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Interactive comment on "The morphology and surface features of olivine in kimberlite lava: implications for ascent and emplacement mechanisms" *by* T. J. Jones et al.

Anonymous Referee #1

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I find this manuscript very interesting in presenting novel observations of the morphology and surface features of olivine in a kimberlitic magma and relating these features to processes operating during ascent. The manuscript is well written and concise (no unnecessary figures and well described aims and methods). As the conclusions are relatively well-supported by the data presented I also agree with most of the findings reached by the authors (see comment below). I think that the topic would be of interest for a rather broad geological community and should thus be of interest for a journal like Solid Earth. I really only have a few minor comments on this manuscript and these are listed below and I would therefore recommend publication after some very minor revision/clarifications.

I am wondering a little bit about the volume proportions of the mantle material in the model. If a (pyrope) garnet-bearing source is envisaged as the source of the mantle debris (as stated at the end of page 2286), you would expect roughly 60% being olivine and the remaining ~40% divided between Cpx, Opx and Grt. If, this is the case why are not any of these minerals present in the IH rocks? The magma ascent model applied here assumes, building on the experiments of Russell et al. (2012), that Opx breaks down and lowers the overall solubility of CO2 in the "hybrid" melt, which actually propels the ascent of the kimberlite. So in this case, the absence of Opx in the IH kimberlite is not a major problem, but why are there no mantle Cpx and Grt present at IH? Would you not expect these mineral phases to experience the same amount of differential stress and expansion during decompression as the olivines do, and subsequently also produce similar flaking/mechanical abrasion en route to the surface? In other words, what makes olivines the unique mantle phase to be preserved in this process at Igwisi Hills?

In connection with this I am also a little bit confused on the olivine content of the Igwisi Hills lava. When reading the manuscript, the text simply states that the lower section of the kimberlitic pahoehoe flow at Igwisi Hills contain up to 45 vol.% ellipsoidal-shaped olivine crystals (line 4, page 2288 in the manuscript). In the paper by Brown et al. (2012) high proportions of 26 vol.% is reported to occur just above the base of this lava (Fig. 7 in Brown et al., 2012), and a similar value is also given for the digitized slab in the caption to Figure 3 (i.e., 27 vol.%, page 2305), but not really in the text. Why this big discrepancy in the reported olivine content? Have the CSD data been stereologically corrected? And if so, why is the sorting good ($\sigma\varphi$=0.595; Line 11, page 2290) whereas the olivines are described to range in size from 1-10 mm (line 4, page 2288). To me, a variation in size between 1-10 mm do not "reflect a relatively narrow range of olivine sizes in the cratonic mantle lithosphere" as stated in lines 12-14, page 2290. I think this needs some clarifications in the text.

In a simple back of the envelope attempt to calculate the total olivine content within

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the lava flow (also including the vesicular flow top in Fig. 7; Brown et al. 2012) I come up with a value in the range of 10 to 14% (in 2D). However, it is also stated that 25-45% of the primary olivine is abraded away by mechanical abrasion/collisions during ascent. This indicates that there may have been a input of just under 20% of mantle olivine into the ascending magma (pre-abrasion) and assuming that roughly 60% of the mantle material is composed of olivine then this should represent an approximate mantle fraction of 0.3-0.4 being incorporated into the ascending magma. These values makes sense to me, as higher fractions of mantle material will be very difficult to carry to the surface. Therefore, I also think that the statement of $\sim$45 vol.% olivine crystals in the lower parts of the lava flow needs to be clarified in the text and also to give an estimate of total olivine content (see comment above).

I am not sure about the timescales of olivine recrystallization around the edges of larger grains (as seen in Fig. 2), could this perhaps also contribute to the flaky appearance in the IH olivines and make them more susceptible to mechanical abrasion?

Finally, in line 15 on page 2297 there are some spelling errors regarding the rock types and it should read (basalt, basanite, nephelinite).

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