

Enhanced EDX images by fusion of multimodal SEM images using pansharpening techniques

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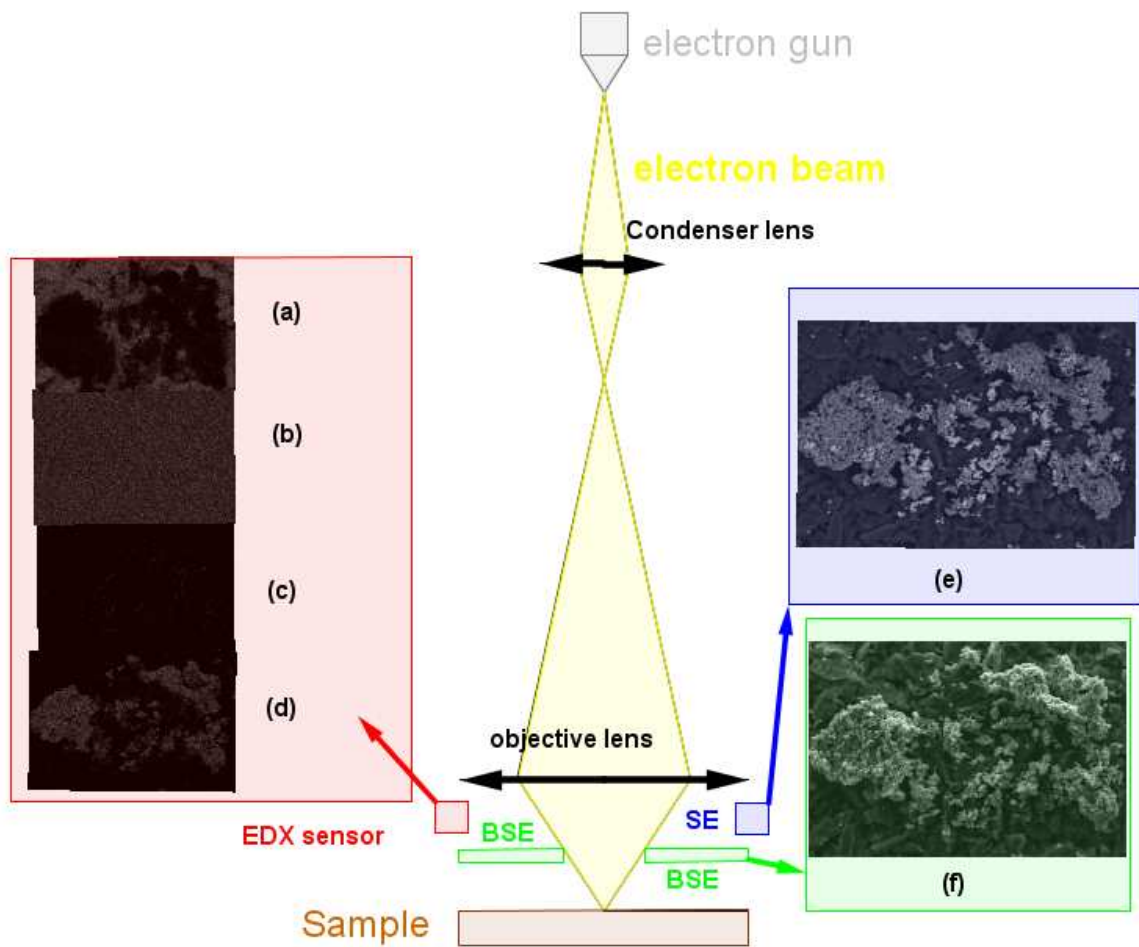


Figure 1: Multimodal SEM image acquisition. In the red square (a,b,c,d) we represented 4 abundances. In the blue square (e) we represented the backscattered image and in the green square (f) the secondary electron image. As one can notice each modality brings different information, that are perfectly registered in our experimental set up. Our goal is to merge the SEM backscattered (green square) and SEM EDX modality (red square).

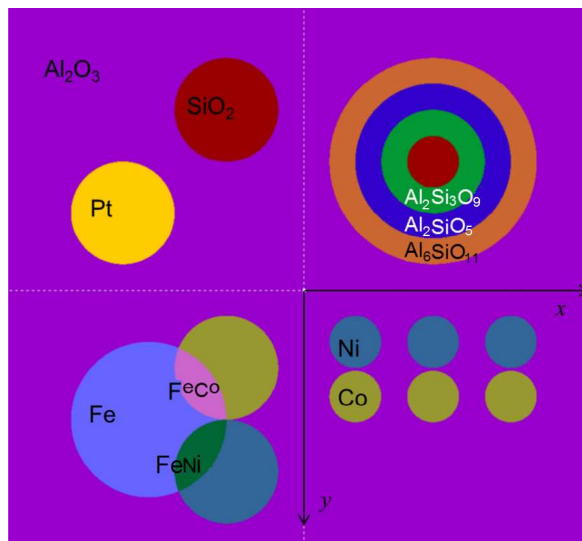


Figure 2: Ground truth of the simulated multimodal SEM image.

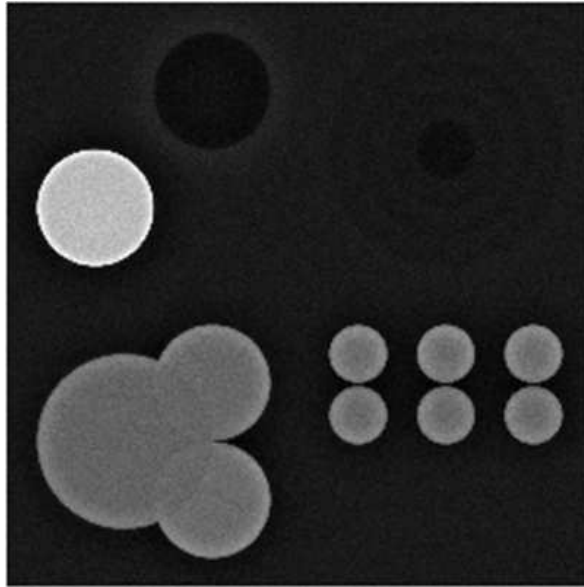


Figure 3: Simulated backscattered electron image.

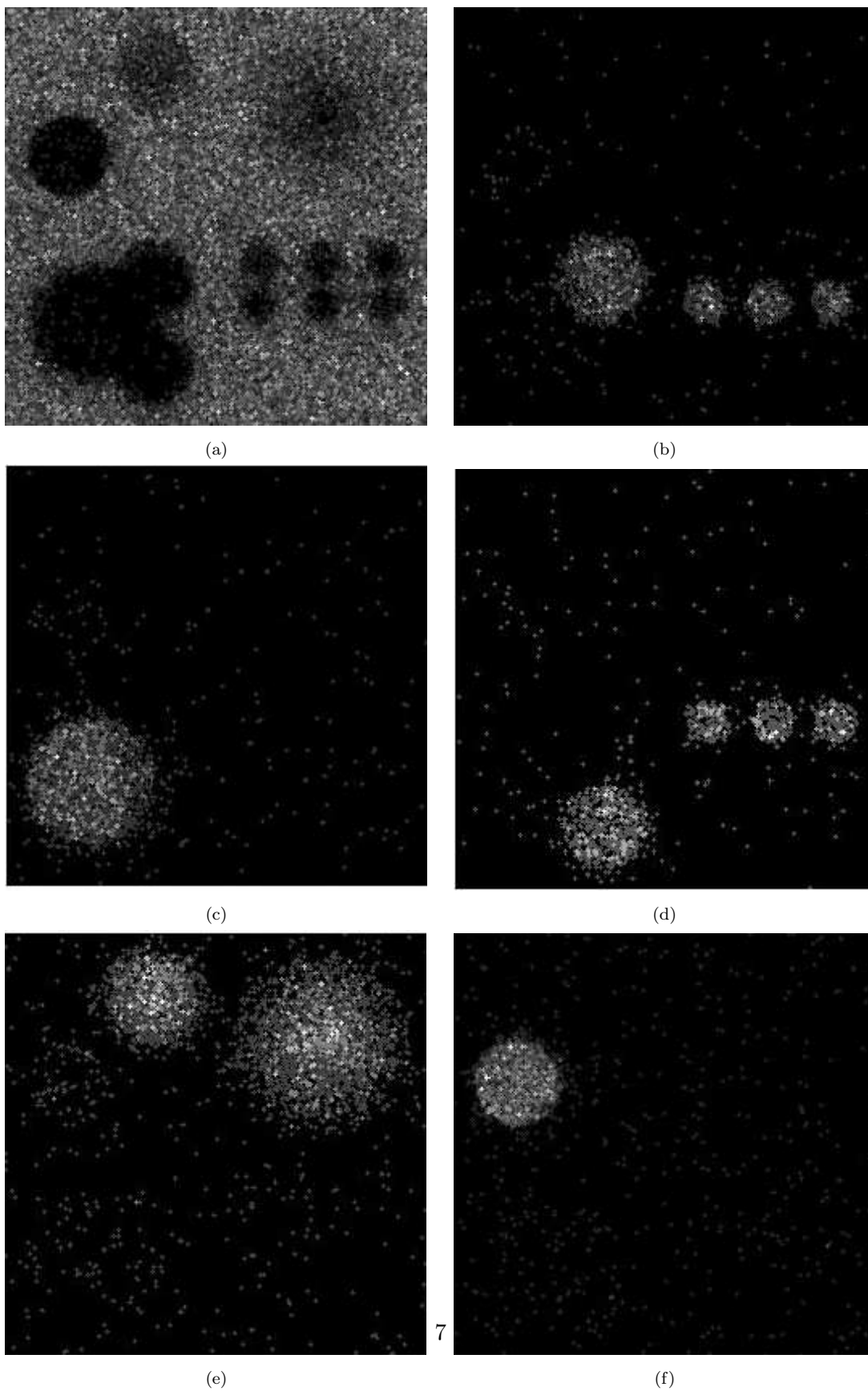


Figure 4: Simulated Al energy channel in (a), Co energy channel in (b), Fe energy channel in (c), Ni energy channel in (d), Si energy channel in (e), Pt energy channel (the first peak) in (f).

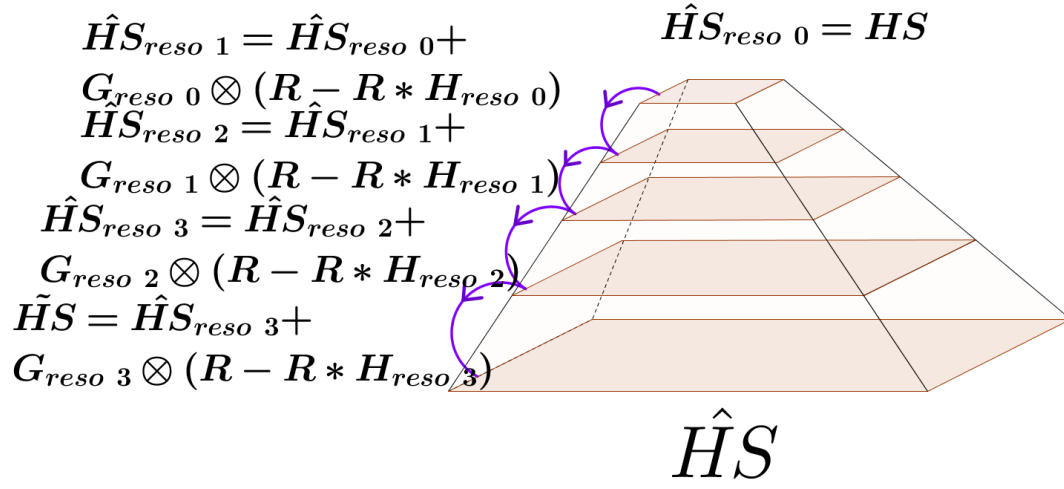
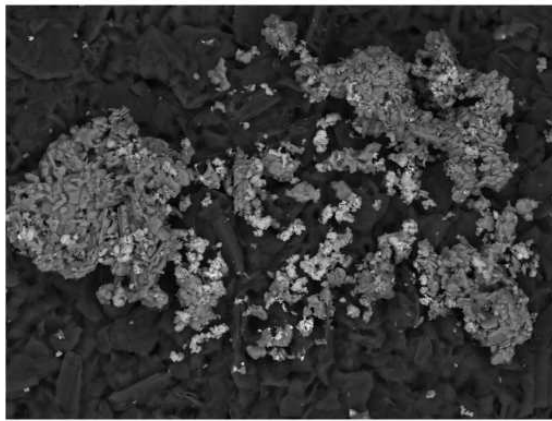
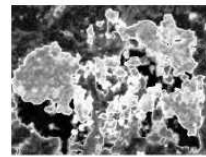


Figure 5: Model of a hierarchical decomposition of the information. The algorithm takes as input image $\hat{H}S_{reso\ 0}$ and increases its resolution to build $\hat{H}S_{reso\ 1}$, and so one up to $\tilde{H}S$.



Backscattered electrons



order map

1/5 resolution

Figure 6: The two images used for the fusion of SEM information by AGB filter.

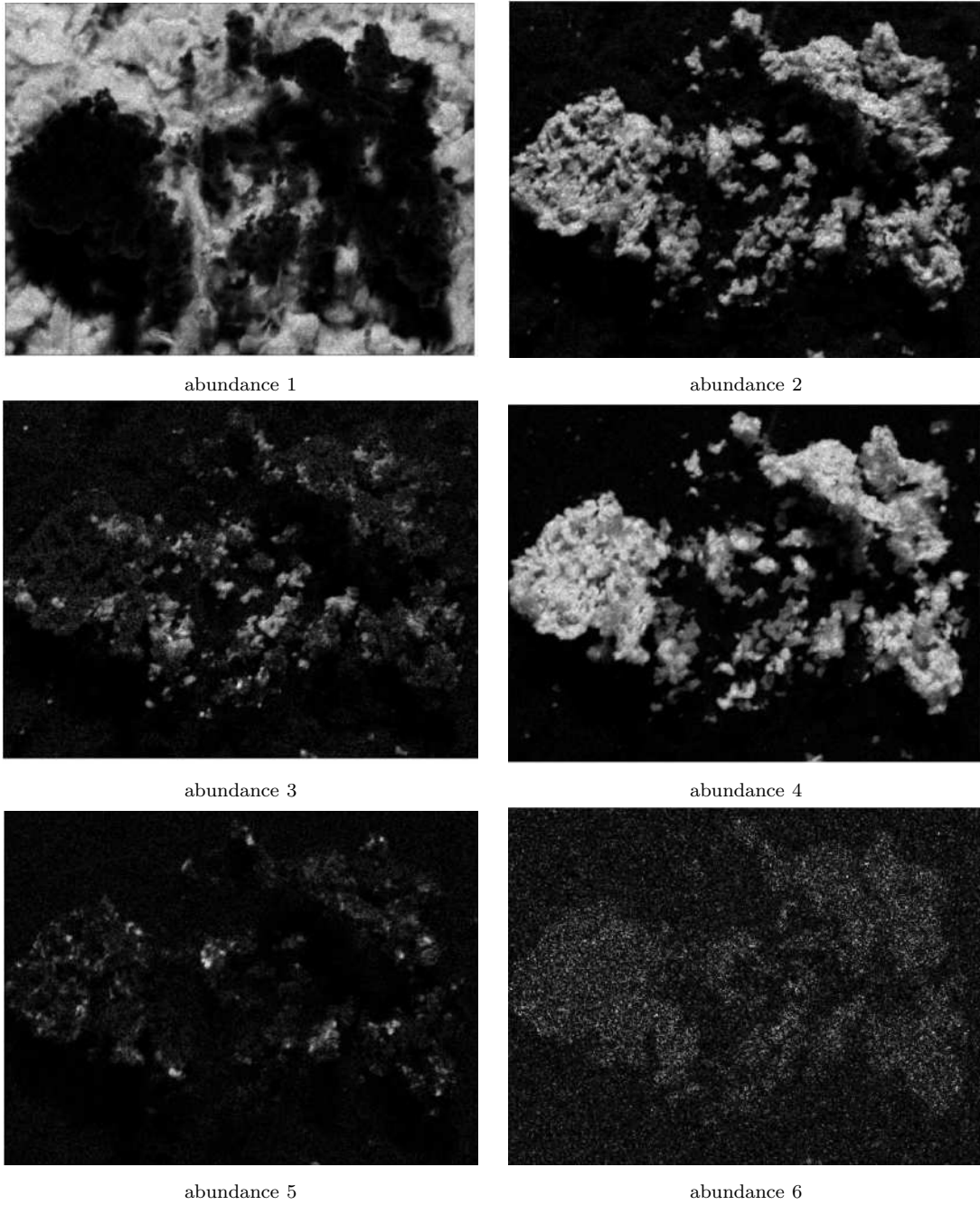


Figure 7: The six EDS abundance maps of SEM dataset 1 at the nominal resolution.

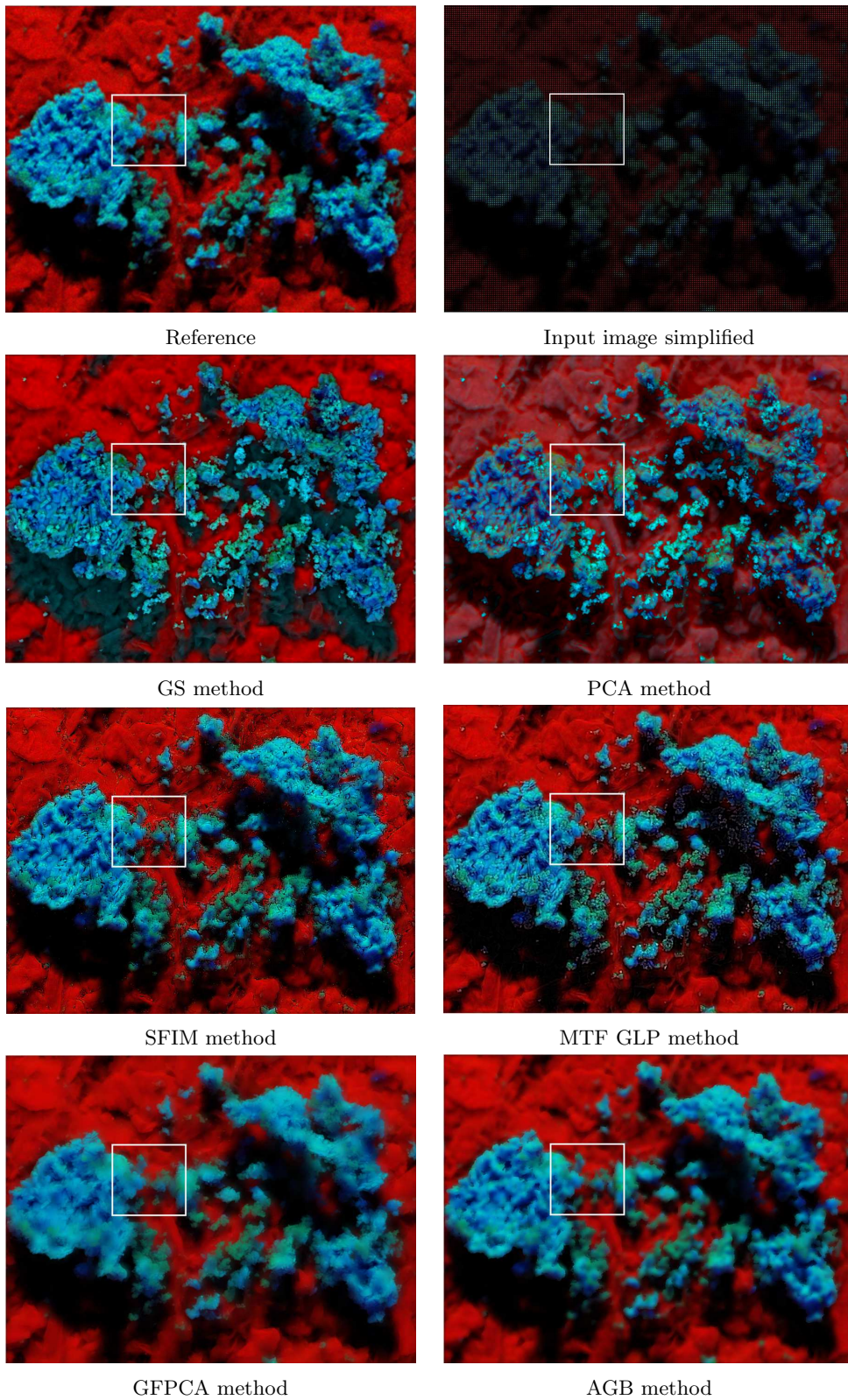


Figure 8: RGB color image from abundances $1,2,4$ of the dataset 1 for the different pansharp-ening techniques. The input image has been simplified by applying a dilation for visualization purpose.

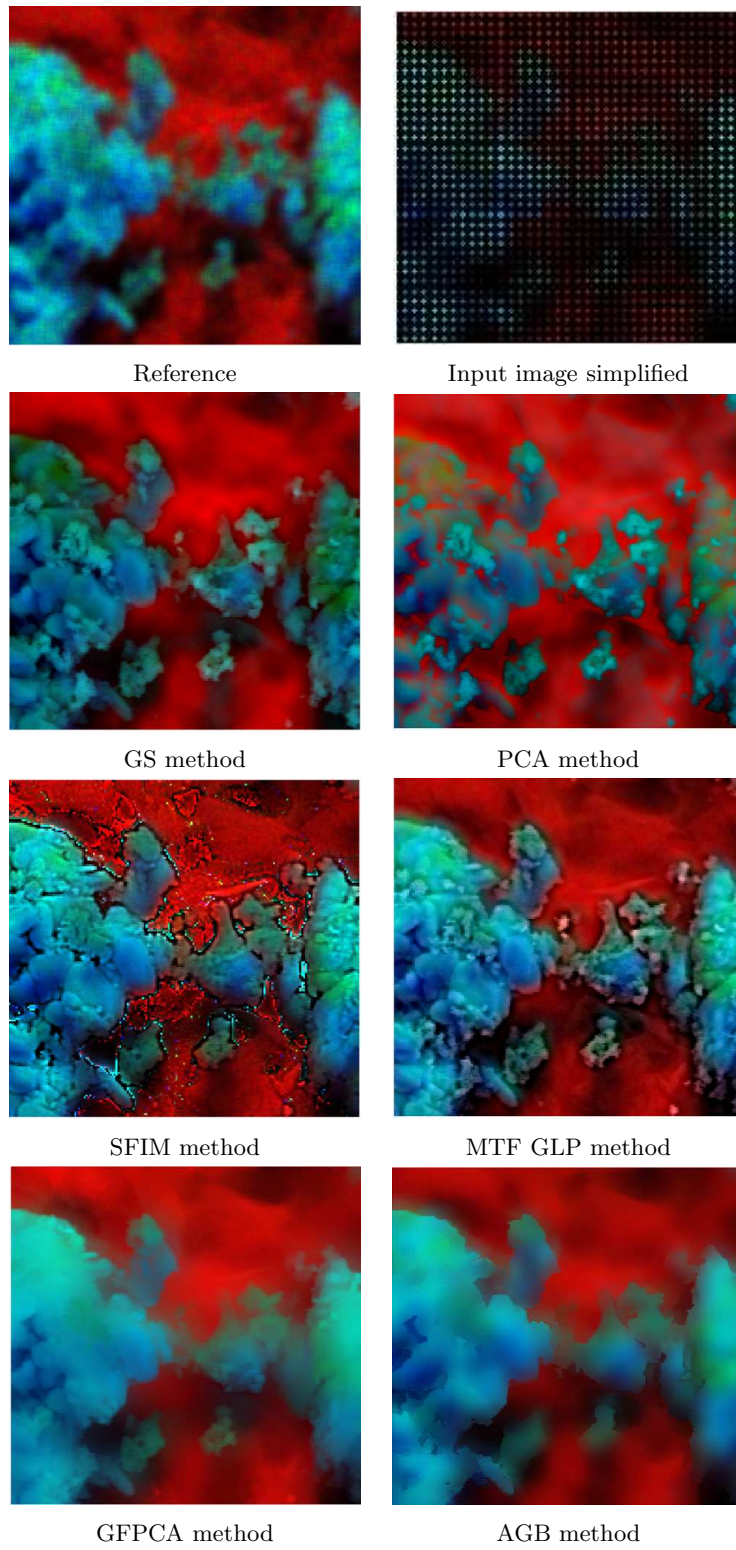


Figure 9: Zoom of the RGB color image from abundances 1,2,4 of the dataset 1 for the different pansharpening techniques. The input image has been simplified by applying a dilation for visualization purpose.

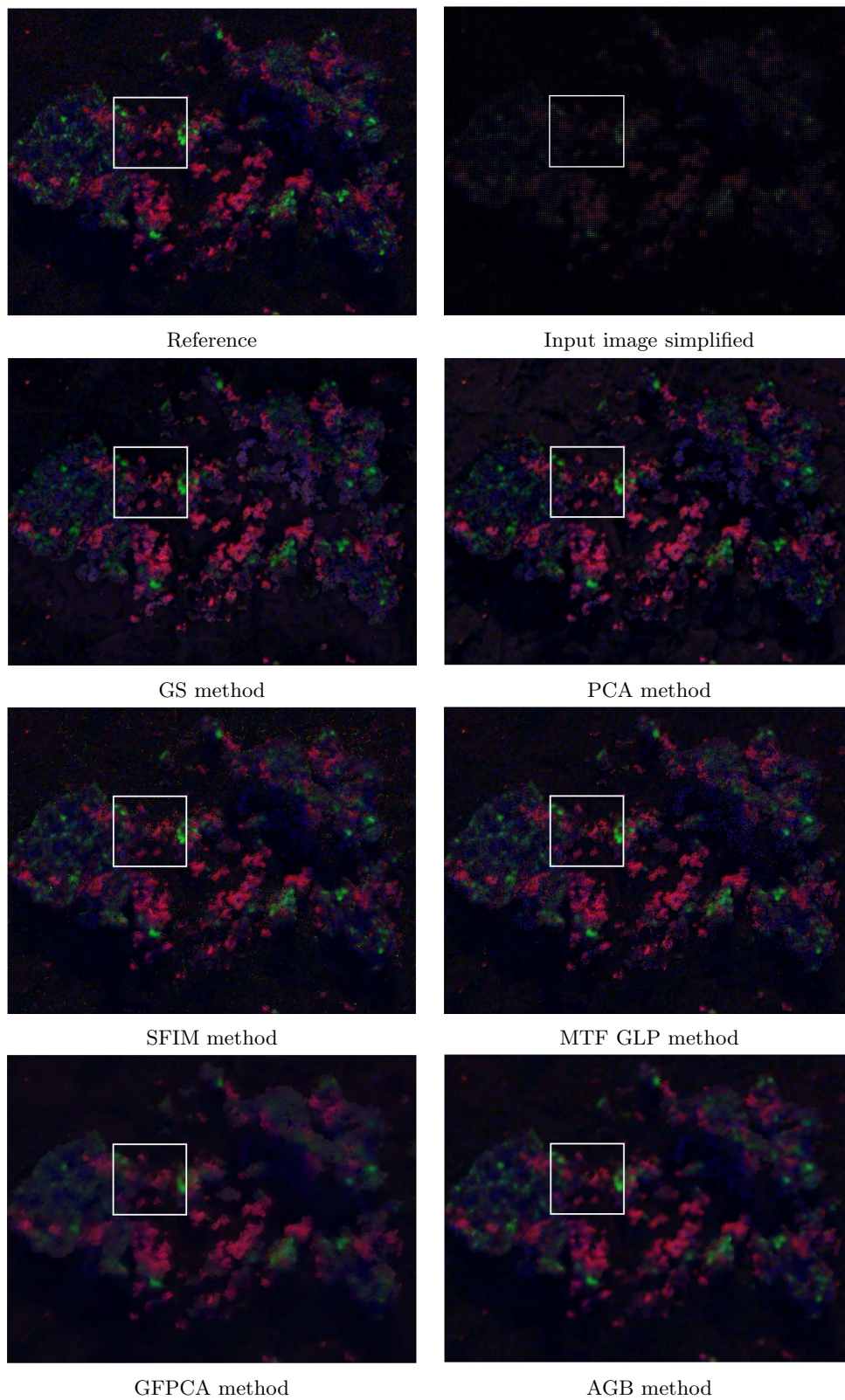


Figure 10: RGB color image from abundances ¹³_{3,5,6} of the dataset 1 for the different pansharp-ening techniques. The input image has been simplified by applying a dilation for visualization purpose.

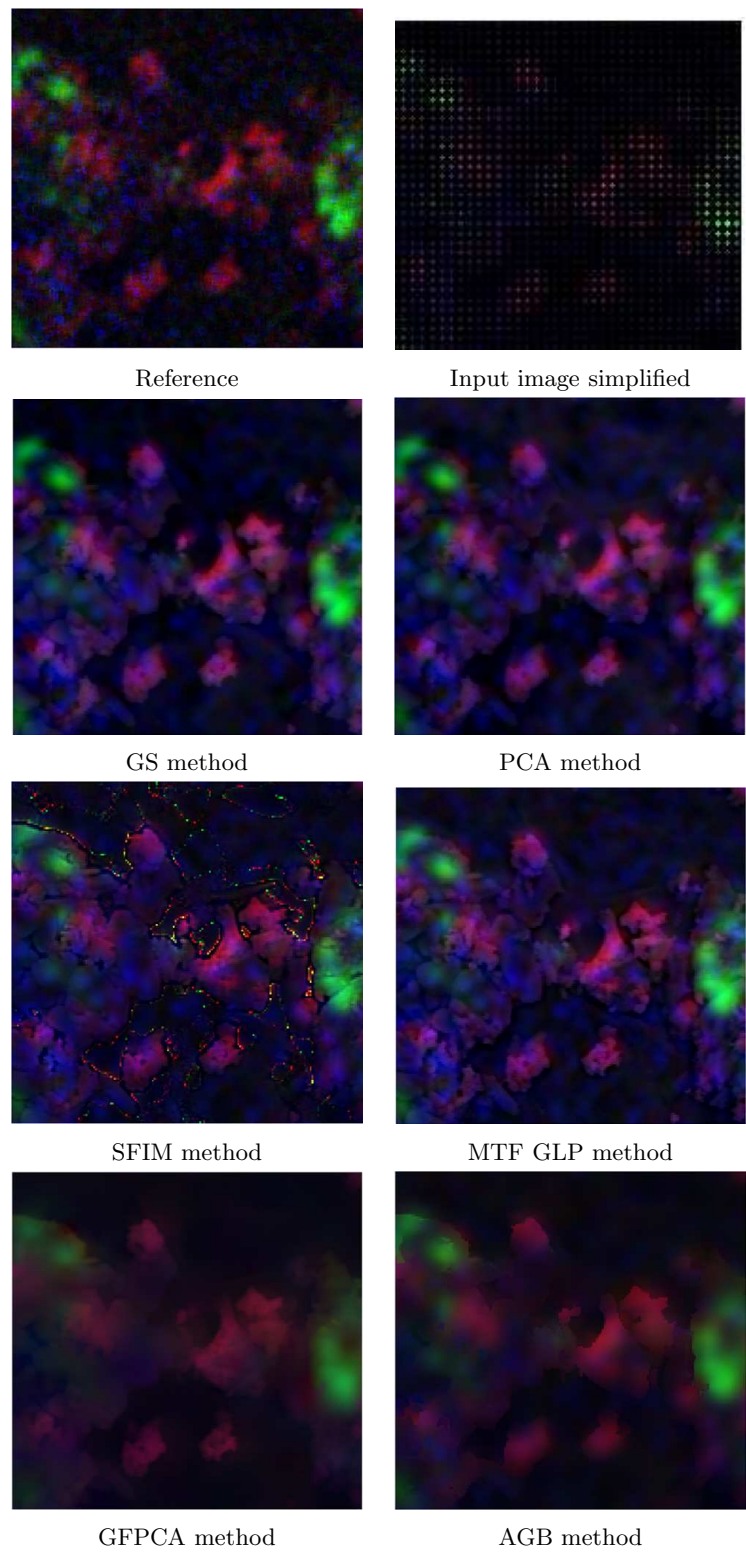


Figure 11: Zoom of the RGB color image from abundances 3,5,6 of the dataset 1 for the different pansharpening techniques. The input image has been simplified by applying a dilation for visualization purpose.

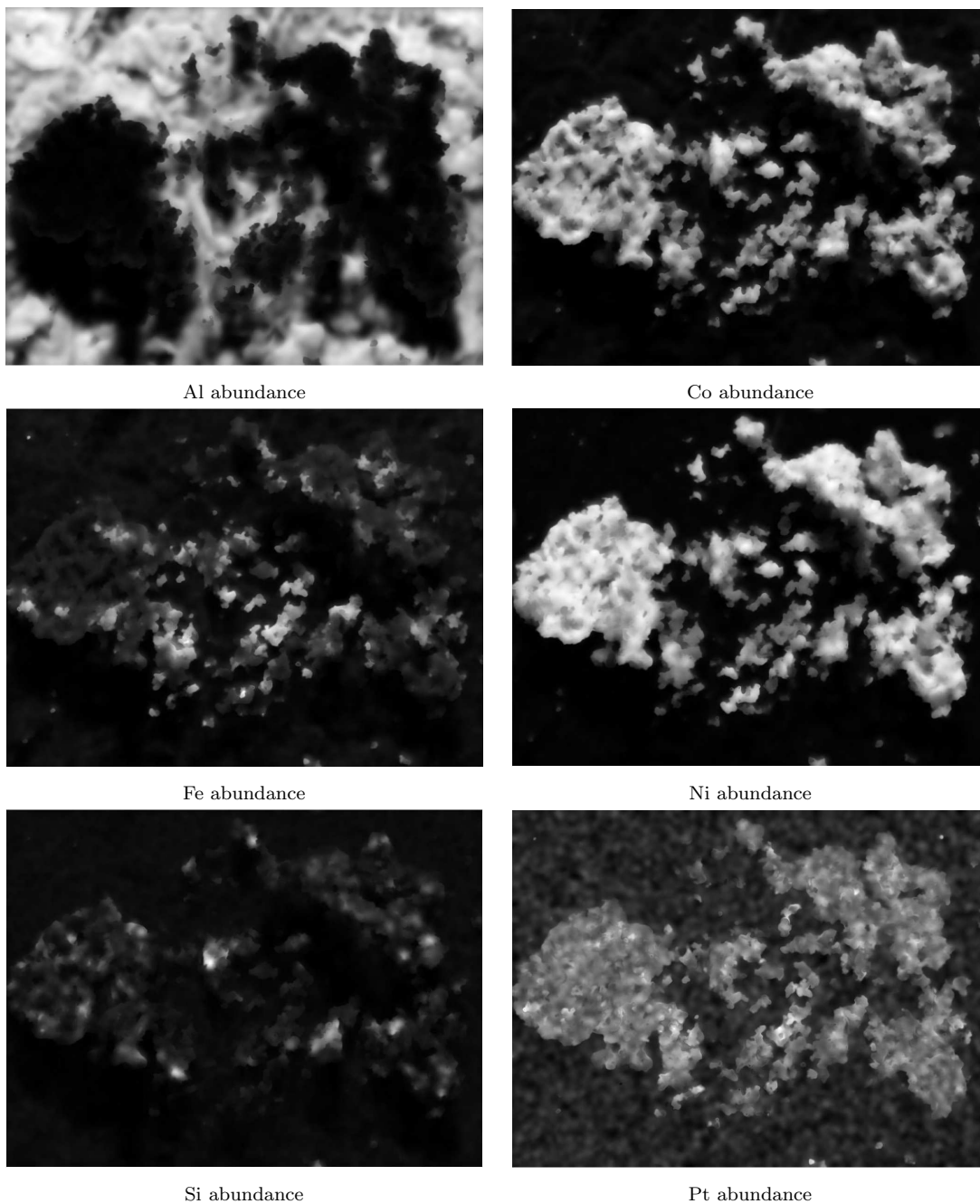


Figure 12: Six enhanced EDS abundance maps by means of ABG method of SEM dataset 1 at the nominal resolution.

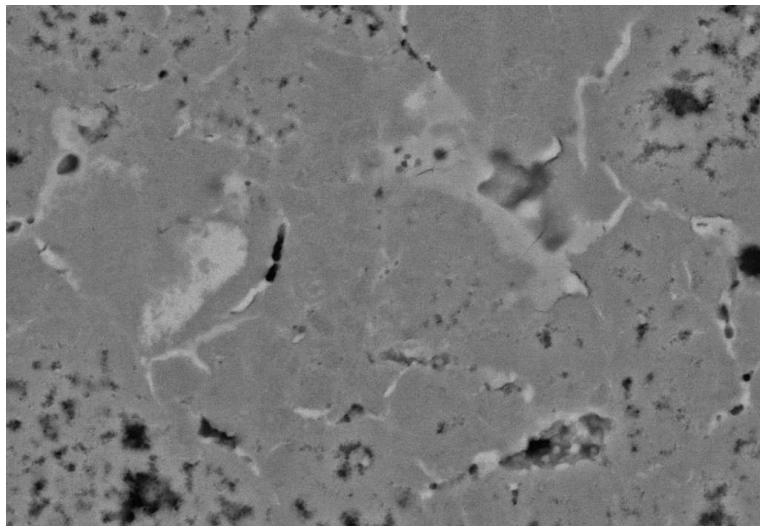


Figure 13: BSE image of SEM dataset 2.

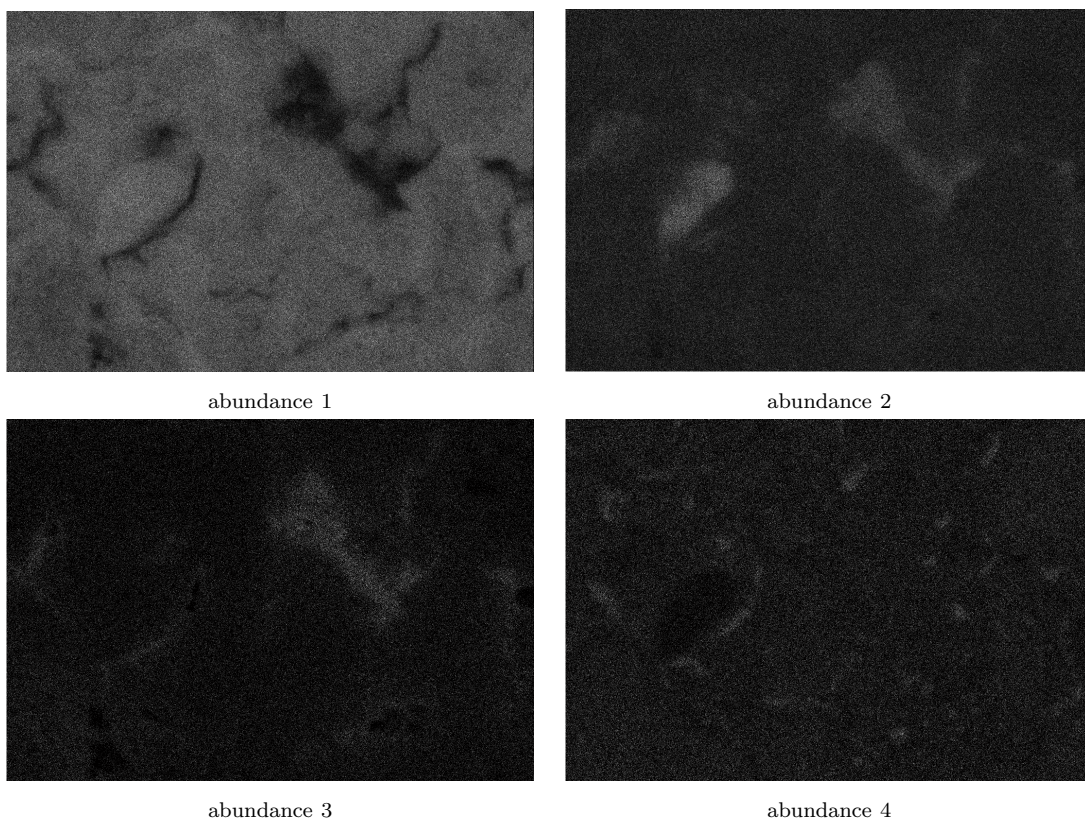


Figure 14: Four EDS abundance maps of SEM dataset 2 at the nominal resolution.

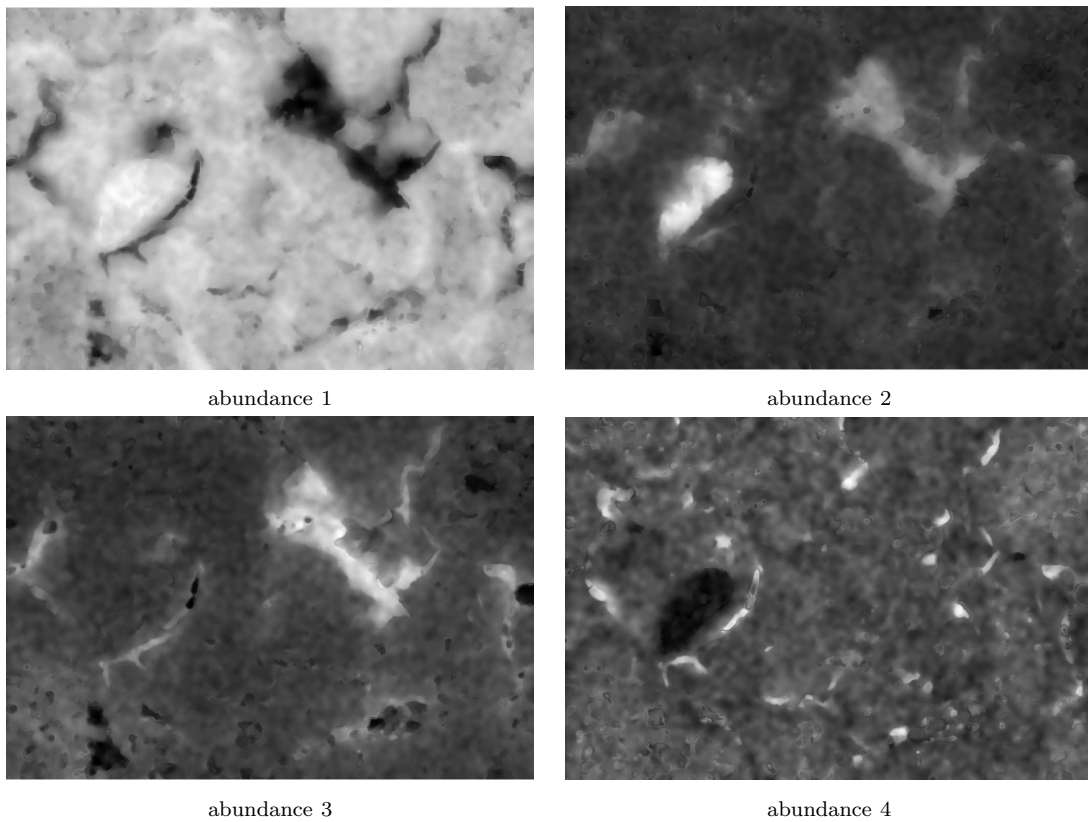


Figure 15: Four enhanced EDS abundance maps by means of ABG method of SEM dataset 2 at the nominal resolution.

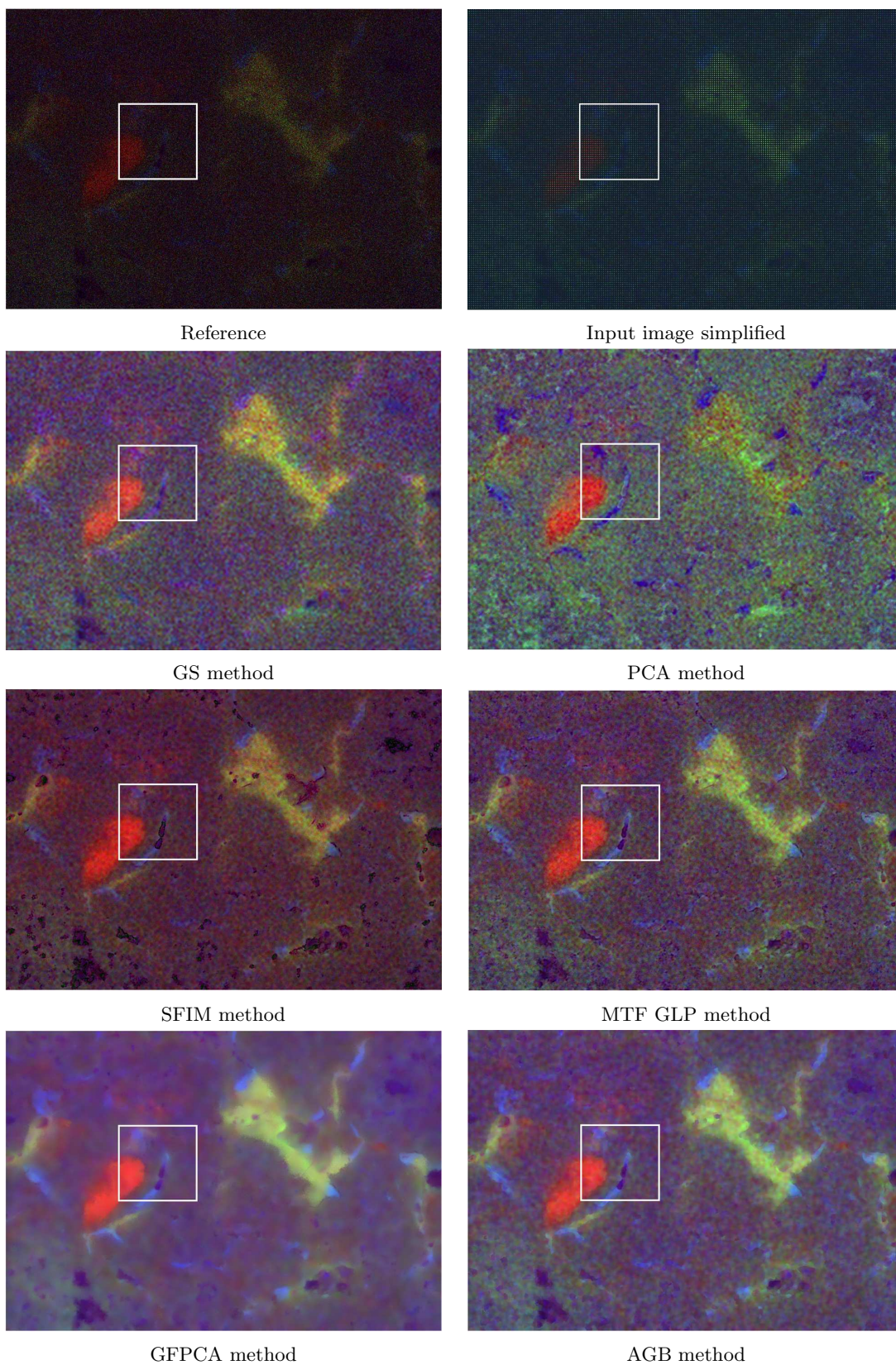


Figure 16: RGB color image from abundances 2,3,4 of the dataset 2 for the different pansharp-ening techniques. The input image has been simplified by applying a dilation for visualization purpose.

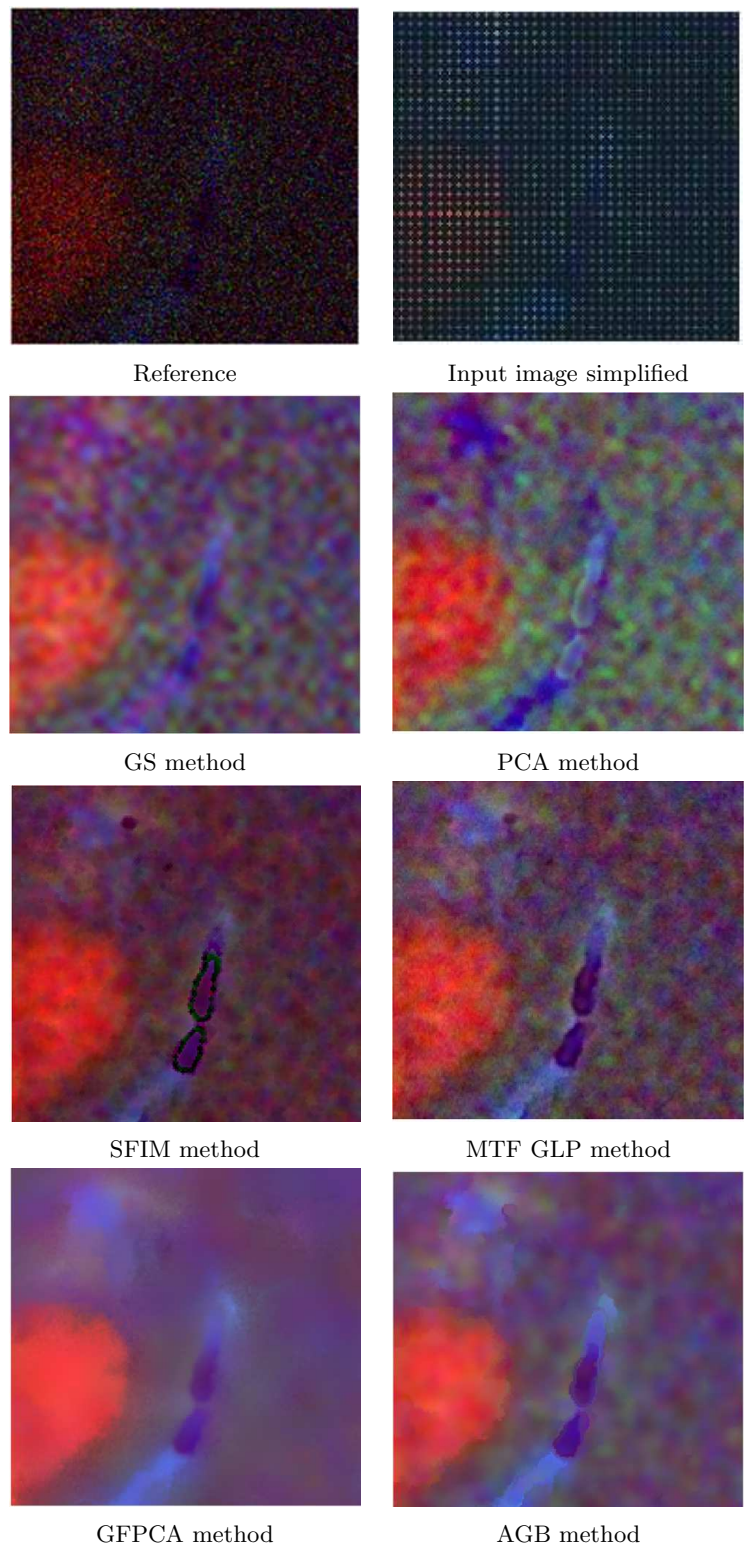


Figure 17: Zoom of the RGB color image from abundances 2,3,4 of the dataset 2 for the different pansharpening techniques. The input image has been simplified by applying a dilation for visualization purpose.

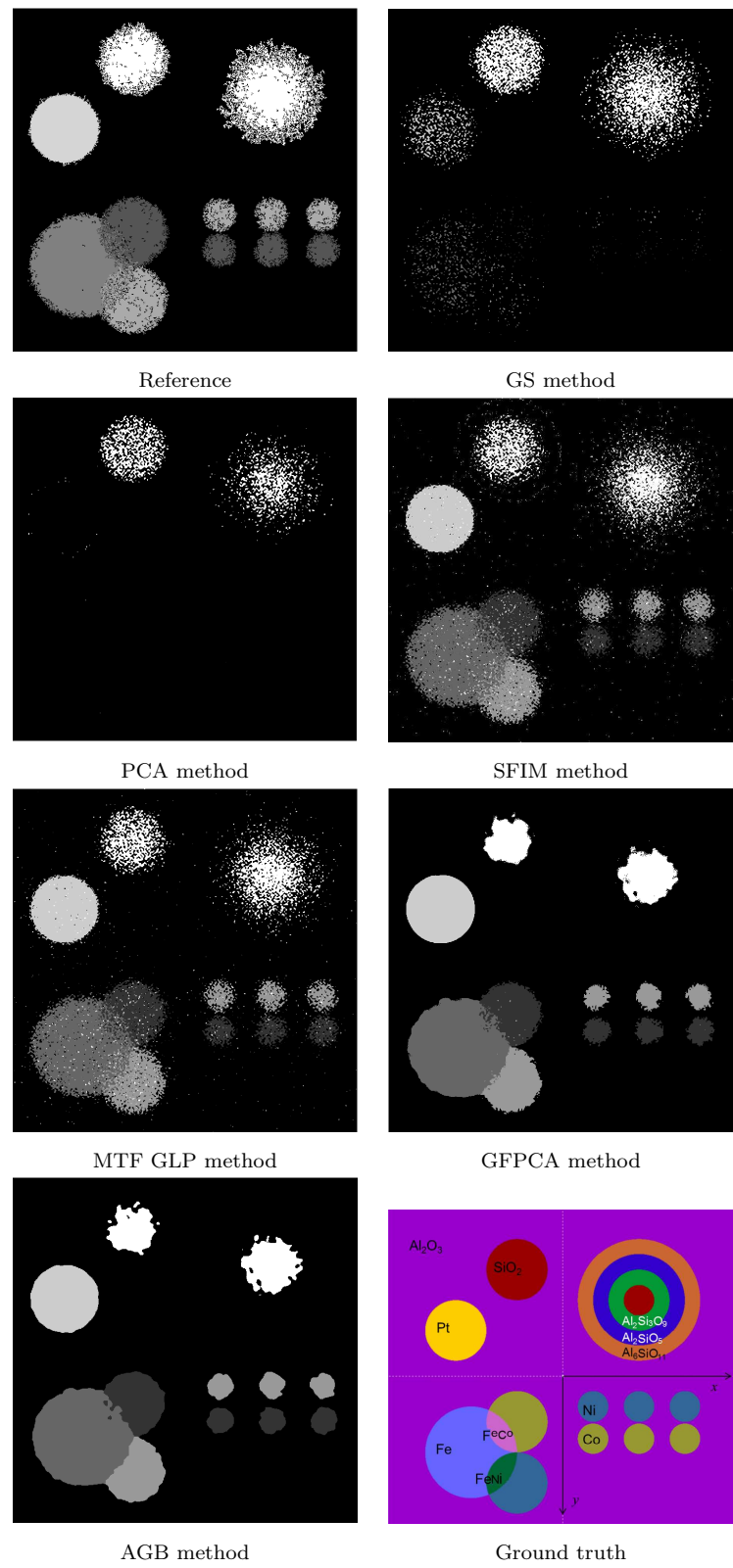
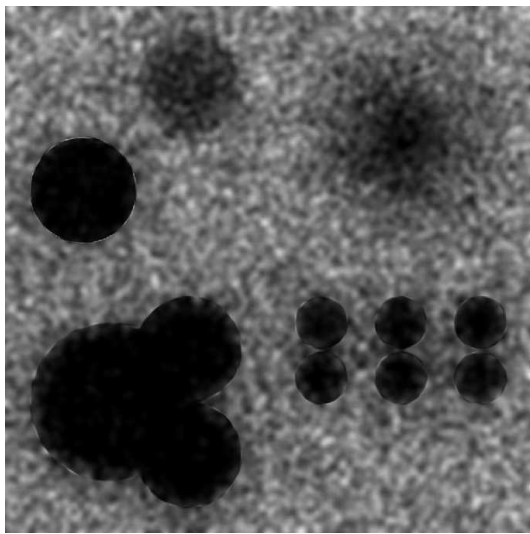
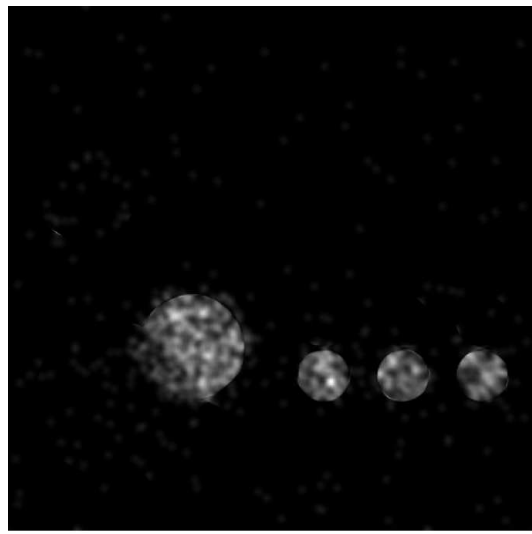


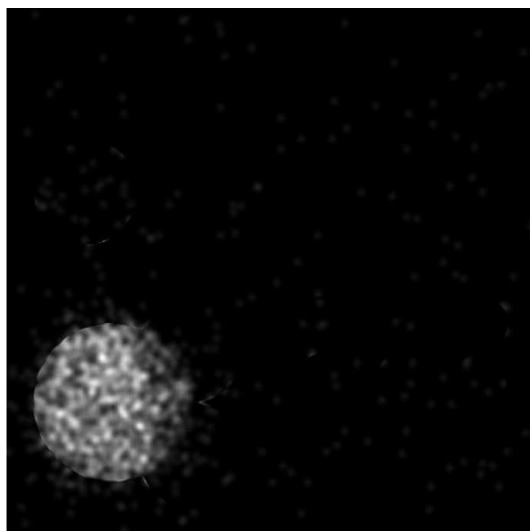
Figure 18: Extraction of the most abundant material at each pixel for the different pansharp-ening techniques.



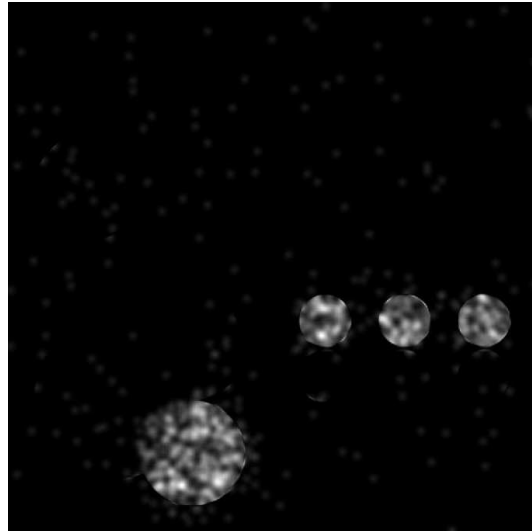
Al abundance



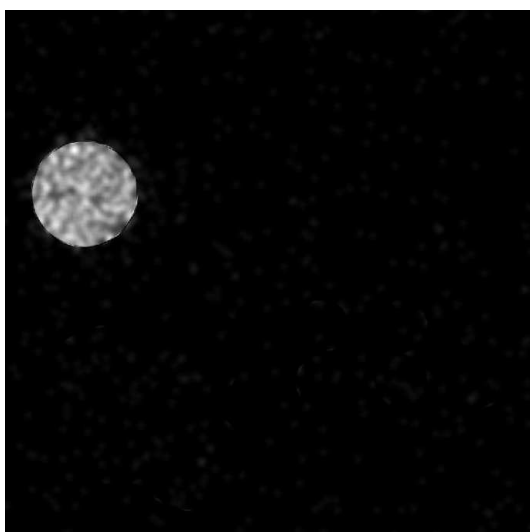
Co abundance



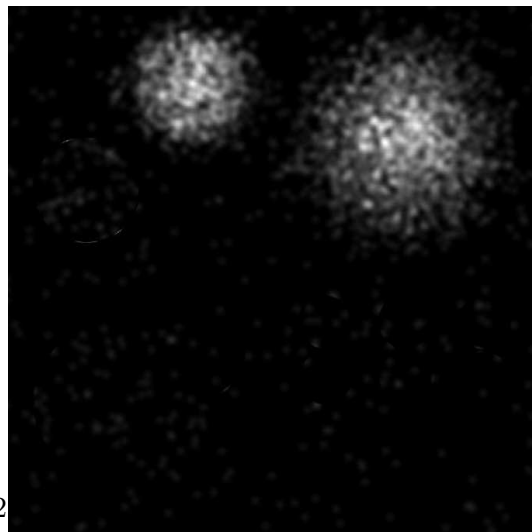
Fe abundance



Ni abundance



Si abundance



Pt abundance

Figure 19: Six enhanced EDS abundance maps by means of ABG method of SEM simulated dataset at the nominal resolution.