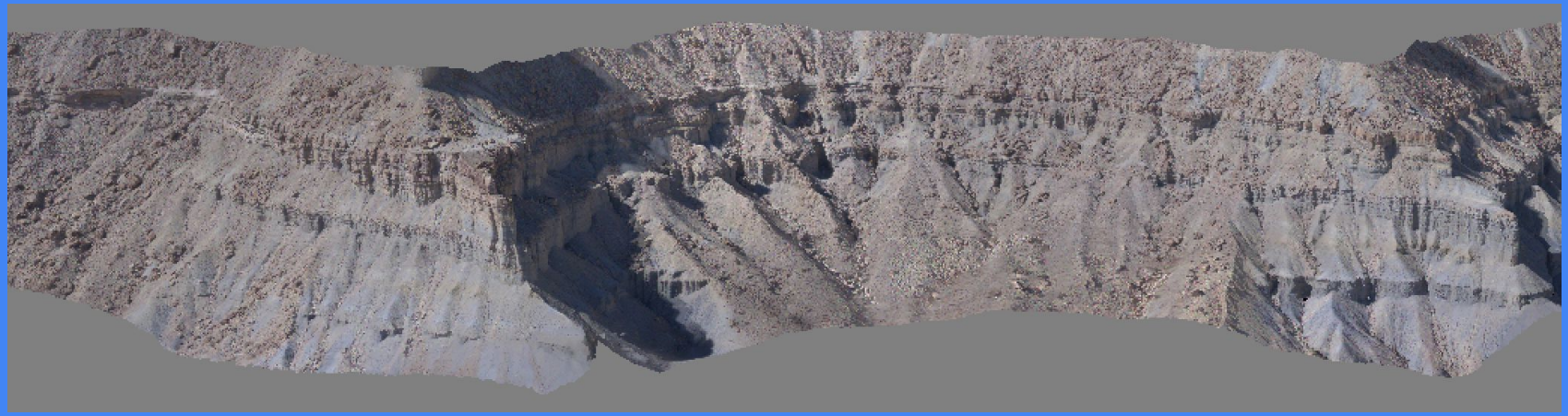

Digital Outcrop Models: Gee Whiz!

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Executive Summary

What?

Evaluate facies variability from digital outcrop models.

Why?

Rapid evaluation of facies heterogeneity from outcrops, generate quantitative analogs.

How?

Generate facies classification for weathering profile and image color at vertical profiles along outcrop.

Where to?

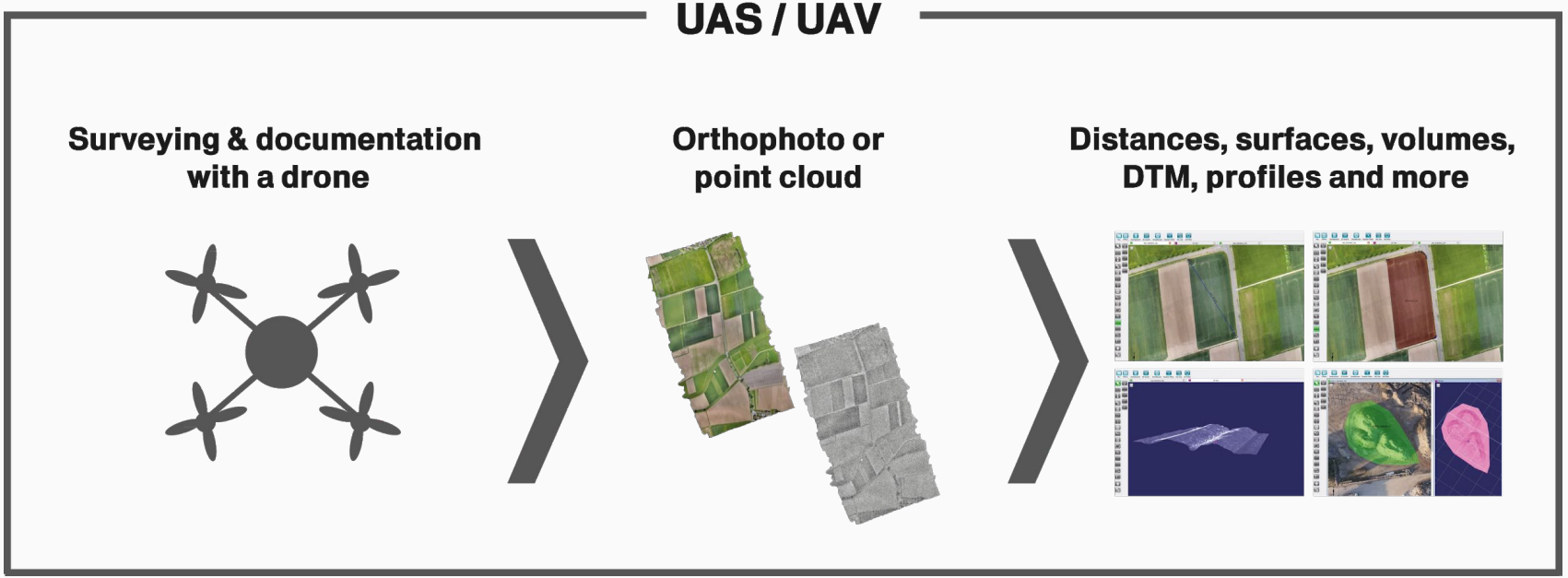
Further refine workflow, compare key outcrop segments, auto-detect facies boundaries, high-grade key locations of outcrop variance.

3D model interrogation for geologic analysis

- Build SfM digital outcrop models
- Use color and model texture to pick facies and facies boundaries
- Extract outcrop weathering profiles as a proxy for lithology
- Explore lateral continuity of outcrop profiles

- Derive quantitative information from outcrops (analogs)
- Leverage as reservoir modeling constraints

UAV processing workflow



https://www.pointcab-software.com/en/point-clouds-from-drones-uav-unmanned-aerial-vehicle-2/

Pros and Cons of point clouds vs mesh

Point Cloud

Pros:

- Earlier in data stream, less computationally expensive
- Color and texture data georeferenced to each point
- Roughly “pre-stack” data

Cons:

- Error in absolute locations
- Discontinuous data

Mesh

Pros:

- Output is a surface: encodes connectivity, many geometric algorithms available
- Easily shared in Arc, Sketch Fab, etc
- Digital elevation model as a product

Cons

- Computational time to create a mesh, finer the mesh the more time
- Color, texture, and location are averaged over a triangle
- Roughly “post stack” data

Downfall of (our) Mesh ...

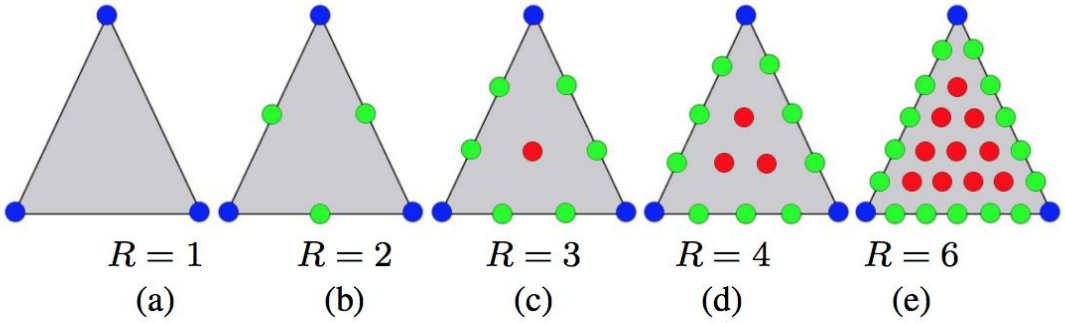


Fig. 2. Color positions on vertices (blue), edges (green), and face (red) for different resolutions (R).

R=1 is what is a standard output of Agisoft PhotoScan, R=3 or better is what's needed for advanced geological analysis.

http://www.cs.jhu.edu/~misha/ReadingSeminar/Papers/Yuksel10.pdf

UAV geospatial data

Built with Agisoft Photoscan

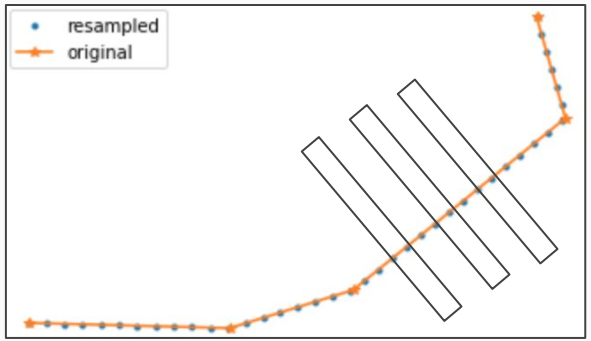
- 1 hour flying time
- ~ 200 photos
- 5 hours processing time
- georeferenced

UAV geospatial data

Subset of model

Outcrop orientation line

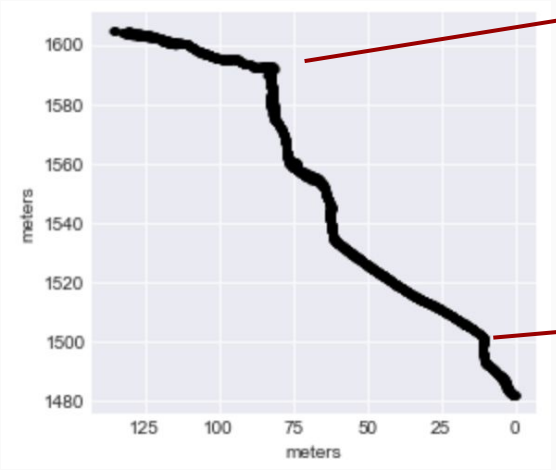
Normal ‘slices’



UAV geospatial data

Slice example:

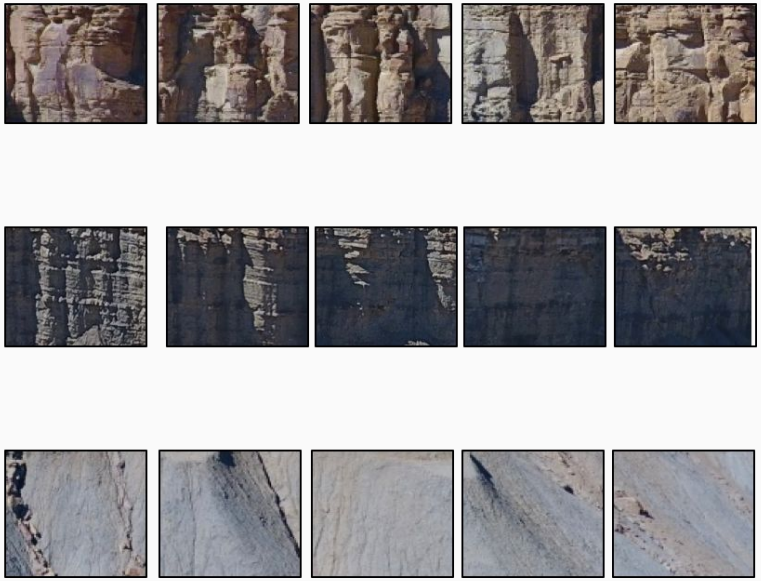
~ 3000 points (xyzrgb)



Facies Classification via Color Spectrum Extraction

Outcrop Image

Facies Blocks



Facies Classification via Color Spectrum Extraction (HSV)

Facies Blocks

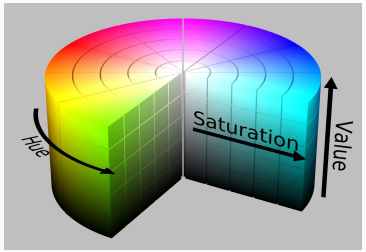
Sand

Heterolithics

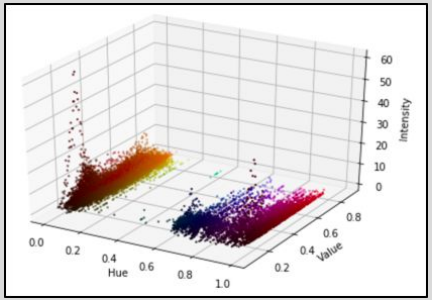
Shale

Extract characteristic color-spectrum for each facies based on k-means clustering

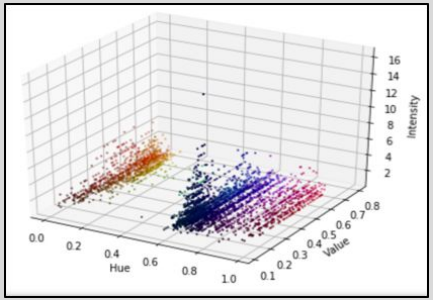
RGB conversion to HSV



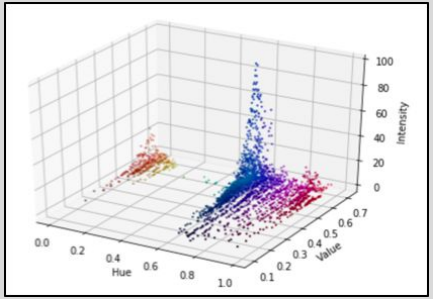
Sand



Heterolithics



Shale



Feature Importance

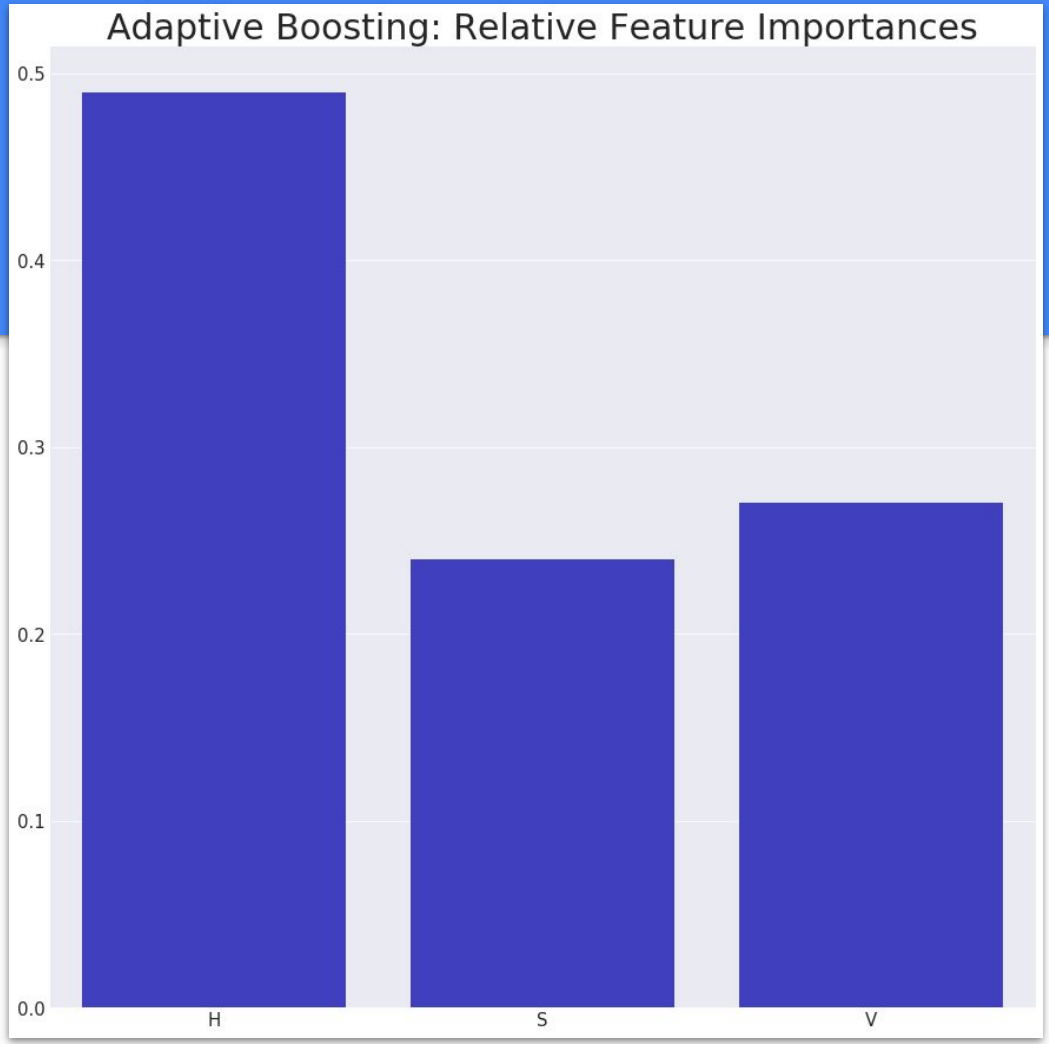
H = Hue (color value)
S = Saturation (strength of color)
V = Value (luminosity/brightness)

Better aligned with perceptual characteristics.

- Hue invariant w.r.t. illumination, etc.

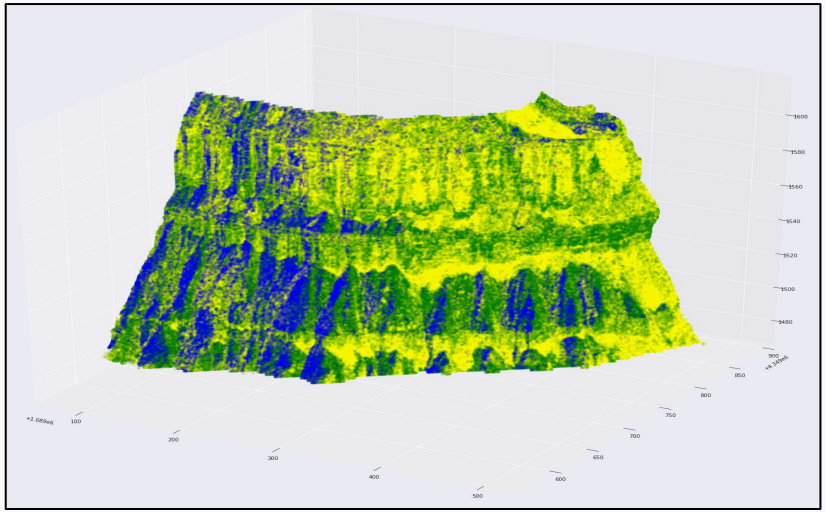
Used Decision Tree ensemble with Adaptive Boosting training algorithm:

- K-fold cross validation scores of 87-89% with K's from 3-10



Movie Time ….

3D outcrop model with facies classification



https://vimeo.com/270994566?utm_source=email&utm_medium=vimeo-cliptranscode-201504&utm_campaign=28749