Project 1 Report

Tejas Panambur
31860798

1. Introduction

The Images obtained are of Martian terrain acquired by the Mastcam instrument of the Mars Science Laboratory rover. The images contain rocks,soil, dust particles and parts of rover in them. The objective of the project is to obtain segmentation using clustering techniques like k means,mean shift algorithm,spectral clustering algorithms. K means algorithm is a popular clustering algorithm which clusters using within-cluster sum-of-squares. The number of clusters have to be specified for K means algorithm. Mean shift clustering technique tries to find the clusters based on centroid i.e the mean of the data points in a region. The images have been transformed into color spaces like RGB,HSV and techniques like decorrelation stretching have been explored.

2. Experiments

a. The original images without any processing were given to K means algorithm with n_clusters of range [2,16]. The elbows of the loss plot were around [4,6] indicating that the number of clusters in the image lies in this range. This can be explained by considering rocks,soil,dust,shadows,noise as individual cluster. So we are expected to get around [4,6] clusters. Even though the k means grouped them into 6 clusters they were bad. This maybe due to highly correlated images and poor separation between pixels of each cluster.

b. We use decorrelation stretching technique before the image is sent to k means clustering algorithm. This helps to remove the high correlation between the pixels and thus better clustering and better segmentation of regions in images. The number of clusters were kept around [4,6] for this experiment as well.

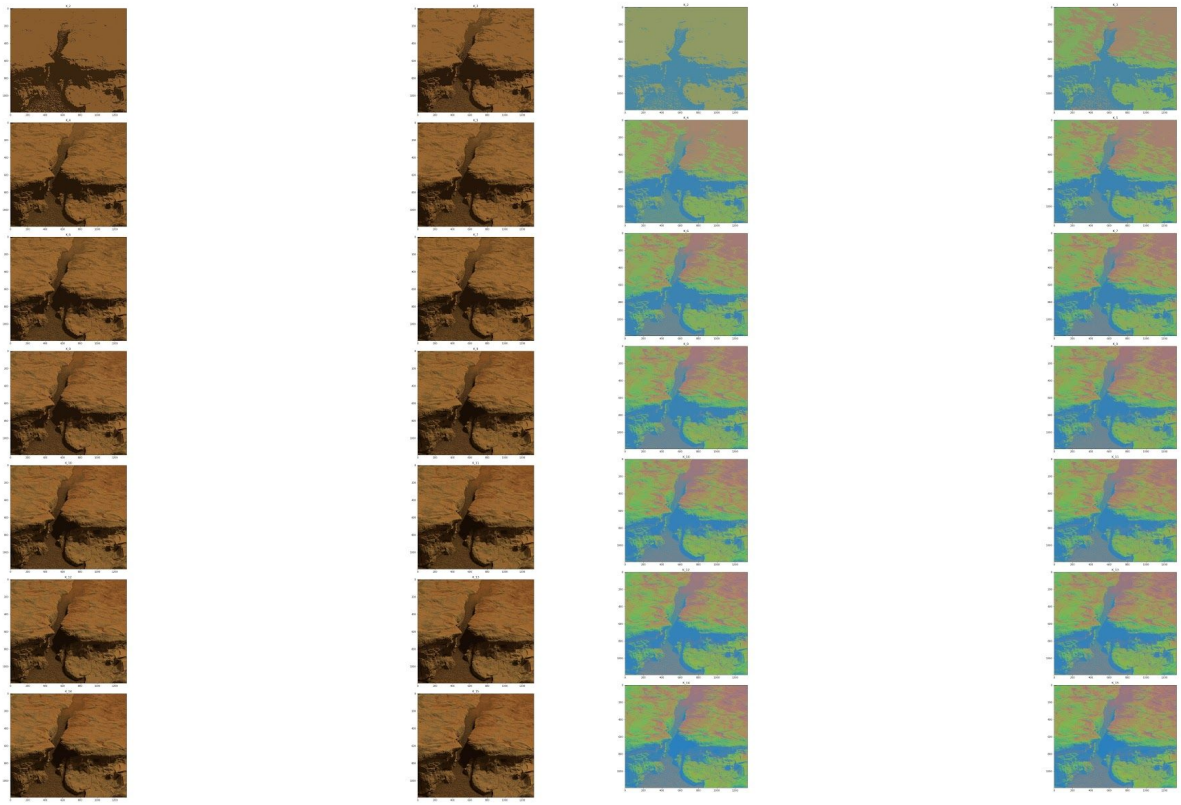
c. Mean shifting algorithm was kept running for 4-5 hours and yet it did not converge even with 16gb of memory. Tried to implement speeding techniques mentioned in scikit documentation and couldn't make it to converge. The mean shift algorithm is usually computationally expensive to use. So could not produce results using Mean shifting algorithm.

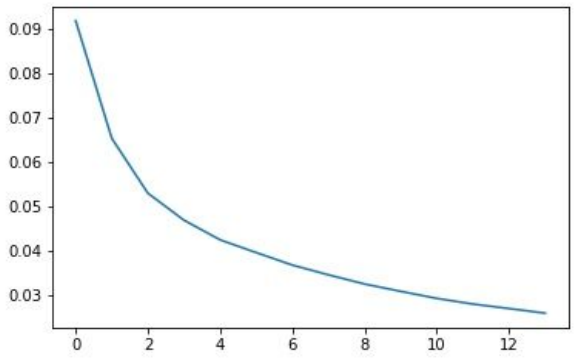
d. The images were transformed into HSV format before clustering. The clusters of shadows were better but overall this did not give any better results compared to decorrelation stretching + kmeans.

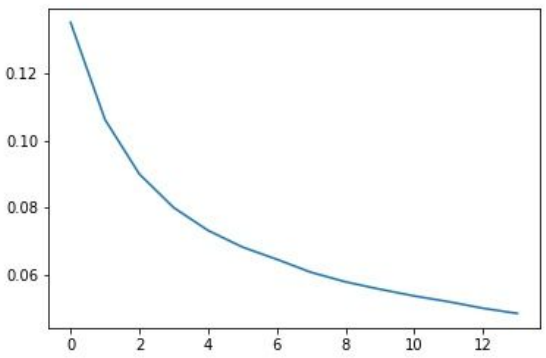
e. Tried to implement spectral clustering which does a low-dimension embedding of the affinity matrix between samples but the space complexity of the algorithm is very high and hence the algorithm breaks down for large images of type float32. Agglomerative clustering is a Hierarchical clustering algorithm. When it tries to evaluate distance it runs out of memory.

3. Results

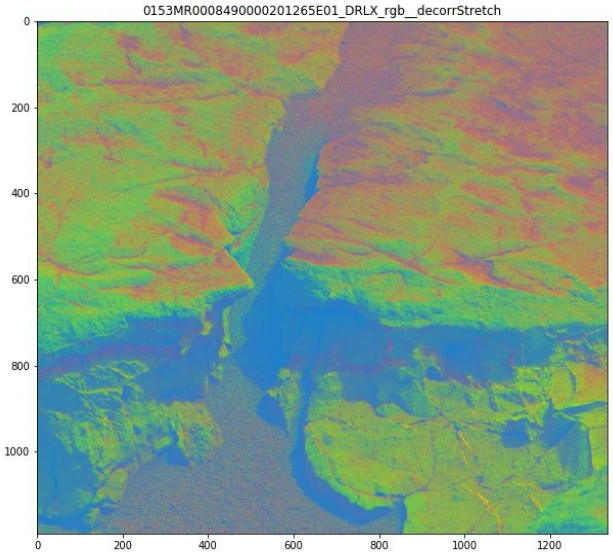
a. The K means reconstructed image for k values in range [2,16] for image 0153MR0008490000201265E01_DRLX . The images on the left are reconstructed images and loss plot for original image without preprocessing and images on the right are reconstructed images after decorrelation stretching.

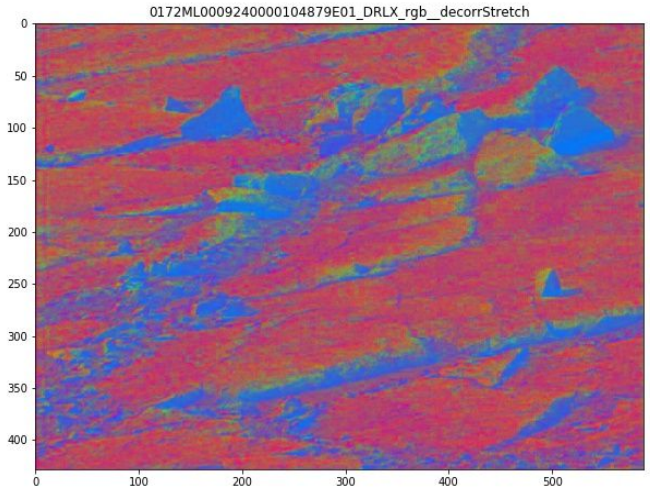


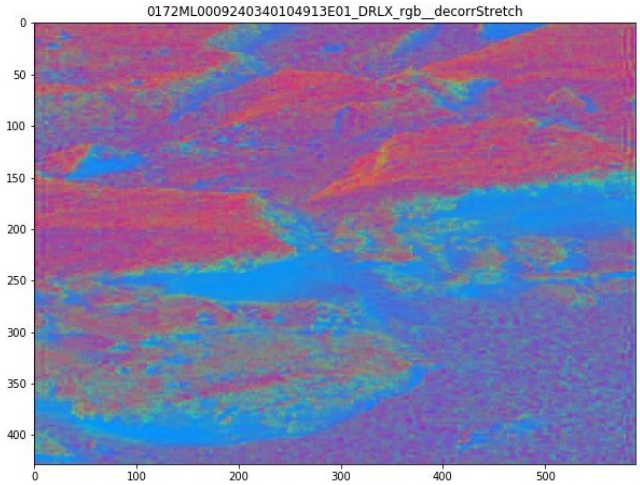


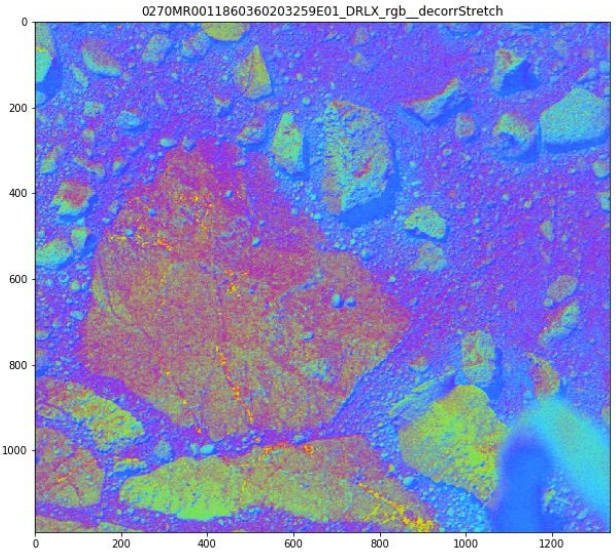


b. The Images below are images after decorrelation stretching. We can see that rocks in the first image is colored in light green, shadows are of dark blue color and soil is in grey color. In the second image the rocks are represented in blue color. In the third image the rocks are colored in red. In fourth image the rocks covered in dust are colored red and other rocks are colored in green.

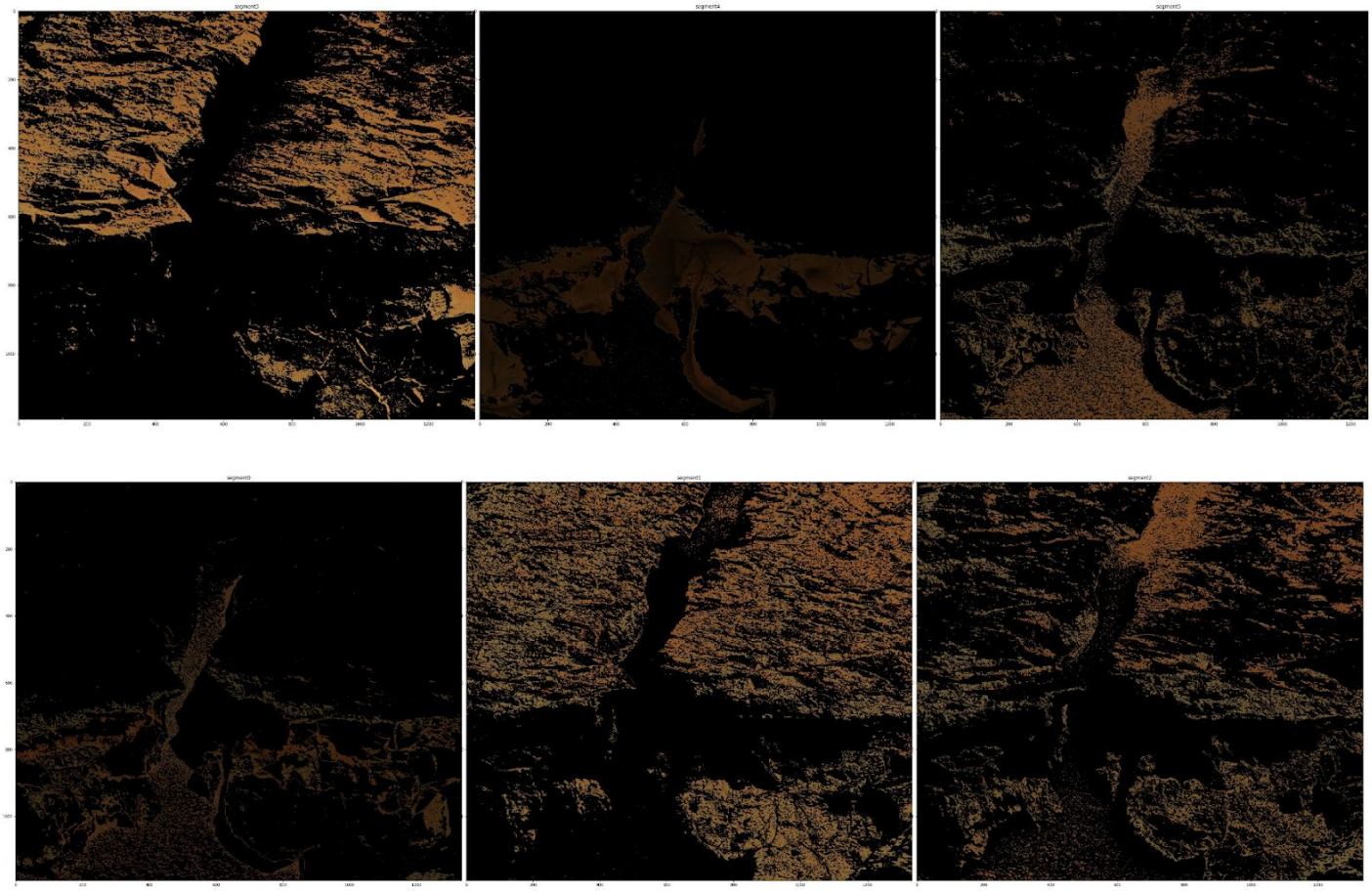




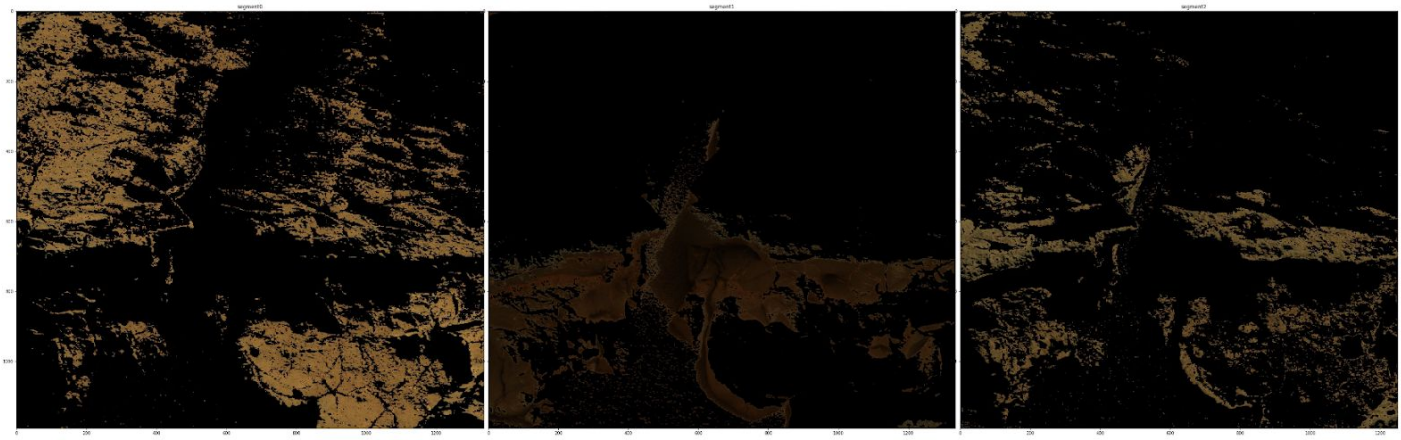


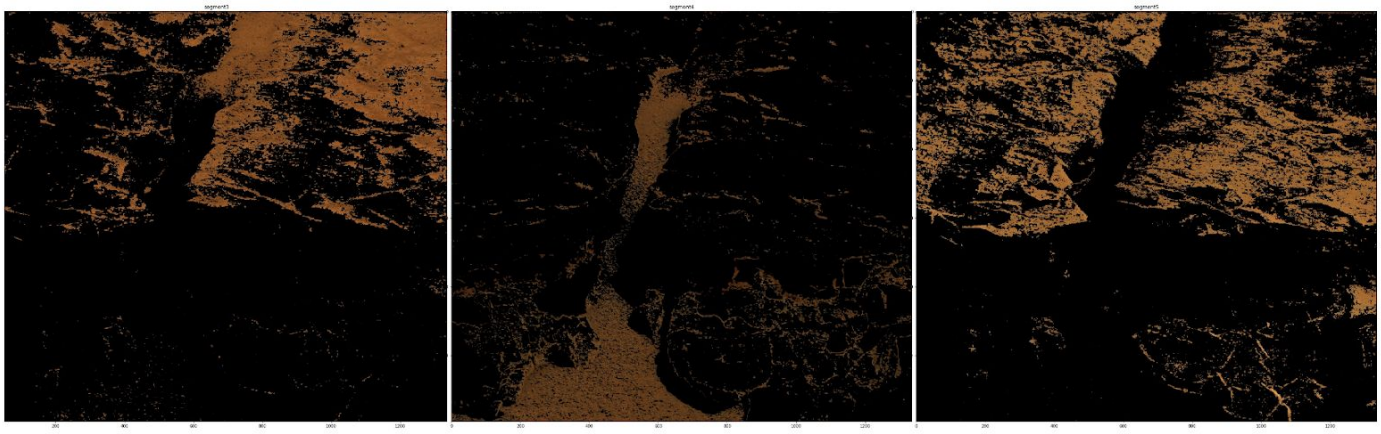


c. The segments for k= 6 before decorrelation are below.

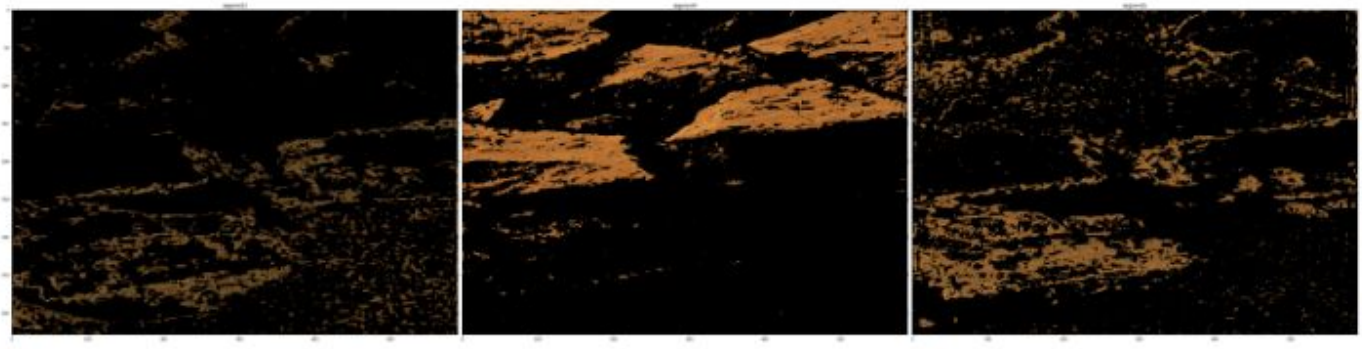


d. The segments for k = 6 after decorrelation stretching are below. We can see that it has tried to cluster rocks in segment 0, dust on top of rocks and soil and some part of shadows in segment 3.

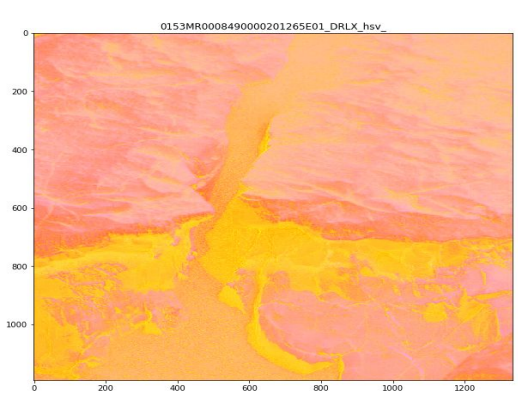


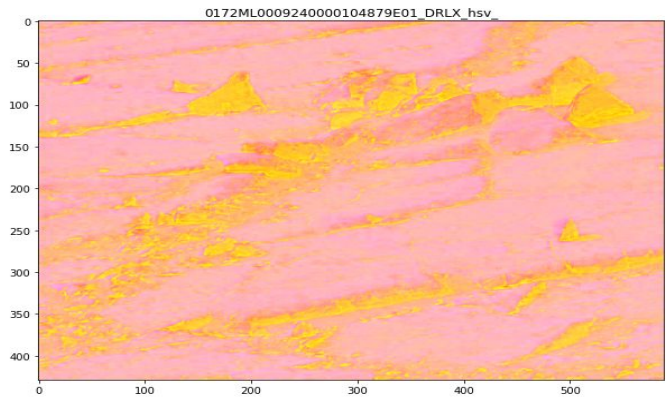


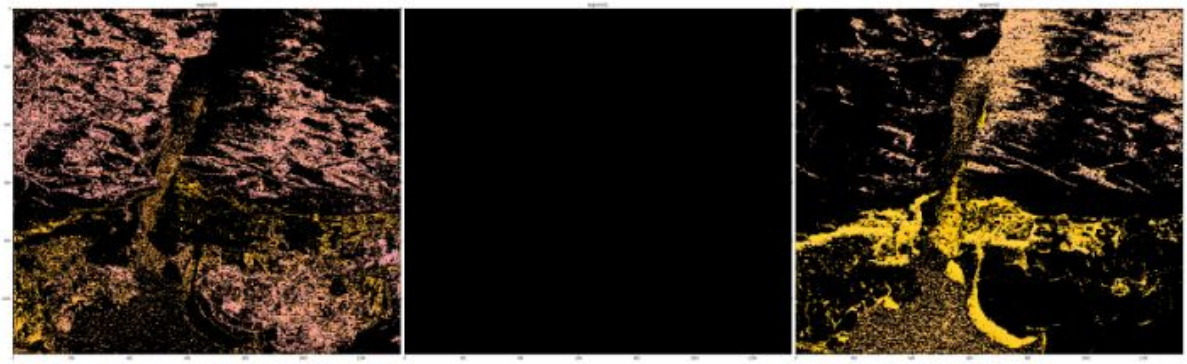
e. This is the image 0172ML0009240340104913E01_DRLX after segmentation and we can clearly see rocks to be in separate cluster.

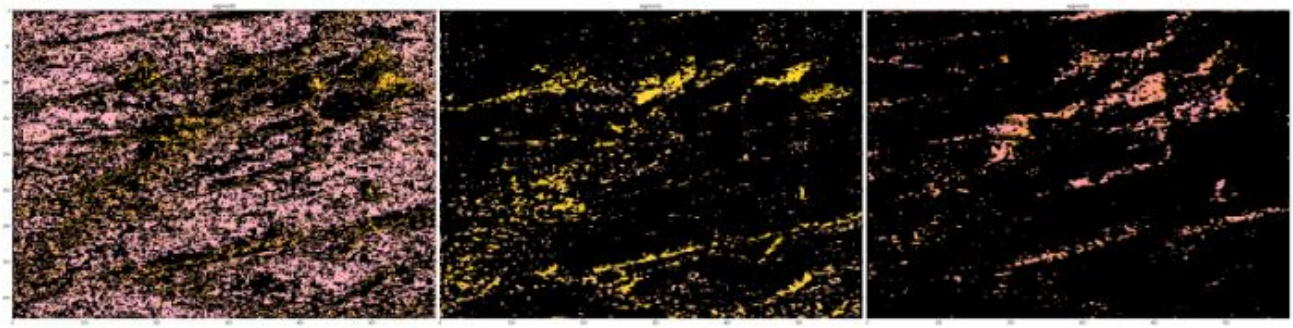


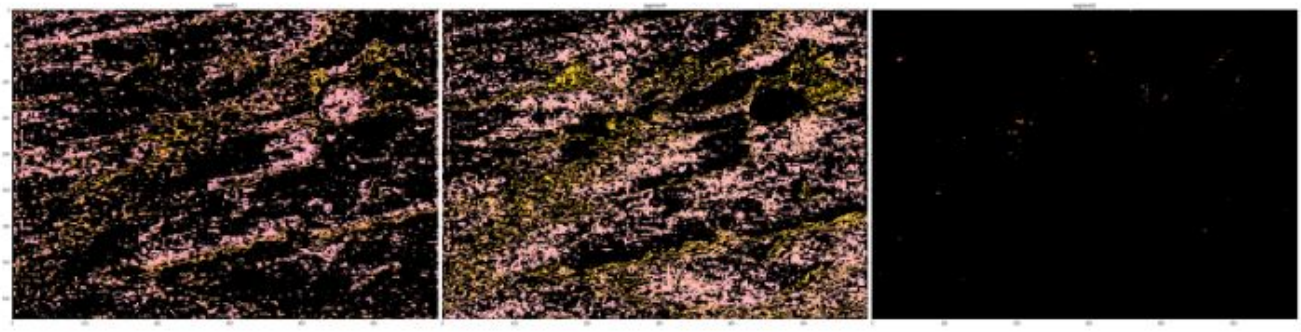
f. Converting the images into hsv format and then applying k means to segment.
After converting it into hsv format the shadows have been clustered very well but soil and rocks have not been clustered accurately.











Conclusion

The best results have been obtained with decorrelation stretching followed by k means clustering with 6 clusters. Mean shifting algorithm is computationally expensive and Spectral, Agglomerative, DBSCAN clustering techniques requires a lot of space. Projecting it into HSV did not improve the result.