

Shoreline Verification with Unmanned Aerial Systems

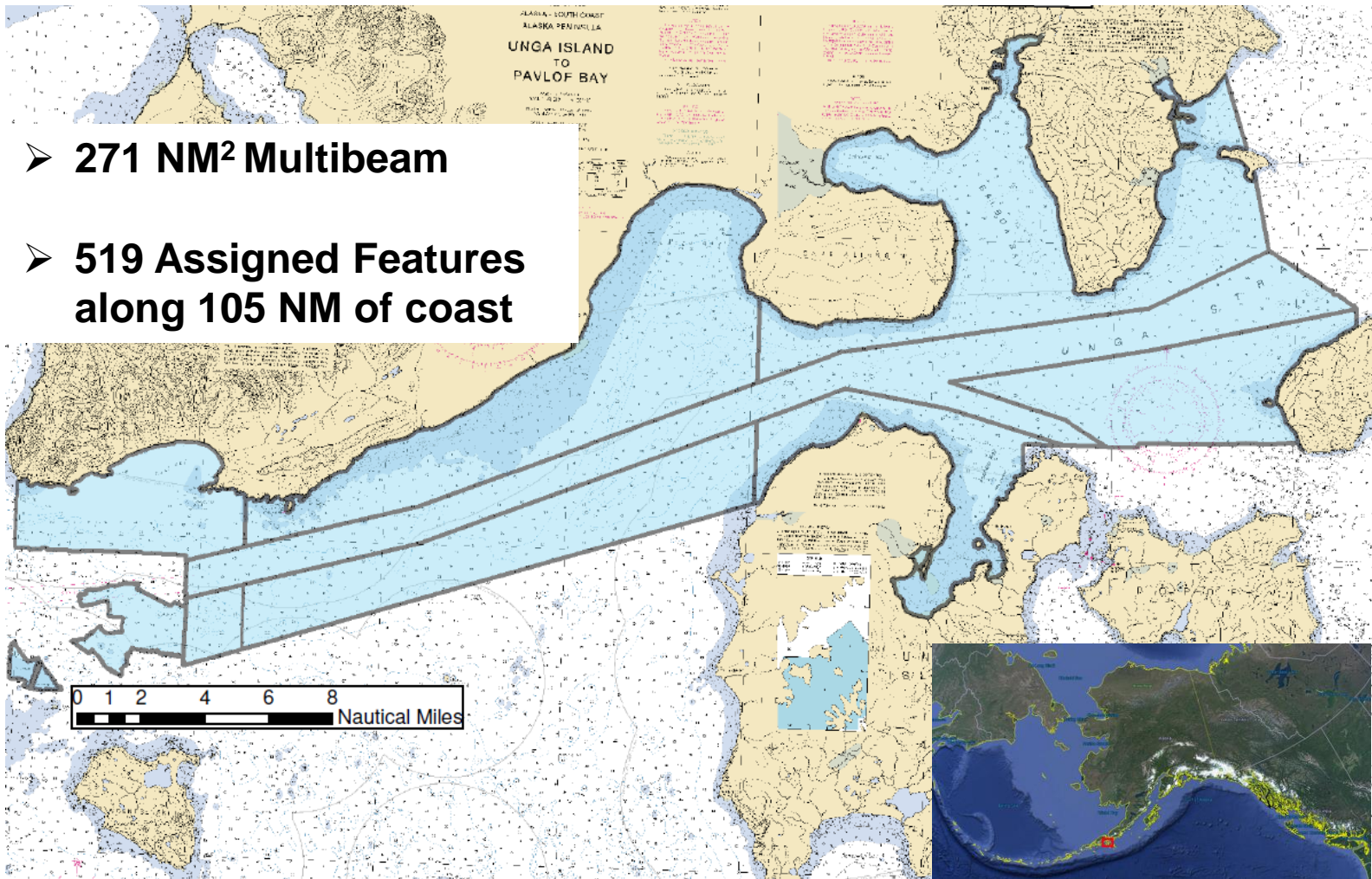


Tim Smith, TerraSond Limited
Alaska Coastal Mapping Summit
February, 2018

TERRASOND

Pavlof Islands and Vicinity Project Area

- 271 NM² Multibeam
- 519 Assigned Features along 105 NM of coast



Common Shoreline Features

- Rocks & Islets
- Ledges & Reefs
- Foul Areas & Kelp



Photos from this project via UAS

Vessel-based Investigation Methodology

Investigation via Skiff:

- Navigate to assigned features
- Ranges and bearings
- Visually estimate heights



Vessel-based Investigation Methodology

Some problems with skiff-based approach:

- Can't approach features
- Low-confidence measurements
- What is NOT seen?
- Low efficiency
- Safety concerns



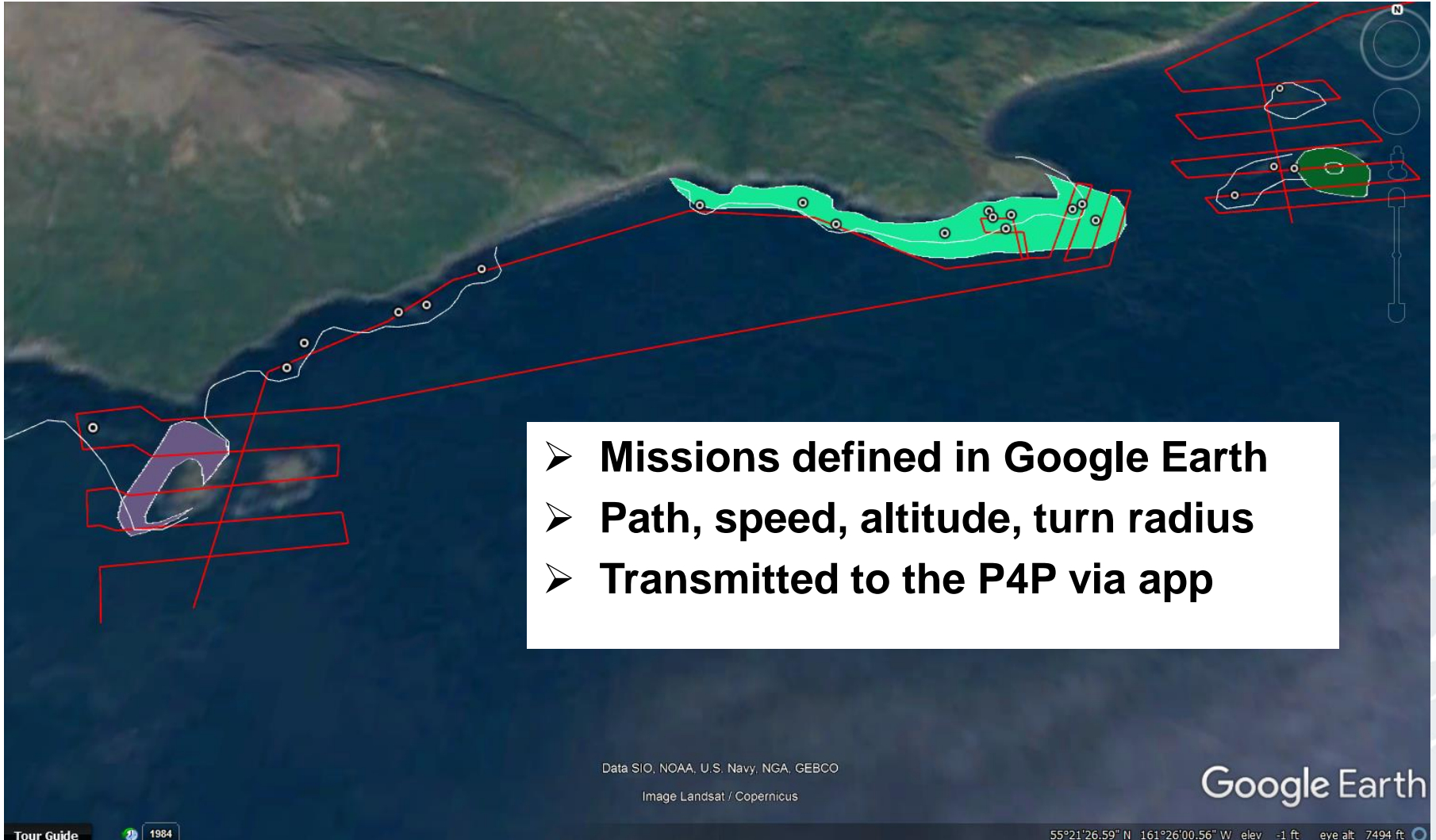
UAS (Drone) Equipment

DJI Phantom 4
Professional (P4P):

- 3 lbs
- GNSS positioning
- ~ 20 minute flight time (real-world)
- Camera – 20 megapixel, gimbal stabilized
- Affordable, simple

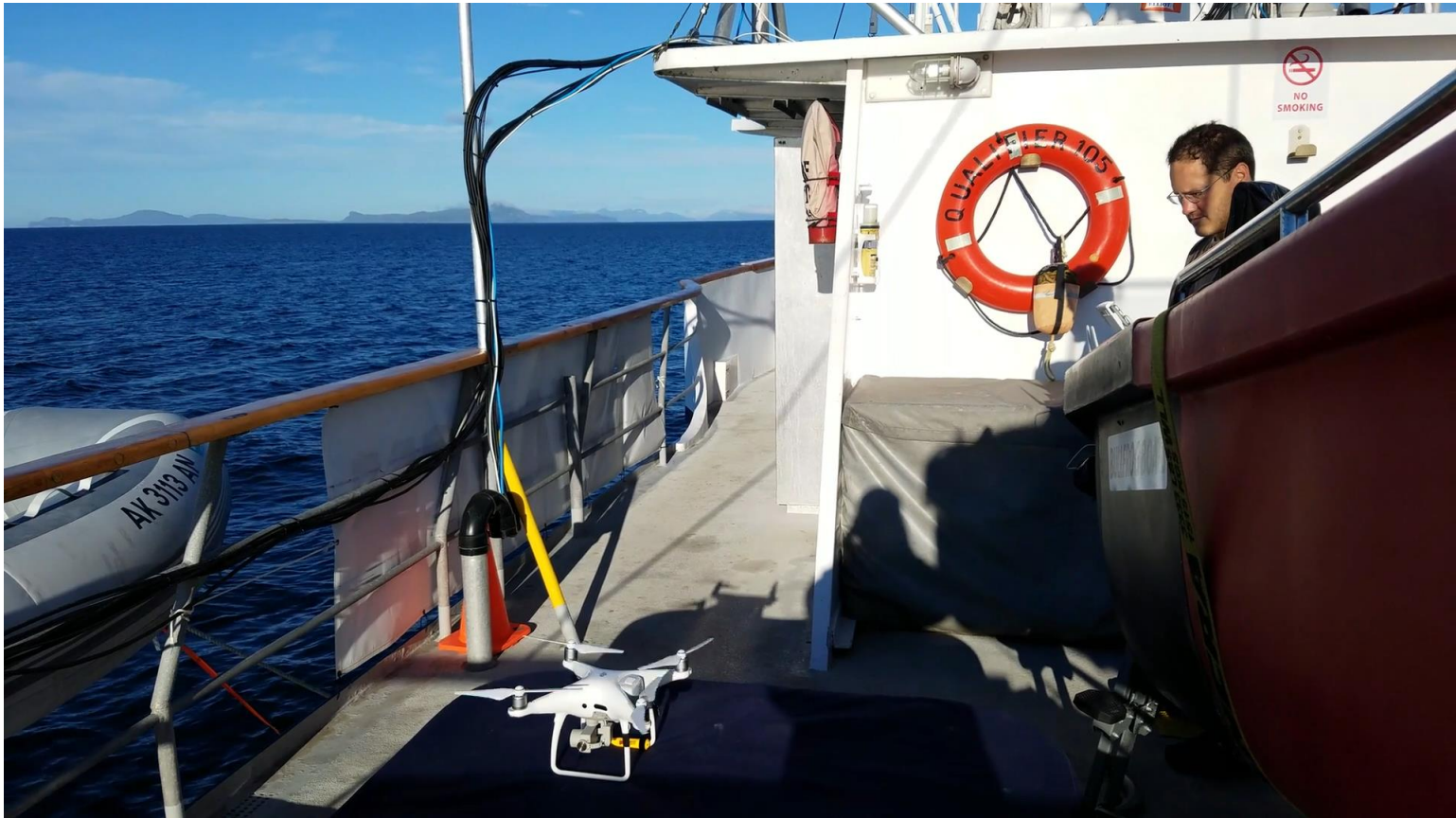


Mission Planning



Launch

- **Manually-controlled launch**
- **After clear of vessel, initiate pre-planned mission**



Automatic Photo-taking

- 2-second photo interval
- 45 km/hr normal flight speed
- 120 m (~ 400') altitude
- At least 3 photos per object
- Average 375 photos per mission



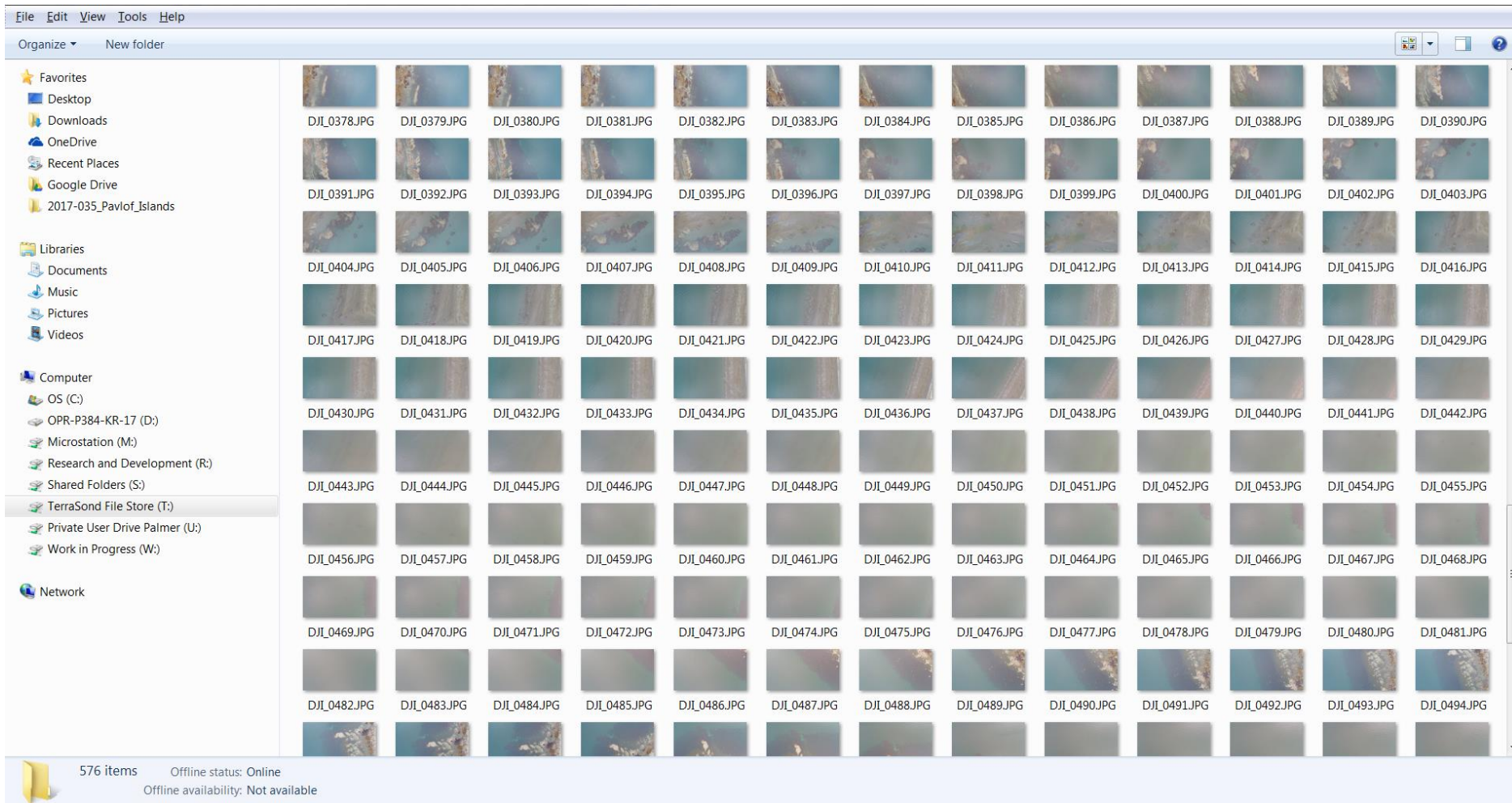
Recovery

➤ Manually-controlled recovery



Processing

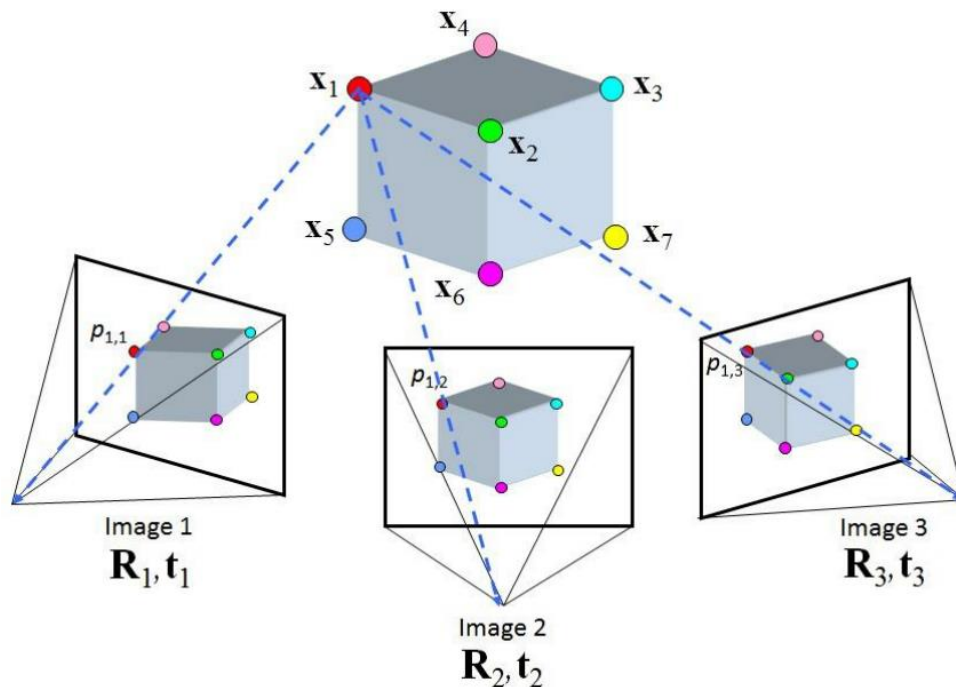
Examining hundreds of photos individually not an option...



Processing

- Agisoft PhotoScan Professional
- Ortho-rectified photomosaics AND 3D-point clouds via SfM

“**Structure from motion (SfM)** is a photogrammetric range imaging technique for estimating three-dimensional structures from two-dimensional image sequences” - Wikipedia

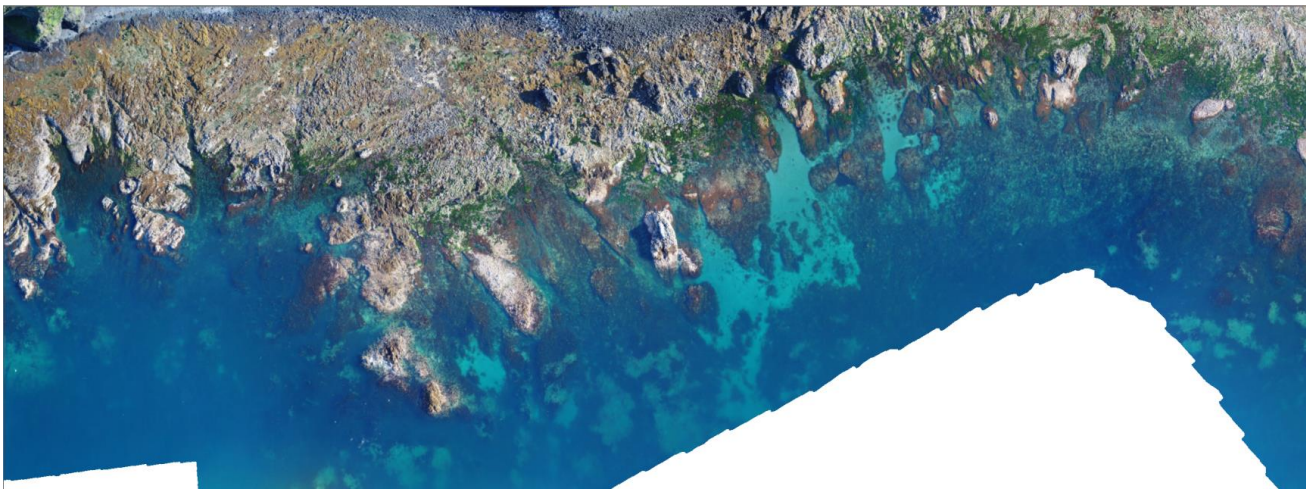


Important elements:

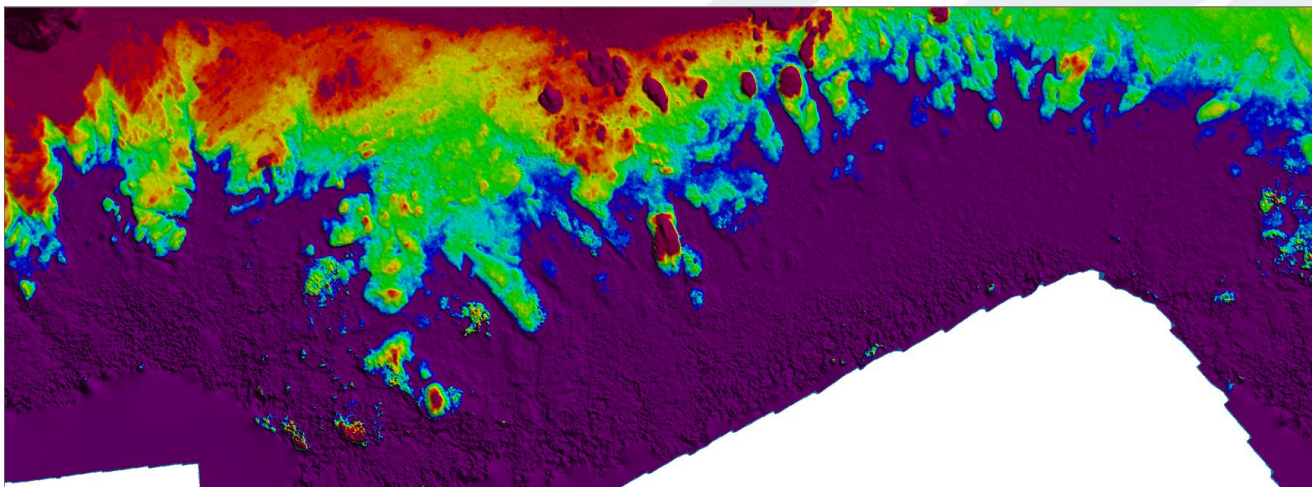
- Minimum 3 photos per object
- Common tie points
- Photo position (geotag) for absolute positioning
- Perspective (nadir to oblique)

Processing Products

Ortho

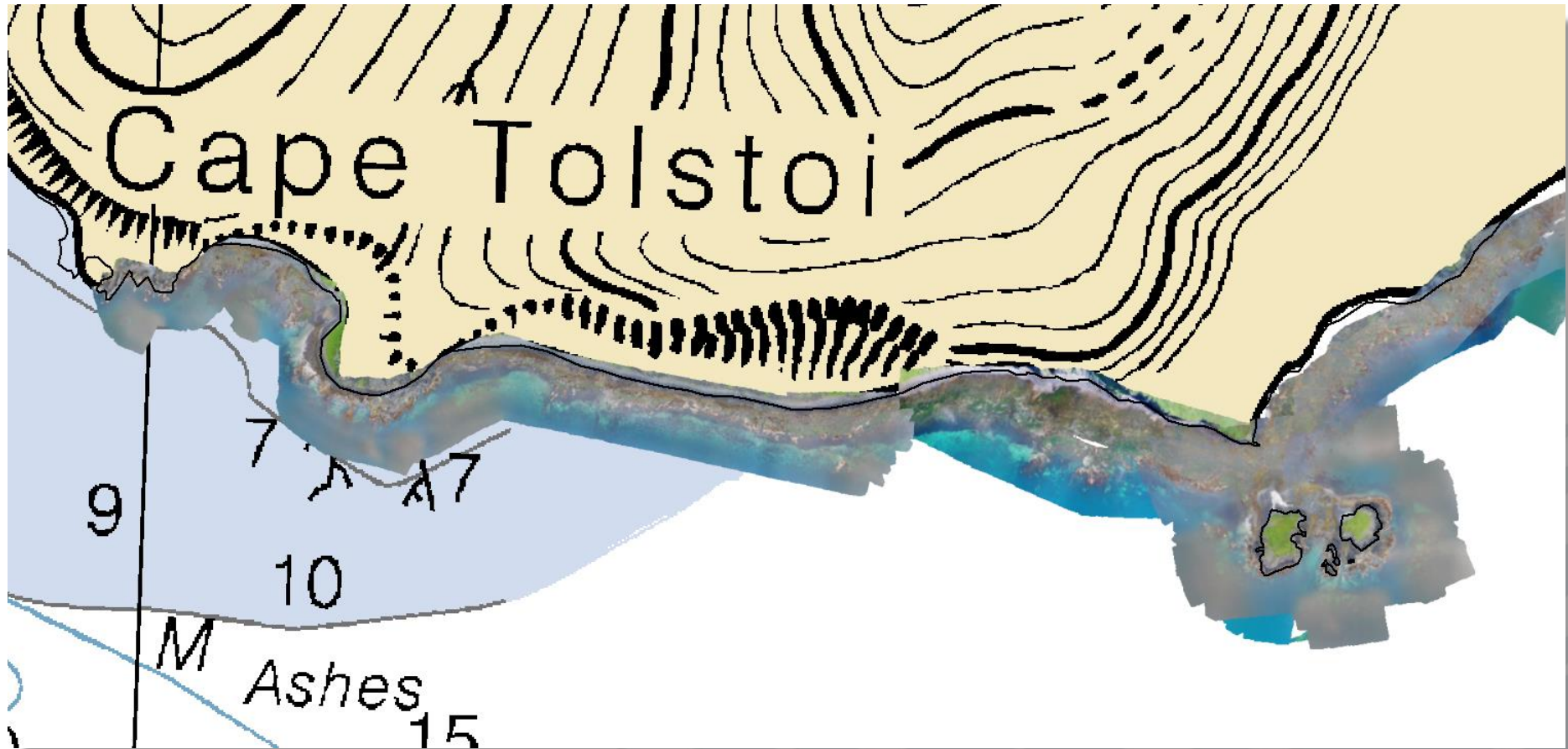


DEM



Purple = 0 m MLLW and deeper

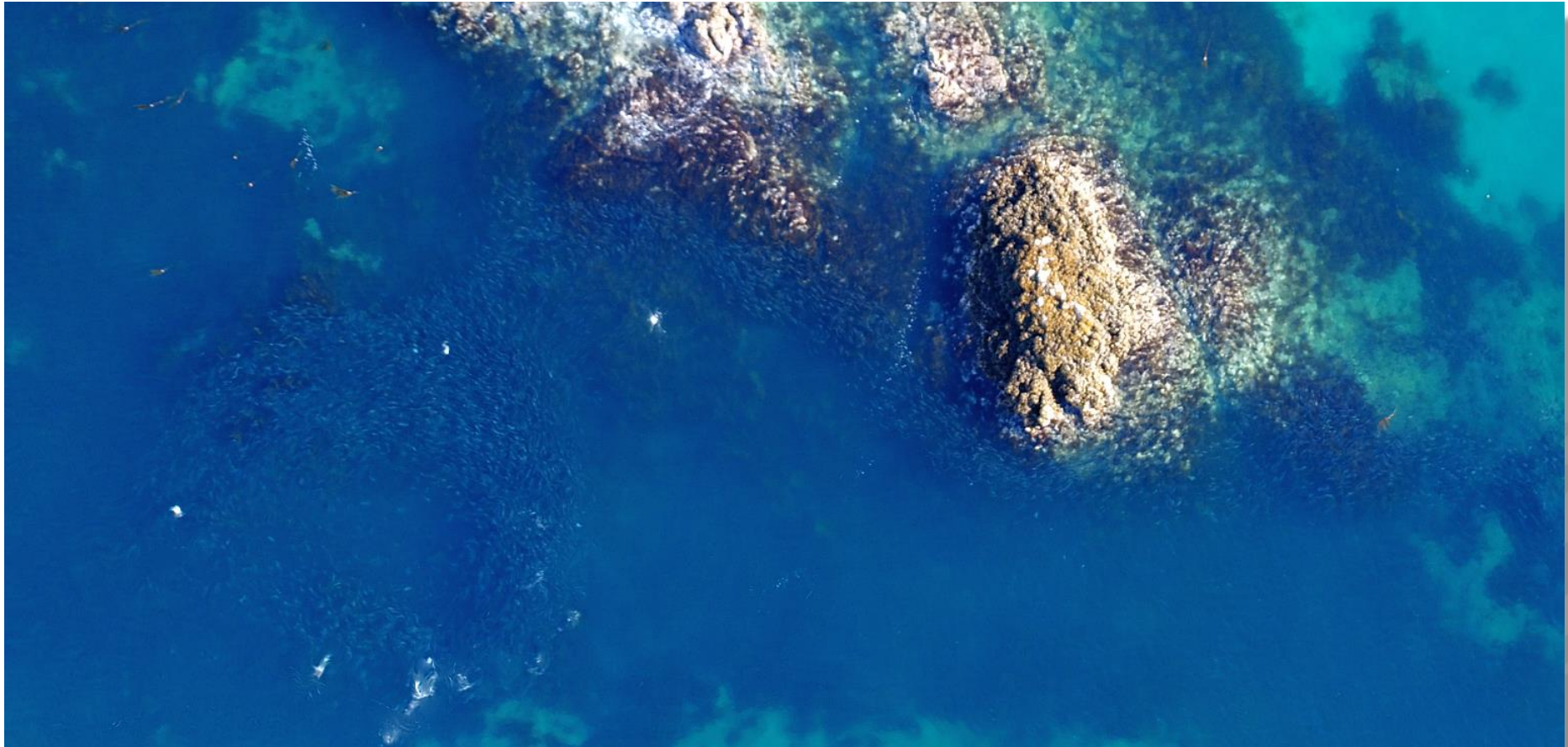
Ortho-photomosaics



Ortho-photomosaics

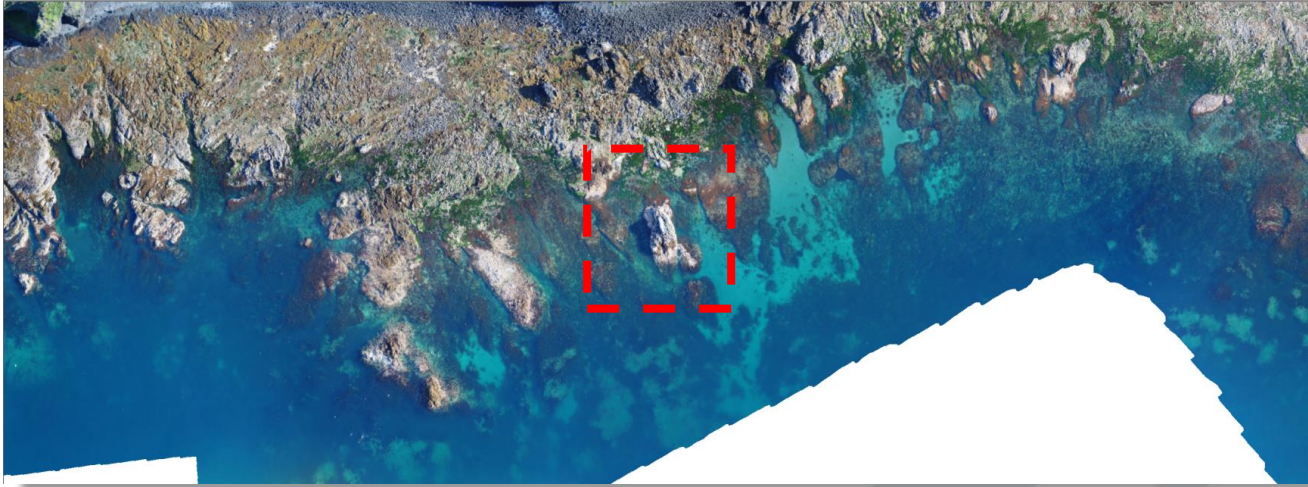


Ortho-photomosaics

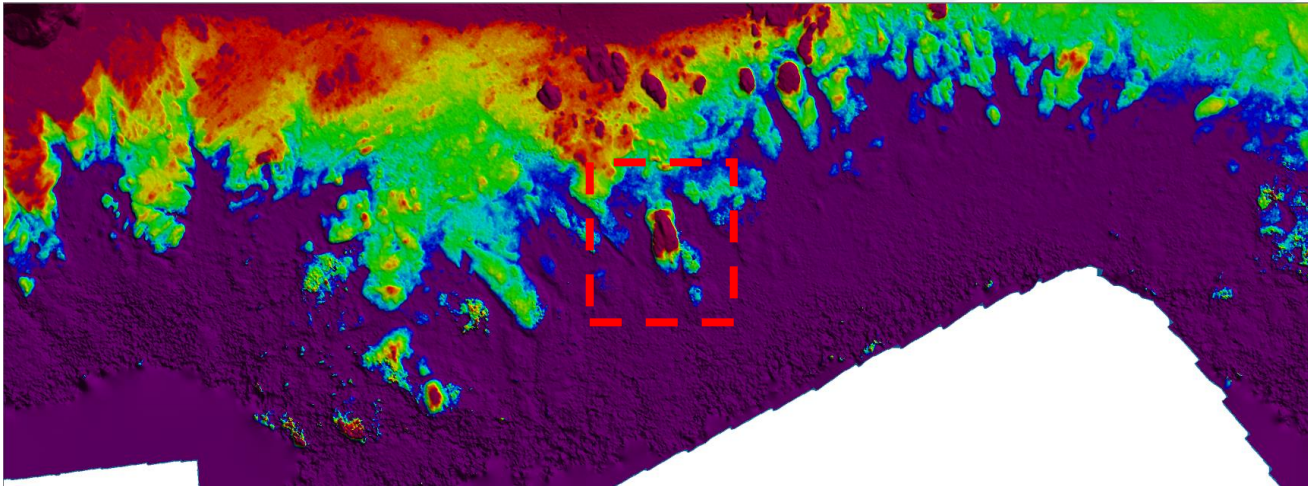


SfM Derived DEMs

Ortho

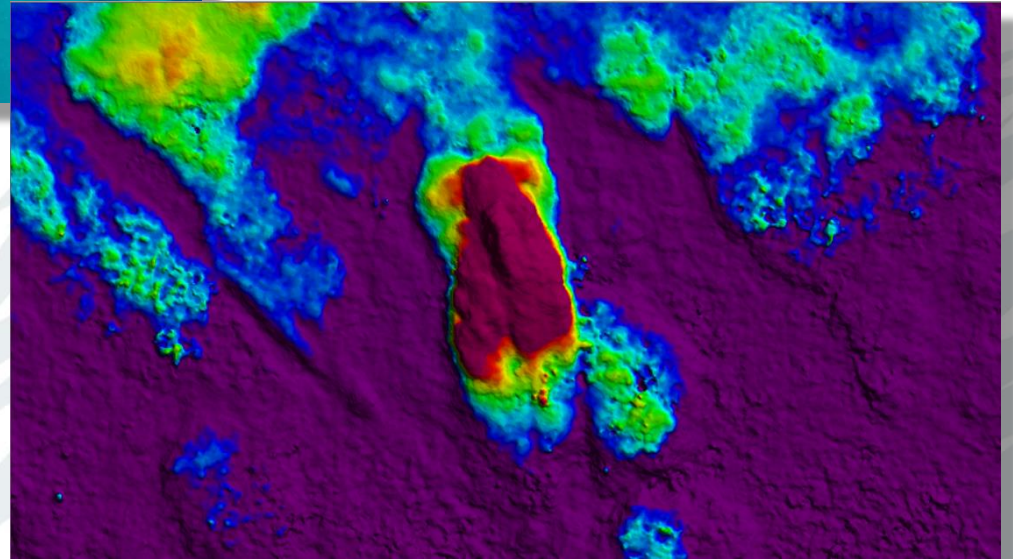
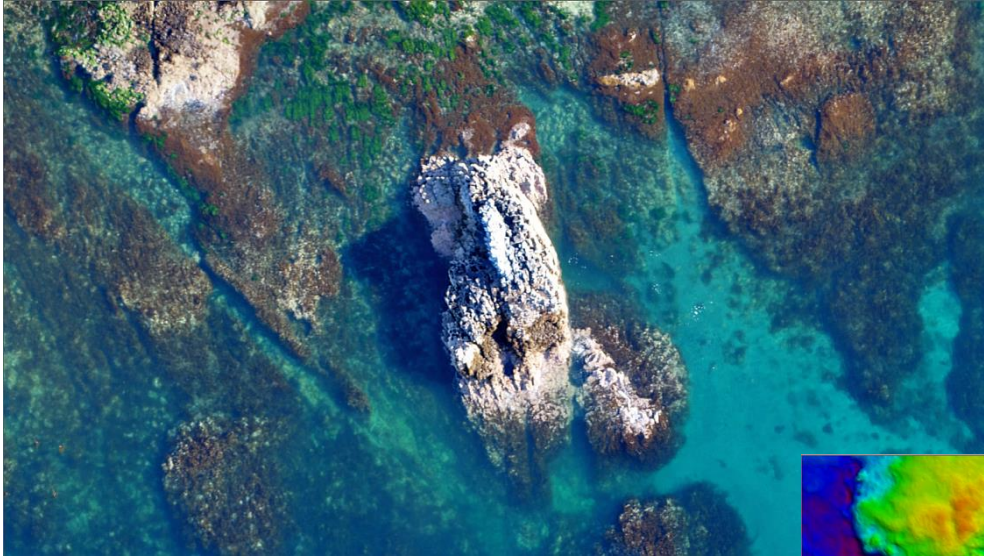


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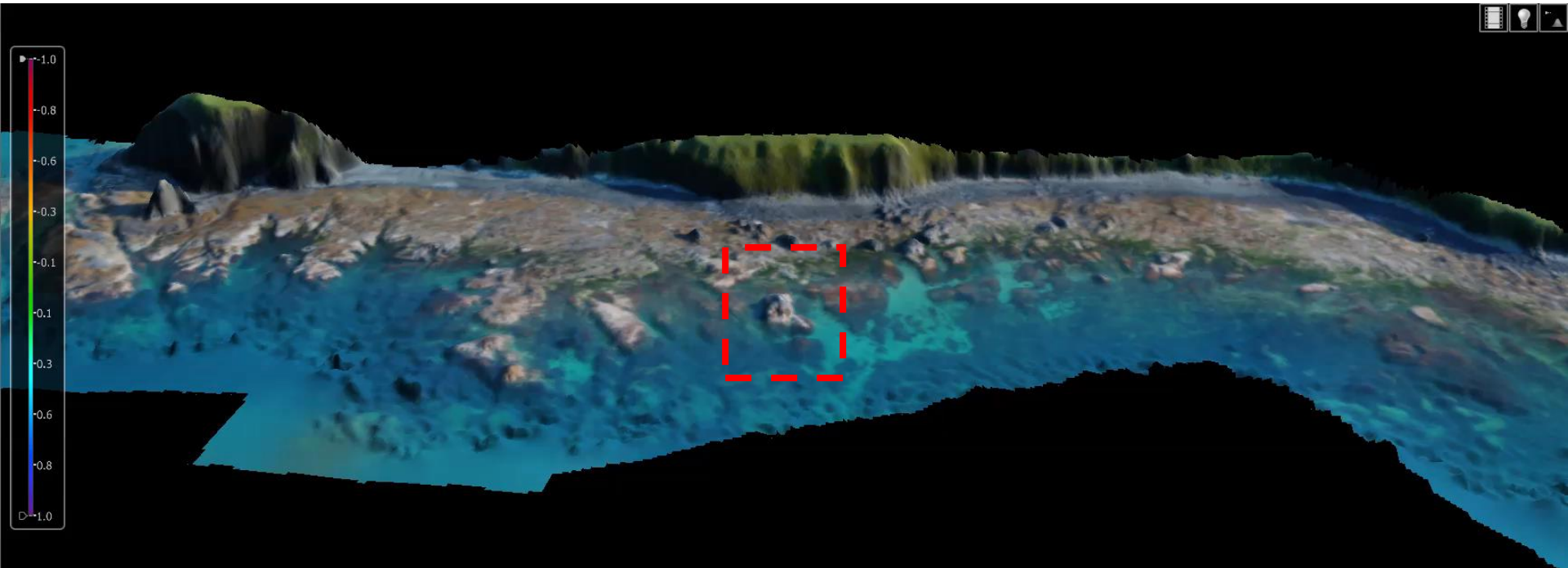
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SfM Derived DEMs



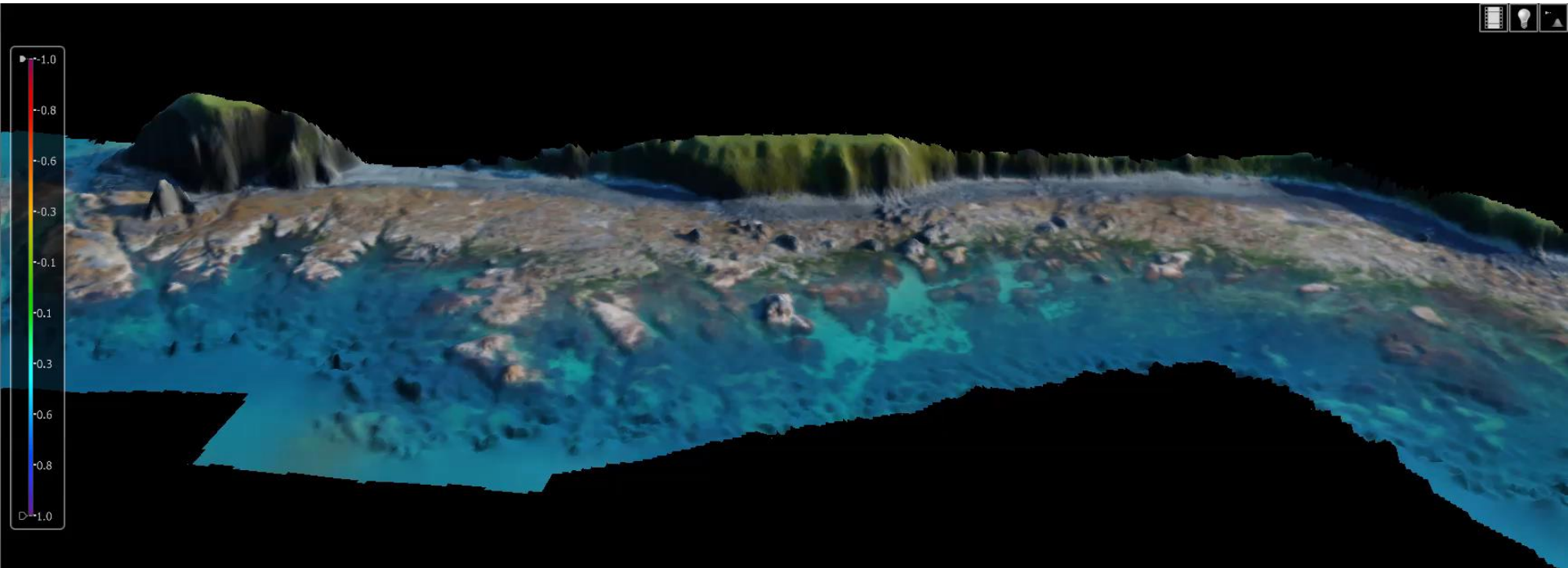
Purple = 0 m MLLW and deeper **TERRASOND**

Ortho-DEM Drape (in CARIS HIPS)



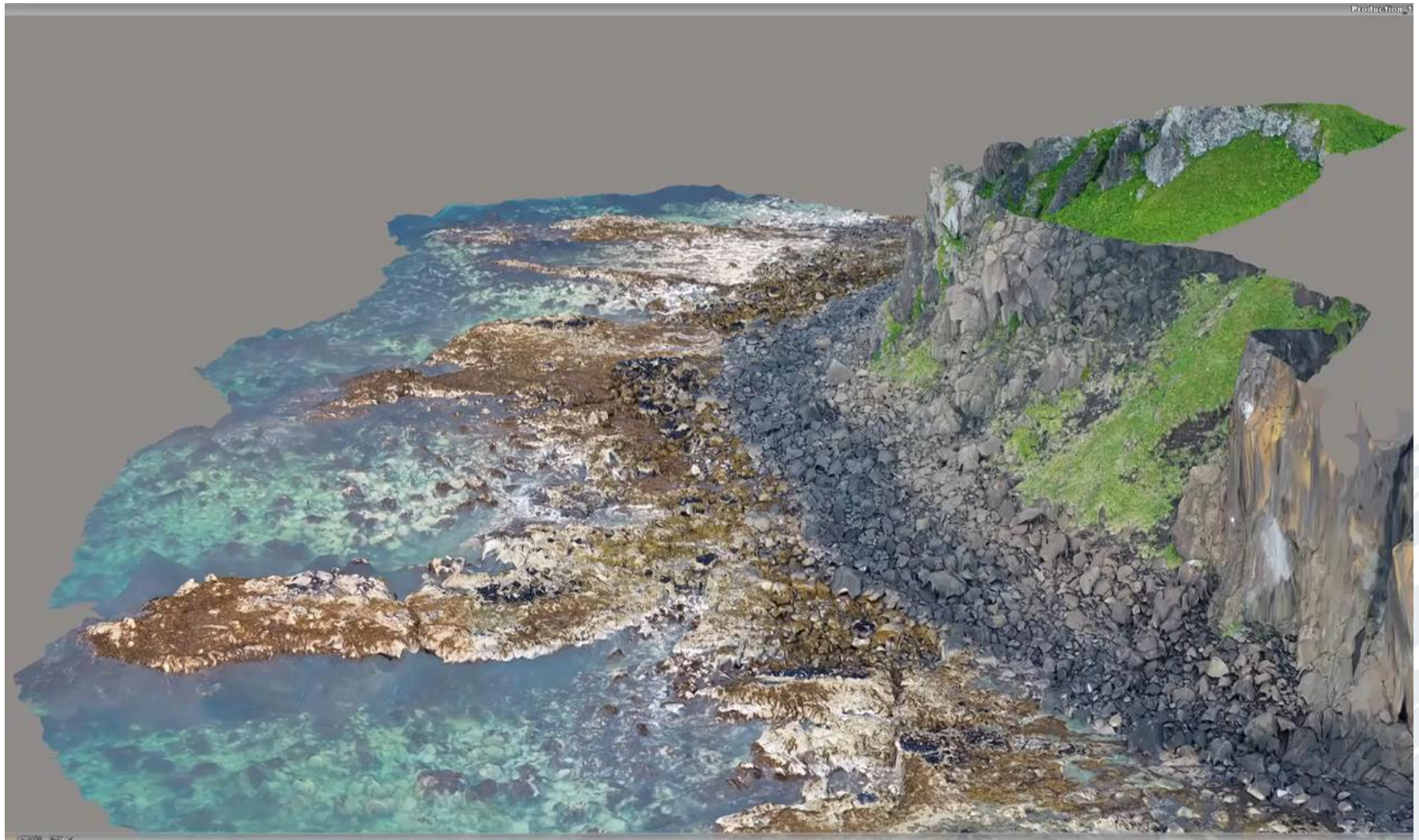
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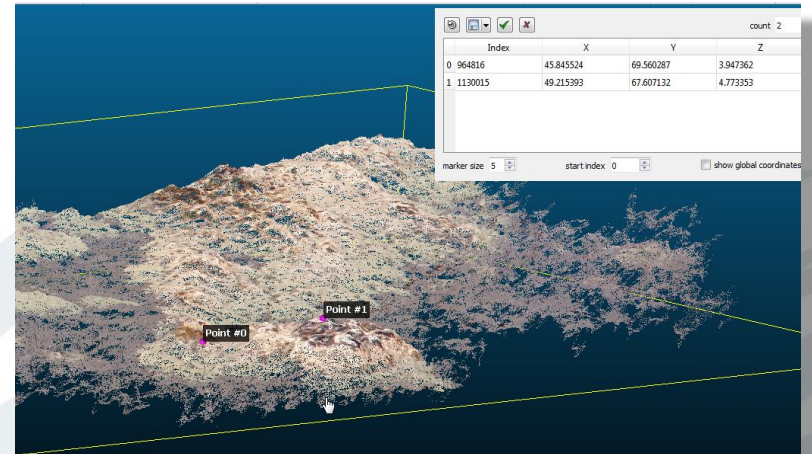
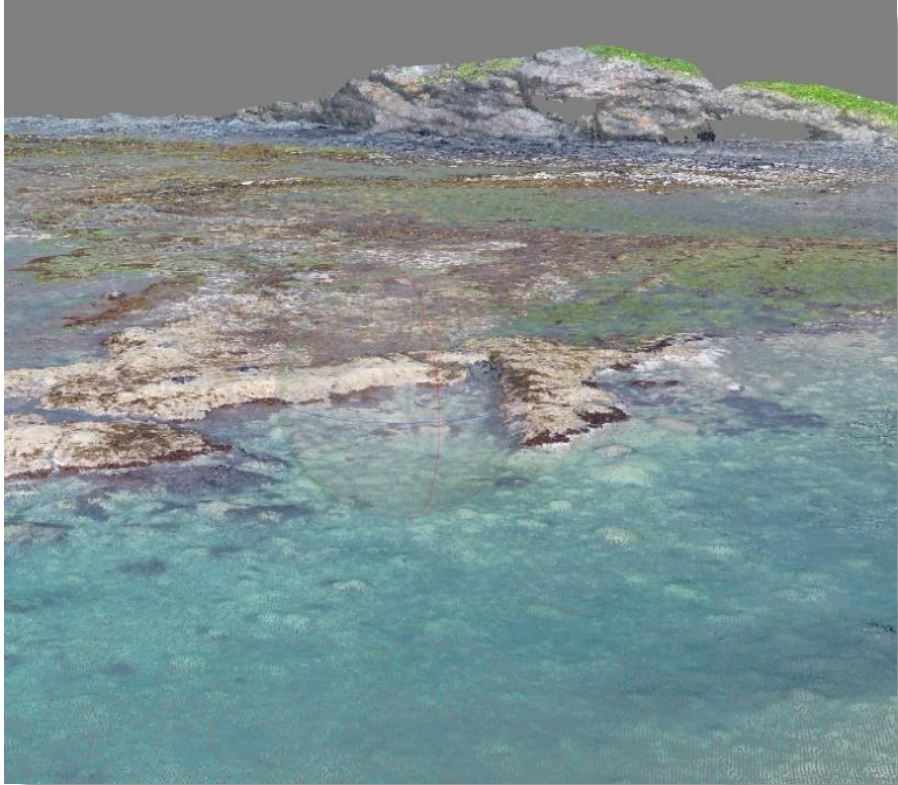


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Ortho-DEM Drape



Point Cloud Adjustment to MLLW



Point Cloud Adjustment to MLLW

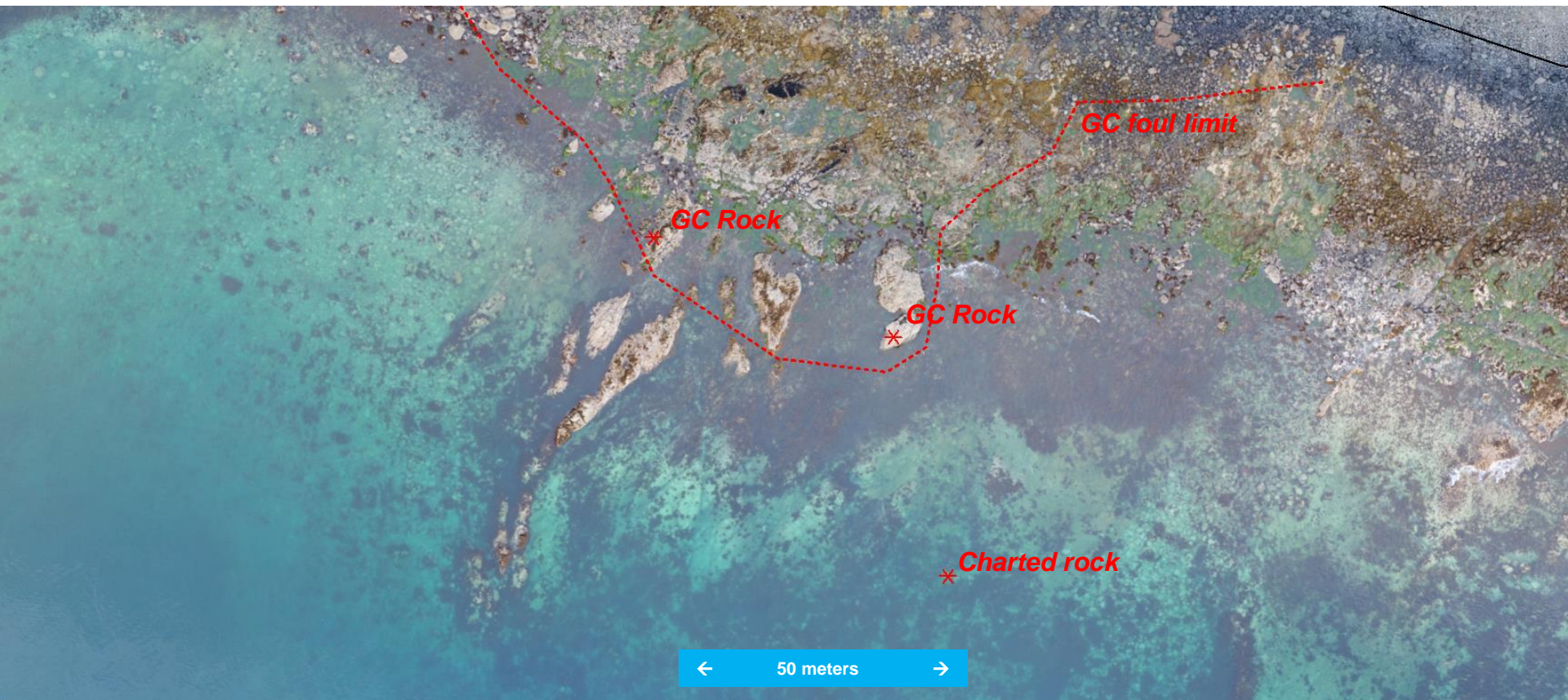


Using the Data / S57 Encoding

Verification of Assigned Features

- SfM products overlaid with assigned features
- Features verified and deconflicted

Assigned features



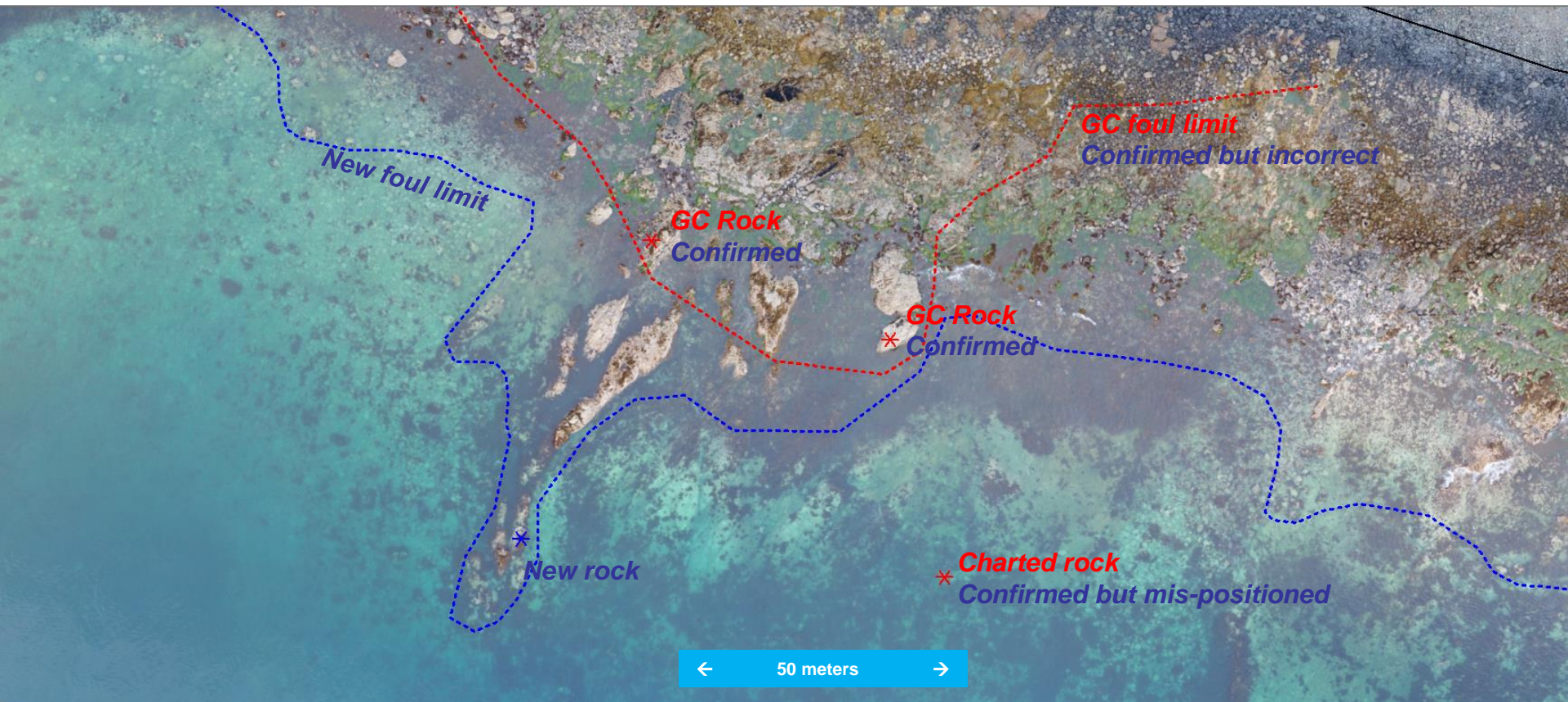
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Verification results

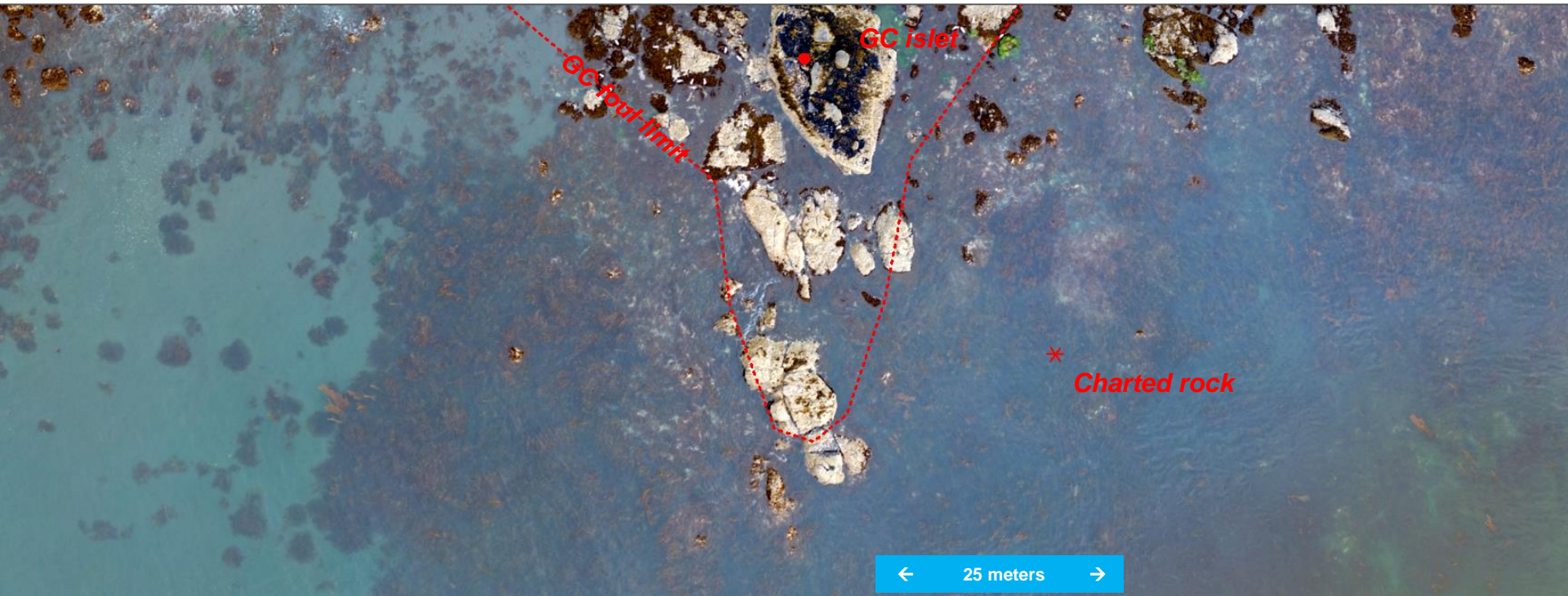


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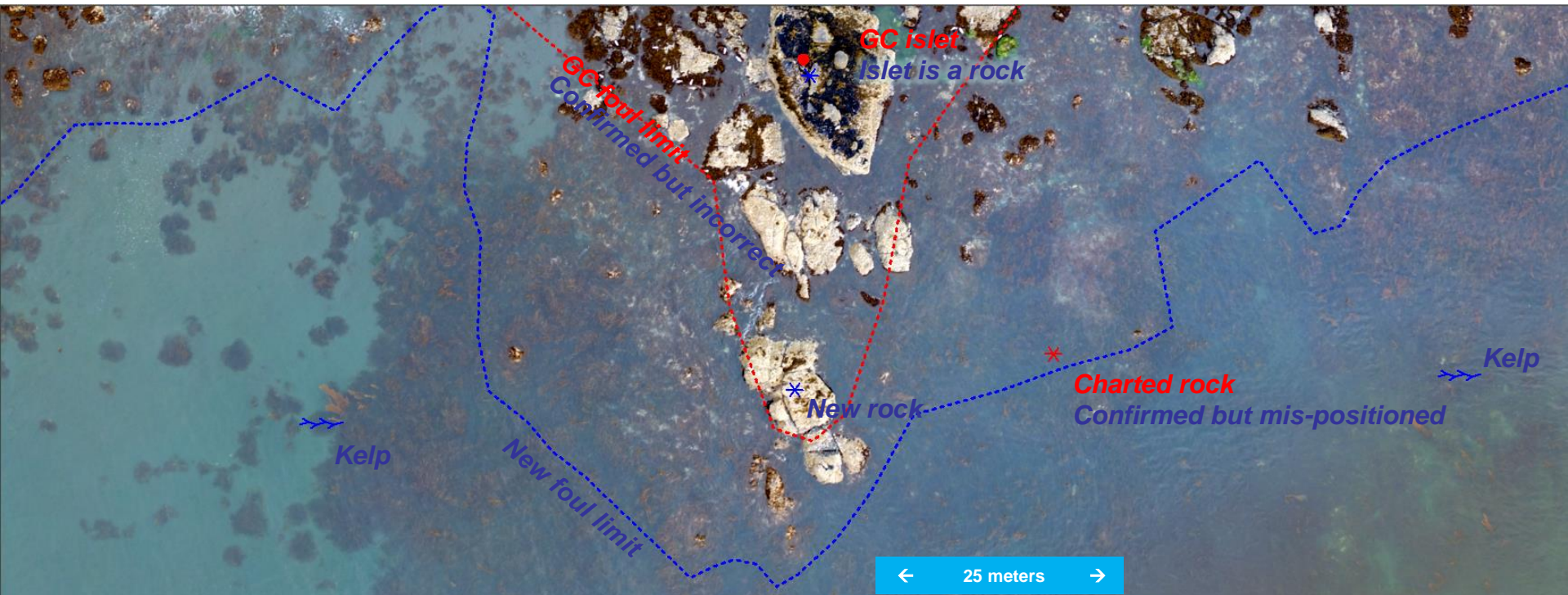
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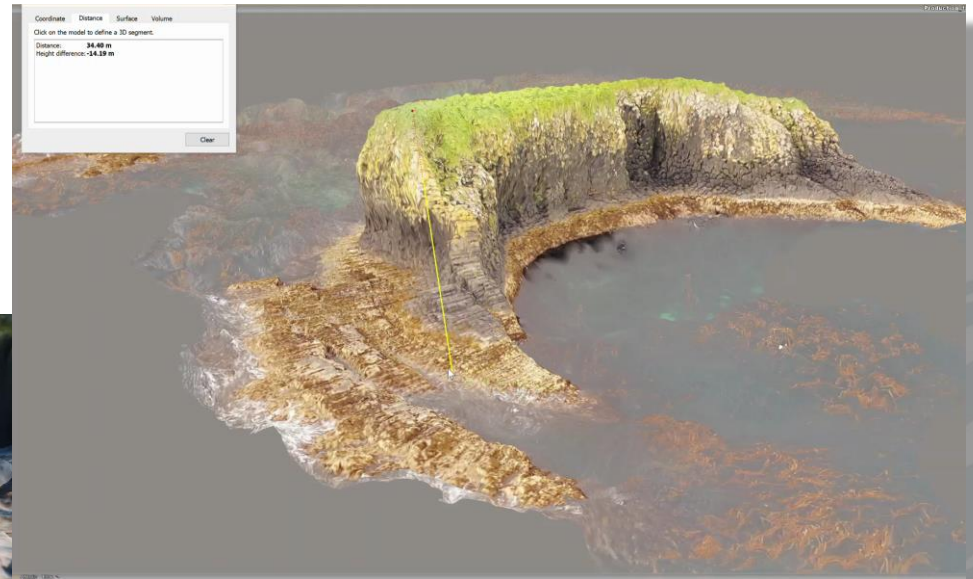
Results

Compared to traditional, vessel-based investigation:

PROS:

✓ **Quality**

Quantitative – not estimated / interpolated

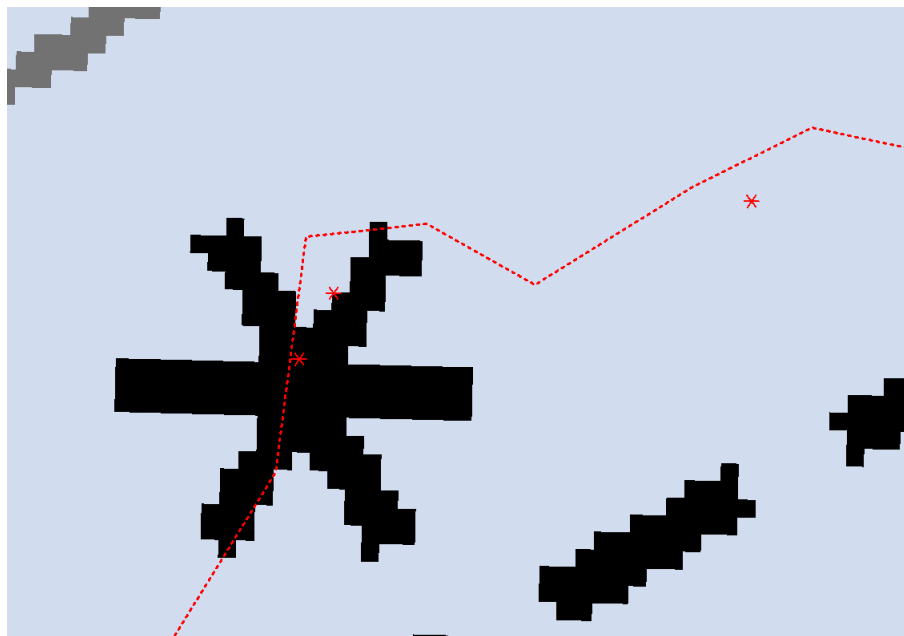


Results

Compared to traditional, vessel-based investigation:

PROS:

Comprehensive – wholistic view of the shoreline area

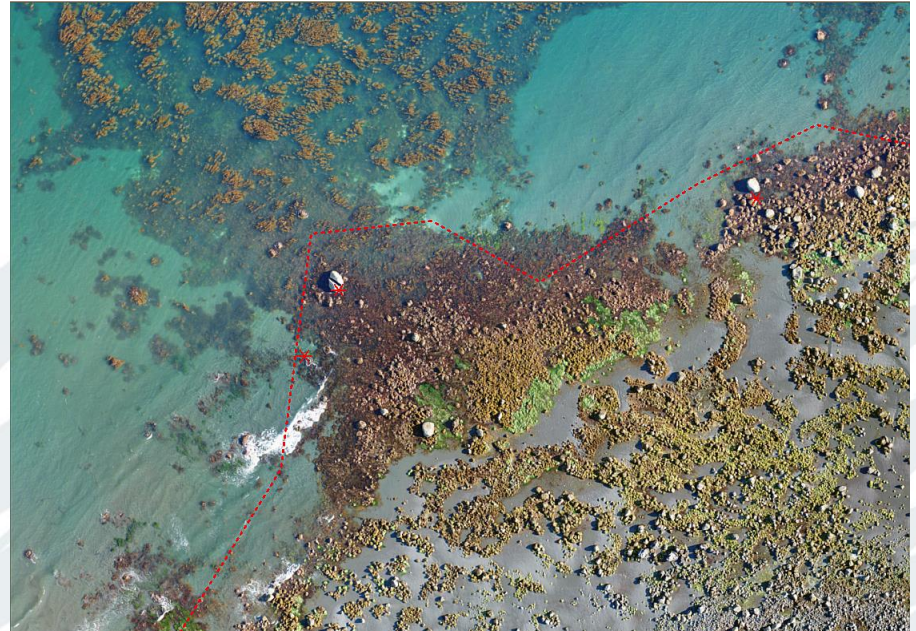
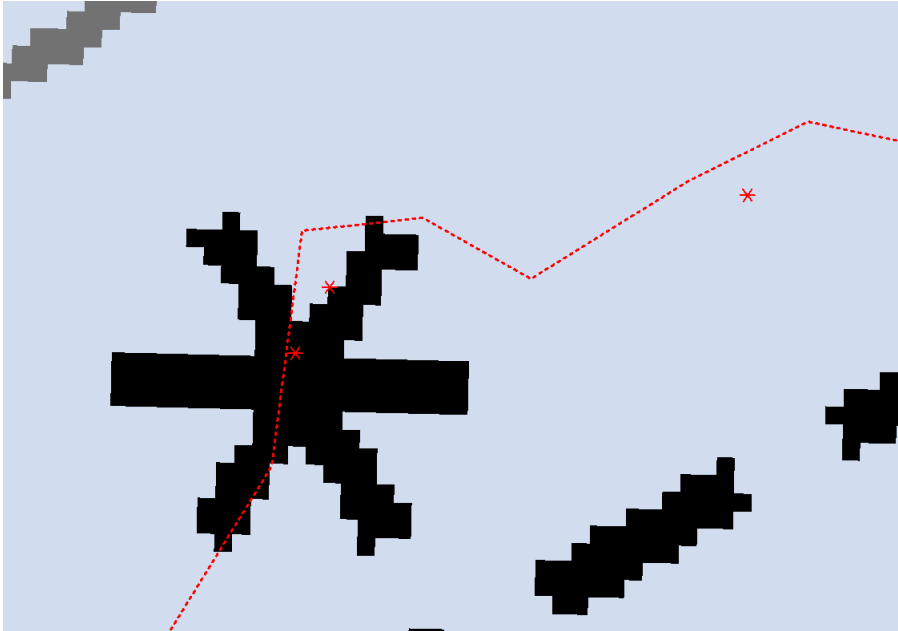


Results

Compared to traditional, vessel-based investigation:

PROS:

Comprehensive – wholistic view of the shoreline area



Results

Compared to traditional, vessel-based investigation:

PROS:

- ✓ Quality
- ✓ Efficiency

- About 2 NM per 15-20 minute flight
- No skiff deployment
- Reposition larger vessel between flights
- Two drones airborne at once



Results

Compared to traditional, vessel-based investigation:

PROS:

- ✓ Quality
- ✓ Efficiency
- ✓ **Simplicity**

- Simple, off-the-shelf
- Fits in a small case
- Easy to learn



Results

Compared to traditional, vessel-based investigation:

PROS:

- ✓ Quality
- ✓ Efficiency
- ✓ Simplicity
- ✓ **SAFETY**



**STAY ON THE BIG BOAT,
DRINK COFFEE,
INVESTIGATE SHORELINE!**



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Results

Compared to traditional, vessel-based investigation:

PROS:

- ✓ Quality
- ✓ Efficiency
- ✓ Simplicity
- ✓ SAFETY



CONS:

- ✓ FAA Licensure



Results

Compared to traditional, vessel-based investigation:

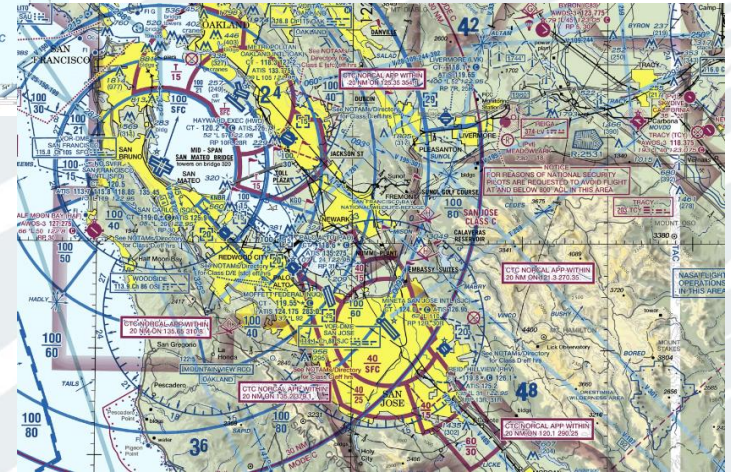
PROS:

- ✓ Quality
- ✓ Efficiency
- ✓ Simplicity
- ✓ SAFETY



CONS:

- ✓ FAA Licensure
- ✓ FAA Regulations



Results

Compared to traditional, vessel-based investigation:

PROS:

- ✓ Quality
- ✓ Efficiency
- ✓ Simplicity
- ✓ SAFETY

- Probably MORE wind-capable
- But, precipitation & visibility are concerns

CONS:

- ✓ FAA Licensure
- ✓ FAA Regulations
- ✓ **Different Wx Windows**



Results

Compared to traditional, vessel-based investigation:

PROS:

- ✓ Quality
- ✓ Efficiency
- ✓ Simplicity
- ✓ SAFETY

CONS:

- ✓ FAA Licensure
- ✓ FAA Regulations
- ✓ Different Wx Windows
- ✓ **Training & Procedures**

Results

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PROS:

- ✓ Quality
- ✓ Efficiency
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- ✓ SAFETY

CONS:

- ✓ FAA Licensure
- ✓ FAA Regulations
- ✓ Different Wx Windows
- ✓ Training & Procedures
- ✓ **More Data**

- ~ 200 GB raw
- ~ 1 TB processed (larger than the CARIS dataset)

Summary / Looking Forward

- Took over 25,000 photos
- 200 km of coastline
- 700 features

- Will continue to use!
- Shoreline, scouting, documentation
- New technology

Other Possibilities:

- Full shoreline verification (with ground control)
- Bathymetry from SfM...



Questions?



3D rendering from SfM of Unga Point ATON

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