thermoscientific

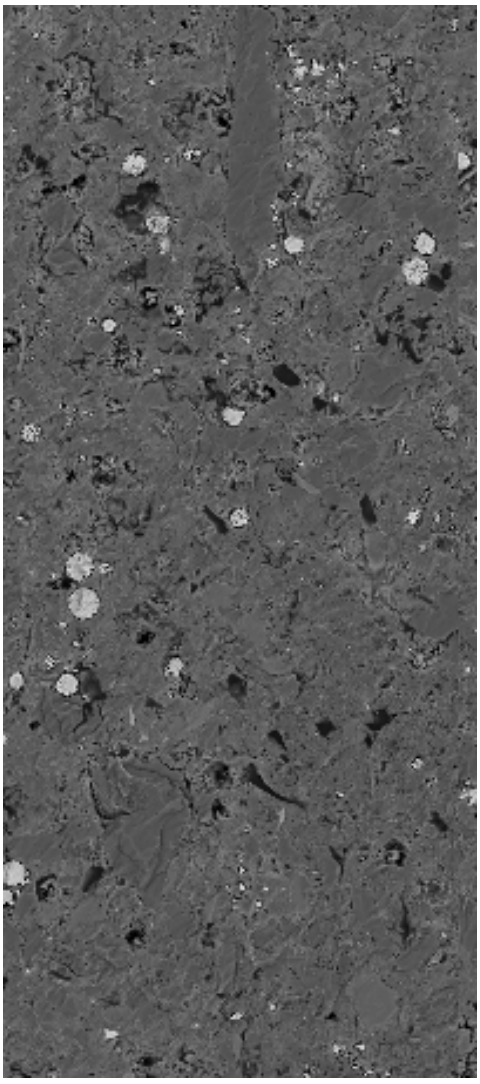
Fusion of EDS and BSE Image – by Pixels

1. Introduction

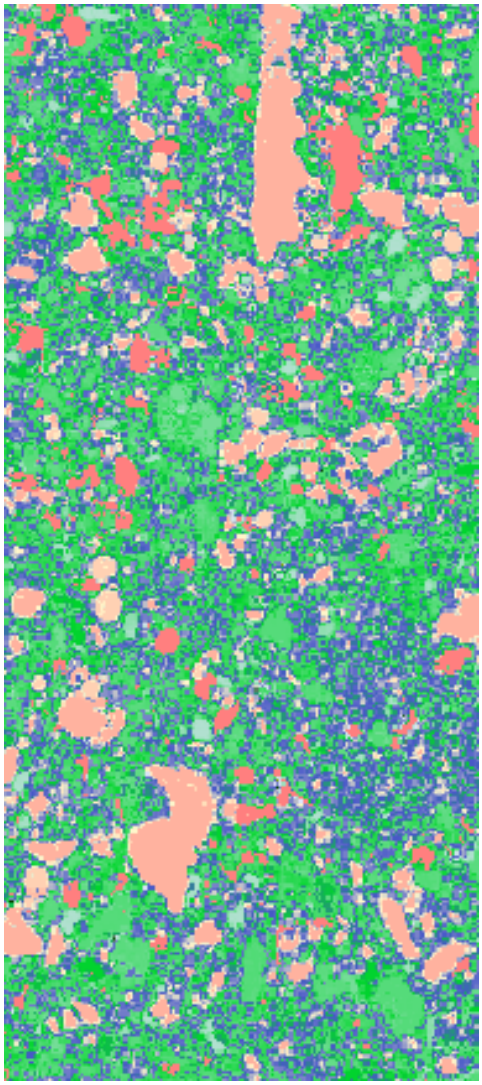
This tutorial is part of the PerGeos Training course, and will detail how to do the so-called fusion between an EDS and a BSE image pixel by pixel. Both can have different resolution.

The goal of this fusion is to obtain statistical information about the minerals in direct contact with the organic matter, and differentiate the pyrite grains from the framboids, together with a characterization of the size and shape of these pyrite particles.

The data is courtesy of Dr Stefan Loehr, Macquarie University, Australia



BSE image, resolution : 8308 x 18473, 146 MB

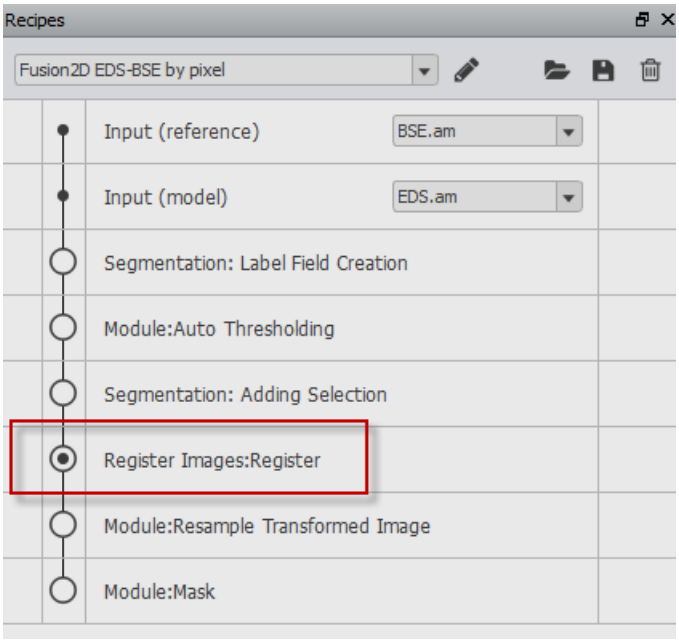


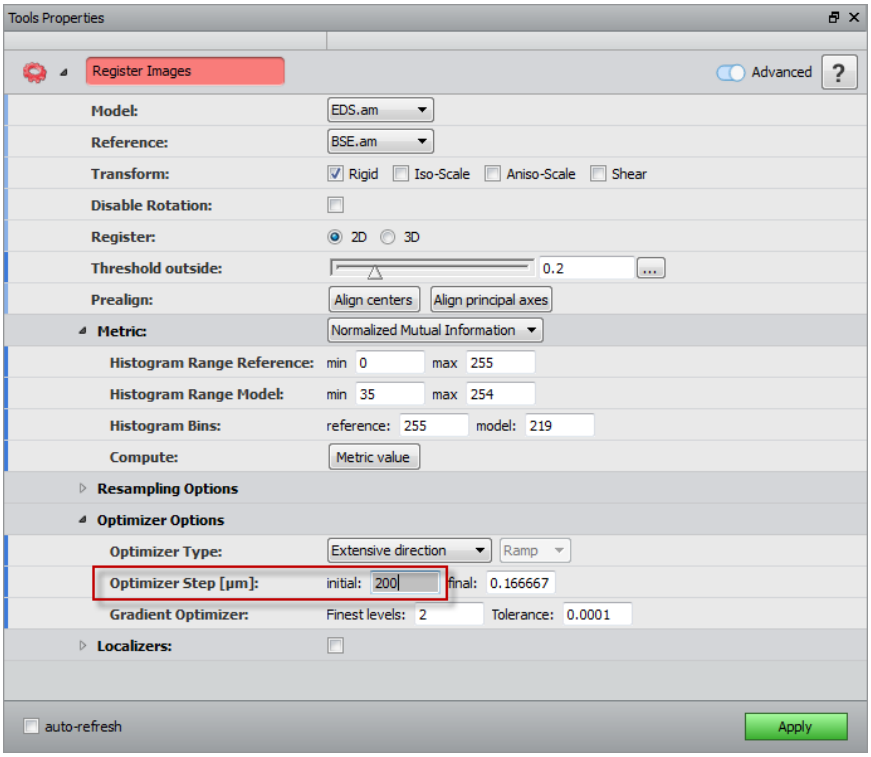
EDS image, resolution : 8290 x 18459, 146 MB

2. Applying the Fusion EDS – BSE by pixel recipe

The F*usion 2D EDS-BSE by pixel* Recipe contains all the needed steps. However, special care should be given to the registration one, since the *Optimizer step* often requires an adjustment.

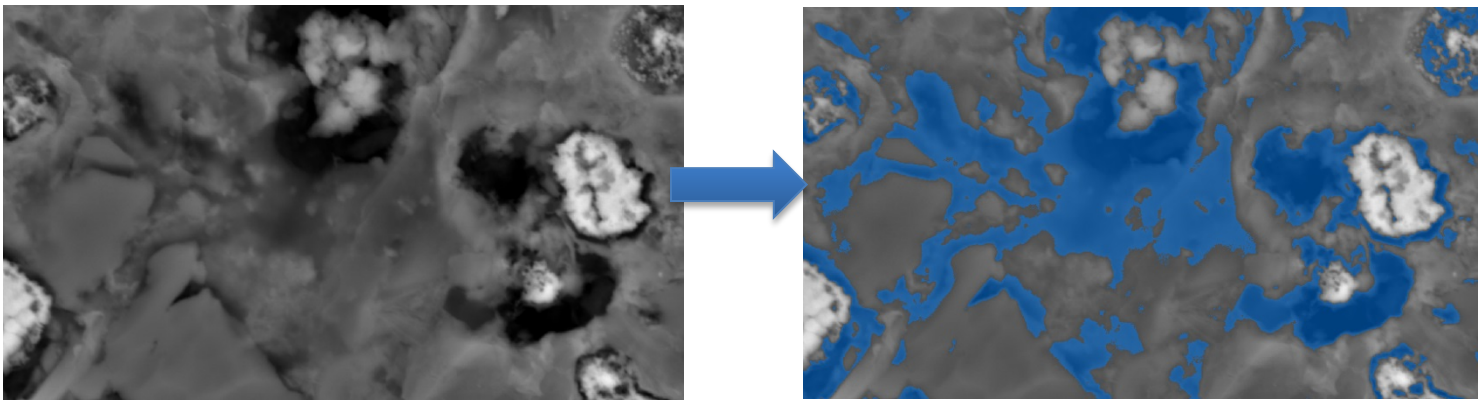
Add a breakpoint on the Register Images step, and reduce the initial step to 200 µm





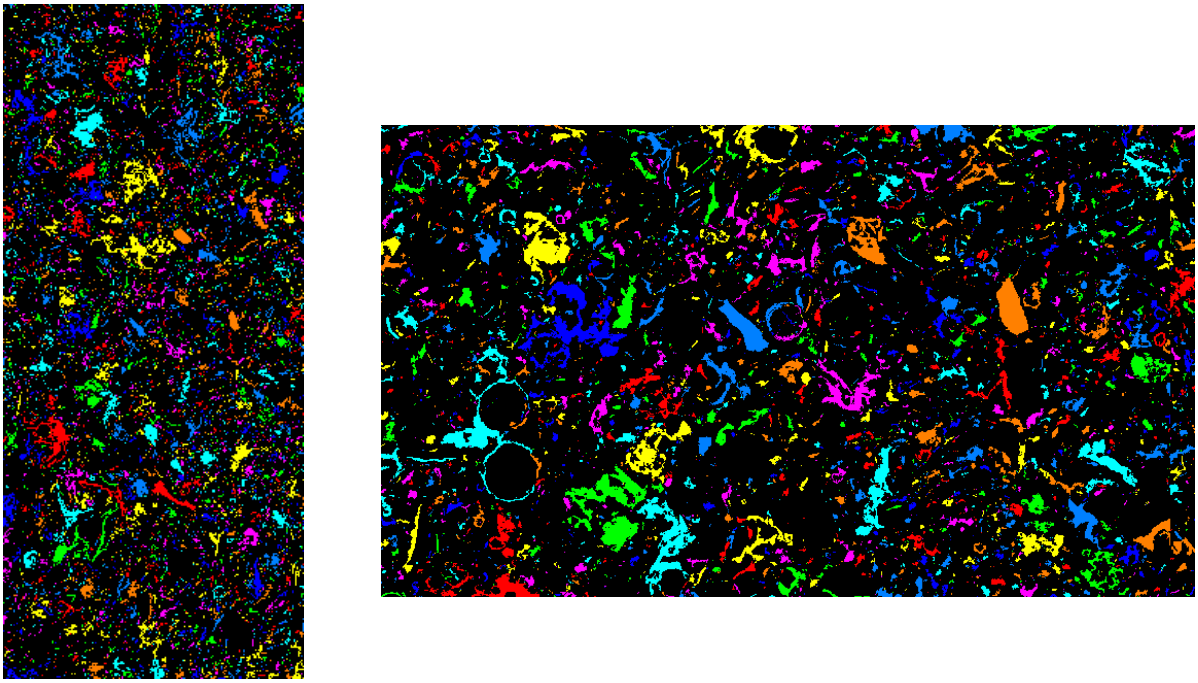
3. Organic Matter segmentation and analysis

Due to the low resolution of the BSE image, the organic matter segmentation can be obtained with a low intensity thresholding.



Organic Matter segmentation with Thresholding

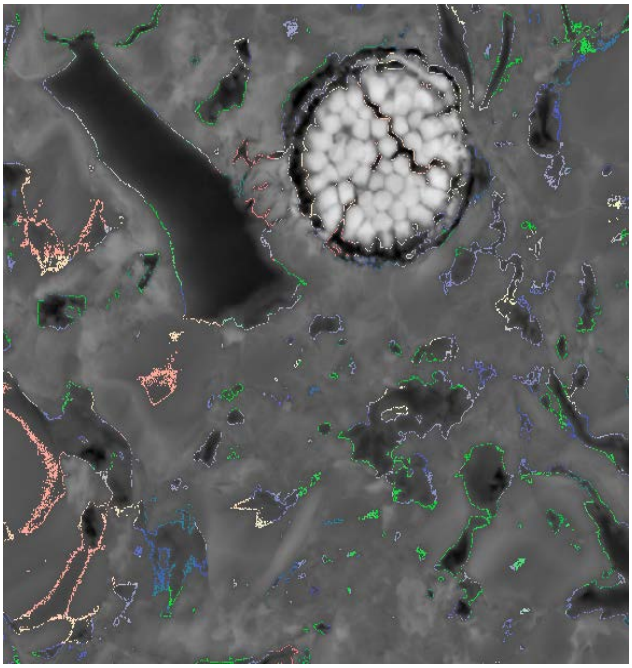
The basic analysis of the cross sectioned organic matter can be obtained with a Label analysis

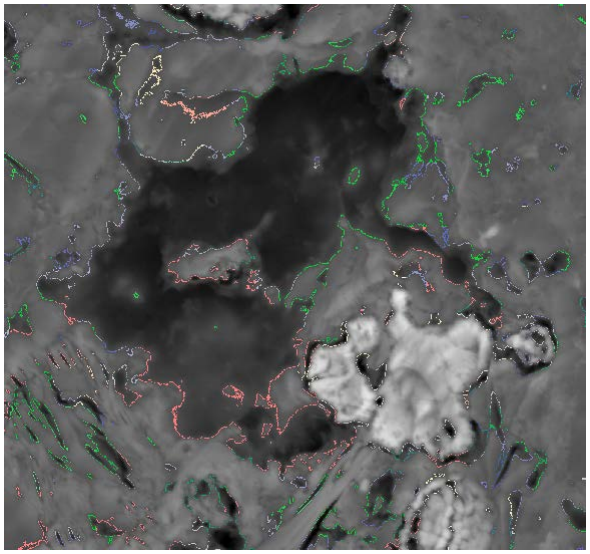


Organic Matter separated into multiple connected components

4. Minerals in contact with Organics

Mineral pixels bordering the organic matter are obtained after applying the *Minerals In Contact with Binary* recipe





Mineral pixels bordering the organic Matter

Organics.measure | Organics.Label-Analysis-2 | MineralsInContactWithOrganics.measure

	Image	Volume Fraction	Label Volume	Total Volume	Label Voxel Count	Total Voxel Count	Lab
Mean	--	0.000135902	20857.4	1.53473e+08	20857.4	1.53473e+08	127.5
Min	--	0	0	1.53474e+08	0	1.53474e+08	1
Max	--	0.00420917	645997	1.53474e+08	645997	1.53474e+08	254
Median	--	9.14659e-05	14037.6	1.53474e+08	14037.6	1.53474e+08	127
Variance	--	9.27229e-08	2.18401e+09	20078.7	2.18401e+09	20078.7	5376.2
Kurtosis	--	124.577	124.577	373800	124.577	373800	-1.200
Skewness	--	9.84479	9.84479	-737.886	9.84479	-737.886	1.2683

	Image	Volume Fraction	Label Volume	Total Volume	Label Voxel Count	Total Voxel Count	Lab
172	Mine...	0.000366245	56209	1.53474e+08	56209	1.53474e+08	172
173	Mine...	0.00040259	61787	1.53474e+08	61787	1.53474e+08	173
174	Mine...	0.000636389	97669	1.53474e+08	97669	1.53474e+08	174
175	Mine...	0.000726307	111469	1.53474e+08	111469	1.53474e+08	175
176	Mine...	0.000614679	94337	1.53474e+08	94337	1.53474e+08	176
177	Mine...	0.000425526	65307	1.53474e+08	65307	1.53474e+08	177
178	Mine...	0.000240386	36893	1.53474e+08	36893	1.53474e+08	178
179	Mine...	0.00034243	52554	1.53474e+08	52554	1.53474e+08	179
180	Mine...	0.000473593	72684	1.53474e+08	72684	1.53474e+08	180
181	Mine...	0.000761016	116796	1.53474e+08	116796	1.53474e+08	181
182	Mine...	0.000487934	74885	1.53474e+08	74885	1.53474e+08	182
183	Mine...	0.000343642	52740	1.53474e+08	52740	1.53474e+08	183

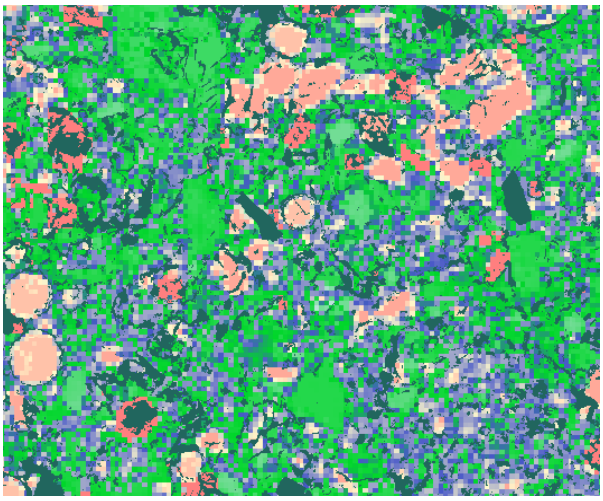
Fraction of each mineral in contact with organics

Different minerals can have the same intensity values in the BSE image. This recipe will extract the mineral location from the EDS image, and correlate with a BSE image segmentation.

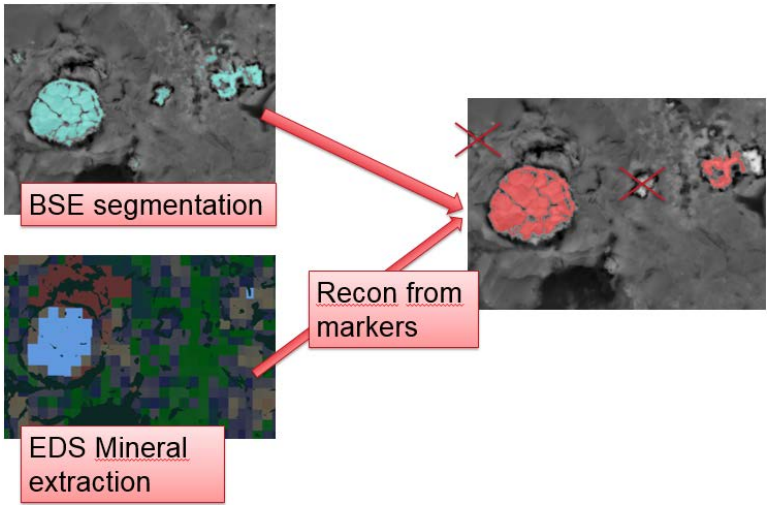
The MineralFromEDS recipe contains two steps :

- Segmentation of the mineral in the BSE image (including “false” minerals)
- Extraction of the mineral in the EDS fusioned image (the mineral value can be obtained through probing)

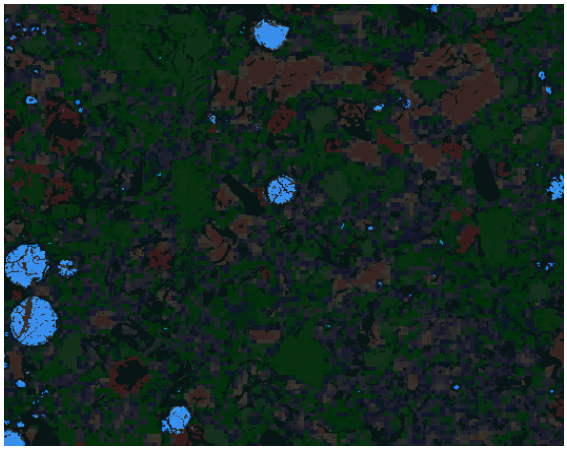
Then, a *reconstruction from markers* module is applied, resulting in a high resolution mineral segmentation



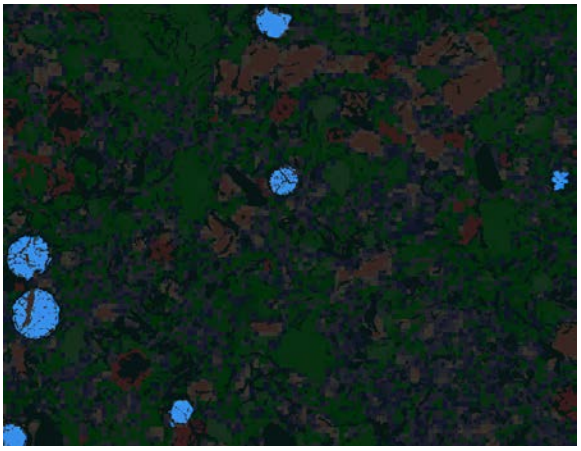
Fusioned mineralogy



MineralFromEDS recipe



Highest BSE intensities particles including pyrite



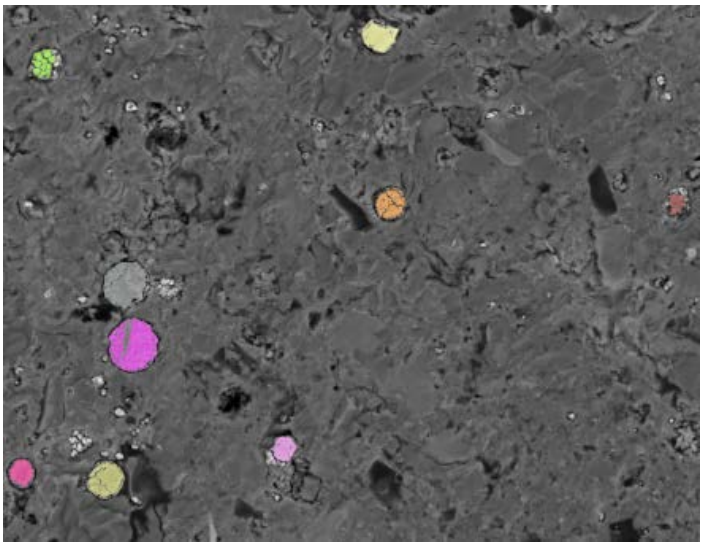
Isolated pyrite

6. Pyrite labeling

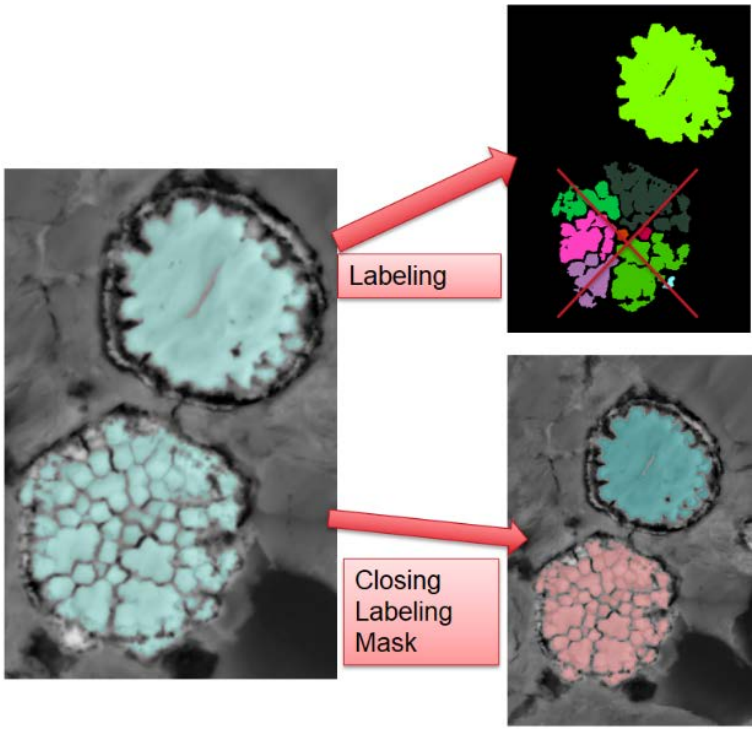
A pyrite particle can be composed of multiple individuals on the SEM plane, due to the resolution or orientation of the rock section.

Thus, a *labeling* operation would output multiple labels for the same particle.

Applying the *PyriteLabeling* recipe will ensure that one pyrite particle is identified with a unique label ID.



Labelized Pyrite particles



Pyrite Labeling recipe

7. Pyrite vs framboids

Differentiating a pyrite from a framboid particle can be done by applying the *PyriteVSFramboid* recipe.

This recipe looks at the difference between the Pyrite labeling and a classical labeling operation. If there is a difference, the particle is identified as being a framboid (composed of multiple elements).