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Interactive comment on "Beam-hardening correction by a surface fitting and phase classification by a least square support vector machine approach for tomography images of geological samples" *by* F. Khan et al.

Anonymous Referee #1

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The correct identification of materials in micro-CT images afflicted with image artifacts like beam-hardening can be problematic. The authors demonstrate this for a clay rock sample and present a correction method for beam hardening followed by a machine learning algorithm for multi-class segmentation. The topic fits well into the scope of the special issue. However, the are several aspects of the current draft that could be improved:

1. Demonstrating the suitability of the workflow with only one individual sample is problematic. I think it is clear that the LS-SVM segmentation of an uncorrected image

has to fail and one illustrative sample is definitively enough to show this. But the paper would be more sound if the robustness of each method (BH correction and LS-SVN segmentation - not its combination) would be demonstrated with more test images, potentially more complicated ones.

2. The methodology is explained with mathematical rigor. However, especially for the description of the LS-SVM method is hard to digest and it would be helpful if the authors explained the method also with their own words instead of referring to the standard literature. For instance, what constitutes the dimensions in the higher-dimensional feature space (does each material class represent one dimension?)? Later in the description it follows that the algorithm operates in dual space and Fig. 1b only shows two axes (which have identical labels!?) so why refer to a higher dimensional feature space in the first place? If I understood the method correctly, then each pixel in the remaining data set is assigned a class label according to the similarity with the class statistics of each material in the training data plus some internal regularization with a Gaussian kernel. Perhaps a high similarity also entails a higher weighting factor w? What is the job of the Gaussian kernel, or in other words, what happens if sigma and gamma is set too high or too low? I like the idea of providing a schematic like in Figure 1b. However, it is not self-explanatory, even after having read the main text. What are the properties x1 and x2 and what do the properties z1 and z2 stand for in the context of image classification?

3. The brief discussion of the BH-correction should be moved from the conclusions to the discussion section and extended substantially. I didn't understand exactly how a strong material contrast leads to an over- or underestimation of gray values in each individual phase. Is it because the polynomial surface is a compromise between the spatial variability of intensities of all materials at once? What if the volume fraction of halite, clay and anhydrite would be more balanced (instead of mostly clay). Would the BH-correction then work at all? This is why I'd like to see at least a second sample for a completely different rock, where this issue is addressed. I don't see why a 3D

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correction algorithm would solve these issues. The true solution to the problem would be to have a separate BH model for each material. I also didn't understand if the model surface for one individual 2D slice is applied to all other z-slices or if the fitting parameters are optimized individually for all slices.

Minor comments:

- LS-SVM was trained with 1755 pixels, but the remaining 1570149 pixels is nowhere near 1417x1417 or 1417x1417x450. Please check again.

- Conclusions: "Without ... any requirement for prior knowledge" - Doesn't the definition of training data represent your prior knowledge of the materials in the image?

Interactive comment on Solid Earth Discuss., 7, 3383, 2015.