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Interactive comment on "Local versus field scale soil heterogeneity characterization – a challenge for representative sampling in pollution studies" *by* Z. Kardanpour et al.

Anonymous Referee #1

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This is an interesting paper on the use of variographic analysis to determine the spacing between sampling locations along a profile in contaminated site characterization studies. The focus of the paper is not on using variographic analysis as a basis for geostatistical interpolation of concentration data (e.g. kriging) but to use the variogram as a tool to determine the maximum spacing at which samples should be taken in the field to ensure that the sampling variance due to the intrinsic heterogeneity of the site will be representative of the scale at which the investigation is performed.

As a general comment, this use of the variogram is interesting in that it provides a relatively simple tool to determine sample spacing in the field based on site heterogeneity.

However, the approach presented in this paper is limited to a 1-D profile, while site characterization studies often require 2-D and 3-D sampling patterns. Incidently, several geostatistical applications to 2-D site characterization have been published, while 3-D geostatistical adaptative sampling are at the forefront of recent developments in this field. Therefore, while interesting in its approach to assess the representativeness of sampling plans, this paper is limited in scope and potential applications in the field of site characterization. The authors are encouraged to pursue 2-D and 3-D applications of their approach.

More specific comments can be made on the paper. First, the use of PCA to determine the average variogram from the variograms obtained for each measured parameter is interesting. It greatly simplifies data interpretation and facilitates the identification of the required sample spacing along the profile from the average range. However, I would like the authors to comment on this approach in comparison to using the smallest range from all the experimental variograms? Wouldn't using the average range result in over- and underestimation of sampling variance for some parameters? Would using the smallest range be too conservative? What would be the implications for sampling costs?

Second, I'm not sure I understand correctly the intent behind the small-scale roman-grid sampling performed at the center of the profile, nor the discussion regarding small-scale vs large-scale variability. For instance, on page 630, the authors state that "the local variability does not necessarily extend to larger scales", but what does this mean exactly in regards to the results on Figures 2 and 3? The explanations provided in the discussion regarding small-scale and large-scale variability should be developed further. Several questions come to mind. What is the implication of the fact that, on all graphs from Figures 2 and 3, large-scale variations of the measured parameter values are almost always totally contained in the interval $\mu \pm 2s$ obtained at a much smaller scale? Moreover, assuming the purpose of the large-scale study would be to obtain the average parameter value along the transect, wouldn't the small scale measurement

provide an equivalent result? Or, would the small-scale variance be comparable in some way to the nugget-effect of the variograms? The relationship between the small-scale and large-scale results should be more thoroughly addressed.

Third, the authors state that their approach will "also provide relevant information about how to take samples with less uncertainty stemming from the procedures themselves (grab vs composite sampling approaches)". I'm not sure how that conclusion was reached by the authors. Variogaphic analysis helps in selecting the sampling points, thus minimizing the long-range selection error, while sampling procedures, i.e. delineating and extracting the sample, should minimize and control the fundamental as well as the grouping and segregation errors. The act of taking a sample is affected by the constitutional and distributional heterogeneity of the material, not the large-scale heterogeneity. The authors should be more explicit regarding the aforementioned conclusion.

Fourth, the authors should provide more details regarding the field sampling and mass reduction procedures. Is the 200-300 g sample mass taken from the field sufficient to minimize the variance due to the fundamental error? How was this mass delineated and extracted? How did the sampling procedure controlled correct and incorrect sampling errors? Why did subsampling not involve some form of comminution during mass reduction? What was the effect of that on sampling variance?

Finally, some spelling and grammatical mistakes as well as typos were found in the manuscript. The authors are encourage to perform a thorough revision of their manuscript, check the spelling of all references (e.g. (Soniarodriguezcruz et al., 2006) on page 620), and define all acronyms (e.g. LOI on page 622). Moreover, the word Âń facility Âż was used ambiguously in several instances (e.g. "This study is a contribution to [the] development of a heterogeneity characteri[z]ation facility . . ."). I'm not sure of the meaning of this word herein.

Interactive comment on SOIL Discuss., 2, 619, 2015.