thermoscientific

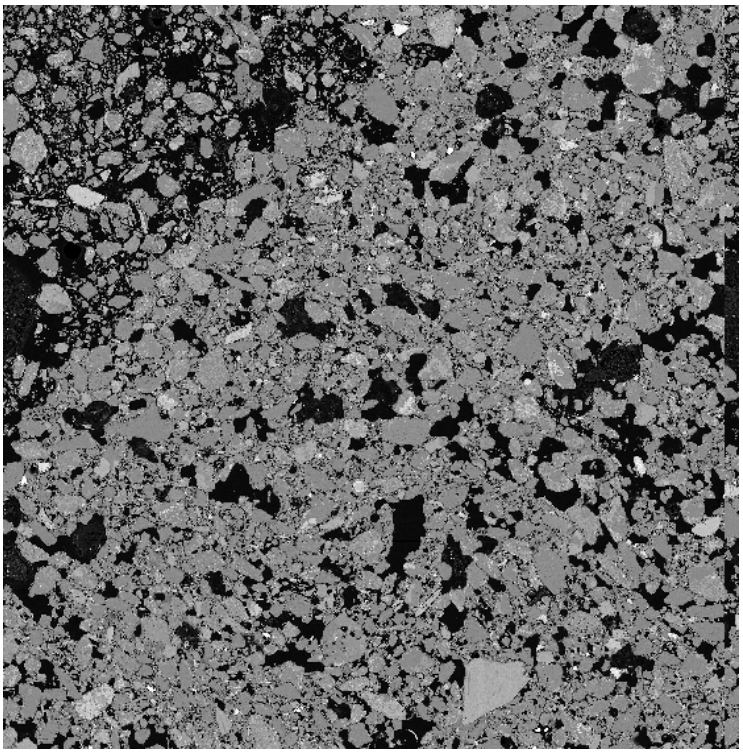
# Fusion of EDS and BSE Image

## 1. Introduction

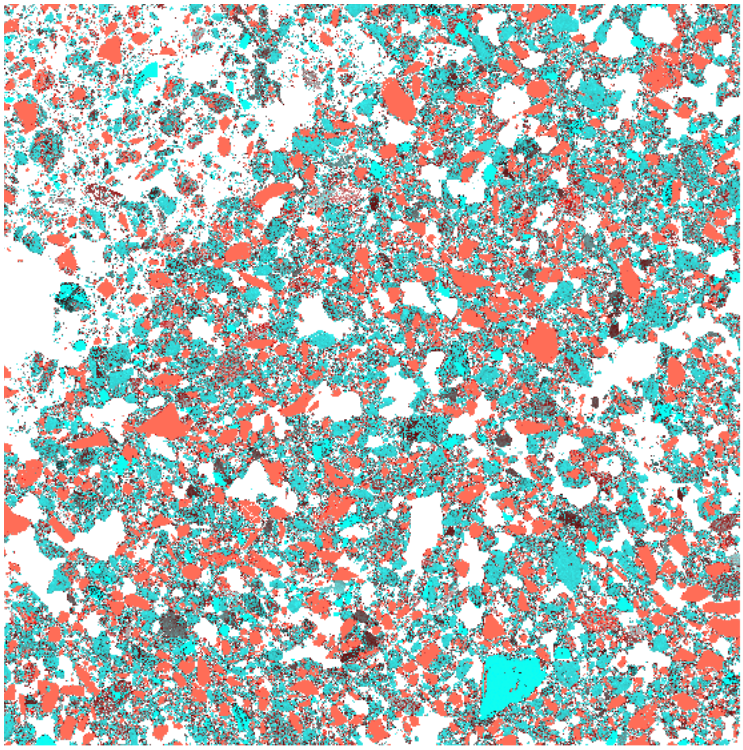
This tutorial is part of the PerGeos Training course, and will detail how to do the so-called fusion between an EDS and a BSE image. Both can have different resolution.

The goal of this fusion is to study the grain size distribution and mineral shapes based on the mineralogy information coming from the EDS image, using the high resolution BSE image, since EDS is most of the time of a lower resolution.

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



BSE image, resolution : 16624x 16647, 264 MB

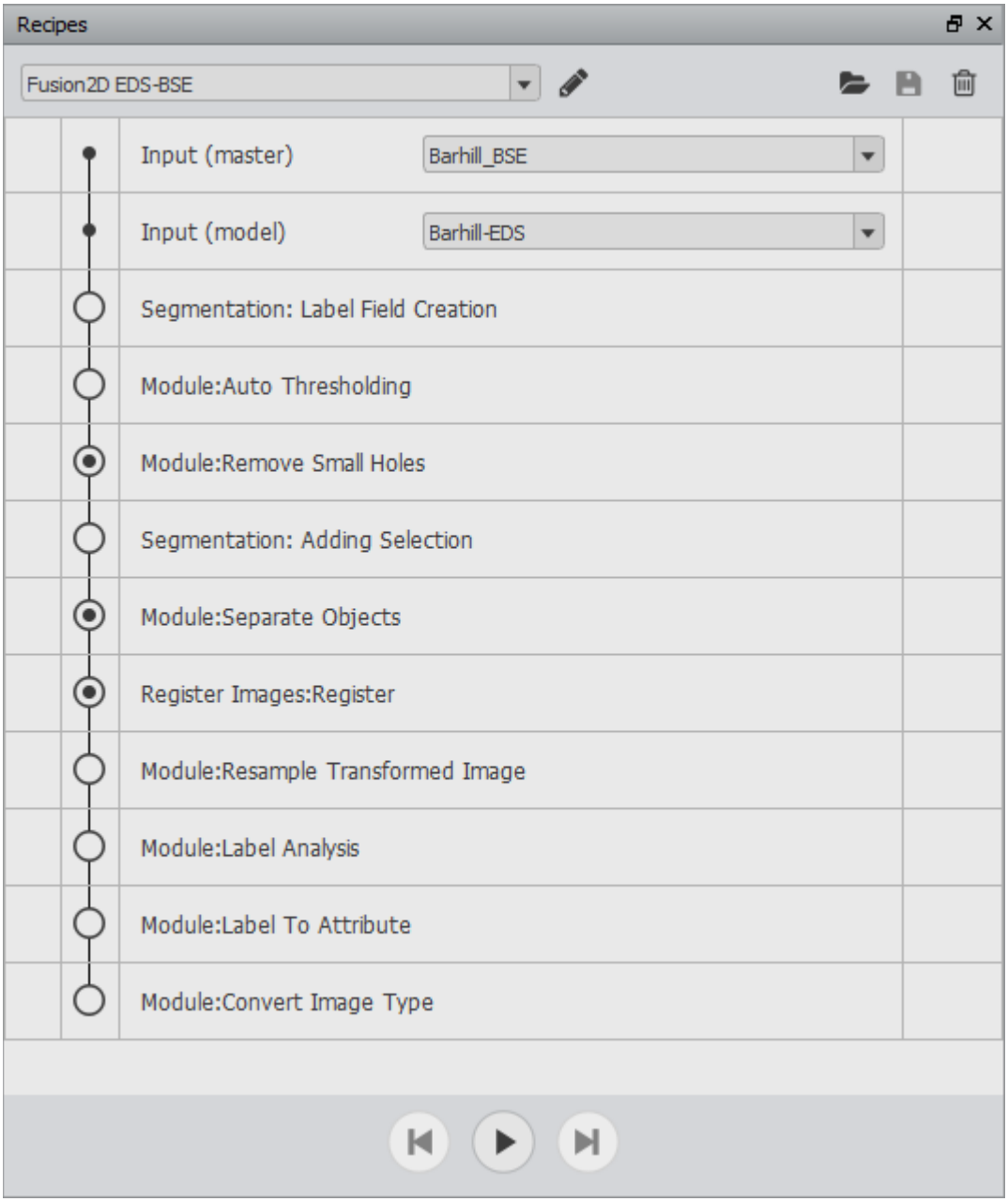


EDS image, resolution : 16896 x 16896, 272 MB

ThermoFisher SCIENTIFIC

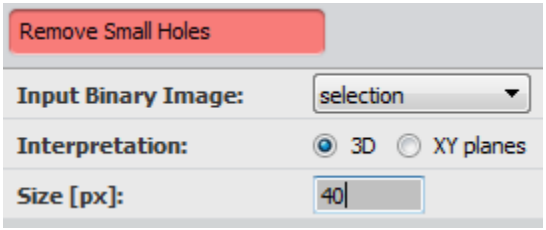
## 2. Applying the Fusion EDS – BSE recipe

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



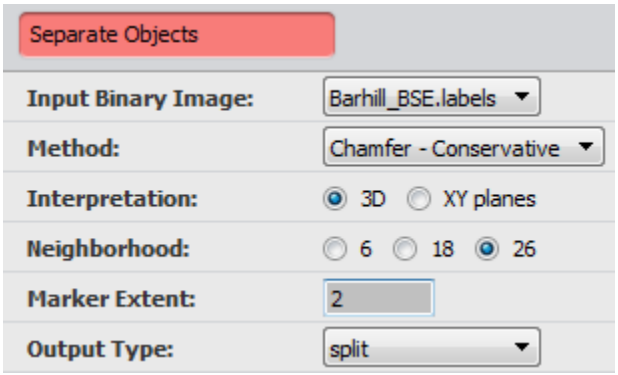
### Remove Small Holes

Designed to facilitate the grain separation. Here a value of 40 is used.



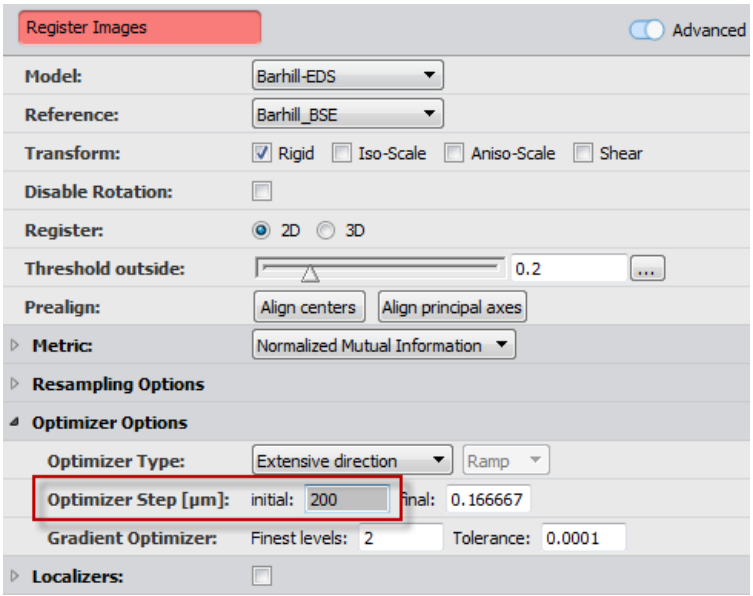

### Separate Objects

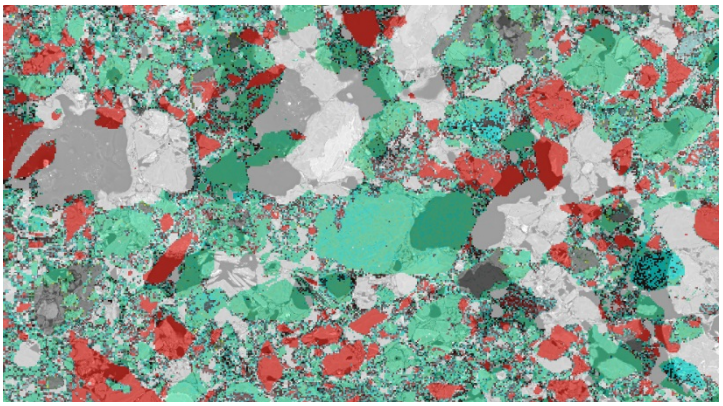
A marker extent of 2 will give good results during the grain separation




### Register Images

The Optimizer initial Step will need to be reduced to around 200 µm since the images are not far from each other.



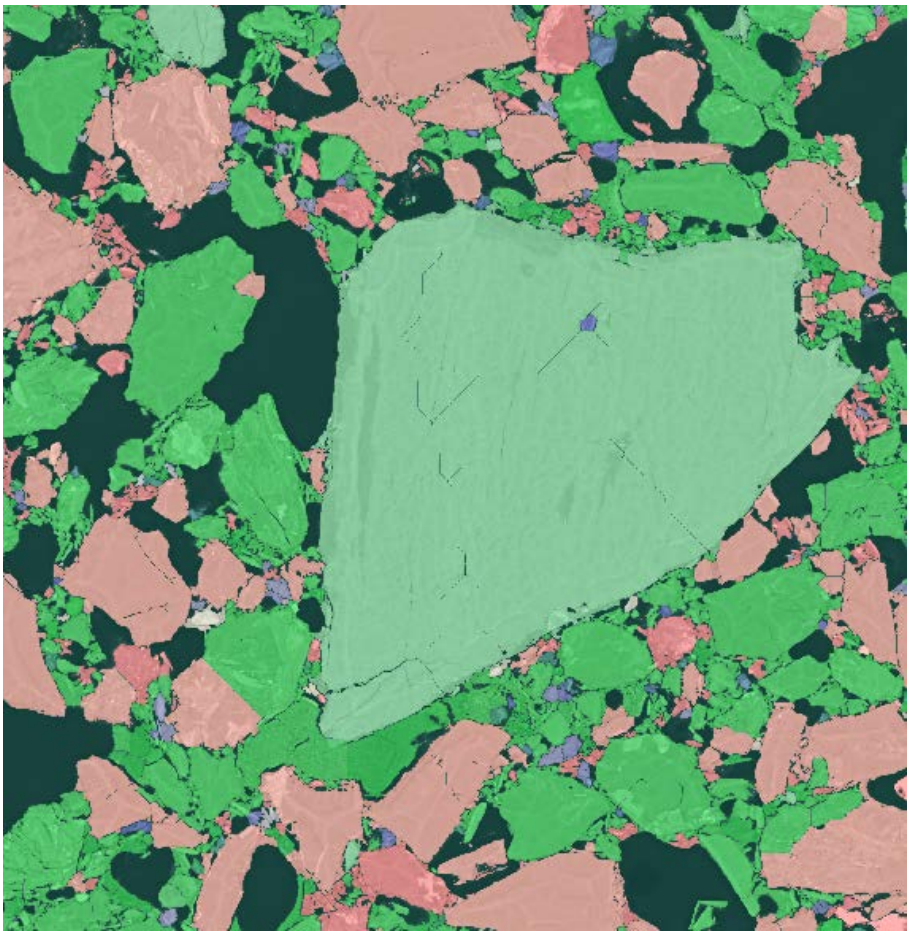



Initial displacement between the images

## 3. Analysis

Now that both images are correctly registered and fusioned, it is possible to extract statistics and use the mineralogy information from the EDS image.

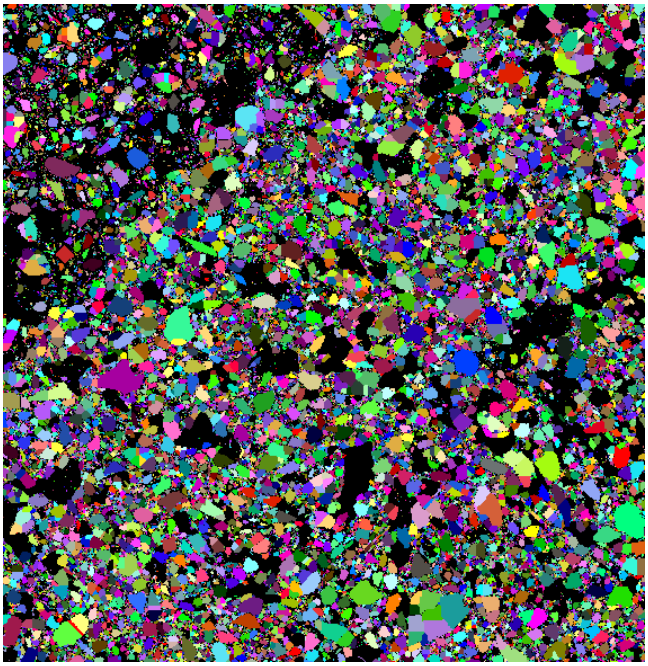
*Note : PerGeos 2.0 will come with a dedicated import function for Nanomin, the EDS analyzer from the MAPS Mineralogy software. This import function will allow the user to directly retrieve mineral names and colors in PerGeos.*

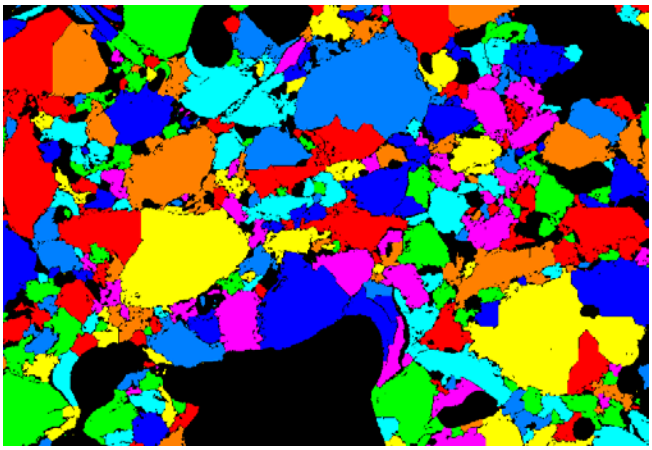


Each of the identified grain has received the most representative mineral

## Grain size distribution

A **Label analysis** on the resulting image will give around 64300 different grains

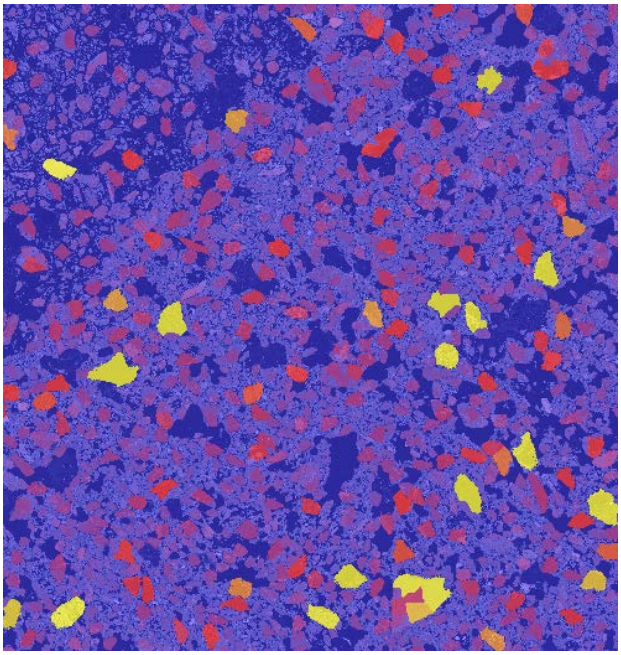




Arbitrary colors represent adjacent grains

| | Area (µm^2) | BaryCenterX (µm) | BaryCenterY (µm) | Mean | Index |
|---|---|---|---|---|---|
| 19 | 13851 | 1407.27 | 84.008 | 1 | 19 |
| 20 | 40 | 1452.75 | 2.375 | 1 | 20 |
| 21 | 457 | 1486.25 | 13.0438 | 1 | 21 |
| 22 | 3 | 1502 | 0 | 1 | 22 |
| 23 | 6 | 1560 | 0.5 | 1 | 23 |
| 24 | 848 | 1614.73 | 8.61203 | 1 | 24 |
| 25 | 7 | 1653.29 | 0.428571 | 1 | 25 |
| 26 | 3 | 1679.33 | 0.666667 | 1 | 26 |
| 27 | 1399 | 1703.41 | 26.8628 | 1 | 27 |
| 28 | 58 | 1742.29 | 1.24138 | 1 | 28 |
| 29 | 605 | 1835.27 | 7.03802 | 1 | 29 |
| 30 | 45205 | 1949.22 | 99.4957 | 1 | 30 |
| 31 | 1 | 2093 | 0 | 1 | 31 |
| 32 | 2134 | 2095.21 | 36.4461 | 1 | 32 |
| 33 | 369 | 2126.42 | 11.065 | 1 | 33 |
| 34 | 300 | 2204.23 | 5.63 | 1 | 34 |
| 35 | 35 | 2241.2 | 2.68571 | 1 | 35 |
| 36 | 329 | 2328.72 | 5.68997 | 1 | 36 |

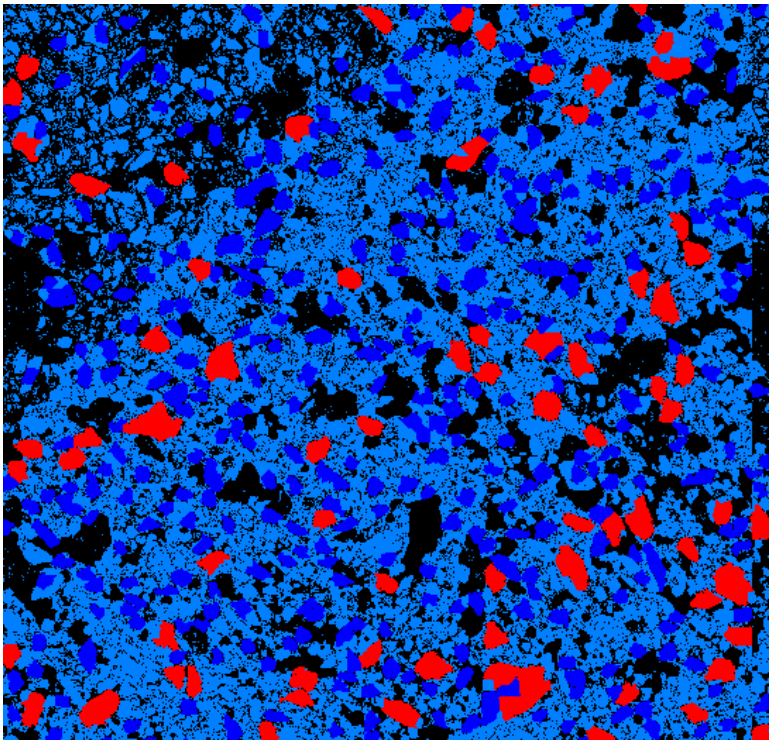
Grain Size Distribution

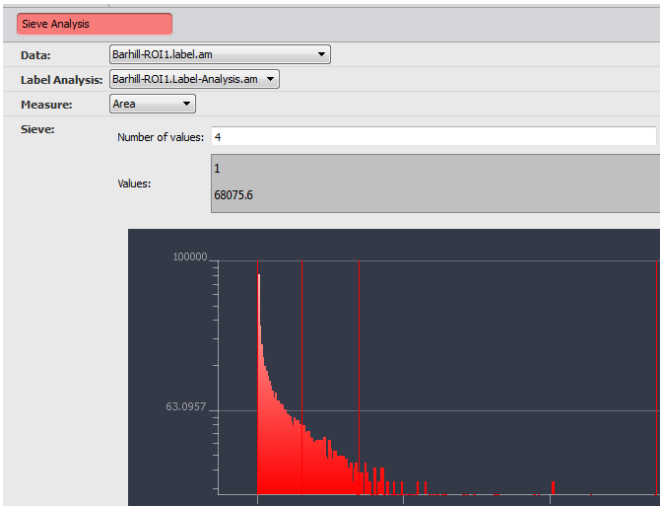


Colors represent grain size

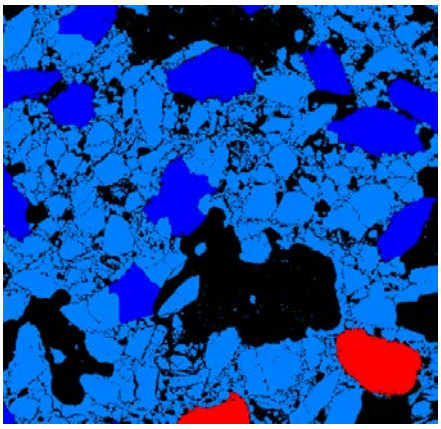
## Grain size classification

A **Sieve analysis** on the resulting label image will segregate the different grains into 3 classes.



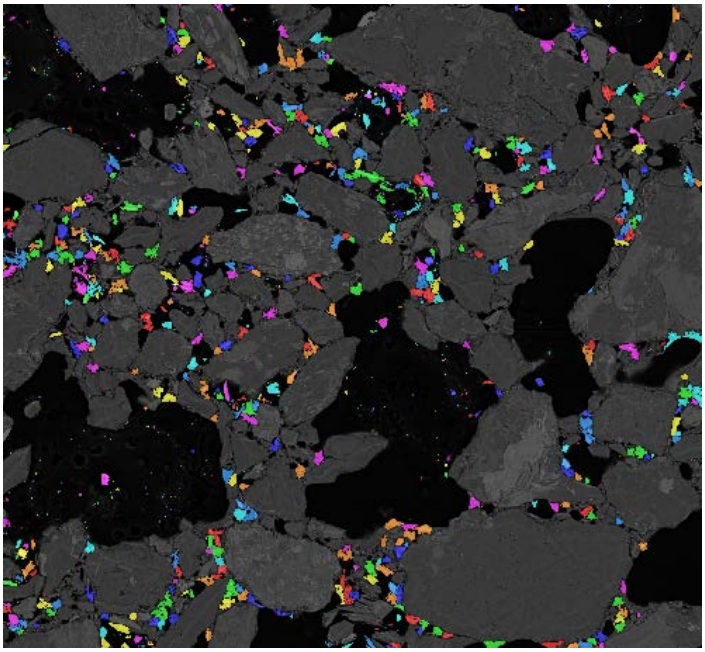



Classification into 3 different classes

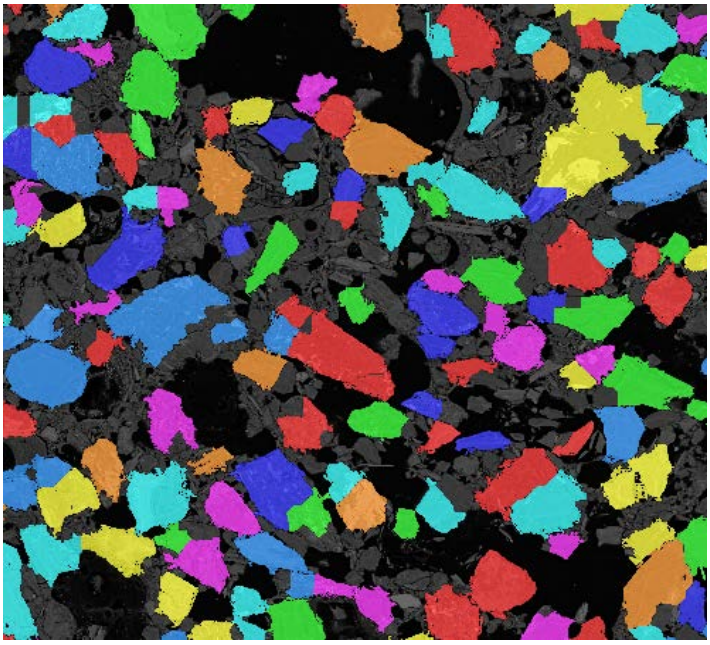


## Shape factors

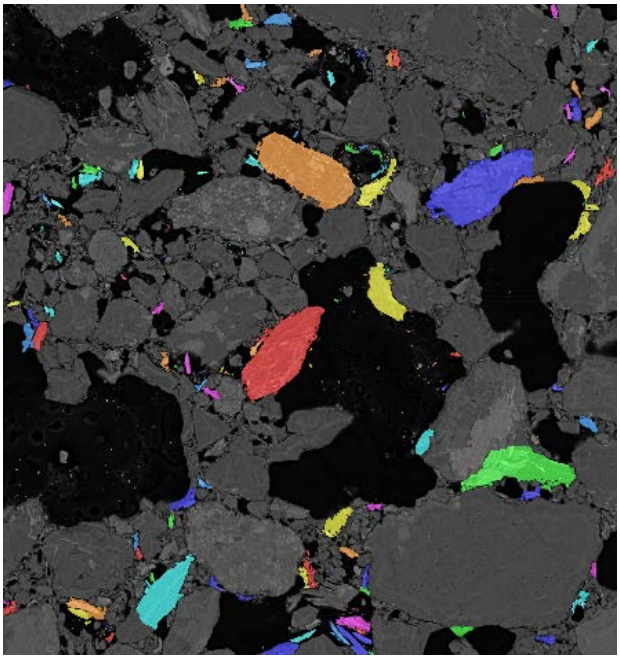
An **Analysis Filter** on the resulting label image will segregate the different classes depending on their size or length.



Area < 3000 µm2



Area > 20000 µm2

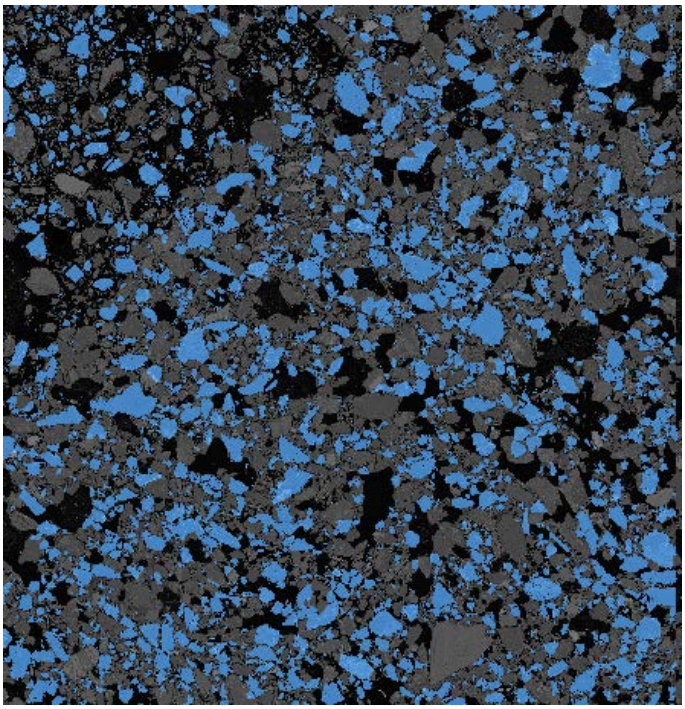


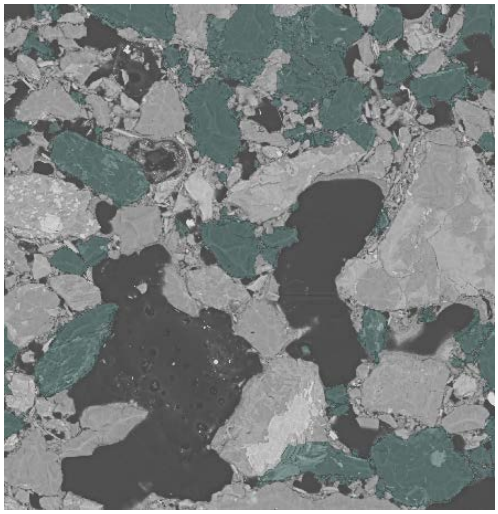
Elongated grains

thermoscientific

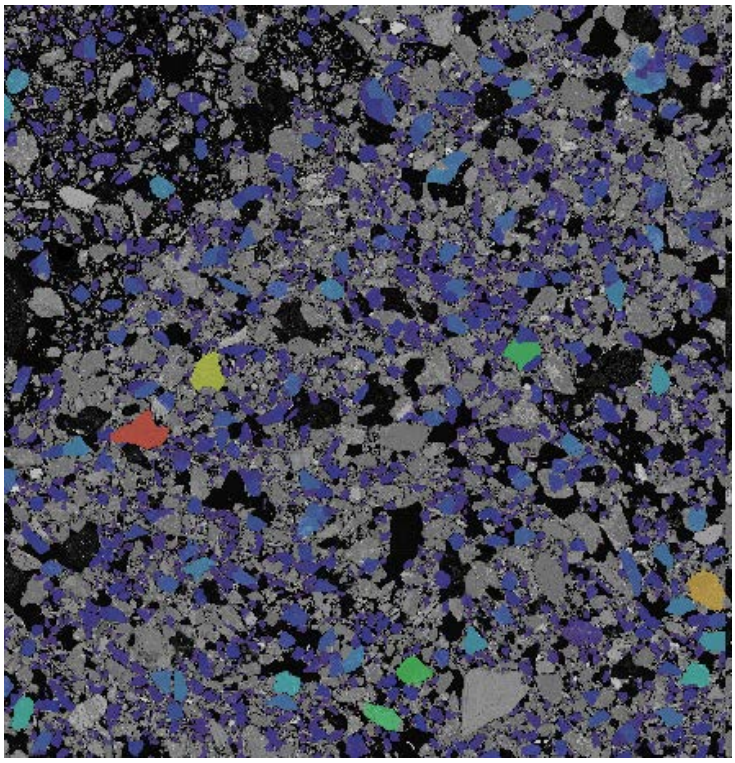
## Mineral -grain association

All grains corresponding to one mineral can easily be extracted with an **Arithmetic** module ( A == mineral ID)





Quartz ( Mineral 234 )



| | Area (µm^2) | BaryCenterX (µm) | BaryCenterY (µm) | Mean | index |
|---|---|---|---|---|---|
| Mean | 16045 | 8176.74 | 8615.34 | 1 | 2057.5 |
| Min | 1 | 4.55625 | 3.27027 | 1 | 1 |
| Max | 605058 | 16197 | 16641.3 | 1 | 4114 |
| Median | 5265.32 | 8088.55 | 8725.07 | 1 | 2057 |
| Variance | 1.00531e+09 | 2.05902e+07 | 2.33903e+07 | 0 | 1.41042e+06 |
| Kurtosis | 65.2607 | -1.14297 | -1.22124 | -- | -1.2 |
| Skewness | 6.00149 | 0.0109276 | -0.0484146 | -- | -7.74554e-06 |

| | Area (µm^2) | BaryCenterX (µm) | BaryCenterY (µm) | Mean | index |
|---|---|---|---|---|---|
| 1 | 1072 | 8.81716 | 25.7108 | 1 | 1 |
| 2 | 1524 | 520.602 | 8.67257 | 1 | 2 |
| 3 | 20240 | 623.012 | 72.0465 | 1 | 3 |
| 4 | 28541 | 841.953 | 62.3455 | 1 | 4 |
| 5 | 700 | 1088.83 | 8.63429 | 1 | 5 |
| 6 | 20634 | 1237.04 | 59.5671 | 1 | 6 |
| 7 | 3137 | 3006.28 | 30.8145 | 1 | 7 |
| 8 | 185 | 3365.88 | 3.27027 | 1 | 8 |
| 9 | 588 | 3793.05 | 7.82483 | 1 | 9 |
| 10 | 100069 | 4774.33 | 132.186 | 1 | 10 |
| 11 | 7265 | 4887.28 | 30.6742 | 1 | 11 |
| 12 | 16901 | 6376.79 | 48.9914 | 1 | 12 |
| 13 | 2745 | 6495.69 | 19.259 | 1 | 13 |
| 14 | 4329 | 7248.88 | 25.5223 | 1 | 14 |
| 15 | 4154 | 8016.34 | 28.766 | 1 | 15 |
| 16 | 19065 | 10271 | 57.7197 | 1 | 16 |
| 17 | 11600 | 10426.9 | 50.1147 | 1 | 17 |
| 18 | 51761 | 11199.5 | 99.9806 | 1 | 18 |
| 19 | 3104 | 11447.7 | 18.1372 | 1 | 19 |
| 20 | 159623 | 11657.1 | 229.749 | 1 | 20 |
| 21 | 29051 | 12195.6 | 81.9789 | 1 | 21 |
| 22 | 34779 | 12428.6 | 119.456 | 1 | 22 |
| 23 | 4707 | 14658.5 | 29.3973 | 1 | 23 |
| 24 | 14487 | 14760.2 | 53.2116 | 1 | 24 |
| 25 | 3521 | 15081.3 | 12.4198 | 1 | 25 |
| 26 | 1152 | 15571.9 | 14.2691 | 1 | 26 |
| 27 | 33576 | 15735.2 | 65.485 | 1 | 27 |

Quartz size distribution ( colors represent grain size)

ThermoFisher SCIENTIFIC