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Solid Earth Discussions

# *Interactive comment on* "Analytical solution for residual stress and strain preserved in anisotropic inclusion entrapped in isotropic host" *by* Xin Zhong et al.

**Xin Zhong et al.**

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We thank the reviewer for the very positive and helpful comments. Below, we provide point-by-point replies to the comments. Our replies are given in blue and the original comments from the reviewers are in black.

Dear editor, I read the manuscript from Zhong and co-authors with great interest. Their manuscript deals with several open questions in the field of elastic thermobarometry and the results provided by the authors can be very useful to the community. Apart from the lengthy, but necessary, theoretical derivations provided by the authors, this manuscript has significant results when it comes to the application of Raman elastic



thermobarometry. In addition, I find their new results on the application of the "volumetrically averaged stress" and the "irregularly faceted inclusions" very interesting and of exceptional quality. Finally, it is very rare to find such studies where the authors have tested their analytical work so extensively.

General Comments

My major point of criticism concerns the detailed and clear description of the steps involved in the procedure for the calculation of the eigenstrain. I have written in detail my main points below but they concern the clarity of the presentation and not the actual methodology (which is actually based on well-established theories). I believe that this part may be difficult to the petrological community and some things which are considered basic in other fields need to be explained in more detail here.

Specific Comments

l. 27-28: Please be more specific that you refer to cases with garnet hosts.

Revised as suggested.

l. 36-37: Somewhere here is implied that you need an elastic model to recover the entrapment conditions. The reason I make this distinction is because one may confuse the elastic model that can be done to convert strains (from vibrational mode shifts) to pressure, with the elastic model that is performed to calculate entrapment conditions from residual P. Please be more specific.

Revised as suggested.

l. 40: Zhang's model allows non-infinite host, it is more general.

Corrected. We removed the word "infinite". The existing model considers an isotropic inclusion in isotropic host.

l. 50: "no numerical software or programming is required". Theoretically, one could do things by hand (even FEM), in addition, plotting the analytical solution may be more

efficient by a software such as Matlab. I would rephrase as "..is that the solution is exact and can be obtained rapidly..."

Revised as suggested.

l. 51-52 Please add a relevant reference that relates MC with Uncertainty propagation.

Reference about MC has been added.

l. 69: "The MATLAB code", which MATLAB code, of the analytical solution, of the FE? Please be more specific. We have revised this sentence to clarify the point. We only present the MATLAB codes for calculating the 1) Eshelby tensor, 2) lattice strain and 3) effective ellipsoidal shape. No FE code is given. This is made clear now. l. 118-120: I do not quite follow what you mean here ("The thermal effects..."). Could you please develop a bit more?

We have revised this sentence. We realized that thermal effect can be confusing as it is often related to volume change, but we are here referring to the T dependence of the stiffness tensor, which has no effect on the final result. This is made clear here now.

l. 121: I think that this way of formulating may be confusing. My point is that the eigenstress is what it is (as defined in Eq. 2) and any mineral can have it no matter how stiff or soft. However, if I understood your argument correctly, for a very soft inclusion in an infinitely rigid host, its eigenstress will be equal to its actual stress. The reason why I would be so specific is because the way it's currently expressed it looks that eigenstresses can be defined only for soft minerals in rigid inclusions.

We see the confusion here. We have revised this sentence. The eigenstress can be understood as the equilibrated stress for an infinitely soft inclusion in an infinitely stiff host. But for practical inclusion and host system, it is just an internal stress that loads the system.

l. 136, what is the "equivalent eigenstrain"? How it is different from the previous one. Could you be more specific? Please also add that the equivalent eigenstrain is yet



unknown and needs to be solved for. I think this part deserves a bit more development so clarify some details that may not be obvious to the reader who is not familiar to the Eshelby solution. In that case I would highlight if the stress balance solved for or if it is satisfied by the solution (i.e. is given). In addition, I would highlight that eigenstrain is needed in order to have "equivalent" loading conditions.

We have added several new sentences here to clarify the concept of the equivalent eigenstrain and the use of the Eshelby's tensor, which transforms the loaded inclusion eigenstrain into the final strain that is under mechanical equilibrium with the host.

l. 143, as before: please mention how the Eshelby tensor is obtained in general, i.e. it is solved for, is it known a-priori (e.g. from Mura, 1987)

We have added some new sentences here to explain that this tensor is taken as known a-priori based on the previous work of e.g. Mura.

l. 171, please add "phonon-mode" in the Gruneisen tensor so that this is not confused with the macroscopic definition.

Added.

l. 173, please add "(pressure)" after stress, since you are using it later.

Added.

l. 238, 256, like in l. 171

Added. We also checked the rest of the text for similar points.

l. 283, which "size" you are referring to? The largest? A mean size?

Revised. We refer to the boundary of the model and the radius of the inclusion.

l. 370, thus the results using rutile should be viewed with caution since they potentially have large errors.

Revised as suggested.

Minor things l. 45: “long time” is relative in geology. I would be more specific, i.e. for more than 50 years

Revised as suggested.

l. 139-141, I would break this sentence in smaller parts.

This sentence is broken into two separate shorter sentences.

l. 150, I would suggested reformatting, “equals” -> “.. to be equal to..”

Revised as suggested.

l. 155, I suppose that this is actually a system of equations that gives you all the eigenstrain components. I would add some brackets here to emphasize this point.

The reviewer is right and we have changed ‘equation’ into ‘system of equations’.

l. 204, I would rather replace “space” with “medium”

Revised as suggested.

l. 290, Please give the formula of Root Mean Square in the text or in Appendix

The definition of RMSD is now given in the bracket at its first appearance in the main text.

l. 560, “is aligned” -> “are aligned”

Corrected.

l. 567, please add in brackets the garnet composition (e.g. alm)

Revised. We just call it almandine garnet.

l. 570 as in l. 171

Done.

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