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Interactive comment on "Petrophysical constraints on the seismic properties of the Kaapvaal craton mantle root" *by* V. Baptiste and A. Tommasi

Anonymous Referee #2

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The manuscript "Petrophysical constraints on the seismic properties of the Kaapvaal craton mantle root" by V. Baptiste and A. Tommasi adds new valuable data on isotropic and anisotropic seismic properties of lithospheric mantle in an intensely studied region. Such paper is definitely relevant for publishing in Solid Earth after adding some important information suggested below. Large part of the text is dedicated to detailed analysis of calculated seismic properties and discussion of their relation to large scale, in situ seismic observations. I believe that if such kind of sample-based modeling and critical evaluation of the existing velocity models is carried out, a corresponding attention should be paid to argumentation on how representative the selected sample set is for the present-day lithosphere and how well its seismic properties are modeled. My

review is therefore focused primarily at these methodical problems for which I suggest to consider answering the following questions and notes:

Sample set How were the xenoliths chosen and why? How is the maximum representativeness for the present-day lithosphere ensured? It is said on page 967 that the age of kimberlite pipes ranges from 1200 to 87 My. It is quite substantial range and it would be good to give the ages for individual pipes. I wonder if there could be a possible bias resulting from assessing together rocks sampled at so different phases of the lithosphere's evolution. This is not mentioned in sections 4.3 to 5.2 dealing with large scale seismic model constructed from this xenolith dataset. Is it assumed that there was no evolution in the Kaapvaal lithosphere since 1.2 By? This might be true for olivine CPO and hence the seismic anisotropy but how about the metasomatic processes and resulting isotropic seismic properties? The problem is four-dimensional and this would deserve some paragraph in Discussion. Fig. 1 is a bit confusing since the tomographic section at 150 km depth is presented at a depth of 0 km of the sampling columns - the 3D view does not help much here. Furthermore, I suggest to add to this figure a simple schematic map of the region with coordinates.

Textures and EBSD At least the range of grain size could be given so that we know how coarse the "coarse-grained" peridoties are (e.g., page 968, line 1). How often the lineation was observed in the samples and how is it defined? (referred to on page 971, line 12 and elsewhere). But most of all it is necessary to give more methodical details on the EBSD setting and results so that we can asses how good the description of preferred orientation can be (EBSD performed on single thin section for each sample? Or multiple sections were used for coarse-grained types? How many grains were measured per each phase? Manual or automatic indexing? How the pseudosymmetry of olivine EBSP was dealt with? How successful was the indexing of pyroxenes?...)

Densities and elastic constants It is not clear to me how the sample densities were obtained. Was it by measurement or by modeling based on modal mineralogy? In either case the method should be described. In the latter case it should be taken into

account that mineral compositions of pyroxenes vary strongly in peridotites and so do their densities. How was this solved? And the same problem might be with the elastic constants used. How close were the pyroxene compositions in the present samples to those at which the elastic constants were measured? How well the effects of chemical variations in pyroxenes on their seismic properties are known anyway? The mineral chemistry will also reflect the equilibration pT conditions, so this effect, if not taken into account, might lead to systematic depth-dependent bias in isotropic seismic properties. Perhaps these factors will not have dramatic effect, but this should all be discussed and an estimate of effective errors in seismic properties should be given, taking into account all potentially important uncertainties. It is written on page 969, lines 1-3, that elastic constant tensors for fayalite, forsterite and olivine of three compositions were used. But it is not clear in which cases the end-members were used and why in other cases the Mg-Fe olivine was used instead? It is not clear how the isotropic Vp and Vs are defined (page 975, line 20). Is it calculated by D. Mainprice's careware using isotropic elastic constants as input? What are G and P in equation 1? Some eigenvalues?

Other items page 969, line 20: ...properties of six 20km-deep sections... | perhaps 20km-thick would sound better page 970, line 13: ...J indexes varies... page 970: M-indices are now used by significant part of the community. It might be useful to calculate these as well. page 972, line 7: ...anisotropy is observed between to the Y... page 974, line 25: ...garnet content may attain up to 15% | There is 18% in Tab. 1 and Fig. 4. page 981, lines 27/28 ...anisotropy of the individual samples seismic anisotropy... | I am not sure whether this is gramatically correct.

Interactive comment on Solid Earth Discuss., 5, 963, 2013.