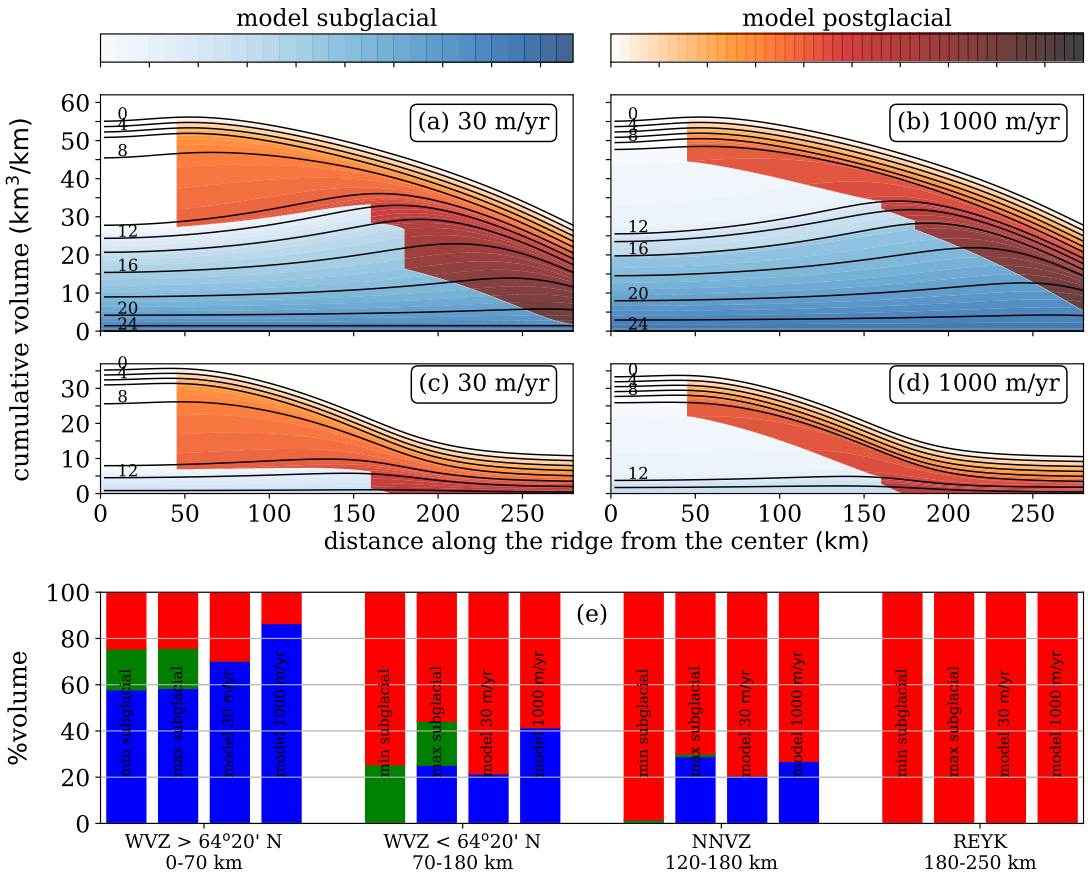


Figure S2: (a)–(d): Isochrons of cumulative lava volume per unit length along the ridge axis as predicted by the model at melt ascent velocity of 30 m/yr for (a) and (c) and 1,000 m/yr for (b) and (d). Subglacial and postglacial lavas are indicated by blue and red colors (as indicated by the two color bars on top of the figure) with color intensity proportional to the lava age. Contour lines are separated at an equal interval of 2 kyr and the ages labelled on the lines are in kyrBP. (a) and (b) show volume accumulated from 24.0 kyrBP; whereas, (c) and (d) show volume accumulated from 14.5 kyrBP using the same modelling-inputs as in (a) and (b). (e): Volume proportions of different eruption types that erupted between 14.5 and 0 kyrBP in different volcanic zones. Observational data with lower and upper bounds of subglacial volumes are shown by the two left bars. The blue, green and red bars are the subglacial, finiglacial and postglacial volumes respectively. The model results with melt ascent velocity of 30 and 1,000 m/yr are shown on the two right bars with blue bars showing the subglacial and finiglacial types combined.

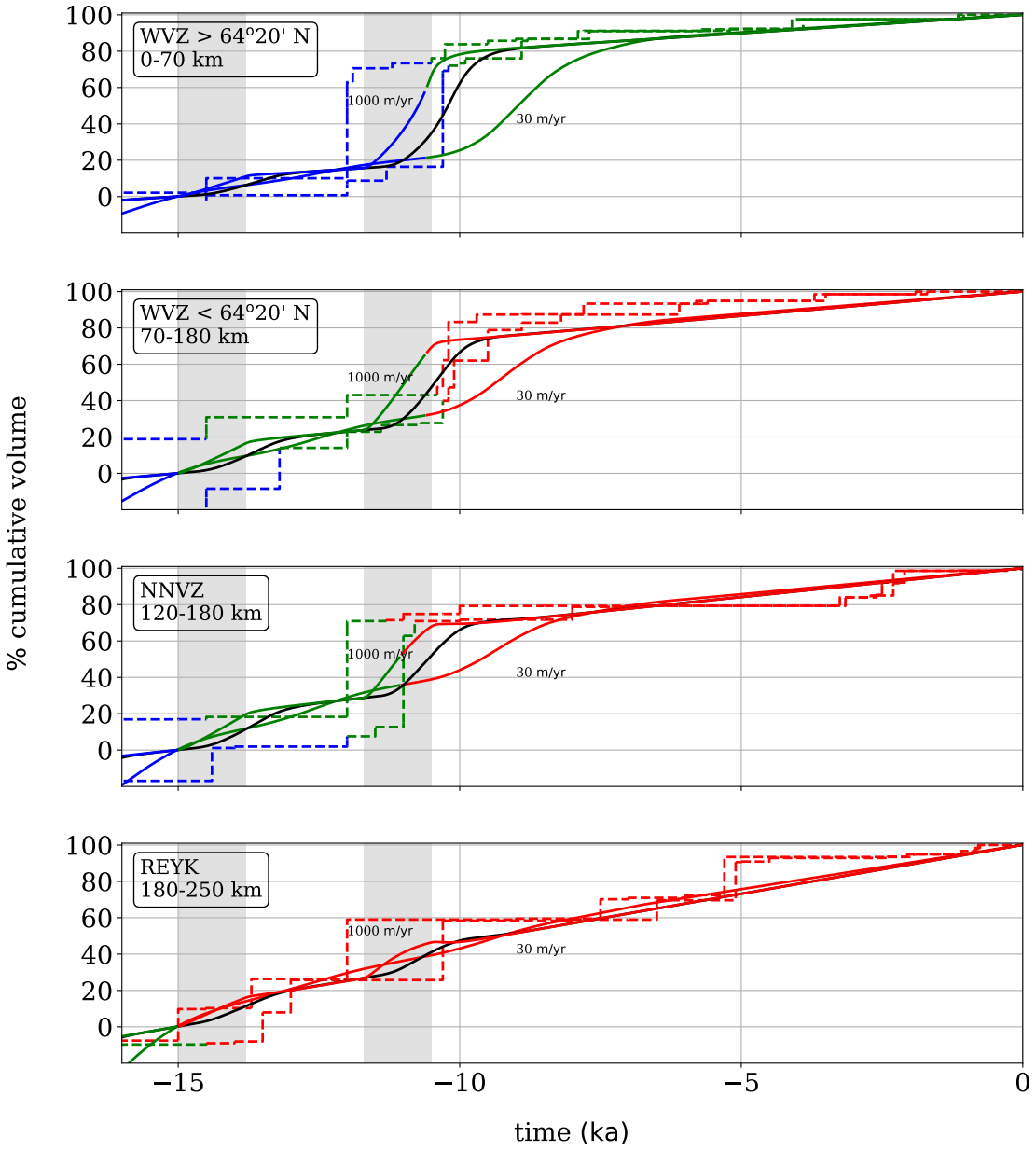


Figure S3: Cumulative eruptive volume normalized to the total volume erupted between time $t = -15$ and 0 kyr. The cumulative volumes of the observational data plotted as steps (dashed lines) come from cumulating the eruptive volumes sorted by either the minimum age bounds or the maximum age bounds of the eruption units. The eruptive volume begins at 0% at -15 kyr and ends at 100% at 0 kyr. We use the mean cumulative volumes at these two ends to normalize the observational data. The model results for melt ascent velocity of 30 and $1,000$ m/yr are plotted as non-black colored solid lines. Colors on these dashed and solid lines illustrate the eruption periods: subglacial in blue, transitional in green and postglacial in red. Black solid line in each panel shows the model result for melt ascent velocity of 100 m/yr. The timings of the eruption periods for the black curve are the same as those for the remaining model-result curves. Different panels correspond to different volcanic zones as indicated on the upper-left corner of each panel together with the corresponding modelling-input zone range. Grey shaded regions indicate the time interval during which the modelling-input ice is retreating.

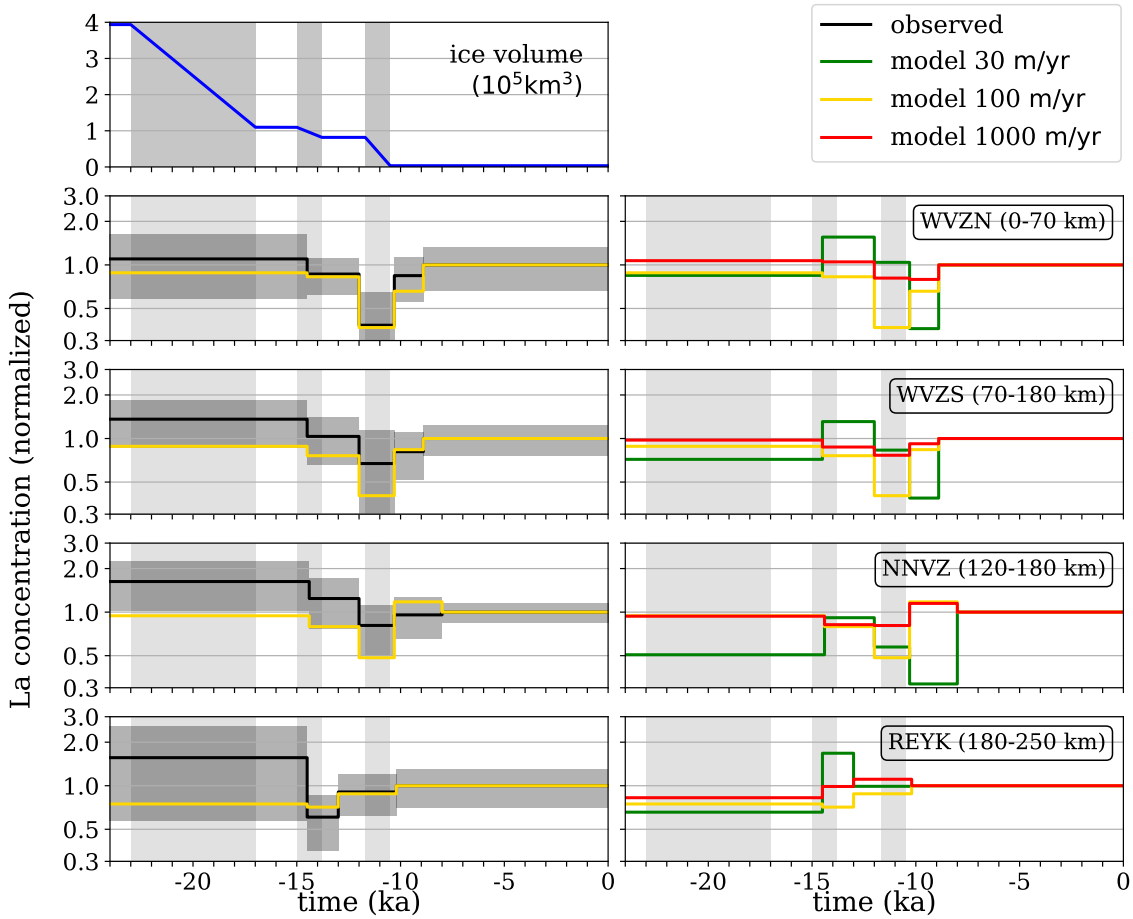


Figure S4: Top panel is the modelling-input ice volume. Each row of the remaining panels shows La concentrations normalized to the steady-state concentration in each volcanic zone. The upper-right corner of the right panel labels the corresponding zone and the modelling-input zone range. On the left panel, the black curve shows the observational La concentrations together with grey bands indicating ±1 S.D. of rock samples. The yellow curve is the model result from a melt ascent velocity of 100 m/yr. The right panel illustrates the model La concentrations calculated from different values of melt ascent velocity labelled with different line colors. Details of how the La concentrations are calculated can be found in the main text.

Table S1: Description of each column in the data table in Eksinchol-ds01.csv file.

Column	Description
Reference	Reference to papers where the data has already been published
Sample	International Geo Sample Number
Zone	Volcanic zone[a]
System	Volcanic system
Eruption	Eruption name
Volume(km3)	Estimated eruption volume in km^3
Longitude	Longitude at where the rock sample was collected
Latitude	Latitude at where the rock sample was collected
num_min_age	Youngest possible age of the eruption in years BP
num_max_age	Oldest possible age of the eruption in years BP
MgO	Concentration of Magnesium-Oxide in wt% Oxide
La	Concentration of Lanthanum in ppm
Frac(Volume(km3))	Estimated eruption volume in km^3 after the fractionation/accumulation correction[b]
Frac(La)	Concentration of Lanthanum in ppm after the fractionation/accumulation correction[b]

[a] NNVZ: Northern Volcanic Zone; REYK: Reykjanes Peninsula and WVZ: Western Volcanic Zone.

[b] See main text for more details of the fractionation/accumulation correction.

Table S2: Description of each column in the data table in Eksinchol-ds02.csv file.

Column	Description
Zone	Volcanic zone[a]
Eruption	Eruption name
N_samples	Number of rock samples in Eksinchol-ds01.csv
Volume(km3)	Estimated eruption volume in km^3
Longitude	Mean longitude at where the rock samples were collected
Latitude	Mean latitude at where the rock samples were collected
num_min_age	Youngest possible age of the eruption in years BP
num_max_age	Oldest possible age of the eruption in years BP
MgO	Mean Magnesium-Oxide concentration in wt% Oxide
La	Mean Lanthanum concentration in ppm
Frac(Volume(km3))	Estimated eruption volume in km^3 after the fractionation/accumulation correction[b]
Frac(La)	Mean Lanthanum concentration after the fractionation/accumulation correction[b]
Type	Eruption Type
Period_minAgeSorted	Period during which the eruption took place as estimated when sorting all the eruptions in the zone by num_min_age[c]
Period_maxAgeSorted	Period during which the eruption took place as estimated when sorting all the eruptions in the zone by num_max_age[c]

[a] NNVZ: Northern Volcanic Zone; REYK: Reykjanes Peninsula and WVZ: Western Volcanic Zone.

[b] See main text for more details of the fractionation/accumulation correction.

[c] See main text for how the period is estimated.