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Report on the PhD thesis of Vaclav Spillar, Charles University.

I have read the thesis of Vaclav Spillar, which is in the form of four published articles and one submitted manuscript. The overall standard is high, but I have a few comments, some of which may reflect on questions that the referees of the papers should have raised rather than weakness of the candidate. The selection of the same referee for three papers may have contributed to this problem.

The English is generally good, but there are more spelling mistakes than I would expect. Some of these are not in the published papers, so I suspect that the versions used in the thesis were not the final versions of the article with the typos corrected.

The thesis is completely acceptable.

Questions for the candidate are indicated in italics.

Chapter 2

I was reviewer on this paper. I was impressed by the new model that was presented here. My only minor reservation is that the candidate compares his modelling with older published CSDs, some of which we now realise were not calculated correctly (Figure 2.9). At that the time stereological constraints were not applied to most studies. In addition, the importance of the distinction between methodological (artefact) and actual lower size limits (no smaller crystals) was not appreciated.

Could the candidate explain how the published data were manipulated to give that seen in figure 2.9?

Chapter 3

This is a very interesting paper on modelling of textures in 3D. Similar studies have been done in the past (some unpublished) but this paper seems to be a much higher quality model, especially with the combination of discrete and continuous methods. There are, however, some errors and I am not sure how these affect the result.

In section 3.2.2.1, page 87, line 8, the candidate mentions a conversion from 2D crystal number to 3D number by raising the 2D number to the 3/2 power. This is stereologically wrong, as is known from my American Mineralogist paper (Higgins, 2000) and all general stereology texts (Royet, 1991; Russ, 1986; Underwood, 1970). The phenomenon is known as the ‘intersection probability’ effect. The actual conversion for monodisperse populations is 3D number = 2D number/size and is called the ‘intersection probability effect’. *I would like the candidate to explain if this error has any effect on his results.*

Equation 3.5 below is also incorrect, partly as a result of the error above and also because in a general situation there is no connection between the number of crystals in a volume (or area) and their size, unless the volume is completely filled. *Again the candidate should explain if this affects his results*.

On page 88 and 99 the slope 'b2D' is discussed. However, it is not clear if this was determined after stereological corrections of the 2D data.

In the conclusions on page 118, the author discusses the origin of porphyritic textures. This was not mentioned earlier in the text and in general new ideas should not be introduced in the conclusions.

Chapter 4

This paper uses simulations of homogeneous and heterogeneous nucleation to examine the nature of rock textures. The authors then compare the texture with natural rock examples. The simulated textures (figure 4.3) are interesting, but there is a significant problem with the CSDs.

On page 136 the candidate describes how he has chosen to use uncorrected 2D measurements so that he could compare his data directly with measurements from thin sections. He mentions that this produces an apparent CSD. However, in figure 4.4 the word apparent has been dropped and the data are presented as a CSD, which is a 3D measurement. The graph has a vertical axis with units of length to the power -4. This would imply that the data have now been stereologically corrected as an apparent (2D) CSD would have units of length to the -3. However, the caption states that the size axis is the 2D equivalent circle diameter.

Could the candidate explain the nature of figure 4.4 – is it a true (3D) CSD with stereological corrections or an apparent (2D) CSD? If it is the former, then I hope that the candidate has not used the so-called 'Wager' equations that he mentioned in the previous chapter but instead a stereologically correct conversion. If it is the latter then the CSDs cannot be compared with published data as almost all recent published CSDs have been stereologically corrected and hence are not apparent CSDs.

If the graphs in figure 4.4a are indeed apparent CSDs then a component of the curvature will be due to the 'cut-section' stereological effect. That is, intersections do not go through the centre of crystals. Hence, the arguments based on measurement of the degree of curvature are suspect.

If figure 4.4a is an apparent CSD then the changes in slope for different shapes shown in figure 4.4b may just be caused by lack of corrections for the 'cut-section' effect.

Chapter 5

This chapter continues the modelling of petrologic processes with a theme of compaction. The modelling uses both spheres and parallelepipeds and develops the variation in the R parameter.

As pointed out by the candidate on page 92, R has a dependence on the total volume of the solid phase. The candidate has tried to compensate for this, but perhaps in a future paper it would be wise to use a clustering measure that is independent of phase volume. The Gaussian model (page 182) follows the Random Sphere Distribution Line of Jerram (Jerram et al., 1996) quite closely, showing that it yields no useful information on clustering.

On page 184 the author states that ‘straight’ CSDs are self-similar. There is much work on self-similar geometric forms. *I would like the candidate to say how it is possible to determine if a texture is self-similar, and if the textures described by straight CSDs are indeed self-similar.*

Diagram 5.13 describes the size distribution of crystals in some natural samples. It suffers from the same problems as fig 4.4. That is, it cannot be either an apparent and true CSD diagram as it stands.

Chapter 6

This chapter concerns the textures of a porphyritic granite. There have been a number of quantitative studies of the textures of porphyritic granites, not all of which have been referenced here (e.g. Higgins, 1999). The data have been acquired in a much more complete way than earlier studies and give much more information. The data are very interesting and show a clear relationship to height in the pluton. However, the CSD figures (6.3a, 6.3b) suffer from the same errors as the others in this thesis. It is easy to calculate the volume fraction of a phase from the CSD and crystal shape (Higgins, 2002). Application of this to the graph in figure 6.3a shows a phase abundance of 4%. This is far from the actual phase abundance (18.6%) and shows the extent of the error in the presentation of CSDs in this thesis. It is easy to do stereological corrections (Higgins, 2000) and almost all studies now do this (there are 350 references to this paper). So why not finish the job so that the data can be compared with other studies, and can be modeled?

In my experience K-feldspar macrocrysts are not evenly distributed in granites, but tend to follow ‘channels’ in the former crystal mush. *I would like the candidate to say if he found such a behaviour and if so how he treated it.*

Higgins, M.D., 1999. Origin of megacrysts in granitoids by textural coarsening: A Crystal Size Distribution (CSD) Study of Microcline in the Cathedral Peak Granodiorite, Sierra Nevada, California. In: Fernandez, C., Castro, A. (Eds.), Understanding Granites: Integrating Modern and Classical Techniques. Special Publication 158. Geological Society of London, London, pp. 207-219.

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Jerram, D.A., Cheadle, M.J., Hunter, R.H., Elliott, M.T., 1996. The spatial distribution of grains and crystals in rocks. Contributions to Mineralogy and Petrology, 125(1): 60-74.

Royet, J.-P., 1991. Stereology: A method for analysing images. Progress in Neurobiology, 37: 433-474.

Russ, J.C., 1986. Practical stereology. Plenum Press, N.Y., 185 pp.

Underwood, E.E., 1970. Quantitative stereology. Addison-Wesley series in metallurgy and materials. Addison-Wesley Pub. Co., Reading, Mass., 274 pp.