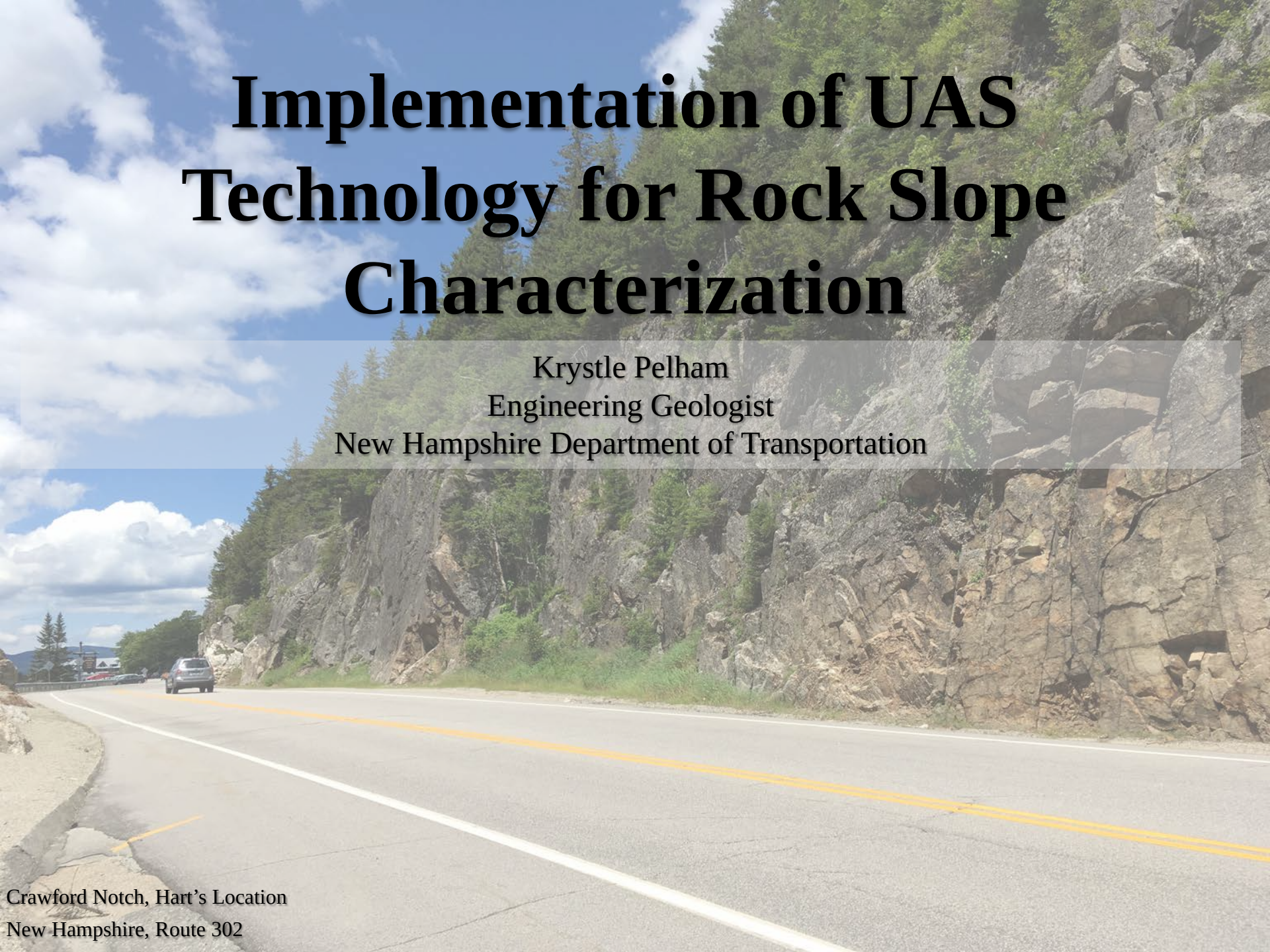
Implementation of UAS Technology for Rock Slope Characterization

Krystle Pelham
Engineering Geologist
New Hampshire Department of Transportation



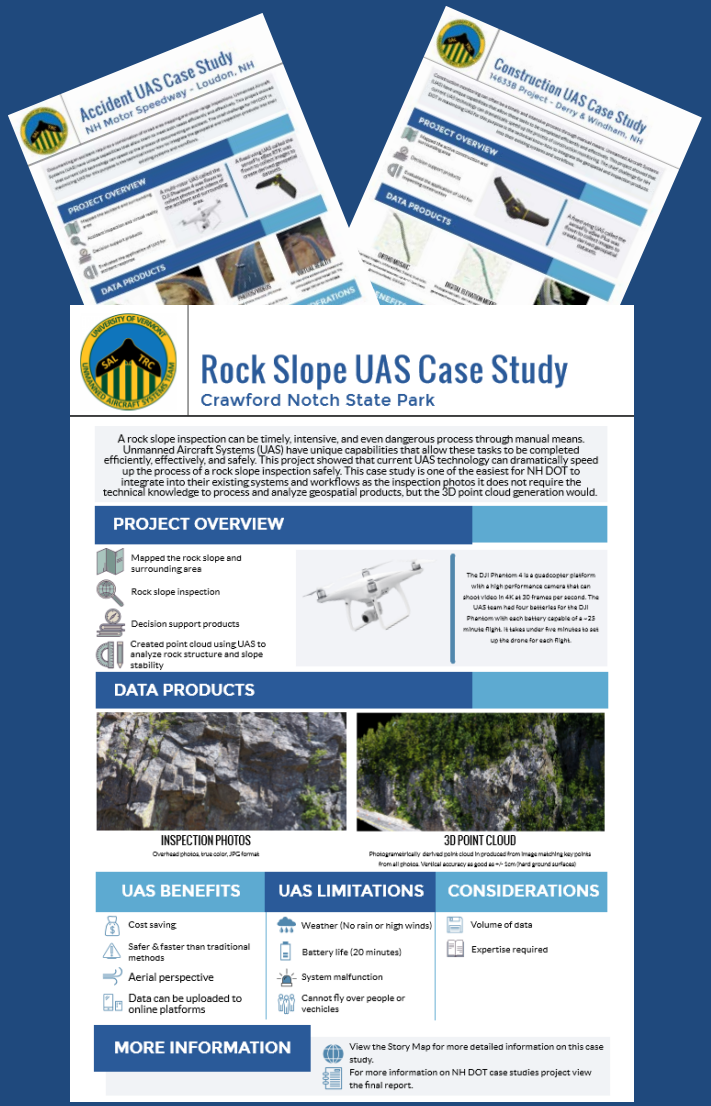
Crawford Notch, Hart's Location
New Hampshire, Route 302

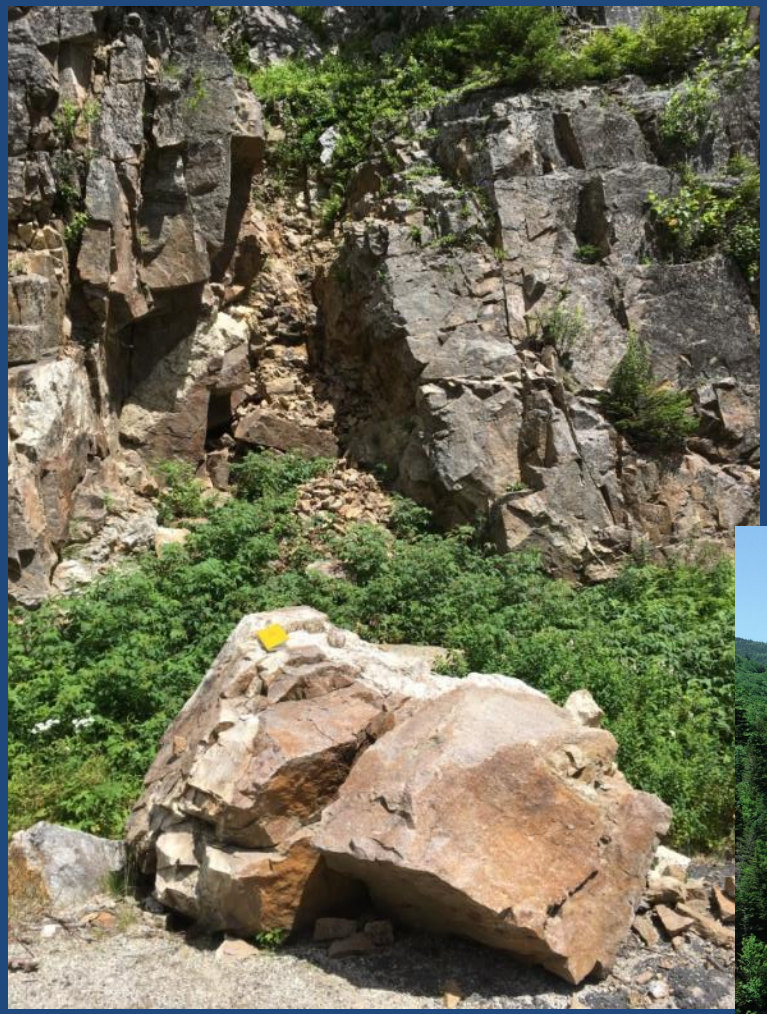
Outline

- History – UAS in NHDOT
- Data Collection
  - Manual and UAS
- Data Analysis
- Results
- Conclusions

- SPR2 funded DOT UAS assessment project & STIC grant based on the current EDC5 “Unmanned Aerial Systems”
- SPR Purpose: Assess the use of UAS department wide – bridge, construction, design, etc.
  - Geotechnical: compare a rock cut assessment using UAS data to that from data collected manually
    - PI: Prof. Jarlath O’Neill-Dunne, UVM SAL
    - Pilot: Tayler Engel, UVM
    - Instrument: DJI Phantom 4, data processed by UVM with Pix4D
    - Flight: July 26, 2017

- SPR2 provided the Dept. with guidance, experience, and factsheets
- STIC grant for ground based camera and software to create point clouds to analyze slopes using photogrammetry or structure for motion

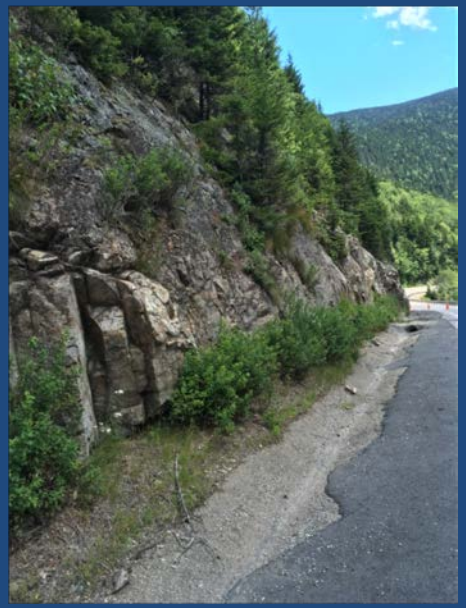


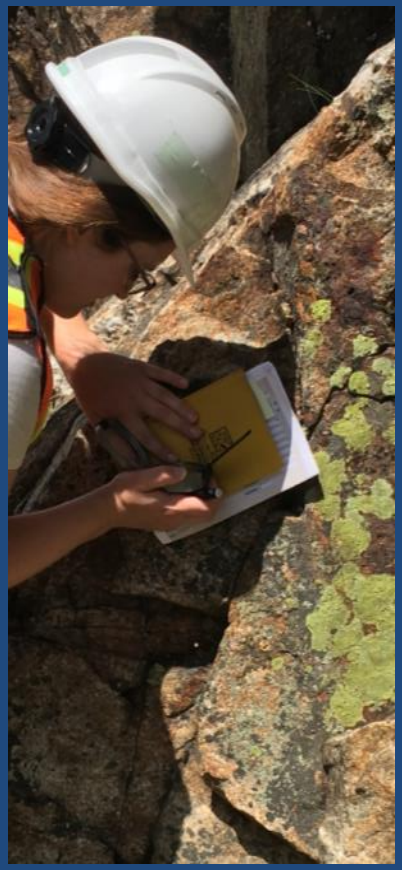


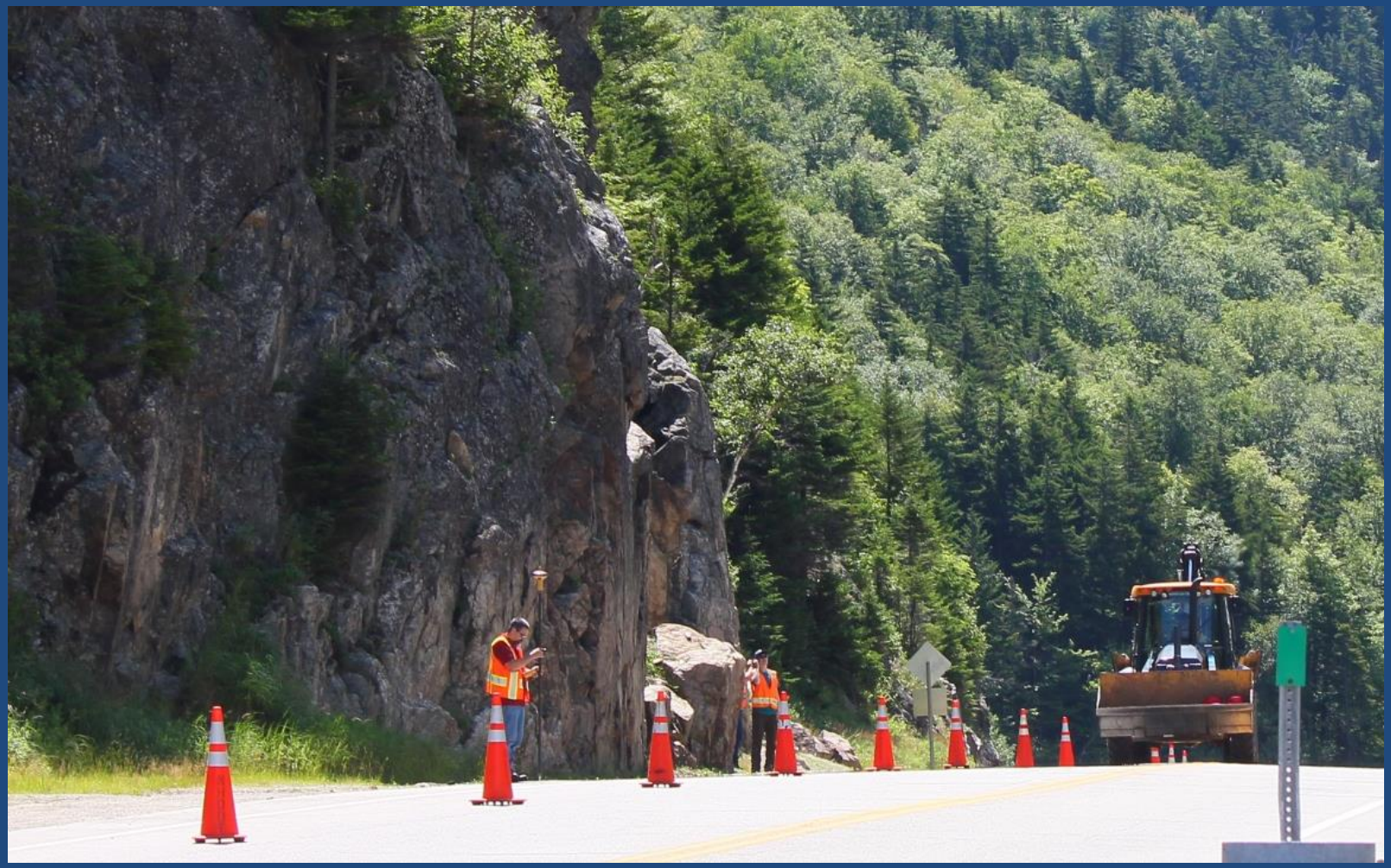
- Crawford Notch rock cut on Rt. 302
- Highest hazard in our rating system
- Over 100ft high and poor overall stability rating
- Limited shoulder/catchment width
- Remediation work was included in a drainage upgrade project

- Traditional rock cut inspection/data collection techniques: manual methods
  - Brunton compass, field book…
- Rope access methods or from the ground
- Without rope access method measurements and inspections are limited

- Road hazards – sight distance
- Block size and stability, dimensions, and changes
- Recent rockfall data
- Structural data
- Pictures for documentation



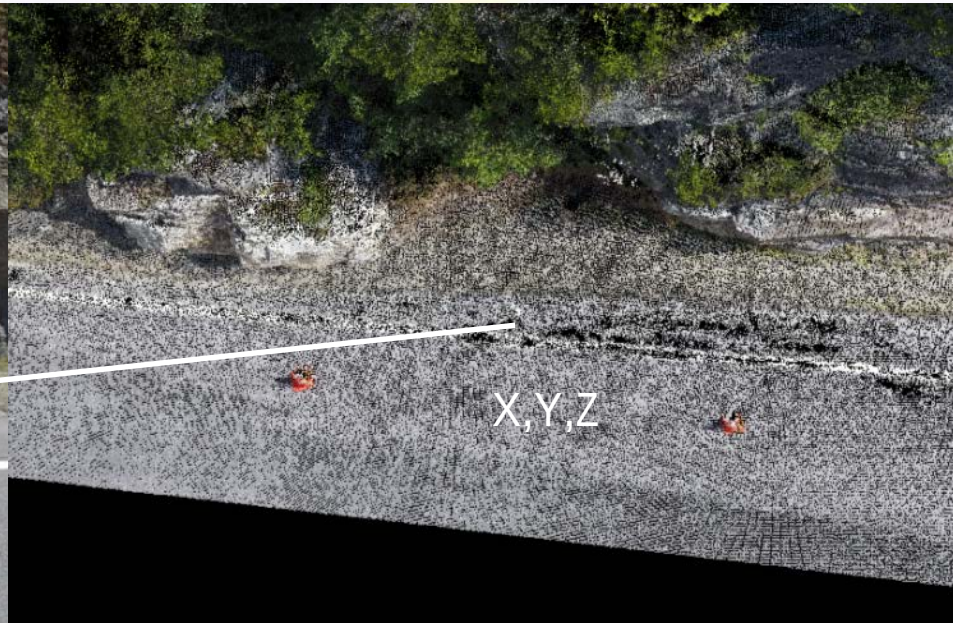




Coordination with maintenance: Work on a catch basin the same day necessitated the closure of a passing lane and allowed for room to fly UAS


FALLING
ROCKS


X,Y,Z


X,Y,Z

- UVM acquired 1.5 ha area and processed the data, resulting in:
  - Oriented point cloud (1.94×10^7points, 167/m^3 0.66 cm GSD)
  - 310 high-resolution images (and 2 videos)

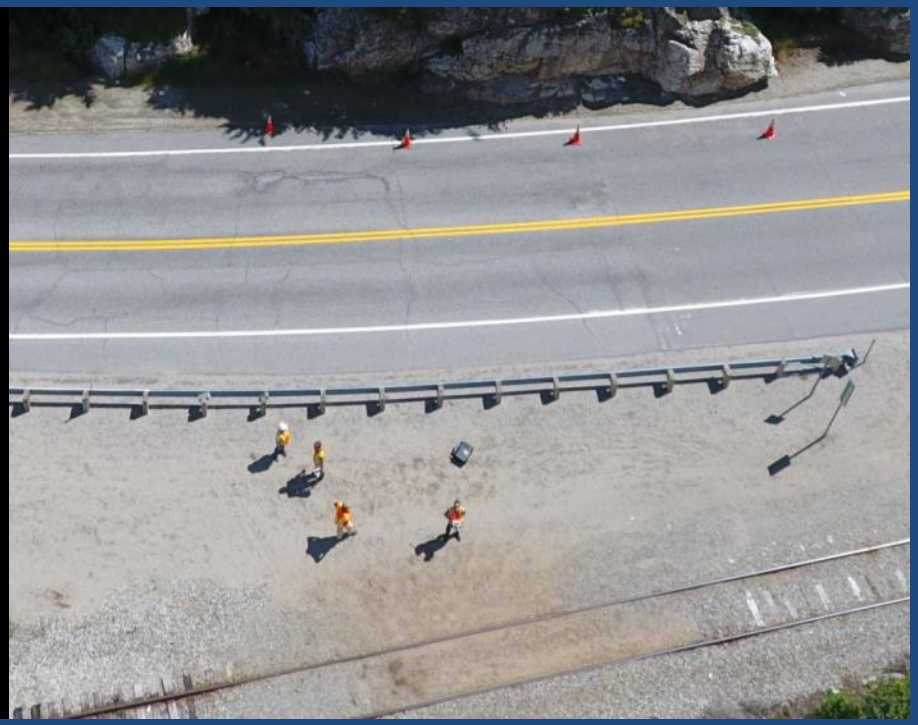
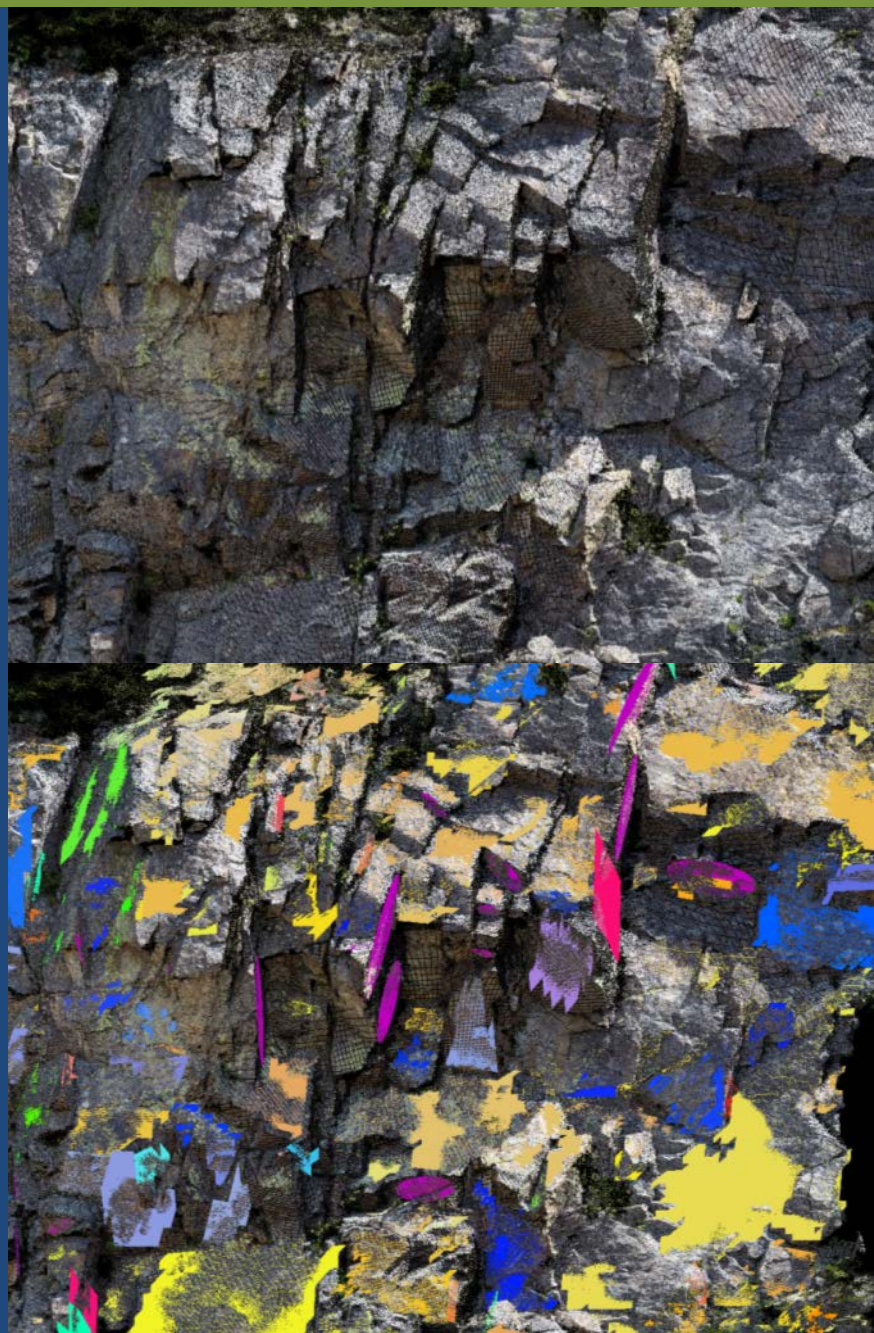


Photo panorama (top) and point cloud (bottom)

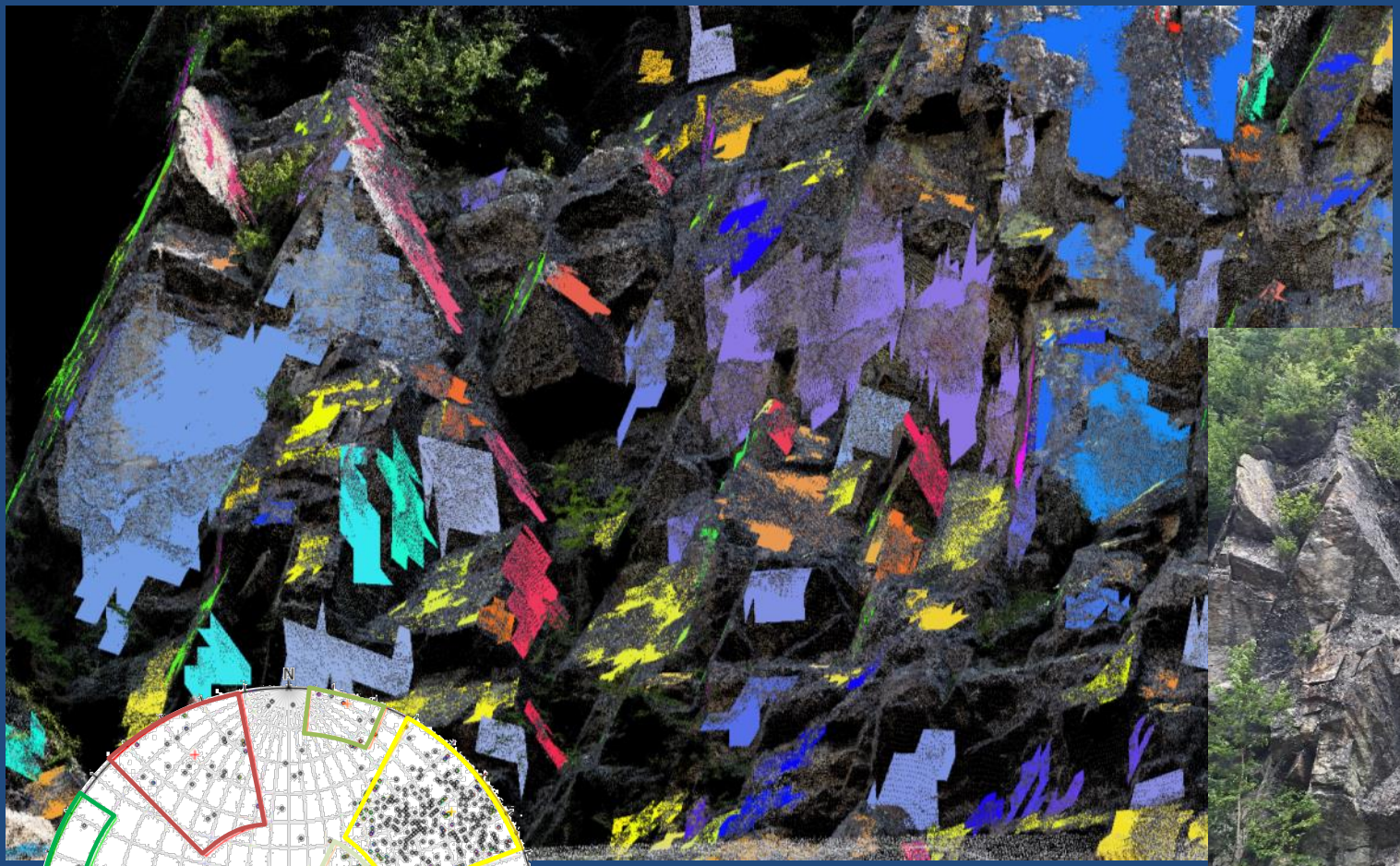
Original image (left) and point cloud (right)

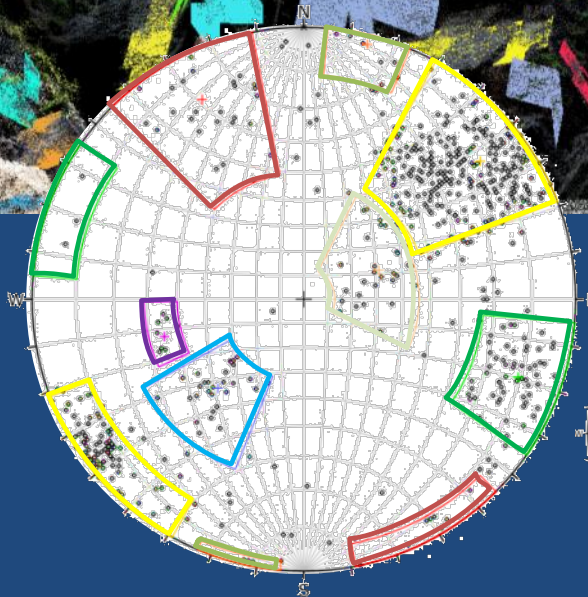
Original image (left) and point cloud (right)

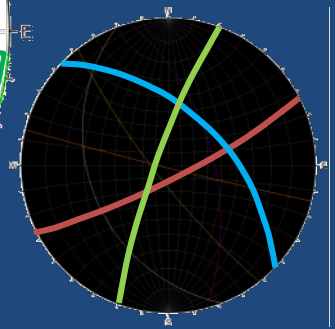
- DOT used Split-FX and RocScience's Dips for fracture analysis
- Orient point cloud in Split-FX
- Create mesh
- Find patches (auto)
- Inspect and edit patches
- Add traces
- Stereonet analysis



Top: Point cloud
Bottom: Auto-identified fracture surfaces (multi-colored) and manual fracture traces (pink)

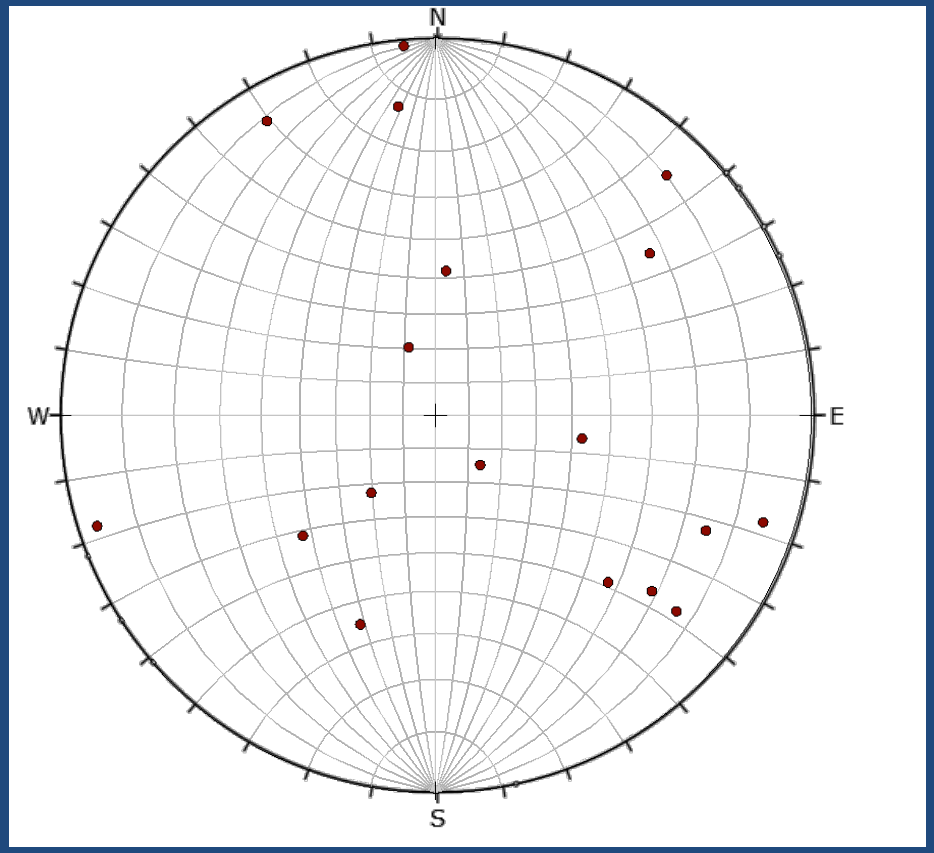




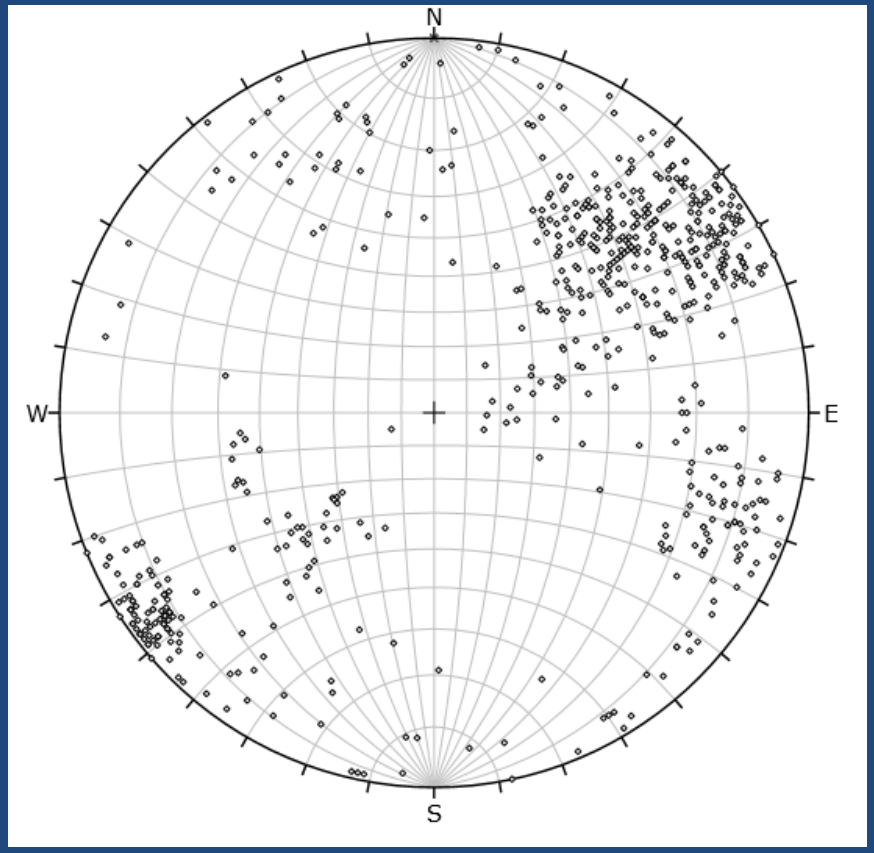


Viewpoint: Looking up at the rock face as if standing on the road

Collected with Compass (18)

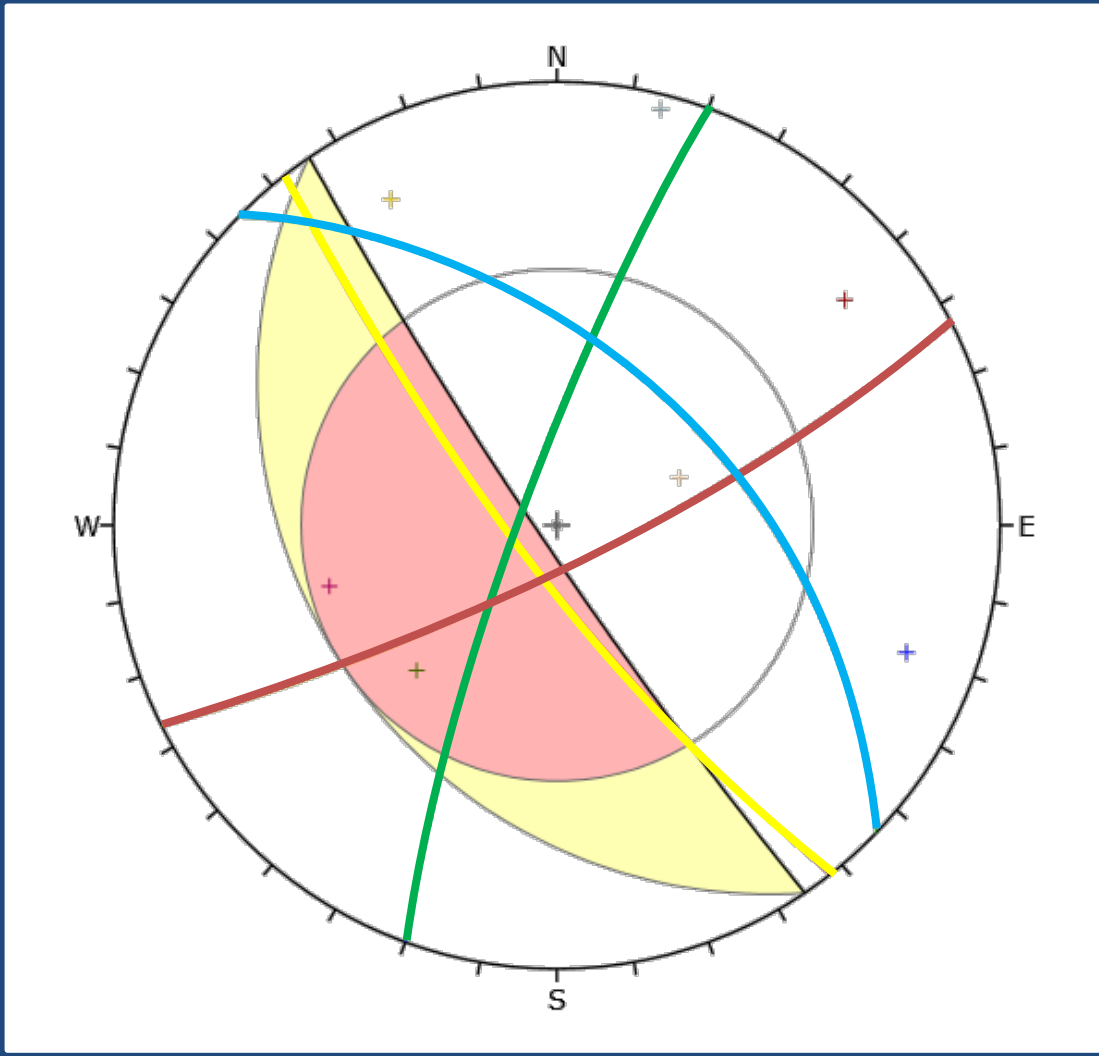


Generated on Point Cloud (614)

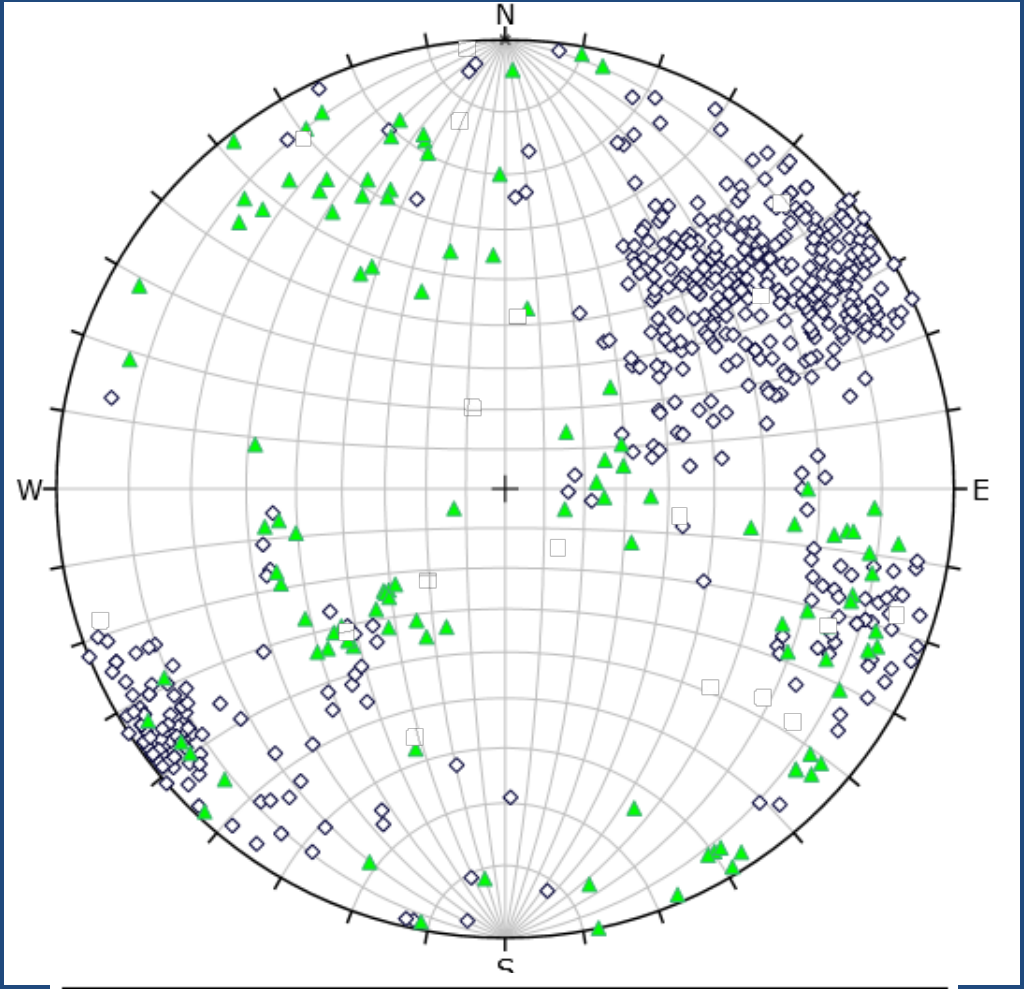


- Analysis shows failure by wedge sliding, plane sliding, toppling

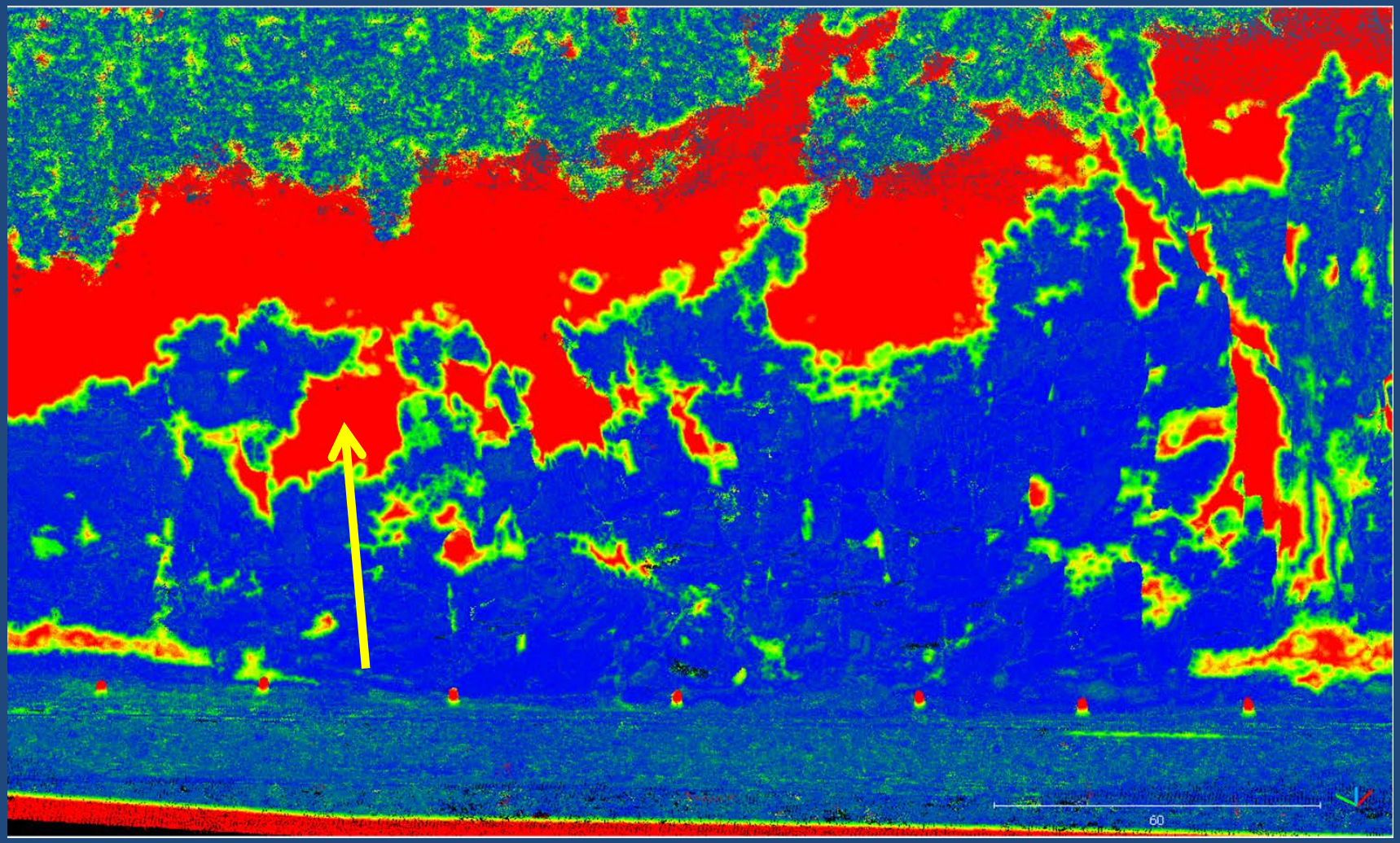
Kinematic Analysis	Wedge Sliding		
Slope Dip	85		
Slope Dip Direction	236		
Friction Angle	30°		
	Critical	**Total**	**%**
Wedge Sliding	96302	188128	51.19%



- Orienting cloud: variable instrument direction
- Mesh smooths surface
- Sampling bias parallel instrument



Symbol	TYPE	Quantity
◇	Auto	504
▲	Trace	110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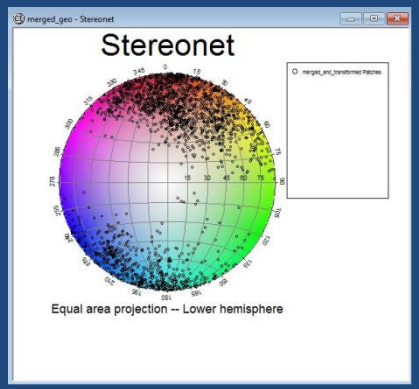
merged_geo - Stereonet
Stereonet
Equal area projection -- Lower hemisphere

- Drone allows measurement of *many* more structural measurements than possible by hand
- Increased coverage, time to assess by bringing into the office
- Ability to measure, heights, volumes, profiles of otherwise unreachable spots
- Quantify change and ongoing slope monitoring
- Detailed profiles – project level data
- Data can include sample bias and there is additional processing time

Questions?